Department of Health and Social Security

Report on Health and Social Subjects

16

# NUTRITION AND HEALTH IN OLD AGE

London
Her Majesty's Stationery Office
£5.25 net

RHSS 16
NUTRITION AND HEALTH IN OLD AGE
HMSO

Department of Health and Social Security

Report on Health and Social Subjects

16

# NUTRITION AND HEALTH IN OLD AGE

## The cross-sectional analysis of the findings of a survey made in 1972/3 of elderly people who had been studied in 1967/8

Report by the Committee on Medical Aspects of Food Policy

London

Her Majesty's Stationery Office

*First published 1979*

ISBN 0 11 320687 9

# Preface

The number of people who live well beyond the age of retirement is increasing and, if present trends continue, there will be over 40% more octogenarians in the 1990s than at present. The Committee on Medical Aspects of Food Policy has long been aware of the lack of information about the process of ageing and in 1967/68, under the aegis of this committee, a survey was made of men and women over the age of 65 years who were living in their own homes. There were equal numbers of men and women in the sample and they were randomly selected from areas in which senior physicians in geriatric medicine were willing to help. The survey, therefore, did not provide information which was nationally representative. None the less information about dietary habits, socio-economic circumstances and medical condition was obtained from 879 people. About three per cent were diagnosed as malnourished and, in most, malnutrition was associated with the presence of debilitating clinical disease.

Five years later, in 1972/73, all but three of the sample of 879 people were traced and, although about one third had died, over half were willing and able to take part in a follow-up study. Three hundred and sixty-five of these subjects had participated fully in the 1967/68 survey and did so again in 1972/73. The present report describes the cross-sectional analysis of information from the 365 full participants: the findings of the longitudinal analysis will be published later.

The field work in 1972/73 again produced a wealth of information—dietary, social, medical, biochemical and haematological. Much greater attention was paid to the identification of malnutrition and also of the "risk factors" associated with it. In addition, unlike the 1967/68 survey, all biochemical measurements were made in the same laboratory and were therefore comparable between the different areas.

The present study confirmed yet once more that the dietary pattern of these elderly people was not very different from that of the general population. As expected, the incidence of disease was greater than in the previous survey. Twenty-six people were considered to be malnourished and in 25 malnutrition was associated with clinical signs of disease; for the twenty-sixth person the diagnosis was questionable and the cause of malnutrition not clear.

The Committee on Medical Aspects of Food Policy is grateful to Professor A N Exton-Smith for his leadership of the team of consultant physicians who made the medical assessments and for the chairmanship of the Working Group who were responsible for the analysis of the survey findings. The study could not have been made without efficient organization and co-ordination by all those taking part. The clinicians and the dietary investigators did the field work but the co-operation of the general medical practitioners in the areas and of the clerks of the Family Practitioner Committees in England and Primary Care

Division of the Health Boards in Scotland is gratefully acknowledged. The Committee on Medical Aspects of Food Policy is especially grateful to all elderly persons who so willingly provided the information which is the basis of this report.

**H YELLOWLEES**
Chief Medical Officer

# Membership of the Working Group for the Analysis of the Nutrition Surveys of the Elderly

**Chairman**

Professor A N Exton-Smith *University College Hospital, London*

**Clinical medicine** *Areas*

Dr C Cohen *Angus*
Professor A N Exton-Smith *Camden*
Dr T Judge *Rutherglen*
Dr N Cowan *Rutherglen*
Dr N M Plowright *Portsmouth*
Dr S Rao *Cambridge*
Dr E Woodford Williams *Sunderland*
Dr A R Mandal *Sunderland*

**Nutrition—Department of Health and Social Security, London**

Mrs M M Disselduff
Dr S J Darke
Dr P D Whiteman
Mr L G Smith *until June 1977*
Mr D K Smith *from July 1977*

**Biochemistry—Human Nutrition Studies Group, London School of Hygiene and Tropical Medicine**

Dr J M L Stephen
Dr D I Thurnham

**Haematology—Department of Haematology, St Bartholomew's Hospital, London**

Dr B Brozovic

**Statistics—Department of Health and Social Security, London**

Mrs M E Cadman *until December 1977*
Dr G Jones *from December 1977*
Miss C Lavery *from September 1978*
Mrs J Mills *until May 1978*
Mr A J Spinks *from January 1978*
Mr G P Try *until November 1977*

# Acknowledgements

The survey was planned and organized by the members of the Working Group. The physicians gave freely of their time and expertise in the medical assessments of the subjects in each of the six areas and especial thanks are due to them.

The Working Group also wish to acknowledge the helpful advice of Sir Ferguson Anderson, OBE, Professor of Geriatric Medicine, Glasgow University, and Professor J C Waterlow, CMG, Professor of Human Nutrition, London School of Hygiene and Tropical Medicine; the co-operation of Professor D Mollin and the staff of the Haematology Department, St Bartholomew's Hospital, London, and in particular the help of Dr B B Anderson and Miss A Unwin; the work of Dr P Trinder of the Central Laboratory, The Royal Infirmary, Sunderland, who measured leucocyte vitamin C for the Sunderland subjects, and the co-operation of Dr W J Thom and his successor Dr H Miller of the Scottish Home and Health Department.

Without the hard work and cheerful co-operation of the field workers the survey would not have been possible and thanks are due to Miss J A Blythe and Miss W M Leslie in Portsmouth; Mrs S Turner and Mrs J C Robinson in Cambridge; Miss C Henry and Mrs S Brown in Sunderland; Mrs A Busby in Rutherglen; Dr S E Cohen in Angus, and Miss W Latchford and Miss H Lloyd-Williams in Camden. Not least, the co-operation of all the elderly people who took part in the survey is gratefully acknowledged.

The analysis of the survey findings would not have been possible without the excellent custodianship of all the field records by Miss P M Hurley and her team in the statistics section. Thanks are also due to the computer team in Newcastle-Upon-Tyne.

# Contents

Copies of the forms used in the survey can be obtained from:
Mrs M M Disselduff, Department of Health and Social Security, Alexander Fleming House, Elephant and Castle, London SE1 6BY

# 1. Introduction

1.1 The first nutrition survey of elderly people in England was made in 1962 in two North London boroughs by Exton-Smith and Stanton (1965). A group of 60 women, who were living alone in their own homes, was studied. In 1967/68 the Department of Health and Social Security, in conjunction with the Scottish Home and Health Department and with consultant physicians in geriatric medicine, made a nutrition survey, in four areas in England and two in Scotland, of elderly people over the age of 65 years who were living in their own homes or with relatives or friends. The survey extended over a period of one year. The report of this survey was published in 1972 by HMSO for the Department of Health and Social Security and is referred to throughout as the 1972 Report.

1.2 The 1967/68 survey was the first of its kind to give a comprehensive picture of the diet of elderly people in terms of 26 different food groups, five principal protein-containing foods, energy value and 13 nutrients. In addition, socio-economic information was obtained, the subjects were assessed medically by clinicians and blood was taken for haematological and biochemical investigation.

1.3 The survey revealed differences in nutrient intakes not only between men and women, and between different age groups but also between the different areas (Table A14, pp 88, 89 and section 4.2, p 18 of the 1972 Report). Area differences were statistically significant for men though not for women. In all four age/sex groups Sunderland had the lowest average intakes; the highest were in Angus, Cambridgeshire and Camden. Differences in the intakes of most nutrients reflected differences in total food energy consumption. The survey also revealed a small percentage (3%) of people in whom malnutrition was diagnosed. In the majority, malnutrition was in association with clinical disease but for about a quarter of the malnourished subjects no cause, either medical or socio-economic, for the malnutrition was identified and lack of money did not seem to be implicated.

1.4 The difficulties in making an assessment of undernutrition, that is to say too little to eat, were discussed in section 1.2 on pp 2 and 3 of the 1972 Report. Among these difficulties was a lack of information upon which a sound estimate of requirements for nutrients could be based. The lack of this information continues both for the elderly and for younger age groups of the population. There were also difficulties in making a clinical diagnosis of malnutrition. Definite signs and symptoms of clear-cut deficiencies are easily recognized but the diagnosis becomes more difficult when malnutrition is

marginal and where non-nutritional disease produces signs and symptoms difficult to distinguish from those of deficiency. The difficulties were magnified when different clinicians used different criteria in making the diagnosis.

1.5 Biochemical measurements were of less help than was expected in assessing mild degrees of nutrient deficiency, and this was chiefly because the normal range of these measurements is not known for people in the upper age groups. Doubt was expressed about the validity of some of the biochemical values which have been used as indicators of marginal nutrition. To apply to the elderly standards which have been derived for young people is not necessarily justified.

1.6 The 1967/68 survey was designed as a cross-sectional study. There are however fundamental limitations to the kind of information that cross-sectional studies can give. The aim of the study was not only to assess the amount of malnutrition among the participants but also to investigate ageing as a biological process, and for this a longitudinal study seemed to be necessary.

1.7 Ideally, longitudinal studies, in which measurements are repeated on the same individuals, should perhaps start at birth and continue throughout the whole of life but shorter studies can be made of those parts of the life span during which changes are rapid, for example, early childhood, adolescence and senescence. Such studies are particularly needed in the elderly since there is little information about age-related changes in individuals towards the end of life and predictions about the age-structure of the United Kingdom population indicate a growth in the number of very elderly people. By 1986 there will be approximatelv 24% more people aged over 75 years than there are now, and by 1991, if present trends continue, there will be over 40% more people aged 85 years (Figure 1.1).

1.8 A decision was therefore made to resurvey in 1972/73 the sample of men and women who had been studied in 1967/68. In this report we present the analysis of the findings of the 1972/73 survey on a cross-sectional basis. The longitudinal aspects of the study will be presented in a second report to be published in due course. Tables and figures which are relevant to the text are situated at the end of each chapter of the report.

FIGURE 1.1 ***Population changes [England] and projections [base year 1976].***


Adapted from *The Way Forward* (Department of Health and Social Security, 1977)

# 2. The survey sample

## 2.1 The 1967/68 sample

2.1.1 In 1967/68 a random sample of men and women who were over the age of 65 years and who were living in their own homes or with relatives (but not in institutions) was drawn from registers maintained by local Executive Councils for the administration of the National Health Service in six areas of Great Britain. The areas were chosen for practical reasons not least of which was that the senior physician in geriatric medicine in each area was interested in the aims of the survey and was willing to cooperate fully. The 6 areas were therefore not necessarily representative of Great Britain as a whole. Two were predominantly rural – south Cambridgeshire in England (excluding the city of Cambridge) and the county of Angus in Scotland (excluding the large borough of Arbroath). The remaining areas were different types of urban community – Rutherglen, part of Greater Glasgow; the northern industrial seaport town of Sunderland; Camden[1], a part of London (not geographically identical with the present borough), and the southern seaport of Portsmouth.

2.1.2 The sample was weighted in favour of men and of the more elderly in that information was obtained from approximately equal numbers of men and women in the two age groups 65 (70 in Camden) but under 75 years, 75 years and over. In Angus and Rutherglen the target was to obtain 100 records, i.e. 25 in each sex and age group; and in each of the other four areas the target was 200 records, that is to say, 50 in each sex and age group. Thus, the survey was planned to yield 1 000 records in all. The details of obtaining the sample and the response rate are described in chapter 3 (p 7) of the 1972 Report. In all, 879 people took part in the study although not all of them provided the full range of information.

## 2.2 The 1972/73 sample

2.2.1 About 3–4 months before the commencement of the field work of the 1972/73 survey, the names and addresses of the 879 who co-operated in 1967/68 were sent to the respective Clerks of the Area Executive Councils (now called Family Practitioner Committees in England, and Primary Care Division of the Health Boards in Scotland). These lists were revised and returned after any changes in address of the elderly persons or of the general medical practitioners, removals out of the area or deaths had been noted. This preliminary check was a great help in the task of tracing the 879 men and women.

---

[1] The sample in Camden was selected from the patients of one large group practice who were aged 70 years or over in 1968/69. The sample was stratified by age and sex and by the number of visits to a general practitioner – one third had not seen their general practitioner, one third saw him 1–4 times/year, and one third saw him 5 or more times/year.

2.2.2 A total of 277 (32%) of the original 879 people were known to have died in the five years since 1967/68 and 27 (3%) had moved out of the area or could not be traced which meant that the eligible sample for the study was 575 (65% of the original 879). Two percent (12) of the eligible sample were not contacted, either because they were on holiday or because they were said by the general practitioner to be too ill to take part. Of the remaining 563 who were asked to take part in the study, 59 (10% of the eligible sample) refused to participate; 483 of the 504 respondents, who supplied at least some of the required information, were still living in private households and 21 had moved to some form of institution in the intervening five years. The information on response is summarized, separately for each area, in Table 2.1.

2.2.3 The aim of this study, as for the study in 1967/68, was to obtain a wide range of information about the health and circumstances of elderly people, which can be broadly summarized into five categories, socio-economic characteristics, a medical assessment, a weighed dietary record of all food eaten or drunk for seven[1] consecutive days and biochemical and haematological investigations. Participation in such a comprehensive study imposes a burden on elderly people and some 104 of the 483 subjects living in private households who agreed to co-operate provided only part of the required information. Of the 379 who provided full information for this study 14 of them had not done so in the 1967/68 survey. This meant that in total 365 respondents provided the full range of information in 1972/73 and also in 1967/68. The detailed pattern of response is set out in Table 2.2.

2.2.4 The chapters of this report relating to the cross-sectional analysis of the 1972/73 survey are based on the data for the 365 respondents who provided the full range of information in both surveys. These subjects comprise the 'base population'. The decision to confine the analysis to a base population rather than to analyse all available information for each of the 483 respondents was taken primarily to ensure that all findings presented in the report, and in the report to follow on the longitudinal aspects of the study, were based on a single well-defined group of people. As will be seen from Table 2.2, an attempt to use all available data would have resulted in medical analyses based on 406 respondents, dietary analyses on 436 and socio-economic analyses on 471. However, the major purpose of this study was to examine the inter-relationships between these different aspects and, in this context, the potential loss of information by concentrating on the 365 base population was less than may at first be supposed. For example, an analysis of socio-economic and medical factors would have been based on 394 respondents, socio-economic, medical and dietary factors on 389 subjects.

2.2.5 It was, however, necessary to ascertain whether the subjects who were omitted from the analysis, either because they refused to participate or because they did not provide the full range of information, were different from those included in the base population and, if so, to what extent they differed. An

(1) Five subjects provided records for five or six days only.

extensive analysis of those excluded was carried out, using all the available information. The results are presented in Appendix A. Comparison of the information provided by those who did not participate fully in 1972/73 with that provided by the 'base population' of full responders did not reveal any important differences between the two groups of subjects (Appendix A, para 3.11).

**Table 2.1**: *The origin of the 1972/73 sample, tracing the participants in the 1967/68 survey*

| | All areas | Portsmouth | Cambridge-shire | Sunderland | Rutherglen | Angus | Camden |
|---|---|---|---|---|---|---|---|
| Participated in 1967/68 | 879 | 142 | 200 | 199 | 100 | 101 | 137 |
| Results of tracing these subjects in 1972/73 | | | | | | | |
| (i) not traced or moved out of area | 27 | 6 | 2 | 3 | 3 | 0 | 13 |
| (ii) Died | 277 | 36 | 57 | 64 | 44 | 32 | 44 |
| Available sample in 1972/73 | 575 | 100 | 141 | 132 | 53 | 69 | 80 |
| Respondents not contacted | | | | | | | |
| (i) on holiday | 1 | — | — | — | — | 1 | — |
| (ii) Long stay hospital | 6 | — | 1 | — | 5 | — | — |
| (iii) General medical practitioner advised against participation in survey | 5 | 5 | — | — | — | — | — |
| Respondents contacted | 563 | 95 | 140 | 132 | 48 | 68 | 80 |
| (i) Refused to participate | 59 | 19 | 15 | — | 10 | — | 15 |
| (ii) Participated but were living in institutions | 21 | 3 | 5 | 4 | 1 | 3 | 5 |
| (iii) Participated living in private households | 483 | 73 | 120 | 128 | 37 | 65 | 60 |

**Table 2.2**: *Numbers of subjects who were living in private households in the 1972/73 survey and who participated in the different aspects of the survey in 1972/73 and 1967/68*

| Pattern of response in 1972/73 | | Pattern of response in 1972/73 by pattern of response in 1967/68 | | | |
|---|---|---|---|---|---|
| | | Full response | Socio-economic, dietary | Socio-economic, medical, dietary | Medical, biochemical, haematological |
| Full response | 379 | 365 | 6 | 5 | 3 |
| Socio-economic, dietary, medical, biochemical | 1 | 1 | — | — | — |
| Socio-economic, dietary medical, haematological | 2 | 2 | — | — | — |
| Socio-economic, dietary, medical | 7 | 5 | 1 | 1 | — |
| Socio-economic, dietary | 47 | 33 | 8 | 6 | — |
| Socio-economic, medical, biochemical, haematological | 5 | 5 | — | — | — |
| Socio-economic | 30 | 19 | 7 | 3 | 1 |
| Medical, biochemical, haematological | 12 | 1 | — | — | 11 |
| Total | 483 | 431 | 22 | 15 | 15 |

# 3. Methods

### 3.1 General

3.1.1 As far as possible the methods used in the 1972/73 study were the same as those for the 1967/68 survey and have been described fully in chapter 2 (pp 4-6) of the 1972 report. As before, socio-economic, dietary, medical, anthropometric, biochemical, haematological and radiological information was obtained for each subject.

### 3.2 Socio-economic

3.2.1 The dietary investigators were asked to make enquiries about the socio-economic circumstances of each subject, and to record the information obtained however limited, so that some comparison could be made with their 1967/68 record for those who did not co-operate on the second occasion.

### 3.3 Dietary

3.3.1 In 1967/68 the survey extended for a full year in order to detect any seasonal variation in the diet but in 1972/73 the number of participants was smaller and in most areas the study was completed within about six months. Participants were asked to keep a record of every item of food or drink consumed over a seven-day period. A weighing machine (a postal scale with modified dial) was left in each household and used to weigh each item by those who were capable of doing so. The interviewer demonstrated the use of the scale. Some subjects could not cope with this procedure and it was the responsibility of the interviewer to quantify the descriptive records kept by the subjects. The socio-economic questionnaire was completed over the course of a week, the interviewer using her judgement to decide how much information to obtain at each visit. A minimum of 4 visits was made to each subject and many more were necessary when the respondent was mentally or physically handicapped. Every effort was made to minimize the inevitable bias which must be introduced when conducting a survey of this kind. Investigators were asked to write a 'case report' at the end of each study. The purpose of this was to provide a description of the subject in his or her environment and to include relevant information which could explain deviations from normal habits. These 'case reports' were of great value when there appeared to be discrepancies between findings of different parts of the study.

3.3.2 The Food Composition Table, which had been especially compiled in 1963 for use in the various nutrition studies made by the Department (then the Ministry of Health) was revised for use in 1967/68, and again in 1972/73, when the composition of some foods was amended in the light of more recent

analyses. The number of food groups was increased from 26 in 1967/68 to 34 in 1972/73.

3.3.3 The diet records were coded by field workers according to a scheme which had been previously prepared by the Department.

### 3.4 Medical

3.4.1 As in 1967/68 the medical assessment of each subject was arranged to be in or as near as possible to the week in which the dietary information was collected. In no case was the time interval between dietary and medical assessments greater than four weeks before or after the week of the diet record. Some questions asked in the medical assessment were more detailed in 1972/73 and a different approach was made to the problem of the diagnosis of malnutrition. In 1967/68 the diagnosis was made by the physician in each area and accepted in the analysis of the findings without question. In 1972/73 an attempt was made to standardize the criteria upon which any diagnosis of malnutrition was based. This involved consultation and discussion with all the physicians in the light of the findings on all aspects of the survey. Subjects were selected as being possibly malnourished on the basis of agreed criteria, and a careful appraisal of individual case records was made.

### 3.5 Biochemical

3.5.1 Problems of quality control between laboratories arose in 1967/68 because each area was responsible for biochemical measurements on the subjects in that area. The most important difference between the follow-up study and the original survey was that in 1972/73 all biochemical estimations were carried out in the laboratory of the DHSS Human Nutrition Studies Group which had been set up at the London School of Hygiene and Tropical Medicine (LSHTM). The only exception was that the measurement of leucocyte ascorbic acid, which has to be made within a few hours of taking the blood sample, was made on the Sunderland samples by Dr. P. Trinder in the Central Laboratory at the Royal Infirmary, and on the Camden samples in the LSHTM Laboratory. Comparison of plasma ascorbic acid concentrations obtained by Dr. Trinder with those made at LSHTM showed very good agreement and it was assumed from this that the two sets of measurements of leucocyte ascorbic acid were comparable.

3.5.2 As before, blood samples were obtained from each subject during the medical assessment, which was done routinely on the same day mid-week in each area. Blood samples were taken in the late morning. Each sample was divided into several portions (Appendix D) and those from areas outside London were packed in insulated containers, sent by rail and received at the LSHTM the following morning. Samples from Camden were despatched direct to the LSHTM and kept overnight to be dealt with at the same time as the ones from other areas.

### 3.6 Haematological

The blood samples, apportioned for haematological investigation, travelled in the same container as the samples intended for biochemistry but on arrival at LSHTM were at once transported to St Bartholomew's Hospital, London, where all haematological investigations were made[1] in the Department of Haematology.

### 3.7 Radiological

Radiographs of the metacarpals of both hands were taken in the radiology departments of the hospitals at which the subjects were clinically assessed by the geriatricians. Measurements from which skeletal status could be assessed were made by Professor A N Exton Smith and will be reported elsewhere.

### 3.8 Statistics and computing

The socio-economic and medical questionnaires were coded by the statistics division of DHSS, while the biochemical and haematological questionnaires were self-coding forms. Data preparation from the coding documents was carried out within DHSS. Creation of computerized data files, data cleaning, and statistical analysis based on these files, were carried out jointly by the Department's Newcastle computing installation and the statistics division. Standard statistical techniques were used throughout.

---

[1] In 1967/68 the haematology for subjects in the Camden area was the responsibility of the Department of Haematology, University College Hospital, London, and all haemoglobin measurements were made locally.

# 4. Demographic and socio-economic characteristics of the sample

### 4.1 Introduction

4.1.1 The dietary investigators asked a number of questions about the subject's way of life. Some of the questions were included to help in the verification and interpretation of the diet record. Others were designed to establish facts about the subject's social conditions and economic situation which might have a bearing on the dietary and clinical findings. Information about other items of interest, for example, the use of a car and of a telephone, was also collected.

### 4.2 Area

4.2.1 Table 4.1 shows the distribution of the 764 full participants in the survey in 1967/68 by each area; 26% lived in Sunderland, 21% in Cambridgeshire and between 12% and 15% lived in each of the remaining areas. By 1972/73, of the survivors who provided a full response, 33% lived in Sunderland, 20% lived in Cambridgeshire, 17% in Angus and approximately 10% in each of the remaining areas. Thus, although the Sunderland respondents formed a major part of the 1967/68 sample, in 1972/73 they dominated the sample and the proportion of respondents in Portsmouth, Rutherglen and Camden decreased. Because of the domination of Sunderland in 1972/73, care has to be taken in the analysis and interpretation of the results presented in the following chapters.

### 4.3 Age

4.3.1 Table 4.2 shows the number of subjects, mean age, standard deviation of the mean, and age range of the full participants in the different areas. Because the 1967/68 sample in Camden selected only subjects over 70 years, by 1972/73 all the Camden respondents were aged 75 years and over compared with 70 years and over in the other areas (3 Camden respondents were aged 69 years, because not quite 5 years had elapsed since they were surveyed in 1967/68). On average the men in Angus and the women in Angus and Camden were older, but there was very little difference between the mean ages in the other areas. Figure 4.1 compares the age structure of the 1972/73 nutrition survey and the 1971 census and shows the slight bias in the survey towards the older age group.

### 4.4 Marital status

4.4.1 The marital status of the 1972/73 respondents was also compared with census data (Table 4.3) and showed that both for men and for women there was a slightly smaller proportion of married subjects (men 63% and women 21%) compared with census figures of 66% and 26% respectively, and a

correspondingly larger proportion of widowed subjects. Table 4.3 also compares the marital status distribution in the 6 areas. A greater proportion of the men in Angus (17%) and Camden (11%) were single and a greater proportion of the men in Sunderland (38%) were widowed. The proportion of single women was low in Cambridgeshire (10%) and was particularly low in Sunderland (2%), while the proportion of widowed women was high in Sunderland (80%) and in Rutherglen (76%).

### 4.5 Mode of living

4.5.1 The mode of living by area for men and women separately is shown in Table 4.4. Only 24% of the men were living alone and the proportion was about the same in each area. The proportion of women (53%) who were living alone ranged from 38% in Cambridgeshire to 80% in Camden. Sixteen of the men and eighteen of the women who were living alone had been widowed since the last survey, and 7 of them (3 men and 4 women) had lost their spouse less than a year before the 1972/73 survey. None of the men and relatively few of the women (4%) lived with persons other than relatives, but 25% of the men (11% with the spouse) and 26% of the women (3% with the spouse) were living with other relatives.

### 4.6 Social class

4.6.1 Social class was coded in accordance with the Registrar General's classification of occupations (1970); 29% of the men and 38% of the women were classified in the non-manual social classes (Table 4.5) and a comparison with census data shows a similar distribution. In Sunderland 79% of the men were in the manual social classes; in the other areas percentages ranged from 50% in Portsmouth to 85% in Rutherglen. In Portsmouth 22% of the men were classified as belonging to the class "Armed Forces". The pattern for the women (married women were classified according to their husband's social class) was similar with 77% in Sunderland in the manual social classes and 15% of the Portsmouth women classified in the "Armed Forces" class.

### 4.7 Income

4.7.1 An attempt was made to obtain some information about income. Respondents were asked to state their total weekly income minus any expenditure on housing, for example, on mortgages, rent, or rates. They were also asked for the sources of their income in terms of a State retirement pension, supplementary pension, employer's pension, income from employment or regular income from other sources. Only 52% of the subjects provided information about their total weekly income, although all stated their sources of income.

4.7.2 Interpretation of information about income proved to be difficult for various reasons. The income given by respondents who were living alone could not be directly compared with half the joint income of married subjects living with a spouse. Even greater problems arose when a respondent was living with, and probably subsidized by, other relatives. Secondly the accuracy of the

information was in doubt. Experience in previous surveys has shown that subjects are unwilling and sometimes unable to give accurate information either about income or the amount of money spent on food. It is of interest that only 52% of the sample attempted to give information about income in this survey. From the information supplied no relationship between the stated income and the source could be established and it was impossible to identify even broad income groups in this way. For these reasons information obtained in all the different aspects of this survey was not analysed in relation to income even of those subjects who answered the questions relevant to financial matters.

### 4.8 Work status

4.8.1 27 of the respondents were still working in 1972/73. 11 men and 6 women were in paid employment (5 men full time) and 4 men and 6 women worked part time voluntarily.

### 4.9 Housing conditions

4.9.1 Table 4.6 presents information on toilet facilities, piped water, hot water, cooking facilities and sheltered accommodation. Two subjects had no piped water in the house but in both cases a water supply was reasonably close. Of the 4 subjects who had no oven 3 lived alone, 1 said that he did not have regular cooked meals and the other 3 subjects did have some meals out regularly.

4.9.2 Where possible the above figures on amenities were compared with corresponding figures reported by a recent survey on the elderly (Hunt, 1978). The population covered by this survey was slightly different from that of the nutrition survey in that it covered households containing an elderly person (aged 65 or over) and it was nationally representative, but in most cases there was a close agreement between the two sets of figures.

4.9.3 The interviewers made an overall subjective assessment of the standard of accommodation (Table 4.6). The standard was assessed as good for 67% of the subjects, as satisfactory for 30% and as poor for 3%.

### 4.10 Meals on wheels

4.10.1 Only 14 (3.8%) of the subjects were having meals on wheels and 10 of these 14 had such meals only twice a week. A further 24 respondents would have liked to receive the service. A national average of 3%[1] is quoted as the number of old age pensioners (men 65 years or over, women 60 years or over) in receipt of meals on wheels.

---

[1] "About 3% of the elderly population receive meals in their own home" (Department of Health and Social Security 1977). Background paper for Conference on the Elderly: 26 July 1977.

### 4.11 Other amenities

4.11.1 Table 4.6 also gives information about the use of a refrigerator, radio, television, telephone and a car. In Portsmouth 68% and in Camden 69% of the subjects used a refrigerator compared with only 37% in Sunderland, and an average figure of 52% for all the areas. Some of the subjects (28%) had a telephone where they lived and could use it, but 68% had no telephone; 4% had a telephone but could not use it. Sunderland included the largest number of subjects without a telephone (89%). The two Scottish areas (Rutherglen and Angus) included the largest percentage of subjects (18% and 15%) who did not have a radio. Sunderland and Rutherglen had the biggest proportion of subjects who had a television set (93% and 97% respectively). Five of the survey subjects did not have either radio or television. Camden and Rutherglen had the biggest proportion of subjects who did not have the use of a car (85% and 90% respectively).

### 4.12 Heating

4.12.1 Nearly a quarter of the subjects (24%) had no heating in their bedroom in cold weather; 2% said that they were not warm enough in winter in the room in which they spent most of their time, and four subjects (1%) said that they were not warm enough in bed during the winter (Table 4.6).

### 4.13 Mental and physical competence

4.13.1 At the end of the socio-economic interview, interviewers made an assessment of the mental and physical competence of the respondent. 60% of the men and 55% of the women were assessed as fully alert, mobile and competent, 2% of the men and 5% of the women as mentally confused, and 33% of the men and 35% of the women were thought to be physically limited.

### 4.14 Overall dependency

4.14.1 The interviewer's assessment of overall dependency showed that 72% of the men and 69% of the women were classified as independent.

**Table 4.1** *The distribution of full-participants in the 1967/68 survey and in the 1972/73 survey*

| Area | Full participants in 1967/68 | | Full participants in 1972/73 | |
|---|---|---|---|---|
| | No. | % | No. | % |
| Portsmouth | 115 | 15 | 38 | 10 |
| Cambridgeshire | 163 | 21 | 72 | 20 |
| Sunderland | 196 | 26 | 122 | 33 |
| Rutherglen | 99 | 13 | 34 | 9 |
| Angus | 95 | 12 | 60 | 17 |
| Camden | 96 | 13 | 39 | 11 |
| Total | 764 | 100 | 365 | 100 |

**Table 4.2:** *The number of subjects, mean age, standard deviation of the mean, and age range of full participants in the different areas of the 1972/73 survey*[1]

| Area | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | No. of subjects | Mean age yrs | Standard deviation | Age range yrs | No. of subjects | Mean age yrs | Standard deviation | Age range yrs |
| Portsmouth | 18 | 76.1 | 4.3 | 69–83 | 20 | 77.0 | 4.6 | 69–85 |
| Cambridgeshire | 43 | 77.9 | 5.8 | 70–97 | 29 | 76.3 | 4.1 | 71–86 |
| Sunderland | 56 | 76.8 | 4.9 | 70–91 | 66 | 77.4 | 5.7 | 70–90 |
| Rutherglen | 13 | 76.9 | 5.5 | 70–86 | 21 | 76.6 | 5.0 | 70–86 |
| Angus | 30 | 78.2 | 5.3 | 70–88 | 30 | 78.1 | 6.3 | 70–90 |
| Camden | 9 | 77.7 | 1.4 | 76–80 | 30 | 79.2 | 2.8 | 75–86 |

[1] 365 people who provided a full response to both surveys (1967/68 and 1972/73)

**Table 4.3:** *The distribution by marital status of the full participants in the survey*

| Marital status | Portsmouth | Cambridge-shire | Sunderland | Rutherglen | Angus | Camden | All areas | | Census 1971 |
|---|---|---|---|---|---|---|---|---|---|
| | No. | No. | No. | No. | No. | No. | No. | % | % |
| All persons | 38 | 72 | 122 | 34 | 60 | 39 | 365 | | |
| *Men* | | | | | | | | | |
| All men | 18 | 43 | 56 | 13 | 30 | 9 | 169 | 100 | 100 |
| Single | 1 | 2 | 4 | 0 | 5 | 1 | 13 | 8 | 7 |
| Married | 14 | 28 | 31 | 9 | 17 | 7 | 106 | 63 | 66 |
| Widowed | 3 | 13 | 21 | 4 | 8 | 1 | 50 | 29 | 27 |
| Divorced | 0 | 0 | 0 | 0 | 0 | 0 | — | — | — |
| *Women* | | | | | | | | | |
| All women | 20 | 29 | 66 | 21 | 30 | 30 | 196 | 100 | 100 |
| Single | 4 | 3 | 1 | 5 | 7 | 7 | 27 | 14 | 15 |
| Married | 8 | 13 | 12 | 0 | 3 | 5 | 41 | 21 | 26 |
| Widowed | 8 | 12 | 53 | 16 | 19 | 17 | 125 | 64 | 58 |
| Divorced | 0 | 1 | 0 | 0 | 1 | 1 | 3 | 1 | 1 |

**Table 4.4:** *The distribution by mode of living of the full participants in the survey*

| Mode of living | Portsmouth | Cambridge-shire | Sunderland | Rutherglen | Angus | Camden | All areas | |
|---|---|---|---|---|---|---|---|---|
| | No. | No. | No. | No. | No. | No. | No. | % |
| All persons | 38 | 72 | 122 | 34 | 60 | 39 | 365 | — |
| *Men* | | | | | | | | |
| All men | 18 | 43 | 56 | 13 | 30 | 9 | 169 | 100 |
| Living alone | 4 | 10 | 14 | 3 | 8 | 2 | 41 | 24 |
| Living with wife | 13 | 24 | 25 | 5 | 13 | 6 | 86 | 51 |
| Living with wife and other relatives | 1 | 4 | 6 | 4 | 3 | 1 | 19 | 11 |
| Living with relatives other than wife | — | 5 | 11 | 1 | 6 | — | 23 | 14 |
| Living with persons other than relatives | — | — | — | — | — | — | — | — |
| *Women* | | | | | | | | |
| All women | 20 | 29 | 66 | 21 | 30 | 30 | 196 | 100 |
| Living alone | 9 | 11 | 31 | 10 | 18 | 24 | 103 | 53 |
| Living with husband | 7 | 10 | 11 | — | 1 | 5 | 34 | 17 |
| Living with husband and other relatives | — | 3 | 1 | — | 2 | — | 6 | 3 |
| Living with relatives other than husband | 1 | 4 | 22 | 10 | 8 | — | 45 | 23 |
| Living with persons other than relatives | 3 | 1 | 1 | 1 | 1 | 1 | 8 | 4 |

**Table 4.5:** *The distribution by social class of the full participants in the survey*

| Social class | Portsmouth | Cambridge-shire | Sunderland | Rutherglen | Angus | Camden | All areas | | Census 1971 |
|---|---|---|---|---|---|---|---|---|---|
| | No. | No. | No. | No. | No. | No. | No. | % | % |
| All persons | 38 | 72 | 122 | 34 | 60 | 39 | 365 | — | — |
| *Men* | | | | | | | | | |
| All men | 18 | 43 | 56 | 13 | 30 | 9 | 169 | 100 | 100 |
| I and II | 3 | 13 | 3 | 0 | 9 | 2 | 30 | 18 | 20 |
| III non-manual | 2 | 4 | 8 | 2 | 1 | 1 | 18 | 11 | 11 |
| III manual | 7 | 12 | 23 | 9 | 5 | 2 | 58 | 34 | 27 |
| IV and V | 2 | 13 | 21 | 2 | 14 | 4 | 56 | 33 | 27 |
| Armed forces | 4 | 1 | 0 | 0 | 1 | 0 | 6 | 4 | 15 |
| Unknown | 0 | 0 | 1 | 0 | 0 | 0 | 1 | — | |
| *Women* | | | | | | | | | |
| All women | 20 | 29 | 66 | 21 | 30 | 30 | 196 | 100 | Not available |
| I and II | 3 | 11 | 4 | 6 | 11 | 9 | 44 | 23 | |
| III non-manual | 5 | 2 | 9 | 5 | 3 | 5 | 29 | 15 | |
| III manual | 6 | 9 | 19 | 8 | 7 | 7 | 56 | 29 | |
| IV and V | 2 | 6 | 32 | 2 | 6 | 8 | 56 | 29 | |
| Armed forces | 3 | 1 | 2 | 0 | 2 | 1 | 9 | 4 | |
| Not known | 1 | 0 | 0 | 0 | 1 | 0 | 2 | — | |

**Table 4.6:** *The distribution of some characteristics of the homes in which the full participants in the survey lived*

| | Portsmouth | Cambridge-shire | Sunderland | Rutherglen | Angus | Camden | All areas | | OPCS survey[4] |
|---|---|---|---|---|---|---|---|---|---|
| | No. | No. | No. | No. | No. | No. | No. | % | % |
| All persons | 38 | 72 | 122 | 34 | 60 | 39 | 365 | 100 | |
| Toilet facilities outside house only | 5 | 11 | 16 | 5 | 3 | 1 | 41 | 11 | 12 |
| Toilet facilities shared with other households | 1 | 1 | 3 | 4 | 0 | 4 | 13 | 4 | 4 |
| No piped water in house | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 0.3 |
| No hot water supply | 3 | 13 | 9 | 2 | 4 | 4 | 35 | 10 | 8 |
| Cooking facilities | | | | | | | | | |
| No oven available | 0 | 0 | 2 | 2 | 0 | 0 | 4 | 1 | — |
| Oven available but not used | 0 | 0 | 3 | 0 | 2 | 0 | 5 | 1 | — |
| Sheltered housing and warden available | 2 | 1 | 3 | 0 | 2 | 4 | 12 | 3 | 5 |
| Standard of accommodation | | | | | | | | | |
| good | 28 | 55 | 61 | 30 | 42 | 27 | 243 | 67 | — |
| satisfactory | 8 | 15 | 60 | 3 | 16 | 9 | 111 | 30 | — |
| poor | 2 | 2 | 1 | 1 | 2 | 3 | 11 | 3 | — |
| No refrigerator used | 12 | 31 | 77 | 17 | 28 | 12 | 177 | 48 | 26† |
| Telephone on premises | | | | | | | | | |
| No | 22 | 46 | 105 | 18 | 41 | 13 | 245 | 68* | |
| Yes but cannot use | 2 | 3 | 4 | 3 | 2 | 0 | 14 | 4 | 44 |
| Yes can use | 14 | 22 | 10 | 13 | 17 | 26 | 102 | 28 | |
| Radio[1] | 38 | 67 | 116 | 28 | 51 | 36 | 336 | 92 | 90 |
| Television[1] | 33 | 62 | 114 | 33 | 52 | 35 | 329 | 90 | 90 |
| Use of car | 17 | 36 | 21 | 4 | 17 | 6 | 101 | 28 | 31 |
| Subject not warm enough in living room in winter[2] | 4 | 0 | 1 | 2 | 0 | 1 | 8 | 2 | — |
| No heating in bedroom in cold weather | 15 | 15 | 26 | 6 | 20 | 6 | 88 | 24 | |
| Subject not warm enough in bed[3] | 1 | 0 | 2 | 0 | 1 | 0 | 4 | 1 | 7 |

[1] 5 subjects had neither radio nor television

[2] refers to room in which subject spent most of the time

[3] these 4 subjects were different from those who were not warm enough in their living room in winter

[4] Hunt, A. (1978)

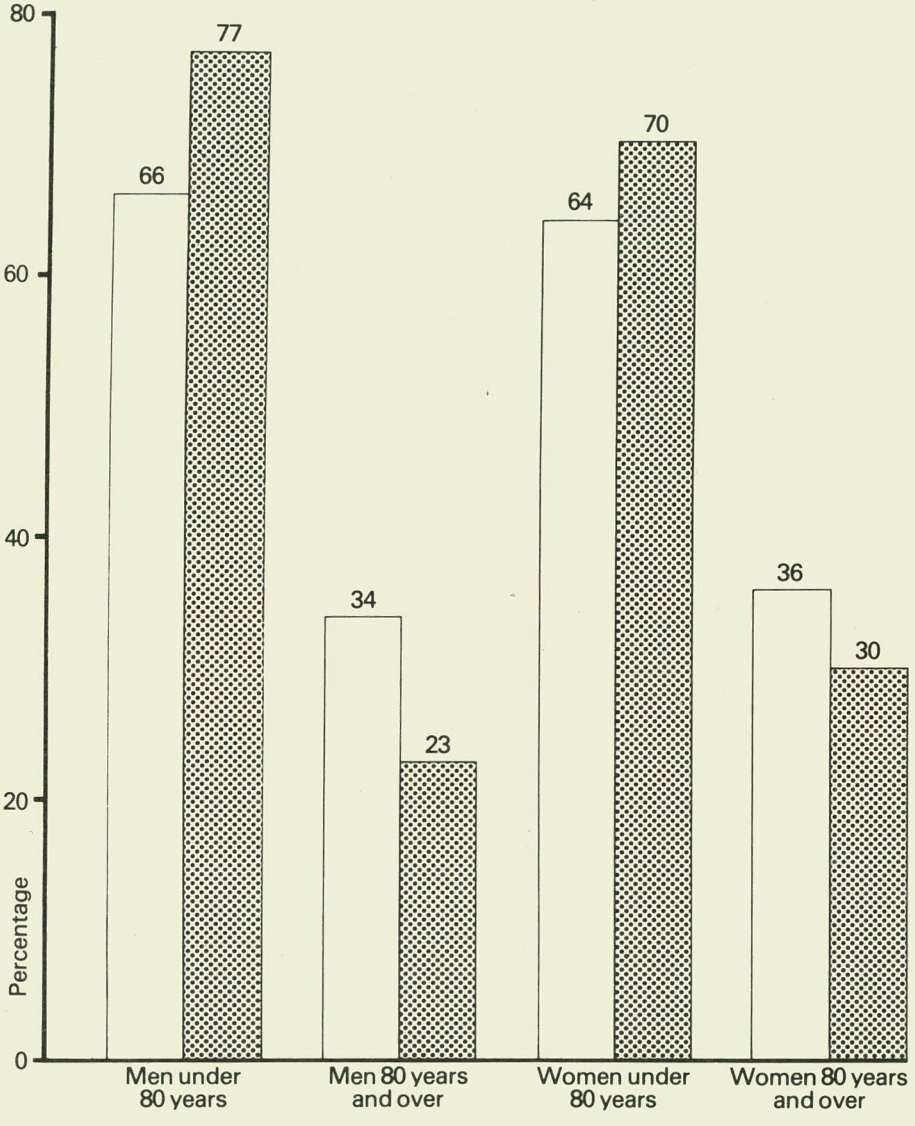
— no information obtained

† 26% of the subjects interviewed in the OPCS survey had no refrigerator on the premises

* including 1% where it was not known whether a telephone was on the premises

FIGURE 4.1

***Distribution by age groups of men and women whose diet was recorded in the sample areas compared with that of men and women in the population of Great Britain at the 1971 census.***



# 5. Diet

## 5.1 Introduction

5.1.1 Each subject who participated fully in the survey recorded the weight of all food and drink ingested over a period of seven consecutive days (para 3.3). The food composition table which had been compiled for the purpose (para 3.4) enabled the information obtained to be analysed in terms of mean intakes of foods classified into 34 different groups each of which contained foods with at least one major nutrient in common; five principal animal protein containing foods (meat, fish, eggs, cheese and milk); total food energy available from protein, carbohydrate and fat; two minerals (calcium and iron) and certain vitamins (A, thiamin, riboflavin, nicotinic acid, pyridoxine, C and D). In addition, the analysis permitted an estimation of "added sugars" that is to say of the total amount of all sugars (chiefly sucrose) added to the food either during manufacture or processing, in the kitchen or at table. Thus some assessment of the intake of refined sugars (usually sucrose) was possible and could be distinguished from the intake of total carbohydrate. All individual intakes were expressed as mean daily intakes which could be subdivided into the mean daily intakes for three periods of the day – before 11.30 am, from 11.30 am to 2.30 pm and from 2.30 pm to the end of the day (bed-time).

5.1.2 The findings for individuals apply only to the week of the survey and certain foods may not be eaten every week. Nevertheless, weekly surveys of the same subject, repeated after an interval of time, have shown that, although exact estimates of total food energy and nutrients may vary, large eaters were on the second occasion still large eaters and vice versa, and the variety of foods consumed during the week was more or less the same (1972 Report, pp 118-122).

## 5.2 Food energy

5.2.1 The mean daily intakes of food energy and the percentage of energy from protein, carbohydrate and fat are shown for men and women separately in Tables 5.1 and 5.2, and in the two age groups (under 80 years of age, 80 years and over) in Table 5.3. The average percentage frequency distribution of energy intakes for men and women in the two age groups are shown in Figure 5.1.

5.2.2 Men had significantly larger ($P < 0.001$) mean intakes of energy (2151 kcal) than women (1636 kcal); 4% of all the men had intakes over 3250 kcal/day and 3% of the older men had intakes over 3000 kcal/day. The younger men and women had significantly larger intakes of energy than the older men and women ($P < 0.05$). Area differences were not marked except that

in Sunderland the mean energy intake of the women was significantly smaller than the mean for women in all the other areas ($P < 0.05$).

5.2.3 Age, sex and area differences in the proportion of energy derived from protein fat and carbohydrate were small and not statistically significant.

5.2.4 Similarly there were no significant differences in the contribution of added sugars (para 5.1.1) to total food energy between the age and sex groups or between areas. The contribution of added sugars was smaller than that found in nutrition studies of other groups, (Department of Health and Social Security, 1972; and unpublished surveys).

**5.3 Nutrient intakes**

5.3.1 The mean daily intakes of nutrients for all men and all women in the survey, and for all areas are given in Tables 5.1 and 5.2, and for men and women in the two age groups in Table 5.3. The corresponding percentage frequency distributions of the average daily intakes of the different nutrients are shown in Figures 5.2 – 5.14. The percentage frequency distribution of intakes of added sugars is shown in Figure 5.15.

5.3.2. The mean daily nutrient intakes of men were significantly larger than those of the women ($P < 0.001$) except for three nutrients – vitamins A, C and D. Intakes of these vitamins are not in any way related to energy intake.

5.3.3 Differences between the two age groups were significant only for a few nutrients. Men in the younger age group had intakes of thiamin ($P < 0.05$) and of nicotinic acid ($P < 0.05$) which were significantly larger than those of the older men; younger women had on average intakes of total protein ($P < 0.05$), and of fat, calcium, thiamin and riboflavin ($P < 0.01$) which were significantly larger than older women. A comparison between nutrient intakes is more meaningful if it is based on a common energy intake. The mean nutrient density of the diet per 1000 kcal was remarkably constant for both men and women in each age group. On the whole, the 4 age/sex groups of elderly people ate a diet similar in composition and varying only in quantity.

5.3.4 Figures 5.16 and 5.17 compare for men and women separately, mean daily intakes of energy, nutrients and of nutrients per 1000 kcal. For each area the mean intake is shown as the percentage above or below the all areas mean. In general the men in Rutherglen and Sunderland had low mean intakes of most nutrients, even when intakes per 1000 kcal were considered, but mean intakes of vitamin A, riboflavin, nicotinic acid, pyridoxine and vitamin C were also low in Angus and mean intakes of fat, carbohydrate, calcium, vitamin A and vitamin D were low for men in Camden. For women, except for nicotinic acid and vitamin A, the mean intakes of energy and all nutrients in Sunderland were lower than the mean intakes for any other area but this was not the case for intakes per 1000 kcal; mean intakes and the mean per 1000 kcal of thiamin, vitamin C, vitamin D and added sugars were all smaller for Rutherglen women than the means for all areas.

### 5.4 Food sources of nutrients

5.4.1 The percentage contribution of the different food groups to the dietary intake of energy and the various nutrients are shown in Table 5.4. The information is given only for all subjects because no differences were found between men and women or between different age groups.

5.4.2 Almost half of the total food energy was derived from "meat and meat dishes", "bread and related products", and about a quarter from "milk and cream" and "fats and oils".

5.4.3 The food groups "meat and meat dishes", "milk and cream", and "bread" between them provided about 55% of the intake of total protein. About 20% was from flour products, fish and eggs. Over one third of the animal protein in the diet was obtained from meat and meat dishes, nearly a quarter from milk and between a quarter and a third from foods containing eggs, fish, cheese, poultry and game.

5.4.4 Butter, margarine, cooking fats and cooking oils between them were important sources of fat in the diet, providing about 23%of the total fat for women and about 24% of the total for men. Meat provided 21% and 26% total fat for women and men respectively. The remaining fat came from made-up dishes and 11% from the food group – "biscuits, scones, cakes and pastry".

5.4.5 The chief sources of carbohydrate, as might be expected, were bread, flour products (biscuits, cakes and pastry) and sugars. Potatoes contributed a constant 7%–8%.

5.4.6 Calcium in the diet was derived mainly from milk (40–49%). A further 10–13% was supplied by bread, and about 10% from cheese. Foods containing flour, and milk puddings and sauces also provided about 15% of the dietary calcium. No account was taken of the possible contribution to calcium intake from drinking water.

5.4.7 Over half (52%) of the dietary iron came from meat dishes, bread and flour products, while a small but constant proportion came from eggs (7%) and liver (6%). No distinction was made between haem iron and iron from other sources.

5.4.8 Liver, butter and margarine between them provided about 50% of the total vitamin A in the diet. In addition, milk and cream, vegetables (other than potatoes, tomatoes, leafy green vegetables, pulses and legumes) and eggs and egg dishes each accounted for about 10%.

5.4.9 Nicotinic acid is widely distributed in foods and therefore, as would be expected, the food group which contributed most to total energy intake (ie meat and meat dishes) also provided the highest proportion of nicotinic acid

in the diet. It is of interest to note that, among the men aged under 80 years, alcohol contributed, on average, 13% of the total nicotinic acid. A large amount of beer was consumed by these men in one area.

5.4.10 Citrus fruits, potatoes and leafy green vegetables between them provided about 60% of the vitamin C in the diet. In the case of men, potatoes made the greatest single contribution but for women this place was taken by citrus fruits.

5.4.11 Meat and meat dishes and bread, followed by milk were the main sources of thiamin in the diet. Fortified cereals made an appreciable contribution to total intake for women, particularly the younger group of women.

5.4.12 Riboflavin in the diets of all groups was derived largely from milk (29--36% of the total) with meat and meat products providing a further 12%–14%. The 5% obtained from the food group "tea and coffee" was obtained from these foods and not from the milk served with them.

5.4.13 The major sources of vitamin D were fats and oils (predominantly margarine fortified with vitamin D), fat fish and eggs. Women, particularly the older group, derived a higher proportion, on average, of their total vitamin D from fat fish. This finding does not necessarily reflect anything more than a taste preference on the part of a number of respondents.

5.4.14 Pyridoxine, like nicotinic acid, is found in many foods but the two chief sources were meat (including meat dishes) and potatoes.

5.4.15 Thus the survey subjects obtained essential nutrients from the following basic foodstuffs – meat (including liver), milk, eggs, butter, margarine, fish, bread, potatoes, citrus fruits, green leafy vegetables and fortified cereals, an eating pattern which is characteristic of all adult age groups in the United Kingdom.

### 5.5 Principal animal protein foods

5.5.1 The dietary information obtained in the survey was analysed in such a way that individual intakes of meat, fish, eggs, cheese and milk (liquid whole milk) could be calculated. The resulting figure for each food represented the mean daily intake averaged over the 7 days for the food, for example, meat includes meat as such plus meat obtained from composite dishes. Tables 5.5 and 5.6 give the mean intakes for men and women separately for all areas, and in each area. Table 5.7 gives the information for men and women in the two age groups. Figures 5.18 to 5.22 show the percentage frequency distribution of each of these foods for men and women separately.

5.5.2 On average, women ate less meat than did men, and older subjects, both men and women, ate less than younger subjects. All respondents, except

2% of women in the younger age group, ate some meat. Mean daily intakes ranged from 2.36 oz for older women to 3.25 oz for younger men.

5.5.3 Fish was eaten by 74% of the women and 78% of the men. Older men appeared to eat more fish than the younger men. However, a calculation of the average intake by omitting those who did not eat this food showed that the younger men ate more (1.1 oz/day) than the older men (0.96 oz/day).

5.5.4 Only 2% of the men and 1% of the women ate no eggs in the week of the survey. Although the average intake was less than 1 egg per day, the percentage contribution to total nutrients from this source was appreciable and shows the importance of eggs in the diet of the elderly subjects.

5.5.5 Cheese was eaten only by 69% of men and 76% of women. Nevertheless, the mean daily consumption was 0.5 oz and 0.4 oz respectively, indicating that cheese, for those individuals who consumed it, constituted an appreciable part of the diet. On average, for all subjects, cheese contributed about 10% to the total calcium intake (para 5.4.6).

5.5.6 All subjects took milk in some form. The range of intakes was from less than 2.5 oz per day to more than 25 oz per day. Average consumption was higher for men than for women (12.11 oz compared with 11.52 oz). Milk was an important food for these older men and was the biggest single contributor to dietary calcium and riboflavin.

5.5.7 *Other foods* Information about four other basic foods – bread, margarine, butter and offal is shown in Table 5.8 and confirms that younger subjects ate more than older subjects. More butter than margarine was eaten by both men and women.

### 5.6 Area differences in mean daily intakes of the different food groups

5.6.1 Tables 5.9 and 5.10 compare for men and women separately the mean daily intakes of the different food groups in each of the areas as a percentage difference from the mean for all areas.

5.6.2 In general the men in Sunderland and Rutherglen had mean intakes of most food groups which were about equal to or below the mean for all areas. Exceptions were bread, pulses and legumes, and fats and oils. Sunderland men had higher intakes of alcohol and of "other meats" (which compensated largely for lower intakes of poultry). Rutherglen men ate more cereals, biscuits and scones then the average for all areas. These differences probably reflect differences in regional eating patterns. On the whole mean intakes in Portsmouth were above average. In Camden the men had a higher consumption of poultry and fish and a relatively low consumption of milk and egg dishes. Amounts of fruit and vegetables eaten tended to be mostly larger in rural Cambridge and smaller in the northern areas, Sunderland, Rutherglen and Angus. The two Scottish areas had a much higher consumption –

Rutherglen (138%) and Angus (194%) – of breakfast cereals. This was chiefly because some subjects in these areas ate porridge and this food was weighed "ready to eat" whereas other breakfast cereals were weighed dry.

5.6.3 Similarly, women subjects in Sunderland consumed about the same or less of most food groups compared with the other areas, and showed the same regional food pattern as the men. The women had a relatively high consumption of bread, biscuits and scones in both Rutherglen and Sunderland, of pulses and legumes in Sunderland, and in Rutherglen of cereal (largely porridge). Women subjects in Portsmouth and Camden had intakes higher than the means for all areas in many food groups. In rural Cambridgeshire more fruits and vegetables were consumed than in Sunderland, Rutherglen and Angus.

### 5.7 Intakes of principal animal protein foods and of some nutrients in different periods of the day

5.7.1 Analysis of dietary information was made for three periods of the 24 hours: up to 11.30 am, from 11.30 am to 2.30 pm and from 2.30 pm onwards. The percentage distribution of mean daily intakes of men and of women in these three periods are shown for energy, total protein, vitamin C and the principal animal protein foods in Figures 5.23 and 5.24.

5.7.2 About 75%–85% of the average daily intake of all nutrients was eaten after 11.30 am. The analysis did not distinguish between frequent small snack meals, and a single larger meal in each of the periods of the day. However, the findings indicate a pattern of eating the principal animal protein foods which on average gave the proportion of the consumption of each of the 5 foods as follows:

| | |
|---|---|
| until 11.30 am | rather more than one third of the milk and eggs intake<br>a little fish by the men but not the women<br>some cheese and some meat, |
| 11.30 am to 2.30 pm | most of the meat intake,<br>some milk, cheese, fish, eggs |
| after 2.30 pm | most of the cheese and fish intake,<br>some of the meat, milk and egg intake |

Examination of individual records showed that most of the elderly subjects in fact ate at more or less regular intervals of time so that the daily meal pattern for the majority was breakfast, mid-morning drink and small snack, mid-day meal, tea plus snack and then supper, or a high tea and a drink plus snack before going to bed.

### 5.8 Mean cost of food per day

5.8.1 45 subjects were asked to record the cost of all foods consumed during

the week of the survey. These costs were obtained from local shops. Only those subjects who were considered by the dietary investigators to be the more co-operative and more physically and mentally competent were asked to participate in this aspect of the study and the results are therefore not necessarily representative of the whole sample.

5.8.2 The cost of foods consumed per day in the week of the survey ranged from 25p to 76p per day (Figure 5.25) with a mean cost of 39.6p. For the same year (1972/73) the mean cost of food purchased for domestic consumption which was reported by the National Food Survey[1] for pensioner households was 38.3p/person/day.

5.8.3 Individual total food costs correlated significantly with intakes of energy, animal and total protein and riboflavin ($P < 0.01$ for animal protein,) $P < 0.001$ for the remainder), but no association was found between cost and vitamin C intakes.

[1] Source: Ministry of Agriculture, Fisheries and Food (1974,1975)

**Table 5.1:** *Mean daily intakes of energy and nutrients, and the percentage of energy derived from protein, fat and added sugars[1], for the men from different areas in the survey*

| | | All areas (169 men) | | Portsmouth (18 men) | | Cambridgeshire (43 men) | | Sunderland (56 men) | | Rutherglen (13 men) | | Angus (30 men) | | Camden (9 men) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily intake | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Energy | kcal | 2 151 | (520) | 2 154 | (444) | 2 117 | (541) | 2 101 | (513) | 1 989 | (442) | 2 313 | (602) | 2 021 | (369) |
| | MJ | 9.0 | (2.2) | 9.0 | (1.9) | 9.1 | (2.3) | 8.8 | (2.2) | 8.3 | (1.9) | 9.7 | (2.5) | 8.5 | (1.5) |
| Animal protein | g | 47.6 | (13.3) | 51.8 | (11.8) | 49.2 | (11.6) | 44.2 | (14.0) | 41.0 | (9.60) | 51.9 | (14.0) | 48.2 | (16.1) |
| Total protein | g | 70.4 | (16.2) | 73.9 | (13.2) | 70.9 | (14.9) | 68.4 | (17.6) | 63.9 | (14.2) | 74.6 | (17.1) | 68.7 | (17.1) |
| Fat | g | 97 | (27.7) | 99 | (26.9) | 99 | (29.6) | 95 | (26.5) | 86 | (20.4) | 108 | (27.9) | 82 | (26.6) |
| Carbohydrate | g | 248 | (66.4) | 246 | (59.2) | 252 | (67.7) | 236 | (57.1) | 251 | (66.7) | 270 | (86.2) | 229 | (42.3) |
| Calcium | mg | 880 | (293) | 930 | (380) | 960 | (291) | 800 | (249) | 810 | (188) | 950 | (311) | 780 | (320) |
| Iron | mg | 11.4 | (3.03) | 13.2 | (3.85) | 11.3 | (2.90) | 11.1 | (3.08) | 10.0 | (2.39) | 11.8 | (2.73) | 10.8 | (1.91) |
| Vitamin A | μg | 1 100 | (714) | 1 340 | (828) | 1 150 | (692) | 1 110 | (885) | 1 050 | (637) | 940 | (262) | 920 | (445) |
| Thiamin | mg | 1.0 | (0.27) | 1.0 | (0.23) | 1.0 | (0.30) | 0.9 | (0.27) | 0.9 | (0.22) | 1.0 | (0.25) | 1.0 | (0.28) |
| Riboflavin | mg | 1.5 | (0.57) | 1.8 | (0.58) | 1.5 | (0.52) | 1.5 | (0.67) | 1.2 | (0.25) | 1.4 | (0.33) | 1.7 | (0.86) |
| Nicotinic acid | mg | 13.7 | (5.46) | 15.3 | (4.37) | 12.9 | (4.38) | 14.9 | (7.27) | 11.2 | (2.37) | 12.1 | (3.95) | 14.7 | (4.07) |
| Pyridoxine | mg | 1.3 | (0.40) | 1.5 | (0.40) | 1.3 | (0.35) | 1.20 | (0.44) | 1.0 | (0.24) | 1.2 | (0.32) | 1.6 | (0.43) |
| Vitamin C | mg | 44 | (29.4) | 48 | (19.4) | 52 | (30.9) | 40 | (32.1) | 26 | (18.4) | 38 | (28.0) | 56 | (25.0) |
| Vitamin D | μg | 2.5 | (1.77) | 3.3 | (2.22) | 2.4 | (1.45) | 2.2 | (1.60) | 2.6 | (2.47) | 2.7 | (1.35) | 2.3 | (2.92) |
| Added sugars | g | 69.7 | (34.8) | 69.4 | (34.1) | 79.1 | (41.6) | 58.4 | (27.7) | 71.4 | (32.9) | 77.5 | (36.1) | 67.4 | (25.7) |
| % energy from protein | | 13.3 | (2.41) | 13.9 | (2.18) | 13.3 | (2.33) | 13.2 | (2.66) | 13.1 | (2.76) | 13.1 | (1.90) | 13.7 | (2.87) |
| % energy from fat | | 40.7 | (5.81) | 41.3 | (6.79) | 40.8 | (5.00) | 40.7 | (6.71) | 39.0 | (3.24) | 42.3 | (4.06) | 36.2 | (7.54) |
| % energy from added sugars | | 12.9 | (5.85) | 12.5 | (5.45) | 14.2 | (6.67) | 11.4 | (6.06) | 14.4 | (5.63) | 13.1 | (4.34) | 13.4 | (4.92) |

[1] The food "added sugars" is included in the table of nutrients for convenience. For definition see para 5.1.1

**Table 5.2:** *Mean daily intakes of energy and nutrients, and the percentage of energy derived from protein, fat and added sugars[1], for the women from different areas in the survey*

| | | All areas (196 women) | | Portsmouth (20 women) | | Cambridgeshire (29 women) | | Sunderland (66 women) | | Rutherglen (21 women) | | Angus (30 women) | | Camden (30 women) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily intake | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Energy | kcal | 1 636 | (399) | 1 645 | (412) | 1 747 | (418) | 1 547 | (388) | 1 614 | (306) | 1 669 | (466) | 1 699 | (369) |
| | MJ | 6.9 | (1.7) | 6.9 | (1.7) | 7.3 | (1.8) | 6.5 | (1.6) | 6.8 | (1.3) | 7.0 | (2.0) | 7.1 | (1.5) |
| Animal protein | g | 38.3 | (10.4) | 39.0 | (10.9) | 38.3 | (10.9) | 36.0 | (9.8) | 39.8 | (11.2) | 39.4 | (11.6) | 40.5 | (8.5) |
| Total protein | g | 55.7 | (13.3) | 55.4 | (15.1) | 56.2 | (13.0) | 53.8 | (13.8) | 58.2 | (12.1) | 56.7 | (14.9) | 57.0 | (10.8) |
| Fat | g | 78 | (22.5) | 80 | (25.2) | 82 | (25.6) | 74 | (21.3) | 80 | (17.8) | 77 | (26.3) | 79 | (19.4) |
| Carbohydrate | g | 186 | (65.3) | 184 | (58.7) | 205 | (52.1) | 174 | (54.3) | 174 | (41.3) | 196 | (59.2) | 195 | (58.6) |
| Calcium | mg | 750 | (232) | 750 | (224) | 880 | (275) | 670 | (212) | 710 | (213) | 740 | (195) | 810 | (226) |
| Iron | mg | 9.0 | (2.98) | 8.9 | (2.34) | 8.7 | (2.36) | 8.5 | (2.78) | 10.1 | (3.75) | 9.4 | (3.62) | 9.4 | (2.98) |
| Vitamin A | μg | 1 030 | (1 037) | 830 | (539) | 910 | (834) | 870 | (761) | 1 520 | (1 992) | 940 | (729) | 1 340 | (1 191) |
| Thiamin | mg | 0.8 | (0.25) | 0.8 | (0.37) | 0.8 | (0.20) | 0.7 | (0.27) | 0.7 | (0.17) | 0.8 | (0.26) | 0.8 | (0.22) |
| Riboflavin | mg | 1.2 | (0.49) | 1.2 | (0.33) | 1.2 | (0.43) | 1.1 | (0.39) | 1.2 | (0.64) | 1.2 | (0.50) | 1.5 | (0.60) |
| Nicotinic acid | mg | 10.1 | (3.26) | 11.1 | (3.90) | 9.5 | (2.59) | 9.9 | (3.13) | 10.8 | (3.29) | 9.7 | (3.43) | 10.3 | (3.46) |
| Pyridoxine | mg | 0.9 | (0.27) | 1.0 | (0.20) | 1.0 | (0.20) | 0.9 | (0.24) | 0.9 | (0.31) | 0.9 | (0.30) | 1.1 | (0.29) |
| Vitamin C | mg | 39 | (27.8) | 49 | (22.5) | 50 | (31.1) | 32 | (30.4) | 30 | (23.1) | 34 | (20.6) | 47 | (24.9) |
| Vitamin D | μg | 2.2 | (2.12) | 2.9 | (3.82) | 2.2 | (1.82) | 2.0 | (1.77) | 1.8 | (1.87) | 2.1 | (1.56) | 2.3 | (2.26) |
| Added sugars | g | 48.7 | (27.4) | 49.3 | (24.8) | 54.7 | (24.9) | 42.4 | (22.4) | 42.0 | (23.3) | 54.1 | (30.1) | 55.5 | (37.5) |
| % energy from protein | | 13.8 | (2.44) | 13.5 | (2.22) | 13.0 | (1.94) | 14.1 | (2.97) | 14.5 | (1.78) | 13.8 | (2.05) | 13.7 | (2.40) |
| % energy from fat | | 42.7 | (5.61) | 43.6 | (6.74) | 42.0 | (5.16) | 43.2 | (5.79) | 44.7 | (4.96) | 41.2 | (5.12) | 41.8 | (5.52) |
| % energy from added sugars | | 11.7 | (5.68) | 12.1 | (5.63) | 12.5 | (5.35) | 11.1 | (5.73) | 10.1 | (4.75) | 12.8 | (5.63) | 12.3 | (6.55) |

[1] The food "added sugars" is included in the table of nutrients for convenience. For definition see para 5.1.1

**Table 5.3:** *Mean daily intakes of energy and nutrients, and the percentage of energy derived from protein fat and added sugars[1], for all men and all women in the survey in two age groups*

| | | Sex and age group | | | |
|---|---|---|---|---|---|
| | | Under 80 yrs (111 men) | 80 yrs and over (58 men) | under 80 yrs (125 women) | 80 yrs and over (71 women) |
| Daily intake | | Mean s.d. | Mean s.d. | Mean s.d. | Mean s.d. |
| Energy | kcal | 2217 (522) | 2024 (498) | 1679 (416) | 1559 (358) |
| | MJ | 9.3 (2.2) | 8.5 (2.1) | 7.0 (1.7) | 6.5 (1.5) |
| Animal protein | g | 47.5 (12.9) | 47.8 (14.3) | 39.3 (10.7) | 36.4 (9.5) |
| Total protein | g | 71.2 (15.6) | 68.9 (17.5) | 57.5 (13.7) | 52.6 (12.1) |
| Fat | g | 100 (27.4) | 93 (27.9) | 81 (23.8) | 72 (19.1) |
| Carbohydrate | g | 255 (67.5) | 235 (63.1) | 189 (56.8) | 182 (52.8) |
| Calcium | mg | 890 (285) | 870 (311) | 780 (251) | 690 (184) |
| Iron | mg | 11.6 (3.01) | 11.0 (3.06) | 9.3 (3.09) | 8.6 (2.74) |
| Vitamin A | μg | 1120 (728) | 1050 (689) | 1050 (1161) | 980 (776) |
| Thiamin | mg | 1.0 (0.27) | 0.9 (0.26) | 0.8 (0.27) | 0.7 (0.20) |
| Riboflavin | mg | 1.5 (0.62) | 1.4 (0.47) | 1.3 (0.53) | 1.1 (0.40) |
| Nicotinic acid | mg | 14.4 (5.97) | 12.3 (4.02) | 10.3 (3.45) | 9.7 (2.86) |
| Pyridoxine | mg | 1.3 (0.41) | 1.2 (0.37) | 0.9 (0.26) | 0.9 (0.29) |
| Vitamin C | mg | 46 (28.2) | 38 (31.1) | 40 (29.3) | 37 (25.1) |
| Vitamin D | μg | 2.4 (1.64) | 2.7 (2.01) | 2.1 (1.79) | 2.3 (2.61) |
| Added sugars | g | 71.6 (35.7) | 66.0 (33.0) | 48.8 (27.0) | 48.5 (28.3) |
| % energy from protein | | 13.1 (2.29) | 13.7 (2.59) | 13.9 (2.52) | 13.7 (2.30) |
| % energy from fat | | 40.6 (5.98) | 41.0 (5.50) | 43.2 (5.63) | 41.8 (5.51) |
| % energy from added sugars | | 12.7 (5.34) | 13.2 (6.76) | 11.5 (5.47) | 12.2 (6.04) |

[1] The food "added sugars" is included in the table of nutrients for convenience. For definition see para 5.1.1

**Table 5.4:** *Percentage contribution to the food energy and nutrient intakes for all men and all women from the different food groups (excluding food groups which contributed less than 5% of the nutrient intake)*

| | Energy Value | Animal Protein | Total Protein | Fat | Carbohydrate | Calcium |
|---|---|---|---|---|---|---|
| Mean intake: | 1 874 kcal (7.84 MJ) | 42.6g | 62.5g | 87g | 215g | 810mg |
| Standard deviation: | 525.8 kcal (2.20 MJ) | 12.71g | 16.44g | 26.9g | 68g | 270mg |
| Food Groups | | | | | | |
| Milk and Cream | 11 | 23 | 15 | 14 | 7 | 44 |
| Milk Puddings and Sauces | — | — | — | — | — | 6 |
| Cheese and Cheese Dishes | — | 7 | 5 | 5 | — | 10 |
| Liver | — | — | — | — | — | — |
| Poultry and Game (including Products) | — | 6 | — | — | — | — |
| Other Meats and Meat Dishes | 15 | 36 | 26 | 24 | — | — |
| Fat Fish and Fat Fish Dishes | — | — | — | — | — | — |
| Non-Fat Fish and Non-Fat Fish Dishes | — | 8 | 6 | — | — | — |
| Eggs and Egg Dishes | — | 8 | 6 | 5 | — | — |
| Fats and Oils | 10 | — | — | 24 | — | — |
| Sugar and Preserves | 7 | — | — | — | 16 | — |
| Chocolates and Sweets | — | — | — | — | — | — |
| Potatoes | 5 | — | — | — | 8 | — |
| Tomatoes | — | — | — | — | — | — |
| Leafy Green Vegetables | — | — | — | — | — | — |
| Pulses and Legumes | — | — | — | — | — | — |
| Other Vegetables | — | — | — | — | — | — |
| Citrus Fruits | — | — | — | — | — | — |
| Major Vitamin C Non-Citrus Fruits | — | — | — | — | — | — |
| Other Fruits | — | — | — | — | — | — |
| Breakfast Cereals | — | — | — | — | — | — |
| Pasta and Rice | — | — | — | — | — | — |
| Bread | 13 | — | 14 | — | 24 | 11 |
| Biscuits, Scones, Cakes, Pastry | 13 | — | 7 | 11 | 17 | 9 |
| Fruit Pies and Fruit Puddings | — | — | — | — | — | — |
| Other Pies and Puddings | — | — | — | — | — | — |
| Alcoholic Beverages | — | — | — | — | — | — |
| Powdered Beverages not Fruit Based | — | — | — | — | — | — |
| Tea and Coffee | — | — | — | — | — | — |
| Soups | — | — | — | — | — | — |
| Totals: | 74 | 88 | 79 | 83 | 72 | 80 |

| Iron | Vitamin A | Thiamin | Riboflavin | Nicotinic Acid | Pyridoxine | Vitamin C | Vitamin D |
|---|---|---|---|---|---|---|---|
| 10.1mg | 1 060μg | 0.9mg | 1.3mg | 11.8mg | 1.1mg | 41mg | 2.3μg |
| 3.22mg | 901μg | 0.28mg | 0.55mg | 4.76mg | 0.37mg | 28.6mg | 1.97μg |
| – | 11 | 14 | 32 | – | 11 | 8 | – |
| – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – |
| 6 | 27 | – | 8 | – | – | – | – |
| – | – | – | – | – | 7 | – | – |
| 28 | – | 19 | 13 | 28 | 21 | – | – |
| – | – | – | – | – | – | – | 23 |
| – | – | – | – | 6 | – | – | – |
| 7 | 9 | – | 7 | – | 7 | – | 22 |
| – | 23 | – | – | – | – | – | 24 |
| – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – |
| 5 | – | 7 | – | 6 | 15 | 21 | – |
| – | – | – | – | – | – | 5 | – |
| – | – | – | – | – | – | 13 | – |
| – | – | – | – | – | – | – | – |
| – | 11 | – | – | – | – | 7 | – |
| – | – | – | – | – | – | 23 | – |
| – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | 5 | – |
| – | – | 7 | – | – | – | – | – |
| – | – | – | – | – | – | – | – |
| 15 | – | 19 | – | 14 | 8 | – | – |
| 9 | – | 9 | – | 5 | 5 | – | 12 |
| – | – | – | – | – | – | – | – |
| – | – | – | – | – | – | – | – |
| – | – | – | – | 6 | – | – | – |
| – | – | – | – | – | – | – | 7 |
| – | – | – | 5 | 9 | – | – | – |
| – | – | – | – | – | – | – | – |
| 70 | 81 | 75 | 65 | 74 | 74 | 82 | 88 |

**Table 5.5:** *Mean daily intake of the principal animal protein contributing foods for the men in the different areas of the survey*

| | | All areas (169 men) | | Portsmouth (18 men) | | Cambridgeshire (43 men) | | Sunderland (56 men) | | Rutherglen (13 men) | | Angus (30 men) | | Camden (9 men) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily intake | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Meat | oz | 3.24 | (1.38) | 3.32 | (1.41) | 3.17 | (1.16) | 3.42 | (1.46) | 1.98 | (0.64) | 3.47 | (1.58) | 3.31 | (1.23) |
| Fish | oz | 0.78 | (0.751) | 0.92 | (0.687) | 0.63 | (0.626) | 0.69 | (0.721) | 1.42 | (1.31) | 0.77 | (0.554) | 1.04 | (0.752) |
| Eggs | oz | 1.38 | (0.906) | 1.48 | (0.862) | 1.48 | (0.996) | 1.31 | (1.03) | 1.26 | (0.753) | 1.49 | (0.657) | 0.94 | (0.559) |
| Cheese | oz | 0.48 | (0.537) | 0.42 | (0.492) | 0.58 | (0.668) | 0.43 | (0.430) | 0.19 | (0.223) | 0.59 | (0.591) | 0.48 | (0.571) |
| Milk (liquid whole) | oz | 12.11 | (6.82) | 14.34 | (11.9) | 14.73 | (6.22) | 9.36 | (5.00) | 11.21 | (5.23) | 13.36 | (5.47) | 9.30 | (6.03) |
| Milk (skimmed) | oz | 0.40 | (1.35) | 0.22 | (0.560) | 0.13 | (0.277) | 0.58 | (1.67) | 0.24 | (0.401) | 0.23 | (0.374) | 1.77 | (3.80) |

**Table 5.6:** *Mean daily intake of the principal animal protein contributing foods for the women in the different areas of the survey*

| | | All areas (196 women) | | Portsmouth (20 women) | | Cambridgeshire (29 women) | | Sunderland (66 women) | | Rutherglen (21 women) | | Angus (30 women) | | Camden (30 women) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Daily intake | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Meat | oz | 2.38 | (1.05) | 2.60 | (0.820) | 2.16 | (0.966) | 2.42 | (1.05) | 2.64 | (1.12) | 2.40 | (1.10) | 2.15 | (1.12) |
| Fish | oz | 0.58 | (0.599) | 0.63 | (0.619) | 0.42 | (0.371) | 0.60 | (0.740) | 0.47 | (0.483) | 0.63 | (0.508) | 0.65 | (0.580) |
| Eggs | oz | 1.02 | (0.700) | 0.72 | (0.464) | 0.86 | (0.631) | 1.01 | (0.671) | 1.10 | (0.701) | 1.16 | (0.907) | 1.22 | (0.673) |
| Cheese | oz | 0.37 | (0.441) | 0.37 | (0.376) | 0.39 | (0.401) | 0.27 | (0.341) | 0.47 | (0.428) | 0.30 | (0.317) | 0.55 | (0.709) |
| Milk (liquid whole) | oz | 11.5 | (5.84) | 11.6 | (5.82) | 15.2 | (7.10) | 9.77 | (5.13) | 9.76 | (4.86) | 11.4 | (5.23) | 13.1 | (5.52) |
| Milk (skimmed) | oz | 0.58 | (1.75) | 1.08 | (3.57) | 0.19 | (0.687) | 0.67 | (1.91) | 0.31 | (0.551) | 0.93 | (1.58) | 0.28 | (0.589) |

**Table 5.7:** *Mean daily intake of the principal animal protein contributing foods for all men and all women in the survey, in two age groups*

| | | Sex and age group | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | under 80 yrs (111 men) | | 80 yrs and over (58 men) | | under 80 yrs (125 women) | | 80 yrs and over (71 women) | |
| Daily intake | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Meat | oz | 3.25 | (1.39) | 3.22 | (1.38) | 2.39 | (1.10) | 2.36 | (0.963) |
| Fish | oz | 0.76 | (0.727) | 0.84 | (0.801) | 0.59 | (0.638) | 0.56 | (0.525) |
| Eggs | oz | 1.39 | (0.891) | 1.36 | (0.943) | 1.07 | (0.713) | 0.93 | (0.673) |
| Cheese | oz | 0.51 | (0.493) | 0.42 | (0.613) | 0.41 | (0.473) | 0.28 | (0.366) |
| Milk (liquid whole) | oz | 11.7 | (7.12) | 12.8 | (6.19) | 12.0 | (6.40) | 10.7 | (4.60) |
| Milk (skimmed) | oz | 0.41 | (1.35) | 0.37 | (1.36) | 0.66 | (1.93) | 0.44 | (1.38) |

**Table 5.8:** *Mean daily intake of some foods for all men and all women in the survey, in two age groups*

| | | Sex and age group | | | |
|---|---|---|---|---|---|
| | | Under 80 yrs (111 men) | 80 yrs and over (58 men) | Under 80 yrs (125 women) | 80 yrs and over (71 women) |
| Daily intake | | Mean | Mean | Mean | Mean |
| Bread | oz | 4.15 | 3.90 | 2.73 | 2.49 |
| Butter | oz | 0.71 | 0.61 | 0.65 | 0.65 |
| Margarine | oz | 0.24 | 0.24 | 0.13 | 0.07 |
| Offal | oz | 0.22 | 0.17 | 0.24 | 0.15 |

**Table 5.9:** *Mean daily intakes (oz) of food groups by men in each area (percentage differences from the all areas means are shown in parentheses)*

| Food Group | All Areas | | Portsmouth | | Cambridgeshire | |
|---|---|---|---|---|---|---|
| Milk and Cream | 10.3 | — | 12.3 | (+19) | †13.0 | (+26) |
| Milk Puddings and Sauces | 1.6 | — | 1.8 | (+13) | 1.6 | (0) |
| Cheese and Cheese Dishes | 0.5 | — | 0.4 | (−20) | 0.6 | (+20) |
| Liver | 0.1 | — | ††0.3 | (+200) | 0.1 | (0) |
| Poultry and Poultry Dishes | 0.4 | — | 0.5 | (+25) | 0.5 | (+25) |
| Other Meats | 3.9 | — | 3.7 | (−5) | 3.4 | (−13) |
| Fish and Fish Dishes | 0.9 | — | 1.0 | (+11) | 0.7 | (−22) |
| Egg and Egg Dishes | 1.2 | — | 1.2 | (0) | 1.2 | (0) |
| Fats and Oils | 0.9 | — | 0.8 | (−11) | 0.9 | (0) |
| Sugar and Preserves | 1.6 | — | 1.5 | (−6) | 1.9 | (+19) |
| Chocolate and Sweets | 0.2 | — | 0.2 | (0) | 0.3 | (+50) |
| Potatoes | 3.2 | — | 3.6 | (+13) | 3.4 | (+6) |
| Tomatoes | 0.4 | — | 0.5 | (+25) | 0.4 | (0) |
| Leafy Green Vegetables | 0.7 | — | ††1.4 | (+100) | ††1.2 | (+71) |
| Pulses and Legumes | 0.7 | — | 1.0 | (+43) | 0.6 | (−14) |
| Other Vegetables | 1.0 | — | 1.5 | (+50) | †1.4 | (+40) |
| Citrus Fruits | 0.7 | — | 0.5 | (−29) | 0.7 | (0) |
| Major Vitamin C Non-Citrus Fruits | 0.1 | — | 0.1 | (0) | †0.3 | (+200) |
| Other Fruits | 1.4 | — | ††2.6 | (+86) | 1.6 | (+14) |
| Breakfast Cereals | 1.6 | — | 1.3 | (−19) | *0.5 | (−69) |
| Pasta and Rice | 0.1 | — | 0.1 | (0) | ***0.0 | (−100) |
| Bread | 4.0 | — | 3.3 | (−18) | 4.1 | (+3) |
| Biscuits, Scones, Cakes and Pastry | 2.2 | — | 2.4 | (+9) | 1.8 | (−18) |
| Fruit Pies and Fruit Puddings | 0.4 | — | 0.5 | (+25) | 0.6 | (+50) |
| Other Pies and Puddings | 0.5 | — | 0.7 | (+40) | 0.7 | (+40) |
| Alcoholic Beverages | 5.6 | — | 5.7 | (+2) | 4.0 | (−29) |
| Powdered Beverages not Fruit Based | 0.1 | — | †0.2 | (+100) | 0.1 | (0) |
| Tea and Coffee | 24.0 | — | 19.0 | (−21) | 21.4 | (−11) |
| Soups | 1.8 | — | 1.4 | (−22) | **0.5 | (−72) |
| All Other Foods | 1.8 | — | ††4.4 | (+144) | 1.0 | (−44) |
| Number of Men | 169 | | 18 | | 43 | |

Note: Care should be taken when interpreting percentage changes from small all areas mean intakes (e.g. mean intake of pasta and rice is 0.1 oz)

Area mean significantly greater than all areas mean: †$P<0.05$ ††$P<0.01$ †††$P<0.001$

Area mean significantly lower than all areas mean: *$P<0.05$ **$P<0.01$ ***$P<0.001$

| Sunderland | | Rutherglen | | Angus | | Camden | |
|---|---|---|---|---|---|---|---|
| *7.9 | (−23) | 9.5 | (−8) | 10.7 | (+4) | 8.9 | (−14) |
| *1.0 | (−38) | 1.8 | (+13) | ††2.8 | (+75) | 1.4 | (−13) |
| 0.4 | (−20) | 0.2 | (−60) | 0.6 | (+20) | 0.5 | (0) |
| 0.1 | (0) | 0.1 | (0) | 0.1 | (0) | 0.1 | (0) |
| *0.2 | (−50) | 0.2 | (−50) | 0.3 | (−25) | †0.9 | (+125) |
| †4.5 | (+15) | 2.9 | (−26) | 4.3 | (+10) | 3.6 | −8) |
| 0.8 | (−11) | ††1.6 | (+78) | 0.9 | (0) | 1.1 | (+22) |
| 1.2 | (0) | 1.2 | (0) | 1.4 | (+17) | 0.7 | (−42) |
| 1.0 | (+11) | 1.1 | (+22) | 1.0 | (+11) | 0.7 | (−22) |
| *1.3 | (−19) | 1.7 | (+6) | 2.0 | (+25) | 1.3 | (−19) |
| 0.2 | (0) | 0.0 | (−100) | 0.2 | (0) | 0.1 | (−50) |
| 2.9 | (−9) | 2.9 | (−9) | 3.4 | (+6) | 3.6 | (+13) |
| 0.4 | (0) | 0.1 | (−75) | 0.3 | (−25) | 0.4 | (0) |
| *0.4 | (−43) | 0.2 | (−71) | 0.5 | (−29) | 1.3 | (+86) |
| 0.9 | (+29) | 1.1 | (+57) | **0.2 | (−71) | 0.7 | (0) |
| 1.0 | (0) | *0.4 | (−60) | *0.6 | (−40) | 1.0 | (0) |
| 0.8 | (+14) | 0.2 | (−71) | 0.7 | (0) | 1.3 | (+86) |
| 0.1 | (0) | 0.0 | (−100) | 0.0 | (−100) | 0.1 | (0) |
| **0.7 | (−50) | 1.0 | (−29) | 1.6 | (+14) | ††3.2 | (+129) |
| **0.4 | (−75) | †3.8 | (+138) | †††4.7 | (+194) | 0.3 | (−81) |
| ***0.0 | (−100) | 0.1 | (0) | **0.0 | (−100) | 0.2 | (+100) |
| 4.4 | (+10) | 4.2 | (+5) | 3.6 | (−10) | 3.2 | (−20) |
| 2.2 | (0) | 2.6 | (+18) | †2.9 | (+32) | 1.2 | (−45) |
| 0.4 | (0) | 0.2 | (−50) | 0.4 | (0) | 0.4 | (0) |
| 0.5 | (0) | *0.1 | (−80) | 0.4 | (−20) | 0.6 | (+20) |
| 8.2 | (+46) | 1.8 | (−68) | 2.3 | (−59) | 13.7 | (+145) |
| ***0.0 | (−100) | *0.0 | (−100) | ***0.0 | (−100) | 0.1 | (0) |
| †28.7 | (+20) | 21.3 | (−11) | 24.0 | (0) | 21.6 | (−10) |
| *1.0 | (−44) | 3.1 | (+72) | †††4.5 | (+150) | 2.0 | (+11) |
| 1.3 | (−28) | 2.0 | (+11) | 1.7 | (−6) | 3.6 | (+100) |
| 56 | | 13 | | 30 | | 9 | |

**Table 5.10:** *Mean daily intakes (oz) of food groups by women in each area (percentage differences from the all areas means are shown in parentheses)*

| Food Group | All Areas | | Portsmouth | | Cambridgeshire | |
|---|---|---|---|---|---|---|
| Milk and Cream | 9.9 | — | 10.3 | (+4) | ††13.3 | (+34) |
| Milk Puddings and Sauces | 1.4 | — | 1.5 | (+7) | 1.5 | (+7) |
| Cheese and Cheese Dishes | 0.4 | — | 0.4 | (0) | 0.4 | (0) |
| Liver | 0.1 | — | 0.1 | (0) | 0.1 | (0) |
| Poultry and Poultry Dishes | 0.3 | — | *0.1 | (−67) | 0.2 | (−33) |
| Other Meats | 2.9 | — | 3.3 | (+14) | 2.7 | (−7) |
| Fish and Fish Dishes | 0.7 | — | 0.7 | (0) | 0.5 | (−29) |
| Egg and Egg Dishes | 0.8 | — | 0.5 | (−37) | 0.6 | (−25) |
| Fats and Oils | 0.8 | — | 0.7 | (−12) | 0.8 | (0) |
| Sugar and Preserves | 1.0 | — | 1.0 | (0) | 1.2 | (+20) |
| Chocolate and Sweets | 0.2 | — | 0.2 | (0) | 0.2 | (0) |
| Potatoes | 2.3 | — | 2.5 | (+9) | †2.9 | (+26) |
| Tomatoes | 0.4 | — | 0.4 | (0) | 0.5 | (+25) |
| Leafy Green Vegetables | 0.7 | — | 0.9 | (+29) | †††1.4 | (+100) |
| Pulses and Legumes | 0.6 | — | 0.4 | (+33) | 0.7 | (+17) |
| Other Vegetables | 0.9 | — | †1.5 | (+67) | 1.1 | (+22) |
| Citrus Fruits | 0.8 | — | 1.1 | (+38) | 0.7 | (−12) |
| Major Vitamin C Non-Citrus Fruits | 0.1 | — | 0 | (−100) | 0.2 | (+100) |
| Other Fruits | 1.5 | — | 1.9 | (+27) | 1.2 | (−20) |
| Breakfast Cereals | 0.9 | — | 0.6 | (−33) | 0.6 | (−33) |
| Pasta and Rice | 0.1 | — | 0.1 | (0) | 0.0 | (−100) |
| Bread | 2.6 | — | 2.4 | (−8) | 3.0 | (+15) |
| Biscuits, Scones, Cakes and Pastry | 2.0 | — | 1.7 | (−15) | 1.7 | (−15) |
| Fruit Pies and Fruit Puddings | 0.4 | — | 0.3 | (−25) | ††0.8 | (+100) |
| Other Pies and Puddings | 0.4 | — | 0.5 | (+25) | ††0.9 | (+125) |
| Alcoholic Beverages | 0.7 | — | 0.5 | (−29) | 0.7 | (0) |
| Powdered Beverages not Fruit Based | 0.1 | — | 0.1 | (0) | 0.1 | (0) |
| Tea and Coffee | 22.2 | — | *17.7 | (−20) | 21.3 | (−4) |
| Soups | 1.7 | — | 0.7 | (−59) | **0.4 | (−76) |
| All Other Foods | 1.7 | — | ††3.6 | (+112) | 1.0 | (−41) |
| Number of Women | 196 | | 20 | | 29 | |

Note: Care should be taken when interpreting percentage changes from small all areas mean intakes (e.g. mean intake of pasta and rice is 0.1 oz)

Area mean significantly greater than all areas mean: † $P<0.05$ †† $P<0.01$ ††† $P<0.001$

Area mean significantly lower than all areas mean: * $P<0.05$ ** $P<0.01$ *** $P<0.001$

| Sunderland | | Rutherglen | | Angus | | Camden | |
|---|---|---|---|---|---|---|---|
| *8.0 | (−19) | 8.6 | (−13) | 9.6 | (−3) | †12.0 | (+21) |
| **0.9 | (−36) | 1.3 | (−7) | †2.1 | (+50) | 1.5 | (+7) |
| 0.3 | (−25) | 0.5 | (+25) | 0.3 | (−25) | †0.7 | (+75) |
| 0.1 | (0) | 0.2 | (+100) | 0.1 | (0) | 0.2 | (+100) |
| 0.3 | (0) | 0.4 | (+33) | 0.2 | (−33) | 0.4 | (+33) |
| 2.9 | (0) | 3.0 | (+3) | 3.0 | (+3) | *2.3 | (−21) |
| 0.8 | (+14) | 0.5 | (−29) | 0.8 | (+14) | 0.7 | (0) |
| 0.8 | (0) | 1.0 | (+25) | 1.0 | (+25) | 1.0 | (+25) |
| 0.8 | (0) | †1.0 | (+25) | 0.7 | (−12) | 0.8 | (0) |
| 0.9 | (−10) | 0.9 | (−10) | 1.2 | (+20) | 1.2 | (+20) |
| *0.1 | (−50) | 0.1 | (−50) | 0.3 | (+50) | 0.3 | (+50) |
| 1.9 | (−17) | 1.7 | (−26) | 2.2 | (−4) | 2.7 | (+17) |
| 0.4 | (0) | 0.2 | (−50) | 0.3 | (−25) | 0.4 | (0) |
| **0.4 | (−43) | 0.5 | (−29) | 0.4 | (−43) | ††1.2 | (+71) |
| 0.7 | (+17) | 0.5 | (−17) | **0.2 | (−67) | 0.6 | (0) |
| 0.7 | (−22) | 0.6 | (−33) | *0.5 | (−44) | 1.3 | (+44) |
| 0.6 | (−25) | 0.7 | (−12) | 1.0 | (+25) | 0.9 | (+13) |
| **0.0 | (−100) | 0.0 | (−100) | 0.1 | (0) | 0.1 | (0) |
| *1.0 | (−33) | 1.3 | (−13) | 1.2 | (−20) | †††3.0 | (+100) |
| 0.6 | (−33) | 1.4 | (+56) | †1.9 | (+111) | 0.8 | (−11) |
| *0.0 | (−100) | 0.0 | (−100) | 0.0 | (−100) | ††0.4 | (+300) |
| 2.8 | (+8) | 2.7 | (+4) | 2.5 | (−4) | 2.2 | (−15) |
| 2.2 | (+10) | 2.4 | (+20) | 2.3 | (+15) | 1.8 | (−10) |
| 0.3 | (−25) | 0.2 | (−50) | 0.6 | (+50) | 0.3 | (−25) |
| 0.4 | (0) | 0.2 | (−50) | 0.2 | (−50) | 0.4 | (0) |
| 0.8 | (+14) | 0.1 | (−86) | 0.2 | (−71) | 1.4 | (+100) |
| 0.1 | (0) | 0.1 | (0) | **0.0 | (−100) | 0.1 | (0) |
| 23.2 | (+5) | 22.3 | (0) | 23.3 | (+5) | 22.6 | (+2) |
| 1.4 | (−18) | ††3.2 | (+88) | †††3.7 | (+118) | 1.3 | (−24) |
| **0.7 | (−59) | 1.2 | (−29) | 2.3 | (+35) | †3.2 | (+88) |
| 66 | | 21 | | 30 | | 30 | |

FIGURE 5.1 ***Percentage frequency distribution of average daily intakes of energy — in kilocalories [and megajoules].***

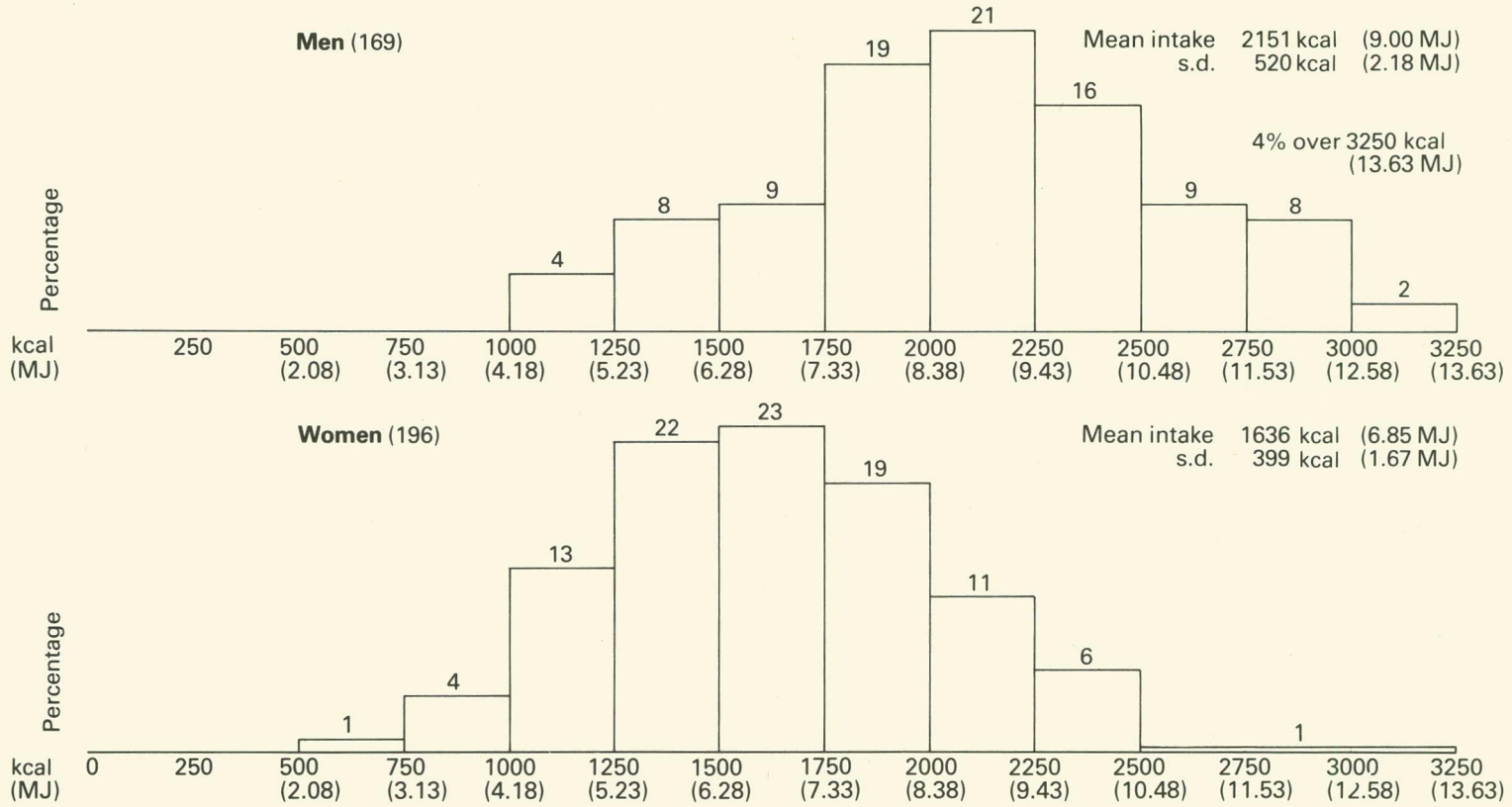


FIGURE 5.2 ***Percentage frequency distribution of average daily intakes of animal protein — in grams.***

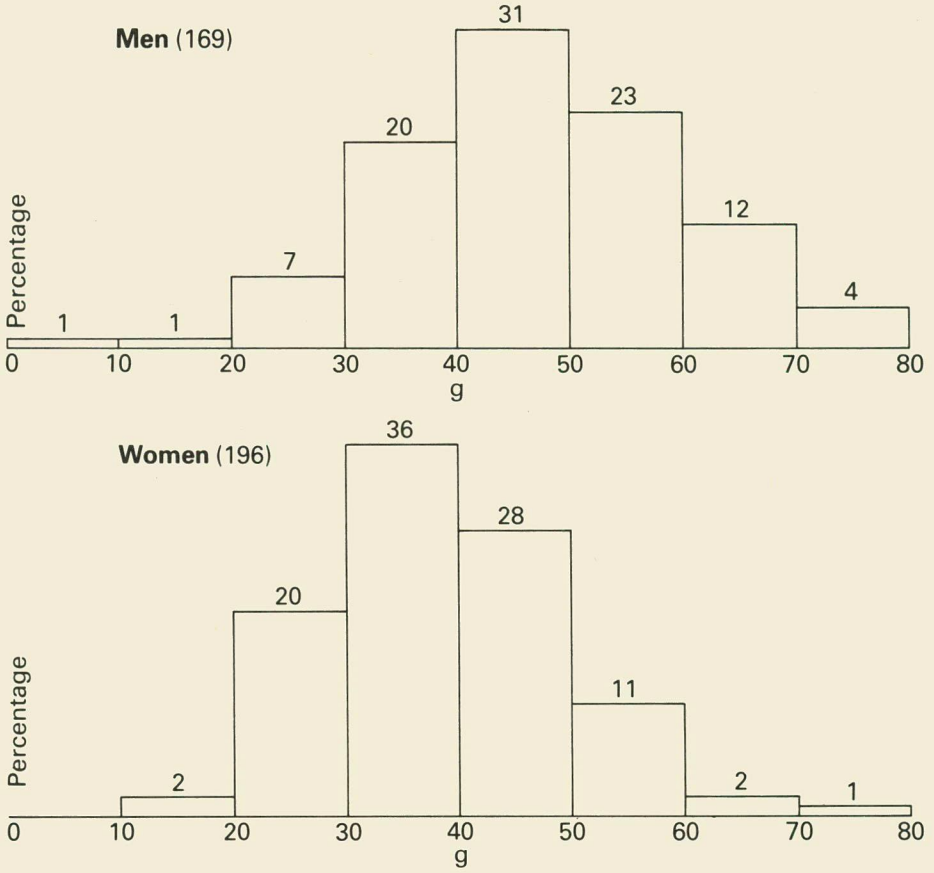


FIGURE 5.3 ***Percentage frequency distribution of average daily intakes of total protein — in grams.***

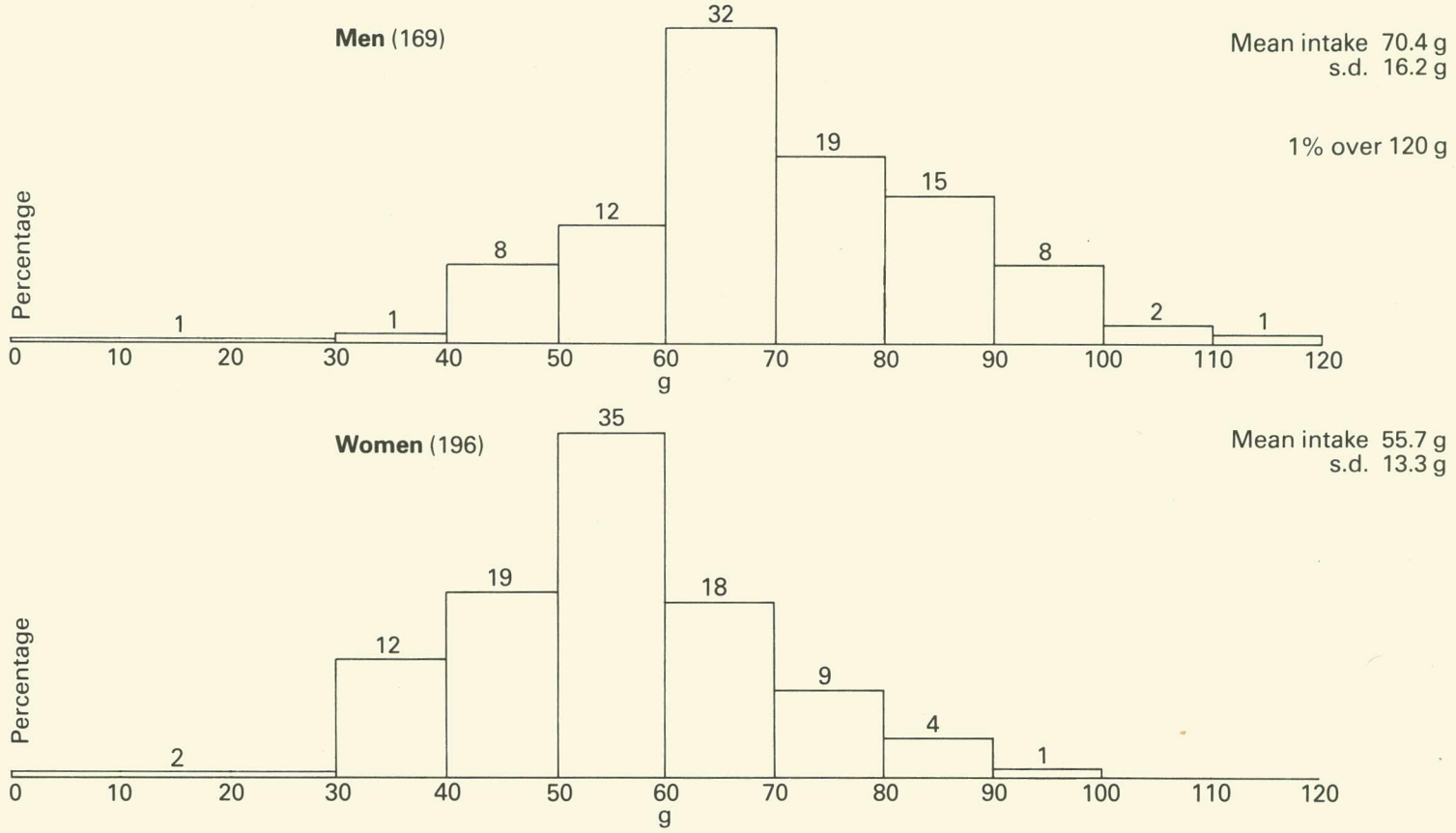


FIGURE 5.4 ***Percentage frequency distribution of average daily intakes of fat — in grams.***

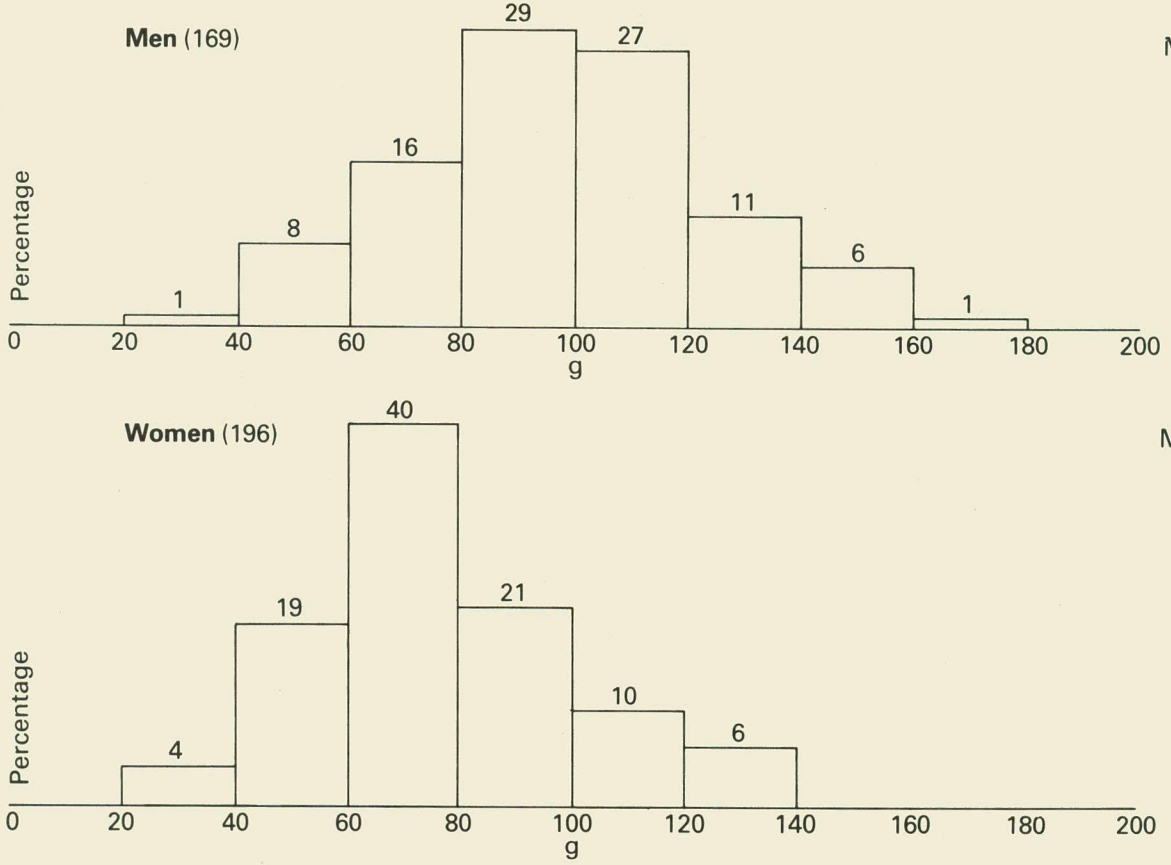


FIGURE 5.5 ***Percentage distribution of average daily intakes of carbohydrate — in grams.***

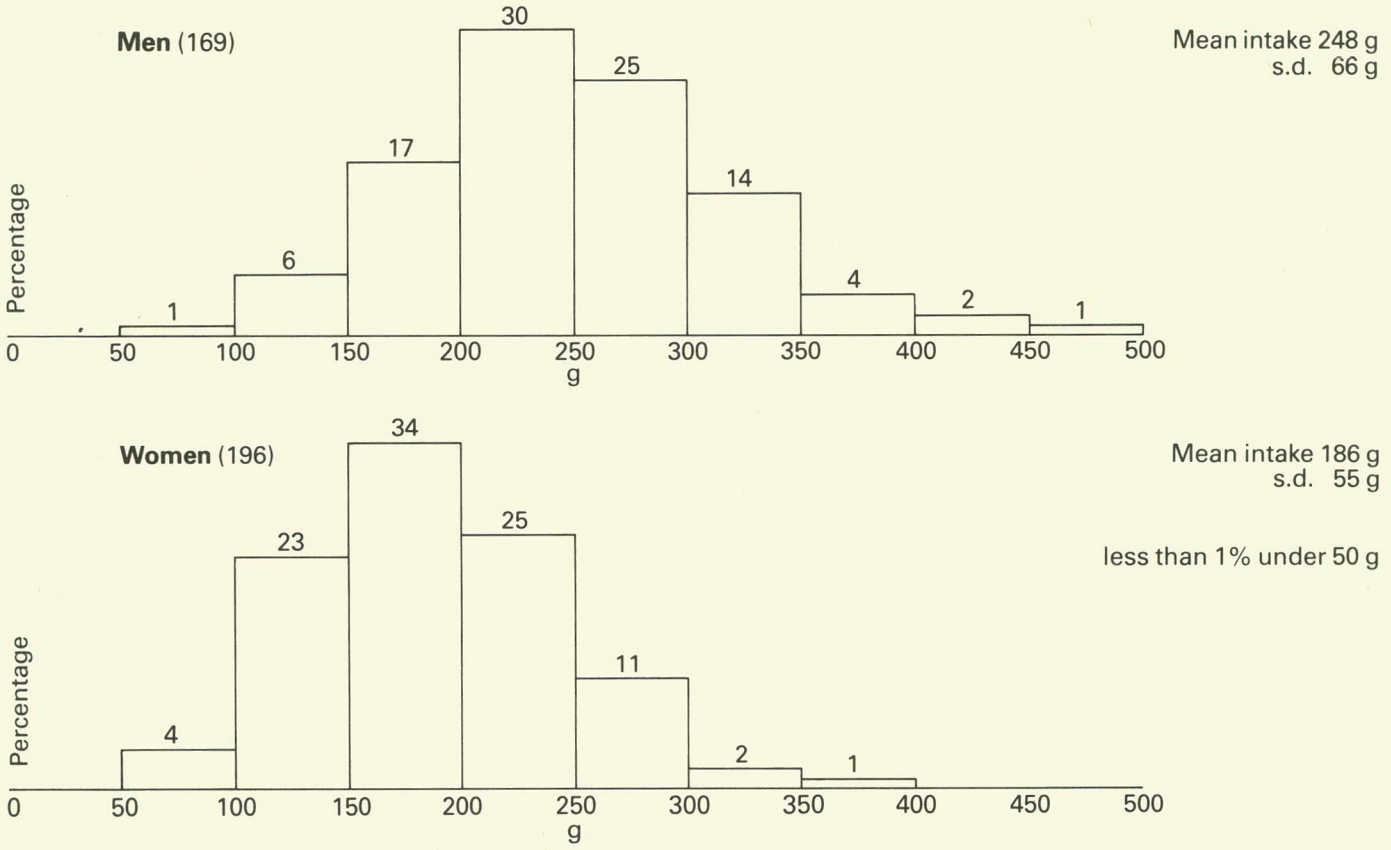


FIGURE 5.6 ***Percentage frequency distribution of average daily intakes of calcium — in milligrams.***

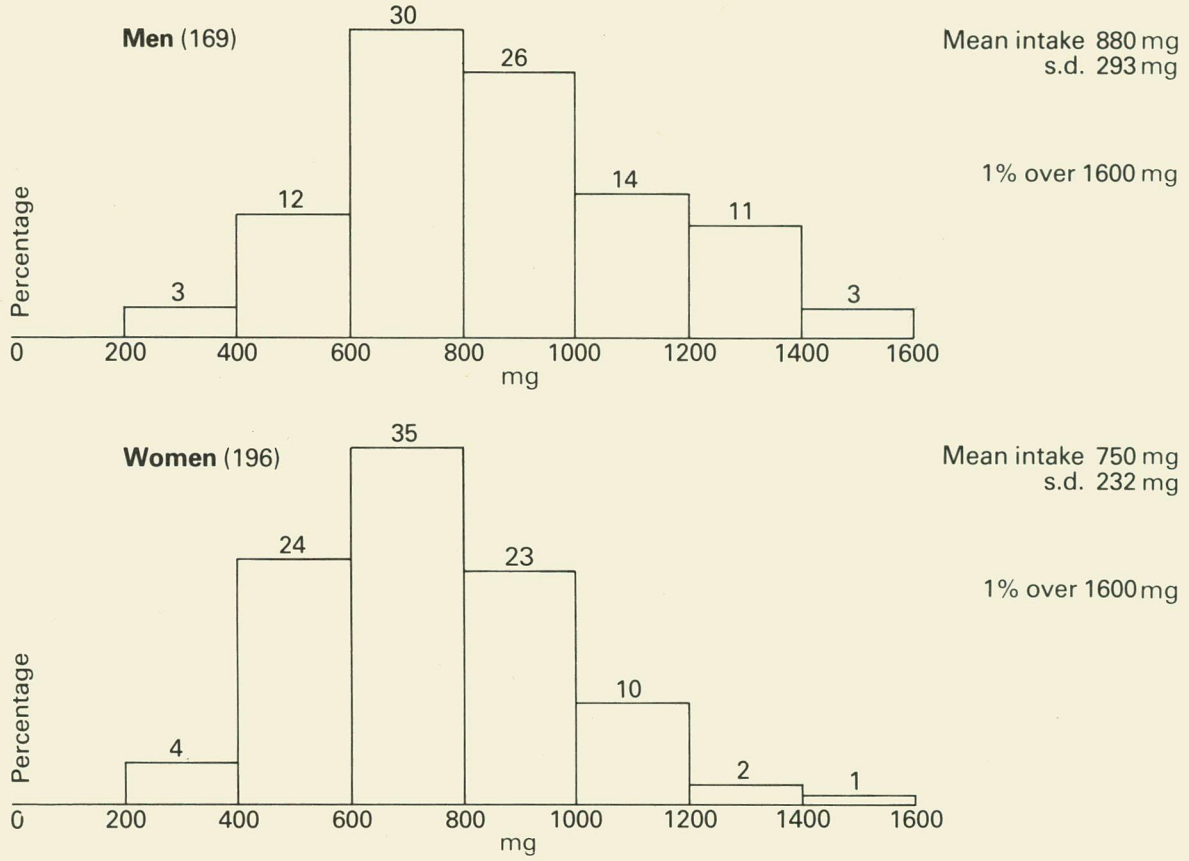


FIGURE 5.7 ***Percentage frequency distribution of average daily intakes of iron — in milligrams.***

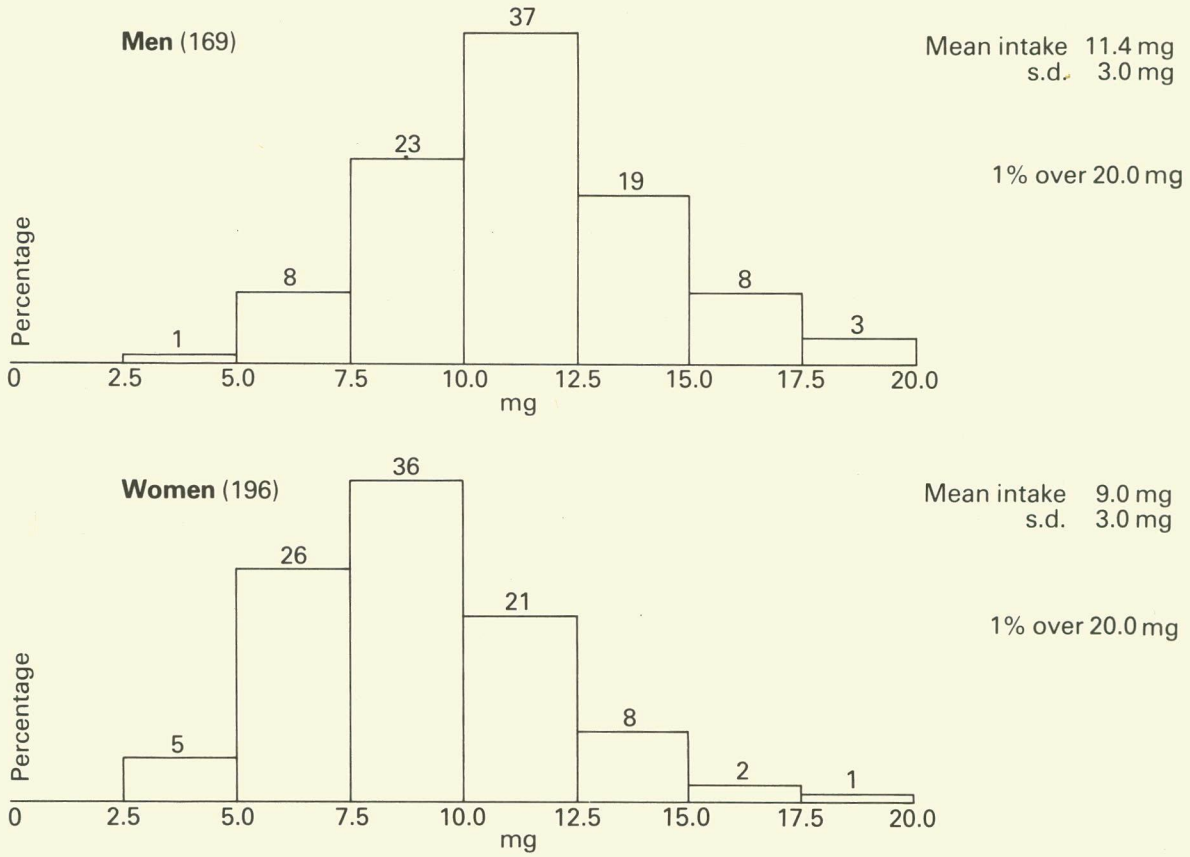


FIGURE 5.8 ***Percentage frequency distribution of average daily intakes of vitamin A — in micrograms.***

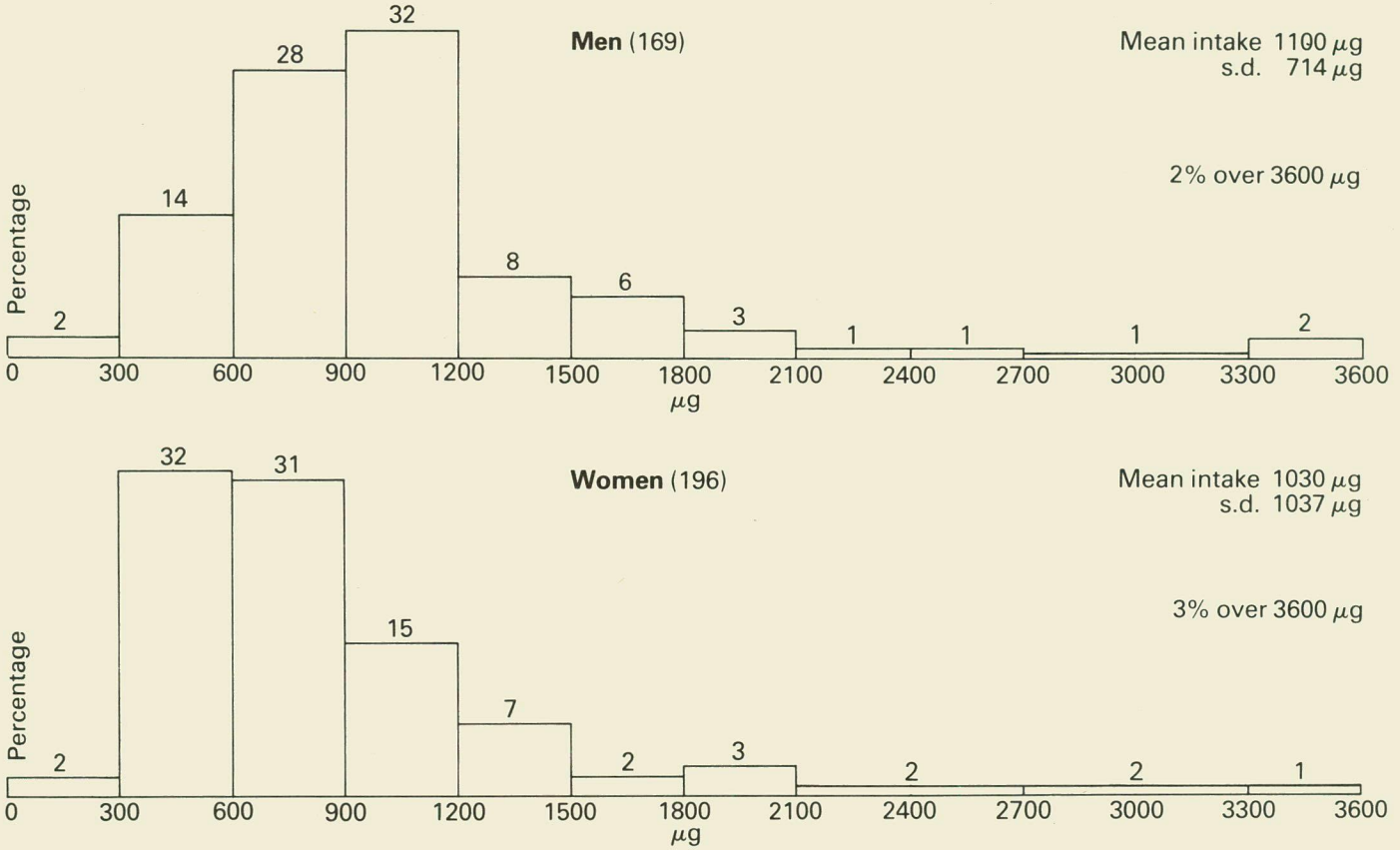


FIGURE 5.9 ***Percentage frequency distribution of average daily intakes of thiamin — in milligrams.***

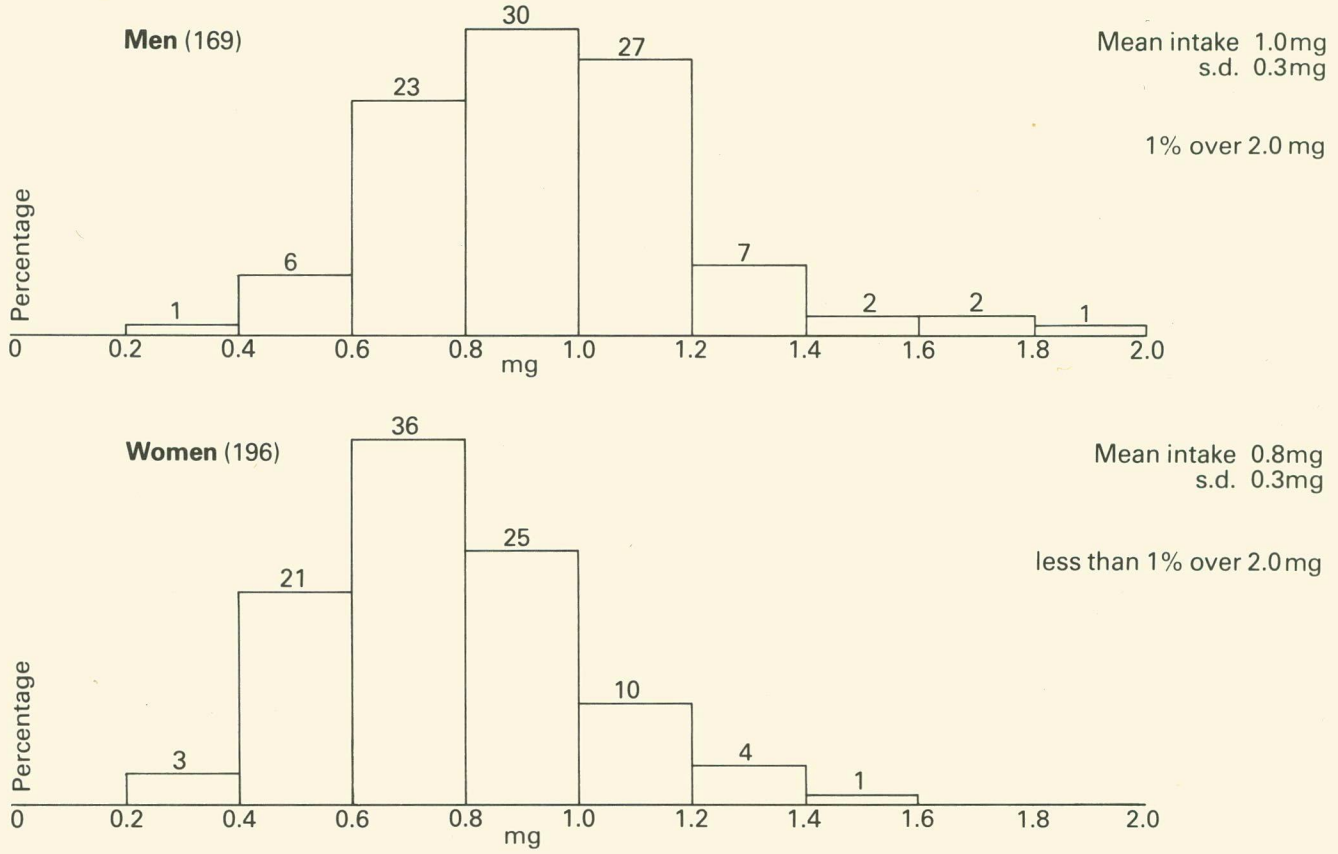


FIGURE 5.10 ***Percentage frequency distribution of average daily intakes of riboflavin — in milligrams.***

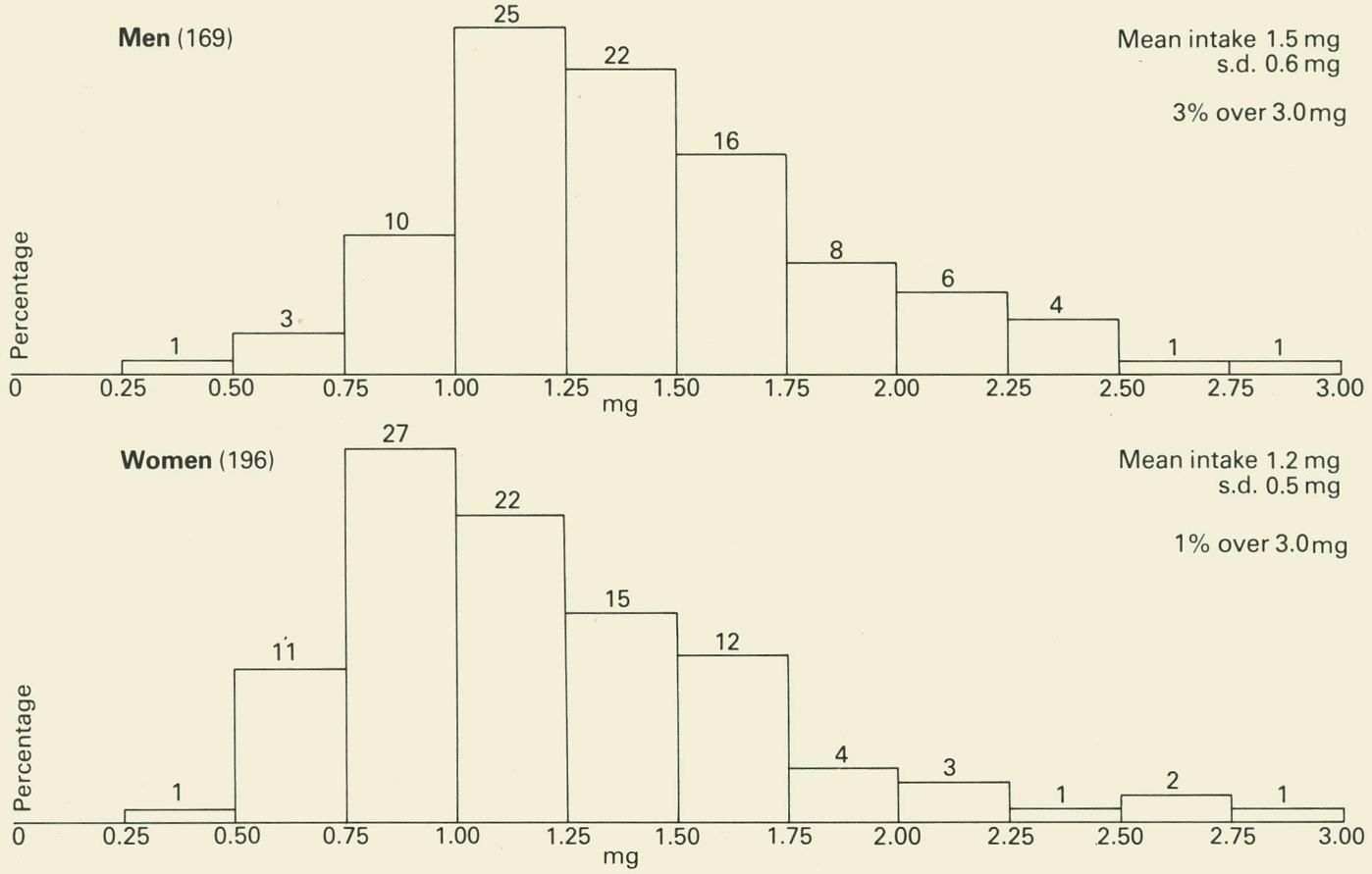


FIGURE 5.11 ***Percentage frequency distribution of average daily intakes of nicotinic acid — in milligrams.***

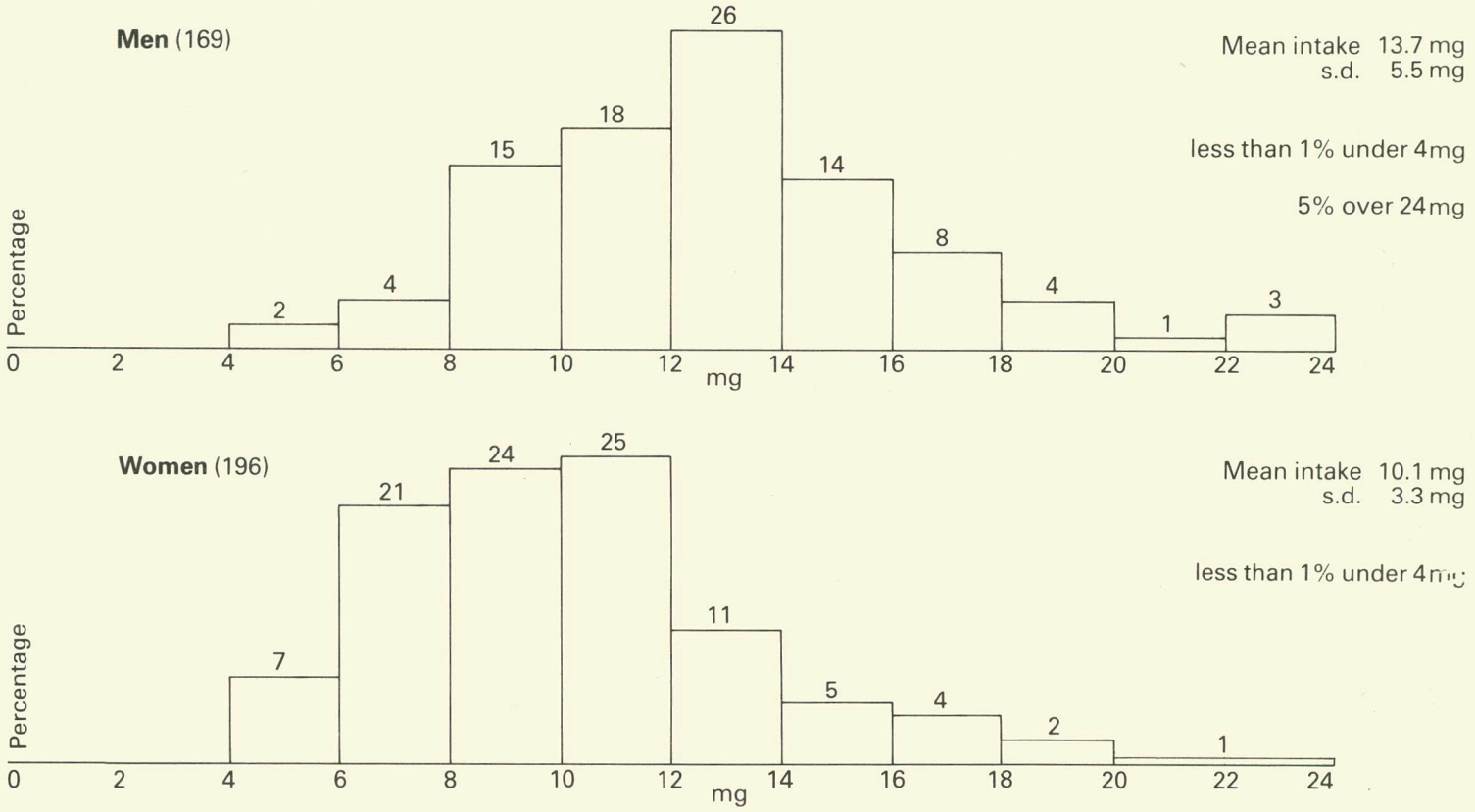


FIGURE 5.12 ***Percentage frequency distribution of average daily intakes of pyridoxine — in milligrams.***

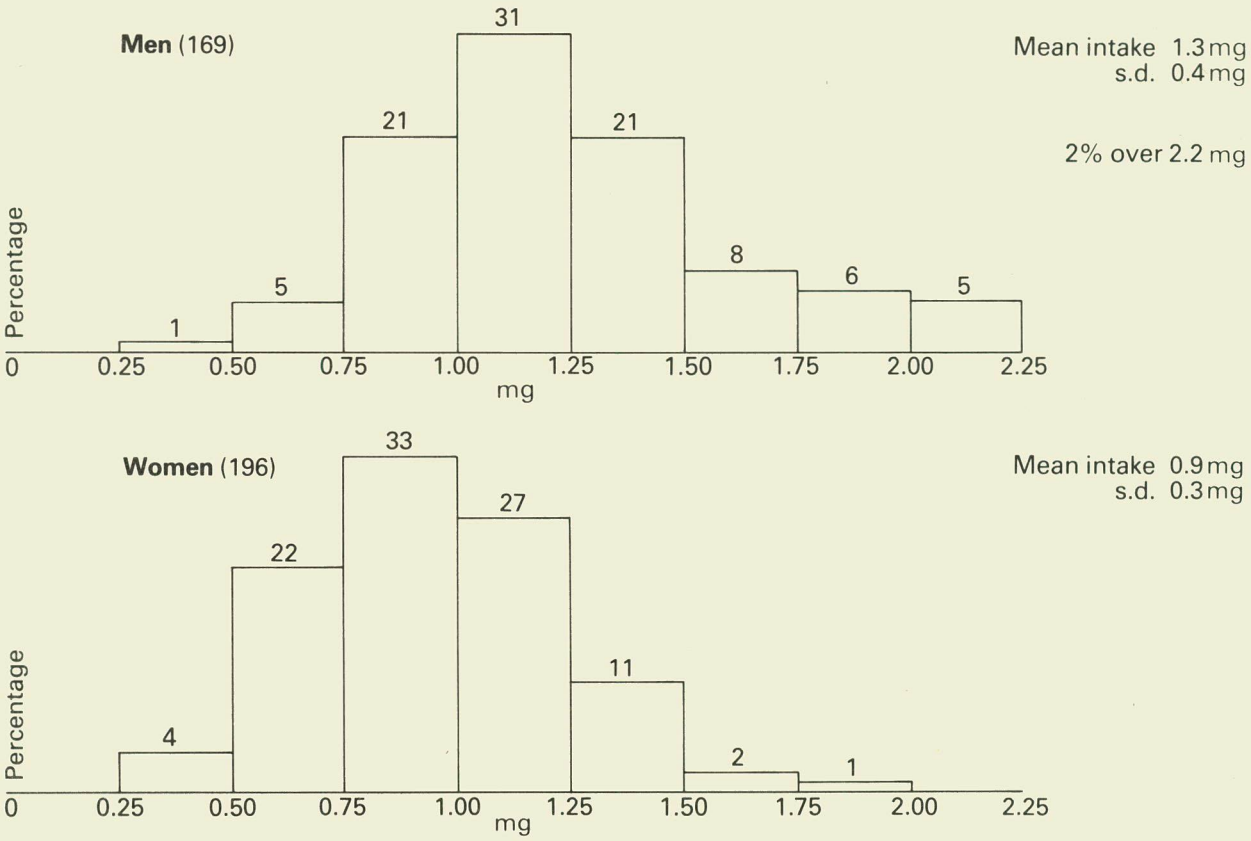


FIGURE 5.13 ***Percentage frequency distribution of average daily intakes of vitamin C — in milligrams.***

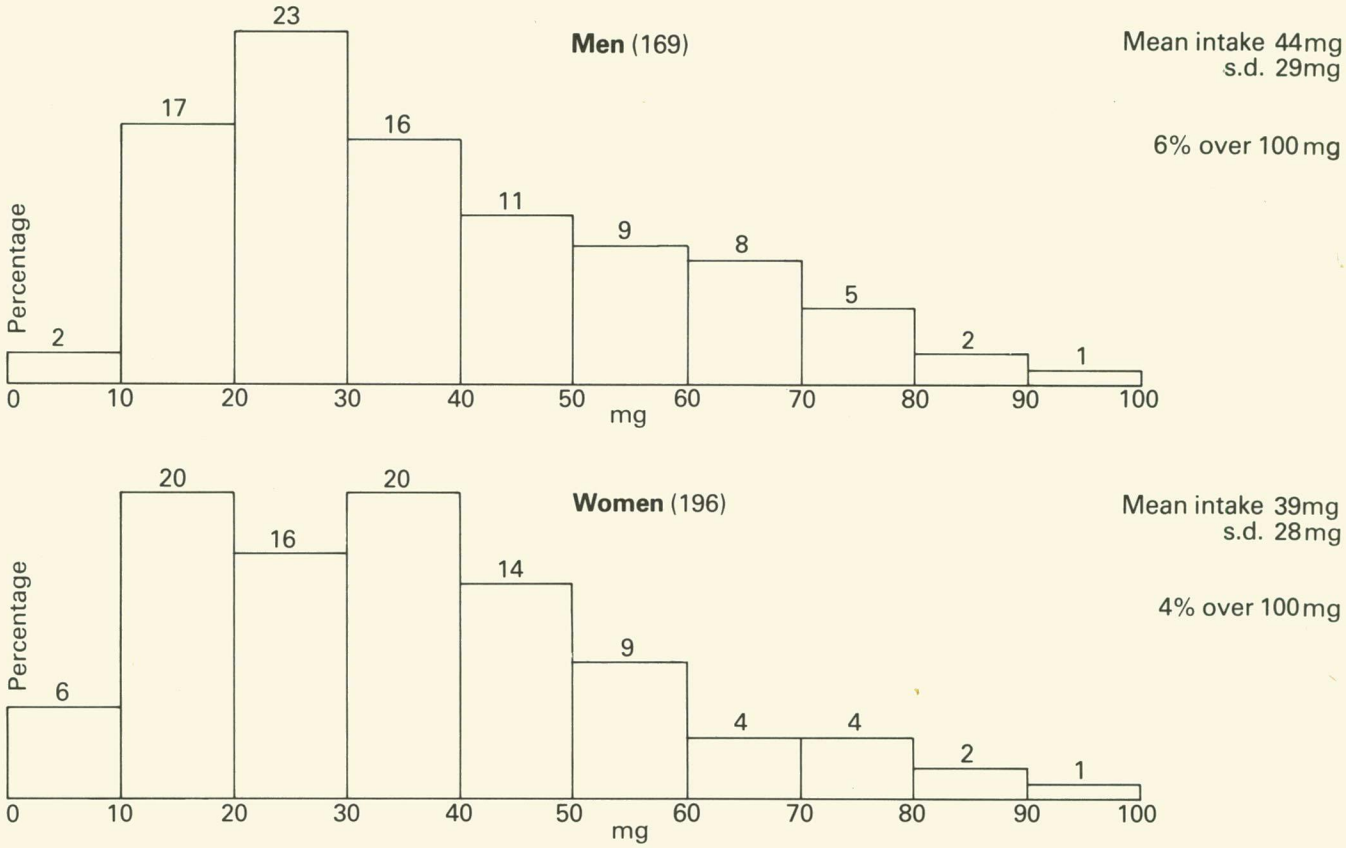


FIGURE 5.14 ***Percentage frequency distribution of average daily intakes of vitamin D — in micrograms.***

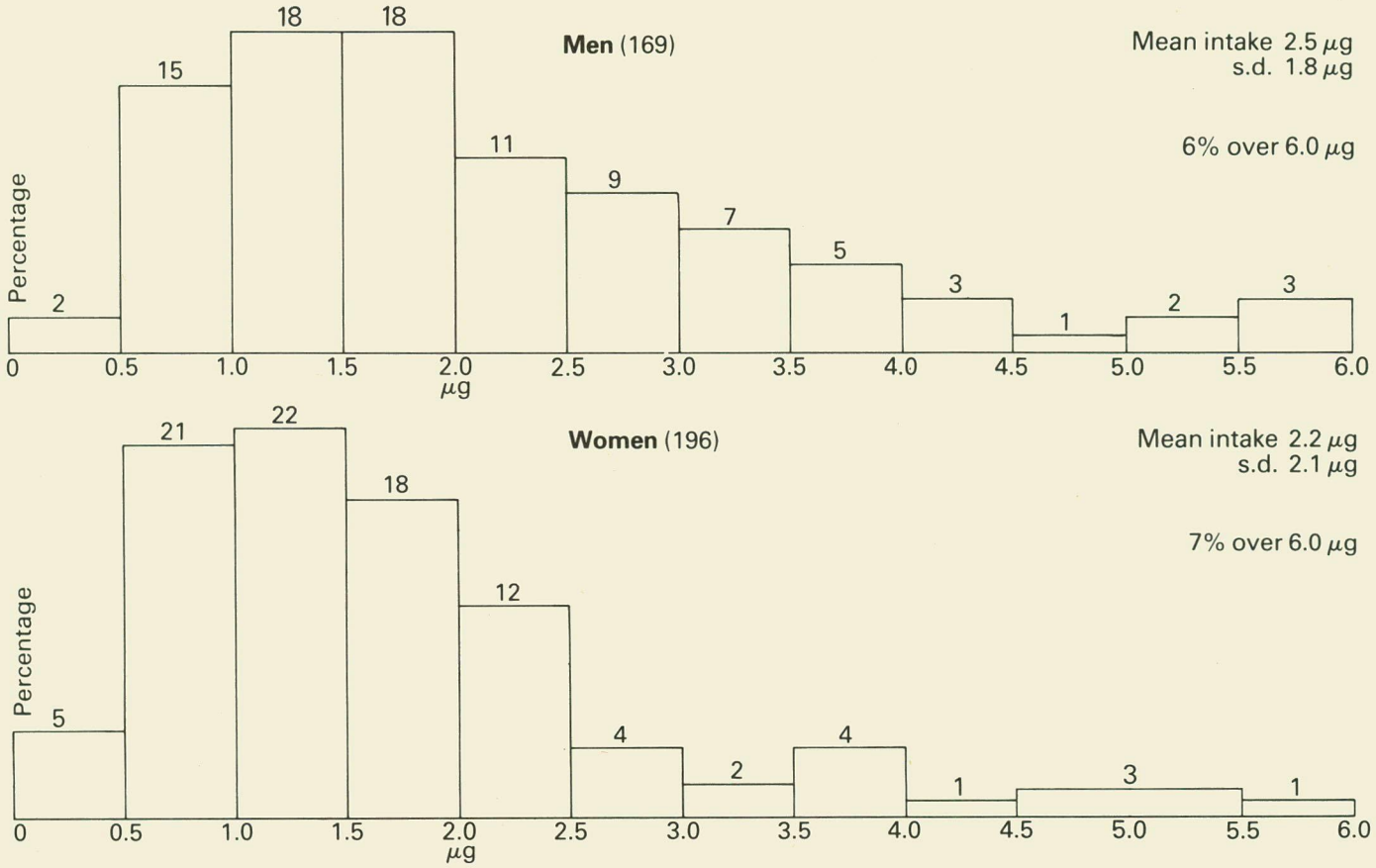


FIGURE 5.15 ***Percentage frequency distribution of average daily intakes of "added sugars" — in grams.***

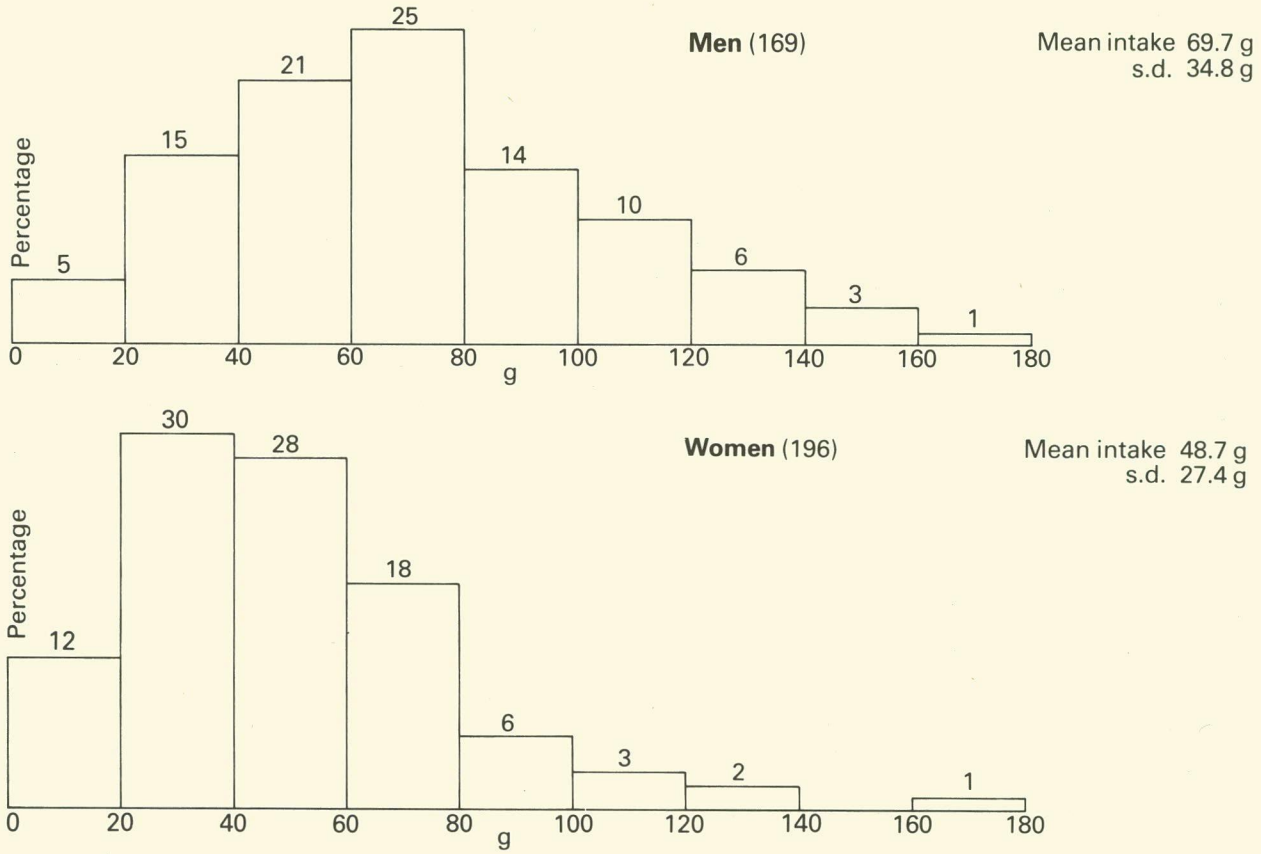
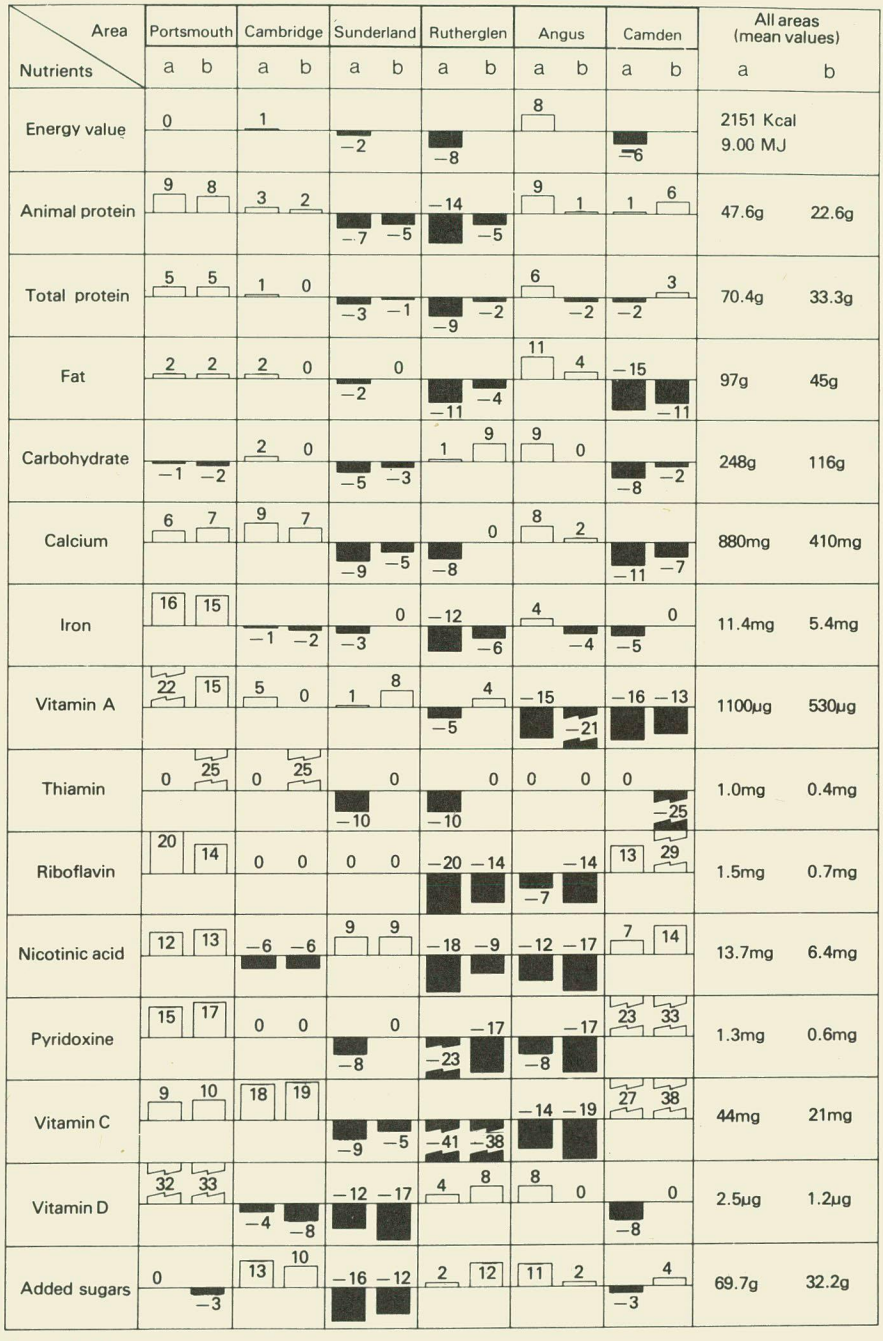


FIGURE 5.16

***Mean daily intakes of nutrients, and of nutrients per 1000 kcal, by area — expressed as percentage differences from the mean values for all areas.***

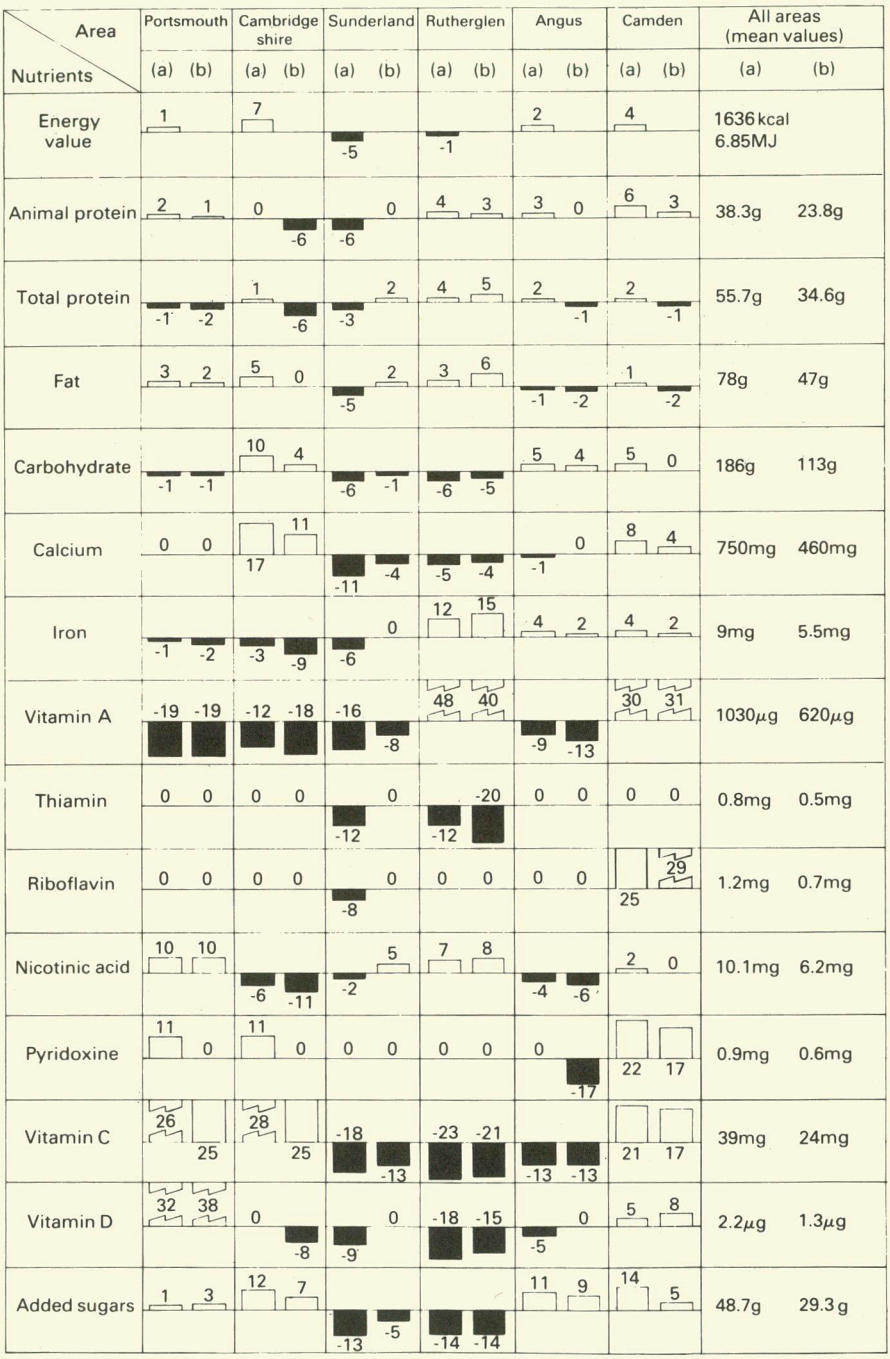
**Men**




Key a) Intake
b) Intake/1000 kcal

FIGURE 5.17 ***Mean daily intakes of nutrients, and nutrients per 1000 kcal, by area — expressed as percentage differences from the mean values for all areas.***

## Women




a) Intake
b) Intake/1000 kcal

FIGURE 5.18 ***Percentage frequency distribution of average daily intakes of meat — in ounces.***

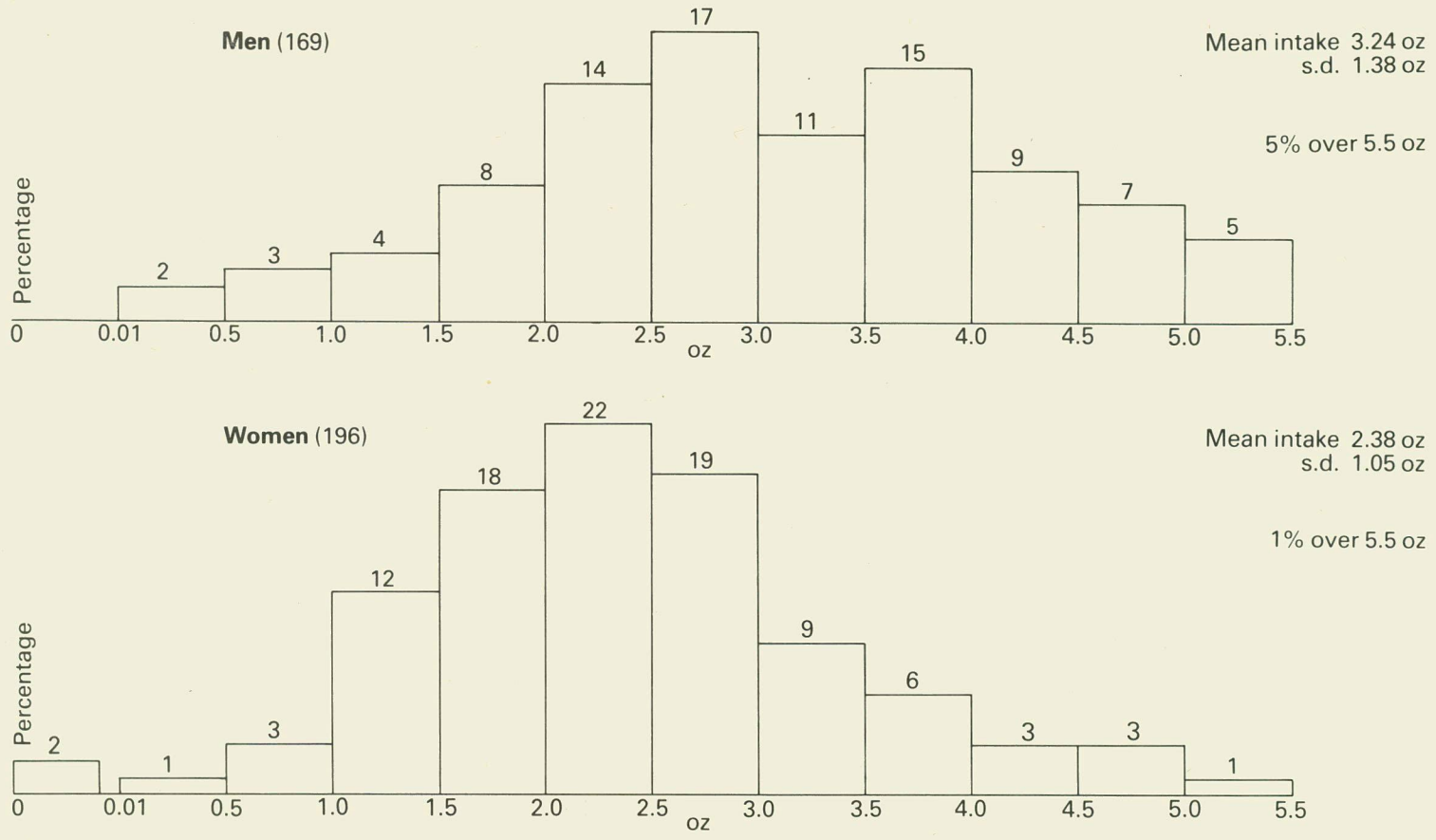


FIGURE 5.19 ***Percentage frequency distribution of average daily intakes of fish — in ounces.***

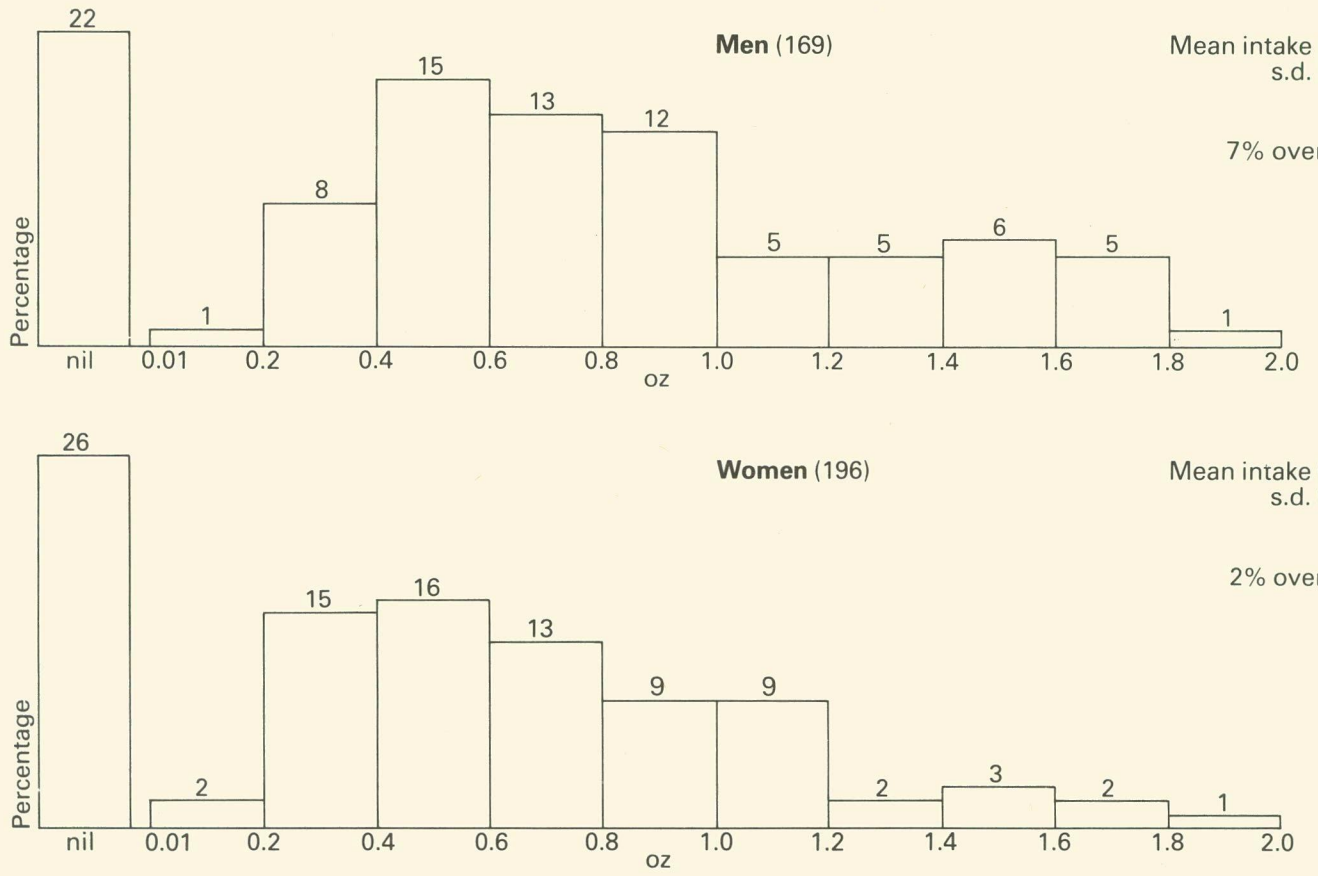


FIGURE 5.20 ***Percentage frequency distribution of average daily intake of eggs — in ounces.***

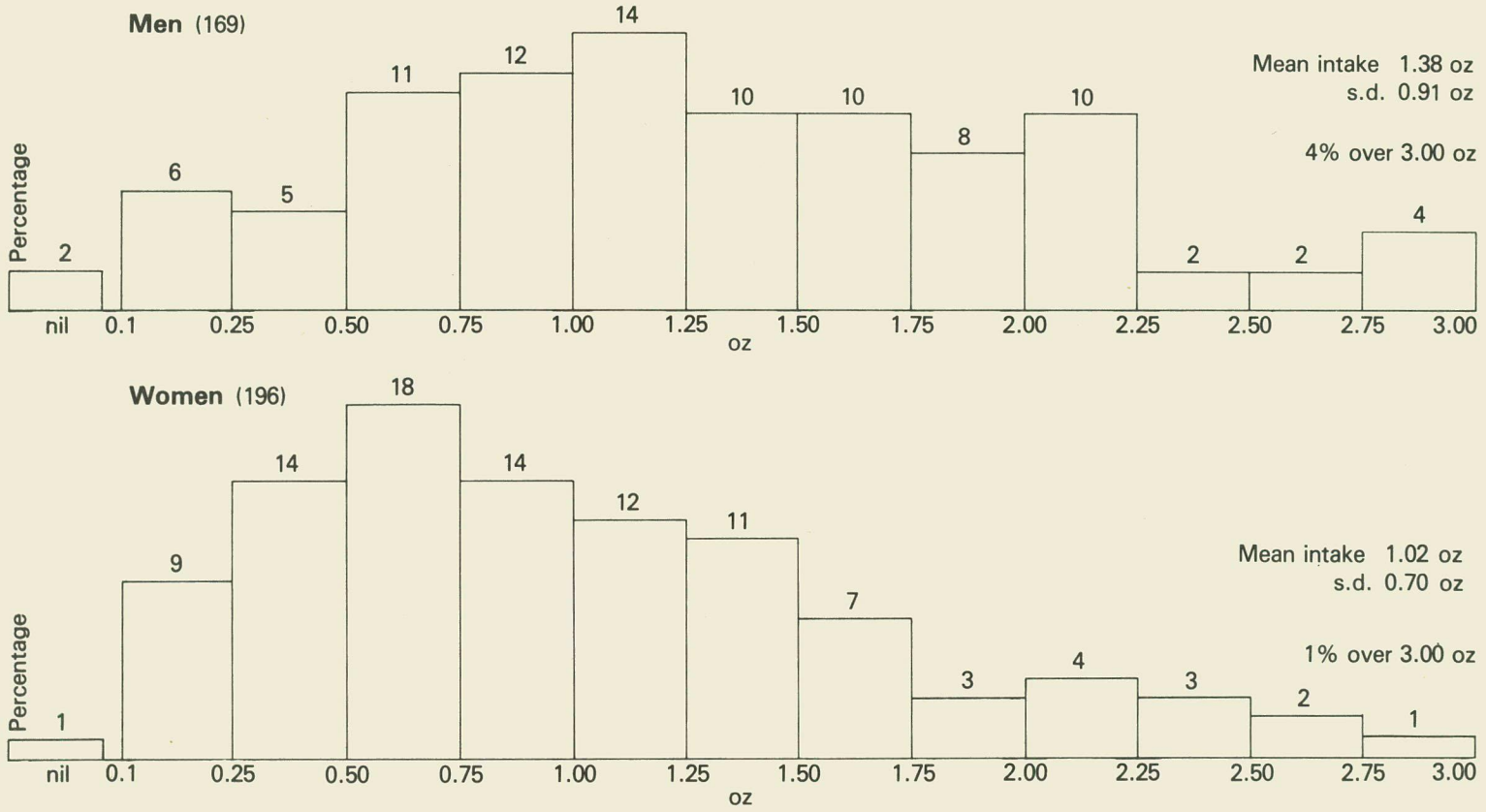


FIGURE 5.21 ***Percentage frequency distribution of average daily intakes of cheese — in ounces.***

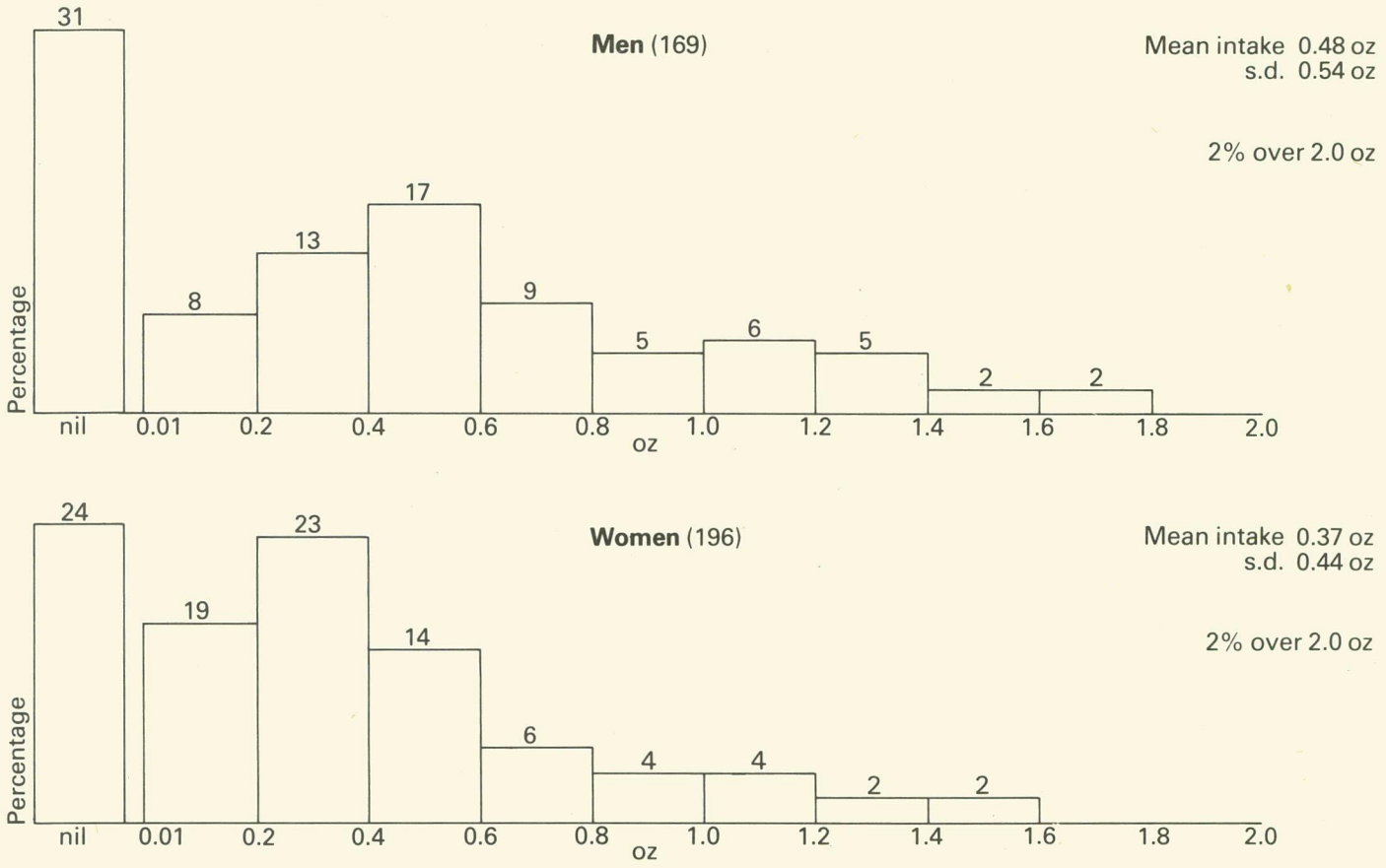
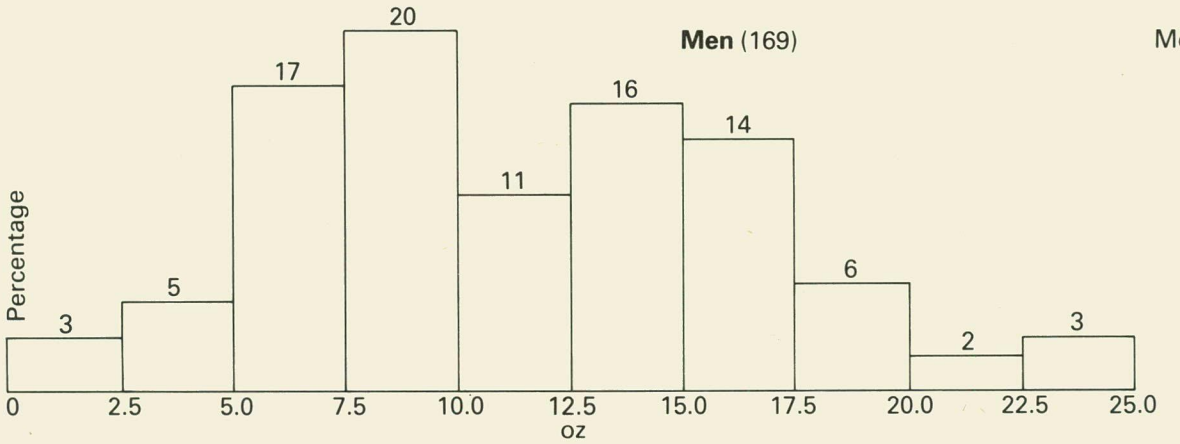


FIGURE 5.22 ***Percentage frequency distribution of average daily intakes of liquid whole milk — in ounces.***



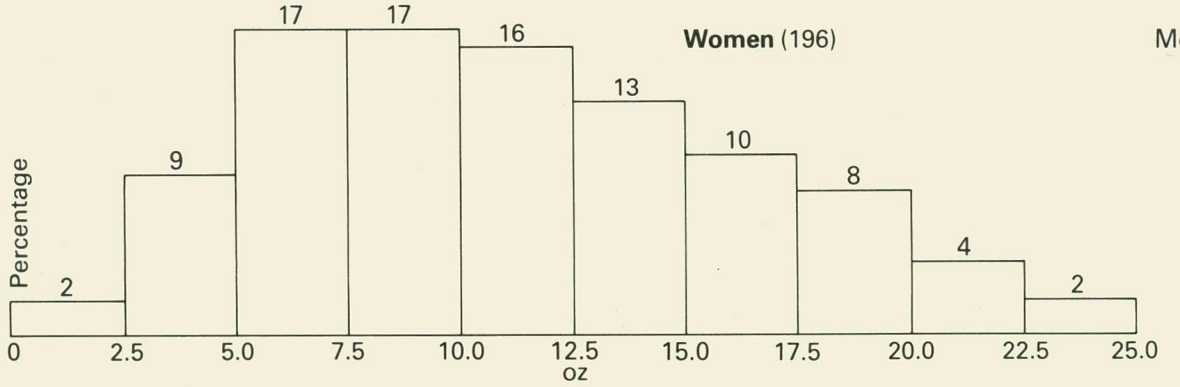



FIGURE 5.23 ***The percentage distribution of mean daily intakes [MDI] of energy, total protein and vitamin C of the elderly men and women — in two age groups: under 80 years and 80 years or over.***

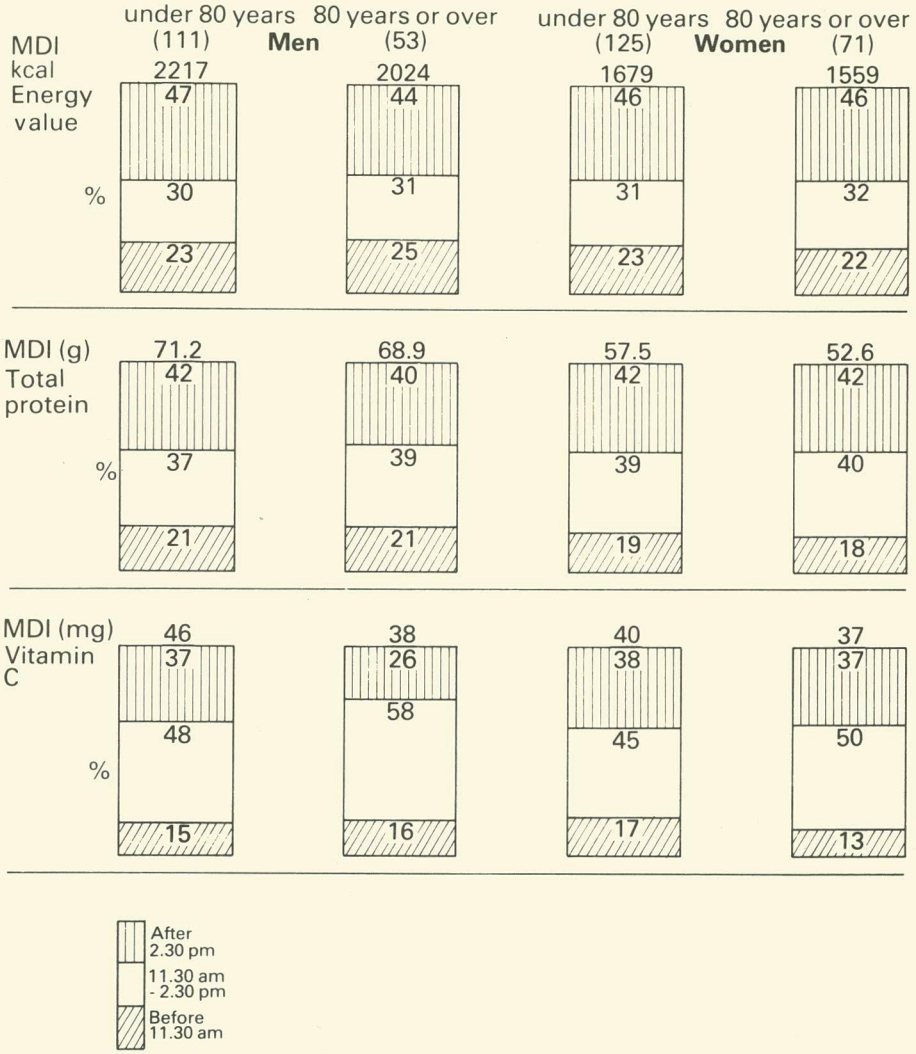
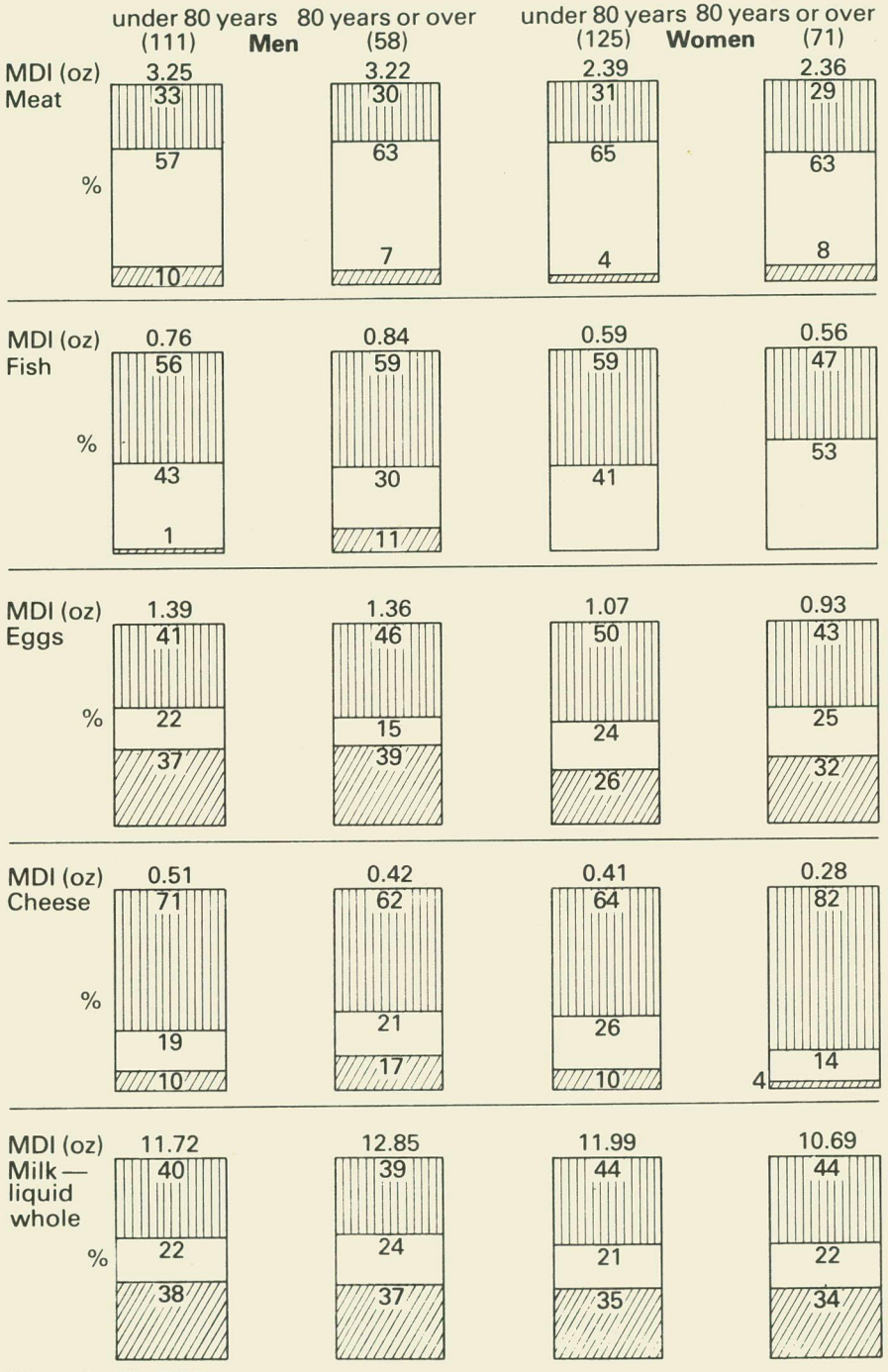
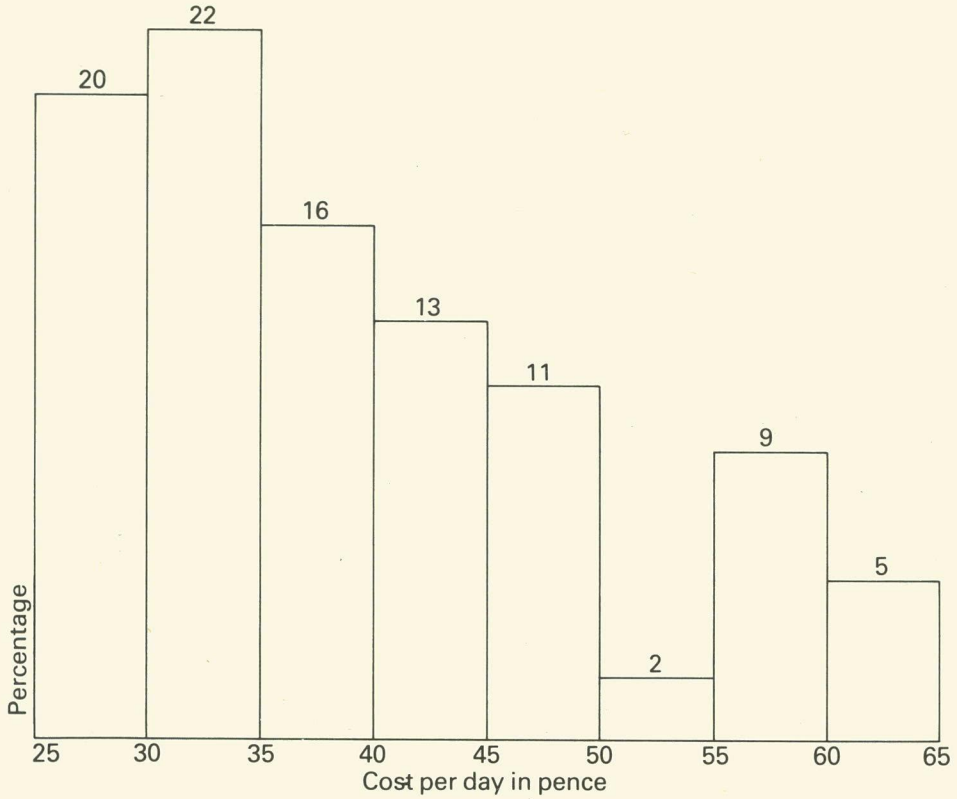


FIGURE 5.24 ***The percentage distribution of mean daily intakes of principal animal protein — contributing foods by periods of the day.***




Key as for Fig. 5.23

FIGURE 5.25 ***Percentage frequency distribution of cost of foods consumed per day — in pence.***




Number of persons 45
Mean daily cost 39.6p
s.d. 11.4p

2% over 75p

# 6. Medical status

## 6.1 Introduction

6.1.1 The survey provided an opportunity to study the frequency and distribution of disease in the elderly subjects. Such a study is not only of intrinsic interest but also a prerequisite for the proper assessment of nutritional status. Disease may influence nutritional status either directly by altering (a) the intake of food, (b) absorption from the gastro-intestinal tract, (c) utilization of nutrients by the tissues or (d) by causing excessive loss of substances from the body; or indirectly by affecting mobility and ability to cope.

6.1.2 The medical examination was conducted by a senior physician in geriatric medicine in each area. Preliminary meetings of the physicians aimed to standardize the techniques of the clinical examination but there remained the possibility of individual variation in diagnostic criteria. For this reason less certainty can be attached to area differences than to age and sex differences in some of the medical findings. The dietary intakes associated with diseases which might predispose to undernutrition are considered elsewhere (paragraph 11.4).

## 6.2 Medical findings

6.2.1 *General assessment of health* As part of the medical questionnaire the geriatricians were asked to classify each subject as either "healthy" or "not healthy". The "healthy" were defined as those who were free from major constitutional disease or major disability. Such an assessment encompasses a wide range of disease of varying severity. Nevertheless, as far as possible, each clinician used reasonably constant criteria for diagnosis so that information was obtained for the overall incidence of infirmity in the different age groups. Table 6.1 shows that 40% of the men and 50% of the women were graded as "not healthy" and that the incidence of the grade "not healthy" in men and women, respectively, aged 85 years and over was twice that in men and women aged 70–74 years. Despite the general impression of an age-related increase in the incidence of this grading, the trend was less marked for men in the 80–84 year age band and a fall in incidence occurred for women in the 75–79 year age band. This change of trend around the age of 80 years may represent the survival of an elderly "disease free" group. Cohort studies would be necessary to verify the hypothesis. 48% of the women and 45% of the men who were regarded as "not healthy" came from Sunderland whereas the numbers of men and women subjects in this area were only 33% and 34% respectively of the whole sample.

6.2.2 *Disorders most commonly found* The diagnoses shown in Table 6.2 were made in more than 10% of the sample. The conditions which were more commonly diagnosed in men than in women were ischaemic heart disease, chronic bronchitis and emphysema, and deafness, where in women the more commonly diagnosed conditions were hypertension, osteoarthritis of hips and knees, kyphosis, low mental test score and obesity. In general, ischaemic heart disease, peripheral vascular disease, chronic bronchitis, osteoarthritis, kyphosis, low mental test score, impaired hearing, inadequate vision and obesity occurred with greater frequency in the older age group although, in many instances, the differences were not statistically significant. The incidence rates of ischaemic heart disease, peripheral vascular disease, chronic bronchitis, osteoarthritis, inadequate eyesight and low mental test score were all greater in Sunderland, although the general age/sex trends in Sunderland were similar to those in the whole sample.

6.2.3 *Major abdominal surgery – gastrectomy and cholecystectomy* Thirteen men (8% of male sample) and 7 women (4% of female sample) had a past history of gastrectomy and, of these, 9 men and 6 women had had the operation more than 5 years before the survey. In another 14 subjects (8 men and 6 women) an operation scar was consistent with a gastrectomy but they either did not know or did not remember the nature of the operation. The lowest incidence of gastrectomy was in Sunderland (2.5% of Sunderland sample) and the highest incidence was in Camden (15% of Camden sample). A wasted appearance was more frequent ($P < 0.05$) in both male and female gastrectomized subjects (30%) than in the sample as a whole (11% for both men and women).

6.2.4 Cholecystectomy, in contrast to gastrectomy, had been more commonly performed on women (19 subjects, 10% of women) than on men (7 subjects, 4% of men). However, abdominal scars compatible with cholecystectomy were also present in another 9 men and 5 women who did not know the nature of their operation. As with gastrectomy there was a wide area variation in incidence ranging from 3% in Portsmouth and Cambridge to 10% and 15% in Camden and Angus respectively. The incidence of either obesity or of a wasted appearance was not significantly higher in those subjects who had had a cholescystectomy than in the sample as a whole.

6.2.5 *Smoking* Subjects were arbitrarily divided into non-smokers, light smokers who smoked fewer than 50 cigarettes or the equivalent per week, and heavy smokers who smoked 50 or more cigarettes per week. In general, patterns of smoking were similar in subjects under and over 80 years of age. Heavy smoking was much commoner in men (33% of the male sample) than in women (9% of the female sample) but the sex difference was less marked for light smokers. The incidence of chronic bronchitis in the smokers is shown in Table 6.3. For both men and women, the higher incidence of chronic bronchitis found in heavy smokers was not statistically significant.

6.2.6 *Depression, barbiturates and tranquillizers* A diagnosis of depression was made in 16 subjects (7 men, 9 women) and, of these, 2 men were taking barbiturates and one woman was taking tranquillizers. Depression was diagnosed more frequently in Sunderland (12 subjects; 10% of the Sunderland sample) than in the rest of the sample (4 subjects; 2% of subjects from all other areas). Twenty women (10% of female sample) and 10 men (6% of male sample) were receiving barbiturates. Seventeen women (9%) and ten men (6%) were taking tranquillizers and 2 of these men were also receiving barbiturates. There were area differences in the number of elderly subjects taking these drugs. The proportion of subjects on barbiturates was smallest in Portsmouth and Sunderland and largest in Angus and Camden and the proportion of subjects on tranquillizers was smallest in Portsmouth and Angus.

6.2.7 In all, 54% of the female sample and 20% of the male sample suffered falls at least several times a year. Table 6.4 shows the incidence of falls in the elderly who were depressed or were receiving barbiturates or tranquillizers. For men there appeared to be no association between the incidence of falls and depression. Women with depression had a higher incidence of falls than women who were not depressed. The taking of barbiturates or tranquillizers appeared to have no effect on the incidence of falls in these survey subjects. Three subjects (all women) had suffered fractures of the hip after falls (in 2 cases within 5 years of the survey) but, at the time of the survey, none of them was depressed and none was taking barbiturates or tranquillizers and there was no available information about either their mental state or whether they were taking any drugs at the time of the accidents.

6.2.8 *Obesity* A subjective clinical assessment of obesity was made by the physicians in 31% of the women and 17% of the men in the study sample. The incidence of obesity was higher in women aged 80 years and over than in women under 80 years of age but for men no age effect was apparent (Table 6.5). The incidence of hypertension and diabetes mellitus in the obese was not significantly higher than that in non-obese subjects. However, obese women under 80 years of age had a significantly higher incidence ($P < 0.05$) of osteoarthritis of the knees than did non-obese women (Table 6.5). The older obese women also had a higher incidence of osteoarthritis of the knees but the difference was not statistically significant.

6.2.9 A study of the mean daily intake of food energy of the obese subjects was of interest in view of suggestions in previous reports that the obese tended to have lower food energy intakes than non-obese subjects. A number of factors had to be taken into account. For instance, 22% of the obese women and 11% of the obese men were on special diets compared with 10% of both non-obese men and non-obese women. Mean daily energy intakes of the obese were compared with intakes of subjects with normal appearance, that is to say, non-obese, non-wasted subjects (Table 6.6). Subjects on special diets and the few suffering from diabetes mellitus were excluded. In order to allow for the effects of major constitutional disease or infirmity these 2 groups were further

sub-divided into the "healthy" and the "not healthy" as described previously. Differences in intake between obese and non-obese non-wasted subjects in all groups were small and not statistically significant. Differences in intake between healthy and non-healthy subjects, whether obese or not, were mostly larger but only significant for healthy and non-healthy, non-obese women (Table 6.6). The differences in energy intake could have been associated with disease, altered mobility or a difference in age distribution. The sample was too small to investigate further. There was no evidence of any difference between obese and non-obese subjects in the distribution of food energy intake between the 3 periods of the day.

## 6.3 Anthropometry

6.3.1 *Introduction* The clinical examination included measurements of height, weight, skinfold thickness and arm circumference. These functions, and indices derived from them, are influenced by a variety of genetic, physiological, medical and environmental factors. Nutritional status, past or present, is one such factor. Conversely, nutritional requirements are partly determined by body size and composition. Muscle mass is related to the degree of physical activity and this in turn is one factor governing food energy requirements. Anthropometric information may be helpful in assessing the nutritional status of an individual but must be used in conjunction with clinical, dietary and laboratory information. Somatotype may be influenced by the involutionary changes of advancing age, increasing infirmity and decreased activity. These changes add to the difficulty of defining limits of normality for anthropometry of the elderly. Differences in the anthropometry of different age-groups in a cross-sectional survey cannot alone be taken to reflect the changes of advancing age; longitudinal studies may provide more reliable information.

6.3.2 *Measurements* Height, weight and left upper arm circumference at the mid-point between the acromion and the olecranon were measured. Harpenden calipers were used to determine triceps, biceps, subscapular and suprailiac skin-fold thickness on the left side and a mean value of 3 measurements at each site was calculated. All measurements were made in accordance with the methods recommended by the International Biological Programme (Weiner and Laurie, 1969). In addition to the basic measurements a number of derived indices were calculated (Appendix C).

6.3.3 *Results* The anthropometric information obtained for men and women in the sample is shown in Tables 6.7 and 6.8. The measurements for the mean height, weight, arm muscle area and lean arm radius of all the men were significantly greater ($P < 0.001$) than the corresponding measurements for all the women, whereas the means for the 2 site and 4 site skinfold thicknesses and the 2 corresponding calculated percentages of body fat[1] were significantly larger in women ($P < 0.001$).

---

[1] See Appendix C

6.3.4 The mean heights of men under 80 years of age in the 6 areas were similar, the 2 extremes being 164.1 cm in Camden and 169.6 cm in Rutherglen. The mean heights of women under 80 years of age displayed a greater difference between areas, the 2 extremes being 150.6 cm in Portsmouth and 156.7 cm in Camden. Mean weights of men showed statistically significant area differences but the mean weights of the women did not. The heaviest men were those in Angus, with a mean of 71.6 kg and the lightest were those in Sunderland, with a mean of 62.8 kg. For both men and women, Quetelet's index[1] showed little area variation.

6.3.5 Arm muscle area and lean arm radius calculations[1] showed similar area variations. Of the men, those from Angus gave the biggest mean values for arm muscle area and lean arm radius and those from Rutherglen gave the smallest mean values for both these indices. Sunderland women gave the smallest mean values for arm muscle area and lean arm radius.

6.3.6 For both men and women, the smallest mean values for the 2 site and 4 site skinfold thicknesses and the 2 site and 4 site calculated percentage of body fat[1] were in Camden. Of the men, those in Cambridgeshire gave the greatest mean values for the 2 site skinfold thickness and corresponding calculated percentage body fat, those in Sunderland gave the largest means for the 4 site skinfold thickness and those in Angus gave the largest means for the 4 site calculated percentage body fat. Of the women, those in Portsmouth had the biggest mean values for the 2 site skinfold thickness and corresponding calculated percentage body fat and those in Sunderland had the biggest means for the 4 site skinfold thickness and corresponding 4 site calculated percentage body fat. There was only one area, Camden, where the means for women of the 2 site and 4 site percentage of body fat were significantly less ($P < 0.01$, $P < 0.05$ respectively) than the means for all areas.

6.3.7 Men and women of 80 years or more were significantly shorter than those under 80 years but the differences were mainly due to the Sunderland sample. Sunderland men of 80 years or more were also significantly lighter and had a significantly smaller Quetelet's index, arm circumference, lean arm radius, arm muscle area and 4 site percentage body fat than those under 80 years. Similar but less marked trends were found in men and women of most other areas but differences were either not significant or the number of subjects involved were too small for analysis.

6.3.8 *Association between clinical appearance and anthropometry* The clinicians were asked to classify subjects by subjective assessment as either obese, normal or wasted. Figure 6.1 illustrates that the relationship between this clinical assessment and Quetelet's index, the 4 site skinfold thickness, 2 site and 4 site percentage body fat calculations was highly significant ($P < 0.001$).

---

[1] see Appendix C

6.3.9 Of particular interest was the finding that men showed a highly significant association between the lean arm radius and arm muscle area calculations and the clinical assessment of obesity but no such association was found for women. This suggested that obese women were not more muscular than other women. The calculation of percentage body fat was based on the data of Durnin and Wormesley (1974) who studied men in the 50-72 year age range and women in 50-68 year range. The elderly of the present study were considerably older and a number of factors could cause discrepancies in these calculations. For example, skinfold compressibility decreases with age (Brozek and Mori, 1958; Brozek and Kinzey, 1960). Discrepancies in the calculation of percentage body fat would be more marked in subjects with small skinfold thicknesses but obesity might distort the estimation of arm muscle area and lean arm radius.

6.3.10 *Association between energy intake and anthropometry* Total muscle mass may to some extent reflect physical activity over a long period of time. Food energy requirements, which depend in part on physical activity, may therefore also correlate with indices, such as arm muscle area, which are indirect measures of muscle mass. The mass of an individual muscle is approximately proportional to its length and the latter would be dependent on skeletal size. Correlations between energy intake and 8 anthropometric variables are shown in Table 6.9. Significant correlations were found with height for all men and for all women. In addition, arm circumference, lean arm radius and arm muscle area were significantly correlated with energy intake for men. Most of the significant correlations found were retained when analysis was confined to the healthy. However there were no significant correlations between energy intake and anthropometric variables for those classified as "not healthy".

**Table 6.1:** *The number of full participants (in 5-year age bands) who were assessed as 'not healthy' in the medical assessment*

| | 70–74[1] yrs | 75–79 yrs | 80–84 yrs | 85 yrs and over[2] |
|---|---|---|---|---|
| | No. | No. | No. | No. |
| *Men* | | | | |
| All men | 55 | 56 | 43 | 15 |
| Assessed as 'not healthy' | 16 | 23 | 19 | 9 |
| % 'not healthy' | 29 | 41 | 44 | 60 |
| *Women* | | | | |
| All women | 66 | 59 | 54 | 17 |
| Assessed as 'not healthy' | 30 | 20 | 34 | 14 |
| % 'not healthy' | 45 | 34 | 63 | 82 |

[1] includes 2 men and 1 woman aged 69

[2] includes 3 men and 4 women aged 90 and over

**Table 6.2:** *The number and percentage of men and women participants in four age-groups who were diagnosed as having those disorders most commonly diagnosed. Some participants had more than one disorder*

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | 70–79 yrs | | 80 yrs and over | | 70–79 yrs | | 80 yrs and over | |
| | No. | % | No. | % | No. | % | No. | % |
| All persons | 111 | | 58 | | 125 | | 71 | |
| *Disorders of circulatory system:* | | | | | | | | |
| ischaemic heart disease | 23 | 21 | 19 | 33 | 19 | 15 | 15 | 21 |
| hypertension[1] | 21 | 19 | 7 | 12 | 39 | 31 | 24 | 34 |
| peripheral vascular disease | 11 | 10 | 10 | 17 | 13 | 10 | 13 | 18 |
| *Respiratory disorders:* | | | | | | | | |
| chronic bronchitis and emphysema | 26 | 23 | 14 | 24 | 11 | 9 | 11 | 15 |
| *Disorders of the locomotor system:* | | | | | | | | |
| osteoarthritis of hips | 8 | 7 | 10 | 17 | 22 | 18 | 23 | 32 |
| osteoarthritis of knees | 33 | 30 | 24 | 41 | 60 | 48 | 44 | 62 |
| kyphosis | 35 | 32 | 27 | 47 | 56 | 45 | 49 | 69* |
| *Impaired memory or senses:* | | | | | | | | |
| MTS[2] less than 13 | 23 | 21 | 25 | 43* | 50 | 40 | 33 | 46 |
| inadequate vision for needs | 11 | 10 | 12 | 21 | 9 | 7 | 18 | 25** |
| *Nutritional:* | | | | | | | | |
| obesity | 18 | 16 | 10 | 17 | 32 | 26 | 28 | 39 |

*, ** indicate that the proportion of subjects aged 80 years and over was significantly greater than the proportion aged under 80 years

*$P<0.05$ **$P<0.01$

[1] subjects who had a diastolic pressure of 100mm mercury or more, including 6 subjects (1 man, 5 women) who were being treated with antihypertensive drugs and had a diastolic pressure of less than 100mm of mercurcy

[2] Mental Test Score (MTS) of 13 to 16 is regarded as normal
10 to 12 denotes a mild degree of dementia
0 to 9 denotes a moderate to severe degree of dementia

**Table 6.3:** *The number of subjects diagnosed as having chronic bronchitis among full participants in the survey who did or did not smoke*

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | No. | Chronic bronchitis | | No. | Chronic bronchitis | |
| | | No. | % | | No. | % |
| All persons | 169 | 40 | 24 | 196 | 22 | 11 |
| Heavy smokers 50 cigarettes or more per week | 56 | 18 | 32 | 17 | 4 | 24 |
| Light smokers less than 50 cigarettes per week | 24 | 5 | 21 | 19 | 2 | 11 |
| Non-smokers | 89 | 17 | 19 | 160 | 16 | 10 |

**Table 6.4:** *The number of full participants in the survey who had at least several falls per year and who suffered from depression or who took barbiturates or tranquillizers*

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | No. in group | No. having falls | % having falls | No. in group | No. having falls | % having falls |
| Depressed | 7 | 0 | 0 | 9 | 5 | 56 |
| Not depressed | 162 | 11 | 7 | 187 | 30 | 16 |
| On barbiturates | 10 | 1 | 10 | 20 | 2 | 10 |
| Not on barbiturates | 159 | 10 | 6 | 176 | 33 | 19 |
| On tranquillizers | 10 | 0 | 0 | 17 | 5 | 29 |
| Not on tranquillizers | 159 | 11 | 7 | 179 | 30 | 17 |

**Table 6.5:** *The occurrence of osteoarthritis of the knees in obese and non-obese subjects*

| | Men | | Women | |
|---|---|---|---|---|
| | under 80 yrs | 80 yrs and over | under 80 yrs | 80 yrs and over |
| Obese subjects | | | | |
| Total number | 18 | 10 | 32 | 28 |
| No. with osteoarthritis of knees | 5 | 5 | 21 | 19 |
| % with osteoarthritis of knees | 28 | 50 | 69* | 68 |
| Non-obese subjects | | | | |
| Total number | 93 | 48 | 93 | 43 |
| No. with osteoarthritis of knees | 28 | 19 | 38 | 25 |
| % with osteoarthritis of knees | 30 | 40 | 41* | 58 |

*significant difference $P<0.05$

**Table 6.6:** *The mean daily intakes of food energy by healthy and non-healthy full participants in the survey who were assessed as obese or as non-obese and non-wasted*

| | Obese subjects | | | Non-obese, non-wasted subjects | | |
|---|---|---|---|---|---|---|
| | No. of subjects | Mean daily intake kcal (MJ) | s.d. kcal (MJ) | No. of subjects | Mean daily intake kcal (MJ) | s.d. kcal (MJ) |
| Men[1] | | | | | | |
| Healthy | 10 | 2 194 (9.18) | 520 (2.18) | 78 | 2 254 (9.43) | 549 (2.30) |
| Not healthy | 14 | 1 975 (8.26) | 388 (1.62) | 32 | 2 119 (8.87) | 477 (2.00) |
| Women[1] | | | | | | |
| Healthy | 18 | 1 636 (6.85) | 347 (1.45) | 59 | 1 739 (7.28) | 380 (1.59) |
| Not healthy | 28 | 1 606 (6.72) | 384 (1.61) | 41 | 1 561* (6.53) | 383 (1.60) |

[1] Subjects on special diets and those suffering from diabetes mellitus were excluded

*Mean intake significantly different ($P<0.05$) than mean intake for healthy non-obese non-wasted subjects

**Table 6.7:** *The means, and standard deviations of the mean, for various anthropometric indices*[1] *of men in the survey in two age groups in the different areas*

| Men | Portsmouth | | | Cambridgeshire | | | Sunderland | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Mean | s.d. | No. | Mean | s.d. | No. | Mean | s.d. |
| Height (cm) | | | | | | | | | |
| under 80 yrs | 13 | 167.2 | (5.73) | 27 | 166.9 | (6.23) | 40 | 165.9 | (7.49) |
| 80 yrs and over | 5 | 167.0 | (6.71) | 16 | 165.1 | (7.44) | 16 | 160.3** | (5.30) |
| Weight (kg) | | | | | | | | | |
| under 80 yrs | 13 | 68.08 | (9.574) | 27 | 67.56 | (10.015) | 36 | 66.36 | (10.182) |
| 80 yrs and over | 5 | 69.58 | (10.074) | 16 | 65.91 | (14.011) | 14 | 53.46*** | (10.270) |
| Quetelet's Index | | | | | | | | | |
| under 80 yrs | 13 | 24.3 | (3.09) | 27 | 24.2 | (3.28) | 36 | 23.9 | (3.09) |
| 80 yrs and over | 5 | 25.0 | (3.77) | 16 | 24.1 | (4.14) | 14 | 20.9** | (3.64) |
| Arm circumference (cm) | | | | | | | | | |
| under 80 yrs | 13 | 28.0 | (1.89) | 27 | 26.9 | (3.19) | 40 | 27.2 | (3.00) |
| 80 yrs and over | 5 | 28.2 | (3.76) | 16 | 27.0 | (3.74) | 16 | 24.0** | (3.69) |
| Lean arm radius (mm) | | | | | | | | | |
| under 80 yrs | 13 | 38.0 | (2.18) | 27 | 36.8 | (3.64) | 40 | 36.6 | (5.13) |
| 80 yrs and over | 5 | 39.5 | (4.06) | 16 | 36.2 | (3.92) | 16 | 33.2* | (5.58) |
| Arm muscle area (sq cm) | | | | | | | | | |
| under 80 yrs | 13 | 48.2 | (5.39) | 27 | 45.2 | (9.03) | 40 | 45.4 | (11.59) |
| 80 yrs and over | 5 | 51.5 | (10.45) | 16 | 44.3 | (9.61) | 16 | 37.2* | (11.44) |
| Skinfold thickness (mm) (sum of triceps, subscapular) | | | | | | | | | |
| under 80 yrs | 13 | 25.5 | (8.79) | 27 | 25.1 | (7.86) | 39 | 27.0 | (12.82) |
| 80 yrs and over | 5 | 20.6 | (8.88) | 16 | 26.2 | (11.28) | 16 | 19.8 | (12.67) |
| Skinfold thickness (mm) (sum of biceps, triceps subscapular, suprailiac) | | | | | | | | | |
| under 80 yrs | 12 | 40.0 | (13.03) | 27 | 43.2 | (13.71) | 39 | 50.1 | (27.07) |
| 80 years and over | 5 | 36.9 | (16.79) | 16 | 44.5 | (19.85) | 16 | 37.2 | (25.93) |
| Percentage of body fat (2 sites) | | | | | | | | | |
| under 80 yrs | 13 | 24.5 | (5.98) | 27 | 24.3 | (5.85) | 39 | 25.1 | (6.39) |
| 80 yrs and over | 5 | 20.9 | (7.09) | 16 | 24.5 | (7.26) | 16 | 19.5 | (7.88) |
| Percentage of body fat (4 sites) | | | | | | | | | |
| under 80 yrs | 12 | 22.0 | (5.83) | 27 | 23.2 | (5.75) | 39 | 24.9 | (6.74) |
| 80 yrs and over | 5 | 20.4 | (7.47) | 16 | 23.1 | (7.41) | 16 | 19.7* | (7.90) |

[1] see Appendix C

Tests of significance * $P<0.05$, ** $P<0.01$, *** $P<0.001$ } mean values of subjects 80 years and over were significantly less than the means for those under 80 years of age.

| Rutherglen | | | Angus | | | Camden | | | All areas | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Mean | s.d. | No. | Mean | s.d. | No. | Mean | s.d. | No. | Mean | s.d. |
| 9 | 169.6 | (7.38) | 14 | 166.0 | (5.31) | 8 | 164.1 | (7.88) | 111 | 166.5 | (6.73) |
| 3 | 158.7* | (4.16) | 16 | 166.8 | (4.34) | 1 | 164.0 | (—) | 57 | 164.0* | (6.33) |
| 9 | 65.33 | (11.043) | 14 | 69.61 | (11.934) | 8 | 63.63 | (12.704) | 107 | 67.00 | (10.435) |
| 3 | 56.27 | (11.164) | 16 | 73.28 | (11.791) | 1 | 61.40 | (—) | 55 | 64.61 | (13.855) |
| 9 | 22.7 | (3.51) | 14 | 25.2 | (3.68) | 8 | 23.4 | (2.90) | 107 | 24.1 | (3.22) 0.31 |
| 3 | 22.4 | (4.75) | 16 | 26.4 | (4.21) | 1 | 22.8 | (—) | 55 | 23.9 | (4.38) 0.59 |
| 9 | 25.3 | (3.15) | 14 | 28.6 | (2.21) | 7 | 26.3 | (2.60) | 110 | 27.2 | (2.91) |
| 4 | 23.1 | (2.25) | 16 | 28.4 | (3.15) | 1 | 26.0 | (—) | 58 | 26.4 | (3.88) |
| 9 | 34.8 | (4.56) | 14 | 40.3 | (3.85) | 7 | 38.0 | (4.67) | 110 | 37.2 | (4.43) |
| 4 | 32.1 | (2.35) | 16 | 39.6 | (4.27) | 1 | 38.8 | (—) | 58 | 36.4 | (5.15) |
| 9 | 40.6 | (10.06) | 14 | 53.7 | (9.62) | 7 | 47.4 | (10.83) | 110 | 46.5 | (10.32) |
| 4 | 34.0 | (5.17) | 16 | 52.2 | (10.25) | 1 | 48.3 | (—) | 58 | 44.5 | (11.81) |
| 9 | 22.8 | (6.71) | 14 | 23.6 | (7.61) | 8 | 19.0 | (4.62) | 110 | 25.0 | (9.84) |
| 4 | 17.3 | (3.63) | 16 | 24.4 | (6.65) | 1 | 16.7 | (—) | 58 | 22.7 | (10.16) |
| 9 | 40.8 | (11.86) | 14 | 44.8 | (11.99) | 8 | 36.2 | (8.30) | 109 | 44.8 | (19.31) |
| 4 | 35.2 | (10.68) | 16 | 45.8 | (12.70) | 1 | 31.7 | (—) | 58 | 41.3 | (19.19) |
| 9 | 23.0 | (5.42) | 14 | 23.5 | (4.92) | 8 | 20.3 | (4.69) | 110 | 24.1 | (5.86) |
| 4 | 19.2 | (3.55) | 16 | 24.2 | (4.28) | 1 | 18.9 | (—) | 58 | 22.3 | (6.70) |
| 9 | 22.5 | (5.26) | 14 | 24.2 | (4.19) | 8 | 20.9 | (4.53) | 109 | 23.6 | (5.87) |
| 4 | 20.4 | (5.40) | 16 | 24.5 | (4.12) | 1 | 19.4 | (—) | 58 | 22.1 | (6.70) |

**Table 6.8:** *The means, and standard deviations of the mean, for various anthropometric indices*[1] *of women in the survey in two age groups in the different areas*

| Women | Portsmouth | | | Cambridgeshire | | | Sunderland | | |
|---|---|---|---|---|---|---|---|---|---|
| | No. | Mean | s.d. | No. | Mean | s.d. | No. | Mean | s.d. |
| Height (cm) | | | | | | | | | |
| under 80 yrs | 12 | 150.6 | (5.16) | 23 | 155.7 | (7.23) | 41 | 153.0 | (8.14) |
| 80 yrs and over | 8 | 151.3 | (4.43) | 6 | 155.0 | (3.85) | 23 | 149.0 | (6.79) |
| Weight (kg) | | | | | | | | | |
| under 80 yrs | 12 | 55.96 | (8.364) | 23 | 59.83 | (9.897) | 41 | 58.19 | (13.484) |
| 80 yrs and over | 8 | 59.95 | (8.469) | 4 | 56.95 | (8.962) | 23 | 55.56 | (13.383) |
| Quetelet's Index | | | | | | | | | |
| under 80 yrs | 12 | 24.7 | (3.72) | 23 | 24.6 | (3.43) | 41 | 24.9 | (5.49) |
| 80 yrs and over | 8 | 26.3 | (4.22) | 4 | 23.6 | (2.68) | 23 | 24.9 | (5.06) |
| Arm circumference (cm) | | | | | | | | | |
| under 80 yrs | 12 | 27.6 | (3.89) | 23 | 26.6 | (3.52) | 42 | 26.7 | (4.44) |
| 80 yrs and over | 8 | 27.7 | (2.05) | 6 | 24.8 | (3.43) | 24 | 26.4 | (4.06) |
| Lean arm radius (mm) | | | | | | | | | |
| under 80 years | 12 | 31.7 | (5.99) | 23 | 32.8 | (3.60) | 42 | 30.6 | (5.66) |
| 80 yrs and over | 8 | 33.3 | (4.39) | 6 | 32.1 | (4.80) | 24 | 30.9 | (5.02) |
| Arm musle area (sq cm) | | | | | | | | | |
| under 80 yrs | 12 | 36.7 | (13.90) | 23 | 37.6 | (8.36) | 42 | 34.2 | (11.25) |
| 80 yrs and over | 8 | 39.0 | (8.79) | 6 | 35.4 | (10.03) | 24 | 34.4 | (10.34) |
| Skinfold thickness (mm) (sum of triceps, subscapular) | | | | | | | | | |
| under 80 yrs | 12 | 37.3 | (8.61) | 23 | 32.0 | (9.80) | 42 | 37.1 | (16.59) |
| 80 yrs and over | 8 | 38.1 | (11.43) | 6 | 27.9 | (6.72) | 24 | 34.5 | (14.88) |
| Skinfold thickness (mm) (sum of biceps, triceps subscapular, suprailiac) | | | | | | | | | |
| under 80 yrs | 11 | 55.2 | (12.98) | 23 | 53.0 | (17.50) | 42 | 68.5 | (33.79) |
| 80 years and over | 8 | 62.6 | (14.22) | 6 | 46.6 | (11.93) | 24 | 62.7 | (26.37) |
| Percentage of body fat (2 sites) | | | | | | | | | |
| under 80 yrs | 12 | 35.8 | (3.82) | 23 | 33.2 | (4.60) | 42 | 34.7 | (7.22) |
| 80 yrs and over | 8 | 35.8 | (5.44) | 6 | 31.0 | (4.00) | 24 | 33.8 | (6.40) |
| Percentage of body fat (4 sites) | | | | | | | | | |
| under 80 yrs | 11 | 34.2 | (3.42) | 23 | 33.4 | (4.31) | 42 | 35.9 | (6.82) |
| 80 yrs and over | 8 | 36.0 | (3.10) | 6 | 31.9 | (3.79) | 24 | 35.2 | (5.72) |

[1] see Appendix C

Tests of significance * $P<0.05$ Mean values of subjects 80 years and over were significantly less than the means for those under 80 years of age.

| Rutherglen | | | Angus | | | Camden | | | All areas | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Mean | s.d. | No. | Mean | s.d. | No. | Mean | s.d. | No. | Mean | s.d. |
| 13 | 151.8 | (5.79) | 20 | 154.6 | (7.04) | 15 | 156.7 | (4.32) | 124 | 153.8 | (7.05) |
| 7 | 154.7 | (7.76) | 10 | 152.5 | (2.92) | 15 | 152.4 | (6.63) | 69 | 151.6* | (6.18) |
| 13 | 61.81 | (9.319) | 20 | 59.98 | (11.286) | 15 | 57.53 | (9.912) | 124 | 58.87 | (11.168) |
| 8 | 55.60 | (11.982) | 10 | 56.61 | (14.639) | 15 | 61.09 | (11.544) | 68 | 57.54 | (12.124) |
| 13 | 26.8 | (3.66) | 20 | 25.1 | (4.44) | 15 | 23.5 | (4.18) | 124 | 24.9 | (4.49) |
| 7 | 23.9 | (4.28) | 10 | 24.3 | (5.96) | 15 | 26.4 | (5.15) | 67 | 25.1 | (4.88) |
| 13 | 27.8 | (2.66) | 20 | 27.4 | (2.86) | 15 | 25.3 | (4.74) | 125 | 26.8 | (3.88) |
| 8 | 24.1* | (3.64) | 10 | 25.7 | (3.29) | 15 | 26.7 | (4.01) | 71 | 26.1 | (3.70) |
| 13 | 33.0 | (4.28) | 20 | 33.8 | (3.08) | 15 | 32.2 | (6.28) | 125 | 32.1 | (5.02) |
| 8 | 29.2 | (4.74) | 10 | 32.5 | (2.39) | 15 | 34.1 | (4.97) | 71 | 32.0 | (4.72) |
| 13 | 38.6 | (8.62) | 20 | 39.7 | (7.01) | 15 | 36.4 | (11.73) | 125 | 36.7 | (10.28) |
| 8 | 30.1 | (9.66) | 10 | 36.2 | (5.51) | 15 | 40.4 | (12.65) | 71 | 36.0 | (10.26) |
| 13 | 37.6 | (12.40) | 20 | 33.4 | (11.24) | 15 | 25.5 | (8.27) | 125 | 34.2 | (13.10) |
| 8 | 26.3* | (9.17) | 10 | 31.4 | (13.00) | 15 | 28.5 | (12.05) | 71 | 31.7 | (12.75) |
| 13 | 67.3 | (22.04) | 20 | 54.9 | (17.71) | 14 | 45.7 | (15.84) | 123 | 59.5 | (25.40) |
| 8 | 47.4 | (20.05) | 10 | 53.9 | (20.31) | 15 | 50.8 | (20.53) | 71 | 55.9 | (21.89) |
| 13 | 35.5 | (5.60) | 20 | 33.7 | (5.65) | 15 | 29.6 | (5.25) | 125 | 33.8 | (6.04) |
| 8 | 30.1* | (5.27) | 10 | 32.6 | (5.80) | 15 | 31.0 | (5.95) | 71 | 32.7 | (5.90) |
| 13 | 36.5 | (4.83) | 20 | 33.8 | (4.87) | 14 | 31.2 | (5.26) | 123 | 34.5 | (5.61) |
| 8 | 31.6* | (5.37) | 10 | 33.6 | (4.53) | 15 | 32.5 | (5.25) | 71 | 33.8 | (5.11) |

**Table 6.9:** *Correlations of anthropometric variables with energy intake*

*Men*

| | Healthy | Not healthy | All |
|---|---|---|---|
| Height | 0.19 (102)* | 0.12 (66) | 0.19 (168)** |
| Weight | 0.03 ( 97) | 0.16 (65) | 0.11 (162) |
| Arm circumference | 0.15 (101) | 0.09 (67) | 0.16 (168)* |
| Quetelet's index | −0.05 (97) | 0.12 (65) | 0.04 (162) |
| Lean arm radius | 0.22 (101)* | 0.10 (67) | 0.21 (168)** |
| Muscle area | 0.20 (101)* | 0.08 (67) | 0.19 (168)** |
| 2 site skinfold | −0.08 (101) | 0.08 (67) | 0.01 (168) |
| 4 site skinfold | −0.11 (101) | 0.02 (66) | −0.04 (167) |

*Women*

| | Healthy | Not healthy | All |
|---|---|---|---|
| Height | 0.29 (98)** | 0.09 (95) | 0.19 (193)** |
| Weight | 0.14 (98) | −0.09 (94) | 0.01 (192) |
| Arm circumference | 0.03 (98) | −0.05 (98) | 0.00 (196) |
| Quetelets index | 0.00 (98) | −0.13 (93) | −0.07 (191) |
| Lean arm radius | −0.02 (98) | 0.00 (98) | 0.00 (196) |
| Muscle area | −0.01 (98) | −0.03 (98) | −0.01 (196) |
| 2 site skinfold | 0.08 (98) | −0.09 (98) | −0.01 (196) |
| 4 site skinfold | 0.05 (98) | −0.11 (98) | −0.04 (194) |

(Sample numbers in brackets)

*$P<0.05$

**$P<0.01$

FIGURE 6.1 ***Percentage frequency distribution of some body measurements of obese and of non-obese, non-wasted subjects.***

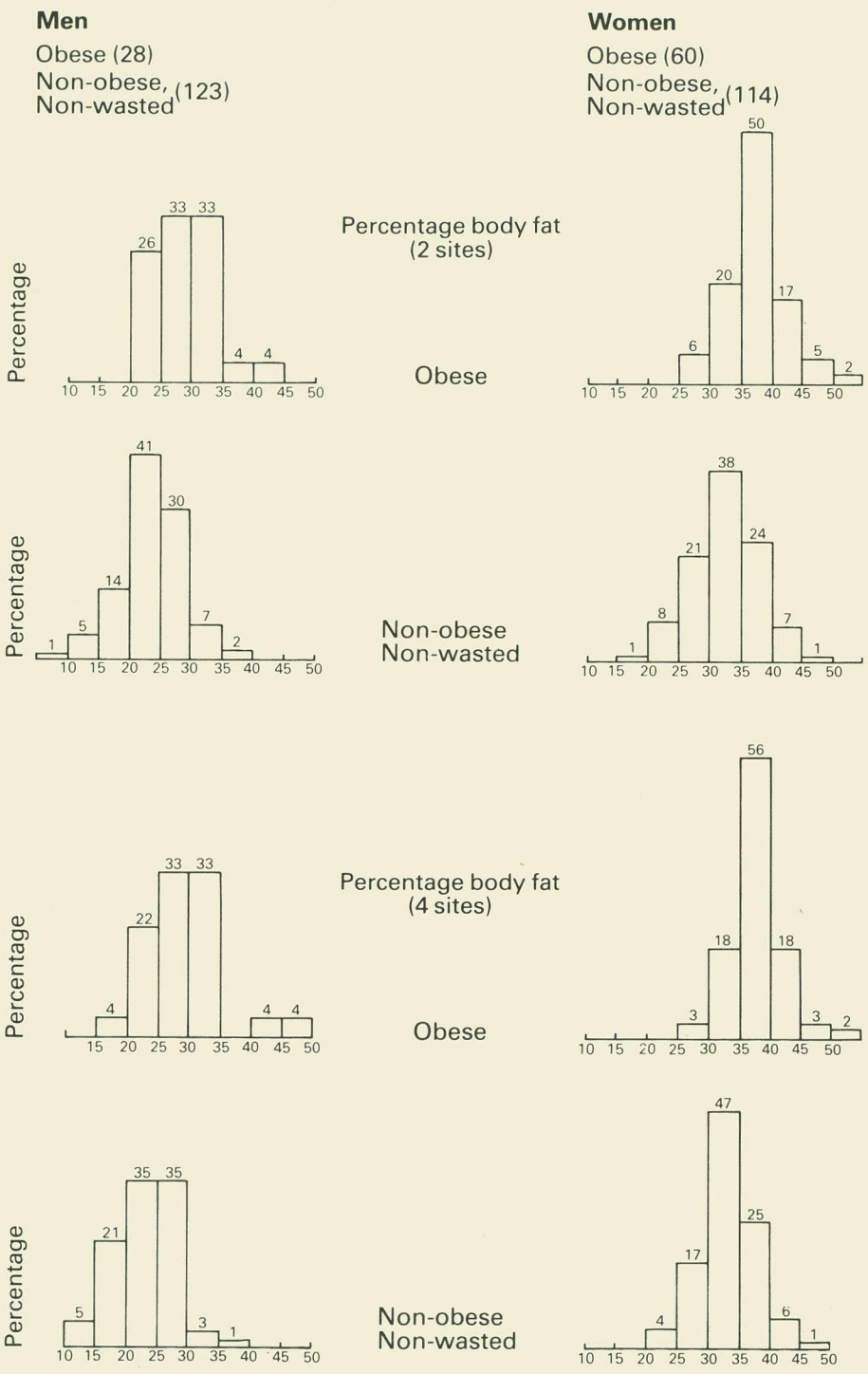
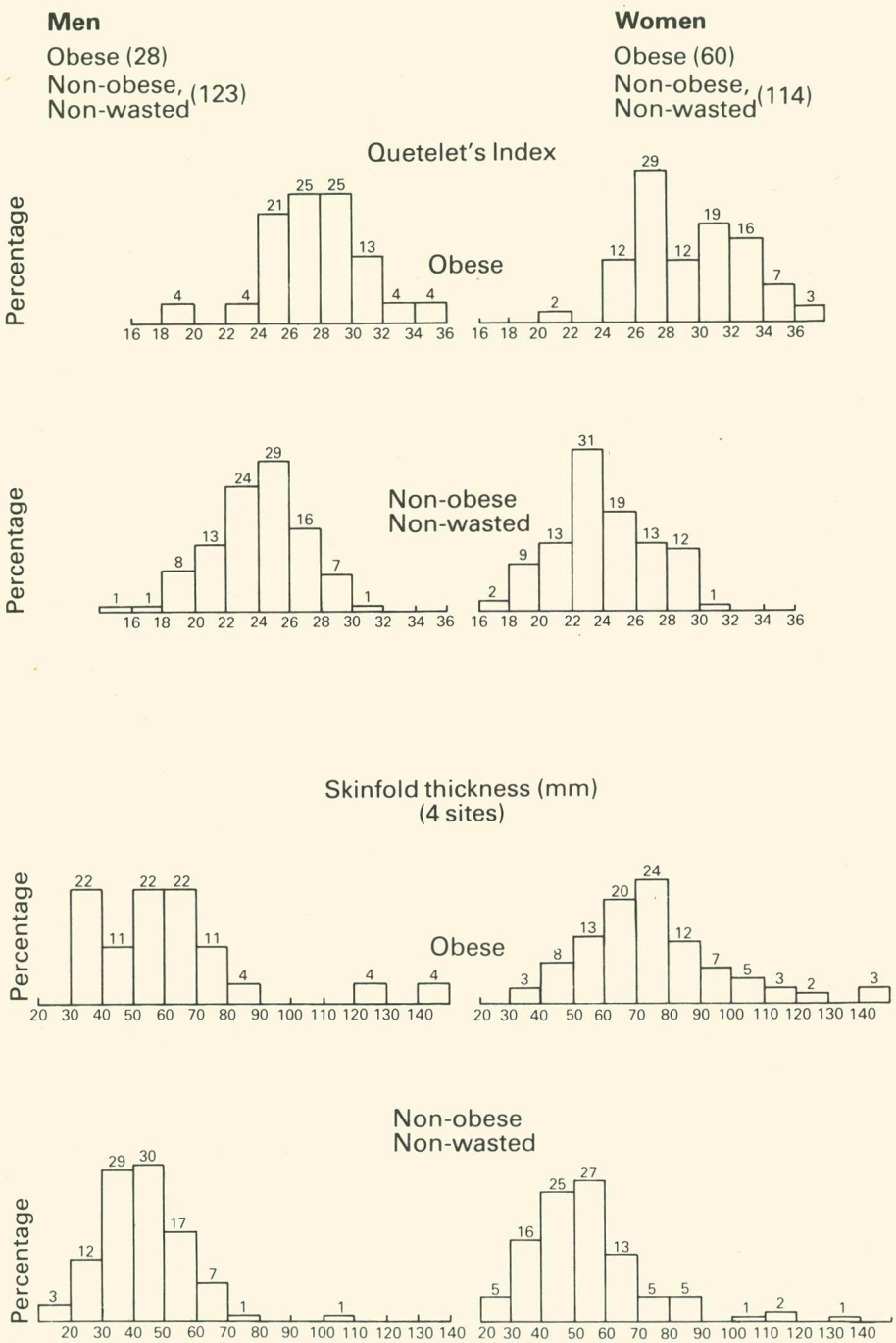


FIGURE 6.1 (contd.) ***Percentage frequency distribution of some body measurements of obese and of non-obese, non-wasted subjects.***



# 7. Biochemistry

## 7.1 Introduction

7.1.1 Before clinical signs of undernutrition occur there may be a period during which metabolic abnormalities can be detected. The biochemical information obtained in this survey was used in conjunction with dietary, clinical and haematological findings for the assessment of the nutritional status of individual subjects. An additional aim of the survey was to establish reference ranges for the various biochemical measurements in elderly people so that these ranges could be used in future surveys (Appendix E p 198).

7.1.2 The biochemical analyses were all made in the same laboratory, with the exception of leucocyte ascorbic acid determinations which were done in Sunderland as well as in London. The methods of storage and transport of samples from the different areas were standardized. These precautions allowed a comparison to be made of results from the different areas.

## 7.2 Measurements

7.2.1 Serum total protein, albumin, calcium, inorganic phosphate concentrations and serum alkaline phosphatase and pseudocholinesterase activities were measured with a Technicon autoanalyser. Other determinations included plasma ascorbic acid (PAA), red cell glutathione reductase (EGR) as a measure of riboflavin status, and red cell transketolase (TKL) as a measure of thiamin status. Leucocyte ascorbic acid concentrations (LAA) were measured only in samples from Sunderland and Camden. Details of sampling and analytical techniques are given in Appendix D with the appropriate references.

7.2.2 Table 7.1 shows a list of the biochemical measurements made and the ranges of values used to interpret the results.

## 7.3 Results - general

7.3.1 The means and standard deviations for the different measurements are shown for men and women separately in the two age groups under 80 years and 80 years and over in Table 7.2. The comparable results for men and women separately in the different areas are shown in Tables 7.3A and 7.3B.

7.3.2 The only difference in the biochemical results between the areas was that the plasma ascorbic acid concentrations were significantly lower ($P< 0.001$) in the combined three northern areas – Sunderland, Rutherglen and Angus, than in the three more southern areas for men and women. There were no significant differences for any of the measurements between men and

women except that the mean serum phosphate concentration was lower in the men than in the women (para 7.5.4) for all areas. For this sample of elderly people over 70 years of age there were no significant differences between the two age groups in any of the measurements.

7.3.3 The different biochemical measurements were correlated with a number of dietary and clinical findings and with haematological and other biochemical measurements. These correlations are summarized in Table 7.4. Where log transformations of the measurements have been used in the calculations, this is stated in the relevant tables of results.

### 7.4 Serum total protein and albumin concentrations and pseudocholinesterase activity

7.4.1 In men, the serum total protein and albumin concentrations and pseudocholinesterase activity each showed a significant correlation with the intake of dietary protein. Serum albumin was significantly correlated with total protein and pseudocholinesterase for both men and women, and total protein was correlated with pseudocholinesterase, though this was only significant in men.

7.4.2 Pseudocholinesterase in men was significantly correlated with the following anthropometric indices: arm circumference, skinfold thickness (mean of measurements at 2 or 4 sites) and with Quetelet's index. Skinfold thickness (measured at 2 sites) and Quetelet's index were also significantly correlated with pseudocholinesterase in women. Albumin showed a significant correlation in men with skinfold thickness and arm circumference but not with Quetelet's index. The only anthropometric index which was significantly correlated with serum total protein was arm circumference in men.

7.4.3 Serum proteins, and particularly albumin, are the variables usually measured in nutrition surveys to assess nutritional status (Jansen and Harrill, 1977), although pseudocholinesterase was first suggested as an indicator of protein-energy malnutrition by Hutchinson, McCance and Widdowson (1951) and later by Cohen (1964).

7.4.4 In the 1967/68 survey, there was a relationship between pseudocholinesterase activity and skinfold thickness (p 62, 1972 report). The results of the present survey have again shown better correlations of anthropometric measurements with pseudocholinesterase activity than with albumin and total protein concentrations.

### 7.5 Serum alkaline phosphatase activity and serum calcium and phosphate concentrations

7.5.1 Serum alkaline phosphatase activity was inversely correlated with serum calcium concentration for both men and women. The correlation of alkaline phosphatase with serum phosphate concentration was only significant for women. There were 12 women and 10 men with alkaline phosphatase

values above 13 KA units. Osteomalacia was diagnosed in one woman on clinical examination, and in two men only after the physicians had seen the biochemical results.

7.5.2 The mean alkaline phosphatase value of the housebound was significantly higher than that of subjects who were not housebound ($P< 0.001$). Out of 46 subjects who were housebound, 8 (17%) had alkaline phosphatase values above 13 KA units compared with 14 (4%) of the other 319 subjects. One woman and one man, who were diagnosed as malnourished and were both over 90 years old and housebound, had alkaline phosphatase values of 19.5 and 48.3 KA units and probably had osteomalacia.

7.5.3 Alkaline phosphatase activity was not significantly correlated with vitamin D intake. There was a significant inverse correlation of the metacarpal index with alkaline phosphatase in women but not with serum calcium or phosphate concentrations.

7.5.4 The mean serum phosphate concentration for men in the whole sample (2.87 mg/100 ml, 0.93 mmol/l) was lower than that for women (3.38 mg/100 ml, 1.09 mmol/l) and was also lower than that usually accepted for men in younger age groups. Serum phosphate concentration in men has been said by some authors (McPherson, Healy, Flynn and Piper, 1978) to fall with age at least up to 65 years while for women over 50 years of age it tends to rise (Wilding, Rollason and Robinson, 1972). Mean serum phosphate concentrations in the survey subjects were very similar to the results obtained by McPherson et al (1978) for post-menopausal women or men in the 56-65 year age range which suggests that little further change takes place after 65.

7.5.5 Serum calcium concentrations were correlated with serum phosphate concentrations in men and women ($P< 0.05$). Three men and two women had serum calcium concentrations less than 8.5 mg/100 ml (2.13 mmol/l) after correction for differences in albumin concentration. This correction is explained in Appendix D. These low calcium values were not associated with a high serum alkaline phosphatase. There were also one man and two women who had serum calcium concentrations above 11.0 mg/100 ml (2.75 mmol/l).

### 7.6 Ascorbic acid (vitamin C) status

7.6.1 Sunderland was the only area apart from Camden where leucocyte ascorbic acid (LAA) was measured. The results are not strictly comparable since the measurement was made by different operators. However the colorimetric procedure was standardized between the two laboratories. Reliability of modern cell counting equipment lessens the likelihood of variation in the leucocyte counts. Therefore the information from the two laboratories can be usefully compared.

7.6.2 The mean values for PAA and LAA for men and women were not significantly different but the proportion of subjects with results in the lower

ranges was different in the sexes. Table 7.5 shows the distribution of low PAA values in the six areas and low LAA in the two areas. More men had PAA values below 0.2 mg/100 ml and LAA values below 15$\mu$g/$10^8$ WBC than women. There were four men in Sunderland whose PAA concentrations were below 0.1 mg/100 ml and five men and one woman, also in Sunderland, who had LAA values less than 10 $\mu$g/$10^8$ white cells. Two of these subjects, one man and one woman, who had been clinically diagnosed as having scurvy, had LAA values of 3.5 and 5.0 $\mu$g/$10^8$ cells and PAA concentrations of 0.09 and 0.10 mg/100 ml respectively. A clinical diagnosis of scurvy was made in one other subject in Rutherglen but no ascorbic acid assays were done for this subject.

7.6.3 The proportion of men with PAA values less than 0.2 mg/100 ml was higher in Sunderland, Rutherglen and Angus (Table 7.5) and the dietary intake of vitamin C was lower in these areas compared with other areas (Table 5.1). For women this was not so. Subjects from Cambridge appeared to have the fewest low values and those in Sunderland the most (Table 7.5).

7.6.4 LAA concentration was significantly correlated with PAA and with serum folate concentrations for both men and women, and with red cell folate concentration for the women only (Table 7.4) but the correlation with dietary vitamin C was significant ($P< 0.01$) only in men. PAA concentration was also significantly correlated with serum folate and vitamin C intake for both men and women, and with red cell folate for women only (Table 7.4).

### 7.7 Thiamin (vitamin $B_1$) status

7.7.1 There was very little biochemical evidence of poor thiamin status amongst the survey subjects, since only 8% (29 of 357 subjects) gave transketolase (TKL) activation coefficients (AC)[1] above 1.25. These increased values were distributed equally between the sexes, but the numbers were too small to detect any significant area differences. Only women in Camden seemed a little different where 6 out of the 30 (20%) showed raised AC values.

7.7.2 The biochemistry of subjects with a low mental test score was also examined to see if thiamin status was impaired but no differences were detected.

### 7.8 Riboflavin (vitamin $B_2$) status

7.8.1 In the survey 30% of the subjects had erythrocyte glutathione reductase (EGR) activation coefficients (AC)[2] above 1.3, a value which was adopted as the upper limit of normal on the basis of the results of Tillotson and Baker (1972). The distribution of these subjects in the whole sample was not related to age or sex but there were differences between the areas (Table 7.6). The three northern areas showed the poorest riboflavin status in that

(1) Appendix D, para 6.1
(2) Appendix D, paras 7.1 and 7.3

mean activation coefficients were higher than in the three southern areas. The proportion of women with AC values above 1.3 in the north was significantly greater ($P < 0.001$) than in the south, but the difference was not significant for men.

7.8.2 EGR-AC values were significantly ($P < 0.001$) inversely correlated with riboflavin dietary intakes for both men and women (Table 7.4). There was also an inverse correlation with the intake of milk (for men $P < 0.05$, for women $P < 0.001$).

### 7.9 Subjects who took vitamin supplements

7.9.1 There were 9 men and 13 women among the 365 full participants in the survey who were recorded as receiving vitamin supplements. Full information on the vitamins taken by these subjects was not available in all cases and for this reason and the small numbers of subjects involved, none of the information on extra vitamins was added to the dietary data or used in the analyses.

7.9.2 If the extra vitamins were being taken regularly, then indices of vitamin status could possibly be inconsistent with the recorded daily intakes. Such data might have adversely affected the significance of the correlation between nutrient intake and vitamin status. Correlations between the dietary intake of vitamins $B_1$, $B_2$ and C and the corresponding biochemical indices were therefore recalculated excluding the 22 subjects who were said to be taking vitamin supplements. The recalculated results suggested that no inconsistencies were introduced by the inclusion of these subjects in the analysis.

**Table 7.1:** *Biochemical measurements made and the ranges of values used as reference ranges during the survey*

| Measurement | Units | Acceptable limits* |
|---|---|---|
| Serum total proteins | g/100 ml | » 6.5 |
| | g/l | »65.0 |
| Serum albumin | g/100 ml | » 3.5 |
| | g/l | »35.0 |
| Serum pseudocholinesterase | mmol/l/min | M 2.04 – 5.04 |
| | | F 2.74 – 5.32 |
| Serum alkaline phosphatase | K.A. Units | «13 |
| Serum calcium | mg/100 ml | 8.5 – 10.5 |
| | mmol/l | 2.125 – 2.625 |
| Serum phosphate | mg/100 ml | 2.5 – 4.8 |
| | mmol/l | 0.81 – 1.55 |
| Red cell glutathione reductase | AC | « 1.30 |
| Red cell transketolase | AC | « 1.25 |
| Plasma ascorbic acid | mg/100 ml | » 0.2 |
| | μmol/l | »11.36 |
| Leucocyte ascorbic acid | $\mu g/10^8$ white cells | »15.0 |

*The acceptable limits were based on personal experience and taken from a number of published values as follows:

serum total protein and albumin, plasma ascorbic acid: I.C.N.N.D. (1963)

pseudocholinesterase: T. P. Whitehead (1972) personal communication

alkaline phosphatase: Wootton (1964)

serum calcium: O'Halloran, Studley-Ruxton and Wellby (1970)

serum phosphate: Wilding, Rollason and Robinson (1972)

red cell glutathione reductase: Tillotson and Baker (1972)

red cell transketolase: Brin (1962)

leucocyte ascorbic acid: Windsor and Williams (1970)

**Table 7.2:** *Means and standard deviations of biochemical values for men and women under and over 80 years of age*

| Biochemical variable | | Men — All areas under 80 yrs | | 80 yrs and over | | Women — All areas under 80 yrs | | 80 yrs and over | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | s.d. (Number) | Mean | s.d. (Number) | Mean | s.d. (Number) | Mean | s.d. (Number) |
| Total serum proteins | g/l | 73.1 | 4.83 (110) | 73.4 | 6.39 (57) | 72.4 | 5.58 (124) | 72.0 | 5.28 (71) |
| Serum albumin | g/l | 43.4 | 3.56 (110) | 42.1 | 4.41 (57) | 43.4 | 3.27 (124) | 42.7 | 3.46 (71) |
| Serum pseudocholinesterase | mmol/l/min | 4.71 | 1.43 (110) | 4.44 | 1.20 (57) | 4.96 | 1.26 (124) | 4.67 | 1.23 (71) |
| Serum alkaline phosphatase | K.A. units | 7.9 | 2.08 (111) | 9.5 | 6.14 (57) | 8.4 | 2.62 (124) | 9.2 | 3.58 (71) |
| Serum calcium (adjusted) | mmol/l | 2.36 | 0.106 (110) | 2.36 | 0.159 (57) | 2.38 | 0.141 (124) | 2.36 | 0.096 (71) |
| Serum phosphate*** | mmol/l | 0.93 | 0.155 (110) | 0.93 | 0.170 (57) | 1.10 | 0.169 (124) | 1.07 | 0.159 (71) |
| Leucocyte ascorbic acid | $\mu g/10^8$ cells | 22.8 | 11.6 (41) | 21.8 | 10.8 (17) | 27.0 | 10.3 (53) | 23.3 | 8.08 (35) |
| Plasma ascorbic acid | $\mu$mol/l | 27.8 | 19.36 (109) | 29.0 | 20.04 (57) | 28.4 | 18.68 (122) | 31.2 | 19.93 (69) |
| Red cell transketolase | AC | 1.14 | 0.09 (109) | 1.14 | 0.12 (56) | 1.13 | 0.10 (122) | 1.11 | 0.10 (70) |
| Red cell glutathione reductase | AC | 1.27 | 0.18 (109) | 1.26 | 0.20 (57) | 1.25 | 0.17 (122) | 1.25 | 0.18 (70) |

***Mean value all areas combined for all men was significantly lower than the mean value for all women

**Table 7.3A:** *Means and standard deviations of biochemical values for men in the different areas*

| | | All areas | | Portsmouth | | Cambridge | | Sunderland | | Rutherglen | | Angus | | Camden | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Total serum proteins | g/l | 73.2 | 5.39 | 76.4 | 5.03 | 73.6 | 5.48 | 72.5 | 5.56 | 73.3 | 5.02 | 72.0 | 5.48 | 73.7 | 2.57 |
| | | (167) | | (18) | | (41) | | (56) | | (13) | | (30) | | (9) | |
| Serum albumin | g/l | 43.0 | 3.90 | 43.1 | 3.75 | 43.9 | 3.79 | 42.7 | 4.26 | 42.1 | 4.69 | 42.5 | 3.27 | 43.2 | 3.23 |
| | | (167) | | (18) | | (41) | | (56) | | (13) | | (30) | | (9) | |
| Serum pseudocholinesterase | mmol/l/min | 4.62 | 1.36 | 5.06 | 1.75 | 4.62 | 1.59 | 4.63 | 1.16 | 4.25 | 1.07 | 4.65 | 1.27 | 4.02 | 1.08 |
| | | (167) | | (18) | | (41) | | (56) | | (13) | | (30) | | (9) | |
| Serum alkaline phosphatase | KA units | 8.4 | 4.01 | 8.3 | 2.67 | 7.7 | 2.19 | 9.3 | 6.05 | 9.0 | 2.72 | 7.8 | 2.19 | 8.2 | 2.43 |
| | | (168) | | (18) | | (42) | | (56) | | (13) | | (30) | | (9) | |
| Serum calcium (adjusted) | mmol/l | 2.36 | 0.126 | 2.28 | 0.082 | 2.37 | 0.184 | 2.38 | 0.108 | 2.41 | 0.094 | 2.34 | 0.071 | 2.34 | 0.102 |
| | | (167) | | (18) | | (41) | | (56) | | (13) | | (30) | | (9) | |
| Serum phosphate | mmol/l | 0.93 | 0.160 | 0.95 | 0.079 | 0.95 | 0.186 | 0.93 | 0.149 | 0.92 | 0.211 | 0.88 | 0.159 | 0.97 | 0.134 |
| | | (167) | | (18) | | (41) | | (56) | | (13) | | (30) | | (9) | |
| Leucocyte ascorbic acid | $\mu g/10^8$ cells | 22.5 | 11.3 | — | — | — | — | 22.9 | 11.9 | — | — | — | — | 20.2 | 7.4 |
| | | (58) | | (0) | | (0) | | (49) | | (0) | | (0) | | (9) | |
| Plasma ascorbic acid | $\mu$mol/l | 28.4 | 19.53 | 32.9 | 16.75 | 41.4 | 21.07 | 20.4 | 15.7 | 18.2 | 11.92 | 23.8 | 16.69 | 34.1 | 20.90 |
| | | (166) | | (16) | | (43) | | (56) | | (12) | | (30) | | (9) | |
| Red cell transketolase | AC | 1.14 | 0.10 | 1.11 | 0.11 | 1.15 | 0.09 | 1.13 | 0.08 | 1.16 | 0.12 | 1.16 | 0.13 | 1.12 | 0.10 |
| | | (165) | | (15) | | (43) | | (56) | | (12) | | (30) | | (9) | |
| Red cell glutathione reductase | AC | 1.27 | 0.19 | 1.19 | 0.11 | 1.22 | 0.15 | 1.31 | 0.21 | 1.31 | 0.22 | 1.29 | 0.20 | 1.23 | 0.10 |
| | | (166) | | (16) | | (43) | | (56) | | (12) | | (30) | | (9) | |

**Table 7.3B:** *Means and standard deviations of biochemical values for women in the different areas*

| | | All areas | | Portsmouth | | Cambridge | | Sunderland | | Rutherglen | | Angus | | Camden | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Total serum proteins | g/l | 72.3 | 5.46 | 72.3 | 4.78 | 74.4 | 7.52 | 71.9 | 4.93 | 74.2 | 5.43 | 70.4 | 5.51 | 71.6 | 3.97 |
| | | (195) | | (20) | | (28) | | (66) | | (21) | | (30) | | (30) | |
| Serum albumin | g/l | 43.2 | 3.34 | 43.5 | 2.47 | 43.9 | 3.67 | 42.3 | 3.10 | 45.3 | 3.69 | 42.1 | 3.38 | 43.8 | 2.93 |
| | | (195) | | (20) | | (28) | | (66) | | (21) | | (30) | | (30) | |
| Serum pseudocholinesterase | mmol/l/min | 4.85 | 1.26 | 5.24 | 1.26 | 4.73 | 1.29 | 4.92 | 1.30 | 5.13 | 1.33 | 4.69 | 1.08 | 4.51 | 1.20 |
| | | (195) | | (20) | | (28) | | (66) | | (21) | | (30) | | (30) | |
| Serum alkaline phosphatase | KA units | 8.7 | 3.03 | 9.0 | 5.10 | 8.7 | 2.98 | 9.2 | 3.13 | 8.8 | 2.28 | 8.3 | 1.83 | 7.6 | 2.24 |
| | | (195) | | (20) | | (28) | | (66) | | (21) | | (30) | | (30) | |
| Serum calcium (adjusted) | mmol/l | 2.37 | 0.127 | 2.36 | 0.081 | 2.35 | 0.152 | 2.39 | 0.092 | 2.33 | 0.087 | 2.42 | 0.213 | 2.34 | 0.077 |
| | | (195) | | (20) | | (28) | | (66) | | (21) | | (30) | | (30) | |
| Serum phosphate | mmol/l | 1.09 | 0.165 | 1.14 | 0.114 | 1.09 | 0.139 | 1.06 | 0.147 | 1.09 | 0.190 | 1.05 | 0.204 | 1.17 | 0.171 |
| | | (195) | | (20) | | (28) | | (66) | | (21) | | (30) | | (30) | |
| Leucocyte ascorbic acid | $\mu g/10^8$ cells | 25.6 | 9.64 | — | — | — | — | 26.0 | 10.4 | — | — | — | — | 24.5 | 7.3 |
| | | (88) | | (0) | | (0) | | (62) | | (0) | | (0) | | (26) | |
| Plasma ascorbic acid | $\mu$mol/l | 29.5 | 19.1 | 33.5 | 23.8 | 38.6 | 18.9 | 23.8 | 15.7 | 23.3 | 14.1 | 25.6 | 18.1 | 38.0 | 21.3 |
| | | (191) | | (20) | | (29) | | (66) | | (20) | | (28) | | (28) | |
| Red cell transketolase | AC | 1.12 | 0.10 | 1.08 | 0.07 | 1.12 | 0.07 | 1.13 | 0.11 | 1.10 | 0.08 | 1.13 | 0.11 | 1.13 | 0.12 |
| | | (192) | | (20) | | (29) | | (66) | | (18) | | (29) | | (30) | |
| Red cell glutathione reductase | AC | 1.25 | 0.17 | 1.16 | 0.07 | 1.24 | 0.17 | 1.29 | 0.19 | 1.31 | 0.20 | 1.26 | 0.15 | 1.19 | 0.14 |
| | | (192) | | (20) | | (29) | | (66) | | (18) | | (29) | | (30) | |

The number of subjects is given in parentheses

**Table 7.4:** *Correlations of biochemical variables with other biochemical or haematological variables and with some dietary and clinical findings*

| Biochemical variable studied | Biochemical/haematological | Correlation coefficient | | Dietary intake | Correlation coefficient | | Anthropometric/clinical | Correlation coefficient | |
|---|---|---|---|---|---|---|---|---|---|
| | | M | F | | M | F | | M | F |
| Serum total protein | Pseudocholinesterase | 0.24*** | 0.08 | Protein | 0.20** | 0.004 | Quetelet's index | 0.05 | 0.07 |
| | | | | Energy | 0.12 | 0.02 | Arm circumference | 0.13* | −0.01 |
| | | | | | | | Skinfold thickness§ | 0.04 | 0.07 |
| Serum albumin | Serum total protein | 0.50*** | 0.37*** | Protein | 0.17* | 0.03 | Quetelet's index | 0.08 | 0.07 |
| | Pseudocholinesterase | 0.40*** | 0.23*** | Energy | 0.04 | 0.03 | Arm circumference | 0.17* | 0.03 |
| | Iron-binding capacity | 0.17* | 0.06 | | | | Skinfold thickness§ | 0.18** | 0.10 |
| Serum pseudocholinesterase | Iron-binding capacity | −0.01 | 0.01 | Protein | 0.21** | 0.002 | Quetelet's index | 0.23** | 0.15* |
| | | | | Energy | 0.09 | −0.01 | Arm circumference | 0.32*** | 0.11 |
| | | | | | | | Skinfold thickness§ | 0.29*** | 0.15* |
| Serum alkaline phosphatase | Calcium | −0.14* | −0.16* | Vitamin D | −0.02 | −0.11 | Metacarpal index† | −0.05 | −0.24*** |
| | Phosphate | −0.03 | −0.18** | Calcium | −0.09 | −0.08 | | | |
| Serum calcium | Phosphate | 0.13* | 0.15* | Vitamin D | 0.003 | 0.06 | Metacarpal index† | 0.02 | −0.01 |
| | | | | Calcium | 0.12 | 0.16* | | | |
| Serum phosphate | | | | Vitamin D | −0.001 | 0.04 | Metacarpal index† | −0.03 | 0.03 |
| | | | | Calcium | 0.06 | 0.21** | | | |
| Calcium/phosphate product | | | | Vitamin D | 0.02 | 0.05 | Metacarpal index† | 0.01 | −0.05 |
| | | | | Calcium | 0.10 | 0.19** | | | |
| Red cell glutathione reductase | Haemoglobin | −0.08 | −0.19* | Riboflavin (mg) | −0.25*** | −0.29*** | | | |
| | Transketolase | 0.11 | 0.23*** | | | | | | |
| | Serum $B_6$ | −0.22 | −0.18** | Riboflavin (mg/1 000 kcal) | −0.30*** | −0.34*** | | | |
| | | | | Milk | −0.17* | −0.28*** | | | |

**Table 7.4** (CONTINUED)

**Table 7.4:** *Correlations of biochemical variables with other biochemical or haematological variables and with some dietary and clinical findings*

| Biochemical variable studied | Biochemical/ haematological | Correlation coefficient | | Dietary intake | Correlation coefficient | | Anthropometric/ clinical | Correlation coefficient | |
|---|---|---|---|---|---|---|---|---|---|
| | | M | F | | M | F | | M | F |
| Red cell transketolase | | | | Energy | −0.03 | −0.05 | | | |
| | | | | Thiamin (mg) | −0.14* | −0.16* | | | |
| | | | | Thiamin (mg/1 000 kcal) | −0.18* | −0.19** | | | |
| | | | | Bread | −0.00 | −0.08 | | | |
| | | | | Alcohol | −0.05 | −0.09 | | | |
| Plasma ascorbic acid | Serum folate (log) | 0.15* | 0.33*** | Vitamin C (mg/d) | 0.49*** | 0.40*** | Metacarpal index† | −0.03 | −0.01 |
| | Red cell folate (log) | 0.08 | 0.21*** | | | | | | |
| | Haemoglobin | −0.13 | 0.07 | | | | | | |
| Leucocyte ascorbic acid†† | Serum folate (log) | 0.34** | 0.25* | Vitamin C (mg/d) | 0.35** | 0.11 | Metacarpal index† | −0.01 | −0.06 |
| | Red cell folate (log) | 0.13 | 0.23* | | | | | | |
| | Haemoglobin | 0.04 | 0.06 | | | | | | |
| | Plasma ascorbic acid | 0.46*** | 0.32*** | | | | | | |
| Haemoglobin | | | | Vitamin C (mg/d) | −0.05 | 0.08 | | | |
| Serum iron | | | | Vitamin C (mg/d) | 0.10 | −0.09 | | | |

* $P<0.05$ **$P<0.01$ ***$P<0.001$

§ mean of measurements at 2 sites; measurements at 4 sites gave almost identical results except for serum pseudocholinesterase where the correlation in females was not significant

†† only measured in 2 areas, therefore results are based on smaller numbers

† metacarpal index is the ratio of the cortical area to surface area of the 2nd metacarpal ($\frac{D^2-d^2}{DL}$ where D = outside diameter, d = inside diameter, L = length of bone)

**Table 7.5:** *The number of subjects in the different areas who had low values for plasma (PAA) and leucocyte (LAA)*[1] *ascorbic acid concentrations (PAA expressed as mg/100ml, LAA expressed as μg/$10^8$ cells)*

| Area | Men | | | | | | Women | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PAA | | | LAA | | | PAA | | | LAA | | |
| | No. of subjects | PAA No. | <0.2 % | No. of subjects | LAA No. | <15 % | No. of subjects | PAA No. | <0.2 % | No. of subjects | LAA No. | <15 % |
| Portsmouth | 16 | 1 | 6 | — | — | — | 20 | 5 | 25 | — | — | — |
| Cambridge | 43 | 2 | 5 | — | — | — | 29 | 0 | 0 | — | — | — |
| Sunderland | 56 | 17 | 30 | 49 | 12 | 24 | 66 | 10 | 15 | 62 | 7 | 11 |
| Rutherglen | 12 | 4 | 33 | — | — | — | 20 | 1 | 5 | — | — | — |
| Angus | 30 | 6 | 20 | — | — | — | 28 | 3 | 11 | — | — | — |
| Camden | 9 | 1 | 11 | 9 | 3 | 33 | 28 | 1 | 4 | 26 | 3 | 12 |
| All areas | 166 | 31 | 19 | 58 | 15 | 26 | 191 | 20 | 10 | 88 | 10 | 11 |

[1] Leucocyte ascorbic acid measurements were made only in Sunderland and Camden

**Table 7.6:** *Mean values for erythrocyte glutathione reductase activation coefficients (EGR-AC) in the different areas and number of subjects with AC »1.3*

| Area | EGR-AC for all subjects | | | Subjects with EGR-AC »1.3 | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Men | | Women | | Total | |
| | No. of subjects | Mean | s.d. | No. | % of all men | No. | % of all women | No. | % of all subjects |
| Portsmouth | 36 | 1.17 | 0.09 | 3 | 19 | 0 | 0 | 3 | 8 |
| Cambridge | 72 | 1.23 | 0.16 | 10 | 23 | 9 | 31 | 19 | 26 |
| Sunderland | 122 | 1.30 | 0.20 | 23 | 41 | 26 | 39 | 49 | 40 |
| Rutherglen | 30 | 1.31 | 0.20 | 3 | 25 | 8 | 44 | 11 | 37 |
| Angus | 59 | 1.27 | 0.18 | 10 | 33 | 10 | 34 | 20 | 34 |
| Camden | 39 | 1.20 | 0.14 | 2 | 22 | 4 | 13 | 6 | 15 |

# 8. Haematology

## 8.1 Introduction

8.1.1 As in 1967/68, samples of blood taken from the elderly subjects who participated in the follow-up survey were sent to the Department of Haematology, St. Bartholomew's Hospital, London, where a full blood count was carried out, blood films prepared and examined, and concentrations of serum iron and total iron binding capacity (TIBC), serum vitamin $B_{12}$, serum and red cell folate and vitamin $B_6$ were determined. The methods used for these determinations are listed in Table 8.1.

8.1.2 With the exception of haemoglobin concentration, to which the World Health Organization (1968) criteria were applied, the ranges taken as "normal"[1] were those determined and currently used at St. Bartholomew's Hospital, London, for a healthy adult population of less than 65 years of age (Table 8.2). These ranges are essentially the same as those used at present by WHO. No attempt to introduce ranges for "normality" for the elderly was made at this stage of investigation.

8.1.3 The results have been analysed primarily to investigate factors which may cause or which have already caused anaemia due to nutritional deficiency. The distribution and incidence of "abnormal"[1] values for each measurement were studied and the relationships between each measurement and a number of other relevant factors were investigated. The haematological status of subjects diagnosed as malnourished was also studied (section 8.8).

8.1.4 The initial statistical analysis has shown that the means and distributions of all the haematological values for the six areas were similar and no significant difference could be demonstrated between areas, or between the two age groups (under 80 years of age, 80 years and over), either for men or for women. Therefore, the full analysis of haematological results was carried out on pooled data for all the areas, both age groups and both sexes, with the exception of the analyses of haemoglobin concentration, serum iron concentration and TIBC for which there is a known difference between the means and distributions for men and women younger than 65 years of age.

## 8.2 Haemoglobin concentration

8.2.1 The distribution, mean value and percentage of subnormal values for haemoglobin concentration (Hb) of the subjects are presented in Figure 8.1. The mean haemoglobin values for men and women were 14.5 and 13.5 g/dl

[1] In this section the use of inverted commas in relation to the words normal and abnormal, although implied, has been omitted in succeeding paragraphs.

respectively. The overall frequency of anaemia, that is to say of Hb less than 13.0 g/dl for men and less than 12.0 g/dl for women (WHO, 1968) was 12.5% in all areas and was twice as high in men (16.9%) as in women (8.8%) (Table 8.2).

8.2.2 The analyses of all the haematological values for 28 men and 17 women with anaemia revealed that iron deficiency was either the sole or a contributing cause of anaemia in 4 men (14.3%) and 7 women (41.2%). Incidence of folate and vitamin $B_{12}$ deficiency, as defined by subnormal concentration of red cell folate and serum vitamin $B_{12}$ respectively, was essentially the same for men and women. Folate deficiency was found in 10 subjects (22.2%) and vitamin $B_{12}$ deficiency in 13 subjects (28.8%). A small proportion of subjects (13.3%) had combined deficiency of iron and vitamin $B_{12}$, and in only two of them, both malnourished, was there also evidence of folate deficiency.

### 8.3 Serum iron and total iron-binding capacity

8.3.1 The body iron status was assessed using both the serum iron concentration (SI) and the total iron-binding capacity (TIBC). The distribution of SI in the survey subjects was as shown in Figure 8.2. The mean values of SI for men and women were 85.4 and 77.6 μg/100 ml respectively. Subnormal values were found in 19.3% of men and 24.6% of women.

8.3.2 The mean TIBC values for the men and women were 353 and 384 μg/100 ml, respectively. These values were approximately the same as those for a healthy population aged less than 65 years. The distribution of the TIBC values, however, was much wider than for younger people (Figure 8.3) and only 58.8% of men and 59.4% of women had values within the normal range. There was a considerable difference in the proportion of abnormal values for men and women: three times as many men as women had a TIBC below the normal range but 21% of the men and 34% of the women had a TIBC above the normal range.

### 8.4 Serum folate and red cell folate

8.4.1 There was no difference in the distribution of the serum folate concentrations (SF) of the men and women (Figure 8.4). 13.3% of all the subjects investigated had a SF concentration of less than 3 ng/ml, which would usually be taken as indicating the presence of folate deficiency.

8.4.2 The distribution of red cell folate concentrations (RCF) was almost identical in the men and women (Figure 8.5). Most of the subjects had RCF values within the normal range and only about one fifth of the men and one quarter of the women had evidence of long-term folate deficiency as measured by RCF of less than 150 ng/ml. RCF values of less than 100 ng/ml were found in 4.7% of men and 6.1% of women.

### 8.5 Serum vitamin $B_{12}$

8.5.1 The distribution of serum vitamin $B_{12}$ concentrations ($SB_{12}$) in the

survey subjects was as shown in Figure 8.6. The incidence of $SB_{12}$ values in the range found in overt pernicious anaemia (< 100 pg/ml) was 2.5%. About one fifth of all the subjects investigated had a $SB_{12}$ value in the range 100–200 pg/ml. Such concentrations of $B_{12}$ occur at some stage in the development of pernicious anaemia, and are also found in atrophic gastritis, following partial gastrectomy and in the malabsorption syndrome. Although the significance of such concentrations of $B_{12}$ as an index of vitamin $B_{12}$ deficiency remains uncertain, an increased incidence may be one of the characteristics of the ageing process.

## 8.6 Serum and red cell vitamin $B_6$

8.6.1 The distribution of serum vitamin $B_6$ concentrations ($SB_6$) in the 156 men and 188 women over 70 years of age was as shown in Figure 8.7. In younger subjects the concentration of $B_6$ is known to decrease with age (Anderson, Peart and Fulford-Jones, 1970) and to be greater in men than in women, but there was no significant difference between the sexes or age groups in this sample of elderly people.

8.6.2 In younger subjects the concentrations of serum vitamin $B_6$ which are less than 4 ng/ml are considered borderline or subnormal. In the survey sample 18.8% had $B_6$ concentrations between 3 and 4 ng/ml and 9.6% had concentrations of less than 3 ng/ml. Because it is known that in healthy people younger than 65 years the concentration of vitamin $B_6$ in serum decreases with age, the significance of the findings in this sample of people all of whom were over 70 years is uncertain.

8.6.3 The distribution of red cell vitamin $B_6$ concentration ($RCB_6$) in this sample of 149 men and 184 women over 70 years of age was as shown in Figure 8.8. In younger subjects the $RCB_6$ does not decrease with age nor is there a difference between men and women. Among the survey subjects there was also no decrease in $RCB_6$ with age and the mean concentration was not statistically significantly different from the means for younger subjects. However, 11.4% of the elderly subjects had a red cell vitamin $B_6$ concentration less than the 14 ng/ml which is considered subnormal for younger subjects.

## 8.7 Conclusions

8.7.1 The overall incidence of anaemia was 12.5% and twice as many men as women were anaemic (16.9% of men and 8.8% of women).

8.7.2 The mean values for serum iron, folate, vitamin $B_{12}$ and vitamin $B_6$ concentrations were lower than in the population below 65 years of age. The mean values for TIBC in men and women and for red cell folate were similar to those found in the younger population. For all measurements there was also a higher proportion of abnormal values than in the younger population.

8.7.3 The high incidence of anaemia in men appears to be due to an increased

prevalence of constitutional disease. This is supported by the finding of a higher proportion of low TIBC values in men (20%) than in women (6.4%).

### 8.8 Haematological status of the 26 subjects who were diagnosed as malnourished

8.8.1 *Incidence of anaemia.* Of the 26 subjects classified as being malnourished 10 were not anaemic (Table 8.3). Six of these subjects had no biochemical evidence of iron, folate or vitamin $B_{12}$ deficiency, but four subjects had concentrations of serum iron, TIBC, serum and red cell folate or serum vitamin $B_{12}$ which were abnormal.

8.8.2 Of the 16 subjects who were anaemic, one had normal values for serum iron, TIBC, folate, vitamin $B_{12}$ and vitamin $B_6$. Five of the subjects had had a partial gastrectomy before the survey. All five (four men and one woman) were iron deficient. Two of these five subjects had, in addition, evidence of vitamin $B_{12}$ deficiency and one had evidence of both vitamin $B_{12}$ and folate deficiency. The remaining 10 anaemic subjects had evidence of deficiency of at least one of the three nutrients.

8.8.3 *Incidence of iron, folate, vitamins $B_{12}$ and $B_6$ deficiency.* Small numbers preclude the statistical analysis of the results for the 19 malnourished subjects who had biochemical evidence of iron, folate and/or vitamin $B_{12}$ deficiency (Table 8.3). It is of interest, however, that 6 out of 19 deficient subjects had a combined deficiency of at least two of these nutrients.

8.8.4 Within this group of 19 subjects there were three subjects whose dietary intake appeared to be reasonably good (Appendix B, subjects 5, 9 and 22). The other subjects, after excluding those with partial gastrectomy, all had a low intake of energy and most nutrients.

8.8.5 Ten subjects had a serum vitamin $B_6$ concentration which was less than 4 ng/ml and in three the concentration was less than 3 ng/ml. Four of the malnourished subjects, however, had red cell vitamin $B_6$ concentration less than 13 ng/ml which is considered subnormal in the younger population.

8.8.6 *Conclusion.* In contrast to the group of the elderly as a whole, most of the malnourished subjects had biochemical evidence of iron, folate or vitamin $B_{12}$ deficiency, which was associated with anaemia in 15 subjects (58%). In spite of clinical, dietary and biochemical evidence of malnutrition, 7 subjects (Appendix B, subjects 4, 12, 14, 15, 18, 19 and 24), that is to say 27% of the malnourished subjects, had normal serum iron, TIBC, folate or $B_{12}$ concentrations.

**Table 8.1:** *Haematological measurements and the methods used*

| Measurement | Method |
|---|---|
| Haemoglobin concentration* | Coulter Counter Model S |
| Serum iron concentration | Garry & Owen (1966) |
| Total iron-binding capacity | Brozovic & Copestake (1969) |
| Serum folate | Waters & Mollin (1961) |
| Red cell folate | Hoffbrand, Newcombe & Mollin (1966) |
| Serum vitamin $B_{12}$ | Anderson (1964) |
| Serum vitamin $B_6$ | Anderson, Peart & Fulford-Jones (1970) |
| Red cell vitamin $B_6$ | Anderson, unpublished |

*In addition to haemoglobin concentration the following values were recorded for each sample: red blood cell count, packed cell volume, mean cell volume, mean cell haemoglobin, mean cell haemoglobin concentration and white blood cell count (Dacie and Lewis, 1975).

**Table 8.2:** *Number of subjects with normal and abnormal values* for some haematological measurements*

| Measurement | Range | All persons | | Men | | Women | |
|---|---|---|---|---|---|---|---|
| Haemoglobin | Normal, men >13g/dl | 315 | (87.5%) | 138 | (83.1%) | — | |
| | women >12g/dl | | | — | | 177 | (91.2%) |
| | Subnormal, men <13g/dl | 45 | (12.5%) | 28 | (16.9%) | — | |
| | women <12g/dl | | | — | | 17 | (8.8%) |
| | Total | 360 | (100%) | 166 | (100%) | 194 | (100%) |
| Serum iron | Normal >60μg/100ml | 278 | (77.9%) | 134 | (80.7%) | 144 | (75.4%) |
| | Subnormal <60μg/100ml | 79 | (22.1%) | 32 | (19.3%) | 47 | (24.6%) |
| | Total | 357 | (100%) | 166 | (100%) | 191 | (100%) |
| Total iron-binding capacity | Normal 300-400μg/100ml | 208 | (59.1%) | 97 | (58.8%) | 111 | (59.4%) |
| | Lower than normal <300μg/100ml | 45 | (12.8%) | 33 | (20.0%) | 12 | (6.4%) |
| | Higher than normal >400μg/100ml | 99 | (28.1%) | 35 | (21.2%) | 64 | (34.2%) |
| | Total | 352 | (100%) | 165 | (100%) | 187 | (100%) |
| Serum folate | Normal >6ng/ml | 148[a] | (41.3%) | 66[a] | (40.0%) | 82 | (42.5%) |
| | Borderline 3–6ng/ml | 161 | (45.0%) | 77 | (46.7%) | 84 | (43.5%) |
| | Subnormal <3ng/ml | 49 | (13.7%) | 22 | (13.3%) | 27 | (14.0%) |
| | Total | 358[a] | (100%) | 165[a] | (100%) | 193 | (100%) |
| Red cell folate | Normal >150ng/ml | 257[b] | (77.7%) | 119[b] | (80.4%) | 138 | (75.4%) |
| | Borderline 100–150ng/ml | 56 | (16.9%) | 22 | (14.9%) | 34 | (18.6%) |
| | Subnormal <100ng/ml | 18 | (5.4%) | 7 | (4.7%) | 11 | (6.0%) |
| | Total | 331[b] | (100%) | 148[d] | (100%) | 183 | (100%) |
| Serum vitamin $B_{12}$ | Normal >200pg/ml | 289[c] | (79.6%) | 137[d] | (81.5%) | 152[e] | (77.9%) |
| | Borderline 100–200pg/ml | 65 | (17.9%) | 27 | (16.1%) | 38 | (19.5%) |
| | Subnormal <100pg/ml | 9 | (2.5%) | 4 | (2.4%) | 5 | (2.6%) |
| | Total | 363[c] | (100%) | 168[d] | (100%) | 195[e] | (100%) |
| Serum vitamin $B_6$ | Normal >4ng/ml | 247 | (71.6%) | 108 | (69.2%) | 139 | (73.5%) |
| | Borderline 3–4ng/ml | 65 | (18.8%) | 29 | (18.6%) | 36 | (19.1%) |
| | Subnormal <3ng/ml | 33 | (9.6%) | 19 | (12.2%) | 14 | (7.4%) |
| | Total | 345 | (100%) | 156 | (100%) | 189 | (100%) |
| Red cell vitamin $B_6$ | Normal > 14ng/ml | 295 | (88.6%) | 130 | (87.2%) | 165 | (89.7%) |
| | Borderline 12–14ng/ml | 23 | (6.9%) | 14 | (9.4%) | 9 | (4.9%) |
| | Subnormal <12ng/ml | 15 | (4.5%) | 5 | (3.4%) | 10 | (5.4%) |
| | Total | 333 | (100%) | 149 | (100%) | 184 | (100%) |

*See paragraph 8.1.2

a. Includes 2 men with values over 100ng/ml, excluded from Figure 8.4

b. Includes 2 men with values over 1 000ng/ml, excluded from Figure 8.5

c. Includes 7 subjects with values over 1 000pg/ml, excluded from Figure 8.6

d. Includes 1 man with the value over 1 000pg/ml, excluded from Figure 8.6

e. Includes 6 women with the values over 1 000pg/ml, excluded from Figure 8.6

**Table 8.3:** *The incidence of anaemia and the deficiency of iron, folate and vitamin $B_{12}$ in the 26 malnourished subjects*

| Subjects | Men | | Women | |
|---|---|---|---|---|
| | Not anaemic | Anaemic | Not anaemic | Anaemic |
| Total | 6 | 8 | 4 | 8 |
| No iron, folate or $B_{12}$ deficiency | 3 | — | 3 | 1 |
| Iron deficiency alone | — | 2 | — | 3 |
| Folate deficiency alone | | | | |
| borderline | — | — | 1 | 1 |
| overt | — | 1 | — | 1 |
| Vitamin $B_{12}$ deficiency alone | | | | |
| borderline | 2 | 1 | — | — |
| overt | — | 1 | — | — |
| Combined deficiencies of iron, folate or vitamin $B_{12}$ | 1 | 3 | — | 2 |

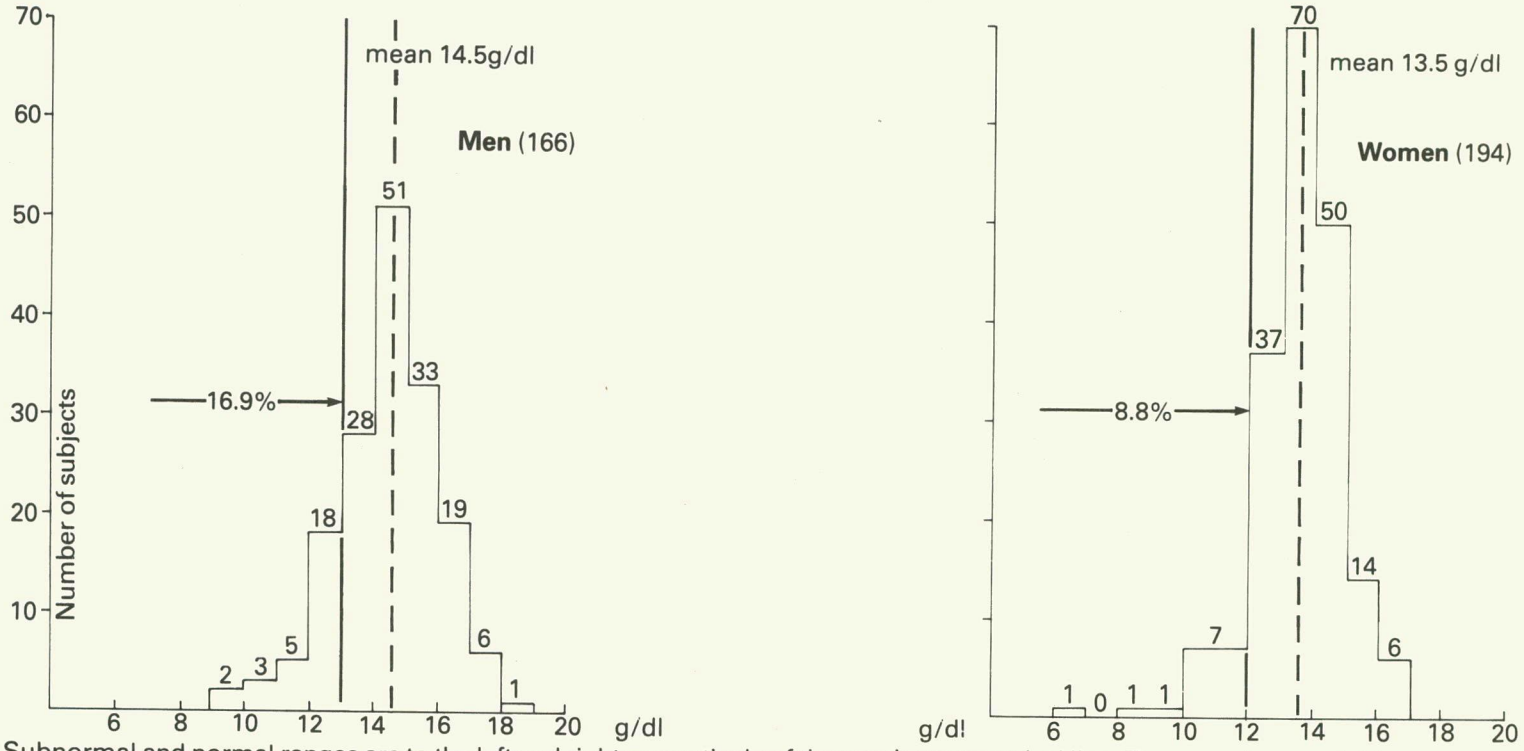
*Definitions of biochemical deficiency used in this table*

Iron deficiency: serum iron of less than 60μg/100ml *together with* a serum total iron-binding capacity of more than 400μg/100ml

Folate deficiency:
borderline: red-cell folate of 100–150ng/ml
overt: red-cell folate of less than 100ng/ml

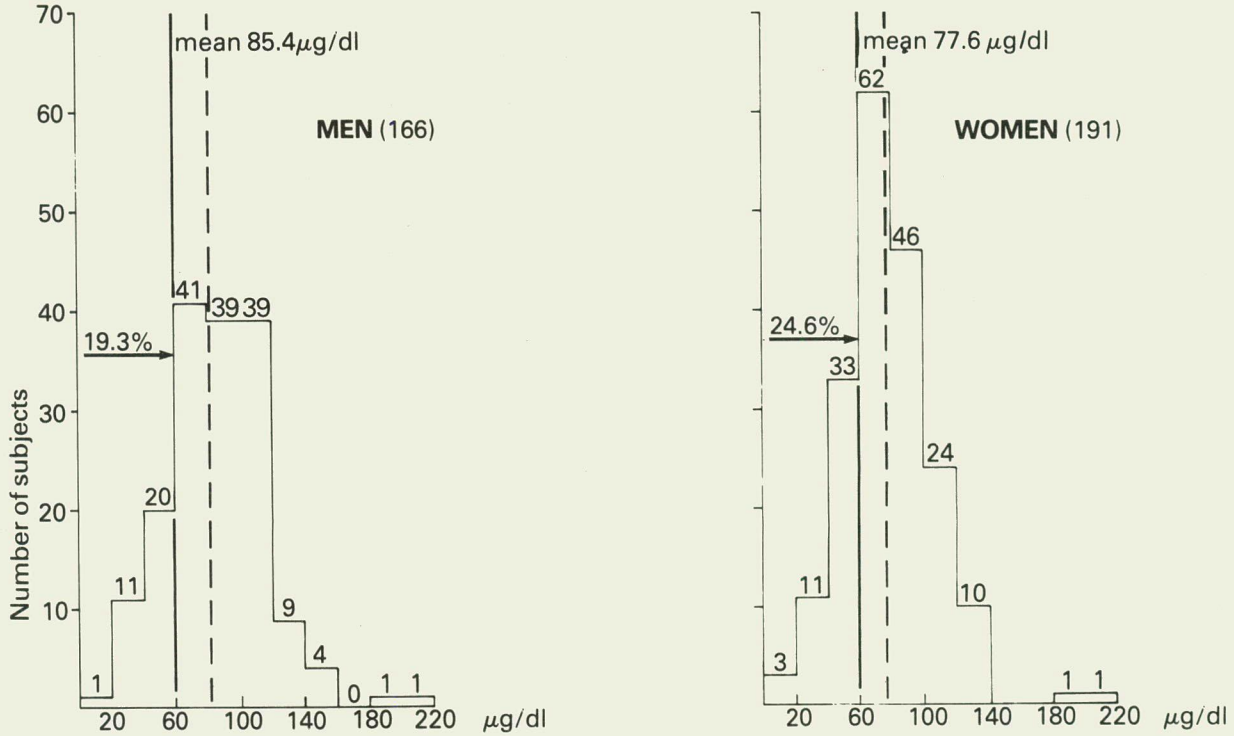
Vitamin $B_{12}$ deficiency:
borderline: serum vitamin $B_{12}$ of 100–200pg/ml
overt: serum vitamin $B_{12}$ of less than 100pg/ml

FIGURE 8.1 ***Frequency distribution of haemoglobin concentration — in grams per decilitre.***



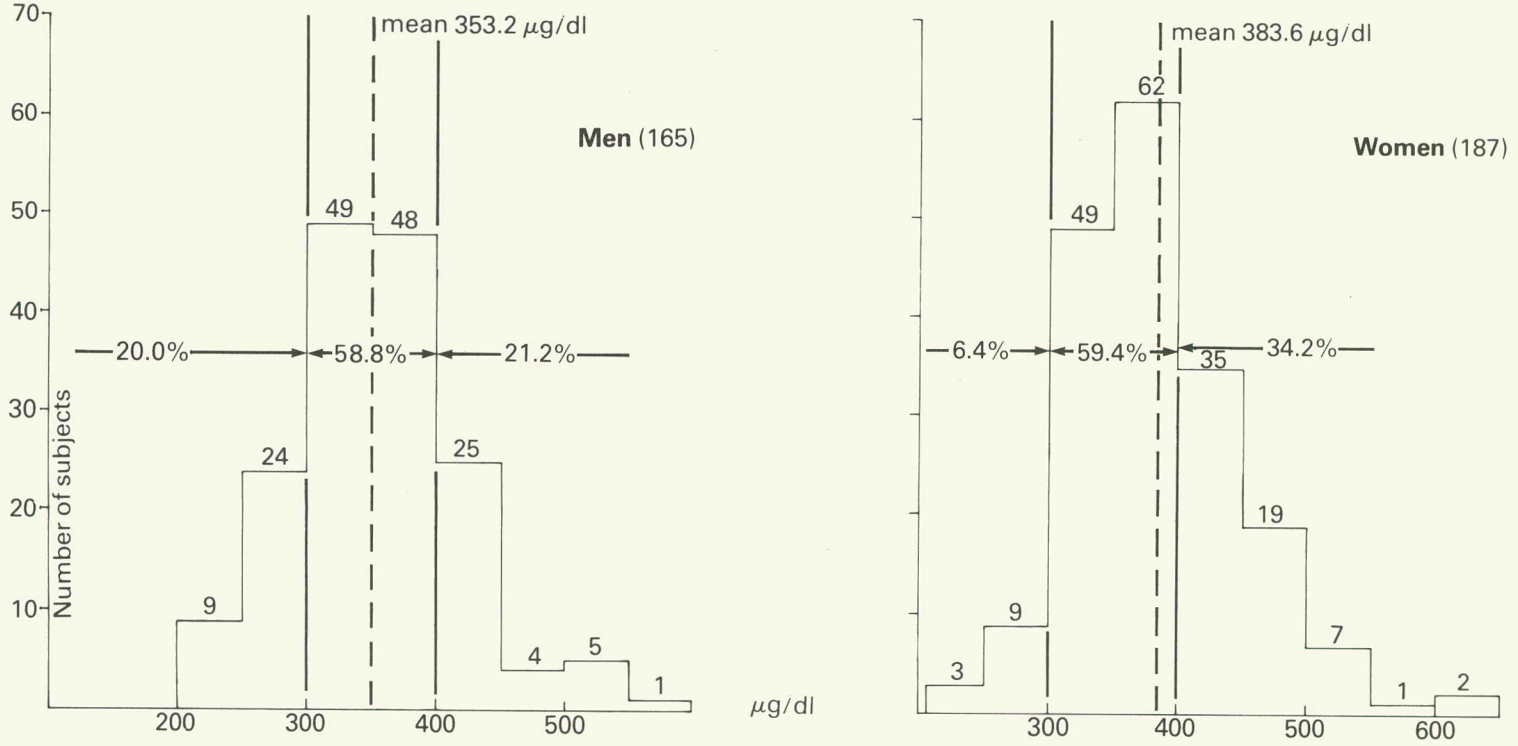

Subnormal and normal ranges are to the left and right respectively of the continuous vertical line. The mean haemoglobin concentration is represented by the broken line. Haemoglobin concentration was not known for three men and two women.

FIGURE 8.2 ***Frequency distribution of serum iron concentration — in micrograms per decilitre.***



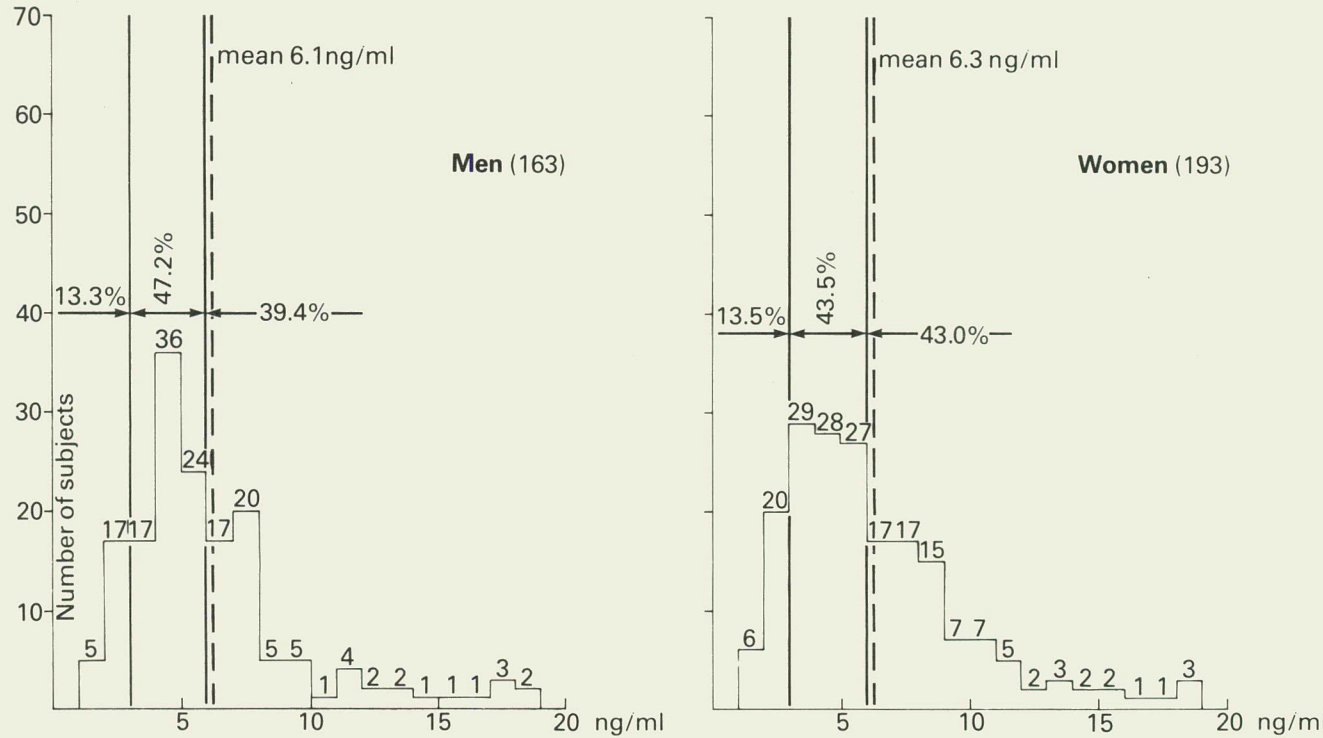

Subnormal and normal ranges are to the left and right respectively of the continuous vertical line. The mean serum iron concentration is represented by the broken line. Serum iron concentration was not known for three men and five women.

FIGURE 8.3 ***Frequency distribution of total iron binding capacity of serum — in micrograms per decilitre.***



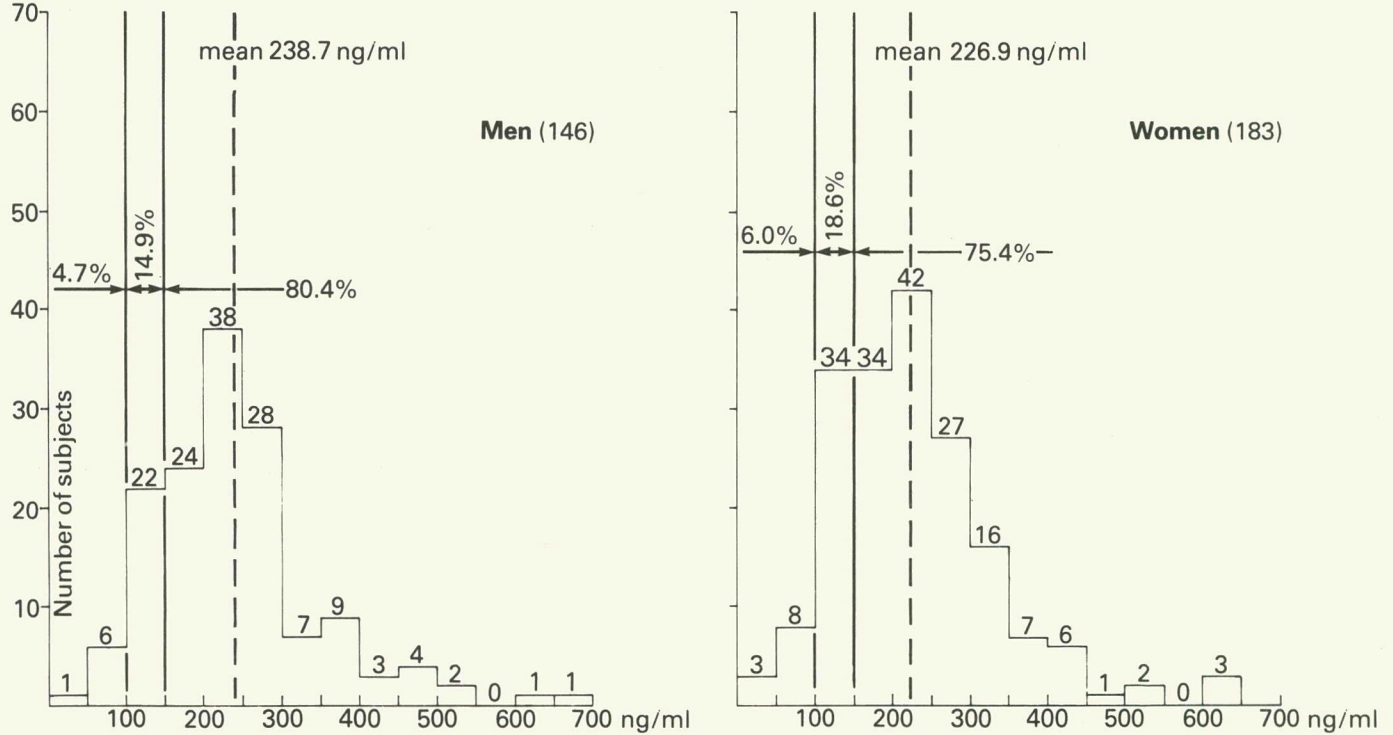

The normal range is within the continuous vertical lines. The mean total iron binding capacity is represented by the broken line. Total iron binding capacity of serum was not known for four men and nine women.

FIGURE 8.4 ***Frequency distribution of serum folate concentration — in nanograms per millilitre.***



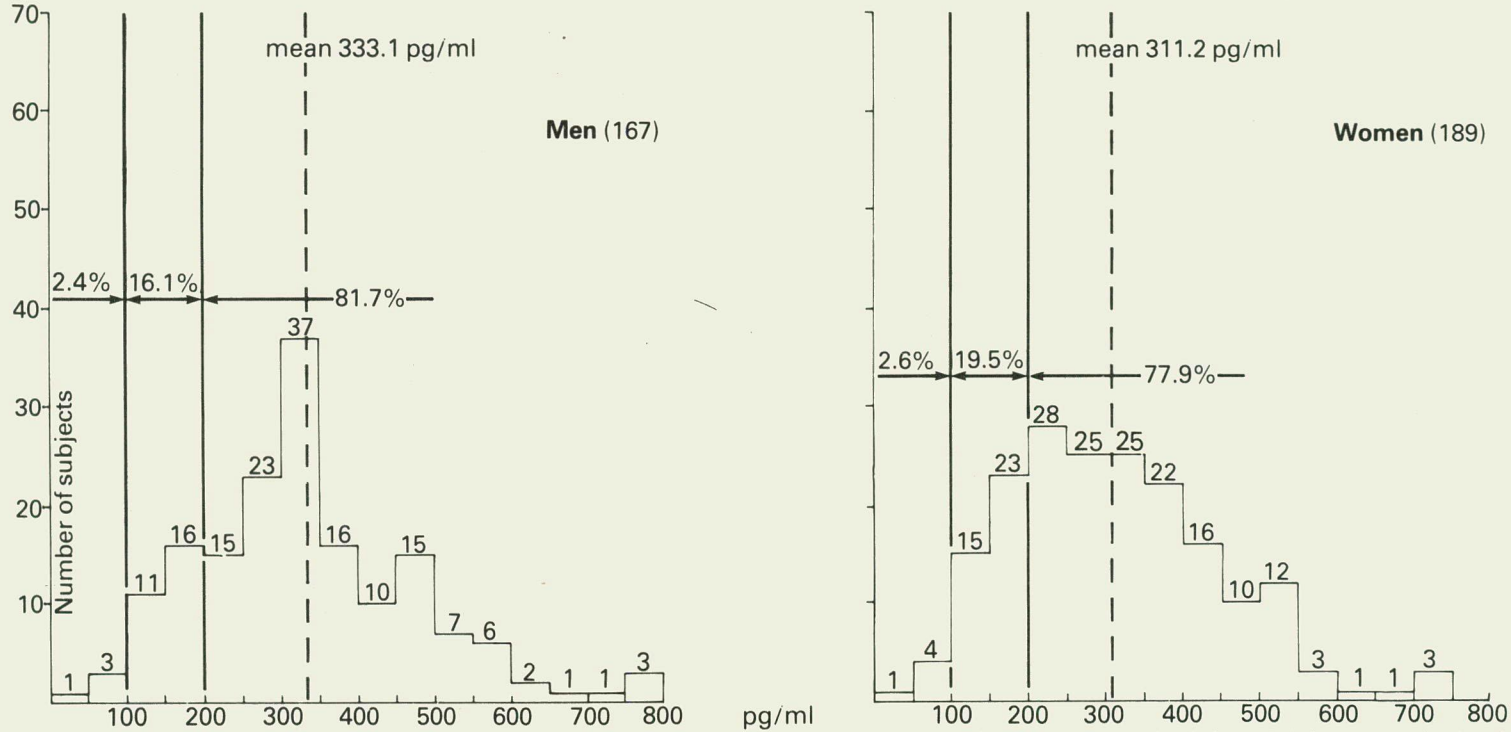

The borderline range is within the continuous vertical lines. The abnormal and normal ranges are to the left and right respectively of the borderline range. The mean serum folate concentration is represented by the broken line. Two men had serum folate concentration higher than 100ng/ml and their values have not been used in calculating the mean and are not presented in the histogram, but have been included in the calculation of the percentage distribution. Serum folate concentration was not known for four men and three women.

FIGURE 8.5 ***Frequency distribution of red cell folate concentration — in nanograms per millilitre.***



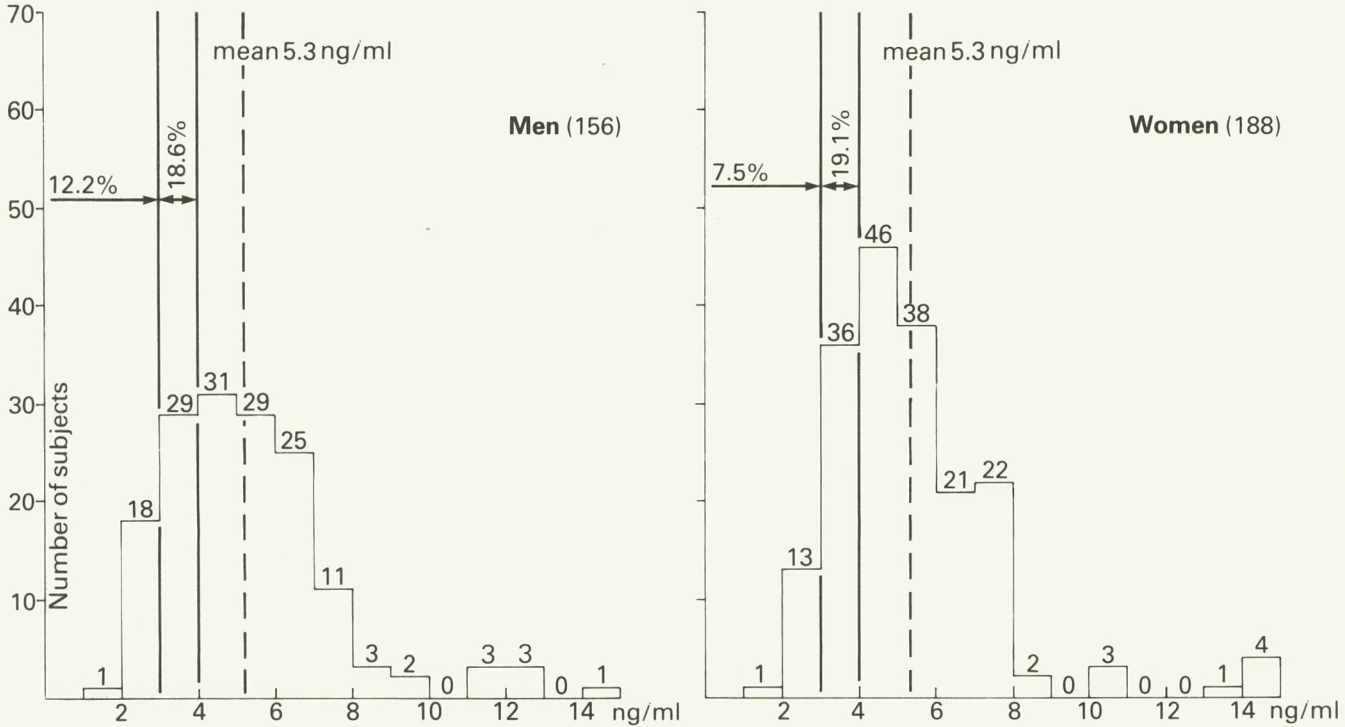

The borderline range is within the continuous vertical lines. The abnormal and normal ranges are to the left and right of the borderline range. The mean red cell folate concentration is represented by the broken line. Two men had red cell folate concentration higher than 1000ng/ml and their values have not been used in calculating the mean and are not presented in the histogram, but have been included in the calculation of the percentage distribution. Red cell folate concentration was not known for 21 men and 13 women.

FIGURE 8.6 ***Frequency distribution of serum vitamin B12 concentration — in picograms per millilitre.***



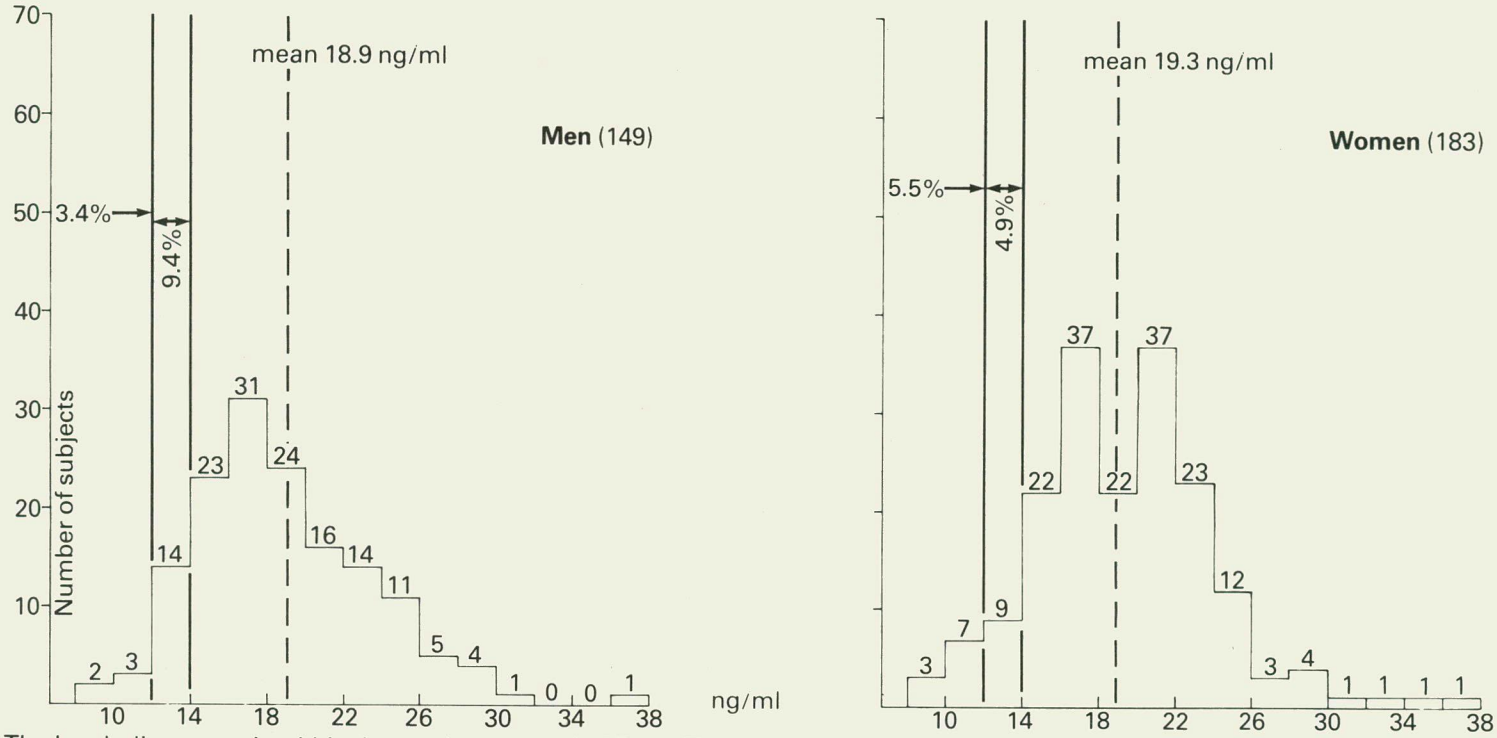

The borderline range is within the continuous vertical lines. The abnormal and normal ranges are to the left and right respectively of the borderline range. The mean serum vitamin B12 concentration is represented by the broken line. One man and six women had serum vitamin B12 concentration higher than 1000pg/ml and their values have not been used in calculating the mean and are not presented in the histogram, but have been included in the calculation of the percentage distribution. Serum vitamin B12 concentration was not known for one man and one woman.

FIGURE 8.7 ***Frequency distribution of serum vitamin B6 concentration — in nanograms per millilitre.***




The borderline range is within the continuous vertical lines. The abnormal and normal ranges are to the left and right respectively of the borderline range. The mean serum vitamin B6 concentration is represented by the broken line. One woman had serum vitamin B6 concentration higher than 200ng/ml and her value has not been used in calculating the mean and is not presented in the histogram, but has been included in the calculation of the percentage distribution. Serum vitamin B6 concentration was not known for 13 men and 7 women.

FIGURE 8.8 ***Frequency distribution of red cell vitamin B6 concentration — in nanograms per millilitre.***




The borderline range is within the continuous vertical lines. The abnormal and normal ranges are to the left and right respectively of the borderline range. The mean red cell vitamin B6 concentration is represented by the broken line. One woman had red cell vitamin B6 concentration higher than 200ng/ml, and her value has not been used in calculating the mean and is not presented in the histogram, but has been included in the calculation of the percentage distribution. Red cell vitamin B6 concentration was not known for 20 men and 12 women.

# 9. The malnourished

## 9.1 Introduction

9.1.1 Malnutrition can be defined as any distortion in form or function that could be due to an excess or deficiency of total food energy or of one or more nutrients. Only undernutrition is considered here and in this chapter the terms undernutrition and malnutrition are used synonymously.

9.1.2 Undernourishment occurs when the tissues of the body are deprived of food energy or essential nutrients, and may be due to inadequate intakes of suitable foods, poor absorption of nutrients despite adequate intake or poor tissue perfusion. Changes in form may be local as in angular stomatitis, cheilosis and glossitis or there may be a decrease in tissue mass as in generalised wasting, anaemia and osteomalacia. Many of these findings are not specific and may be associated with disorders other than malnutrition. Undesirable functional changes may occur in the presence of subclinical deficiencies of some nutrients but sophisticated techniques would be necessary in order to assess altered tissue function and metabolism. The demonstration of a lowered concentration of a particular nutrient in a body fluid is not necessarily of pathological significance.

9.1.3 The diagnosis of malnutrition in the elderly is particularly difficult, due to the frequent coexistence of illness and to ignorance of the "normal" changes accompanying the ageing process. Clinical signs are usually non-specific and the results of laboratory tests may be difficult to interpret.

9.1.4 Classification of undernutrition in the elderly is also difficult, since in some instances more than one factor may be responsible. Environmental factors, medical conditions or a combination of both may predispose to malnutrition in individual cases. In the 1967/68 report the term primary malnutrition was used to describe undernutrition associated with adverse environmental conditions. Secondary malnutrition was reserved for undernutrition associated with clinical disease. In this report these terms have been avoided because of the overlap in the causes of undernutrition so that a clear-cut classification is sometimes not possible. A classification is preferred in which the relative importance of (a) environmental causes that might respond to public health measures, and (b) medical causes which might respond to appropriate treatment are considered.

9.1.5 *Environmental conditions* which may cause or accelerate the development of undernutrition include insufficient money spent on food, inadequate cooking facilities, loneliness, bereavement and lack of help in the home for infirm elderly people especially those who live alone.

9.1.6 *Medical conditions* associated with undernutrition can be poor dentition, diminished appetite, or disorders of the alimentary tract, for example, partial gastrectomy. Undernutrition may also occur in the presence of chronic diseases of the heart and lungs, malignancy and chronic inflammation. Some subjects may become undernourished on an apparently adequate diet because of an increased rate of utilization of one or more nutrients. For instance, requirements for protein and vitamin C may increase in conditions associated with excessive breakdown and repair of connective tissue; iron utilization may be increased in patients with polycythaemia due to obstructive airway disease; and some tumours may utilize excessive amounts of particular nutrients. Inadequate food intake may result from an altered mental state due to dementia or depression. Furthermore, mental illness may, through mechanisms involving the neuro-endocrine axis, induce metabolic changes and later the rate of ultilization of nutrients. Such metabolic changes may lead to a lower food-energy intake which in itself should not necessarily be construed as undernutrition although in these circumstances the diet may become deficient in some essential nutrients.

9.1.7 Some causes of malnutrition are less easily classified. An inadequate intake of food may be due to a restrictive diet of the subject's own devising or to an altered mental state, for example, depression consequent upon external environmental factors such as bereavement, or due to isolation or bad living conditions. In some instances of undernourishment, it is not possible to ascribe any particular cause. Furthermore, cause and effect may not always be distinguished with certainty; for example, it may be difficult to decide whether mental disorders are the cause or the effect of nutrient deficiencies.

9.1.8 Appendix B includes the case histories of the 26 malnourished subjects together with Tables B1 to B4 which summarize the clinical, dietary, biochemical and haematological findings. Figures B1 to B4 show separately for men and women in the two age groups - under 80 years and 80 years and over - the individual daily intakes of food energy and nutrients compared with the mean intakes of subjects in the same area of the same age and sex.

### 9.2 Diagnostic criteria

9.2.1 In general, the diagnosis of undernourishment was based on the clinical and dietary information and supported by appropriate laboratory findings. As already indicated many clinical and laboratory findings, taken in isolation, were considered to be unreliable indicators of malnutrition. However, greater credibility was attached to such a diagnosis when suggestive clinical, dietary and laboratory findings occurred in an appropriate combination. Such subjective assessments may err on the side of over-diagnosis or under-diagnosis but attempts were made to introduce consistency of diagnostic criteria. For example, subjects who were anaemic (WHO classification; haemoglobin concentrations below 13g /dl for men and below 12g /dl for women) were considered to be undernourished when dietary intakes and biochemical evidence suggested that the anaemia was due to a specific nutrient

deficiency of for example iron, folate or vitamin $B_{12}$, and when no other illness was present which could have caused the anaemia. A few subjects who had macrocytosis, biochemical evidence of folate or vitamin $B_{12}$ deficiency and normal blood haemoglobin concentration and who could not be considered undernourished from their clinical and dietary history were not included with the "malnourished group" of subjects.

### 9.3 The search for the malnourished

9.3.1 The clinicians in each area initially decided which subjects were clinically malnourished and later re-assessed their diagnosis after the laboratory findings were made available. These diagnoses were scrutinized by the team of geriatricians for a consensus opinion. Using this approach 17 subjects were diagnosed clinically as malnourished. A further search for malnutrition in the remaining 348 subjects was undertaken by assessing appropriate clinical indicators and all the dietary and laboratory data. The clinical diagnostic indicators were a history of weight loss, wasted appearance, frailty, small skinfold thicknesses, cheilosis, glossitis, angular stomatitis, red or seborrhoeic naso-labial fold, signs of scurvy, peripheral neuritis, sublingual haemorrhages, gross sublingual varicosities, back and bone pain, hyperkeratosis, skin pigmentation, a general assessment of health, a history of partial gastrectomy and in addition the presence of anaemia. From this search, and after a more detailed scrutiny of the individual case records, a further 18 subjects were selected for reconsideration of a diagnosis of malnutrition. After a further detailed examination of the findings of the 17 subjects identified in the first search, and of the 18 subjects identified in the second, a diagnosis of malnutrition was finally considered justified in 26 subjects (16 from the first and 10 from the second search).

9.3.2 Of the 41 partial respondents who were medically examined, the available data indicated that one of the partial responders, the only partial respondent from Sunderland, had some clinical evidence of malnutrition but in this case a dietary survey could not be carried out and the results of laboratory tests were inconclusive.

### 9.4 Survey findings

9.4.1 *Overall incidence of malnutrition.* Of the 365 full respondents, 26 (7%) were finally diagnosed as clinically malnourished. Of these 14 were men (8% of the male sample) and 12 were women (6% of the female sample). In both men and women, there was a higher incidence of malnutrition in those subjects over 80 years of age than in those under 80 years (Table 9.1). Fifteen per cent (18 out of 122 full respondents) of the Sunderland sample were considered to be malnourished. None of the 5 malnourished subjects who had had partial gastrectomies came from this area. Thus, the overall incidence of malnutrition appeared to be higher in Sunderland than in the other 5 areas. This difference in incidence was greatly accentuated if the gastrectomized subjects were excluded from the malnourished group; the incidence in Sunderland then

remained at 15% but the overall incidence for the other 5 areas decreased from 3% (8 out of 243 full respondents) to only 1% (3 out of 243). The incidence of malnutrition in Rutherglen was 9% but the number of subjects involved was small (3 out of 34 subjects) and 2 of the undernourished subjects from that area had had partial gastrectomies.

9.4.2 *Dietary intake of the malnourished*

9.4.2.1 A diminished food intake may result from organic disease, loneliness, bereavement, general loss of interest, depression or poverty, and may if prolonged lead to clinical malnutrition in susceptible individuals. However, individual dietary requirements vary widely. In subjects with increased energy or nutrient requirements, an apparently adequate intake may be associated with clinical undernutrition. Diets of poor quality may give rise to particular nutrient deficiencies despite an adequate food energy content. For instance, avoidance of solid foods such as fruit and vegetables, by subjects who have difficulty in swallowing or poor dentition may lead to a reduced intake of vitamin C unless this is supplied from other sources.

9.4.2.2 *Mean daily intakes of energy and nutrients.* The mean daily food energy and nutrient intakes of the 26 malnourished individuals grouped by sex and age (under 80 years, 80 years and over), were compared with the expected mean daily intakes, which were standardized for area variation (Tables 9.2, 9.3, 9.4). For men and women of both age groups the mean daily intakes of food energy, protein and most nutrients were lower than the expected standardized means but in many instances these differences were not statistically significant. Men aged 80 years and over had mean daily intakes of vitamins C, D and nicotinic acid which were significantly lower ($P < 0.01$) than the standardized expected means, whether expressed in terms of the total daily nutrient intake or of dietary energy, that is to say per 1000 kcal. Similarly, women aged 80 years or over had mean daily intakes of vitamins C and D which were significantly lower ($P < 0.01$) than expected means. The total mean daily intakes of animal protein in men and women aged 80 years and over and the total daily intakes of vitamin A in men and women under 80 years of age were also significantly lower than the standardized expected mean intakes.

9.4.2.3 In men and women of both age groups the total energy, carbohydrate and fat intakes were lower than the expected mean values but the mean added sugar[1] content of the diet was higher than or, in the case of malnourished women under 80 years of age, equal to the standardized expected mean intakes of added sugar. This finding, together with the lower vitamin C content, indicated that the diets of the malnourished were generally of poorer quality than those of the sample as a whole. Diets containing a poor quality of natural foods and a higher content of refined foods are more likely to lead to nutrient deficiencies, not only of the nutrients assessed in this survey but also of others such as the trace minerals.

---

[1] for definition see paragraph 5.1.1, p. 20.

9.4.2.4 *Dietary intakes of individual malnourished subjects.* Analysis of the mean daily intakes of groups of malnourished subjects provides little information about the dietary habits of the individual. Because of the many different causes and different types of undernutrition each subject was considered in the light of his or her particular circumstances. Figures B.1 to B.4 compare the daily intakes of energy and nutrients of individual malnourished subjects with the mean intake of subjects of the same sex, age and area.

9.4.2.5 Although the intakes of food energy and most nutrients were, for most subjects, below the expected means, there were exceptions. For instance, subject 12, who had severe chronic bronchitis and emphysema, had an apparently adequate intake of food energy and nutrients, including vitamin C, but despite this provided clinical and biochemical evidence of scurvy (Appendix B). As indicated previously some diseases may be associated with an increased energy or nutrient requirement. On the other hand another subject (18), who also had clinical and laboratory evidence of scurvy, had a diet of poor quality and low intake of vitamin C. Of several subjects with apparently low intakes of calcium and vitamin D only 2 had evidence suggesting a diagnosis of osteomalacia but both these subjects were housebound and in their tenth decade. This emphasizes the necessity of considering the individual rather than the group when assessing the relevance of dietary intakes.

9.4.2.6 Another factor which may complicate the interpretation of recorded dietary intakes is the bio-availability of particular nutrients. For instance, iron in meat is more readily absorbed than that present in cereal. Although digested food provides nutrients, which may be absorbed efficiently from the ageing alimentary tract, there is some evidence that digestion may be less efficient than in younger subjects (Werner and Hambræus, 1972). Subjects who swallow poorly masticated solid food may not be able to digest such food efficiently and may therefore not absorb all the available nutrients. Thus poor dentition may not markedly affect the recorded food intake but may lead to impaired digestion and consequently a reduced absorption of nutrients.

9.4.3 *Clinical signs of malnutrition in the elderly*

9.4.3.1 An analysis of the incidence of particular clinical signs in the elderly malnourished is given in Table 9.5. The incidence of a "wasted appearance" was high in the malnourished group (13 out of 26 subjects) compared with the non-malnourished group (27 out of 339 subjects). Of particular interest was the finding that 3 of the 4 subjects with red seborrhoeic naso-labial folds were in the malnourished group (11.5% of the malnourished; 0.3% of the non-malnourished). All 3 had biochemical evidence suggesting at least 3 nutrient deficiencies which included folate, vitamin $B_{12}$, riboflavin and ascorbic acid. Interestingly, the remaining subject with a red seborrhoeic naso-labial fold also had evidence of folate deficiency which in this case could probably have been attributed to taking primidone. A red naso-labial fold, which was not

seborrhoeic, appeared with the same frequency in both the malnourished and non-malnourished groups.

9.4.3.2 Other clinical signs which occurred much more frequently in the malnourished group were sublingual haemorrhages, pigmented skin, and hyperkeratosis. These signs were not, however, necessarily signs of specific nutrient deficiencies.

9.4.3.3. The combination of pigmentation of exposed skin and hyperkeratosis in the same subject deserves special consideration because of its much higher incidence in the malnourished (27%; 7 out of 26 subjects) compared with the non-malnourished (3.5%; 12 out of 339 subjects). Only 2 women had this combination of signs and both were malnourished. 11 (including 5 malnourished) of the 19 subjects with hyperkeratosis and pigmentation had vitamin C intakes below the 20th percentile for the corresponding sex group. Furthermore, another malnourished subject who had this combination of clinical signs also had clinical and biochemical evidence of scurvy despite an apparently adequate intake of vitamin C (he had severe chronic bronchitis and emphysema and may have had a higher requirement for vitamin C).

9.4.3.4 Hyperkeratosis is an early sign of scurvy and may have resulted from vitamin C deficiency in at least some of the elderly malnourished subjects studied in this survey. However, these signs could also have been due to deficiencies of other nutrients which have a distribution in foods similar to that of vitamin C. Four of the malnourished subjects with hyperkeratosis and pigmentation had chronic bronchitis and emphysema (subjects: 9, 12, 20, 3) and 3 had gross sublingual varicosities (subjects: 9, 12, 7).

9.4.3.5 Although the incidence of flat nails or koilonychia in the malnourished was higher than in the non-malnourished subjects, these signs did not correlate well with iron deficiency anaemia.

9.4.3.6 Signs such as angular stomatitis, cheilosis and smooth atrophic tongue, which are known to be non-specific signs, occurred infrequently and their incidence in the malnourished group was not greater than in non-malnourished subjects.

9.4.3.7 Six of the malnourished subjects had gross sublingual varicosities (23%) compared with 22 (7%) of the non-malnourished subjects and of these, 5 subjects had evidence of either clinical scurvy or biochemical deficiency of ascorbic acid. More than one third of the whole sample had sublingual micro-varicosities (130 out of 365 subjects) although the incidence was significantly higher ($P< 0.001$) in the malnourished group (18 out of 26 subjects). The incidence of sublingual haemorrhages was also significantly greater ($P< 0.001$) in the malnourished than in the non-malnourished. These sublingual findings were diagnosed much more frequently in Sunderland than in the remaining

areas and the possibility of a diagnostic bias had to be considered. Although less striking, the incidence of these signs in the Sunderland malnourished was also greater than in the non-malnourished from Sunderland (still significant for haemorrhages and microvaricosities; $P < 0.05$). For diagnostic purposes sublingual microvaricosities did not discriminate well between malnourished and non-malnourished because of the great frequency with which the sign appeared in the latter. The findings suggested that sublingual microvaricosities could also be caused by factors other than malnutrition.

9.4.3.8 A number of signs appeared to be useful in the search for malnutrition in the elderly population but whether or not these signs were directly related to nutrient deficiencies is uncertain. Both clinical signs and malnutrition may be due to other disorders.

9.4.4 *Types of malnutrition*

9.4.4.1 Clinical scurvy was diagnosed in 3 subjects (Appendix B, subjects 12, 18, and 23). Confirmatory laboratory tests were available for one subject who was bedridden with a hemiplegia and had a poorly balanced diet with a low vitamin C content and for another who had chronic bronchitis and emphysema (paragraph 7.6.2). The third subject had a history of partial gastrectomy, chronic bronchitis with heart failure and poor living conditions. 8 other subjects in the malnourished group had leucocyte ascorbic acid concentrations of less than 15 $\mu g/10^8$ leucocytes and 2 of these subjects gave values of less than 10 $\mu g/10^8$ leucocytes. The nutritional significance of low blood ascorbic acid concentrations is uncertain but it is noteworthy that 2 subjects with clinical scurvy had leucocyte ascorbic acid concentrations of 3.5 and 5 $\mu g/10^8$ leucocytes. Blood ascorbic acid was not determined in the third subject. Only 4 of the 9 malnourished subjects who had hyperkeratosis also had low leucocyte ascorbic acid; hyperkeratosis was reported in one patient with clinical scurvy (12). The malnourished subjects who had poor dentition (6, 11, 12, 13, 22 and 23) had some evidence of vitamin C deficiency (2 subjects had clinical scurvy and 4 had biochemical evidence suggesting deficiency). Of the 6 malnourished subjects with gross sublingual varicosities 5 were associated with either clinical scurvy (12, 23) or low leucocyte ascorbic acid concentrations (9, 11, 26). The remaining subject with "caviare" tongue had a low ascorbic acid intake for the week of the survey and a low plasma ascorbic acid concentration but the leucocyte ascorbic acid concentration was normal.

9.4.4.2 There was evidence suggestive of a diagnosis of osteomalacia in 2 subjects (Appendix B: subjects 4, 11). Both were housebound and fairly immobile and had in common low dietary intakes of calcium and vitamin D together with raised serum alkaline phosphatase activities.

9.4.4.3 Twenty malnourished subjects had evidence of weight loss either from clinical history, appearance or anthropometry (measurements of weight and/or skinfold thicknesses). A diagnosis of protein or protein-calorie malnutrition (albeit mild) was made in 6 of these subjects (Appendix B,

subjects: 11, 13, 17, 19, 20 and 25). These subjects had low dietary intakes of protein or food energy and other findings suggestive of malnutrition.

9.4.4.4. Anaemia was present in 16 of the malnourished subjects and was associated with deficiencies of iron (in 10 subjects of which 5 had a partial gastrectomy), of folate (5 subjects) and of vitamin $B_{12}$ (2 subjects). Another subject (25) had a "low normal" haemoglobin (13.5 g/dl), macrocytosis and biochemical evidence suggesting a marked folate deficiency; he also had other evidence of malnutrition.

9.4.4.5 Biochemical demonstration of a low concentration of a particular nutrient in the blood, without change in form or function, could not be taken necessarily as evidence of malnutrition. For instance, low leucocyte ascorbic acid concentrations may not necessarily indicate a nutritional deficiency of ascorbic acid. Even so, a stage must exist before the development of overt scurvy in which some functional changes are present. Tests for altered connective tissue metabolism (eg, altered excretion of connective tissue breakdown products in urine) were not available during this study and in any case the reliability of these methods is still uncertain. [Haematological studies provided evidence of change in form or function accompanying low blood concentrations of particular haematinic factors such as iron, folate and vitamin $B_{12}$]. Macrocytosis could be interpreted as a change in form and may in some of these subjects represent a mild deficiency state but the finding is non-specific. The demonstration of subclinical deficiencies of other nutrients is more difficult. Further details of laboratory findings are given in chapters 7 and 8.

9.4.4.6 The identification of malnourished subjects required consideration of all the available data rather than any one diagnostic criterion. Seven subjects who had some evidence of nutrient deficiencies were not included in the malnourished group because diagnosis was complicated by other factors such as incompatible dietary data, drugs capable of causing deficiency states and anaemia of unknown origin. One subject probably had pernicious anaemia and was not included since this condition could not reasonably be expected to respond to change in diet or oral vitamin supplements. Some subjects had subclinical deficiencies of vitamin $B_{12}$ (4 subjects) or folate (11 subjects) associated with macrocytosis. However, these subjects were not anaemic and were not included in the malnourished group. Two of these subjects who had evidence of folate deficiency also had low food energy intakes but the diet of the remainder appeared to be adequate.

**Table 9.1:** *The number and percentage of full participants in the survey who were diagnosed as undernourished*

| | Under 80 yrs | | 80 yrs and over | |
|---|---|---|---|---|
| | Male | Female | Male | Female |
| No. of subjects | 111 | 125 | 58 | 71 |
| No. diagnosed as undernourished | 7 | 6 | 7 | 6 |
| % undernourished | 6 | 5 | 12 | 8 |

**Table 9.2:** *Mean daily intakes of energy and nutrients in malnourished subjects compared with expected means*

| | | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Under 80 yrs (7) | (84) | 80 yrs and over (7) | (37) | Under 80 yrs (6) | (90) | 80 yrs and over (6) | (53) |
| | | Mean daily intake | Expected mean | Mean daily intake | Expected mean | Mean daily intake | Expected mean | Mean daily intake | Expected mean |
| Energy value | kcal | 1968 | 2 135 | 1 603 | 1 917 | 1 412 | 1 640 | 1 293 | 1437 |
| | MJ | 8.2 | 8.9 | 6.7 | 8.0 | 5.9 | 6.9 | 5.4 | 6.0 |
| Animal protein | g | 39.5 | 45.1 | 29.2 | 44.5* | 30.5 | 38.4 | 27.1 | 32.6 |
| Total protein | g | 59.9 | 68.7 | 49.1 | 66.3* | 45.9 | 57.2 | 38.6 | 48.3 |
| Fat | g | 72 | 95 | 67 | 87 | 67 | 79 | 64 | 67 |
| Carbohydrate | g | 213 | 243 | 210 | 227 | 163 | 183 | 146 | 167 |
| Calcium | mg | 630 | 827 | 654 | 807 | 605 | 745 | 527 | 620 |
| Iron | mg | 9.0 | 11.0 | 7.9 | 10.6* | 7.5 | 9.0 | 5.8 | 7.8 |
| Vitamin A | μg | 607 | 1070 | 808 | 1 154 | 531 | 928 | 748 | 807 |
| Thiamin | mg | 0.7 | 0.9 | 0.7 | 0.9 | 0.6 | 0.8 | 0.5 | 0.6 |
| Riboflavin | mg | 1.4 | 1.5 | 0.9 | 1.3* | 0.9 | 1.1 | 0.8 | 1.0 |
| Nicotinic acid | mg | 17.8 | 14.6 | 7.7 | 11.9* | 8.3 | 10.3 | 7.1 | 9.0 |
| Vitamin C | mg | 32 | 44 | 17 | 32 | 55 | 39 | 10 | 23 |
| Vitamin D | μg | 1.3 | 2.0 | 1.3 | 2.8 | 1.5 | 2.0 | 0.8 | 2.1 |
| Pyridoxine | mg | 1.5 | 1.3 | 0.7 | 1.0 | 0.7 | 0.9 | 0.6 | 0.8 |
| Added sugars | g | 69.5 | 65.3 | 64.0 | 60.5 | 44.9 | 44.9 | 46.4 | 42.6 |

Number of subjects in parentheses

*Mean daily intake significantly less than the expected mean ($P<0.05$)

**Table 9.3:** *Mean daily intakes of energy value and nutrients per 1 000 kcal in the malnourished subjects compared with expected means*

| | | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Under 80 yrs (7) | (84) | 80 yrs and over (7) | (37) | Under 80 yrs (6) | (90) | 80 yrs and over (6) | (53) |
| | | Mean daily intake | Expected mean | Mean daily intake | Expected mean | Mean daily intake | Expected mean | Mean daily intake | Expected mean |
| Animal protein | g | 21.6 | 21.6 | 17.8 | 23.4* | 22.3 | 24.2 | 21.6 | 23.2 |
| Total protein | g | 31.7 | 32.7 | 29.7 | 34.7 | 32.8 | 35.6 | 30.3 | 34.0 |
| Fat | g | 38 | 45* | 41 | 45 | 47 | 48 | 48 | 48 |
| Carbohydrate | g | 111 | 114 | 133 | 120 | 117 | 111 | 114 | 116 |
| Calcium | mg | 345 | 393 | 403 | 419 | 437 | 455 | 419 | 442 |
| Iron | mg | 4.7 | 5.3 | 4.7 | 5.7 | 5.4 | 5.4 | 4.4 | 5.4 |
| Vitamin A | μg | 334 | 516 | 485 | 667 | 369 | 573 | 574 | 580 |
| Thiamin | mg | 0.4 | 0.4 | 0.4 | 0.5* | 0.4 | 0.5* | 0.4 | 0.4 |
| Riboflavin | mg | 0.7 | 0.7 | 0.6 | 0.7 | 0.7 | 0.7 | 0.7 | 0.7 |
| Nicotinic acid | mg | 8.3 | 6.8 | 4.7 | 6.3* | 5.9 | 6.4 | 5.6 | 6.3 |
| Vitamin C | mg | 17 | 22 | 11 | 16 | 39 | 25 | 8 | 16 |
| Vitamin D | μg | 0.7 | 0.9 | 0.8 | 1.5 | 0.9 | 1.2 | 0.6 | 1.4 |
| Pyridoxine | mg | 0.7 | 0.6 | 0.4 | 0.5 | 0.5 | 0.6 | 0.5 | 0.6 |
| Added sugars | g | 37.1 | 30.3 | 44.5 | 33.1 | 34.5 | 27.5 | 38.7 | 29.4 |

Number of subjects in parentheses

*Mean daily intake significantly less than the expected mean ($P<0.05$)

**Table 9.4:** *Mean daily intakes of principal animal protein contributing foods compared with expected means*

| | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Under 80 yrs (7) | (84) | 80 yrs and over (7) | (37) | Under 80 yrs (6) | (90) | 80 yrs and over (6) | (53) |
| | Mean daily intake | Expected mean | Mean daily intake | Expected mean | Mean daily intake | Expected mean | Mean daily intake | Expected mean |
| Meat (oz) | 2.81 | 3.17 | 1.77 | 2.94* | 2.36 | 2.43 | 2.18 | 2.23 |
| Fish (oz) | 0.99 | 0.79 | 0.50 | 1.07 | 0.38 | 0.64 | 0.35 | 0.45 |
| Eggs (oz) | 1.22 | 1.31 | 0.99 | 1.20 | 0.59 | 1.07 | 0.61 | 0.90 |
| Cheese (oz) | 0.33 | 0.47 | 0.12 | 0.26 | 0.24 | 0.33 | 0.22 | 0.23 |
| Milk—liquid whole (oz) | 7.66 | 9.94 | 10.75 | 12.17 | 9.26 | 11.36 | 8.45 | 8.96 |
| Milk—liquid skimmed (oz) | 0.02 | 0.61 | 0.29 | 0.60 | 0.09 | 0.68 | 0.14 | 0.62 |

Number of subjects in parentheses

*Mean daily intake significantly less than the expected mean ($P<0.05$)

**Table 9.5:** *The number and percentage of undernourished and non-malnourished full respondents in the survey who showed the physical signs used in making the diagnosis of undernutrition*

| | Wasted appearance | Angular stomatitis | Cheilosis | Smooth atrophic tongue | Sublingual haemorrhages |
|---|---|---|---|---|---|
| All subjects | | | | | |
| 365 = 100% | | | | | |
| No. with clinical sign | 40 | 8 | 9 | 16 | 22 |
| % with clinical sign | 11.0 | 2.2 | 2.5 | 4.4 | 6.0 |
| Malnourished | | | | | |
| 26 = 100% | | | | | |
| No. with clinical sign | 13 | 0 | 1 | 0 | 8 |
| % with clinical sign | 54.0*** | 0.0 | 3.8 | 0.0 | 30.8*** |
| Non-malnourished | | | | | |
| 339 = 100% | | | | | |
| No. with clinical sign | 27 | 8 | 8 | 16 | 14 |
| % with clinical sign | 7.7 | 2.4 | 2.4 | 4.7 | 4.1 |

* $P<0.05$

** $P<0.01$

*** $P<0.001$

| Red nasolabial fold | Red seborrhoeic nasolabial fold | Pigmentation of exposed skin | Hyperkeratosis | Flat nails | Koilonychia | Sublingual varicosities | |
|---|---|---|---|---|---|---|---|
| | | | | | | Micro | Gross |
| 14 | 4 | 74 | 35 | 57 | 14 | 130 | 28 |
| 3.8 | 1.1 | 20.3 | 9.6 | 15.6 | 3.8 | 35.6 | 7.7 |
| 1 | 3 | 12 | 9 | 7 | 2 | 18 | 6 |
| 3.8 | 11.5*** | 46.2** | 34.6*** | 26.9 | 7.7 | 69.2*** | 23.1* |
| 13 | 1 | 62 | 26 | 50 | 12 | 112 | 22 |
| 3.8 | 0.3 | 18.3 | 7.7 | 14.7 | 3.5 | 33.0 | 6.5 |

# 10. Causes of malnutrition

## 10.1 Medical causes

10.1.1 Coexisting medical conditions appeared to play an important part in the development of malnutrition in 25 of the 26 subjects who were diagnosed as malnourished. The most common medical conditions which caused or contributed to undernutrition were partial gastrectomy, chronic bronchitis and emphysema, dementia, depression, difficulty in swallowing and poor dentition.

10.1.2 *Partial gastrectomy.* Only 10 (3%) of the 339 full respondents who were not diagnosed as malnourished had had partial gastrectomies of more than 5 years standing, whereas 5 of the 26 (19%) malnourished subjects had had a partial gastrectomy. Four of these subjects were men, and all 5 had their operations 9 years or more before the 1972/73 survey. All 5 had an iron deficiency anaemia and 4 had evidence of weight loss. However, other factors which may have contributed to malnutrition in 4 of these subjects were IgM myeloma (subject 1), bereavement (subject 21), chronic bronchitis and poor environmental conditions (subject 21) and a high alcohol intake (subject 26). Of the 365 respondents, 20 had a known history of gastrectomy and 14 other subjects had operation scars suggestive of past gastrectomies. Only 5 of these 34 subjects had evidence of malnutrition and anaemia.

10.1.3 *Chronic bronchitis and emphysema.* Fifty per cent of both male and female malnourished subjects from all areas suffered from chronic bronchitis and emphysema compared with only 21% of the non-malnourished men and 9% of the non-malnourished women. However this difference in incidence was largely due to the Sunderland sample in which 75% (6 out of 8) of the malnourished men and 60% (6 out of 10) of the malnourished women had chronic bronchitis and emphysema compared with 46% (22 out of 48) of the non-malnourished men and 27% (15 out of 56) of the non-malnourished women. These findings suggested that in the Sunderland area the incidence of chronic bronchitis and emphysema was higher in the malnourished group than in the non-malnourished group. No such differences were found for the other 5 areas but the numbers involved were small and the malnourished group was biased by the high incidence of gastrectomised patients. The overall incidence (combined male and female) of chronic bronchitis and emphysema in Sunderland was 40% (49 out of 122 subjects) compared with an overall incidence of 5% (13 out of 243) for all the other 5 areas.

10.1.4 Although the difference in incidence of chronic bronchitis might be related to factors such as the level of industrialization of the areas concerned,

straightforward comparisons cannot be made with certainty since in each area the diagnosis was made by a different clinician. Chronic bronchitis and emphysema was probably an important contributory factor in the development of undernutrition in at least 7 of the malnourished (subjects: 5, 6, 9, 11, 12, 13, 23). Five subjects had either cyanosis, cardiac failure or dyspnoea (subjects: 9, 11, 12, 13, 23) and of these, 4 subjects had gross sublingual varicosities (9, 11, 12, 23). Another striking feature of the malnourished group with chronic bronchitis and emphysema was poor dentition. Four subjects were edentulous and either did not have dentures or did not use them for eating (subjects: 6, 11, 12, 23); 3 of these subjects had gross sublingual varicosities.

10.1.5 The association of chronic bronchitis and emphysema with a tendency to develop malnutrition could be due to several factors. The high cardiac output and additional work of ventilation present in some of these subjects may be associated with a high energy requirement. There may be an increased requirement for protein and nutrients because of increased glycoprotein synthesis by the mucus producing cells of the respiratory tract, the maintenance of polycythaemia and a tendency to lung infection and therefore tissue damage. Loss of appetite and an increased tendency to peptic ulceration may be additional factors. Also, subjects with chronic bronchitis may be disinclined to wear dentures especially when dyspnoeic, or when coughing is severe and prolonged.

10.1.6 *Depression and dementia* A specific diagnosis of depression was made in 3 (12%) of the malnourished subjects and in 13 (4%) of the non-malnourished subjects. However, the social histories suggested that depression may have played an important role in the development of malnutrition in some of the subjects with low food intakes. The mental test score (MTS) was used to assess the incidence of dementia; the score was determined in 362 of the full responders. Table 10.1 indicates the incidence of low mental test scores in malnourished and non-malnourished men and women. Although the number of subjects in each group was small the results indicate that dementia was more common in the malnourished group, particularly for mental test scores below 10. Of the 17 malnourished subjects with mental test score below 13, 9 lived alone. The mental test score may also be influenced by the presence of depression.

10.1.7 *Difficulty in swallowing* was a symptom found in 19% of the malnourished group (3 women and 2 men) but occurred much less frequently in non-malnourished subjects (3%). Two of the malnourished with this symptom were bedridden; one had rheumatoid arthritis, was edentulous and complained of nausea and vomiting and the other had a right-sided hemiplegia. One subject had a past history of gastrectomy and also complained of nausea and vomiting, another had a history of oesophageal stricture and a fear of swallowing and the remaining subject suffered from chronic bronchitis and cardiac failure.

10.1.8 *Dental status* Two thirds of the whole sample had not had new dentures within the previous 10 years and poor dentition was a striking feature of the malnourished group. Six malnourished subjects had some teeth of their own and only 9 of the 20 edentulous malnourished subjects were satisfied with their dentures and always used them when eating. The incidence of edentulous subjects who never used dentures when eating was higher ($P<0.01$) for men and women in the malnourished group (6 out of 26 subjects; 23%) than in the non-malnourished (17 out of 339 subjects; 5%). All the women (7 subjects) and most of the men (10 out of 17) with this particular dental status came from Sunderland. The incidence of edentulous men who never used dentures when eating was not significantly different in the group suffering from chronic bronchitis and emphysema (18%; 7 out of 40 men) compared with the rest (7%; 9 out of 129).

10.1.9 *Inadequate sight and hearing* Eight (31%) of the malnourished had inadequate vision for their needs compared with 14% of all full participants. The incidence of this affliction was highest in Sunderland and Rutherglen and lowest in Cambridge and Camden. All the malnourished with inadequate vision suffered in addition from other medical conditions; 4 had chronic bronchitis and of the 5 who were also housebound, 2 were bedfast due to stroke. Although inadequate vision may have lessened the ability of these subjects to cope adequately and may thereby have contributed to malnutrition, there were other causes in these subjects. Fourteen (54%) of the malnourished were deaf compared with 36% of all full participants. Six of the malnourished subjects had both inadequate hearing and inadequate vision.

10.1.10 *Other medical conditions* Other medical conditions which predisposed to malnutrition in some individuals were digitalis intoxication (subject 24), severe rheumatoid arthritis (subject 10) and possibly an excessive consumption of alcohol in a few subjects.

### 10.2 Environmental causes

10.2.1 Adverse social environmental factors may have influenced the development of malnutrition in several instances although the extent of this influence was sometimes difficult to assess. In only one instance was there evidence that the provision of more money alone to the subject might have prevented the development of malnutrition (subject 13). This subject ate little meat, fruit or vegetables and had a preference for cakes and pies. Other factors such as severe chronic bronchitis and emphysema and possibly poor dentition also contributed to her poor nutritional status.

10.2.2 Only 286 of the 365 "full responders", including 22 of the 26 malnourished, gave information about the amount of money spent on food. Calculated values for the amount spent on food by each individual are not likely to be very accurate particularly where these were derived from the total

amount spent on food by 2 or more individuals living together[1]. The average amount spent on food by the 286 responders was about £3 per week (1972/73). 23% (5 out of 22) of the malnourished subjects spent less than £2 per person per week on food compared with 9% (23 out of 264) of the non-malnourished subjects. Four of the 5 undernourished subjects who spent less than £2 per week on food appeared to have an adequate income; information was not available for the remaining subject. Two of these subjects (19, 25) probably had protein-calorie malnutrition associated with low food energy and protein intake, 2 had diets low in fresh fruit and vegetables (6, 18) and malnutrition in the remaining subject was associated with alcoholism and dementia (15).

10.2.3 *Regular cooked meals.* Four subjects were not receiving regular cooked meals despite adequate cooking facilities (subjects: 17, 19, 20 and 25). These subjects had in common loneliness (all 4 lived alone), and either dementia or depression. One subject (19) would have liked meals-on-wheels if available. Three of these subjects probably had protein-calorie malnutrition together with vitamin deficiencies. One subject (23) lived alone in one of the few occupied dwellings in a street due for redevelopment and had inadequate cooking facilities. He suffered from scurvy and iron deficiency anaemia. However in this case there were other causes of undernutrition, such as gastrectomy and chronic bronchitis. He also would have liked meals-on-wheels.

10.2.4 *Living alone.* Social circumstances such as living alone and bereavement may lead to malnutrition by causing depression and general loss of interest. Six out of 14 (43%) of the malnourished men lived alone compared with 35 out of 155 (23%) of the non-malnourished men. The difference was less marked for women, 58% (7 out of 12) of the malnourished women lived alone compared with 52% (96 out of 184) of the non-malnourished women. Nine of the malnourished subjects (6 men, 3 women) who lived alone either could not cope adequately or had lost interest in preparing regular cooked meals.

10.2.5 *Bereavement* may have contributed to the development of malnutrition in 6 subjects and was probably the most important cause in 2 of them (17, 19) who had shown a marked reduction of food intake since the loss of a close relative. These 2 women lived alone and had suffered multiple bereavement, which involved the loss of their children. They were depressed and had little interest in preparing meals; both had evidence of protein-calorie malnutrition.

10.2.6 *Being housebound.* Of the malnourished subjects, 31% were completely housebound (8 subjects; including 3 bedridden subjects) compared with 11% (38 out of 339) of the non-malnourished subjects. It is noteworthy that the 2 subjects (4, 11) with possible evidence of osteomalacia were both

[1] The information obtained about income was incomplete and of questionable reliability (para. 4.7).

housebound. Relative immobility and lack of sunlight may have contributed to their condition, but they also had low intakes of vitamin D.

### 10.3 Other causes of malnutrition

Two subjects appeared to be malnourished because they voluntarily restricted their food intakes (subjects 16, 20). One man (subject 20) had evidence of protein-calorie malnutrition and a macrocytic anaemia due to a folate and vitamin $B_{12}$ deficiency. He did not spend sufficient money on food but smoked heavily and drank large quantities of alcohol. The other subject ate little meat and no fish because he "did not want to get fat".

### 10.4 "At-risk" factors for malnutrition

10.4.1 The incidence of malnutrition was determined in different groups of individuals who, in the light of the survey findings, might be considered "at risk". Such information could be useful in future searches for malnutrition in the elderly population. The groups considered included subjects affected by various social circumstances and relevant medical conditions. Single "at-risk" factors which appeared to be strongly associated with undernutrition in both men and women were: not having regular cooked meals, being housebound, depression, chronic bronchitis and emphysema, partial gastrectomy, poor dentition and difficulty in swallowing (Table 10.1).

10.4.2 Malnutrition was nearly twice as common in men who lived alone but no such association was found for women who lived alone. Presumably after the loss of a spouse elderly women who live alone are better able to cope in the home than men in the same situation (Table 10.1).

10.4.3 Subjects with low mental test scores were also more prone to malnutrition. 18% (8 out of 44) of subjects with scores of less than 10 were malnourished, although only 2 of these subjects lived alone. Of the 17 malnourished subjects with scores below 13, 9 lived alone (4 men, 5 women) (para 10.1.6). Another malnourished subject who lived alone had clinical signs of dementia but a mental test score was not determined. Subjects who had scores of less than 13 and who also lived alone were particularly prone to malnutrition.

10.4.4 Caution is necessary in the interpretation of this information since the association of a particular "risk-factor" with a higher incidence of malnutrition may be indirect or may operate in conjunction with other risk-factors. Differences of diagnostic criteria (eg alcoholism) are not easily taken into account and associations may be biased due to the area differences in the incidence of malnutrition.

### 10.5 Multiple aetiology

More than one factor, medical, environmental or both could be implicated in the development of malnutrition in many of these subjects. In only 2 of the 26 subjects was there only one identifiable cause which could have predisposed to

malnutrition (2, 14). There was an inter-relationship between environmental factors (eg loneliness, bereavement), mental state (eg depression, anxiety) and ability to cope. In both men and women a highly significant association was found between the presence of multiple risk-factors and the occurrence of malnutrition (Table 10.2). Subjects in whom four or more risk factors operated were at considerable risk of malnutrition.

### 10.6 Malnutrition in the subjects from Sunderland

10.6.1 A striking feature of this survey was the much higher incidence of malnutrition in Sunderland subjects (para 9.4.1). The incidence of single risk-factors such as low mental test scores, depression, chronic bronchitis and emphysema, poor dentition or being housebound was higher in Sunderland than in the other areas (Table 10.3) and, in addition, more of the subjects in Sunderland had several risk-factors for malnutrition (Table 10.4). This difference is accentuated further if a history of partial gastrectomy is excluded. None of the subjects in Sunderland was malnourished due to partial gastrectomy, but in the other areas this was the most frequent cause.

10.6.2 The combination of poor health (mental and physical), poor dentition and poor social conditions appeared to explain the higher incidence of malnutrition in Sunderland. Chronic deprivation over many years and a hard life in an industrialized northern conurbation may, in some of these subjects, have contributed to some of the medical and social conditions which are conducive to malnutrition in old age. Most of the malnourished subjects (or their husbands) in Sunderland were manual workers and a higher proportion than in other areas were in receipt of supplementary benefit.

### 10.7 Conclusions

10.7.1 Despite the large amount of information obtained for each subject, malnutrition was not easily diagnosed. Clinical signs and laboratory findings were often, on their own, unreliable indicators. Clinical signs which may deserve particular attention and further investigation in future studies of malnutrition in the elderly are: red seborrhoeic naso-labial folds, caviare tongue, sublingual haemorrhages, hyperkeratosis, and pigmentation of exposed skin. Until more sophisticated methods are available to measure change in function or form due to nutrient deficiencies, diagnosis must be based on the partly subjective assessment of all the available information which should include dietary, clinical, laboratory and social studies.

10.7.2 The overall incidence of malnutrition in the elderly studied in this survey was 7% (26 of the 365 subjects). Medical conditions appeared to play an important role in 25 of the 26 malnourished subjects although multiple bereavement was almost certainly the most important underlying factor in 2 of the subjects. The cause of malnutrition, which was marginal, in the remaining subject was uncertain. His food energy intake was reasonable at the time of the survey. Bereavement may have contributed to his condition. In most instances

medical or social causes could be identified and the presence of multiple risk factors was strongly associated with the occurrence of malnutrition. The incidence of malnutrition was higher in Sunderland than in the other 5 areas studied and could be explained in terms of the higher incidence of single and multiple risk factors occurring in individuals from that area.

**Table 10.1:** *Incidence of undernutrition associated with different medical and social conditions*

| Group at risk | Men | | Women | | All persons | |
|---|---|---|---|---|---|---|
| | No. in group | % malnourished | No. in group | % malnourished | No. in group | % malnourished |
| Whole sample | 169 | 8.3 | 196 | 6.1 | 365 | 7.1 |
| Living alone | 41 | 14.6 | 103 | 6.8 | 144 | 9.0 |
| No regular cooked meals | 5 | 60.0*** | 5 | 40.0* | 10 | 50.0*** |
| Supplementary benefit | 47 | 19.1** | 87 | 12.6** | 134 | 14.9*** |
| Social class IV and V | 56 | 12.5 | 56 | 16.1*** | 112 | 14.3*** |
| Mental test score <13 | 48 | 16.7* | 83 | 10.8* | 131 | 13.0* |
| Depression | 7 | 14.3 | 9 | 22.2 | 16 | 18.8 |
| Chronic bronchitis and emphysema | 40 | 17.5* | 22 | 27.3*** | 62 | 21.0*** |
| Gastrectomy | 13 | 30.8* | 7 | 14.3 | 20 | 25.0** |
| Edentulous† | 17 | 29.4** | 7 | 14.3 | 24 | 25.0** |
| Difficulty in swallowing | 10 | 20.0 | 6 | 50.0*** | 16 | 31.3*** |
| Housebound | 13 | 23.1 | 33 | 15.2* | 46 | 17.4** |
| Smokers | 80 | 11.3 | 36 | 5.6 | 116 | 9.5 |
| Alcoholism | 12 | 16.7 | 1 | 0.0 | 13 | 15.4 |

* $P<0.05$

** $P<0.01$

*** $P<0.001$

† Edentulous subjects were those with no dentures, or with full or partial dentures which were never used for eating

**Table 10.2:** *Incidence of multiple risk factors for malnourished subjects compared with the rest of the subjects*

| Number of medical and/or social risk factors (for given individuals) | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Malnourished (14) | | Non-malnourished (155) | | Malnourished (12) | | Non-malnourished (184) | |
| | No. | % | No. | % | No. | % | No. | % |
| 0 | 0 | | 39 | 25 | 0 | | 22 | 12 |
| 1 | 2 | 14 | 44 | 28 | 0 | | 59 | 32 |
| 2 | 2 | 14 | 37 | 24 | 1 | 8 | 45 | 25 |
| 3 | 2 | 14 | 22 | 14 | 1 | 8 | 31 | 17 |
| 4 | 2 | 14 | 9 | 6 | 3 | 25 | 19 | 10 |
| 5 | 3 | 22 | 4 | 3 | 4 | 34 | 4 | 2 |
| 6 | 1 | 8 | 0 | | 2 | 17 | 4 | 2 |
| 7 | 2 | 14 | 0 | | 1 | 8 | 0 | |
| 8 | 0 | | 0 | | 0 | | 0 | |
| 9 | 0 | | 0 | | 0 | | 0 | |
| 10 | 0 | | 0 | | 0 | | 0 | |
| 11 | 0 | | 0 | | 0 | | 0 | |

*Note* For both men and women the distributions for multiple risk factors were significantly different ($P<0.001$) when the malnourished were compared with the rest

The eleven risk factors examined were:

Living alone
No regular cooked meals
Supplementary benefit
Social classes IV and V
Mental test score <13
Depression
Chronic bronchitis and emphysema
Gastrectomy
Poor dentition
Difficulty in swallowing
Housebound

**Table 10.3:** *Incidence of individual risk factors in Sunderland compared with other areas*

| | Sunderland | | | | All other areas | | | |
|---|---|---|---|---|---|---|---|---|
| | Men | | Women | | Men | | Women | |
| *Environmental factors* | | | | | | | | |
| Living alone | 14 | (25%) | 31 | (47%) | 27 | (24%) | 72 | (55%) |
| No regular cooked meals | 2 | (4%) | 2 | (3%) | 3 | (3%) | 3 | (2%) |
| Supplementary benefit | 25 | (45%) | 43 | (65%) | 22 | (19%) | 44 | (34%) |
| Social class IV and V | 21 | (38%) | 32 | (48%) | 35 | (31%) | 24 | (18%) |
| *Medical factors* | | | | | | | | |
| MTS <13 | 19 | (34%) | 43 | (65%) | 29 | (26%) | 40 | (31%) |
| Depression | 5 | ( 9%) | 7 | (11%) | 2 | (2%) | 2 | (2%) |
| Chronic bronchitis and emphysema | 28 | (50%) | 21 | (32%) | 12 | (11%) | 1 | (1%) |
| Gastrectomy | 2 | (4%) | 1 | (2%) | 11 | (10%) | 6 | (5%) |
| Poor dentition | 10 | (18%) | 7 | (11%) | 7 | (6%) | 0 | (0%) |
| Difficulty in swallowing | 5 | (9%) | 3 | (5%) | 5 | (4%) | 3 | (2%) |
| Housebound | 7 | (13%) | 17 | (26%) | 6 | (5%) | 16 | (12%) |

**Table 10.4:** *Incidence of multiple risk factors for subjects in Sunderland compared with other areas*

*Environmental factors*
Living alone
No regular cooked meals
Supplementary benefit
Social class IV and V

*Medical factors*
Mental test score ‹13
Depression
Chronic bronchitis and emphysema
Gastrectomy
Poor dentition
Difficulty in swallowing
Housebound

| Number of risk factors | Men | | | | Women | | | |
|---|---|---|---|---|---|---|---|---|
| | Sunderland (56) | | Remainder (113) | | Sunderland (66) | | Remainder (130) | |
| *Environmental factors* | A | | B | | C | | D | |
| 0 | 18 | (32%) | 53 | (47%) | 10 | (15%) | 36 | (28%) |
| 1 | 19 | (34%) | 38 | (34%) | 18 | (27%) | 55 | (42%) |
| 2 | 15 | (27%) | 17 | (15%) | 26 | (40%) | 29 | (22%) |
| 3 | 3 | (5%) | 5 | (4%) | 10 | (15%) | 10 | (8%) |
| 4 | 1 | (2%) | 0 | | 2 | (3%) | 0 | |
| *Medical factors* | E | | F | | G | | H | |
| 0 | 11 | (20%) | 60 | (53%) | 11 | (17%) | 76 | (58%) |
| 1 | 23 | (41%) | 41 | (37%) | 25 | (38%) | 42 | (32%) |
| 2 | 15 | (27%) | 6 | (5%) | 19 | (29%) | 10 | (8%) |
| 3 | 6 | (10%) | 5 | (4%) | 8 | (12%) | 2 | (2%) |
| 4 | 0 | | 1 | (1%) | 3 | (4%) | 0 | |
| 5 | 1 | (2%) | 0 | | 0 | | 0 | |
| 6 | 0 | | 0 | | 0 | | 0 | |
| 7 | 0 | | 0 | | 0 | | 0 | |
| *Medical and environmental factors combined* | I | | J | | K | | L | |
| 0 | 7 | (13%) | 32 | (28%) | 2 | (3%) | 20 | (15%) |
| 1 | 8 | (14%) | 38 | (34%) | 9 | (14%) | 50 | (38%) |
| 2 | 16 | (28%) | 23 | (20%) | 14 | (21%) | 32 | (25%) |
| 3 | 11 | (20%) | 11 | (10%) | 16 | (24%) | 16 | (12%) |
| 4 | 8 | (14%) | 5 | (4%) | 11 | (17%) | 11 | (9%) |
| 5 | 4 | (7%) | 3 | (3%) | 7 | (11%) | 1 | (1%) |
| 6 | 1 | (2%) | 0 | | 6 | (9%) | 0 | |
| 7 | 1 | (2%) | 1 | (1%) | 1 | (1%) | 0 | |
| 8 | 0 | | 0 | | 0 | | 0 | |
| 9 | 0 | | 0 | | 0 | | 0 | |
| 10 | 0 | | 0 | | 0 | | 0 | |
| 11 | 0 | | 0 | | 0 | | 0 | |

Groups C and D, I and J } difference significant ($P<0.01$)

Groups E and F, G and H, K and L } difference significant ($P<0.001$)

# 11. A study of special groups

## 11.1 Introduction

11.1.1 Groups of subjects who were affected by particular social and medical factors are considered further in this section. Some medical conditions may be associated with poor absorption or an increased requirement of food energy or nutrients, and a study of food intake in such cases can belie a relative dietary deficiency. However, a reduced food intake or a diet of poor quality would explain the higher incidence of undernutrition in some susceptible groups, such as those with dementia or the housebound. Even so, the calculation of mean daily food intakes can mask traits in individuals when the group under study contains a few subjects with exceptionally high intakes of particular nutrients (especially, for example, of ascorbic acid). The dietary intakes of special groups of subjects need to be interpreted with care since some groups contain only a few subjects and the experimental error of dietary survey methods is difficult to assess.

11.1.2 Groups of subjects associated with a higher incidence of undernutrition should show some supportive laboratory evidence of their susceptibility. In some of the special groups considered in this section the numbers of subjects involved were too small to allow meaningful interpretation of biochemical findings.

## 11.2 Subjects with low intakes of food-energy and nutrients

11.2.1 Men with food energy intakes which were arbitrarily set, as in the 1972 Report, at below 1500 kcal per day, and women with food energy intakes below 1200 kcal per day were included in the low-energy intake group and constituted 11.8% of the male sample and 14.3% of the female sample respectively. Table 11.1 summarizes the incidence of undernutrition in these subjects. Twenty-five per cent of the men and 10.7% of the women with low food-energy intakes were diagnosed as malnourished compared with 8.3% of the total male sample and 6.1% of the total female sample. However, of the subjects with low food energy intakes, some were on special diets. 16 were obese (3 men, one of whom was diabetic; 13 women, 2 of whom were diabetic). One woman was a non-obese diabetic and 3 subjects (2 men, one woman) were on special low-calorie diets for reasons which were not stated. The 7 malnourished subjects (4 men, 3 women) were among the remaining 28 (15 men, 13 women) non-obese, non-diabetic subjects who were not on special diets. All these 7 subjects had evidence of clinical disease.

11.2.2 As expected, there was a relatively high incidence of malnutrition in those subjects whose intake of protein and other nutrients was below the 10th

percentile (Table 11.1). Overall (men and women together), the incidence was highest in those whose dietary intakes of total protein, pyridoxine and ascorbic acid were below the 10th percentile (for the respective sex group). However, the highest incidence of malnutrition was found in men with vitamin A intakes below the 10th percentile (7 out of 17 men; 2 out of 20 women), and in women with ascorbic acid intakes below the 10th percentile (7 out of 20 women; 4 out of 17 men). Subjects whose intakes of a particular nutrient were below the 10th percentile of values obtained for the whole sample were not necessarily deficient in that nutrient.

### 11.3 Effect of "state of health" on dietary intake

11.3.1 The dietary intakes of subjects who were assessed by the physicians as "healthy and much better than average" were compared with those of subjects who were assessed as "not healthy and much worse than average". Subjects were further subdivided into those under 80 years of age and those of 80 years or more. The numbers in individual groups were small and statistical significance could not be reliably tested but, in general, poor health appeared to be more important than age as a cause of diminished food intake in the elderly (Table 11.2). Mean daily food energy and ascorbic acid intakes were lower in the unhealthy than in the healthy subjects matched for age and sex. Apart from women of 80 years or more, the subjects in poor health also had lower mean daily intakes of protein, iron and riboflavin. Although advancing age *per se* may be associated with a gradual reduction of basal metabolic rate, disease and infirmity presumably have a more marked effect on energy requirements when there is a corresponding reduction in physical activity.

### 11.4 The diet of subjects affected by various risk factors for malnutrition

11.4.1 *Low mental test score* Mean intakes of subjects with low mental test scores were compared with those of subjects with normal mental test scores (Table 11.3). Of the men under 80 years, those with scores of less than 13 had significantly lower mean intakes of food energy, total protein and iron than subjects with normal mental test scores. All the women with low mental test scores had significantly lower mean intakes of total protein, iron and riboflavin and women of 80 years or more with low mental test scores had in addition significantly lower mean intakes of ascorbic acid. Of the men with mental test scores of less than 13, those living alone had lower mean intakes of iron and ascorbic acid than those not living alone (Table 11.4). Women of 80 years or more who lived alone and had low mental test scores also had particularly low mean intakes of iron. However, the numbers of subjects in these sub-groups were small and interpretation should be guarded. The findings appear to correspond with the higher incidence of undernutrition found in subjects with low mental test scores. Biochemical studies did not reveal any abnormality in the thiamin status of subjects with low mental test scores.

11.4.2 *Depression, barbiturates and tranquillizing drugs*
The dietary intakes of subjects with depression and those taking barbiturates

or tranquillizers were studied, although the number of subjects involved was small. Of the clinically depressed women, a higher proportion than expected had food energy and iron intakes below the 10th percentile and of the men taking barbiturates a higher proportion than expected had food energy, iron, riboflavin and total protein intakes below the 10th percentile. Tranquillizers appeared to have no effect on dietary intake.

11.4.3 *Chronic bronchitis and emphysema*
Subjects with chronic bronchitis and emphysema had smaller mean intakes of food energy and nutrients than did the rest of the sample (Table 11.5). The differences were highly significant for protein, iron and riboflavin in men and for ascorbic acid in women. Subjects with severe chronic bronchitis may be prone to undernutrition due to a poor dietary intake but they may also have an increased food requirement (para 10.1.5).

11.4.4 A significantly greater proportion of men with chronic bronchitis (16 out of 40) had serum albumin concentrations below 4.0 g/100 ml than did men who were not bronchitics (16 out of 127; $P < 0.01$). All but one of the bronchitic women came from Sunderland and biochemical findings in these women were therefore compared with those of the non-bronchitic women in Sunderland. Low plasma ascorbic acid (< 0.2 mg/100 ml), low serum iron (< 60 ng/100 ml), low red-cell folate (< 150 ng/ml), raised TIBC (> 400 ng/100 ml) and raised riboflavin activation coefficient (> 1.30) values did not occur significantly more frequently in bronchitics than in non-bronchitics but the numbers of subjects involved were small. However, in bronchitic women the mean plasma ascorbic acid concentration was significantly lower and the EGR-AC significantly higher than in non-bronchitic women (section 12.6).

11.4.5 *Partial gastrectomy*
Apart from significantly higher mean carbohydrate and calcium intakes in women ($P < 0.05$), the mean dietary intakes of subjects with a partial gastrectomy were not significantly different from those of other subjects. The high incidence of iron deficiency anaemia, which was found in subjects who had had a partial gastrectomy several years before the survey (para 8.8.2) was presumably due to impaired absorption. Like iron, calcium is absorbed in the duodenum and upper jejunum, and osteomalacia is a recognized complication of some types of partial gastrectomy. Of the subjects who had had partial gastrectomies none showed a reduced blood calcium or raised serum alkaline phosphatase as evidence of osteomalacia, although one subject had suffered from this complication in previous years.

11.4.6 *Difficulty in swallowing*
The mean dietary intakes of subjects who had difficulty in swallowing and of edentulous subjects who did not use dentures when eating were compared with the mean dietary intakes for all subjects (Table 11.6). When one man and one woman were excluded because of exceptionally high intakes of ascorbic acid, subjects with difficulty in swallowing and the edentulous who did not use

dentures had a smaller mean intake of food energy, total protein and ascorbic acid. Seven of the 10 men who had difficulty in swallowing were over 80 years of age but the other groups did not have an age distribution different from that of the whole sample. The numbers of subjects in these groups were too small for firm conclusions to be drawn.

11.4.7 Of the 16 subjects with poor dentition who were edentulous and not using dentures and in whom leucocyte ascorbic acid concentrations were determined 6 (38%) had values less than 15 $\mu g/10^8$ white cells. Similarly 8 of 22 subjects with poor dentition and in whom plasma ascorbic acid concentrations were determined had values less than 0.2 mg/100 ml. These findings are in agreement with the poor ascorbic acid intake recorded in some of these subjects.

11.4.8 *Smoking*

Male smokers in both age groups - under 80 years of age, and 80 years and over - had significantly lower mean dietary intakes of total protein, animal protein and iron than did non-smokers (Table 11.7). Male smokers of 80 years or more also had significantly lower mean intakes of animal protein and iron. On the other hand female smokers in both age groups had a higher food energy intake. This was significantly higher ($P< 0.05$) in women under 80 years of age as was their intake of animal protein compared with the corresponding non-smokers. The reason for the disparity between the dietary findings of male and female smokers is uncertain but this corresponds with the findings that only the male smokers had a higher incidence of malnutrition compared with the sample as a whole. The proportion of heavy smokers was greater in the male sample than in the female sample. Appetite did not appear to be related to the number of cigarettes smoked in these groups.

## 11.5 The housebound

11.5.1 Subjects were housebound for a variety of different reasons but as a group the housebound shared a number of common problems, such as relative immobility and insufficient exposure to sunlight. Only 2% of men and 9% of women under 80 years of age were housebound compared with 19% of men and 31% of women of 80 years or more. The highest incidence of housebound subjects was in Sunderland (20%, 24 out of 122 subjects) and Rutherglen (21%, 7 out of 34 subjects) and the lowest incidence was in Cambridgeshire (4%, 3 out of 72 subjects). The main reasons for being housebound were disorders of the joints, cardiovascular system, central nervous system, lungs and eyes. Many subjects had more than one disorder contributing to immobility. In Sunderland the main disorders found in the housebound subjects were diseases of the cardiovascular system, lungs and eyes. However, disorders of the musculo-skeletal system appeared to be the main cause of immobility in the housebound women from Rutherglen.

11.5.2 Table 11.8 shows the mean dietary intakes of housebound subjects compared with the rest of the sample. Mean daily intakes of food energy,

protein, iron and riboflavin were smaller in the housebound men compared with the non-housebound men but the differences were not statistically significant. Housebound women had significantly smaller food energy, iron, riboflavin and ascorbic acid intakes than non-housebound women. The serum albumin and total protein concentrations were significantly lower in housebound men than in non-housebound men. The 2 survey subjects who were found to have osteomalacia were both housebound. The mean serum alkaline phosphatase values of housebound men and women were significantly higher than those of non-housebound subjects.

11.5.3 Table 11.9 shows the incidence of calcium or vitamin D intakes below the 10th percentile in housebound subjects. Low calcium intakes ($P < 0.01$) and low vitamin D intakes ($P < 0.001$) were, significantly more frequent in housebound women than in non-housebound women.

11.5.4 Of the 46 subjects who were housebound, 8 (17%) had serum alkaline phosphatase greater than 13 KA units compared with 14 (4%) of the non-housebound subjects. Of the 7 housebound subjects who had both calcium and vitamin D intakes below the 20th percentile, 3 had raised serum alkaline phosphatase activities and 4 were diagnosed as malnourished (two of these were thought to have had osteomalacia in addition to other nutrient deficiencies). Thus inadequate diet and lack of exposure to sunlight may both be important factors in the development of osteomalacia in elderly housebound subjects. 45% of housebound women (15 out of 33) had red-cell folate concentrations below 150 ng/ml compared with only 22% of non-housebound women ($P < 0.05$). The male sample was too small to permit a meaningful analysis.

### 11.6 Subjects who received no regular cooked meals

11.6.1 Five men and 5 women received no regular cooked meals and of these, 4 subjects were in Sunderland (2 men and 2 women) and 4 were in Rutherglen (3 women and 1 man). A high incidence of clinical undernutrition was found in this group (para 10.2.3) which appeared to have a particularly poor dietary intake. All the women had low ascorbic acid intakes. One man and one woman had intakes of food energy, total protein, iron, riboflavin and ascorbic acid in the lowest 10th percentile of the distributions and another man and woman had iron and riboflavin intakes in the lowest 10th percentile.

11.6.2 Of the 4 subjects for whom leucocyte ascorbic acid concentration was determined, one had a concentration of less than 15 $\mu g/10^8$ white cells and of the 8 subjects for whom plasma ascorbic acid concentration was determined, one had less than 0.2 mg/100 ml. The mean riboflavin activation coefficient was significantly higher in those taking no regular cooked meals than in the remainder of the sample, thus providing laboratory evidence of a poorer riboflavin status.

## 11.7 Social class and supplementary benefit

11.7.1 In this survey a diagnosis of malnutrition was made more frequently in those people who were receiving supplementary benefit[1] and those in social classes III manual, IV and V. Interpretation of these findings was difficult because individuals in receipt of supplementary benefit were also those classified as social class III manual, IV and V. An attempt was therefore made to assess the effects of social class and the receipt of supplementary benefit on the average daily intakes of food energy and ascorbic acid and on plasma ascorbic acid concentrations. Total food energy and ascorbic acid intakes were taken as indicators of the quality of the diet.

11.7.2 Figures 11.1 to 11.3 show for men and women separately the mean daily intakes of energy and vitamin C and also plasma ascorbic acid concentration within social classes I and II, III non-manual, III manual, IV, V for subjects who were in receipt of supplementary benefit (unbroken line) and for those not in receipt of supplementary benefit (dotted line). The number of subjects in each of these groups is shown but because of the small numbers involved, the mean intakes for the 4 men on supplementary benefit in social classes I and II and III NM have not been shown on these diagrams.

11.7.3 Analysis has been carried out as follows: social class groups, I, II and III NM have been combined, as have groups III M, IV, V to give a two category social grouping. The effects of receipt (or non-receipt) of supplementary benefit and of social class have been considered jointly on each of the three variables, energy intake, ascorbic acid intake and plasma ascorbic acid. The effect of receipt (or non-receipt) of supplementary benefit has been taken first since this is considered to be a good indicator of low income, whereas social class, as well as being an indicator of income, is also likely to involve effects due to education and cultural background. The results therefore refer to a "supplementary benefit effect" representing the effect of low income and an effect of social class after taking account of differences caused by the supplementary benefit effect. The possibility that the variables might interact in some more complex way than that presented here has been examined and found not to be the case.

11.7.4 In both men and women receipt of supplementary benefit was significantly associated with lower ascorbic acid intake and lower plasma ascorbic acid concentration but was not significantly associated with energy intake. This suggests that low income may have had some effect on quality of diet but rather less effect (if any) on the energy value of the diet. No information was collected about household spending and it is therefore not possible to say whether the smaller vitamin C intake of those subjects in receipt of supplementary benefit was by choice or by necessity.

---

[1]The survey did not include detailed enquiries about income. No check was made as to whether or not those who had supplementary benefit also received any additional allowance to which they may have been entitled on account of a medical condition which required a special diet.

11.7.5 The effect of social class after taking account of supplementary benefit was only statistically significant in women but was significant for both energy and ascorbic acid intakes. This suggests that the educational and cultural aspects of social class had a greater influence on the diets of women than of men. Again the results for plasma ascorbic acid concentration were very similar to those for ascorbic acid intake.

### 11.8 Subjects affected by multiple risk factors

In the preceding chapter (para 10.5) survey findings indicated that the greater the number of risk factors affecting an individual, the greater was the probability that the individual would be undernourished. Subjects affected by many risk factors would therefore be more likely to have less satisfactory diets than subjects affected by only a few risk factors. Tables 11.10 and 11.11 illustrate the significant association between the presence of multiple risk factors and low dietary intakes of total protein, iron and ascorbic acid in men and women, low intakes of vitamin A in men and low food energy intakes in women.

### 11.9 Conclusion

Although the numbers involved were small, a study of very healthy and very unhealthy subjects suggested that the higher incidence of disease in the older subjects might account for some of the observed decrease in food intake which occurs during senescence. Some of the medical conditions and social factors associated with undernutrition in the elderly were also associated with poor dietary intakes. Subjects affected by multiple risk factors were also much more likely to have inadequate dietary intakes.

**Table 11.1:** *The number of undernourished subjects among those with lowest[1] dietary intakes of food energy and nutrients*

| | Whole sample | Food energy | Total protein | Calcium | Iron | Vit A | Thiamin | Riboflavin | Nicotinic acid | Pyridoxine | Ascorbic acid | Vit D | Low-energy intake in non-obese non-diabetic subjects who were not on special low calorie diets |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Men* | | | | | | | | | | | | | |
| malnourished | 14 | 5 | 6 | 5 | 5 | 7 | 5 | 6 | 5 | 6 | 4 | 4 | 4 |
| Total in group | 169 | 20 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 17 | 15 |
| % Malnourished | 8.3 | 25.0 | 35.3 | 29.4 | 29.4 | 41.2 | 29.4 | 35.3 | 29.4 | 35.3 | 23.5 | 23.5 | 26.7 |
| 10th percentile except for energy[1] | | 1500 kcal/day | 51.2 g/day | 578.3 mg/day | 7.76 mg/day | 476 µg/day | 0.65 mg/day | 0.95 mg/day | 8.7 mg/day | 0.84 mg/day | 17.3 mg/day | 0.85 µg/day | 1500 kcal/day |
| *Women* | | | | | | | | | | | | | |
| malnourished | 12 | 3 | 5 | 4 | 5 | 2 | 5 | 3 | 3 | 5 | 7 | 5 | 3 |
| Total in group | 196 | 28 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 20 | 21 | 15 |
| % Malnourished | 6.1 | 10.7 | 25.0 | 20.0 | 25.0 | 10.0 | 25.0 | 15.0 | 15.0 | 25.0 | 35.0 | 23.8 | 20.0 |
| 10th percentile except for energy[1] | | 1200 kcal/day | 37.8 g/day | 476 mg/day | 5.74 mg/day | 399 µg/day | 0.49 mg/day | 0.71 mg/day | 6.4 mg/day | 0.62 mg/day | 12.7 mg/day | 0.64 µg/day | 1200 kcal/day |

[1] Lowest intakes: energy – Men 1 500 kcal and below/day, women 1 200 kcal and below/day
nutrients – below 10th percentile in each sex group

**Table 11.2:** *Mean daily intakes of food energy and some nutrients of those classified as 'healthy' and 'much better than average' compared with those classified as 'not healthy' and 'much worse than average'*

| | No. of subjects | Energy kcal | Energy MJ | Total protein g | Iron mg | Riboflavin mg | Ascorbic acid mg | Ascorbic acid mg/1 000 kcal |
|---|---|---|---|---|---|---|---|---|
| | | Mean s.d. | Mean s.d. | Mean s.d. | Mean s.d. | Mean s.d. | Mean s.d. | Mean s.d. |
| 'Healthy' and 'much better than average' | | | | | | | | |
| *Men* | | | | | | | | |
| Under 80 yrs | 14 | 2 286 (517) | 9.6 (2.2) | 73.6 (16.2) | 11.9 (3.2) | 1.44 (0.38) | 45.5 (27.1) | 20.0 (12.2) |
| 80 yrs and over | 7 | 2 243 (554) | 9.4 (2.3) | 73.8 (21.2) | 11.5 (2.1) | 1.49 (0.28) | 48.3 (33.1) | 21.6 (14.9) |
| *Women* | | | | | | | | |
| Under 80 yrs | 15 | 1 664 (446) | 7.0 (1.9) | 58.0 (16.1) | 9.6 (4.5) | 1.28 (0.67) | 43.0 (26.5) | 26.9 (17.2) |
| 80 yrs and over | 4 | 1 646 (450) | 6.9 (1.9) | 47.7 (12.7) | 8.2 (2.8) | 1.01 (0.43) | 54.9 (40.8) | 30.7 (19.1) |
| 'Not healthy' and 'much worse than average' | | | | | | | | |
| *Men* | | | | | | | | |
| Under 80 yrs | 3 | 1 741 (390) | 7.3 (1.6) | 50.2 (7.0) | 8.6 (2.0) | 1.06 (0.31) | 42.1 (35.0) | 23.2 (17.5) |
| 80 yrs and over | 6 | 1 650 (398) | 6.9 (1.7) | 54.7 (25.9) | 8.6 (4.1) | 1.14 (0.45) | 26.1 (9.1) | 15.9 (3.7) |
| *Women* | | | | | | | | |
| Under 80 yrs | 4 | 1 308 (217) | 5.5 (0.9) | 40.5 (7.7) | 6.7 (1.61) | 0.68 (0.16) | 8.5ϕ (3.2) | 6.9ϕ (2.7) |
| 80 yrs and over | 7 | 1 629 (441) | 6.8 (1.9) | 52.8 (18.7) | 10.0 (4.0) | 1.04 (0.47) | 21.4 (13.9) | 12.6 (6.0) |

ϕ One woman, who had an ascorbic acid intake of 236 mg/day, was excluded from this calculation

**Table 11.3:** *Mean daily intakes of energy and some nutrients of subjects with low mental test scores (MTS)*

| | No. of subjects | Energy kcal | | Energy MJ | | Total protein g | | Iron mg | | Riboflavin mg | | Ascorbic acid mg | | Ascorbic acid mg/1 000 kcal | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| Men under 80 yrs | | | | | | | | | | | | | | | |
| MTS <13 | 23 | 2003* | (459) | 8.4* | (1.9) | 62.9** | (11.0) | 10.3* | (2.8) | 1.4 | (0.5) | 38 | (20) | 20 | (13) |
| MTS≥13 | 88 | 2273 | (525) | 9.5 | (2.2) | 73.4 | (15.9) | 11.9 | (3.0) | 1.6 | (0.7) | 49 | (30) | 22 | (15) |
| Men 80 yrs or over | | | | | | | | | | | | | | | |
| MTS <13 | 25 | 1947 | (496) | 8.2 | (2.1) | 67.8 | (16.3) | 10.7 | (3.2) | 1.4 | (0.5) | 34 | (35) | 18 | (15) |
| MTS≥13 | 32 | 2112 | (476) | 8.8 | (2.0) | 71.3 | (16.2) | 11.6 | (2.6) | 1.5 | (0.4) | 42 | (28) | 20 | (14) |
| Women under 80 yrs | | | | | | | | | | | | | | | |
| MTS <13 | 50 | 1604 | (418) | 6.7 | (1.8) | 53.6** | (12.5) | 8.6* | (2.8) | 1.1* | (0.4) | 39 | (40) | 24 | (26) |
| MTS≥13 | 75 | 1729 | (410) | 7.2 | (1.7) | 60.1 | (14.0) | 9.8 | (3.2) | 1.3 | (0.6) | 41 | (20) | 24 | (12) |
| Women 80 yrs or over | | | | | | | | | | | | | | | |
| MTS <13 | 33 | 1474 | (385) | 6.2 | (1.6) | 48.6** | (11.7) | 7.7** | (2.6) | 1.0* | (0.3) | 29** | (21) | 20* | (15) |
| MTS≥13 | 36 | 1634 | (329) | 6.8 | (1.4) | 56.2 | (11.1) | 9.4 | (2.6) | 1.2 | (0.5) | 46 | (26) | 27 | (13) |

Intakes significantly lower than those of subjects with normal mental test scores (≥13) are indicated by *$P<0.05$

**$P<0.01$

**Table 11.4**: *Mean daily intake of iron and ascorbic acid of subjects with low mental test scores (MTS ‹ 13) who lived alone compared with those who did not live alone*

| | | Number of subjects | Mean daily intake | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Iron (mg) | | Ascorbic acid (mg) | | Ascorbic acid mg/1 000 kcal | |
| | | | Mean | s.d. | Mean | s.d. | Mean | s.d. |
| *Men with MTS <13* | | | | | | | | |
| | Alone | 5 | 8.0 | (1.9) | 28 | (20) | 18 | (16) |
| Under 80 yrs | Not alone | 18 | 10.9 | (2.7) | 41 | (20) | 21 | (12) |
| | Alone | 12 | 10.2 | (3.7) | 24 | (14) | 12 | (7) |
| 80 yrs or over | Not alone | 13 | 11.2 | (2.7) | 43 | (46) | 24 | (19) |
| *Women with MTS <13* | | | | | | | | |
| | Alone | 24 | 9.1 | (3.5) | 32 | (24) | 19 | (12) |
| Under 80 yrs | Not alone | 26 | 8.0 | (1.8) | 45 | (49) | 30 | (34) |
| | Alone | 15 | 6.8 | (1.9) | 29 | (17) | 20 | (12) |
| 80 yrs or over | Not alone | 18 | 8.4 | (2.9) | 29 | (24) | 20 | (17) |

**Table 11.5:** *Mean daily intakes of food energy and some nutrients by subjects with the diagnosis of chronic bronchitis and emphysema compared with the rest of the sample*

| | Number of subjects | Energy kcal | Energy MJ | Protein g | Iron mg | Riboflavin mg | Ascorbic acid mg | Protein g/1 000 kcal | Ascorbic acid mg/1 000 kcal |
|---|---|---|---|---|---|---|---|---|---|
| *Men* | | | | | | | | | |
| Chronic bronchitis and emphysema | 40 | 2 042 (542) | 8.5 (2.3) | 64.2** (16.7) | 10.5* (3.0) | 1.3** (0.5) | 44 (37) | 31.9 (5.9) | 22 (16) |
| The rest | 129 | 2 183 (510) | 9.1 (2.1) | 72.3 (15.6) | 11.6 (3.0) | 1.6 (0.6) | 43 (27) | 33.7 (6.0) | 21 (14) |
| *Women* | | | | | | | | | |
| Chronic bronchitis and emphysema | 22 | 1 560 (459) | 6.5 (1.9) | 51.5 (15.2) | 8.2 (3.0) | 1.0 (0.4) | 27* (17) | 33.3 (4.9) | 17* (10) |
| The rest | 174 | 1 646 (391) | 6.9 (1.6) | 56.3 (13.0) | 9.1 (3.0) | 1.2 (0.5) | 40 (29) | 34.7 (6.2) | 26 (18) |

Standard deviation – figures in parentheses

Intakes which were significantly smaller by the subjects with chronic bronchitis and emphysema *$P<0.05$ **$P<0.01$

**Table 11.6:** *Mean daily intakes of energy and some nutrients of subjects with difficulty in swallowing, and of edentulous subjects who did not use dentures when eating*

| | Number of subjects | Energy kcal Mean | s.d. | Energy MJ Mean | s.d. | Total protein g Mean | s.d. | Riboflavin mg Mean | s.d. | Ascorbic acid mg Mean | s.d. | Ascorbic acid mg/1 000 kcal Mean | s.d. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Men* | | | | | | | | | | | | | |
| No dentures | 17 | 1 961 | (527) | 8.2 | (2.2) | 65.1 | (14.5) | 1.4 | (0.6) | 26† | (15) | 14† | (10) |
| Difficulty in swallowing | 10 | 1 974 | (610) | 8.3 | (2.6) | 66.4 | (20.1) | 1.3 | (0.5) | 31 | (16) | 16 | (7) |
| All subjects | 169 | 2 151 | (520) | 9.0 | (2.2) | 70.4 | (16.2) | 1.5 | (0.6) | 44 | (29) | 21 | (14) |
| *Women* | | | | | | | | | | | | | |
| No dentures | 7 | 1 507 | (466) | 6.3 | (2.0) | 53.0 | (14.5) | 0.9 | (0.3) | 28φ | (13) | 18φ | (4) |
| Difficulty in swallowing | 6 | 1 515 | (153) | 6.3 | (0.6) | 48.4 | (7.1) | 1.0 | (0.2) | 33φ | (17) | 21φ | (10) |
| All subjects | 196 | 1 636 | (399) | 6.9 | (1.7) | 55.7 | (13.3) | 1.2 | (0.5) | 39 | (28) | 24 | (17) |

†One man with an ascorbic acid intake of 146 mg/day was excluded

φ One woman with an ascorbic acid intake of 236 mg/day was excluded

**Table 11.7:** *Mean daily intake of energy and some nutrients of elderly subjects (in two age groups) who smoked and who did not smoke*

| | Age | Number of subjects | Energy kcal | Energy MJ | Total protein g | Animal protein g | Calcium mg | Iron mg | Riboflavin mg | Ascorbic acid mg |
|---|---|---|---|---|---|---|---|---|---|---|
| *Men* | | | | | | | | | | |
| Non-smokers | | 58 | 2283 | 9.6 | 74.3 | 49.9 | 933 | 12.4 | 1.6 | 50 |
| | | | (542) | (2.3) | (16.8) | (13.1) | (261) | (3.1) | (0.6) | (30) |
| | under 80 yrs | | | | | | | | | |
| Smokers | | 53 | 2145 | 9.0 | 67.7* | 44.9* | 842 | 10.7** | 1.5 | 42 |
| | | | (493) | (2.1) | (13.5) | (12.1) | (304) | (2.7) | (0.6) | (26) |
| Non-smokers | | 31 | 2077 | 8.7 | 72.9 | 51.5 | 902 | 11.9 | 1.6 | 44 |
| | | | (439) | (1.8) | (14.0) | (12.4) | (276) | (3.0) | (0.5) | (35) |
| | 80 yrs and over | | | | | | | | | |
| Smokers | | 27 | 1962 | 8.2 | 64.3 | 43.6* | 825 | 10.0* | 1.2** | 32 |
| | | | (560) | (2.3) | (20.0) | (15.5) | (347) | (2.8) | (0.4) | (25) |
| *Women* | | | | | | | | | | |
| Non-smokers | | 105 | 1646 | 6.9 | 56.6 | 38.4 | 773 | 9.1 | 1.2 | 40 |
| | | | (414) | (1.7) | (13.7) | (10.6) | (261) | (3.1) | (0.5) | (30) |
| | under 80 yrs | | | | | | | | | |
| Smokers | | 20 | 1854† | 7.8 | 62.5 | 44.0† | 796 | 10.4 | 1.4 | 41 |
| | | | (391) | (1.6) | (13.1) | (10.3) | (195) | (3.0) | (0.5) | (25) |
| Non-smokers | | 55 | 1536 | 6.4 | 51.0 | 35.2 | 682 | 8.4 | 1.1 | 36 |
| | | | (372) | (1.6) | (12.9) | (10.0) | (179) | (3.0) | (0.4) | (25) |
| | 80 yrs and over | | | | | | | | | |
| Smokers | | 16 | 1637 | 6.9 | 58.1† | 40.4 | 741 | 9.0 | 1.2 | 38 |
| | | | (304) | (1.3) | (7.0) | (6.6) | (198) | (1.7) | (0.2) | (27) |

Mean intakes significantly lower for smokers * $P<0.05$
** $P<0.01$

Mean intakes significantly higher for smokers† $P<0.05$

**Table 11.8:** *Mean daily intakes of energy and some nutrients by subjects who were housebound compared with those who were not*

| | Number of subjects | Energy kcal | Energy MJ | Protein g | Iron mg | Riboflavin mg | Ascorbic acid mg | Ascorbic acid mg/1 000 kcal |
|---|---|---|---|---|---|---|---|---|
| *Men* | | | | | | | | |
| Housebound | 13 | 1 921 | 8.0 | 62.3 | 10.1 | 1.2 | 46 | 23 |
| | | (455) | (1.9) | (18.6) | (2.7) | (0.4) | (47) | (18) |
| The rest | 156 | 2 169 | 9.1 | 71.1 | 11.5 | 1.5 | 43 | 21 |
| | | (521) | (2.2) | (15.9) | (3.0) | (0.6) | (28) | (14) |
| *Women* | | | | | | | | |
| Housebound | 33 | 1 415*** | 5.9 | 48.0*** | 7.9* | 1.0* | 29ϕ | 21ϕ |
| | | (386) | (1.6) | (12.6) | (3.0) | (0.4) | (25) | (14) |
| The rest | 163 | 1 682 | 7.0 | 57.3 | 9.2 | 1.2 | 39 | 24 |
| | | (387) | (1.6) | (13.0) | (2.9) | (0.5) | (24) | (14) |

ϕ One woman with an ascorbic acid intake of 236 mg/day was excluded from the calculation

*Intake of housebound subjects significantly less than that of the non-housebound $P<0.05$

**Intake of housebound subjects significantly less than that of the non-housebound $P<0.01$

***Intake of housebound subjects significantly less than that of the non-housebound $P<0.001$

Standard deviations = figures in parentheses

**Table 11.9:** *The number of housebound subjects with calcium or vitamin D intakes below the 10th percentile intake for all subjects*

| | Men | | | Women | | |
|---|---|---|---|---|---|---|
| | No. of housebound subjects | No. with intake below 10th percentile[1] | % | No. of housebound subjects | No. with intake below 10th percentile[2] | % |
| Calcium | 13 | 1 | 8 | 33 | 8 | 24** |
| Vitamin D | 13 | 3 | 23 | 33 | 9 | 27*** |

[1] 10th percentiles for men under 80 yrs were 598 mg/day for calcium and 0.83 μg/day for vitamin D and for men of 80 yrs and over, 493 mg/day for calcium and 0.94 μg/day for vitamin D

[2] 10th percentiles for women under 80 yrs were 500 mg/day for calcium and 0.52 μg/day for vitamin D and for women of 80 yrs and over 446 mg/day for calcium and 0.64 μg/day for vitamin D

**Among the housebound significantly more than 10% had intakes of calcium and vitamin D below the 10th percentile $P<0.01$

***Among the housebound significantly more than 10% had intakes of calcium and vitamin D below the 10th percentile $P<0.001$

**Table 11.10:** *Relationship between dietary intakes (above and below the 10th percentile) of some nutrients by the men in the sample and the presence of multiple risk factors for malnutrition*

| | Number of risk factors | | | | | | | | *P* value |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| *Total protein* | | | | | | | | | |
| % frequency distribution of intakes below 10th percentile: | 12 | 12 | 24 | 17 | 17 | 12 | 0 | 6 | <0.05 |
| % frequency distribution of intakes above 10th percentile: | 24 | 29 | 23 | 13 | 6 | 3 | 1 | 1 | |
| *Iron* | | | | | | | | | |
| % frequency distribution of intakes below 10th percentile: | 0 | 11 | 24 | 24 | 11 | 24 | 0 | 6 | <0.001 |
| % frequency distribution of intakes above 10th percentile: | 25 | 29 | 23 | 12 | 7 | 2 | 1 | 1 | |
| *Ascorbic acid* | | | | | | | | | |
| % frequency distribution of intakes below 10th pecentile: | 17 | 17 | 12 | 24 | 12 | 12 | 6 | 0 | Not significant |
| % frequency distribution of intakes above 10th percentile: | 24 | 28 | 24 | 13 | 7 | 3 | 0 | 1 | |
| *Vitamin A* | | | | | | | | | |
| % frequency distribution of intakes below 10th percentile: | 12 | 18 | 29 | 12 | 6 | 17 | 0 | 6 | <0.05 |
| % frequency distribution of intakes above 10th percentile: | 24 | 28 | 22 | 14 | 7 | 3 | 1 | 1 | |

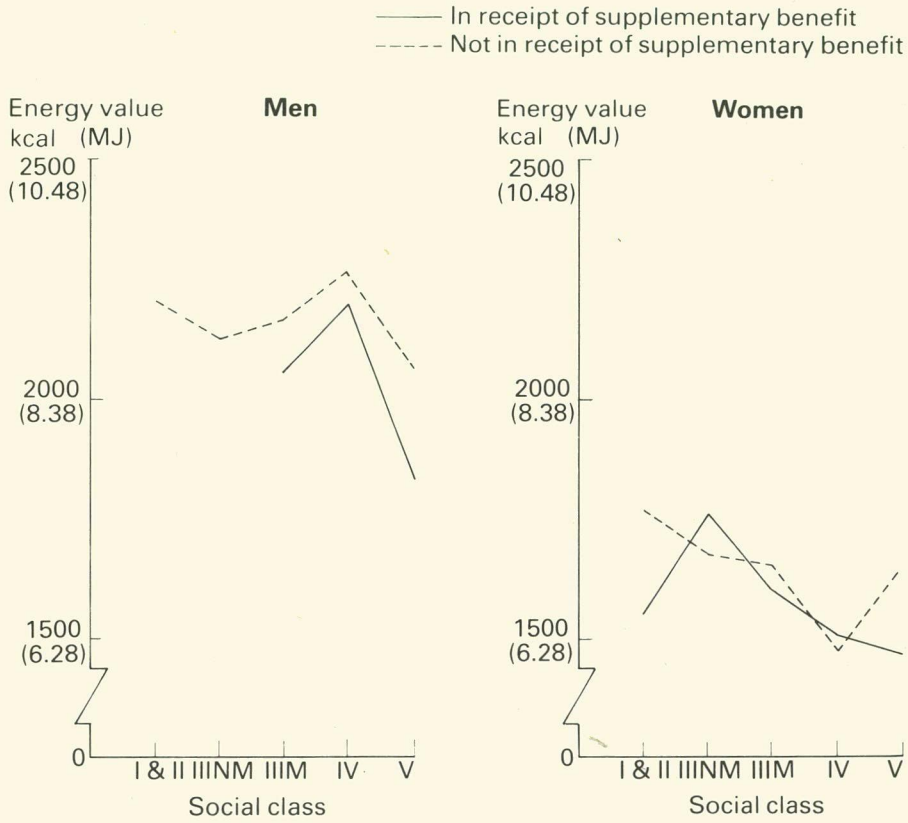
Risk factors considered: Living alone
No regular cooked meals
Supplementary benefit
Social Class IV or V
Mental Test Score <13
Depression
Chronic bronchitis/emphysema
Gastrectomy (partial)
Poor dentition
Difficulty in swallowing
Housebound

**Table 11.11:** *Relationship between dietary intakes (above and below the 10th percentile) of some nutrients by the women in the sample and the presence of multiple risk factors for malnutrition*

| | Number of risk factors | | | | | | | | *P* value |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| *Total protein* | | | | | | | | | |
| % frequency distribution of intakes below 10th percentile: | 20 | 20 | 15 | 20 | 5 | 5 | 10 | 5 | Not significant |
| % frequency distribution of intakes above 10th percentile: | 10 | 31 | 25 | 16 | 12 | 4 | 2 | 0 | |
| *Iron* | | | | | | | | | |
| % frequency distribution of intakes below 10th percentile: | 5 | 10 | 20 | 30 | 10 | 5 | 15 | 5 | <0.01 |
| % frequency distribution of intakes above 10th percentile: | 12 | 32 | 25 | 14 | 11 | 4 | 2 | 0 | |
| *Ascorbic acid* | | | | | | | | | |
| % frequency distribution of intakes below 10th percentile: | 0 | 10 | 15 | 40 | 20 | 10 | 0 | 5 | <0.01 |
| % frequency distribution of intakes above 10th percentile: | 13 | 33 | 25 | 13 | 10 | 3 | 3 | 0 | |
| *Food energy* | | | | | | | | | |
| % frequency distribution of intakes below 10th percentile: | 15 | 15 | 20 | 20 | 5 | 5 | 15 | 5 | <0.05 |
| % frequency distribution of intakes above 10th percentile: | 11 | 32 | 24 | 15 | 12 | 4 | 2 | 0 | |

Risk factors considered: Living alone
No regular cooked meals
Supplementary benefit
Social Class IV or V
Mental Test Score <13
Depression
Chronic bronchitis/emphysema
Gastrectomy (partial)
Poor dentition
Difficulty in swallowing
Housebound

FIGURE 11.1 ***Mean intakes of energy values in relation to social class and receipt of supplementary benefit.***

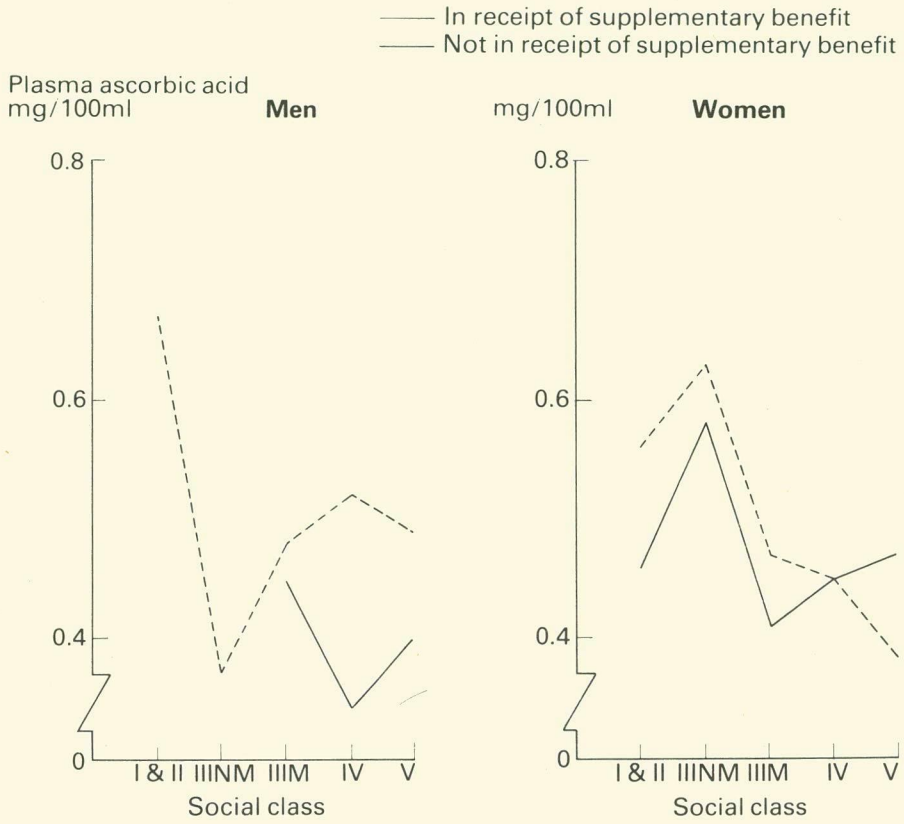



| | | Men | | Women | |
|---|---|---|---|---|---|
| | | Supplementary benefit | No supplementary benefit | Supplementary benefit | No supplementary benefit |
| Number of respondents | I & II | 2 | 28 | 6 | 38 |
| | III NM | 2 | 16 | 11 | 18 |
| | III M | 22 | 36 | 30 | 26 |
| | IV | 12 | 28 | 19 | 13 |
| | V | 9 | 7 | 18 | 6 |

FIGURE 11.2 ***Mean intakes of vitamin C by social class and receipt of supplementary benefit.***


| | | Men | | Women | |
|---|---|---|---|---|---|
| | | Supplementary benefit | No supplementary benefit | Supplementary benefit | No supplementary benefit |
| Number of respondents | I & II | 2 | 28 | 6 | 38 |
| | III NM | 2 | 16 | 11 | 18 |
| | III M | 22 | 36 | 30 | 26 |
| | IV | 12 | 28 | 19 | 13 |
| | V | 9 | 7 | 18 | 6 |

FIGURE 11.3 ***Mean concentrations of plasma ascorbic acid by social class and receipt of supplementary benefit.***




| | | Men | | Women | |
|---|---|---|---|---|---|
| | | Supplementary benefit | No supplementary benefit | Supplementary benefit | No supplementary benefit |
| Number of respondents | I & II | 2 | 28 | 6 | 38 |
| | III NM | 2 | 16 | 11 | 18 |
| | III M | 22 | 36 | 30 | 26 |
| | IV | 12 | 28 | 19 | 13 |
| | V | 9 | 7 | 18 | 6 |

# 12. Biochemistry of some special groups

## 12.1 Introduction

12.1.1 Biochemical results for subjects who were housebound or who were classified by the consultant physicians as not healthy, malnourished, wasted, or chronic bronchitics were considered in an attempt to elucidate differences which might be characteristic of the group in the light of social, dietary and clinical findings. The means of all biochemical measurements in each group were compared with those of the rest of the sample. Significant differences are shown in Table 12.1.

12.1.2 Some other groups, in whom the biochemistry might be expected to have shown differences in vitamin status from the rest of the subjects, were also examined. These included subjects who smoked, or who had hyperkeratosis or sublingual haemorrhages.

12.1.3 In some groups, for example those with poor dentition, those who received no regular cooked meals, who were depressed, or who took barbiturates or tranquillizers, there were too few subjects for statistical analysis of the biochemical findings. Results for the subjects in these groups were examined individually.

## 12.2 "Healthy" and "not healthy"

12.2.1 Subjects who were free from constitutional disease or major disability (para 6.2.1) were classified as "healthy" by the physician. The mean serum alkaline phosphatase activity was greater ($P < 0.001$) in those described as "not healthy" compared with the healthy. This may have been partly because of the high proportion of housebound subjects in the "not healthy" group. Serum albumin concentration was increased in the healthy subjects ($P < 0.01$), as was pseudocholinesterase activity, though the latter difference was not significant (Table 12.1).

## 12.2 The malnourished

12.3.1 The malnourished group of 14 men and 12 women might be expected to have had abnormal biochemistry, since the fact that their biochemical or haematological results lay outside the usual reference ranges contributed to their selection as malnourished (para 9.3). The results which were significantly different in the malnourished group compared with the remainder were: for men, leucocyte ascorbic acid concentration and red cell glutathione reductase activation coefficient ($P < 0.001$), serum albumin concentration and alkaline phosphatase activity ($P < 0.01$), and for women, EGR-AC ($P < 0.001$), serum

alkaline phosphatase activity ($P< 0.01$) and red cell transketolase activation coefficient ($P< 0.05$).

### 12.4 The housebound

12.4.1 As might be expected, the activity of serum alkaline phosphatase was significantly higher in housebound subjects when compared with the rest of the sample ($P< 0.001$). Smaller differences were found in other measurements: serum total protein and albumin concentrations were lower in housebound men ($P< 0.05$). The raised serum alkaline phosphatase found among the malnourished and the "not healthy" may be due to a higher proportion of housebound in these groups. Eight of the 26 malnourished subjects were housebound; only 3 of the 33 housebound women and only one of the 13 housebound men were described as "healthy" by the examining physicians.

### 12.5 Subjects described as "wasted"

12.5.1 Mean concentrations of serum phosphate in men and women described as wasted were found to be significantly increased by comparison with non-wasted subjects (Table 12.1). Apart from two values which were above 5 mg/100 ml (1.62 mmol/l), the serum phosphate concentrations of the wasted male subjects were not abnormally high but had not undergone the reduction with ageing that some workers have shown to occur in men (para 7.5.4). By contrast, the reduction in the non-wasted men confirmed the findings of McPherson et al (1978).

12.5.2 There was a correlation between serum phosphate and serum calcium concentrations in women described as wasted ($r = 0.580$, $P< 0.01$) and in all the women in the survey ($r = 0.161$, $P< 0.05$). These indices were not significantly correlated in the men, wasted or otherwise. Mean concentration of serum calcium, after adjustment for albumin concentration, was raised (9.67 mg/100 ml ±0.905, 2.42 mmol/l ±0.226) in wasted subjects by comparison with the non-wasted subjects (9.40 mg/100 ml ±0.426, 2.35 mmol/l ±0.106) and this difference was significant ($P< 0.01$).

12.5.3 Serum albumin concentrations in men and women, and pseudocholinesterase activity in men only, were significantly lower in the wasted subjects (Table 12.1).

### 12.6 Subjects with chronic bronchitis

12.6.1 A diagnosis of chronic bronchitis was frequently made in subjects who were found to be malnourished (para 10.1.3). 95% of the women and 70% of the men with chronic bronchitis came from Sunderland. The mean serum albumin and total protein concentrations were lower in both men and women who had chronic bronchitis (Table 12.1) but this was only significant in the men. These subjects also had a smaller mean daily intake of energy and total protein (Table 11.5).

12.6.2 Plasma ascorbic acid concentrations were lower in bronchitic subjects

but the difference was only significant in the women (Table 12.1). The finding is probably explained by the higher proportion of bronchitics in Sunderland (Table 10.2) where the mean dietary intake of vitamin C (Table 5.1) and plasma ascorbic acid concentrations were lower than in all other areas except Rutherglen (Tables 7.3a and b). Smoking habits may be associated with low plasma ascorbate concentration – the proportion of smokers (29%) was greater among the bronchitic subjects than in the rest of the sample (Table 6.3).

12.6.3 Riboflavin status was poorer (as indicated by a raised EGR-AC) in bronchitic women than in women without bronchitis (Table 12.1); their mean riboflavin intake, particularly of those aged over 80, was smaller (but not significantly smaller) than that of the rest of the subjects (Table 11.5). However, there was no difference in the riboflavin intake per 1000 kcal between bronchitics and the other subjects.

### 12.7 Smokers

12.7.1 *Vitamin C.* Smoking is associated with reduced concentrations of ascorbic acid in leucocytes and plasma (Brook and Grimshaw, 1968). Thirty-two per cent of the survey subjects were smokers (Table 11.7) and the proportion of plasma ascorbic acid concentrations less than 0.2 mg/100 ml was larger in this group than in subjects who were non-smokers (Table 12.2). In all areas mean plasma vitamin C concentrations of smokers were lower than those of non-smokers, although the difference was only significant for Sunderland and when all areas were combined (Table 12.3). The results are similar to those of the Canadian Nutrition Survey reported by Pelletier (1975), and confirm the findings of Brook and Grimshaw (1968).

12.7.2 Mean dietary intakes of vitamin C differed considerably between the areas but were only significantly different between the smokers and non-smokers in Sunderland (Table 12.4). The lowest mean daily intakes of ascorbic acid were in Rutherglen: 22 mg for smokers and 32 mg for non-smokers. Smokers in Cambridge, Angus and Camden had higher mean daily intakes of ascorbic acid than non-smokers.

12.7.3 The finding of Brook and Grimshaw (1968) that leucocyte ascorbic acid concentrations are reduced in smokers was not confirmed in this survey. Mean leucocyte ascorbic acid concentrations in Camden and Sunderland were very similar (Table 12.3) in spite of the large differences in vitamin C intake in these areas. Pelletier (1975) suggested that a reduced plasma and leucocyte concentration in smokers may be due to an indirect effect of smoking on absorption of ascorbate. Defects in absorption of ascorbic acid would be detected initially by a depression of plasma values and the absence of any effect on leucocyte ascorbic acid concentration would suggest that total body reserves were adequate. This may be the explanation of the findings in this survey but the wide range of values obtained from these subjects makes precise interpretation of the information difficult.

12.7.4 *Riboflavin.* Survey subjects who smoked had a mean EGR-AC of 1.29 which was significantly higher ($P< 0.05$) than that of non-smokers (EGR-AC 1.24). This was particularly evident for the Sunderland subjects where the association between smoking and biochemical riboflavin status was first noticed (Bates, personal communication). But women who smoked had bigger mean daily intakes of riboflavin that those who were non-smokers, and only men smokers over 80 years of age had a bigger mean intake of riboflavin compared with non-smokers (Table 11.7).

## 12.8 Subjects with hyperkeratosis

12.8.1 Hyperkeratosis has been reported on several occasions to be one of the early clinical signs in experimentally-produced vitamin C deficiency (Irwin and Hutchins, 1976). In the survey there were 35 subjects with hyperkeratosis of whom 20 were in Sunderland, 9 in Angus and 2 in Rutherglen – the three areas where vitamin C status was lowest on both biochemical (Table 7.3a and b) and dietary (Tables 5.1 and 5.2) evidence.

12.8.2 Among the subjects with hyperkeratosis, the proportions of those who were 80 years or more (57%, 20/35, $P< 0.01$) and of those who were men (71%, 25/35, $P< 0.01$) were significantly greater than would have been expected by chance.

12.8.3 Leucocyte ascorbic acid was measured in Sunderland and Camden only and there were no subjects with hyperkeratosis in Camden. The mean of the log transformations of leucocyte ascorbic acid concentrations in the subjects with hyperkeratosis from Sunderland was lower ($P< 0.01$) than that of subjects without hyperkeratosis in both areas or in Sunderland only (Table 12.5). When subjects were divided according to age and sex, the mean of the log transformations of LAA concentrations was significantly lower only in men under 80 years ($P< 0.05$). There were no significant differences between the mean dietary intakes of vitamin C except for women over 80 years old or between the mean concentrations of plasma ascorbic acid of men and women with hyperkeratosis in the different age/sex groups. In this survey therefore hyperkeratosis could not be unequivocally linked with a deficiency of vitamin C.

## 12.9 Subjects with sublingual haemorrhages

12.9.1 Sublingual haemorrhages have also been associated with marginal vitamin C status (Taylor, 1968). Twenty-one subjects from Sunderland and one from Rutherglen had sublingual haemorrhages, and mean concentrations of PAA were lowest for all subjects in these two areas (Table 7.3a and b). The proportion of subjects who had a leucocyte ($\ll 15\ \mu g/10^8$ white cells) or plasma ascorbic acid ($\ll 0.2$ mg/100 ml) concentration was not significantly different between those who had sublingual haemorrhages compared with those who did not have sublingual haemorrhages (Table 12.2). There was no significant

difference between the mean concentrations of plasma or leucocyte ascorbic acid in the two groups.

### 12.10 Vitamin C and riboflavin status of other special sub-groups

12.10.1 The mean ascorbic acid intake was smaller in some of the special groups than in the rest of the sample - subjects who had a low mental test score (Table 11.3), and those in the lower social classes (Figure 11.2) or receiving supplementary benefits (Figure 11.1). Table 12.2 shows the proportion of subjects with low plasma and leucocyte ascorbic acid values in these groups. Results indicated that subjects who were wasted, had poor dentition, were in receipt of supplementary benefit and who smoked had biochemical evidence of poor ascorbic acid status. The small number of subjects in the other groups throws doubt on any interpretation of the findings.

12.10.2 There was a wide range of EGR-AC values within each group. However, the proportion of subjects with EGR-AC values equal to or greater than 1.3 was increased in the malnourished, those in social classes IV and V, and those taking no regular cooked meals (Table 12.6).

### 12.11 Conclusions

12.11.1 The biochemical results were examined in those groups of subjects whose clinical condition, social characteristics or dietary habits suggested that abnormalities might occur. Where possible the data were investigated to account for any differences found, since these might be useful for predicting malnutrition in future surveys.

12.11.2 Apart from the measurements of vitamin status, the indices in the groups considered which showed the greatest differences from the rest of the subjects were serum albumin and alkaline phosphatase.

12.11.3 Low concentrations of plasma ascorbic acid were associated with smoking, bronchitis, poor dentition, hyperkeratosis, sublingual microvaricosities and low social status, but interpretation of these associations was complicated by large differences in intake between the areas and to a lesser extent by sex and age differences.

12.11.4 A large number of subjects were biochemically deficient in riboflavin but there were very few special groups where the proportion of subjects with erythrocyte glutathione reductase activation coefficients (EGR-AC) $>1.3$ was significantly higher.

**Table 12.1:** *Biochemical variables which showed significant differences in some special groups*

| Biochemical variable | | Sex | No. | Mean | s.d. | No. | Mean | s.d. | Difference |
|---|---|---|---|---|---|---|---|---|---|
| | | | | *Not healthy* | | | *Healthy* | | *P<* |
| Alkaline phosphatase | KA units | M + F | 165 | 9.55 | 4.35 | 198 | 7.76 | 2.26 | 0.001 |
| Serum albumin | g/l | M + F | 165 | 42.5 | 3.9 | 197 | 43.5 | 3.3 | 0.01 |
| | | | | *Malnourished* | | | *Remainder* | | |
| Leucocyte ascorbic acid | $\mu g/10^8$ cells | M | 9 | 10.7 | 3.67 | 49 | 24.7 | 10.87 | 0.001 |
| Red cell riboflavin | EGR-AC | M | 13 | 1.50 | 0.27 | 153 | 1.25 | 0.16 | 0.001 |
| | | F | 12 | 1.45 | 0.25 | 180 | 1.24 | 0.16 | 0.001 |
| Alkaline phosphatase | KA units | M | 14 | 11.6 | 10.82 | 154 | 8.1 | 2.57 | 0.01 |
| | | F | 12 | 11.0 | 4.34 | 183 | 8.5 | 2.88 | 0.01 |
| Serum albumin | g/l | M | 14 | 40.0 | 5.0 | 153 | 43.3 | 3.7 | 0.01 |
| Red cell transketolase | TKL-AC | F | 12 | 1.18 | 0.19 | 180 | 1.12 | 0.09 | 0.05 |
| | | | | *Housebound* | | | | | |
| Alkaline phosphatase | KA units | M | 13 | 13.7 | 11.20 | 155 | 8.0 | 2.27 | 0.001 |
| | | F | 33 | 10.4 | 4.33 | 162 | 8.4 | 2.58 | 0.001 |
| Serum total proteins | g/l | M | 13 | 70.2 | 5.5 | 154 | 73.5 | 5.3 | 0.05 |
| Serum albumin | g/l | M | 13 | 40.6 | 5.8 | 154 | 43.2 | 3.7 | 0.05 |
| | | | | *Wasted* | | | | | |
| Pseudocholinesterase | mmol/l/min | M | 18 | 3.34 | 0.84 | 149 | 4.78 | 1.31 | 0.001 |
| Serum calcium (adjusted) | mmol/l | M + F | 40 | 2.42 | 0.226 | 322 | 2.35 | 0.106 | 0.01 |
| Serum albumin | g/l | M + F | 40 | 41.6 | 4.5 | 322 | 43.1 | 3.6 | 0.05 |
| Serum phosphate | mmol/l | M | 18 | 1.03 | 0.18 | 149 | 0.92 | 0.15 | 0.01 |
| | | F | 22 | 1.17 | 0.22 | 173 | 1.08 | 0.16 | 0.05 |
| | | | | *Bronchitics* | | | | | |
| Red cell riboflavin | EGR-AC | F | 22 | 1.36 | 0.23 | 170 | 1.24 | 0.16 | 0.001 |
| Serum total proteins | g/l | M | 40 | 71.3 | 5.6 | 127 | 73.8 | 5.2 | 0.01 |
| Serum albumin | g/l | M | 40 | 41.3 | 4.8 | 127 | 43.5 | 3.4 | 0.01 |
| Plasma ascorbic acid | log mg/l | F | 22 | 0.36 | 0.24 | 169 | 0.54 | 0.34 | 0.05 |

**Table 12.2:** *Numbers of subjects with low ascorbic acid values in special groups*

| Group | LAA ≤ 15μg/10⁸ WBC* | | | PAA ≤ 0.2mg/100ml | | |
|---|---|---|---|---|---|---|
| | No. | % | Pϕ | No. | % | Pϕ |
| Malnourished | 10/19 | 53 | .001 | 10/25 | 40 | 0.01 |
| Housebound | 6/26 | 23 | NS | 8/45 | 18 | NS |
| Wasted | 4/25 | 16 | NS | 11/39 | 28 | 0.05 |
| Depressed | 0/11 | 0 | NS | 2/16 | 13 | NS |
| Barbiturates | 2/9 | 22 | NS | 3/29 | 10 | NS |
| Tranquillizers | 1/11 | 9 | NS | 3/27 | 11 | NS |
| Low mental test scores | 13/66 | 20 | NS | 25/129 | 19 | NS |
| Dementia | 0/9 | 0 | NS | 3/11 | 27 | NS |
| Poor dentition† | 5/17 | 29 | NS | 8/23 | 36 | 0.05 |
| Supplementary benefit | 17/83 | 20 | NS | 29/133 | 22 | 0.05 |
| Social classes IV & V | 14/61 | 23 | NS | 23/112 | 21 | NS |
| No regular cooked meals | 0/4 | 0 | NS | 1/8 | 13 | NS |
| Sublingual haemorrhages | 4/21 | 19 | NS | 3/22 | 14 | NS |
| Smokers | 10/51 | 20 | NS | 27/113 | 24 | 0.01 |
| Hyperkeratosis | 7/20 | 35 | NS | 10/35 | 29 | NS |
| All subjects | 21/146 | 14 | | 49/357 | 14 | |

NS No significant difference

* LAA was only measured in two areas, Sunderland and Camden

ϕ Significance of the proportions of low values in respective groups tested against the proportions in the rest in each case

† Subjects with 'poor dentition' were those with no teeth who had no dentures, or who never used their dentures for eating

**Table 12.3:** *Mean plasma and leucocyte ascorbic acid values in smokers and non-smokers*

| | Smokers | | | | | Non-smokers | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Plasma ascorbic acid | | | | | Plasma ascorbic acid | | | | |
| | mg/100ml | | | log mg/l | | mg/100ml | | | log mg/l | |
| | Mean | s.d. | No. | Mean | s.d. | Mean | s.d. | No. | Mean | s.d. |
| Portsmouth | 0.49 | 0.29 | 8 | 0.62 | 0.29 | 0.61 | 0.38 | 28 | 0.68 | 0.33 |
| Cambridge | 0.65 | 0.38 | 21 | 0.73 | 0.28 | 0.73 | 0.34 | 51 | 0.82 | 0.22 |
| Sunderland | 0.32 | 0.22 | 43 | 0.44* | 0.25 | 0.43 | 0.30 | 79 | 0.54 | 0.28 |
| Rutherglen | 0.26 | 0.12 | 9 | 0.39 | 0.19 | 0.42 | 0.26 | 23 | 0.55 | 0.24 |
| Angus | 0.37 | 0.26 | 18 | 0.49 | 0.25 | 0.47 | 0.32 | 40 | 0.58 | 0.28 |
| Camden | 0.61 | 0.31 | 14 | 0.71 | 0.29 | 0.67 | 0.41 | 23 | 0.76 | 0.25 |
| All areas | 0.43 | 0.30 | 113 | 0.54** | 0.28 | 0.54 | 0.35 | 244 | 0.65 | 0.30 |
| | Leucocyte ascorbic acid | | | | | Leucocyte ascorbic acid | | | | |
| | μg/10⁸ WBC | | | log μg/10⁸ WBC | | μg/10⁸ WBC | | | log μg/10⁸ WBC | |
| Sunderland | 23.6 | 10.63 | 37 | 1.32 | 0.24 | 25.1 | 11.42 | 74 | 1.36 | 0.20 |
| Camden | 22.8 | 6.61 | 14 | 1.34 | 0.14 | 23.8 | 8.08 | 21 | 1.36 | 0.16 |
| Both areas | 23.3 | 9.63 | 51 | 1.32 | 0.22 | 24.8 | 10.77 | 95 | 1.36 | 0.19 |

*significantly different from non-smokers ($P<0.05$)

**significantly different from non-smokers ($P< 0.01$)

**Table 12.4:** *Mean daily intake of ascorbic acid by smokers and non-smokers*

| | Smokers Ascorbic acid intake (mg) | | | Non-smokers Ascorbic acid intake (mg) | | | |
|---|---|---|---|---|---|---|---|
| | Mean | s.d. | No. | Mean | s.d. | No. | *P* |
| Portsmouth | 37 | 17.0 | 9 | 52 | 20.9 | 29 | NS |
| Cambridge | 53 | 30.8 | 21 | 51 | 31.0 | 51 | NS |
| Sunderland | 29 | 16.1 | 43 | 40 | 36.7 | 79 | <0.05 |
| Rutherglen | 22 | 8.3 | 10 | 32 | 24.2 | 24 | NS |
| Angus | 41 | 29.9 | 18 | 34 | 21.9 | 42 | NS |
| Camden | 55 | 20.4 | 15 | 43 | 21.5 | 24 | NS |
| All areas | 39 | 23.9 | 116 | 42 | 30.0 | 249 | NS |

NS Not statistically significant

**Table 12.5:** *Ascorbic acid status of subjects with hyperkeratosis*

| Area | Ascorbic acid measurement | Hyperkeratosis Mean | s.d. | No. | No hyperkeratosis Mean | s.d. | No. | *P*< |
|---|---|---|---|---|---|---|---|---|
| Both areas | Leucocyte ascorbic acid (LAA) $\mu g/10^8$ WBC | 18.9 | 9.9 | 20 | 25.2 | 10.2 | 126 | — |
| | Log LAA | 1.23 | 0.25 | 20 | 1.37 | 0.118 | 126 | 0.01 |
| Sunderland only | Leucocyte ascorbic acid (LAA) $\mu g/10^8$ WBC | 18.9 | 9.9 | 20 | 25.9 | 11.05 | 91 | — |
| | Log LAA | 1.23 | 0.25 | 20 | 1.38 | 0.19 | 91 | 0.01 |

**Table 12.6:** *Numbers of subjects with low biochemical riboflavin status in various special groups*

| Group | | AC›1.30 No. | % | *P*ϕ |
|---|---|---|---|---|
| Malnourished | | 19/25 | 76 | .001 |
| Housebound | | 16/45 | 36 | NS |
| Wasted | M | 6/17 | 35 | NS |
| | F | 10/21 | 48 | |
| Depressed | | 8/16 | 50 | NS |
| Barbiturates | | 9/29 | 31 | NS |
| Tranquillizers | | 8/27 | 30 | NS |
| Low mental test scores | M | 16/47 | 34 | NS |
| | F | 32/81 | 40 | |
| Dementia | | 3/12 | 25 | NS |
| Poor dentition† | | 11/23 | 48 | NS |
| Supplementary benefit | | 47/130 | 36 | NS |
| Social classes IV and V | M | 22/56 | 39 | .05 |
| | F | 25/56 | 45 | |
| No regular cooked meals | | 6/7 | 86 | .01 |
| Smokers | | 44/114 | 39 | NS |
| Hyperkeratosis | | 13/35 | 37 | NS |
| All subjects | M | 56/166 | 34 | |
| | F | 61/192 | 32 | |

ϕ Significance of the proportions of low values in respective groups tested against the proportions in the rest in each case.

† Subjects said to have poor dentition were those with no teeth, no dentures or those who had dentures but never used them for eating

# 13. Discussion and summary of findings

## 13.1 Survey sample

13.1.1 The survey sample was drawn from subjects who had participated in the 1967/68 Nutrition Survey of the Elderly (Department of Health and Social Security, 1972) all of whom were at least 70 years of age at the time of this study. Of the original 879 elderly people, 483 were still alive, could be traced, lived in private households and agreed to participate in the 1972/73 survey. 365 of these subjects provided medical, dietary, social, biochemical and haematological information in both this survey and in the 1967/68 survey. An examination of the findings from participants who did not provide information on all these aspects suggested that they did not differ in any important respect from the 365 participants who responded fully. The findings in this report are based on a cross-sectional study of the 365 subjects who participated fully.

## 13.2 Food energy and nutrient intakes of the elderly

13.2.1 The food energy and nutrient intakes of an individual depended on a number of factors including age, anthropometric characteristics and the amount of physical activity undertaken by that individual. Overall, men and women aged 80 years or more had respectively lower mean daily intakes of food energy than men and women under 80 years of age, but this finding may be partly explained by the higher incidence of disease in the older subjects (Table 5.3). For men and women who were classified as "healthy and much better than average" the mean daily energy intakes of subjects aged 80 years or more were not significantly different from those of subjects under 80 years. Subjects classified as "not healthy and much worse than average" had considerably lower mean food energy intakes (statistically significant for men) than subjects classified as "healthy and much better than average" (Table 11.2).

13.2.2 Physical activity is an important factor which influences the food energy requirements of the individual, but this is difficult to measure. Infirm subjects may be generally less mobile and have lower food energy requirements. Housebound subjects had smaller mean intakes than those subjects not confined to their homes (Table 11.8). Those who have a smaller energy intake may have a smaller intake of essential nutrients. Such a situation is more likely to lead to a deficiency state if the quality of the diet is also poor.

13.2.3 Men had higher mean daily food energy intakes than the women (Tables 5.1, 5.2) and this could be partly attributed to differences in their anthropometric characteristics. Men had significantly greater mean values for

height, weight, arm muscle area and lean arm radius than women, whereas women had a significantly greater proportion of body fat than men (Tables 6.7, 6.8). The mean daily food energy intake of clinically obese but otherwise healthy subjects was not significantly different from that of healthy non-obese subjects but the number of subjects involved was small (Table 6.6). The only anthropometric indices significantly correlated with food energy intake were height for both men and women, and lean arm radius and arm muscle area for men. Total muscle mass may to some extent reflect physical activity over a long period of time. Food energy requirements may therefore also correlate with indices such as arm muscle area which are indirect measures of muscle mass. The mass of individual muscles is roughly proportional to muscle area and length and the latter would be dependent on skeletal size. This might explain the relationship of energy intake with height. The areas associated with the lowest mean energy intakes for men and women were Rutherglen and Sunderland respectively, and these areas also had the smallest mean values for both arm muscle area and lean arm radius and the highest incidence of malnutrition.

13.2.4 In men, protein intake (which to some extent is linked to food energy intake) showed a significant correlation with arm circumference, skinfold thickness, Quetelet's index and serum pseudocholinesterase activities. The significance and inter-relationships of the findings and whether similar correlations occur in healthy elderly subjects still require further investigation.

13.2.5 The nutrient density of the diet (nutrient/1000 kcal) was similar for both men and women (para 5.3.3). However, a few nutrients, notably ascorbic acid and vitamin D, showed greater variation and did not always correlate well with total food energy intake. Citrus fruits, potatoes and leafy green vegetables provided most of the ascorbic acid content of the diet. Fortified margarine, fatty fish and eggs were important sources of vitamin D. Milk was an important source of calcium, riboflavin and animal protein (section 5.4).

### 13.3 Malnutrition

13.3.1 Twenty-six (7.1%) of the 365 full participants were considered to be clinically malnourished (8.3% of the men and 6.1% of the women). The incidence of malnutrition in subjects of 80 years or more was twice that in subjects under 80 years of age, thus showing a similar trend with age to that of the incidence of disease in the sample (Table 9.1). Three of the malnourished subjects had scurvy, two had osteomalacia and 13 had nutritional anaemias associated with haematological evidence of iron, folate or vitamin $B_{12}$ deficiency. Several subjects had evidence of multiple nutrient deficiencies. However, these findings cannot be quantitatively extrapolated to the elderly population as a whole, since the sample was not nationally representative.

13.3.2 Although the malnourished subjects formed a heterogeneous group with individual dietary problems, both the malnourished men and women over 80 years of age had mean daily intakes of animal protein, ascorbic acid and

vitamin D which were significantly lower ($P<0.01$) than the expected mean intakes (standardized for area). In addition, men of 80 years and over had a significantly lower mean daily intake of nicotinic acid. Thus, the diets of the malnourished were generally poor in quality (Appendix B, Figures B.1–B.4).

13.3.3 A number of medical and social factors were identified which may have contributed to undernutrition. Medical factors associated with a higher incidence of malnutrition included a history of partial gastrectomy (especially after about 10 years), chronic bronchitis and emphysema, depression, dementia, difficulty in swallowing, poor dentition (edentulous and not using dentures when eating) and being housebound. Medical conditions were either the main or contributory factors in the development of malnutrition in 25 of the 26 malnourished subjects. However, in two of these subjects multiple bereavement was almost certainly the major underlying cause of very poor food intakes (depression was specifically diagnosed in one of these subjects) and in a third subject self-imposed dietary restriction of meat and fish may have been the most important factor. The cause of malnutrition was less clear in one subject in whom in any case the diagnosis was marginal and perhaps questionable. Although he was affected by the death of his sister, his food energy intake appeared to be adequate at the time of the survey.

13.3.4 Social factors associated with undernutrition were living alone (for men only), bereavement, having no regular cooked meals, being in social classes IV and V and being in receipt of supplementary benefit. Information on income and amount of money spent on food was obtained from 22 of the 25 undernourished subjects but was considered to be too unreliable and incomplete to assess with certainty any possible direct association between income and undernutrition (para 4.8). From the evidence available lack of money did not appear to be the sole cause of undernutrition in any of the malnourished subjects except one in whom it may have been a contributory factor. The provision of more money alone to the individual concerned would not necessarily have been the most effective means of improving nutritional status.

13.3.5 In most malnourished subjects a combination of factors, both medical and social, appeared to underlie the development of malnutrition. The greater the number of risk factors affecting an individual, the greater was the probability that the individual would be malnourished (Figures 11.10, 11.11). The complex inter-relationship between some of these "risk" factors and their association with malnutrition is indicated in Figure 13.1. Clearly many of the medical factors are more direct causes than some of the social factors. The quality of the diet to some extent depends on choice and this in turn may depend on a number of factors such as education, mental capacity, family or social class tradition, habit and preference. The amount of money spent on food is obviously not necessarily related to the amount of money available for food and this in turn is only indirectly related to the receipt of supplementary benefit. Subjects in social classes III manual, IV and V are more likely to be in

receipt of supplementary benefit but the relevance of social class information to the elderly when well past retirement age is not easily assessed. It is possible that social class may to some extent reflect education status. Many of these factors have a complex inter-relationship.

13.3.6 A striking feature of this survey was the much higher incidence of malnutrition in Sunderland than in the other 5 areas studied. Partial gastrectomy was not a cause of malnutrition in Sunderland (this operation was performed on a smaller proportion of the elderly subjects in Sunderland than in the remaining areas) but was the most important cause in areas other than Sunderland. If partial gastrectomy were excluded as a cause, then the incidence of malnutrition in Sunderland remained at 14.7% compared with a decrease from 3.3% to 1.2% for the other areas combined (that is 12 times more common in Sunderland than in the other 5 areas). The higher incidence of malnutrition in Sunderland could not be attributed to differences in observer reliability since individual clinical diagnosis, dietary and laboratory evidence all supported this finding.

13.3.7 The incidence of single risk factors such as low mental test score, depression, chronic bronchitis and emphysema, poor dentition, and being housebound was relatively higher in Sunderland (Table 10.3) than in the remaining 5 areas, and the combination of several medical and social risk factors affecting the same individuals occurred much more frequently in Sunderland than in the rest of the sample. A combination of poor health (physical or mental), poor dentition and poor social conditions appeared to explain the higher incidence of undernutrition in Sunderland. This situation might to some extent reflect the services available for the elderly. For instance, Sunderland has the highest ratio in the country (7040 to 1) of patients to general dental practitioners (Annual Report of Dental Estimates Board 1976). Most of the malnourished subjects (or their husbands) in Sunderland were manual workers. Chronic deprivation over many years and a hard life in a northern industrialized conurbation may in some of these subjects have led to some of the medical and social conditions which are conducive to the development of malnutrition in old age.

13.3.8 Despite the large amount of information obtained for each subject, malnutrition was not easily diagnosed. Clinical signs and laboratory findings were, on their own, often unreliable indicators of malnutrition. Clinical signs which may deserve more attention in future surveys are red seborrhoeic naso-labial folds, caviare tongue, sublingual haemorrhages, hyperkeratosis and pigmentation of exposed skin (Table 9.5). These signs occurred more frequently in the malnourished than in non-malnourished subjects and occurred sufficiently infrequently in the non-malnourished to be of possible value in the diagnosis of malnutrition in future surveys. Sublingual micro-varicosities occurred more frequently in the malnourished subjects but, since this sign was also seen in a large number of subjects with no evidence of malnutrition, its value for diagnostic purposes was questionable (that is, the

sign was a poor discriminant). Sublingual micro-varicosities could not be attributed to any particular nutrient deficiency from the evidence available in this study. There was no evidence that sublingual haemorrhages were associated with marginal vitamin C status (para 12.9.1). Although these and other clinical signs were used in the original search for undernutrition, clinical findings were assessed in conjunction with dietary and laboratory evidence before a diagnosis of malnutrition was made. Of the subjects with a red naso-labial fold only those with red and seborrhoeic naso-labial folds showed an association with the malnourished group as opposed to the non-malnourished group. Biochemical and dietary findings suggested that at least in some subjects hyperkeratosis may have been due to vitamin C deficiency. However in most instances it was not possible to attribute particular clinical signs to specific nutrient deficiencies. Some of these signs may be related to disorders other than malnutrition and a statistical association with malnutrition does not necessarily imply a direct causal relationship.

13.3.9 Half of the malnourished subjects had anaemias associated with deficiencies of iron, folate or vitamin $B_{12}$ and only 7 of the 26 malnourished subjects had no haematological evidence of deficiency of these nutrients (para 8.8.2). All 5 malnourished subjects with partial gastrectomies had iron deficiency anaemia and 2 of these subjects also had evidence of vitamin $B_{12}$ deficiency (para 8.8.2) although total energy intakes were not small. Iron deficiency in subjects with partial gastrectomy is presumably often due to poor absorption and a study of the dietary intake of iron may be misleading. An assessment of iron intakes should ideally consider the type of food being consumed. Haem iron is said to be more efficiently absorbed than iron in cereal. Dietary fibre, tannates and ascorbic acid may also influence iron absorption. Thus, the measurement of total iron intake is probably of limited value if some of these other factors are not also taken into account.

13.3.10 Caution is required in the interpretation of some of the biochemical findings, since normal ranges for the elderly are not well established and other factors apart from nutritional status could influence the results. Biochemical findings which could have been associated with particular nutrient deficiencies were considered in conjunction with dietary, clinical and haematological information when assessing the possibility of a diagnosis of malnutrition. The findings confirmed the clinical diagnosis of scurvy. Malnourished men had mean values of leucocyte ascorbic acid and serum albumin which were significantly lower and a mean red cell riboflavin activation coefficient (AC) and serum alkaline phosphatase activity which were significantly higher than those in non-malnourished subjects (Table 12.1). Malnourished women had significantly higher values for red cell riboflavin AC, red cell thiamin AC and serum alkaline phosphatase activities than non-malnourished women (Table 12.1). These findings reflected the poor nutritional status of the malnourished group. At present a detailed consideration of clinical, dietary and laboratory findings is necessary for the reliable diagnosis of malnutrition in the elderly.

## 13.4 The housebound

13.4.1 The housebound were an important and easily identifiable group which was at risk of malnutrition and constituted 12.6% of the full participants. The proportion of housebound subjects increases steeply with increasing age and is much larger in this study of the over 70s than in the general population aged 65 years and over. Subjects were housebound for a variety of medical reasons including disorders of the joints, cardiovascular system, central nervous system, lungs and eyes. The incidence of malnutrition was higher in housebound subjects than in non-housebound subjects and this could be attributed to the lower mean dietary intakes of this group of subjects. Housebound men had significantly lower mean intakes of protein, iron and riboflavin than non-housebound men and housebound women had significantly lower intakes of food energy, iron, riboflavin and ascorbic acid than non-housebound women (Table 11.8). A significantly larger proportion of housebound women had vitamin D intakes below the 10th percentile (Table 11.9).

13.4.2 The smaller nutrient intakes of the housebound were reflected in the biochemical findings. Serum alkaline phosphatase activity was significantly higher in housebound men and women than in non-housebound subjects. These findings suggest that the housebound have a poorer vitamin D status. This needs to be confirmed by a study of the blood concentration of 25-hydroxycholecalciferol which has been done in the survey made in 1973/74. A poor dietary intake of vitamin D and lack of exposure to sunlight are important factors predisposing to vitamin D deficiency in elderly housebound subjects. Laboratory findings which supported the poor nutritional status of the housebound were significantly lower serum total protein and albumin concentrations in the men (Table 12.1) and the significantly larger proportion of low red cell folate concentrations in housebound women than in non-housebound women (para 11.5.4).

13.4.3 The poor dietary intakes of the housebound were associated with the presence of disease, decreased physical activity and perhaps a more limited choice of food. The extent to which nutrient intakes can be improved and the biochemical abnormalities reversed by appropriate supplementary feeding merit further study.

## 13.5 Supplementary benefit and social class

13.5.1 A higher proportion of malnourished than non-malnourished subjects were in receipt of supplementary benefit and also were in the social class combined group III manual, IV and V. An analysis to find the effect of social class and of supplementary benefit on dietary intakes was made for total food energy, dietary intakes of vitamin C and plasma vitamin C concentrations which are known to vary with dietary intakes of vitamin C. Vitamin C intakes were selected as being indicative of a "better-quality diet". In both men and women the receipt of supplementary benefit was not related to total food intake, although both men and women who received supplementary benefit

had smaller mean dietary intakes and smaller mean plasma concentrations of vitamin C than men and women who did not get supplementary benefit. This suggests that a low income, assuming that the receipt of supplementary benefit is indicative of low income, has no effect on the energy value of the diet but may have some influence on the vitamin C content. That is to say the elderly people in this survey who were getting supplementary benefit appeared to be more likely to consume diets of poorer quality, as judged by the vitamin C content, but were no more likely to have inadequate energy intakes than those who did not get supplementary benefit. A diet of poorer quality does not necessarily cost less than a better quality diet of similar energy content.

13.5.2 Comparison of energy intakes, and dietary and plasma vitamin C in the men divided into the two social class groups I, II and III non-manual, and III manual, IV and V showed that there was no difference in mean intakes of total food energy, vitamin C, or in plasma vitamin C concentrations between the two groups. The women, however, in the lower social class group had smaller intakes of food energy and vitamin C, and a smaller concentration of plasma vitamin C. This finding could suggest that educational, cultural and traditional attitudes affect food intake in later life either directly or indirectly. However, reservations must be placed on any finding in respect of social class grading in elderly women since social class was based on the previous occupation of their husbands.

### 13.6 Other studies on special groups

13.6.1 Several groups of subjects with particular characteristics were associated with a higher incidence of malnutrition. The interpretation of dietary and laboratory findings in some special groups was often not possible because of the small numbers of subjects involved. However, the available laboratory and dietary findings suggested that subjects with poor dentition, those receiving no regular cooked meals, the depressed and subjects with chronic bronchitis had a poorer nutritional status than the subjects not affected by these factors.

### 13.7 Laboratory studies

13.7.1 In contrast to the 1967/68 study biochemical analyses on blood samples from the six areas were carried out in one laboratory in the 1972/73 study. Thus a comparison of biochemical, haematological, dietary and clinical findings in the different areas was possible and the relationships between these variables could be determined. Only plasma ascorbic acid showed a significant area variation; the three northern areas had significantly lower mean concentrations than the three southern areas. Riboflavin status also appeared to be poorer in the northern areas than in the southern areas as indicated by higher mean riboflavin activation coefficients.

13.7.2 There was no significant difference between different biochemical variables in the two age groups or between men and women apart from a lower mean serum phosphate concentration and pseudocholinesterase activity in

men. Some findings are of uncertain nutritional significance and indicate the need for further investigation. For instance, a proportion of subjects had riboflavin activation coefficients of more than 1.3[1] but there was no reason to believe that all these subjects were suffering from nutritional deficiency states.

13.7.3 As discussed earlier some special groups of subjects (eg the housebound) gave significantly different values for some biochemical indices when compared with the rest of the sample. Such differences could be partly attributed to differences in the mean dietary intakes of these groups but could also have been due to the effects of stress and disease on metabolism. An examination of the effects of supplementary feeding on some of these "at-risk" groups may help in understanding the inter-relationships of the various factors involved.

13.7.4 In both men and women red-cell riboflavin activation coefficients, red-cell transketolase activation coefficients, and plasma ascorbic acid concentrations were significantly correlated with dietary intake of riboflavin, thiamin and ascorbic acid respectively. In men, serum total protein and albumin concentrations and pseudocholinesterase activity were significantly correlated with protein intake. These correlations do not necessarily imply a causal relationship. The existence of a third factor, such as the stress effects of disease, could lead to alterations in both dietary intake and biochemical values. These relationships could best be assessed in subjects categorized as fit and of above average health. Possibly, only those subjects having a dietary intake below a certain limiting value show a correlation with biochemical values. Such relationships could be better studied in larger groups of healthy subjects. An understanding of these relationships should help to determine nutrient intakes required for health in old age and to evaluate the significance of sub-clinical malnutrition.

13.7.5 In men, serum pseudocholinesterase activity correlated significantly with arm circumference, skin fold thickness (2 and 4 sites), Quetelet's index, protein intake and with serum albumin concentration (Table 7.4) and with a wasted appearance (Table 12.1). The findings suggested that serum pseudo-cholinesterase may be of value in assessing nutritional status. However, to some extent protein intake is linked with food energy intake and the latter was also found to correlate significantly with arm muscle area. Mean serum phosphate concentrations were significantly larger in the wasted compared with the non-wasted subjects (Table 12.1). Interpretation of these findings must remain speculative in the absence of information about renal function.

13.7.6 None of the haematological indices showed significant differences between areas or between different age groups. The higher incidence of anaemia using World Health Organization (1968) criteria in men (16.9%) compared with women (8.8%) merits further study (para 8.2.1). The mean

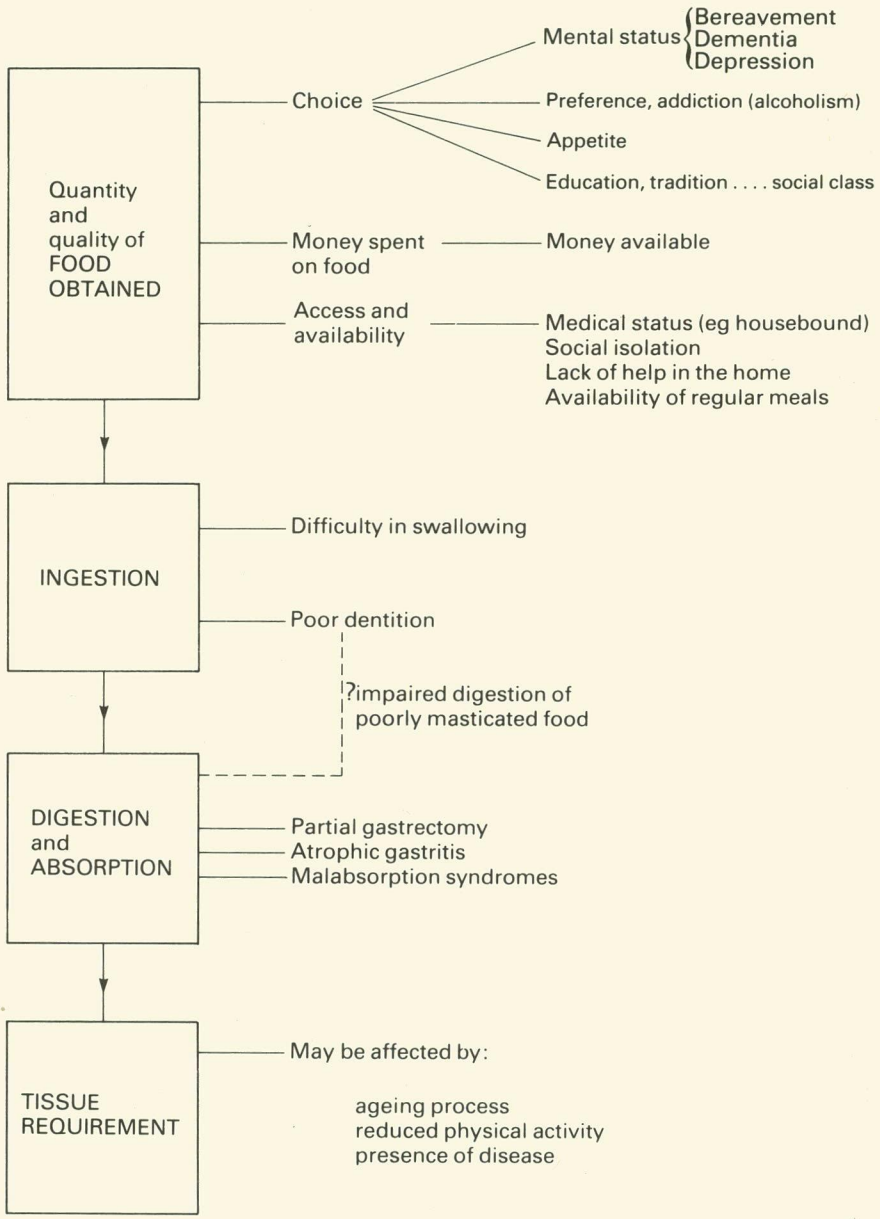
---

[1] See Appendix D, para 6.3

values for serum iron, folate, vitamin $B_{12}$ and pyridoxine concentrations were lower for subjects in this survey than those in the population below 65 years of age and there was a higher proportion of "subnormal" values (para 8.7.2). Men had a higher proportion of low TIBC[1] values than women and this might have been associated with underlying disease. However, women had a higher proportion of high TIBC values than men which presumably reflected iron deficiency in some of the women. The correlation between blood ascorbic acid and folate concentrations (Table 7.4) is of interest and may reflect similar food sources; oranges for instance are a rich souce of both vitamins. Ascorbic acid may have a protective action on the folate in food.

[1] See para 8.3.2

FIGURE 13.1 ***Inter-relationship of the factors which may influence the nutritional status of the elderly.***




**Note:**
Broken lines indicate tentative direct or indirect associations

# 14. Conclusions

14.1 The 365 elderly people who were living in their own homes and who participated in this follow-up survey were not a nationally representative sample and therefore the findings reported here are not applicable to all elderly people, for the following reasons. The original sample, which was studied in 1967/68, was stratified so that there were equal numbers of men and women in the two age groups, 65–74 years, and 75 years and over. The subjects who participated in 1972/73 were those who had lived the full five years since the original study. They may well have had characteristics which accounted for their longevity and so were not typical of all elderly people. The number of subjects in Sunderland was disproportionate in 1972/73 and was greater than in any other area. The survey followed the same pattern as the 1967/68 study and as far as possible the methods used were the same. Socio-economic, dietary, medical, anthropometric, biochemical, haematological and radiological information was obtained for each subject.

14.2 The foods eaten and the dietary pattern of the subjects, all except two of whom were over 70 years of age at the time that they participated in the study, were no different from what is known about the diet of younger people. The total food energy intake was smaller as would be expected of people in whom physical activity was, on the whole, decreasing. In part the reduced food intake may have been due to impaired health because the incidence of disease was greater and the dietary intake smaller in the subjects who were aged 80 years or over compared with those aged under 80 years. Moreover, for subjects who were classified as much better than average in health there was no significant difference in dietary intakes between those above and below the age of 80, whereas subjects who were not healthy and were classified as much worse than average had significantly smaller intakes than those classified as healthy and better than average.

14.3 The incidence of malnutrition was 7% and was twice as large among the subjects aged 80 years or more compared with those who were under 80 years of age. In all except perhaps one subject, malnutrition was associated with non-nutritional disease. Three of the malnourished subjects had scurvy, two had osteomalacia and 13 had nutritional anaemias associated with haematological evidence of iron, folate and vitamin $B_{12}$ deficiency. The figure of 7% is almost certainly an overestimate of malnutrition in elderly people because all of the factors (para 14.1) which made the sample not nationally representative operate in the same direction.

14.4 The diets of the malnourished were generally of poor quality; over the age of 80 the mean daily intakes of animal protein, vitamin C and vitamin D

by the malnourished were significantly smaller than the expected mean intakes standardized for area.

14.5 Malnutrition was associated with both medical and social "risk factors". Among these, certain medical conditions—chronic bronchitis and emphysema, dementia, depression, long-term effects of gastrectomy, difficulty in swallowing, poor dentition—and certain social factors—conditions associated with being housebound, men living alone, having no regular cooked meals, bereavement, being in social classes IV and V and in receipt of supplementary benefit—were associated with a higher incidence of malnutrition. Subjects affected by several risk factors were particularly prone to malnutrition.

14.6 The housebound, who accounted for 12.6% of the survey population over the age of 70, were the most important single group at risk of malnutrition. The higher incidence of malnutrition among the housebound was associated with significantly smaller dietary intakes and abnormalities of biochemical measurements for certain nutrients. In particular, the housebound women had a poorer vitamin D status than the non-housebound subjects which was probably attributable to not taking vitamins and (for vitamin D) to a lack of exposure to sunlight. Since housebound elderly people are a readily identifiable group, they present the best opportunities for proplylaxis of malnutrition.

14.7 Single clinical signs and isolated biochemical findings were considered to be unreliable evidence of malnutrition. The diagnosis required an assessment of all the information available from clinical, dietary, biochemical and haematological studies.

# Appendix A: Subjects who were contacted but either did not participate or did not participate fully in the 1972/73 study

## 1 Introduction

1.1 Chapter 2 of this Report explains the reasons for the adoption of the base populations of 365 "full responders" to both the 1967/68 and 1972/73 surveys as the survey sample. The purpose of this Appendix is to examine the available information on the remaining respondents in order to determine the nature and extent of any bias that the omission of these subjects may have introduced into the study.

1.2 Two groups of subjects were considered: (a) those who refused or were unable to participate in 1972/73 and (b) those who did not participate fully and therefore supplied incomplete information.

## 2 The non-participants in 1972/73

2.1 Fifty-nine subjects (24 men and 35 women) refused to participate in the 1972/73 follow-up survey. Of the 17 respondents who gave reasons for non-participation, 10 were too ill to take part, 2 were about to emigrate and 5 said that it would be too much trouble. In an attempt to assess whether these 59 non-participants were different in any way from the remainder of the sample, information obtained from them in 1967/68 was compared with that obtained from the rest of the sample in 1967/68.

2.2 Thirty-eight of the 59 respondents provided a full response in 1967/68 and 10 subjects provided only medical, biochemical and haematological data. On average the non-participants in 1972/73 were younger in 1967/68 than the rest of the 1967/68 sample. The average age of the men was 71.3 years compared with 74.1 years for the rest of the sample, and of the women 72.7 years compared with 74.4 years, but only the difference for the men was significant ($P < 0.05$).

2.3 From the available 1967/68 information, the clinicians' assessment of health of the 59 subjects showed that 67% were classified as better or much better than average and 73% assessed their own health as "good", compared with 57% and 69% for the rest of the sample. In 1967/68 only 9 of the 59 respondents were known to be widowed, 6 lived alone and none was assessed as housebound. 82% were assessed by the interviewer as fully mobile, competent, alert and independent. The proportion who had been classified as belonging to the manual and non-manual social classes in the RG classification did not differ from that in the 1967/68 sample.

2.4 The 59 non-participants in 1972/73 seemed to have been younger and healthier in 1967/68 than the total 1967/68 sample.

### 3 Subjects who were partial responders in the 1972/73 survey

3.1 Only 365 of the 483 subjects living in private households who participated in the follow-up survey provided a full response in 1967/68 and 1972/73. Table 2.2 shows that the 118 partial responders in 1972/73 provided between them 71 diet records, 41 medical, 196 socio-economic and 34 biochemical and/or haematological records.

3.2 On average the partial responders were significantly older ($P < 0.05$) than those who cooperated fully in the 1972/73 survey. The average age of the men was 79.3 years compared with an average of 77.3 years for those who responded fully; the average age of the women was 79.7 years, compared with 77.6 years.

3.3 The available socio-economic information provided by the partial and the full responders is compared in Table A.1. For women, only minor differences in the marital state and mode of living were apparent. For the men, more of the partial responders were widowed (42% compared with 30%) but a higher proportion lived with relatives other than a spouse (21% compared with 14%). Consequently, the proportion living alone (26%) was similar to that for the full responders (24%).

3.4 There was a higher proportion of men classified as RG social class I, II, III non-manual among the partial responders (37%) compared with 28% for the full responders, and a correspondingly lower proportion of manual workers (social class III manual, IV and V). For women the position was reversed.

3.5 The standard of accommodation of the partial and full responders was not greatly different either for men or women except that, of the very few subjects in poor accommodation, higher proportions were found among those who were partial responders (men 5%, women 8%) compared with 3% of men and of women among the full responders.

3.6 There were no differences in the proportions of either men or women who were classified as "fully alert" and "mentally adequate" between full and partial responders but the partial responders contained a higher proportion of subjects who had some physical disability. This was confirmed by the fact that fewer of the partial responders said that they usually went outdoors, and fewer had hobbies which took them away from home. A smaller proportion of the partial responders were also judged to be independent.

3.7 A smaller proportion of the partial responders (28%) were in receipt of supplementary benefit compared with 37% of those who responded fully.

3.8 A comparison of the incidence of various medical conditions and clinical assessments between the full and partial responders (Table A.2) showed that in general there is a smaller incidence of ischaemic heart disease, peripheral vascular disease, chronic bronchitis and emphysema and osteoarthritis among the subjects who only partially co-operated in the survey but a higher proportion of the partial responders were deaf and a higher proportion of the men were housefast. The clinician's assessments of health and general condition showed that the women partial responders were healthier than the full responders but this was not so for the men.

3.9 A comparison of full responders and partial responders showed that there was little difference in the main daily intakes of energy, of most of the nutrients studied, and of the principal foods containing animal protein (meat, eggs, fish, cheese and milk) in the two groups of subjects. The only significant differences were the mean daily intake of animal protein by men which was greater for the partial responders ($P < 0.005$), and of pyridoxine per 1 000 kcal for women which was also greater among the partial responders ($P < 0.005$).

3.10 When the percentage frequency distributions of the intakes of food energy and animal protein were compared, there was very little difference between the two groups – those who took some part and those who participated fully in the survey.

3.11 The comparison of the information provided by those who did not participate fully in 1972/73 with that from those who formed the base population of responders did not reveal any important differences in the two groups of subjects (para 2.2.5).

**Table A1:** *Comparison of socio-economic factors of those who did not participate in the 1972/73 survey (numbers and percentages of full and partial responders)*

| | Full responders | | | | Partial responders | | | |
|---|---|---|---|---|---|---|---|---|
| | Men (169) | | Women (196) | | Men (43) | | Women (63) | |
| | No. | % | No. | % | No. | % | No. | % |
| Widowed | 50 | 30 | 125 | 64 | 18 | 42 | 37 | 59 |
| Living with relatives (not spouse)[1] | 23 | 14 | 45 | 23 | 9 | 21 | 18 | 29 |
| Living alone[1] | 41 | 24 | 103 | 53 | 11 | 26 | 30 | 48 |
| R.G. social class[2] | | | | | | | | |
| non-manual (i, II, III N M) | 48 | 30 | 73 | 39 | 15 | 37 | 18 | 31 |
| manual (III M, IV, V) | 114 | 70 | 112 | 61 | 25 | 63 | 40 | 69 |
| Poor accommodation | 5 | 3 | 6 | 3 | 2 | 5 | 5 | 8 |
| Mentally 'fully alert' | 131 | 78 | 143 | 73 | 33 | 77 | 44 | 70 |
| Mentally "adequate" | 35 | 21 | 43 | 22 | 8 | 19 | 15 | 24 |
| Subject usually goes out[1] | 149 | 88 | 161 | 82 | 31 | 74 | 46 | 73 |
| Subject has hobby away from home[1] | | | | | | | | |
| (a) high physical activity | 53 | 31 | 15 | 8 | 9 | 21 | 9 | 15 |
| (b) low physical activity | 47 | 28 | 96 | 49 | 10 | 23 | 18 | 29 |
| Independent | 122 | 72 | 136 | 69 | 26 | 60 | 32 | 51 |
| In receipt of supplementary benefit[1] | 47 | 29 | 87 | 46 | 8 | 20 | 22 | 40 |

[1] Excludes not known

[2] Excludes not known and armed forces

**Table A2:** *Comparison of medical diagnoses and assessments of those who did and did not participate fully in the 1972/73 survey (numbers and percentages of full and partial responders)*

| | Full responders | | | | Partial responders | | | |
|---|---|---|---|---|---|---|---|---|
| | Men (169) | | Women (196) | | Men (18) | | Women (23) | |
| | No. | % | No. | % | No. | % | No. | % |
| Ischaemic heart disease | 42 | 25 | 34 | 17 | 4 | 22 | 3 | 13 |
| Peripheral vascular disease | 21 | 12 | 26 | 13 | 1 | 6 | 0 | 0 |
| Chronic bronchitis and emphysema | 40 | 24 | 22 | 11 | 2 | 11 | 0 | 0 |
| Osteoarthritis of hip[1] | 18 | 11 | 45 | 23 | 0 | 0 | 3 | 13 |
| Osteoarthritis of knee | 57 | 34 | 104 | 53 | 0 | 0 | 9 | 39 |
| Kyphosis | 62 | 37 | 105 | 54 | 6 | 33 | 9 | 39 |
| Eyesight inadequate for needs[1] | 23 | 14 | 27 | 14 | 1 | 6 | 1 | 4 |
| Deaf[1] | 76 | 45 | 54 | 28 | 9 | 50 | 8 | 35 |
| Mental test score less than 13[1] | 48 | 29 | 83 | 43 | 5 | 28 | 11 | 50 |
| Housefast | 13 | 8 | 33 | 17 | 4 | 22 | 3 | 13 |
| Clinically assessed as healthy | 102 | 60 | 98 | 50 | 10 | 56 | 17 | 74 |
| General condition clinically assessed as better or much better than average | 120 | 71 | 126 | 64 | 10 | 56 | 18 | 78 |

[1] Excludes not known

# Appendix B: Case histories of the malnourished subjects

Subject 1
A 74-year-old woman who lived alone and worked as a clerk. She was divorced many years previously and was rarely visited. Her medical history included hypertension, a Polya gastrectomy in 1951 and post-gastrectomy osteomalacia in 1963. At the time of the survey she was taking calciferol. Physical examination revealed flat nails and an enlarged heart. She had an iron deficiency anaemia and there was biochemical evidence suggesting riboflavin deficiency. Immunoelectrophoresis of serum proteins showed the presence of IgM myeloma band. Her dietary intake of iron was 9.85 mg/day. Malnutrition was due to partial gastrectomy; myeloma and depression were probably contributory factors.

Subject 2
A 78-year-old man who lived with his wife and was described as alert and fit for his age. He had a partial gastrectomy in 1958 after perforation of a peptic ulcer. Despite an apparently adequate dietary intake for his size he had lost weight during the previous three years. He was emaciated and had cheilosis. Laboratory investigations revealed an iron deficiency anaemia. Malnutrition was secondary to partial gastrectomy.

Subject 3
An 83-year-old widow who lived with her employed son. In the last survey she was described as mentally and physically competent but since then she had been widowed. She had a poor appetite, was wasted and had chronic bronchitis and emphysema, hyperkeratosis, skin pigmentation, moderate dementia and showed signs of peripheral vascular insufficiency. She had an iron deficiency anaemia and the biochemical evidence suggested riboflavin deficiency. Her intake of food energy, iron, B vitamins and ascorbic acid was probably inadequate. Her poor nutritional status was related to the loss of her husband, depression, dementia and chronic bronchitis and emphysema.

Subject 4
A frail 90-year-old woman who was housefast, fairly immobile and tended by her husband and daughter. She was deaf, had poor vision, osteoarthritis of hips and knees, kyphosis, and complained of constant back pain. She also had moderate dementia and mild chronic bronchitis. Biochemical findings suggested a diagnosis of osteomalacia and possibly thiamin deficiency. Her dietary intake of protein and other nutrients was generally low; her diet contained little margarine, egg, cereal or fresh milk. Malnutrition was due to poor food intake; mental and physical infirmity were contributory factors.

Subject 5.
A 71-year-old widow who lived alone but had regular contact with her children and friends. In the previous survey she was living with her son and daughter-in-law. She had a good appetite but appeared wasted and had flat nails. Her medical history included chronic bronchitis and emphysema, ischaemic heart disease (cardiographic evidence), osteoarthritis and mild dementia. Laboratory tests revealed an iron deficiency anaemia and also suggested deficiencies of folate and vitamin $B_{12}$. Her intake of energy and most nutrients was not inadequate. Malnutrition was probably mainly due to chronic bronchitis and emphysema.

Subject 6
An 80-year-old widower (his wife had died 4 years previously) who lived alone. He could not be bothered with meat, vegetables or fruit but his daughter occasionally provided cooked meals. He had chronic bronchitis and moderate dementia, was edentulous and had a red seborrhoeic naso-labial fold. Laboratory investigations suggested deficiencies of vitamins C and $B_{12}$ and incipient iron deficiency. This man had a poorly balanced diet although total food energy intake was probably adequate; vitamin C intake was very low. Malnutrition was due to a combination of factors including dementia, general lack of interest, chronic bronchitis, poor dental status and a lack of regular cooked meals.

Subject 7
A depressed 72-year-old widow who lived alone and could not cope adequately. She was previously living with her son, did all the shopping and cooking and was physically active. Her statements were vague and contradictory. She had recently lost weight and physical examination revealed hyperkeratosis, skin pigmentation, gross sublingual varicosities, cardiomegaly, ischaemic heart disease and mild dementia. She had an iron deficiency anaemia. Her intake was small for energy and all nutrients. Living alone, physical disease, depression, dementia and inability to cope were factors underlying her reduced dietary intake and malnutrition.

Subject 8
An independent 78-year-old widow who lived alone. She had a history of weight loss and vomiting which resolved after dilatation of an oesophageal stricture in 1972. She was frightened to eat despite an improved appetite and her dietary intake remained low. She was pale and wasted and had chronic bronchitis, koilonychia and anaemia. Her dietary intake was low in energy content. Her milk intake had increased threefold. An inadequate food intake due to fear of swallowing and the increased nutrient requirements of chronic bronchitis contributed to malnutrition.

Subject 9
An 81-year-old housefast man who was cared for by his wife. His medical history included mild dementia, emphysema with pulmonary hypertension,

and a mild stroke 15 months previously. Physical examination revealed wasting, cyanosis, gross sublingual varicosities, koilonychia and hyperkeratosis. Laboratory investigations revealed vitamin $B_{12}$ deficiency and suggested vitamin C and possibly riboflavin deficiency. Despite an adequate food energy intake he had a relatively low protein intake and a low intake of vitamins A and C. Malnutrition was largely due to a poorly balanced diet and the presence of long-standing chronic bronchitis and emphysema.

Subject 10
A 73-year-old registered disabled widow who had been bedfast for many years with rheumatoid arthritis. She lived with her married daughter and family. She complained of nausea and vomiting following acidic or fatty meals, was pale, wasted, edentulous and had sublingual haemorrhages, skin pigmentation, a sacral bed sore and moderate dementia. She had a severe iron deficiency anaemia which was rather worse than in the previous survey. Her food intake was low and her diet was of a poor quality. Her poor nutritional state was associated with severe rheumatoid arthritis and a poor food intake due to nausea, vomiting and difficulty in swallowing.

Subject 11
A wasted, frail, deaf, housebound 91-year-old man who suffered from moderate dementia, chronic bronchitis, ischaemic heart disease, congestive cardiac failure and urinary incontinence (? carcinoma of prostate). He had kyphosis, back pain on movement, pigmented skin and gross sublingual varicosities. Although he lived with his sister and niece he received little attention at home and was, soon after the survey, transferred to a local authority home where he subsequently died. He was slightly anaemic and had evidence of vitamin $B_{12}$, ascorbic acid and iron deficiency. A raised alkaline phosphatase during both surveys and absence of Paget's disease suggested the possibility of osteomalacia; electrophoretic studies indicated that the enzyme was derived from bone. Dentures were not used for eating and he complained of difficulty in swallowing. Consequently he could not manage fruit and meat unless these were finely shredded. His food intake was low in both surveys and his intake of protein, iron, calcium and vitamins A and C were inadequate. Chronic bronchitis with heart failure, mental and physical infirmity and lack of dentures all contributed to malnutrition. Additional care and a more nutritious diet might have improved his nutritional status and lessened morbidity.

Subject 12
A 73-year-old widower who lived alone and was partly dependent on his daughter who visited. He consumed a large amount of alcohol and was physically limited by dyspnoea and osteoarthritis. In the previous survey he was fully mobile and able to cook for himself. He had chronic bronchitis, emphysema, evidence of pulmonary hypertension, varicose veins and peripheral vascular insufficiency. He had become deaf in the right ear and nearly blind in the right eye. Gross sublingual varicosities, hyperkeratosis and

skin pigmentation were present. Despite being edentulous his dietary intake seemed adequate and was increased compared with 1967/68. A clinical diagnosis of scurvy was made before laboratory results became available. There was biochemical evidence of ascorbic acid deficiency. Long-standing severe chronic bronchitis and emphysema may have led to increased energy and nutrient requirements and, despite an apparently adequate diet, malnutrition. Excessive consumption of alcohol may have also contributed.

Subject 13
An edentulous blind and deaf 80-year-old woman who relied on her husband and a grand-daughter who visited daily. She suffered from chronic bronchitis and emphysema (dyspnoeic at rest) and had a poor appetite, bone pains, kyphosis, sublingual haemorrhages, and hyperkeratosis (clinically she was thought to have myxoedema). Laboratory studies revealed a macrocytic anaemia and evidence of folate, and possibly vitamin C and riboflavin deficiency. Her dietary intake of protein, iron and vitamins A and C was low and she ate little meat, fruit or vegetables. She preferred to eat cakes and pies and did not want meals-on-wheels (her husband had meals-on-wheels twice a week). They said that they could not afford meat and the grand-daughter occasionally brought meals. Chronic bronchitis, poor dentition and limited income probably all contributed to undernutrition.

Subject 14
A 75-year-old man who lived with his wife. In 1967 and until the death of a sister he walked 10–20 miles a day but he did not maintain this activity. He suffered from indigestion and was very thin. Sublingual haemorrhages and flat nails were present. Biochemical investigation suggested marginal folate, riboflavin and ascorbic acid deficiency. His dietary intake appeared to be adequate apart from little ascorbic acid. Depression following the death of his sister may have been a factor leading to reduced activity but the cause of his marginal degree of undernutrition was not established.

Subject 15
An active 76-year-old married man who drank heavily. His home conditions were relatively unchanged except that his wife had still not recovered from the death of a daughter and he therefore always went out alone. He had moderately severe dementia, clubbing of the fingers, skin pigmentation, hyperkeratosis and a few sublingual haemorrhages. There was laboratory evidence of riboflavin and ascorbic acid deficiency. His dietary intake, particularly of vitamins A and C, was small. His malnutrition was due to inadequate food intake associated with alcoholism and dementia.

Subject 16
A 79-year-old married man who did not go out much because of osteoarthritis in his hips and knees. The general conditions of his home life had apparently not changed since the previous survey, but he had become less mobile. He had a prostatectomy in 1961. Medical examination revealed sublingual

haemorrhages, varicose veins, chronic bronchitis and emphysema, ankle oedema, mild hypertensive heart disease and peripheral vascular insufficiency. He was slightly anaemic but despite an apparently low intake of iron there was no laboratory evidence of iron deficiency. However, biochemical investigations suggested deficiencies of vitamin $B_{12}$ and ascorbic acid. His dietary intake was limited for the 2 years prior to the survey and included little meat and no fish. The limited diet appeared to be of his own devising because he "did not want to get fat" but physical illness may have contributed to malnutrition.

Subject 17

A frail wasted 88-year-old woman who lived alone, was barely able to cope and had lost two stone in weight since the death of a daughter and two sons-in-law in a car crash a year previously. Another daughter was badly injured and unable to work. This old lady was the only survivor of her six brothers, three sisters and two husbands. Although housefast, she was able to cook but had little inclination to do so. Her past medical history included a nephrectomy for renal calculus in 1966, diverticulosis of the colon and ischiorectal abscess in 1971. She had chronic bronchitis, emphysema, congestive cardiac failure, ischaemic heart disease, mild dementia and physical signs included pigmentation of exposed skin and sublingual haemorrhages. Laboratory tests demonstrated a macrocytic anaemia due to folate deficiency. Her food intake was inadequate in all respects. She had mild protein-calorie malnutrition as well as folate deficiency due to inadequate food intake. Bereavement, inability to cope and chronic bronchitis and emphysema all played a role in the development of malnutrition in this subject.

Subject 18

An 87-year-old widow who lived with her son and daughter-in-law and had been bedridden for over 10 years due to a right-sided hemiplegia. She appeared wasted, frail, had a red seborrhoeic naso-labial fold and flat nails and her gums showed signs of scurvy. Despite indigestion and some difficulty in swallowing, probably due to hiatus hernia, she had a good appetite. Biochemical investigations demonstrated deficiencies of ascorbic acid, riboflavin and folate. Her food energy intake had changed little since the previous surveys but her intake of vitamin C was smaller. Her diet was devoid of fresh fruit and low in its content of potato. Malnutrition was a consequence of her poorly balanced diet and accentuated by the presence of physical illness.

Subject 19

A depressed 77-year-old widow who lived alone and had a variable appetite. Although fairly active she had little interest in preparing cooked meals but would have liked meals-on-wheels if available. Her daughter and husband died about one year before the previous survey, and this was reflected in an extremely low food intake during that period (food energy intake 319 kcal/day) and in an anxiety-depression state. She was losing weight and had decreased skinfold thickness at the time of the present survey (1967/68, triceps

12mm, subscapular 10mm; 1972/73, triceps 4mm, subscapular 6mm). She also had hypertension and mild dementia. Biochemical investigations suggested thiamin deficiency. Her intake of food energy and all nutrients was low. A case could be made for protein-calorie malnutrition on clinical grounds, and possibly subclinical thiamin deficiency on biochemical grounds. Malnutrition was probably a consequence of depression which may have been initiated by bereavements six years earlier.

Subject 20

An 86-year-old deaf widower who lived alone but was tended by his children and helpers. He was mostly housefast, had no regular cooked meals, drank and smoked heavily and did not want to spend money on food. In the previous survey, although living alone and deaf, he was co-operative and pleasant. His mental state was then normal but he already had incipient cardiac failure. He was now confused, probably had dementia and looked wasted and ill. In addition he had mild congestive cardiac failure, chronic bronchitis, emphysema, and coarse crepitations at the base of the right lung (bronchogenic carcinoma was suspected). Physical signs included sublingual haemorrhages, a red seborrhoeic naso-labial fold, hyperkeratosis and skin pigmentation. He had a macrocytic anaemia, a low serum albumin concentration and biochemical evidence of vitamin $B_{12}$ and folate deficiency. His dietary itake was small. His malnutrition was partly due to his refusal to spend money on food but dementia, chronic bronchitis, emphysema and alcoholism were contributory factors.

Subject 21

A 78-year-old widower who preferred to live alone but had difficulty in coping. His wife died 3 years before the survey and he was still "shocked" by this event. He had a partial gastrectomy in 1948, was clinically undernourished in the previous survey and now suffered from indigestion, vomiting and some difficulty in swallowing. He looked pale and thin and had clubbing of the fingers, sublingual haemorrhages and peripheral vascular insufficiency. Laboratory tests demonstrated an iron deficiency anaemia and suggested vitamin $B_{12}$ deficiency. His dietary intake was small—1299 kcal per day. Malnutrition was probably due to his previous gastrectomy and accentuated by depression following the loss of his wife.

Subject 22

A blind, frail, bedfast man of 86 years who had had a left hemiparesis which left residual difficulty with speech. He required constant care which was provided by his daughter. He had constant back pain, dry mouth, skin pigmentation and hyperkeratosis. He was slightly anaemic and had biochemical evidence of folate, ascorbic acid and riboflavin deficiency. Although his food intake appeared adequate, he was edentulous and his food had to be cut into shreds before he could eat it. Inefficient mastication, and therefore digestion of food may have contributed to his nutritional state.

Subject 23
An 86-year-old widower who lived alone but was visited by neighbours and friends. He lived in one of the few occupied dwellings in a street due for redevelopment, his cooking facilities were inadequate and he had no regular cooked meals. His medical history included gall bladder disease, a gastrectomy in 1960, chronic bronchitis and mild congestive cardiac failure. He was wasted, had gross sublingual varicosities, skin pigmentation and his gums showed signs of scurvy. He also had an iron deficiency anaemia. There had been little change in his diet and social conditions although in the previous survey he was described as being in good health. Malnutrition was mainly due to gastrectomy and chronic bronchitis but inadequate facilities and inability to cope were contributory factors.

Subject 24
A lonely 85-year-old widow, who was prone to dizzy spells and rarely ventured out of her home. She had a variable appetite, was losing weight and suffered nausea, vomiting and flatulence. She had a mastectomy in 1960 and at the time of the survey she was receiving digoxin. Clinical investigations revealed a wasted appearance, cardiomegaly, sinus rhythm, osteoporosis, osteoarthritis, inflammatory changes at the base of the right lung, flat nails, redundant skin folds and hyperkeratosis. Laboratory evidence suggested thiamin deficiency. Her dietary intakes of energy, protein, iron and vitamins were probably inadequate. Her gastro-intestinal symptoms and loss of appetite were probably associated with digoxin therapy and congestive cardiac failure, and malnutrition could be similarly attributed.

Subject 25
An 80-year-old widower who lived alone, did not have regular cooked meals and refused a good local meals-on-wheels service. He was thought to have protein-calorie malnutrition in the previous survey and had since then lost 22 lbs in weight and showed a reduction in skin fold thickness. He had a variable appetite, depression, ischaemic heart disease, vertebro-basilar insufficiency and had suffered a minor stroke. Physical signs included flat nails, a red naso-labial fold and pigmented skin. He had a "low normal" haemoglobin, macrocytosis and biochemical evidence suggesting folate, riboflavin and marginal vitamin $B_{12}$ deficiencies. His intake of food energy and all nutrients was low—porridge and tinned soup formed a large part of his diet. Clinically he had protein-calorie malnutrition in addition to the other nutrient deficiencies. He was known to have had a "liking" for alcohol during the previous survey, following the death of his wife, but there was no record to support alcoholism in this survey. To some extent malnutrition was self-induced but bereavement, lack of domesticity, depression and dementia were contributory factors.

Subject 26
A 76-year-old man who looked after his chairbound wife. A partial gastrectomy performed in 1963 for a duodenal ulcer was followed by a

subtotal gastrectomy in 1970. He was subject to falls, had indigestion and a poor appetite. He looked wasted, had gross sublingual varicosities and osteoarthritis in the knees. Laboratory investigations demonstrated an iron deficiency anaemia and subclinical deficiencies of riboflavin and ascorbic acid. His food intake, which included iron and ascorbic acid supplements, appeared to be adequate. He drank a moderate amount of alcohol in both surveys. His social conditions had not changed but he had a subtotal gastrectomy between the two surveys. Malnutrition was due mainly to subtotal gastrectomy.

**Table B1:** *The elderly malnourished: summary of findings*

| Subject No. | Sex | Age (yrs) | Area | Clinical indicators of undernutrition: Partial gastrectomy | Wasted appearance | Cheilosis | Sublingual varicosities: Micro | Sublingual varicosities: Gross | Sublingual haemorrhages | Scurvy diagnosed from clinical findings | Naso-labial fold: Red | Naso-labial fold: Red and seborrhoeic | Pigmented exposed skin | Hyperkeratosis | Flat nails | Koilonychia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | F | 74 | 2 | + | | | | | | | | | | | + | |
| 2 | M | 78 | 2 | + | + | + | | | | | | | | | | |
| 3 | F | 83 | 3 | | + | | + | | | | | | + | + | | |
| 4 | F | 90 | 3 | | | | + | | | | | | | | | |
| 5 | F | 71 | 3 | | + | | + | | | | | | | | + | |
| 6 | M | 80 | 3 | | | | + | | | | | + | | | | |
| 7 | F | 72 | 3 | | + | | + | + | | | | | + | + | | |
| 8 | F | 78 | 3 | | + | | + | | | | | | | | | + |
| 9 | M | 81 | 3 | | + | | | + | | | | | + | + | + | + |
| 10 | F | 73 | 3 | | + | | + | | + | | | | + | | | |
| 11 | M | 91 | 3 | | + | | | + | | | | | + | | | |
| 12 | M | 73 | 3 | | | | | + + | | + | | | + | + | | |
| 13 | F | 80 | 3 | | | | + | | + | | | | | + | | |
| 14 | M | 75 | 3 | | | | + | | + | | | | | | + | |
| 15 | M | 76 | 3 | | | | | | + | | | | + | + | | |
| 16 | M | 79 | 3 | | | | + | | + | | | | | | | |
| 17 | F | 88 | 3 | | + | | + | | + | | | | + | | | |
| 18 | F | 87 | 3 | | + | | + | | | + | | + | | | + | |
| 19 | F | 77 | 3 | | | | + | | | | | | | | | |
| 20 | M | 86 | 3 | | + | | + | | + | | | + | + | + | | |
| 21 | M | 78 | 4 | + | + | | + | | + | | | | | | | |
| 22 | M | 86 | 4 | | | | + | | | | | | + | + | | |
| 23 | M | 86 | 4 | + | + | | + | + | | + | | | + | | | |
| 24 | F | 85 | 5 | | | | | | | | | | | + | + | |
| 25 | M | 80 | 5 | | | | | | | | + | | + | | + | |
| 26 | M | 76 | 6 | + | + | | + | + | | | | | | | | |

**Table B2:** *The elderly malnourished — Summary of dietary findings*

| Subject No. | Dietary intake: Energy value (MJ) | Energy value (kcal/day) | Animal protein (g/day) | Total protein (g/day) | Fat (g/day) | Carbohydrate (g/day) | Calcium (mg/day) | Iron (mg/day) | Added sugar (g/day) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | (5.95) | 1 423 | 44.4 | 59.7 | 66.6 | 144.2 | 734.6 | 9.85 | 42.3 |
| 2 | (7.38) | 1 763 | 47.9 | 62.1 | 70.2 | 233.8 | 475.1 | 10.55 | 116.7 |
| 3 | (5.79) | 1 385 | 30.3 | 42.3 | 83.5 | 123.8 | 515.0 | 6.24 | 31.1 |
| 4 | (4.86) | 1 161 | 26.5 | 36.4 | 39.4 | 154.6 | 400.4 | 5.74 | 67.6 |
| 5 | (8.77) | 2 095 | 33.7 | 61.8 | 120.8 | 202.0 | 600.8 | 10.65 | 13.2 |
| 6 | (6.71) | 1 604 | 29.3 | 48.4 | 69.5 | 208.4 | 590.4 | 8.03 | 64.4 |
| 7 | (5.50) | 1 315 | 26.5 | 41.8 | 57.7 | 167.9 | 782.8 | 5.55 | 39.6 |
| 8 | (5.47) | 1 307 | 33.0 | 47.1 | 59.6 | 151.9 | 790.3 | 7.07 | 40.8 |
| 9 | (8.41) | 2 010 | 22.7 | 47.8 | 98.5 | 247.8 | 630.0 | 9.64 | 32.6 |
| 10 | (6.15) | 1 469 | 24.4 | 37.5 | 57.4 | 213.7 | 446.9 | 7.26 | 94.1 |
| 11 | (5.76) | 1 377 | 29.4 | 43.6 | 57.0 | 183.1 | 509.2 | 6.69 | 66.7 |
| 12 | (13.42) | 3 207 | 48.2 | 85.6 | 82.9 | 291.2 | 788.6 | 11.74 | 81.5 |
| 13 | (6.71) | 1 604 | 22.0 | 37.5 | 75.7 | 206.2 | 790.4 | 5.09 | 50.8 |
| 14 | (9.13) | 2 182 | 43.3 | 65.8 | 102.7 | 232.5 | 658.0 | 9.89 | 69.3 |
| 15 | (7.79) | 1 861 | 32.0 | 55.4 | 78.8 | 218.2 | 660.2 | 8.10 | 47.4 |
| 16 | (5.96) | 1 424 | 40.8 | 51.8 | 66.6 | 165.0 | 919.2 | 6.59 | 61.7 |
| 17 | (3.51) | 840 | 22.4 | 27.7 | 33.1 | 109.9 | 521.5 | 2.86 | 55.9 |
| 18 | (6.02) | 1 440 | 30.0 | 44.9 | 82.8 | 137.1 | 387.2 | 9.83 | 24.0 |
| 19 | (3.60) | 860 | 20.7 | 27.2 | 42.7 | 97.2 | 272.0 | 4.89 | 39.3 |
| 20 | (4.69) | 1 120 | 8.7 | 17.7 | 28.6 | 196.9 | 292.4 | 2.79 | 122.0 |
| 21 | (5.44) | 1 299 | 43.3 | 56.0 | 52.8 | 158.2 | 545.8 | 6.35 | 49.7 |
| 22 | (7.39) | 1 767 | 48.0 | 61.7 | 78.5 | 214.3 | 931.6 | 10.63 | 81.2 |
| 23 | (9.08) | 2 170 | 47.1 | 88.2 | 84.3 | 279.8 | 1 030.0 | 13.29 | 43.4 |
| 24 | (5.56) | 1 328 | 31.6 | 42.5 | 69.0 | 142.0 | 548.5 | 4.77 | 48.9 |
| 25 | (4.92) | 1 176 | 19.5 | 36.0 | 55.0 | 139.4 | 593.4 | 3.92 | 37.9 |
| 26 | (8.53) | 2 038 | 21.1 | 42.4 | 51.9 | 191.1 | 362.3 | 10.09 | 59.9 |

| Vitamins | | | | | | | Meat (total) (oz/day) | Liquid whole milk (total) (oz/day) |
|---|---|---|---|---|---|---|---|---|
| A (μg/day) | B1 (mg/day) | B2 (mg/day) | Nicotinic acid (mg/day) | C (mg/day) | D (μg/day) | B6 (mg/day) | | |
| 461 | 0.717 | 1.483 | 11.42 | 37.3 | 0.59 | 0.976 | 3.08 | 14.42 |
| 1 071 | 0.697 | 1.087 | 10.66 | 50.9 | 1.81 | 1.445 | 3.87 | 6.93 |
| 604 | 0.545 | 0.602 | 6.71 | 7.9 | 0.44 | 0.522 | 3.08 | 4.76 |
| 503 | 0.314 | 0.843 | 9.71 | 12.4 | 0.77 | 0.940 | 1.84 | 7.19 |
| 937 | 0.918 | 0.937 | 11.57 | 16.6 | 5.56 | 1.075 | 4.36 | 6.30 |
| 745 | 0.701 | 0.866 | 8.02 | 8.7 | 1.29 | 0.764 | 2.85 | 8.13 |
| 392 | 0.435 | 0.875 | 8.70 | 12.1 | 0.39 | 0.477 | 1.64 | 10.29 |
| 713 | 0.590 | 1.002 | 6.46 | 16.6 | 0.87 | 0.763 | 1.24 | 13.51 |
| 457 | 0.695 | 0.631 | 9.18 | 18.5 | 0.85 | 0.783 | 2.18 | 4.39 |
| 409 | 0.549 | 0.631 | 7.63 | 235.6 | 0.33 | 0.679 | 2.28 | 6.69 |
| 457 | 0.503 | 0.712 | 7.94 | 17.3 | 0.77 | 0.734 | 2.27 | 7.03 |
| 800 | 1.018 | 3.078 | 45.93 | 41.7 | 1.18 | 2.506 | 4.48 | 2.64 |
| 412 | 0.473 | 0.893 | 5.14 | 6.4 | 0.64 | 0.376 | 0.77 | 13.48 |
| 402 | 0.765 | 1.415 | 16.86 | 21.2 | 2.19 | 1.236 | 3.96 | 10.47 |
| 420 | 0.746 | 1.034 | 12.03 | 16.5 | 0.81 | 0.987 | 2.59 | 7.70 |
| 895 | 0.625 | 1.220 | 5.32 | 46.1 | 2.14 | 0.724 | 0.86 | 14.23 |
| 452 | 0.280 | 0.772 | 3.66 | 8.8 | 0.63 | 0.459 | 0.94 | 12.06 |
| 1 957 | 0.678 | 1.051 | 10.61 | 11.0 | 1.32 | 0.818 | 3.49 | 4.38 |
| 275 | 0.311 | 0.542 | 4.31 | 14.3 | 1.19 | 0.493 | 1.56 | 4.34 |
| 250 | 0.263 | 0.444 | 3.44 | 20.0 | 1.41 | 0.263 | 0.33 | 5.94 |
| 419 | 0.756 | 0.874 | 10.57 | 15.5 | 0.70 | 0.845 | 1.93 | 9.64 |
| 2 291 | 0.919 | 1.722 | 10.11 | 21.2 | 1.58 | 1.008 | 2.89 | 21.53 |
| 977 | 1.268 | 1.427 | 11.39 | 27.3 | 1.35 | 1.117 | 0.83 | 19.04 |
| 561 | 0.633 | 0.784 | 7.00 | 12.2 | 0.70 | 0.684 | 2.94 | 8.85 |
| 476 | 0.565 | 0.680 | 4.01 | 7.8 | 1.58 | 0.341 | 1.04 | 9.17 |
| 245 | 0.516 | 1.420 | 23.14 | 29.1 | 0.02 | 2.454 | 2.00 | 2.00 |

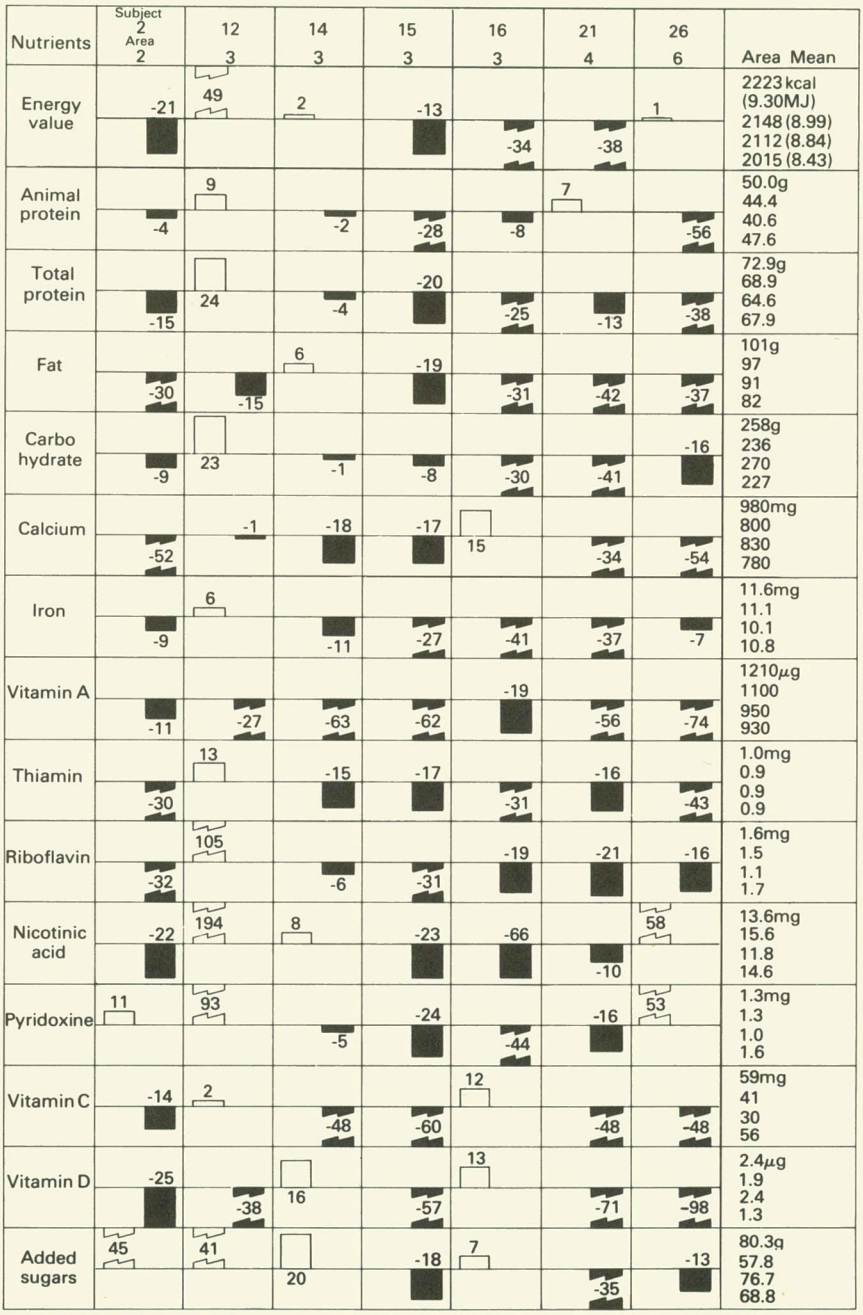
**Table B3:** *The elderly malnourished—summary of biochemical findings*

| Subject No. | Serum proteins (g/100ml) Total | Albumin | Serum alk phosphatase (KA units) | Serum calcium (adjusted) (mg/100ml) | Serum phosphorus (mg/100ml) | Serum pseudocho-linesterase mmol/l/min) | Ascorbic acid Leuco. ($\mu g/10^8$ cells) | Plasma (mg/100ml) | RBC transketolase % TPP stim. | RBC B2 % GR stim. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.77 | 4.61 | 9.9 | 8.69 | 3.46 | 6.20 | | 0.46 | 0 | 57 |
| 2 | 7.35 | 4.09 | 7.2 | 9.96 | 4.23 | 3.01 | | 1.60 | 20 | 47 |
| 3 | 7.99 | 4.68 | 9.4 | 8.77 | 4.11 | 4.49 | 17.0 | 0.25 | 13 | 53 |
| 4 | 7.20 | 4.19 | 19.5 | 9.09 | 2.18 | 6.42 | 25.5 | 0.36 | 35 | 27 |
| 5 | 7.27 | 4.69 | 6.8 | 9.04 | 3.05 | 10.59 | 34.5 | 0.16 | 2 | 87 |
| 6 | 6.65 | 3.95 | 8.2 | 9.60 | 2.81 | 4.48 | 12.5 | 0.12 | 20 | 36 |
| 7 | 6.40 | 3.88 | 9.5 | 9.90 | 3.26 | 4.26 | 20.5 | 0.17 | 20 | 33 |
| 8 | 6.83 | 4.06 | 11.1 | 9.55 | 4.08 | 2.63 | 16.5 | 0.26 | 9 | 33 |
| 9 | 6.55 | 4.36 | 12.0 | 8.47 | 3.09 | 4.17 | 12.0 | 0.12 | 22 | 48 |
| 10 | 7.77 | 3.43 | 19.1 | 9.46 | 3.13 | 2.68 | 36.5 | 0.96 | 6 | 21 |
| 11 | 7.41 | 3.76 | 48.3 | 9.69 | 2.64 | 3.10 | 7.0 | 0.16 | 4 | 33 |
| 12 | 7.46 | 4.22 | 4.6 | 9.93 | 2.69 | 2.52 | 3.5 | 0.09 | 2 | 29 |
| 13 | 7.80 | 3.65 | 12.9 | 9.55 | 3.04 | 3.51 | 10.0 | 0.21 | 11 | 71 |
| 14 | 7.08 | 3.49 | 6.4 | 9.50 | 3.32 | 3.89 | 14.0 | 0.20 | 15 | 78 |
| 15 | 8.09 | 4.09 | 6.4 | 9.72 | 2.96 | 6.39 | 9.5 | 0.08 | 10 | 77 |
| 16 | 8.08 | 5.33 | 9.6 | 8.99 | 3.52 | 3.92 | 12.0 | 0.34 | 15 | 13 |
| 17 | 6.80 | 4.29 | 12.0 | 9.50 | 2.22 | 3.77 | 36.0 | 0.23 | 3 | 1 |
| 18 | 6.60 | 4.04 | 7.6 | 9.28 | 3.15 | 7.36 | 5.0 | 0.10 | 11 | 78 |
| 19 | 6.76 | 4.16 | 7.5 | 10.02 | 3.82 | 4.36 | 34.0 | 1.06 | 60 | 39 |
| 20 | 5.90 | 3.21 | 12.2 | 10.04 | 2.62 | 2.47 | 15.5 | 0.58 | 24 | 63 |
| 21 | 7.43 | 4.11 | 8.5 | 9.54 | 3.69 | 2.90 | | 0.25 | 14 | 6 |
| 22 | 6.50 | 3.40 | 9.9 | 10.29 | 2.12 | 3.34 | | 0.12 | 28 | 88 |
| 23 | 6.95 | 3.97 | 7.9 | 9.11 | 3.12 | 3.84 | | | | |
| 24 | 7.88 | 4.24 | 6.9 | 10.15 | 3.05 | 5.03 | | 0.80 | 44 | 37 |
| 25 | 7.05 | 4.06 | 12.2 | 9.48 | 2.44 | 4.45 | | 0.26 | 10 | 87 |
| 26 | 7.78 | 4.01 | 8.6 | 9.29 | 3.19 | 1.81 | 10.1 | 0.29 | 8 | 42 |

**Table B4:** *The elderly malnourished—summary of haematological findings*

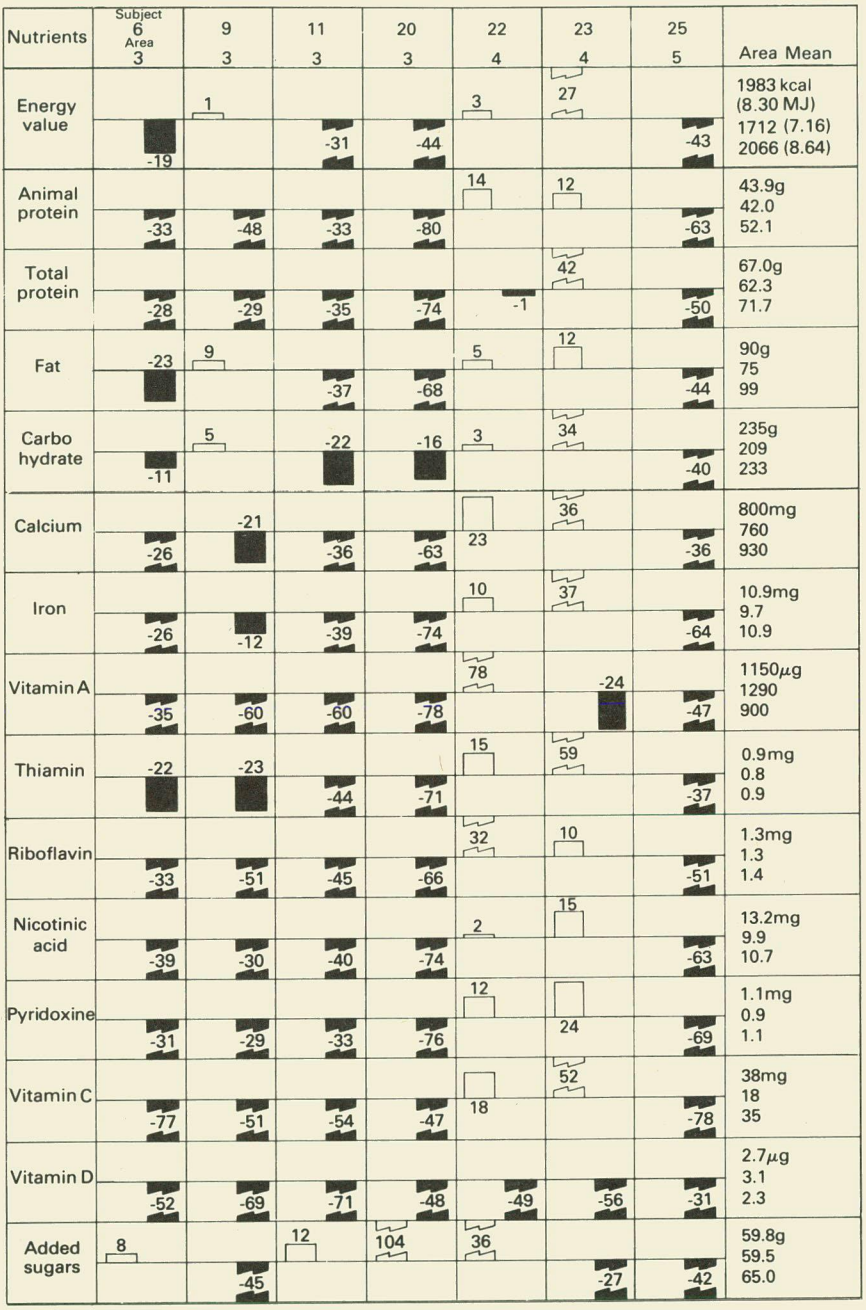
| Subject No. | Haemo-globin (g/dl) | MCV (fl) | Serum iron (μg/100ml) | TIBC (μg/100ml) | TF saturation (%) | Serum folate (ng/ml) | RBC folate (ng/ml) | Serum B12 (pg/ml) | Serum B6 (ng/ml) | RBC B6 (ng/ml) |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 9.6 | 65 | 43 | 614 | 7 | 8.8 | 448 | 194 | 6.2 | 41.5 |
| 2 | 10.4 | 80 | 29 | 504 | 6 | 4.9 | 177 | 163 | 6.4 | 21.5 |
| 3 | 10.4 | 83 | 44 | 531 | 8 | 3.9 | | 300 | 3.5 | 17.9 |
| 4 | 14.7 | 91 | | | | 5.5 | 201 | 294 | | |
| 5 | 10.2 | 76 | 15 | 491 | 3 | 3.4 | 135 | 86 | 2.0 | 27.3 |
| 6 | 15.0 | 91 | 74 | 420 | 17 | 5.8 | 158 | 109 | 5.5 | 19.9 |
| 7 | 11.5 | 81 | 32 | 462 | 7 | 11.6 | 218 | 302 | 3.5 | 19.5 |
| 8 | 10.9 | 95 | 58 | 359 | 16 | 11.3 | 273 | 372 | 3.4 | 19.8 |
| 9 | 16.1 | 108 | 103 | 336 | 31 | 7.7 | 181 | 126 | 4.2 | 29.9 |
| 10 | 6.3 | 70 | 15 | 607 | 3 | 4.4 | 171 | 210 | 3.4 | 21.6 |
| 11 | 11.9 | 96 | 60 | 380 | 16 | 7.2 | 270 | 124 | 3.9 | 18.5 |
| 12 | 16.6 | 88 | 116 | 274 | 42 | 7.0 | 246 | 312 | | |
| 13 | 10.5 | 120 | 66 | 342 | 19 | 1.0 | 57 | 252 | 3.0 | 11.5 |
| 14 | 14.1 | 96 | 123 | 322 | 38 | 1.5 | | 292 | 2.8 | 12.8 |
| 15 | 14.8 | 89 | 68 | 270 | 25 | 4.2 | 237 | 526 | 4.0 | 16.1 |
| 16 | 12.7 | | 101 | 305 | 33 | 9.1 | 164 | 88 | | |
| 17 | 11.5 | 116 | 58 | 357 | 16 | 3.0 | 106 | 382 | 3.4 | 26.7 |
| 18 | 12.4 | 95 | 101 | 321 | 32 | 6.7 | 129 | 240 | 3.9 | 16.9 |
| 19 | 12.5 | 88 | 124 | 321 | 38 | 8.4 | 264 | 212 | 10.0 | 23.6 |
| 20 | 9.2 | 99 | 53 | 234 | 23 | 2.4 | 76 | 120 | 1.7 | 9.8 |
| 21 | 11.6 | 79 | 26 | 539 | 5 | 4.2 | 132 | 104 | 4.6 | 23.8 |
| 22 | 12.8 | 96 | 119 | 295 | 40 | 1.3 | 85 | 272 | 3.4 | 17.0 |
| 23 | 10.1 | 77 | 28 | 459 | 6 | 11.4 | 191 | 275 | 4.4 | |
| 24 | 13.9 | 93 | 92 | 329 | 28 | 7.8 | 467 | 235 | 4.5 | 11.5 |
| 25 | 13.3 | 100 | 130 | 247 | 53 | 2.0 | 26 | 174 | 3.1 | 14.2 |
| 26 | 9.6 | 79 | 17 | 531 | 3 | 17.1 | 647 | 382 | 19.7 | 72.7 |

FIGURE B1 ***Daily intake of energy and nutrients of the individual malnourished men under 80 years of age compared with the mean of subjects of the same age group, sex and area.***



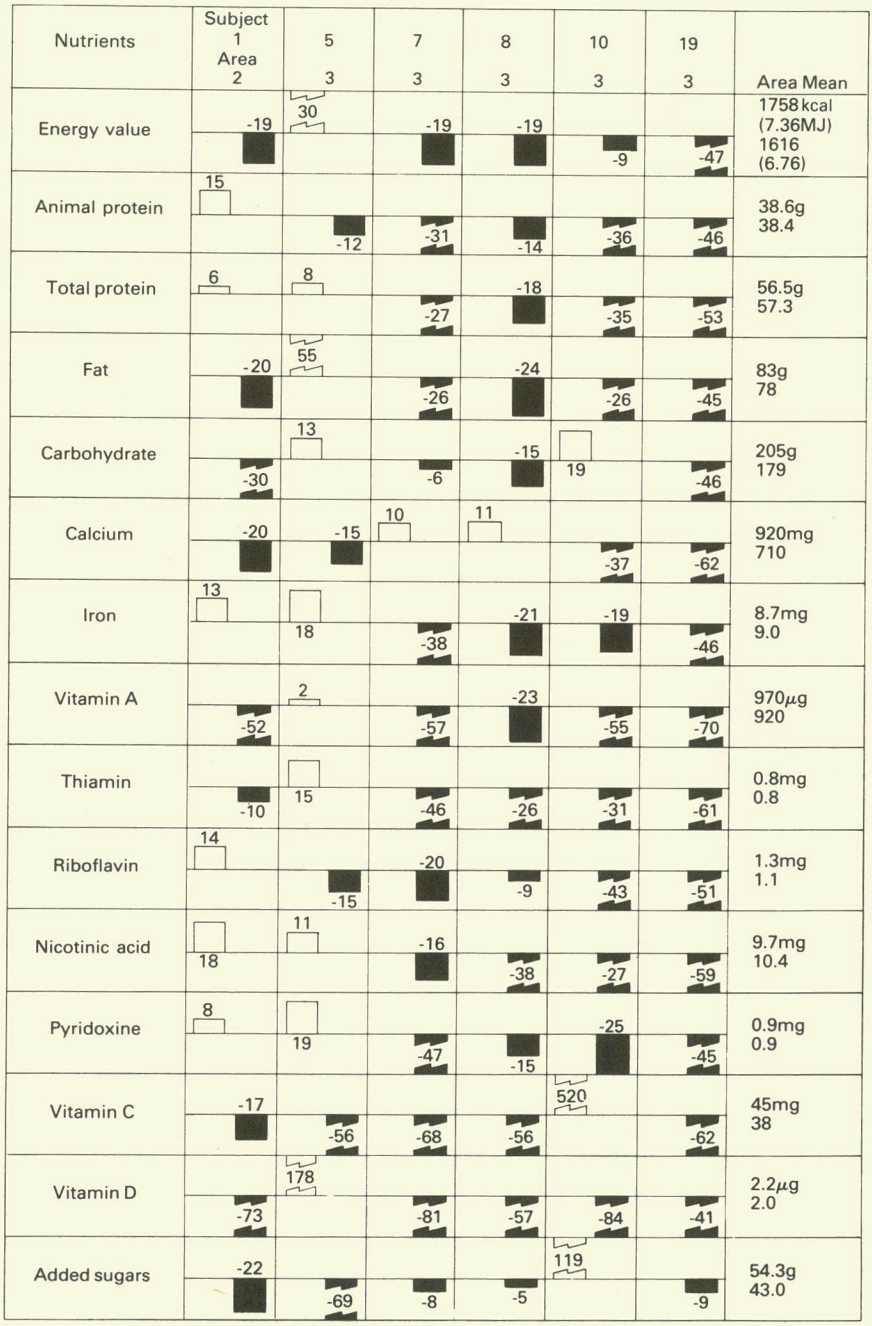

means shown for Areas 2,3,4 and 6

FIGURE B2 ***Daily intake of energy and nutrients of the individual malnourished men of 80 years or over compared with the mean of subjects of the same age group, sex and area.***



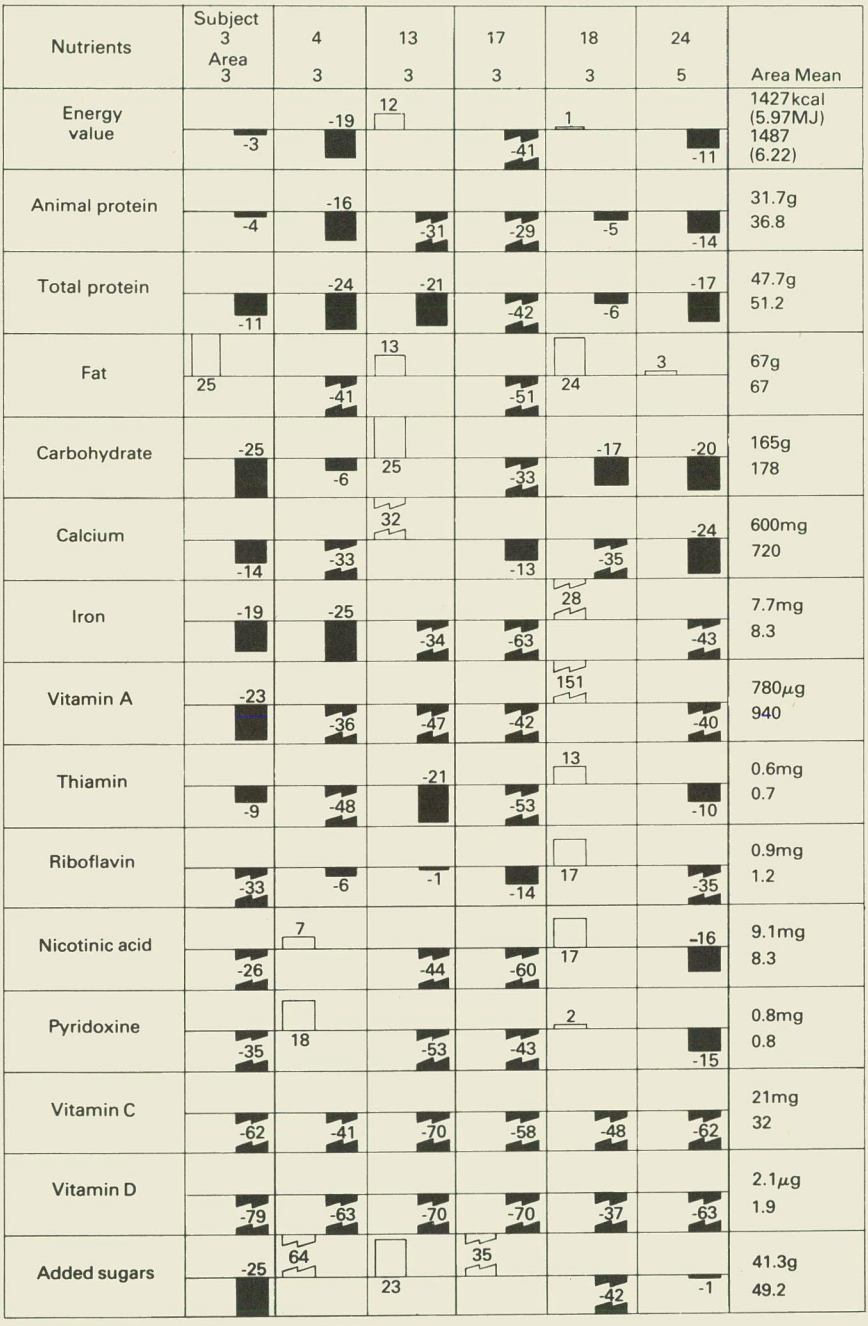

means shown for Areas 3 4 and 5

FIGURE B3 ***Daily intake of energy and nutrients of the individual malnourished women under 80 years of age compared with the mean of subjects of the same age group, sex and area.***




means shown for Areas 2 and 3

FIGURE B4 ***Daily intake of energy and nutrients of the individual malnourished women of 80 years or over compared with the mean of subjects of the same age group, sex and area.***




means shown for Areas 3 and 5

# Appendix C: Indices derived from anthropometry

2 site skinfold thickness (mm) = sum of triceps and subscapular measurements.

4 site skinfold thickness (mm) = sum of biceps, triceps, subscapular and suprailiac measurements.

$$\text{Quetelets index}^{(a)} = \frac{\text{Weight (kg)}}{[\text{Height (m)}]^2}$$

*Percentage body fat 2 sites*[2]

$$\text{for men} = \frac{[35.685 \times \log_{10}(\text{2 site skinfold thickness (mm)})] - 23.715}{1.1527 - [0.0793 \times \log_{10}(\text{2 site skinfold thickness (mm)})]}$$

$$\text{for women} = \frac{[33.39 \times \log_{10}(\text{2 site skinfold thickness (mm)})] - 15.615}{1.1347 - [0.0742 \times \log_{10}(\text{2 site skinfold thickness (mm)})]}$$

*Percentage body fat 4 sites*[b]

$$\text{for men} = \frac{[35.055 \times \log_{10}(\text{4 site skinfold thickness (mm)})] - 32.175}{1.1715 - [0.0779 \times \log_{10}(\text{4 site skinfold thickness (mm)})]}$$

$$\text{for women} = \frac{[29.025 \times \log_{10}(\text{4 site skinfold thickness (mm)})] - 15.255}{1.1339 - [0.0645 \times \log_{10}(\text{4 site skinfold thickness (mm)})]}$$

$$\textit{Arm muscle area } (\text{cm}^2) = \frac{[\text{Arm Circumference (mm)} - \pi \times \text{Triceps (mm)}]^2}{400\pi}$$

$$\textit{Lean arm radius (mm)} = \frac{[\text{Arm Circumference (mm)}]}{2\pi} - [\text{Triceps (mm)} \times 0.6]$$

[a] Kemsley, Billewicz and Thomson, 1962
[b] Durnin and Wormesley, 1974

# Appendix D: Biochemical methods

## 1. Handling of samples

1.1 In Portsmouth, Cambridge, Rutherglen and Angus, 30 ml of blood were taken from the subject during the clinical examination in the morning. In Sunderland and Camden an extra 6 ml of blood were taken for the measurement of leucocyte ascorbic acid (LAA). The blood was divided as follows:

| | | |
|---|---|---|
| 20 ml blood allowed to clot while protected from light, centrifuged and the serum divided into: | 3 ml . . | Sample 1 |
| | 7 ml . . | Sample 2 |
| 3 ml blood into EDTA tube | . . | Sample 3 |
| 6 ml blood into heparin tube | . . | Sample 4 |
| The extra 6 ml blood for LAA into heparin tubes | . . | Sample 5 |
| Samples were wrapped in black plastic bags to exclude light | | |

1.2 Samples were despatched overnight by British Rail in insulated boxes each containing two vacuum jars to the Human Nutrition Studies Group at the London School of Hygiene and Tropical Medicine. Serum samples with dry ice were packed in one jar while samples of whole blood were maintained at 4°C in the second jar under the influence of the dry ice from the first jar.

1.3 The following morning samples 1 and 4 were removed, and samples 2 and 3 re-packed in their respective Thermos jars and sent on by messenger to the Department of Haematology, St. Bartholomew's Hospital.

1.4 Blood for leucocyte ascorbic acid estimations (Sample 5) was delivered within 3 hours either to Sunderland Royal Infirmary Central Laboratory or (from Camden) to the Human Nutrition Studies Group laboratory.

1.5 Samples 1 and 4 were then treated as follows:

Sample 1. The 3 ml serum were used for the following measurements with a Technicon AutoAnalyzer:

total protein
albumin
alkaline phosphatase

pseudocholinesterase
calcium
inorganic phosphate

Sample 4. 6 ml of heparinized blood were centrifuged and the plasma removed for measurement of plasma ascorbic acid.

The red cells were used for the measurement of:
erythrocyte glutathione reductase (EGR)
transketolase (TKL)

All reagents were obtained from British Drug Houses unless otherwise stated.

1.6 As far as possible all measurements on the samples received in any one week were completed within the week. The quality of the autoanalyser measurements was monitored by comparison with samples from the National Quality Control Scheme. The results, on the basis of a variance index, placed the Human Nutrition Studies Group laboratory in the 5% of participating laboratories with the smallest deviations from the computed mean results. The variance index is a measure of the deviation of the results of an individual laboratory from the means of the results from all 400 participating laboratories.

## 2. Automated methods for estimations on sample 1

2.1 *General.* A Technicon AA1 AutoAnalyzer System (Basingstoke, Hants) was used for the automated analyses. The only major modification to the standard system was a reversal of the phasing of the micro-switch in the sampler module so that sampling took place with the programme trip switch in the down position. This was done to reduce sample sizes and also to produce a relatively long wash period (Coward, Sawyer and Whitehead, 1971). To ensure precision with this modification the sample cams were filed where necessary so that all slots were of identical length and 0.5 ml paediatric cups were filled to a constant volume. In all assays a sample rate of 20/hr was used with a wash sampling ratio of 6:1.

2.2 *Serum albumin and total protein concentrations.* Albumin and total protein were assayed on a combined manifold* based on the method of Coward et al. (1971). Albumin was estimated with the dye bromcresol green (Doumas, Watson and Biggs, 1971) and total protein by biuret (BDH working reagent). Working standards (20–80 g/l) were prepared from human albumin solution (Kabi Pharmaceuticals Ltd.) by dilution with 1% (w/v) sodium azide solution and stored at —20°C.

2.3 *Serum alkaline phosphatase activity.* The automated method of Axelsson, Ekman and Knutsson (1965) was used but with narrower sample,

*Details are available from the Department of Human Nutrition, London School of Hygiene and Tropical Medicine, London WC1E 7HT.

substrate and air (2) pump-tubes (internal diameters 0.030, 0.65, 0.065 and 0.073 respectively) to reduce sample size. Commercially prepared reagents were used (BDH) and the automated method was calibrated with Seronorm quality control serum measured manually by the Kind-King method against phenol standards (Wootton, 1964). Manual calibration was necessary since tygon tubing may adsorb phenol in the automated method (Price and Woodman, 1971) and adversely affect the calibration with internal standards. It has also been reported that alkaline phosphatase activity increases after thawing (Moss, Baron, Walker and Wilkinson, 1971); therefore all sera were thawed the day before use and stood overnight at room temperature.

2.4 *Serum cholinesterase (pseudocholinesterase) activity.* Serum cholinesterase was determined by the method of Levine, Scheidt and Nelson (1965) in serum diluted 4.5 times on the autoanalyser with 0.9% (w/v) sodium chloride solution. Quinidine sulphate, an inhibitor of cholinesterase activity, was used to measure the non-enzymatic hydrolysis on a large number of samples. The contribution was negligible however, and background hydrolysis was not routinely measured. Enzyme activity was expressed as mmol SH groups liberated per litre serum per minute.

2.5 *Serum calcium and inorganic phosphate concentrations.*
2.5.1 These measurements were done by Method N-26a I (Technicon method sheets) without modification except that commercially prepared reagents were used (BDH).

2.5.2 High albumin levels increase the proportion of plasma calcium bound to the protein fraction, and vice versa, but the more physiologically important ionised calcium fraction varies very little. "Adjusted calcium values" were therefore calculated using the following formula based on that proposed by Berry, Gupta, Turner and Burns (1973):

adjusted calcium = observed Ca(mg/100 ml)–0.91 (albumin (mg/100 ml)–4.3)

2.5.3 The function of the adjustment is to remove the effect of high or low serum albumin values on serum calcium levels which may be physiologically unrepresentative of the ionised calcium fraction in the serum. The only modification to the formula was the use of the figure 4.3 i.e. the mean serum albumin concentration obtained by the laboratory for the subjects in this survey. This figure was considered more appropriate and relevant to these results than the value of 4.6 used by Berry *et al.* (1973) which they obtained from 1000 blood donors.

**3. Heparinized blood (samples 4 and 5)**
3.1 *Preparation of plasma.* Heparinized blood (sample 4) was centrifuged 15 min at 1700 x g (MSE, Super Medium) and the plasma removed. Any plasma remaining after the aliquots had been taken for measurement of plasma ascorbic acid (below) was kept frozen at —20°C.

3.2 *Preparation of red cells.* Red cells (2–4 ml) remaining after the plasma had been removed were washed twice in 30 ml of 0.9% (w/v) NaCl solution to remove leucocytes and platelets. Washed erythrocytes (0.5 ml) were added to 9.5 ml distilled water and the haemolysate allowed to stand 1 to 16 hours at 4°C before centrifuging at 2000 x g (MSE, Mistral 4L) at 4°C to precipitate the stroma. Clear haemolysate was stored at —20°C until the time of the riboflavin measurement (para 6).

3.3 A further 1.0 ml of washed red cells was mixed with 2.0 ml 0.9% NaCl solution and the packed cell volume adjusted to between 30–35. Samples were dispensed the same day for the transketolase assay (para 7) and the remainder stored at —20°C.

**4. Estimation of plasma ascorbic acid**

4.1 Trichloracetic acid (2 ml 5% w/v) was added to 2 x 0.5 ml aliquots of each plasma sample, mixed, allowed to stand for 10 min and centrifuged for 10 min at 1700 x g. The trichloracetic acid extract was stored at 4°C and used for the analysis of ascorbic acid on the following day by a scaled down version of the macro method described in the Manual for Nutrition Surveys (ICNND, 1963): a method originally based on that of Roe and Kuether (1943).

4.2 From the duplicate acid extracts, single 0.5 ml aliquots were mixed with 0.26 ml of a working reagent comprising 0.1M-2:4 dinitrophenylhydrazine, 0.029M-thiourea and 1.09mM-cupric sulphate in 4.5M-$H_2SO_4$. Tubes were incubated at 60°C for 1 hour together with reagent blanks and ascorbic acid standards of 5.7 and 11.4$\mu$M. A stock solution of 5.7mM-ascorbic acid in 5% (w/v) metaphosphoric acid and 10% (v/v) acetic acid was prepared freshly and diluted with 5% trichloracetic acid to provide working standards.

4.3 After the incubation, tubes were cooled in an ice/water mixture, and 0.65 ml 65% (v/v) $H_2SO_4$ added with mixing before replacing in the cold. Finally absorbance was measured at 520 nm at room temperature against water as reference and the ascorbic acid concentration in the plasma calculated in relation to the standards.

4.4 Storage of whole blood at 4°C for 24 hours may affect the plasma ascorbic acid results. However when a series of 10 different samples of blood kept overnight in a refrigerator was tested the result was found not to differ by more than 10% from that obtained the previous day.

**5. Estimation of leucocyte ascorbic acid**

5.1 Leucocyte ascorbic acid was estimated in sample 5 by a modification of the method of Denson and Bowers (1961).

5.2 Duplicate 3.0 ml samples of freshly collected heparinized blood were mixed with 12.5 ml of a solution of 2.0mM-$K_2$EDTA in 0.147M-NaCl and containing 20% by volume Dextraven 150 (Fisons Pharmaceuticals). After

standing at room temperature for 45–60 min the supernatant suspension of leucocytes and platelets was taken off. 10 ml were centrifuged (1700 x g, MSE Super Medium) for 15 min and white cells in aliquots of the remaining solution were counted in a Coulter Counter. Trichloracetic acid (1.5 ml, 5% w/v) was added to the white cell pellet with mixing and, after standing for 10 min and further mixing, the solution was centrifuged at 1700 x g for 15 min. The trichloracetic acid extract was stored overnight at 4°C and ascorbic acid assayed as described above for plasma.

**6. Assessment of riboflavin status (glutathione reductase assay)**

6.1 The procedure for the measurement of riboflavin status was based on the method of Glatzle, Korner, Christeller and Wiss (1970). In this method the degree of saturation of erythrocyte glutathione reductase (EC 1.6.4.2) with flavin adenine dinucleotide (FAD) is assessed by measuring enzyme activity by the rate reaction technique with and without FAD and calculating the activation coefficient (AC):

$$\text{EGR-AC} = \frac{\text{change in optical density at 334 nm over 10 min with FAD}}{\text{change in optical density at 334 nm over 10 min without FAD}}$$

6.2 *Method.* Enzyme activity in the haemolysate (0.1 ml in duplicate) was measured in a mixture of 0.092M-potassium phosphate buffer (pH 7.4), 0.91 mM-oxidised glutathione (Boehringer), 2.3mM-$K_2$EDTA with or without 8 μM-FAD. The reaction was initiated by 80 μM-reduced nicotinamide adenine dinucleotide phosphate (NADPH) in a total volume of 3.6 ml and the change in optical density was followed at 334 nm and at 35°C. All reagents were freshly prepared except the buffer-EDTA reagent; approximately a month's supply of this was prepared and stored at 4°C.

6.3 The analyses were done semi-automatically, i.e. with automatic diluters, dispensers etc. whenever possible, but precision was not good. The intra-batch coefficient of variation was 14% at the time of the survey and is still running at only 4% even after 6 years' experience. Therefore the AC ratio of 1.30, which was used as a guide to indicate the upper limit of the normal range, should be interpreted with caution.

**7. Assessment of thiamin status (transketolase assay)**

7.1 The procedure for measuring thiamin status is based on the method of Schouten, Statius Van Eps and Struyker-Boudier (1964). Transketolase (EC 2.2.1.1) activity is measured in an end-point reaction with and without thiamin pyrophosphate (TPP). Sedoheptulose, a reaction product, is measured colorimetrically and the data used to calculate the activation coefficient (TKL-AC).

$$\text{TKL-AC} = \frac{\text{Sedoheptulose produced (with TPP)} - \text{Sedoheptulose produced (no TPP)}}{\text{Sedoheptulose produced (no TPP)}}$$

7.2 *Method.* Freshly washed red cells (0.2 ml in duplicate) and standards were mixed with 0.2 ml buffer-electrolyte solution (4.81mM–NaCl, 124.1mM–KCl, 1.21mM–$MgSO_4$ and 15.63mM–$K_2HPO_4$ brought to pH 7.4 with HCl) in 4 ml disposable plastic tubes as outlined in the table below. Each batch of tubes was stored 4 days at –20°C before assay.

| | *Sample Blank* | *Sample Test* | *Sample TPP* | *Standard Blank* | *Standards*† |
|---|---|---|---|---|---|
| Buffer-electrolyte (ml) | 0.2 | 0.2 | 0.2* | 0.2 | 0.2 |
| Red cell suspension (ml) | 0.2 | 0.2 | 0.2 | — | — |
| Standards (ml) | — | — | — | — | 0.2 |
| Water (ml) | — | — | — | 0.2 | — |

* Buffer-electrolyte containing 2.2mM–thiamin pyrophosphate.

† Standards used were 1,2 and 4mM–sedoheptulose solutions.

7.3 *Enzyme assay.* All tubes were incubated at 37°C for 30 min. Trichloracetic acid (0.4 ml, 15% w/v) was then added to the blanks and 0.4 ml 0.018M–$Na_2$–ribose–5–phosphate to all tubes which were incubated for a further 30 min at 37°C. The reaction was stopped by addition of TCA to samples and standards in the same order as addition of ribose. All samples were then centrifuged at 1700 x g (MSE, Super Medium).

7.4 *Colorimetric analysis.* 0.15 ml aliquots of the supernatant and 5.0 ml sulphuric acid (70% v/v) were dispensed with a diluter-dispenser (Fisons LFA 20) and mixed thoroughly. The tubes were heated in a waterbath at 80°C for 15 min, cooled and 0.3 ml 3% (w/v) cysteine added. The tubes were again mixed thoroughly and the colour allowed to develop overnight.

7.5 All solutions were read at 510 and 540 nm and the difference (Δ) between these two readings was used to calculate the TKL-AC (para 7.1) or the enzyme activities in International Units as below. Transketolase activity I.U.* =

$$\frac{\Delta \text{ sample} - \Delta \text{ blank}}{\Delta \text{ standard} - \Delta \text{ blank}} \times \frac{\text{concn. standard}}{30} \times \frac{35}{\text{haematocrit}} \times 1000$$

(*μmol sedoheptulose produced per litre blood corrected to a haematocrit of 35)

7.6 *Precision and interpretation of results.* The precision of this assay in the measurement of the AC was particularly bad: in one early experiment the intra-batch coefficient of variation was 38%. Reasons for the unreliability are probably due to the fact that four measurements are required for a single measurement of status, coupled with the fact that the final solution on which measurements are made is strongly acid and very viscous.

7.7 The reliability of the results of this assay was improved by always considering both the unstimulated transketolase activity and the AC before

reporting the results. The normal unstimulated activity of transketolase is 40-80 I.U. and is usually associated with an AC of ‹ 1.25. When poor duplicates or inconsistencies between enzyme activity and the AC ratio occurred the assay was repeated.

# Appendix E: Special study: Biochemical reference ranges in healthy elderly people

## by D I Thurnham and J M L Stephen

1. The biochemical results obtained in this survey were used primarily to monitor nutritional status in association with clinical and dietary information. Additionally, however, it was hoped to analyse the data to establish reference ranges for healthy elderly people for use in this laboratory.

2. Table E1 shows the reference ranges used for the different biochemical measurements during the survey. They were selected somewhat arbitrarily from a variety of sources, some of which are shown in the legend, but in general the ranges are similar to those in clinical use. The ranges recorded for all subjects in the survey are also shown.

3. The geriatrician was asked at the time of the clinical examination to describe the subject as healthy or not healthy (para 6.2.1). The purpose of this question was to provide an assessment of health status uninfluenced by knowledge of the biochemistry. A second classification was made when the clinician assessed the subject's general condition as much better, better, worse or much worse than that which he would expect for a subject of that age. This assessment was called on the medical form "much better, better, worse or much worse than average" but the "average" was in fact a standard which varied from one subject to another according to their age and general condition in the light of their medical diagnoses.

4. The differences between the biochemical means obtained for the healthy and not-healthy groups have already been described (para 12.2.1); only two biochemical variables showed significant differences (Table 12.1, p. 154). A further analysis was made in which the clinician's assessment as much better, better, worse or much worse than expected was used in conjunction with the healthy : not healthy classification. Table E2 shows how the subjects were divided by the two classifications. The biochemical results of the 194 healthy subjects whose condition was described as better and much better than expected were compared with those of the 113 unhealthy subjects whose condition was worse or much worse.

5. This comparison eliminated from the analysis 6 subjects who were classified as healthy but worse than might be expected for their age and general condition, and 52 subjects classified as not healthy although they were better than expected. These 58 may represent an intermediate category. When they were excluded from the analysis more significant differences showed up

between the two groups of remaining subjects, i.e. those who were healthy and better than expected and those who were not healthy and worse, than in the previous comparison of healthy and not healthy. Significant differences between the means were found for total protein, albumin, alkaline phosphatase and inorganic phosphate (Table E3). The difference between the mean EGR-AC values did not quite reach a 5% significance. (In the discussion which follows the "healthy and better than expected" group are referred to simply as "healthy".)

6. The ranges for the healthy group were calculated from the means; they were in most cases narrower than those for all subjects, as might be expected, although the differences were small. In addition, for almost all the biochemical indices studied the ranges for the healthy group corresponded closely to those used during the survey as reference ranges.

7. The greatest differences found between the ranges for the healthy group and those for all persons occurred for pseudocholinesterase in women and for alkaline phosphatase for both men and women, although as for other indices, the ranges for the healthy were very similar to those used for reference during the survey. This similarity suggests that the clinical conditions associated with these two indices were more easily recognized by the geriatricians as indicative of ill health. For example, the not-healthy group contained most of those classed as housebound. There is an increased risk of vitamin D deficiency for the housebound which could account for the all-persons range having a higher limit for alkaline phosphatase than that of the healthy group or the range used during the survey (para 12.4.1). Pseudocholinesterase may also prove to be a more useful measure of health as assessed clinically than the other indices of protein-energy malnutrition (para 7.4.1). Table 7.4 shows the correlations of anthropometric indices with pseudocholinesterase and similar findings were also noted in the 1967–68 survey (Department of Health and Social Security, 1972).

8. One range of measurements in the healthy which did show a difference from the range used in the survey was the range for phosphate in men. The difference between the sexes was pronounced and the results suggest that the reference range for healthy elderly men should be reduced. Provisionally this might be 2.0–4.0 mg/100 ml (0.645–1.29 mmol/l), and similarly for women a range of 2.5–4.5 mg/100 ml (0.81–1.45 mmol/l) may be more specific than one with an upper limit of 4.8 mg/100 ml (1.55 mmol/l) as used during the survey.

9. It is possible that the limits of the reference ranges for total protein and albumin should be adjusted slightly to ranges similar to those obtained for the healthy subjects. These two nutritional indices however have been widely used for many years and the ranges are well established. It is felt that there is not yet sufficient justification for changing these ranges on the evidence of results from one survey only. It is possible that these results might be slightly biased

although this is considered unlikely in view of the close agreement between this laboratory's results and those of other hospitals (Appendix D, para 2.2). The possibility of adjustment however will be borne in mind in the analysis of results from later surveys.

10. The range of TKL-ACs obtained for all subjects was close to the usually accepted reference range. This is probably because thiamin is added to flour in the UK and therefore intake and thiamin status are generally good.

11. The range of values obtained from the results for riboflavin extended well beyond the accepted "normal" limits. It is possible that vitamin deficiencies associated with failing health in the elderly might account for this. EGR-AC for riboflavin was the only measurement of vitamin status to show some difference between the healthy and not-healthy groups (Table E3). However, incidence of clinical signs usually associated with riboflavin deficiency was not high, which suggests that the high activation coefficients were not due to severe dietary deficiencies.

12. Nevertheless, it seemed advisable to examine the range of AC values obtained in a group who had higher than average intakes of riboflavin, thiamin and vitamin C and in whom the possibility of dietary deficiencies was therefore less likely. Such a group was that eating fortified breakfast cereals (FBCE). The ranges of values for the vitamin status of these subjects are shown in Table E4 and compared with those for all subjects in the survey. The upper limit of the range of plasma ascorbic acid concentration has been extended in the FBCE and the upper limit of the range for EGR-AC has been reduced from 1.63 to 1.43 and that for TKL-AC from 1.33 to 1.28. This is to be expected if the vitamin status of these subjects is superior to that of the whole sample population.

13. The usual upper limit for the "normal" range of ACs in the EGR assay (mean ±2SD) is 1.20 (Glatzle *et al.*, 1970) or 1.30 (Tillotson and Baker, 1972), although others have reported an upper limit as high as 1.76 in a group of laboratory workers (Bayoumi and Rosalki, 1976). On the same basis the upper limit in this survey for all subjects was 1.63 although there was some evidence that ill health may be exerting a bias on this figure (Table E3). The upper limit for the healthy group is 1.52 (Table E3) and that of the FBCE is 1.43. The latter figures are therefore intermediate values but in fact both may be rather high as a reference for healthy elderly subjects since not all the FBCE belonged to the "healthy" group.

14. Men eating breakfast cereals had a mean daily intake of 1.64 mg riboflavin and women FBCE 1.50 mg compared with 1.45 and 1.10 mg for men and women who did not eat breakfast cereals ($P < 0.05$ for men, $< 0.01$ for women). It is possible that the higher riboflavin intake of the FBCE was closer to the physiological requirements of the elderly and may give a more representative range for healthy elderly people. It is proposed therefore to

adopt the figure of 1.40 as the upper limit of the EGR-AC reference range and to examine its usefulness more thoroughly when the results from the larger sample surveyed in 1973–74 are analysed.

15. The lower limits of the ranges found for the two indices of ascorbic acid status (Table E1) are below the usually accepted limits of normality, but this may be a consequence of the age of these subjects. Milne et al. (1971) found that leucocyte ascorbic acid values tended to fall with age in elderly women but not in men. In addition, the mean value for LAA in the women in their sample (aged 62–94) was significantly higher than the mean for men. The findings in the present survey showed similar tendencies, though not great enough to be significant (Table 8.2). However, since the ranges obtained for the healthy and all subjects (Table E1) and the FBCE (Table E4) were almost identical, it seems reasonable to suggest that the lower limit of these ranges (that is, 0.1 mg/100 ml or 5.7 μmol/l) may be a suitable cut-off point with which to identify healthy elderly people.

**Conclusions**

16. It was hoped with the data available from the survey to establish reference ranges for biochemical indices of nutritional status for healthy elderly people. As has already been noted (para 6), the ranges of most of the biochemical indices obtained for healthy subjects, selected according to the clinicians' assessment of health, showed only small differences from those of all subjects and were closer to the reference ranges used during the survey. This would suggest one of two possibilities: that most of these indices do not reflect or are relatively insensitive to the clinical features used by the geriatricians to assess health, or alternatively, that one cannot expect a marked change in these biochemical measurements associated with morbidity. The former possibility means that the ranges for the healthy group bear no relation to health. However, the fact that some significant biochemical differences were found between the healthy and not-healthy groups (Table E3) suggests that the second possibility may be more likely. If health is associated with the biochemical indices then the reference ranges derived from the healthy group might be truly representative of healthy old people. Since there is no difference in practice between most of the ranges for the healthy and the ranges already in use, it seems more sensible to use the latter with the modifications suggested in the preceding paragraphs. The final ranges arrived at are therefore set out in Table E5; their value in contributing to the diagnosis of malnutrition in the elderly will be assessed in a later survey.

17. Of the vitamins, the all-persons range for thiamin was very similar to established values. In the case of ascorbic acid, all ranges examined had a lower limit than is usually acceptable but this may be a consequence of the age of these subjects and not ill health. The range for EGR-AC was much wider than expected and the healthy group (Table E3) showed a little evidence of better riboflavin status. If ill health is associated with raised EGR-AC values of the order of 1.60, the upper limit of the range of the not healthy group

(Table E3), then there is some justification for using as a reference range that of the FBCE (Table E3) whose riboflavin intake was higher than the subjects who did not eat fortified cereals.

**Table E1:** *Comparison of generally accepted "normal" ranges of biochemical measurements with those obtained for elderly subjects in the survey (S.I. units in parentheses)*

| Biochemical measurement | | Acceptable limits used during the survey | Range† found for all survey subjects (365) | Range† found for subjects described as healthy and above average (194) |
|---|---|---|---|---|
| Serum total protein g/100ml (g/l) | | ⩾6.5[1] (⩾65.0) | 6.18 – 8.36 (61.8 – 83.6) | 6.35 – 8.27 (63.5 – 82.7) |
| Serum albumin g/100ml (g/l) | | ⩾3.5[1] (⩾35.0) | 3.59 – 5.03 (35.9 – 50.3) | 3.73 – 5.01 (37.3 – 50.1) |
| Pseudocholinesterase | M | 2.04 – 5.04[2] | 1.93 – 7.31 | 1.98 – 7.62 |
| mmol/l/min | F | 2.74 – 5.32[2] | 2.42 – 7.28 | 2.83 – 7.16 |
| Alkaline phosphatase K.A. units | | ⩽13[3] | 1.6 – 15.6 | 3.2 – 12.3 |
| Serum calcium mg/100ml (mmol/l) | | 8.5 – 10.5[4] (2.125 – 2.625) | 8.41 – 10.51 (2.10 – 2.63) | 8.44 – 10.37 (2.11 – 2.59) |
| Serum phosphate | M | 2.5 – 4.8[5] (0.81 – 1.55) | 1.88 – 3.86 (0.61 – 1.245) | 1.91 – 3.71 (0.62 – 1.20) |
| mg/100ml (mmol/l) | F | 2.5 – 4.8 (0.81 – 1.55) | 2.36 – 4.40 (0.76 – 1.42) | 2.45 – 4.41 (0.79 – 1.42) |
| Plasma ascorbic acid* mg/100ml (μmol/l) | | ⩾0.2[1] (⩾11.36) | 0.11 – 1.57 (6.25 – 89.2) | 0.11 – 1.56 (6.25 – 88.6) |
| Leucocyte ascorbic acid* μg/$10^8$ white cells | | ⩾15[6] | 8.8 – 55.6 | 9.3 – 51.1 |
| Red cell riboflavin* EGR-AC | | ⩽1.30[7] | 0.95 – 1.63 | 0.96 – 1.60 |
| Red cell thiamin* TKL-AC | | ⩽1.25[8] | 0.95 – 1.33 | 0.96 – 1.32 |

[1] I.C.N.N.D. (1963); [2] T. P. Whitehead (1972) personal communication; [3] Wootton (1964); [4] O'Halloran, Studley-Ruxton and Wellby (1970); [5] Wilding, Rollason and Robinson (1972); [6] Windsor and Williams (1970); [7] Tillotson and Baker (1972); [8] Brin (1962)

†Ranges represent the mean plus and minus two standard deviations

*Survey ranges were calculated using logarithms and figures shown are the antilogarithms

**Table E2:** *The number of subjects classified as healthy or not healthy and according to their general condition*

| | Healthy | | | Not healthy | | |
|---|---|---|---|---|---|---|
| | M | F | M F | M | F | M F |
| Much better than average | 21 | 19 | 40 | 3 | 0 | 3 |
| Better | 79 | 75 | 154 | 17 | 32 | 49 |
| Total | 100 | 94 | 194 | 20 | 32 | 52 |
| Worse than average | 2 | 4 | 6 | 38 | 55 | 93 |
| Much worse | 0 | 0 | 0 | 9 | 11 | 20 |
| Total | 2 | 4 | 6 | 47 | 66 | 113 |

**Table E3:** *Biochemical variables which showed significant differences between the healthy and above average and the not-healthy and below average groups*

| | | Healthy and above average | | | Not healthy and below average | | | Significance of difference |
|---|---|---|---|---|---|---|---|---|
| Biochemical variable | Sex | No. | Mean | s.d. | No. | Mean | s.d. | $P<$ |
| Serum total proteins g/l | M + F | 191 | 73.0 | 6.7 | 113 | 70.9 | 7.9 | 0.02 |
| Serum albumin g/l | M + F | 191 | 43.7 | 3.2 | 113 | 42.2 | 4.0 | 0.001 |
| Alkaline phosphatase (K.A. units) | M + F | 192 | 7.77 | 2.28 | 113 | 9.30 | 3.25 | 0.001 |
| Serum phosphate (mmol/l) | M | 98 | 0.906 | 0.145 | 47 | 0.977 | 0.179 | 0.02 |
| Riboflavin* (EGR–AC) | M + F | 194 | 1.24 | 1.14 | 108 | 1.27 | 1.17 | 0.10 |

*Values calculated on logarithms of AC and retransformed

**Table E4:** *Ranges of biochemical indices of vitamin status for subjects eating vitamin fortified breakfast cereals (FBCE) compared with those for all subjects*

| Biochemical measurement | Range | |
|---|---|---|
| | FBCE | All subjects |
| Red cell riboflavin* (EGR-AC) | 0.97 – 1.43 | 0.95 – 1.63 |
| Red cell thiamin* (TKL-AC) | 0.96 – 1.28 | 0.95 – 1.33 |
| Plasma ascorbic acid* (mg/100ml) | 0.13 – 1.83 | 0.11 – 1.57 |
| (μmol/l) | 7.4 – 104.0 | 6.25 – 89.2 |
| Leucocyte ascorbic acid* (μg/$10^8$ white cells) | 11.7 – 52.5 | 8.8 – 55.6 |

*Survey ranges were calculated using logarithms and the figures shown are antilogarithms

**Table E5**: *Suggested reference ranges for some biochemical variables for the elderly*

| Measurement | | Range in conventional units | Range in S.I. units |
|---|---|---|---|
| Serum total proteins | | ⩾6.5g/100ml | ⩾65.0g/l |
| Serum albumin | | ⩾3.5g/100ml | ⩾35.0g/l |
| Pseudocholinesterase | M | ⩾2.0mmol/l/min | ⩾ 2.0mmol/l/min |
| | F | ⩾2.7mmol/l/min | ⩾ 2.7mmol/l/min |
| Alkaline phosphatase | | ⩽13 K.A. units | |
| Serum calcium | | 8.5 – 10.5mg/100ml | 2.125 – 2.625mmol/l |
| Serum phosphate | M | 2.0 – 4.0mg/100ml | 0.645 – 1.29 mmol/l |
| | F | 2.5 – 4.5mg/100ml | 0.81 – 1.45 mmol/l |
| Plasma ascorbic acid | | ⩾0.1mg/100ml | ⩾ 5.7μmol/l |
| Leucocyte ascorbic acid | | ⩾10μg/$10^8$ white cells | — |
| Red cell glutathione reductase | | 1.40 AC | — |
| Red cell transketolase | | 1.25 AC | — |

# References


Anderson, B. B., 1964.
Investigations into the Euglena method for the assay of the vitamin $B_{12}$ in serum.
*Journal of Clinical Pathology,* **17**, 14-26.

Anderson, B. B., Peart, M. B. and Fulford-Jones, C. E., 1970.
The measurement of serum pyridoxal by a microbiological assay using *Lactobacillus casei.*
*Journal of Clinical Pathology,* **23**, 232-242.

Axelsson, H., Ekman, B. and Knutsson, D., 1965.
Autoanalysis of SGOT, SGPT and alkaline phosphatase.
*Fifth Technicon Symposium, Automation in Analytical Chemistry,* p. 603.

Bayoumi, R. A. and Rosalki, S. B., 1976.
Evaluation of methods of coenzyme activation of erythrocyte enzymes for detection of deficiency of vitamins $B_1$, $B_2$ and $B_6$.
*Clinical Chemistry,* **22**, 327-335.

Berry, E. M., Gupta, M. M., Turner, S. J. and Burns, R. R., 1973.
Variation in plasma calcium with induced changes in plasma specific gravity, total protein, and albumin.
*British Medical Journal,* **4**, 640-643.

Brin, M., 1962.
Erythrocyte transketolase in early thiamine deficiency.
*Annals of the New York Academy of Sciences,* **98**, 528-541

Brook, M. and Grimshaw, J. J., 1968.
Vitamin C concentrations of plasma and leukocytes as related to smoking habit, age and sex of humans.
*American Journal of Clinical Nutrition,* **21**, 1254-1258.

Brozek, J. and Kinzey, W., 1960.
Age changes in skinfold compressibility.
*Journal of Gerontology,* **15**, 45-51.

Brozek, J. and Mori, H., 1958.
Some inter-relations between somatic, roentgenographic and densitometric criteria of fatness.
*Human Biology,* **30**(4), 322-336.

Brozovic, B. and Copestake, J., 1969.
Semiautomated micromethod for the estimation of unsaturated iron-binding capacity of serum using radioactive iron.
*Journal of Clinical Pathology,* **22**, 605-608.

Cohen, C., 1964.
Serum pseudo-cholinesterase: a biochemical index of nutritional status in the elderly.
*Gerontologia Clinica,* **6**, 321-330.

Coward, D. G., Sawyer, M. B. and Whiteread, R. G., 1971.
Microtechniques for the automated analysis of serum total protein and albumin, urinary urea, creatinine, and hydroxyproline for nutrition surveys in developing countries.
*American Journal of Clinical Nutrition,* **24**, 940-946.

Dacie, J. V. and Lewis, S. M., 1975.
*Practical Haematology,* 5 ed.
Edinburgh, London and New York, Churchill Livingstone.

Denson, K. W. and Bowers, E. F., 1961.
The determination ascorbic acid in white blood cells. A comparison of W.B.C. ascorbic acid and phenolic excretion in elderly patients.
*Clinical Science,* **21**, 157-162.

Department of Health and Social Security, 1972.
Reports on Health and Social Subjects, No. 3.
A Nutrition Survey of the Elderly.
*London, HMSO.*

Department of Health and Social Security, 1977.
The Way Forward.
*London, HMSO.*

Doumas, B. T., Watson, W. A. and Biggs, H. G., 1971.
Albumin standards and the measurement of serum albumin with bromcresol green.
*Clinica Chimica Acta,* **31**, 87-96.

Durnin, J. V. A. G. and Wormesley, J., 1974.
Body fat assessed from total body density and its estimation from skinfold thickness: measurements on 481 men and women aged 16 to 72 years.
*British Journal of Nutrition,* **32**, 77-97.

Exton-Smith, A. N. and Stanton, B. R., 1965.
Report of an investigation into the diet of elderly women living alone.
*London, King Edward's Hospital Fund for London.*

Garry, P. J. and Owen, G. M., 1968.
Automated microdetermination (100 μl) of serum iron and total iron binding capacity.
In: *Automation in Analytical Chemistry:* Technicon International Symposium, 1967, vol. 1. New York and Brighton, Technicon International Corporation, pp. 177-180.

Glatzle, D., Körner, W. F., Christeller, S. and Wiss, O., 1970.
Method for the detection of a biochemical riboflavin deficiency.
*International Journal of Vitamin Research,* **40**, 166-183.

Hoffbrand, A. V., Newcombe, B. F. A. and Mollin, D. L., 1966.
Method of assay of red-cell folate activity and the value of the assay as a test for folate deficiency.
*Journal of Clinical Pathology,* **19**, 17-28.

Hunt, A., 1978.
The elderly at home.
Office of Population Censuses and Surveys, Social Surveys Division.
*London, HMSO.*

Hutchinson, A. E., McCance, R. A. and Widdowson, E. M., 1951.
Serum cholinesterases.
In: Studies of Undernutrition, Wuppertal. 1949-9, pp. 216-225.
*Medical Research Council Special Report Series,* No. 275.
London, HMSO.

I.C.N.N.D., 1963.
In: *Manual for Nutrition Surveys.* 2nd Edition.
U.S. Government Printing Office, Washington.

Irwin, M. I. and Hutchins, B. K., 1976.
A conspectus of research on vitamin C requirements of man.
*Journal of Nutrition,* **106,** 823-879.

Jansen, C. and Harrill, I., 1977.
Intakes and serum levels of protein and iron for 70 elderly women.
*American Journal of Clinical Nutrition,* **30,** 1414-1422.

Kemsley, W. F. F., Billewicz, W. Z. and Thomson, A. M., 1962.
A new weight for height standard based on British anthropometric data.
*British Journal of Preventative and Social Medicine,* **16,** 189-195.

Levine, J. B., Scheidt, R. A. and Nelson, V. A., 1965.
An automated micro-determination of serum cholinesterase.
*Technical Symposium. Automation in Analytical Chemistry,* p. 582.

McPherson, K., Healy, M. J. R., Flynn, F. V., Piper, K. A. J. and Garcia-Webb, P., 1978.
The effect of age, sex and other factors on blood chemistry in health.
*Clinica Chimica Acta,* **84,** 373-397.

Milne, J. S., Lonergan, M. E., Williamson, J., Moore, F. M. L., McMaster, R. and Percy, N., 1971.
Leucocyte ascorbic acid levels and vitamin C intake in older people.
*British Medical Journal,* **4,** 383-386.

Ministry of Agriculture, Fisheries and Food, 1974 and 1975.
Household Food Consumption and Expenditure, 1972 and 1973.
Annual Report(s) of the National Food Survey Committee.
London, HMSO.

Moss, D. W., Baron, D. N., Walker, P. G. and Wilkinson, J. H., 1971.
Standardization of clinical enzyme assays.
*Journal of Clinical Pathology,* **24,** 740-743.

O'Halloran, M. W., Studley-Ruxton, J. and Wellby, M. L., 1970.
A comparison of conventionally derived normal ranges with those obtained from patients' results.
*Clinica Chimica Acta,* **27,** 35-46.

Pelletier, O., 1975.
Vitamin C and cigarette smokers.
*Annals of the New York Academy of Sciences,* **258,** 156-168.

Price, C. P. and Woodman, D. D., 1971.
An improved autoanalyzer technique for the determination of serum alkaline phosphatase.
*Clinica Chimica Acta,* **35,** 265-271.

Roe, J. H. and Kuether, C. A., 1943.
The determination of ascorbic acid in whole blood and urine through the 2,4-dinitrophenylhydrazine derivative of dehydroascorbic acid.
*Journal of Biological Chemistry,* **147,** 399-407.

Schouten. H., Statius van Eps, L. W. and Struyker-Boudier, A. M., 1964.
Transketolase in blood.
*Clinica Chimica Acta,* **10,** 474-476

Taylor, G. F., 1968.
A clinical survey of elderly people from a nutritional standpoint.
In: *Vitamins in the Elderly,* pp. 51-56.
Editors, A. N. Exton-Smith and D. L. Scott.
Report of the Proceedings of a Symposium held at the Royal College of Physicians, London.

Tillotson, J. A. and Baker, E. M., 1972.
An enzymatic measurement of the riboflavin status in man.
*American Journal of Clinical Nutrition,* **25,** 425-431.

Waters, A. H. and Mollin, D. L., 1961.
Studies on the folic acid activity of human serum.
*Journal of Clinical Pathology,* **14,** 335-344.

Weiner, J. S. and Laurie, J. A., 1969.
Human biology: guide to field methods.
*IBP Handbook,* No. 9, Oxford, Blackwell Scientific.

Werner, I. and Hambraeus, L., 1972.
The digestive capacity of elderly people.
In: *Nutrition in old age,* ed. by L. A. Carlson, pp. 55-59.
Swedish Nutrition Foundation X.
Almqvist and Wiksell, Stockholm/Sweden.

Wilding, P., Rollason, J. G. and Robinson, D., 1972.
Patterns of change for various biochemical constituents detected in well-population screening.
*Clinica Chimica Acta,* **41,** 375-387.

Windsor, A. C. W. and Williams, C. B., 1970.
Urinary hydroxyproline in the elderly with low leucocyte ascorbic acid levels.
*British Medical Journal,* **1,** 732-733.

Wootton, I. D. P., 1964.
*Microanalysis in Medical Biochemistry.*
4th Edition, p. 101.
London, J. and A. Churchill.

World Health Organisation, 1968.
*Nutritional Anaemias: Report of a WHO Scientific Group.*
(Technical Report Series No. 405)
Geneva, World Health Organisation.

Printed in England for Her Majesty's Stationery Office
by The Hillingdon Press (Westminster Press Ltd.), Uxbridge, Middlesex

Dd599734 K12 12/79

HER MAJESTY'S STATIONERY OFFICE

*Government Bookshops*

49 High Holborn, London WC1V 6HB
13a Castle Street, Edinburgh EH2 3AR
41 The Hayes, Cardiff CF1 1JW
Brazennose Street, Manchester M60 8AS
Southey House, Wine Street, Bristol BS1 2BQ
258 Broad Street, Birmingham B1 2HE
80 Chichester Street, Belfast BT1 4JY

*Government publications are also available through booksellers*

ISBN 0 11 320687 9