NUTRIENT INTAKES (1990 COMPARED WITH 1980) AND PLACE OF PURCHASE OF FOODS (1990) BY 11 TO 12-YEAR OLD NORTHUMBRIAN CHILDREN

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ABSTRACT

There are few data from repeated cross-sectional studies to indicate the changes in dietary intake in the UK, yet this information is valuable in assessing the impact of dietary-related health education. One of the least investigated aspects of food habits in Britain, particularly for children, is food consumption outside the home. This project investigated the change in dietary intake of 11 to 12-year old children 1980 to 1990, and the place of purchase of food in 1990.

In 1990, three-hundred and seventy-nine 11 to 12-year old children completed two 3-day dietary records. Each child was interviewed by one dietitian to verify and enlarge upon the information recorded. These children attended the same seven middle schools in south Northumberland as 405 children, of the same age, who had recorded their food intake using the same method in 1980. In addition, the children in 1990 were questioned on the place of purchase of the foods recorded. It was found that:

- Energy intake by boys (but not girls) had fallen. The per cent of energy derived from fat and total sugars was unchanged at about 40 and 22 per cent, respectively. In 1990, 17 per cent of energy was derived from non-milk extrinsic sugars.

- Calcium intake by girls was unchanged but had fallen in boys. Iron, vitamin C and unavailable carbohydrate intakes had increased for both boys and girls and the nutrient density of the diet improved for these nutrients in all sex and social groups. In 1990, 90 per cent of girls and 56 per cent of boys had iron intakes below the Reference Nutrient Intake (RNI) and 66 per cent of girls and 83 per cent of boys had calcium intakes below the RNI.

- A social trend, evident in 1980, persisted in 1990 with children from low social class groups consuming the poorest quality of diet.

- Food 'purchased' outside the home contributed approximately 31 per cent of the total energy intake, although there was significant variation in the nutrient quality of the food obtained at each place of purchase.

It is concluded that whilst there had been improvements in some aspects of the diet, the mean dietary intake of the children in 1990 fell short of current dietary recommendations, and that social inequalities persisted.

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CONTENTS

CHAPTER ONE

INTRODUCTION

> "From the point of view of the state, the adoption of a standard diet lower than the optimum is uneconomic - it leads to a great amount of preventable disease and ill-health which lay a heavy financial burden on the state." (Boyd Orr, 1937).

This statement, made over half a century ago, is equally appropriate today although the emphasis has been to move away from the prevention of nutritional deficiency diseases, which were the cause of concern in the early part of the century, towards nutrition for the avoidance of chronic diseases. This is reflected in a recent report of a World Health Organisation study group:

> "The amount and type of food eaten are fundamental determinants of human health. Since health is a fundamental determinant of the quality of each individual's life, good health should be a primary social goal. Improvement in the collective good health of a population - particularly the avoidance of chronic diseases in adult life - decreases the costs associated with both health care and lost economic productivity. Good health is therefore an important economic asset". (World Health Organisation, 1990a).

The relationship between nutrition and good health, excluding frank deficiencies, is for the most part long-term and the effectiveness of intervention studies are not always apparent. The longer term adverse health effects of an 'affluent' diet - characterised by an excess of energy-dense foods rich in fat and sugars, but deficient in complex carbohydrates - have only become apparent over recent decades. Again, to quote the World Health Organisation:

> "Epidemiological research has demonstrated a close and consistent relationship between this type of diet and the emergence of chronic non-infectious diseases including coronary heart disease, cerebrovascular disease, various cancers, diabetes mellitus, dental caries and bone and joint disorders" (World Health Organisation, 1990a).

In an attempt to mitigate the effects of these chronic non-infectious diseases, national Governments in most developed countries have some form of nutrition policy. This strives to translate contemporary nutrition knowledge into dietary practice, by influencing or directly controlling consumer choice. Nutrition policy in the UK is formulated primarily by the Committee on Medical Aspects of Food Policy (COMA). The COMA panels are drawn from experts and authorities in particular fields on an *ad hoc* basis and are co-ordinated by the Department of Health.

UK nutrition policy is implemented through health promotion and education in line with Government philosophy that responsibility should lie with an individual acting on informed choice (Wiseman, 1990). The responsibility for translating and implementing food policy lies with four Government bodies:

- The Department of Health - giving advice on scientific aspects of nutrition and health - central to this role are the COMA panels. The Department of Health is responsible for the development of messages that the individual is able to use and for developing and fostering the strategies for health promotion.

- The Ministry of Agriculture, Fisheries and Food (MAFF) - is responsible for ensuring consumer choice by maintaining a plentiful supply of wholesome food at affordable prices, and advising Government on food legislation including labelling. MAFF is also responsible for monitoring the diet of the UK population through the National Food Survey (Ministry of agriculture, Fisheries and Food, 1991a).

- The Health Education Authority - is responsible for transmitting information to the public in line with the nutrition policy and strategy formulated by the Department of Health.

- The Department for Education - has a role in school education through the curriculum, school meal policy and in the funding of nutrition research through the Medical Research Council (MRC).

Outside this framework are the influences of European legislation, the media and the individual's choice and ability to respond to the information in the public domain.

The consumers' perception of food policy is derived from and influenced by two principal means (Wiseman, 1990):

- Government legislation leading to labelling policies, food subsidies and pricing policies.

- Nutrition research leading to education, either through the school curriculum or *via* national nutrition education campaigns co-ordinated by the Health Education Authority or by national pressure groups, for example, the Coronary Prevention Group and the British Heart Foundation. In addition, primary health care in the National Health Service (NHS) has a role in health promotion.

Nutrition policy is not fixed and must be able to respond to changes in knowledge, awareness, prevailing social conditions and consumer perceptions. Imposed nutrition policy can have profound effects on the nation's food consumption. The successful wartime food policy of the 1940's resulted in a lower fat intake. However, such policies are unlikely to succeed without public co-operation. When war-time rationing ended, the emphasis was to increase the fat content of the nation's diet. For example, up until 1975, the Department of Education and Science had nutritional standards which required that each school meal had a minimum fat content of 1.15 ounces (Department of Education and Science, 1966). In extreme situations, such as prevailed during the Second World War, consumers could see the need for restrictive food policies; however, most consumers would find this unacceptable in peace-time.

The 1980's was a decade of intense activity in health education, as well as increased interest by the public and media in diet and health. During this decade three major reports on diet and nutrition were published:

- the National Advisory Committee on Nutrition Education (NACNE) report (1983);

- the COMA panel report on Diet in Relation to Cardiovascular Disease (Department of Health and Social Security, 1984); and

- the COMA panel report on Dietary Sugars and Human Disease (Department of Health, 1989b).

The advice of these reports can be summarised as advocating a reduction in the intake of fat and sugar. At the same time, food advertising, often aimed at adolescents, is frequently for high fat and/or high sugar products, a message directly contrary to that of health education.

The diet of the population of Britain is not constant. Changes in lifestyles, increased variety in the food supply, advice from experts, the media, social and economic pressures each exert their influences to a lesser or greater extent. The National Food Survey has, for fifty years, measured changes in the diet of the population, but does not measure the diet of specific age groups of the population. Therefore, there is a need for monitoring the diet of those groups which may be more vulnerable to nutritional inadequacies. Occasional surveys, undertaken by the Government, go some way to meet this need - for example, the Department of Health carried out a survey of adolescents in 1983 (Department of Health, 1989a) and of adults in 1987 (Gregory et al., 1990) and is currently undertaking a survey of pre-schoolchildren. These large national surveys are infrequent for each age-specific group and gaps exist in the information collected.

Of the changes in the UK diet, one which is least investigated is the increase in consumption of foods outside the home. The National Food Survey has recorded that the number of such 'meals' is increasing (Ministry of Agriculture, Fisheries and Food, 1991b). The traditional pattern of three meals a day, usually eaten with the family, should perhaps no longer be considered the norm in Britain. In 1990, 'meals' away from home accounted for 21 per cent of total food expenditure (Ministry of Agriculture, Fisheries and Food, 1991a) and the Dietary and Nutritional Survey of British Adults (Gregory et al, 1990) found that (excluding alcohol), men and women ate 31 and 23 per cent of their total energy outside the home, respectively. This suggests that for adults, foods 'purchased' outside the home now make a substantial contribution to total diet.

If foods from outside the home make a significant contribution to the diets of adults, what of the diet of adolescents ? Is the diet of schoolchildren predominantly influenced by parental choice, with most of their food originating from the home or, do foods bought away from home play a significant part in their diet ? If the latter is the case, does food consumption outside of the home follow the same pattern as food intake at home ? The most recent national study of the diet of young people in Britain, carried out in 1983, investigated the diets of 10 to 11-year-olds and 14 to 15-year-olds (Department of Health, 1989a) - the nutrient composition of school meals was reported but the significance of all foods taken outside the home was not studied.

In 1992, the Government launched health targets for England into the 21st century, which were set out in their white paper 'Health of the Nation - Strategy for Health' (Department of Health, 1992). The 'Health of the Nation' set the goal of 'adding years to life and life to years' (increasing life expectancy by reducing premature death and increasing the years lived free from ill-health) by promoting healthy lifestyles, and healthy physical and social environments. One of the five key areas identified for change in the 'Health of the Nation' was coronary heart disease and stroke - changing eating and drinking habits are one of the primary objectives in the strategy to achieve a reduction in coronary heart disease in the UK.

The 'Health of the Nation' (Department of Health, 1992) provides, for the first time, a national strategy for health and a policy of disease prevention, which has the support of all Government departments and, in theory, could lead to a co-ordinated approach to health promotion at all levels from education through to health care. The strategy includes promotion of healthy surroundings (including schools), healthy lifestyles (by increasing knowledge and understanding about how the way people live affects their health) and quality health services, with an appropriate balance between health promotion, disease prevention and treatment (Department of Health, 1992). Health promotion within primary health care will, from July 1993, focus on coronary heart disease prevention in line with the recommendations in the 'Health of the Nation'. The funding of General Medical Practitioners will be directly linked with coronary heart disease prevention activities and considerable resources will be directed at prevention of disease in adults. However, the food and lifestyle habits of adults are often those acquired in childhood and there is growing evidence that some diseases of adulthood begin during childhood. The World Health Organisation recently recommended that since the risk factors for coronary heart disease found in childhood are potentially predictive of the disease in adults, coronary heart disease prevention should begin with children (World Health Organisation, 1990b).

Within nutrition education, it is necessary to identify target groups and prioritise messages. This must involve a level of judgement which can only be supported by information on current dietary habits, including factors which influence why and how people eat and how this affects their health. The greater the information on food intake and habits, the better will be the judgements which govern the choice of target groups and the more appropriate will be the messages given to those individuals (Wiseman, 1990). One key target group is adolescents.

This thesis aims to address some of the issues raised above. Adolescence is a time of emerging independence and increasing social involvement when food choice may no longer be entirely a parental decision. The diets of adolescents are important for a number of reasons: adolescence is a time of growth and development when good nutrition is essential, but it is also a time when the food habits acquired may establish food habits in adulthood and so determine the potential risk of dietary related diseases. It has been indicated that the 1980's was a time of increased nutritional education and awareness amongst the public - the impact of this increased information on the nutrient intake of 11 to 12-year old adolescents in south Northumberland, 1980 to 1990, has been measured and the implications of the results will be discussed. Indications are that the 1990's will be a decade of continuing dietary awareness and increased dietary education, with an emphasis on disease prevention (Department of Health, 1992). The 1990's may also see a further erosion of traditional food patterns with an increased reliance on foods from 'outside the home'. Information on the nutrient intake and source of food in 1990, presented in this thesis will highlight changes necessary in the diet of adolescents if they are to meet the current guidelines (Department of Health, 1991) and also serve as a baseline against which to assess the impact of the action resulting from the 'Health of the Nation' white paper, on the nutrient intake of 11 to 12-year old adolescents.

CHAPTER TWO

LITERATURE REVIEW

A review of the literature on nutrition of adolescents and their eating habits requires several areas of nutrition research to be considered - the origins of dietary investigations, methods used in dietary surveys, and the diet of the population as a whole; each provide valuable background information. Previous nutritional surveys, both regional and national of young adolescents, the particular nutritional concerns during adolescence, and foods purchased outside the home (the quality of those foods and the increasing part they play in total diet) are all relevant. Finally, the history and derivations of dietary recommendations for adolescents should be considered. Each of these areas will be discussed in this chapter.

2.1 The origins of dietary investigations

The experimentations of William Stark, a young doctor living in London from 1765 to 1770, were perhaps the earliest dietetic investigations. Using himself as the subject, Stark attempted to exist on several restricted diets in turn. The first was that of bread, water and sugar during which he developed scurvy, although he did not recognise it as such. Other diets improved his health for example, when he lived freely on 'a diet of animal food, milk and wine'. Stark tried several restricted diets until, in 1770, on a diet of honey puddings and cheshire cheese, he developed an intestinal disorder and scurvy from which died (Drummond and Wilbraham, 1991).

During the early part of the 19th century nutritional knowledge centred around 'body humours' and the nature and value of food was not understood. A clear example of this was the 'fasting woman of Tutbury' who received wide acclaim when in 1809, she claimed not to have eaten or drunk for five years. The French scientist Lavoisier had come close to the truth in the late 18th century during his experimentations to establish that the oxidation of foods produced energy (Seguin and Lavoisier, 1790). This work came to an abrupt end when in 1794, Lavoisier and his colleagues were sent to the guillotine.

Historically, the value of some foods had been appreciated if not understood; for example the use of cod liver oil as a curative for rickets and other bone disorders. Early records from 1782 show that a Manchester infirmary prescribed 50-60 gallons of cod liver oil annually.

In 1840, Leibig was the first to apply chemical analysis to physiology and nutrition and to investigate the nutritive value of protein. Leibig postulated that hard physical work used up protein which must be replaced by meat. Not until much later in 1889 did two Swedish scientists, Fick and Wislicenus, described the role of the muscle in oxidation to produce energy.

The first dietary investigations were conducted in 1862 by Dr Edward Smith. Concern over the effects the poverty caused by the depressed cotton industry in Lancashire, led the Medical Department of the Privy Council to consider the diet of those affected. Smith was requested to make a full investigation of dietary intake of the redundant cotton workers. He subsequently enquired into food prices and the 'precise dietary' of the cotton operatives both before and during the 'cotton famine'. In presenting the findings of his study, Dr Smith stated: "The exact quantities of food, with its cost and nutritive value, eaten by a large number of persons in periods of abundance and present time is given. The details have been sought with greatest minuteness and care". In fact the actual sample was not as large as implied, since diets of only 36 single people and 44 families were collected.

In 1863, Smith was again commissioned by the Privy Council for a second report, this was to be a 'National study of the food of the poorer labouring classes in England'. Information was collected from families of silk weavers, kid glove makers, stocking and glove weavers, rural labourers and other trades. The criteria for inclusion in this survey were both stringent and subjective; the subjects must live near their place of work, their work should be of a defined character, of 'sufficient importance' to the community and command a low wage. In addition, Smith insisted that the subjects should be: "such as in industry, thrift and intelligence, health and capability of labour and general employment that they would fairly represent their class". The result was usable data from 714 households which were analysed in an occasional paper by Barker et al. (1970). Barker et al. concluded that: "whilst we are fortunate to have the records of this early work the results must be interpreted with caution". Smith's survey selection procedures had excluded the really poor, "the flotsam and jetsam of the then labouring classes", although he had taken the first steps in tackling the thorny problem of measuring dietary intake and, more specifically, obtaining a representative sample.

Halliburton (1891) had described the five proximate principles of food as - protein, fat, carbohydrate, salts and water. Accessories were condiments such as caffeine and alcohol which promoted appetite and digestion. No mention was made of fruit or vegetables, although there was already hundreds of years experience of the anti-scorbutic properties of such foods.

The beginning of the 20th century saw the effects of malnutrition more widespread in England than it had been in medieval and tudor times; the industrial revolution and the demands of the expansion of the British empire had their effect on the working classes (Drummond and Wilbraham, 1991). Few, in positions of authority, had any concern for this situation. Indeed the extent of the apathy and indifference to the state of health of the public was exposed when, in 1900, Rowntree published his study of widespread poverty, poor housing, starvation and ill-health among the poor living in the city of York (Rowntree, 1900). This report caused only a minor stir in Government and was, at the time, ignored.

A year later in 1901, this indifference was challenged when the Armed Services reported difficulty in recruiting men considered fit enough for active service in the South African (Boer) war. Rejection rates for the country as a whole were 40% and reached 60% in some areas. Heart conditions, poor dentition, sight and hearing, and physical deformities were widespread. In 1902 the minimum height for recruits was reduced to 5ft, having been previously reduced from 5ft 6in to 5ft 3in in 1883 (Drummond and Wilbraham, 1991). The Government ordered an inquiry into the physical health of the nation, but not without opposition from the Royal College of Surgeons who recommended that no useful purpose would be served by such an inquiry, since no evidence existed to suggest any deterioration in health. The inquiry went ahead with the view that the high recruitment rejection warranted investigation even if they did not represent a deterioration in the state of health.

The committee reported in 1904 (Inter-departmental committee on physical deterioration, 1904) and found that Rowntree (1900) had not exaggerated the extent of disease and ill-health in Britain. One finding showed that boys aged 11 to 12 years at private schools were 5 inches taller than those in council schools. The report focused on poor housing, working conditions and ignorance rather than the major cause of ill-health - semi-starvation due to poverty. However, feeding of children was highlighted, most particularly the decline in breast feeding due to the new and increasing employment and the chronic ill-health of women. In poverty-stricken areas, the substitute infant foods used were chosen by price, rather than quality. In some towns, nine of every ten babies were fed on sweetened condensed milk, rich in sugar and devoid of any fat, which led to the development of rickets and other symptoms of defective nutrition. It was also reported that some mothers tried to rear their babies on only flour and water mix. There can be little wonder that the infant mortality rates were high and many of those who did survive fared poorly. A 1902 survey of schoolchildren in Leeds showed that in the poorer areas half had marked rickets while more than 60% had carious teeth (Inter-departmental Committee on Physical Deterioration, 1904).

Shocked by the revelation that many children existed on starvation diets, along with the comments from board schools that teaching time was wasted because children came to school hungry, the 1904 committee turned its attention to providing school meals for those children for whom food from home was inadequate. This led to the Education (Provision of Meals) Act (H.M. Government, 1906) and by 1911 more than 200,000 poor children were receiving school lunches (Drummond and Wilbraham, 1991). For the next thirty years school meals were aimed mainly at poor children: attendance numbers rose during the depression of the 1930's until, at the outbreak of the Second World War, school meals became available to all children. In 1991, approximately 42% of schoolchildren (4,000,000 children) used the school meal service each day. Uptake peaked in 1979 when 64% of all schoolchildren had school meals (Department of Education and Science, 1992).

The period before the First World War saw further changes. There was a commitment to reduce infant mortality from the then current levels of 220 per 1000, as reported by the National Conference on Infant Mortality in 1906 (McCleary, 1933). In 1913, as result of Lloyd George's National Health Insurance Act of 1911, the Medical Research Committee was established. This was a significant step forward since it represented an acceptance by Government of responsibility, not only to encourage, but also to participate in investigating the causes of disease.

First World War conscription, found the same high proportion of men unfit for service, as had been found in 1901. This caused more concern than previously; many had believed that the findings in 1901 had reflected the state of health of the 'down and outs' who volunteered for service, rather than the true health of the working classes. Now, for the first time, every man in Britain aged between 18 and 45 was examined; the findings could no longer be disputed. The newly formed Medical Research Committee, later the Medical Research Council, was called on to investigate.

Food rationing during World War I, was eventually instigated in November 1916 with the establishment of the Ministry of Food (later to become the Ministry of Agriculture, Fisheries and Food). The deliberations over what constituted effective rationing did much to further the knowledge of the science of nutrition and the physiological functions of food. As during previous periods of food restrictions, diseases appeared in the ranks of those fighting and also at home. The previously unexpressed view that physical fitness may have its base in adequate nutrition began to be contemplated.

During the late 19th century, research began to suggest the existence of other factors in food besides the five proximate principles described by Halliburton (1891). In 1886, a Dutch scientist, Eijkman, showed the curative properties of rice germ for beri-beri. In 1905, Pekelharing, working at the University of Utrecht, found that a diet of protein, fat, carbohydrate and mineral salts would not maintain good health. He reported that there was an unrecognised substance in milk which was of paramount importance for nutrition although present in minute quantities (Pekelharing, 1905). These were the first steps in the discovery of vitamins.

The early 20th century saw further rapid progress in nutrition science. In 1909, Stepp, a German biochemist, found that pure fat did not make good a deficiency corrected by an impure fat. He had discovered fat soluble vitamins. In 1912, Sir Frederick Hopkins demonstrated a decline in health on a diet lacking what he termed "accessory food factors". Later this was replaced by the universally used term 'vitamins'. Following Hopkins discoveries, individual vitamins were rapidly isolated - Vitamin A in 1913 (Osbourne and Mendel, 1913) and Vitamin D in 1918 (Mellanby, 1918).

Although the curative properties of fruit and vegetables for scurvy had been well known amongst sailors since the 16th century, the lack of a suitable experimental animal delayed the discovery and isolation of vitamin C. Chance discoveries in 1916 led to the use of the guinea-pig as a suitable subject for investigation, although it was not until 1932, that vitamin C was finally isolated. A few years before, in 1915, the British forces in Mesopotamia had suffered from scurvy and from beri-beri. This could have been prevented by a plane drop of vitamins C and B1 - instead opium was delivered to the men to deaden their hunger. By 1916, British forces in Asia had preserved lemon juice to drink and supplemented their rations from garden plots near the front lines.

During the 1920's, the fear of widespread semi-starvation, present before the National Insurance Act of 1911 (H.M. Government, 1911) had dwindled. It became clear that no reliable information existed on food consumption by families or individuals, by which to test the theory of malnutrition being responsible for poor physical health. In order to gather this information, the Scottish Committee for Child Life Investigation, instigated a household survey between 1919 and 1924. The survey was detailed and carefully conducted. However, since the importance of dietary factors other than protein, fat and energy were not recognised, its conclusions were misleading (Paton and Findlay, 1926). This, and other surveys of the time, suggested that the vast majority of the working classes were now getting enough to eat in terms of energy and yet, widespread ill-health continued. During the depression of the 1930's many families were able to purchase sufficient calories, but were unable to obtain an adequate diet (Drummond and Wilbraham, 1991). The importance of 'protective foods' was beginning to be recognised.

In 1931, the Minister of Health, Arthur Greenwood, called for the appointment of an Advisory Committee on Nutrition to advise on the "practical applications of the advances in the knowledge of nutrition". This was the beginnings of the Committee of Medical Aspects of Food Policy (COMA) which we know today. Government interest now focused on what was the minimum expenditure on food which could procure a diet which would generate and sustain good health in a family. In 1933, the British Medical Association gave estimates of 5 to 6 shillings/per man/per week as a minimum expenditure on food - at this time unemployed families had, on average, 1 shillings 7 pence/per head/per week to spend on food and even some in employment had below 4 shillings per head (British Medical Association, 1933).

In the period between 1920 and the late 1950's, nutrition scientists and biochemists continued to improve the understanding of the role 'protective factors' in the diet. In 1926, Minot and Murphy (1926) showed that pernicious anaemia could be treated by raw liver. Over the next two decades many attempts were made to identify the essential factor in raw liver until, in 1948, vitamin B12 was isolated by workers in Britain and the USA (Smith & Parker, 1948; Rickes et al., 1948). In 1957, Moore (1957) proved that carotene was a precursor of vitamin A.

In 1935, the Rowett Research Institute in Aberdeen was asked by the food industry for information on food consumption. These data were not available without an inquiry into the food habits of the country, and what followed were the early investigations of John Boyd Orr. In 1936, Boyd Orr (1936) reported the results of his pioneering dietary survey 'Food, Health and Income'. This survey was the first attempt to assess the inter-relationship of these three key factors. The investigation took as its standard the optimum requirements of nutrition - 'a state of well-being such that no improvement can be effected by a change in diet'. The method used involved several stages: national supplies of main foodstuffs were estimated; estimates based on family budget were made for consumption of various foodstuffs; the composition of the average diet for each income group was examined and compared with a diet required for health; and the state of health of the country was reviewed.

Boyd Orr recognised that his data were inadequate and of doubtful accuracy but he tentatively concluded that a diet completely adequate for health would be reached by an income level above that of 50 per cent of the population. He highlighted the inadequacy of the diets of the lower income groups and the markedly lower standard of health of these people, especially children, compared with those with higher incomes. Boyd Orr concluded, "if this communication helps to increase interest in the subject and to show the need for further investigation, it will serve a useful purpose". The explosion of nutrition research and dietary survey work and the continuing debate on methodology bears testimony to the early work of Sir John Boyd Orr.

Working at the same time as Boyd Orr, Widdowson (1936) was aware of the limitations of previous dietary surveys, particularly those which had used the family as a unit. In household surveys no assessment could be made of the intake of individuals within the family. It was impossible, therefore, to separate the intake of children from adults, or men from women - the variation of intakes within a family has since been shown to be considerable (Nelson, 1986). Widdowson laid down the procedure of the 'individual method' and applied it to children, men and women of the time (Widdowson, 1936, 1947; Widdowson and McCance, 1936). Assessment of individual diets had begun.

With the advent of World War II, the experiences of the 1914-1918 war were called upon and a wartime food policy was quickly established. The huge strides made in nutritional knowledge between the First and Second World Wars meant that the Government was in a much better position to plan for food rationing. Much of the wartime food policy was the work of the chief scientific advisor to the Ministry of Food, Sir Jack Drummond. Several steps were taken to ensure that nutrition was adequate: increased intakes of milk were encouraged and schemes were developed for differential rationing to ensure the needs children, adolescents and expectant mothers were met; vitamins A and D were added to margarine; extraction rate of flour was increased to 85% and calcium carbonate added to flour to improve intakes of vitamin B1, iron, riboflavin, nicotinic acid and calcium; communal meals were encouraged by canteen meals and the introduction of British restaurants, and school meal services were expanded to include all children. An exercise in nutrition education was undertaken by the Ministry of Food and the Ministry of Health, the powers of posters, radio, cinema and leaflets were mobilised to spread the word, which included jingles - "those who have a will to win cook potatoes in their skin". To ensure supplies of fresh fruit and vegetables were maintained, Britain was encouraged to 'dig for victory'. Food rationing led to the first National Food Survey in 1940 - the Ministry of Food wished to monitor the diets of urban working class families and so give an independent assessment of the effectiveness of the food rationing policy (Derry and Buss, 1984).

Wartime food policy and rationing during the Second World War was widely considered to have been a success. In 1943, Boyd Orr, published his visionary work - 'Food and the People' (Boyd Orr, 1943) - this discussed the improvements that had been made in the nation's diet as a result of rationing and planning, and called for a permanent food policy to ensure health and nutrition were not allowed to deteriorate in post-war Britain. The infant mortality rate was at the lowest on record and the growth rate of children was greater than in pre-war years; 13-year old boys had on average increased in height by 0.88 inches and had increased in weight by 2.6 pounds and growth in girls followed similar patterns. If this could be afforded in wartime, Boyd Orr asked, why not when we had peace ? This call for a National Food Policy is still echoed by nutrition pressure groups in Britain today.

In 1950, the Ministry of Food's household survey was extended to become the National Food Survey, covering all sectors of the population. The National Food Survey is a unique source of information on the British diet which spans over 50 years (Ministry of Agriculture, Fisheries and Food, 1991a). The limitations of this survey will be discussed in section 2.3.

During the 20th century, the need for dietary information and monitoring of individual and group dietary intakes had been established and great advances in knowledge of the components of food and their physiological functions had been made. Many early surveys relied on the efforts of McCance and Widdowson (1946) in production of the early food tables 'The Chemical Composition of Foods', which gave nutrient analyses of standard foodstuffs. The end of the Second World War brought a welcome increase in the number of dietary surveys. However, the methods used to collect dietary information remains an area of continuing debate.

2.2 Methods used in dietary surveys

> "A superficial examination of the problems experienced in measuring dietary intake meets such a morass of conflicting opinions, that the first inclination is apt to be a decision for abandonment" (Mann et al., 1962).

2.2.1 Introduction

The methodology of dietary surveys is a much debated issue with authors tending to hold strong views on the advantages and disadvantages of each method. Many of the early workers (Boyd Orr, 1936; Crawford and Broadly, 1938) used the household as a unit for dietary investigation; its attraction undoubtedly lay in the relative simplicity of this approach. Although no individual intakes could be assessed from such surveys, they were useful, in that they drew attention to those sub-groups whose dietary intake warranted closer investigation. Indeed, the National Food Survey continues to fulfil this important role today (Ministry of Agriculture, Fisheries and Food, 1991a).

Methods of measuring the habitual dietary intake of individuals, or groups of individuals, have been developed and refined over the decades to produce those which are widely recognised today. Methods of collecting dietary data vary, as do the acceptability of the methods to subjects and hence the level of cooperation required in surveys, the cost and resources required, the validity of the method and the reliability of the data collected. Bingham (1987) lists the possible sources of error in dietary surveys as: use of food tables, coding errors, incorrect weights assigned to foods, reporting errors, change in diet for the recording period, response bias and sampling bias.

In any dietary survey the initial decision must be to agree the nature of the information required. There are four different types of information which can be collected: the mean food consumption of a group of individuals; the mean and distribution of food consumption of a group of individuals; the relative magnitude of the food consumption of an individual within a distribution of food consumption and finally, the absolute magnitude of the average food consumption of an individual (Bingham, 1988).

The method of choice is dictated by: the type of information required, the nature of the population (that is their age and capabilities), the size of the sample which needs to be studied to give meaningful results, and the resources available. This section will review validity and reliability as they apply to dietary surveys and then will briefly consider the basic principles of the various methods. The advantages and disadvantages and their suitability to collecting the various types of data will also be discussed. The practical applications of the methods will not be included, as full descriptions of the methods have been given in reviews by Marr (1971) and Bingham (1987).

2.2.2 **Validity and reliability**

> "The measurement of voluntary food intake is probably one of the most difficult of physiological measurements. However, it is not so much the recording of food intake which causes problems, as obtaining a representative sample, studying an adequately large sample, converting food intakes into nutrients and obtaining a good estimate of an individual's average intake" (Garrow, 1974).

Validity is a measure of how far a method measures what it is intended to measure (Fehily, 1983). Therefore, if a dietary survey intends to measure the habitual dietary intake of group of individuals, then the extent to which this is achieved is a measure of the validity of the method used. Validity will be affected by any systematic errors which occur within a method. For example, in the case of dietary surveys, the use of food tables, rather than chemical analyses to determine nutrient composition is one possible source of systematic error.

The absence of a 'gold' standard against which to measure the validity of dietary survey methods, has meant several authors have attempted to validate one method against another. Most commonly the weighed inventory method (see section 2.2.3.1) has been taken as the bench mark against which other methods can be judged (Bransby et al., 1948; Hackett et al., 1983; Jenner et al., 1989).

The absolute validity of a method could only be assessed if it were possible to carry out a simultaneous independent check on free-living subjects. Bingham (1987) described several methods of using biological markers of food consumption which can be useful in small samples of volunteers - however, these are invasive and impractical for use in epidemiological surveys where large sample sizes are usually required. One such new approach allows accurate measurement of the energy expenditure of free-living individuals. Previously, measurements of energy expenditure have relied on calorimetry, either direct or indirect, which severely restricts activity and so energy expenditure. A technique, in which energy expenditure can be calculated from the rate of metabolism of 'doubly labelled water', can now be applied to human subjects, giving an opportunity to validate reported energy intakes against simultaneously measured energy expenditures (Livingstone et al., 1992). If a recorded energy intake can be validated against a measured energy expenditure, then it is considered reasonable that similar assumptions can be made about the other nutrients recorded. As a database of measured energy expenditures in different sex and age groups develops, theoretical validation of reported energy intakes in all dietary surveys against these 'gold standards' may be possible (see chapter 7).

Reliability is a measure of the repeatability of measurements (Guilford, 1965). Random error in a survey will affect the reliability of the results: the greater the random error in measurements, the lower the reliability of the data. This distinguishes reliability from validity which is concerned with systematic error.

The reliability of a dietary survey may be difficult to measure since changes in dietary intake may be inherent - for example, seasonal or secular changes in intake. Therefore, dissimilar results may be due to either a true change in intake or to random error. In dietary surveys, random error can be reduced in a number of ways: for example, by increasing the number of days studied, that is by increasing the number of observations per subject; or by using only one interviewer to collect all dietary data, thereby excluding any inter-examiner variability.

2.2.3 Measuring dietary intake

The methods used to measure dietary intake fall into two basic categories: measuring dietary intake by recording present consumption and measuring dietary intake retrospectively.

2.2.3.1 Recording present intake

- **Recording present intake by weighing and recording.**

Marr (1971) describes 'the precise weighing method' as the method of measurement nearest to metabolic laboratory conditions, in the free-living. This requires: ingredients used in food preparation to be weighed. The weight of the individuals' cooked portion and table waste are recorded. Nutrient analysis is by direct chemical means rather than from food tables, so laboratory facilities are a prerequisite of this method. In addition, a skilled field-worker is required to conduct all weighing, making this method unsuitable for all but small samples.

Precise weighing as a method of measuring an individual's intake is likely to have high validity, and high reliability if the number of days recorded per subject is large. However cooperation is likely to be low and normal behaviour difficult to maintain, necessitating a sample biased towards those most willing to cooperate - because of this, the validity of the measurement could be questionable (Marr, 1971).

Other than precise weighing, all methods of assessing dietary intake rely on standard food tables for the conversion of food into nutrients. Although extensive and widely researched food tables are available (Paul & Southgate, 1978) their use is not without problems. The micronutrient content of some foods will vary with season, growing conditions, length of storage and ingredients of composite dishes, therefore, the actual nutrient content of the food items recorded by the subjects may not be exactly equivalent to the values given in the food tables (Southon et al, 1992). The use of food tables in the analysis of nutrient intake will introduce a potential source of error, the extent of which will vary for each nutrient, regardless of the method used to collect the dietary data.

A second method of recording present intake by weighing is the 'weighed inventory method' described by Marr (1971), or the 'individual method' referred to by Bingham (1987). This method usually involves the subject recording 7-day weighed intakes, and has a wider application than precise weighing. The method was first described by Widdowson (1936) and was used in the first large scale survey to measure the habitual dietary intake of individuals continuing their normal lifestyle (Widdowson, 1947).

The 'individual method' has been adapted to reduce the burden imposed on the volunteer, and thus attempt to limit any change in normal eating behaviour. Food is weighed once prior to consumption then any plate waste recorded. Nutrient analysis of food intake is by use of food tables. This method is widely used in surveys today (Department of Health, 1989a; Nelson et al., 1990) and is considered, by some authors, to represent the 'gold standard' of dietary survey methods.

There is little doubt that weighed inventory surveys give accurate and exact recording of what was eaten, but there is considerable debate as to whether this gives a valid measurement of usual intake. The main disadvantages remain the administrative workload, and the commitment, literacy and intelligence that the method requires of volunteers. This may result in the sample being rather selective and unrepresentative of the population under survey. Thomson (1958) illustrated this in a weighed inventory study in which those who did not cooperate were shorter in stature and less well educated than those who did. In those who do volunteer, habitual or usual diet may be altered or reduced in order to simplify the weighing process, leading to recording omissions, either conscious or unconscious, particularly for non-meal items. Adelson (1960) reporting a survey of adults, described two subjects who chose a week free of business or social engagements in which to record their food intake. Marr (1971) speculated that difficulties in weighing dietary intake may increase as eating outside the home becomes more frequent, compounding the problems associated with weighing and thereby reducing subject cooperation. The findings of Livingstone et al. (1992) support Marr's theory - weighed dietary records of younger children (aged 7 to 9 years) agreed well with measured energy expenditure, whilst those of 12 to 18-year old adolescents agreed less closely with increasing age - intakes being calculated to be lower than energy expenditures. The discrepancy was explained by unstructured eating patterns, and increased out-of-home eating by the older children, making weighing tedious, resulting in under-reporting (Livingstone et al., 1992).

Weighed dietary records are in theory, suitable for all types of survey; however, they may be an inefficient tool when the aim of a survey is to determine only the mean and distribution of food consumption of a group of individuals. The absolute composition of the diet of an individual has inherent error when investigated by any method. Such measurements are usually only required for clinical investigations.

Recent research involving the simultaneous measurement of energy intake by weighed inventory and of energy expenditure of free-living individuals continuing their normal lifestyle (Chapter 7), indicates under-reporting of food intake in weighed inventory surveys by both adults and adolescents (Livingstone et al., 1990, 1991; Davies et al., 1991).

- **Recording present intake by estimated weight of foods or household measures.**

The early beginnings of this method were described by Bransby et al. (1948) as 'homely measures'. Bingham (1987) credits Youmans et al. (1942) working in the USA, as the first researchers to describe the use of estimated weights. This method has been used widely (Elwood & Bird, 1983; Cade et al., 1988; Edington et al., 1989) and frequently adapted. As a result, several variations of the method exist, although the basic principle remains the same.

Each subject records all items of food and drink, at the time of consumption, along with either an estimated weight or a household measure to describe the amount eaten. Reliance on estimated weights without cross-checking with the aid of food models presumes a practical working knowledge of food weights by the subject. Subjects can vary in their ability to estimate weights. Fehily (1983) found that women were able to estimate the weight of their food portions more accurately than men. Household measures may be used but can be ambiguous. The use of pre-calibrated volume food models (Moore et al., 1967) or photographs (Hankin et al., 1975) help in checking the size of the portion used and increase the accuracy of the estimated weights (Bingham, 1988). If food models are used, the household measures can be compared with food models representing known weights and volumes and, thus, a description is converted into a weight.

An interview at the beginning of the recording period can be valuable to ensure the subject fully understands the method. An interview at the end of the recording period is essential to assign weights to the household measures and descriptions given; and to question the subjects in case of omissions and ambiguities in the record (Marr, 1971; Bingham, 1988). Having determined the weight of each food item, food composition tables can then be used for nutrient analysis.

The accuracy of the measurement is reduced by the use of estimated weights. However, this method has the advantage of being less intrusive, and therefore less likely to interfere with the normal diet. The method requires only that the subjects are literate and so able to record their food intake with quantitative descriptions. It follows that volunteer and cooperation rates are usually higher than in weighed inventory surveys (Dierks and Morse, 1965; Marr, 1971). The additional advantage of being less labour intensive allows the assessment of diets from a large number of subjects at relatively low cost (Black, 1982). For example, Thomson et al. (1982), using 7 day weighed intakes, achieved 1.8 records per week from hospital in-patients, compared with 14.4 3-day records per week from children, using schools as the point of contact, collected by Hackett using a dietary diary with interview (Hackett et al., 1983). For these reasons estimated weight dietary records are particularly suitable for collecting dietary information from large samples and when the mean food consumption, or the mean and distribution of food consumption of a group of individuals, is required. Estimated weight records have the same ability to rank subjects into thirds or fifths of the distribution as do weighed inventory surveys (Bingham, 1988).

Hackett et al. (1983) investigated the validity of dietary diaries (using household measures followed by interview), against a weighed inventory of one meal. Good agreement was found between the group mean nutrient intakes estimated by the two methods. However, correlation coefficients of the mean intake of individuals were low, being between 0.6 (for total sugars) and 0.4 (for energy). They concluded that the diary and interview method gave a good estimate of the mean intake of a group, but was a relatively imprecise tool for quantitatively estimating the nutrient content of a single meal of an individual. The authors commented that this comparison assumed the validity of the weighed inventory survey and reported that subjects had recorded some foods in their diaries which had been omitted from the weighed inventory.

The reliability of the diary and interview method to assess group intakes was also considered by Hackett et al. (1983); it was concluded that replicating surveys of each individual yielded greater precision than replicating days within a survey. Reliability of the estimate of the mean for an individual, was calculated from the percentage of total variance attributable to three factors: variances between subjects, surveys, and between days within surveys. The percentage reliability of energy intake and weights of fat, carbohydrate, protein and total sugars, when calculated for five surveys of 3 days each, were between 75 per cent and 80 per cent.

The variance of the estimate of total sugar intake, the number of days per survey and the number of surveys, were investigated to assess the combination of days per survey and survey repeats which would give certain levels of reliability. It was reported, for example, that one survey of 14 days would give a reliability of 56%, whilst two surveys of 7 days would give a reliability of 68%. The calculations of Hackett et al. (1983) indicated that repeated short surveys yielded results of a higher reliability than the same number of days surveyed in a single period.

2.2.3.2 Past intake recall

- **The 24 hour recall**

This is the most widely used of the recall methods and is attributed to Wiehl (1942). In this method, described by Bransby et al. (1948) as 'questioning', the subject is asked to recall all food and drink consumed over a certain period, usually the past 24 hours or possibly longer. Weights are then assigned to foods by the interviewer. Recall methods are quick, low cost and require minimum co-operation by the subject.

The main disadvantage of a 24-hour recall is its total reliance on memory, making it unsuitable for certain groups, for example, the very young or the elderly. Children have been shown to be poor at recall of food intake (Bransby et al., 1948; Meredith et al., 1951; Frank et al., 1977). If single 24-hour recalls are used, no account is taken of individual daily variation in dietary intake, which can be considerable, so that a single 24-hour recall will not provide a good estimate of nutrient intake of individuals (Fehily, 1983).

If so called 'short-cut' methods can be shown to be valid, their value would be considerable, reducing the labour intensive work of dietary surveys. Jenner et al. (1989) investigated the relative validity of methods which have been devised to collect large samples of data with limited resources. Diets of 12-year old children were measured using a 24-hour recall, repeated 14 times as a reference method. The results were then compared with data collected by one 24-hour recall, two 24-hour recalls and three 24-hour recalls. One 24-hour recall gave poor results (correlation coefficients varying between 0.34 and 0.53) but this improved when two or three 24-hour recalls were used (correlation coefficients were 0.51 to 0.78). It was concluded that methods based on two to three day records from recall would be a reasonably reliable way to assess the usual mean intake of a group. This study assumes that the reference method used (14 x 24 hour recall) was valid; a further point of note is that correlation between the methods may have been improved by the fact that the 2 or 3 repeat 24-hour recalls, were also the first 2 or 3 days of the 14 repeat 24-hour recalls.

The application of the 24-hour recall method should be restricted to determining the mean food consumption of a group of individuals.

It also may be useful at assessing the distribution of food consumption within the group if repeat surveys are conducted (Bingham, 1988).

- **The diet history**

The 'diet history' is another method of past intake recall. This method is usually attributed to Burke (1947), but Bingham (1987) cites Turner (1940) as the originator of this method, which was then adapted by Burke (1947). In its original form, the diet history method had three discreet parts: one 24-hour recall with quantities recorded in household measures, a cross check list of foods, and a menu recorded by the subject for 3 days. The diet history method is now seldom used in its complete form, the third stage usually being omitted.

An advantage of this method is that it claims to give not only a record of diet for the immediate past but also allows an estimation of nutrient intake over a longer period of time. The method needs at least one hour of careful questioning, and the interviewer must be a nutritionist who is experienced in taking diet histories (Fehily, 1983). The diet history method is not without problems - the method relies on recall of usual dietary intake which is subjective and open to selective reporting. In addition, the interview is likely to be long and detailed requiring both intelligence and motivation from the subject.

In reviewing the then current state of the 'diet history method', Marr (1971) questioned its validity and considered the method unsuitable for the young and the elderly. Several repeat recalls or histories would be needed to establish usual intake, or a period of recall longer than 24-hours which would then be affected by memory.

Livingstone et al. (1992) recently used an adapted 7-day diet history to compare energy intakes reported by both diet history and weighed dietary records with measured energy expenditure. The dietary history was biased towards overestimation; however, this overestimation was relatively small and the results were more representative of habitual energy intake than were the results of the weighed dietary record. In addition, it was found that the diet history overcame some of the problems of under-reporting by adolescents. A word of caution was expressed by the authors that since the diet history is subjective and influenced by memory, it is possible that 'good' foods may be exaggerated whilst 'bad' foods are underestimated. Therefore, energy intakes may be representative of usual intake, whilst nutrient intakes are not.

- **Food frequency questionnaires**

Questionnaires are a more recent addition to dietary survey methodology. In 1960, Wiehl and Reed (1960) advocated the use of a questionnaire in epidemiological studies. The method does not attempt to produce quantitative results, but to give a grade of intake - this can be useful in assessing dietary patterns or specific aspects of the diet. The questionnaires may be self administered and mailed, so no direct contact occurs between subjects and investigators. This method is quick, cheap and relatively simple to analyse. However, the information which can be collected is limited and the production of tested questionnaires requires a great deal of effort from the investigator (Bingham, 1988).

2.2.4 Summary

Each method described above has its merits and limitations. Controversy over which method should represent the 'Gold Standard' has raged. Marr (1971) quoted two opposing views: first, Widdowson (1947) stated that "the method of measurement naturally varies with the material selected, but in all cases the food must be weighed" while, in the same year, Burke (1947) reported that "a detailed dietary history of the dietary habits furnishes important information, since the nutritional status of an individual can be no better than his past and present food habits permit". Similar debate continues today. In 1971, Marr concluded that no all-purpose best method for measuring the nutrient intake of an individual existed. As more attempts to validate different methods had been made, it had become clear that absolute reproducibility and validity were not achieved by any. More recently, in 1987, Bingham (1987) in her review of the dietary assessment of individuals, concluded that from the limited information available, the errors, systematic and random, involved in some of the dietary assessment methods are far greater than generally acknowledged.

Obviously, the absolute intake of an individual is difficult to measure but, in epidemiological surveys, the average intake of the group and the distribution of intakes within that group is usually the information required. In dietary surveys, the investigator's enthusiasm is unlikely to be equalled by all of the subjects. This being the case, the cooperation of the subject has its limitations, but must be maintained particularly when surveys are to be conducted over extended periods.

Experimental developments in dietary survey methodology, for example, the use of photographic or video recordings of intake and use of electronic scales which also record descriptions of food being weighed, may hold promise for future epidemiological surveys. Yet, in the absence of any absolute dietary survey method, the debate over which is the most valid method continues. It will have new interest in the light of the results from recent energy expenditure measurements.

2.3 The National Food Survey: a household survey.

The great importance of the National Food Survey as a long-term monitor of British diets, warrants some discussion of the method used and limitations of the data. When instigated in 1940, the National Food Survey aimed to investigate the diet of the urban working class during wartime Britain, with a view to monitoring the adequacy of their nutritional intake. The survey continued in peace-time and, since 1950, has been national, covering all social groups.

2.3.1 The method

The method used in the National Food Survey has remained virtually unchanged since 1940. Households are selected at random to be representative of Britain as a whole. The 'housewife' (the person responsible for food purchase) keeps a seven day record of quantity and cost of all food items entering the home for human consumption. Sweets, chocolate, soft drinks and alcohol are excluded from the survey as individual household members may buy these without the 'housewife's' knowledge and thus the data collected would be incomplete. The housewife notes the number of family members present at each meal, any visitors and a brief description of the food served over the seven-day recording period. Averages of the amount of food consumed and the expenditure per person, per week, are calculated after making an allowance for waste. The average nutrient intakes are then calculated using standard food tables.

2.3.2 Applications

The National Food Survey gives continuous information on food and nutrient purchasing in Britain. It is also able to give some information on selected sub-groups of the population, for example social class groupings, region and the age of the housewife. The survey monitors trends in household food consumption and provides a means of assessing the 'average' nutritional state in Britain.

This survey, however useful, cannot provide complete data for dietary intake in Britain; it has limitations which should be noted. First, the information collected is confined to food brought into the home and, although the number of meals eaten outside of the home is recorded, the food eaten and hence the nutritional content of those intakes are not included. It is assumed that food at home represents at least 85-90% of the total diet and that the pattern of meals taken at home and outside of the home is similar (Derry and Buss, 1984). All sweets, alcohol, soft drinks and vitamin pills are excluded since, with the exception of vitamin pills, these foods are assumed to contribute only energy to the total diet (Derry and Buss, 1984).

Secondly, although an allowance is made for waste, the survey method investigates the amount of food bought rather than the amount actually eaten. With the rise in use of home freezers this reliance on food bought to reflect food eaten, may no longer be valid.

Thirdly, as the survey collects data for the household as a whole, it is impossible to isolate the estimated nutrient intake of a specific age or sex group. The distribution of food intakes between individuals within families is known to vary considerably (Nelson, 1986).

2.3.3 Developments of the survey

The future of the National Food Survey has recently been reviewed by the Ministry of Agriculture, Fisheries and Food (1991a) and recommendations made to extend the survey to fill the major gaps in the information it collects. It has been recommended that future surveys should include confectionery and that soft drinks should become part of the main analysis. The reason for their previous exclusion (bought by individual family members and eaten outside the home, therefore likely to be under-estimated) is no longer considered a sufficient reason for excluding this important part of the diet. In addition, it has been recommended that information on food bought and eaten away from home should be included in future surveys (Ministry of Agriculture, Fisheries and Food, 1991a). It is estimated in the review, that expenditure on food bought and eaten outside the home, has increased from approximately 20% of total food expenditure in the early 1980's, to approximately 30% today. The gap in the survey in collecting information about the diets of individuals is acknowledged: however, since this was not the intention of the National Food Survey there are no plans to collect this type of information. The changes in the survey method have been implemented from the beginning of 1992.

2.3.4 Summary

If the limitations of the National Food Surveys to date are understood, then the data can be a valuable source of information. The survey can also be useful in highlighting some groups of households which may be nutritionally vulnerable and so warrant investigation by a more detailed method. Indeed, the Department of Health and Social Security, now the Department of Health, have undertaken several such studies of the diets of the very young, adolescents, the elderly and, more recently, adults (Department of Health and Social Security, 1975; Darke and Disselduff, 1981; Department of Health, 1989a; Gregory et al., 1990). Dietary surveys of sub-groups of the population are essential if we are to continue to monitor intake and nutritional adequacy. The new plans for the National Food Survey will make it more complete, but will not remove the need for more detailed dietary investigations of specific age and sex groups within the population.

2.4 Dietary surveys of young adolescents - a review

> 'The majority of dietary surveys have been inspired by an interest in food requirements' (Widdowson, 1947).

This statement is only partially true today, since increased interest and knowledge of correlations between diet and disease has meant many surveys now aim to investigate this link - for example, coronary heart disease or dental caries. However, for certain vulnerable sub-groups of the population - the very young, the elderly and adolescents - adequacy of nutritional intake and food requirements remain an area of concern. Several studies have investigated the diet of very young and pre-schoolchildren, yet the number of surveys of young adolescents, here defined as aged between 10-15 years, is surprisingly small, particularly when the importance of adequate nutrition at this time of growth and physical and social development is considered. This review of the surveys of young adolescents will be confined to those of children in the UK, which include those aged between 10 and 15 years. A summary of the surveys reviewed, their main aims and findings are given in Table 2.1.

The first large scale study of the diets of individuals was the survey of children's food intakes by Widdowson (1947), conducted between 1935 and 1939. Dietary intakes of 916 children were collected using Widdowson's seven-day individual weighed method. One thousand children, aged between 1 to 18 years, were originally recruited from middle class families living in south east London. At least 20 boys and 20 girls at every year of age from 1 to 18 were investigated, the aim being to examine the effects of age on dietary intake and food habits. Recruitment was non-random using word of mouth, friends and colleagues (Table 2.1).

The energy intakes recorded by Widdowson (1947) were considerably higher than those reported in more recent surveys. Boys aged 11 to 12 years recorded energy intakes of between 10.55 and 11.00 MJ, whilst girls of the same age had energy intakes of 9.59 to 9.92 MJ, of which 36% was derived from fat. The most recent comparable survey was of children aged 10 to 11 years (and 14 to 15 years), undertaken by the Department of Health in 1983 and reported in 'Diets of British schoolchildren' (Department of Health, 1989a). The average energy intake by 10 to 11-year old boys was 8.67 MJ and for girls 7.69 MJ (of which 38% was derived from fat); a decrease in energy intake of approximately 20% over 50 years with an increase in the proportion of energy contributed by fat. Intakes of nutrients by 11 to 12-year-olds were also reported by Widdowson (1947): calcium intakes were 890mg and 720mg for 11-year old boys and girls respectively; for iron the corresponding intakes were 13.3mg and 11.6mg. The diets of British schoolchildren (Department of Health, 1989a) found slightly lower calcium intakes by 10 to 11-year old boys (833mg) and girls (702mg), and lower iron intakes (boys 10.0mg, girls 8.6mg).

Widdowson (1947) reported the average height of 11 and 12-year old boys and girls (1.44 to 1.49m and 1.46 to 1.50m, respectively) and weight (36.0 to 39.1 Kg, 37.6 to 39.5 Kg, respectively). There was a tendency for children in the 'artisan' lower social class groups to be smaller and lighter than the children from 'professional' groups. This finding should have been a cause for concern, since the sample for this survey was specifically taken from middle class families and so excluded the children of the lower social classes, whom it may be assumed, would be most at risk of nutritional deficiencies. Although the total sample size for this survey was large (916 children), the age range investigated (1 to 18-years) meant that the age and sex sub-groups in the sample were small (20 to 30 subjects) which restricts the value of the survey for comparative purposes with current studies. In addition, the highly selective nature of the sample means that the results may not reflect the nutritional intake of the population at the time (Table 2.1).

Publication of Widdowson's results was delayed until 1947, due to the outbreak of war. No further surveys of this age group were reported until the late 1960's and 1970's, so that no datum exist on the nutrient intake of adolescents between 1939 and 1968 - a gap of almost 30 years. Following on from the work of Widdowson, some researchers have aimed to select a representative sample, others (the majority) to draw a sample from those who have been considered to be particularly vulnerable.

During the period of 1968 to 1970, Cook et al. (1973) investigated the diets of children and adolescents aged 8 to 11 years and 13 to 15 years using 7-day weighed records. Data were collected from 778 children who accounted for 77 per cent of the original sample. The main concern of this study was the effect of social class on nutritional status. To this end, the sample was intentionally weighted to have high numbers of children who were considered to be at risk, that is, children of low social class or from families where no father was present. It was found that all groups had energy intakes below the Recommended Daily Amounts (Department of Health and Social Security, 1969). Intakes of vitamin A and vitamin C were above Recommended Daily Amounts and calcium intake was high, particularly for boys. Boys had higher intakes than girls of all nutrients. Social class was not found to be associated with differences in average daily nutrient intake, with the exceptions of protein and riboflavin. However, there was a social class trend in nutrient density (nutrients per unit energy), which is considered a measure of diet quality. Children from high social groups had a higher intake of most nutrients per unit energy, than children of low social groups; the exceptions being for carbohydrate and added sugars for which children from low social groups had the highest nutrient density. Children from fatherless families, despite having lower energy intakes, were reported to have a diet of higher nutrient density than other children, for all nutrients except carbohydrate and added sugars. All children were examined for clinical signs of nutritional deficiencies - no overt deficiencies were found. This survey investigated a large sample of children which required the dietary data to be collected by several field-workers (Table 2.1). The effects of using more than one field-worker were investigated in a pilot study (Topp et al., 1972) and found to have negligible effect on the results. The pilot study involved weighed inventories from selected cooperative children for four 7-day periods. Nutrient intake tended to increase towards the second week and decrease towards the fourth (Topp et al., 1972), and it was suggested that this could be explained by the mothers' efforts to provide an optimum diet in the early weeks, which lapsed towards the fourth. This trend may have had an effect on the results of the main study (Cook et al.,1973) which collected only one week of weighed dietary intakes.

In 1970, continued concern about the nutritional status of vulnerable groups of adolescents, prompted the Department of Health and Social Security to investigate the dietary intake of children from one parent families. Newcastle upon Tyne was selected as the survey area (Darke et al., 1980a). Initially, information on family composition was requested from 2960 children; 71 percent responded, from which 110 matched pairs, aged 14 to 15 years (one parent family: two parent family) were randomly selected. Seven day weighed records were completed successfully by 163 children (88 children from two parent families and 75 children from one parent families): this represented 74 per cent of the selected sample. Darke et al. (1980a) reported no significant differences in mean energy or nutrient intakes between girls from one or two parent families. Fatherless boys had larger intakes of energy, protein, calcium, iron and other nutrients than boys with a resident father. The nutrient quality (nutrient density) of diet was similar in both groups, for both boys and girls. There was no measure made of the length of time that the fatherless children had been without a father, or indeed of the social class of either group. Both of these factors may have influenced dietary intake. It may be that low social class children from one-parent families, could have been considered an 'at risk' group, however the sample size in this survey would have been insufficient to allow any sub-divisions of this nature (Table 2.1).

In January to March of 1971, the Department of Health and Social Security conducted a nutritional survey of schoolchildren aged 10-11 years living in Bristol, Croydon and Sheffield. Seven-day weighed records were used (Darke and Disselduff, 1981) (Table 2.1). The survey was instigated to investigate the possible effects on childrens' nutrient intake of discontinuing school milk provision for children over the age of 7 years and in some areas increased school meal costs, from April of that year - no survey was conducted after April 1971 to measure change. Schools were specifically selected to include children thought to be at risk of nutritional deficiencies, that is children whose parents had incomes just above the level which qualified for free school meals. At this time school caterers had a statutory obligation to comply with nutritional requirements set for school meals (Department of Education and Science, 1975). This remained in force until 1980, when that obligation was removed and not superseded.

Darke and Disselduff (1981) collected 321 weighed dietary records, 71% of the original sample. Mean daily intakes of energy and nutrients were similar in the three areas. Nutrient intakes were not found to be related to social class, income, mothers work status or family size, although they were found to be related to the education level of the mother. Children of mothers who had continued in full-time education, after the age of 16 years, had higher intakes of most nutrients. School meals attendance was found not to make a difference to total mean daily intakes. However, the proportion of total daily intake derived from school meals was greater for those children from larger families and from social classes IV or V. Children who took school milk had larger intakes of energy, protein and calcium than other children. This study showed that, at this time, school meals were of particular importance to those who could be considered to be most at risk of nutritional deficiencies.

The survey considered any possible regional variations and aimed to investigate those thought to be at risk. No data were available on non-responders although anthropometric measurements indicated that those who initially agreed to participate, but then did not complete the dietary record, were not different in this respect from those who completed the survey. It is a concern of studies in this nature that the non-responders may be the very population most at risk - a high response rate is essential if valid conclusions about the entire population are to be drawn from the results.

In 1974, Durnin et al. (1974) reported the results of a unique study: a repeated cross-sectional nutritional and anthropometric study of young adolescent schoolchildren, with an interval of 7 years between surveys. This was the first survey to measure change over time in the diet of this age group. The dietary data were collected using 7-day weighed records, in 1964 (n=192) and again in 1971 (n=419) from children aged 14-years (the authors did not state whether the surveys were undertaken by the same fieldworkers in both 1964 and 1971). The children were from a variety of social-economic backgrounds although the social group profile did differ between surveys. In 1964, eight schools were selected from different parts of the city of Glasgow, while in 1971 this was increased to eleven schools - it is unclear whether the 1971 survey included the eight schools of the 1964 survey. In 1964, 41% of the children were of high social group, which fell to 30% in 1971. The authors found that although heights and body weights were similar, there was a decrease in the intake of total energy, protein, fat, carbohydrate, calcium and iron between 1964 and 1971. A decrease in physical activity over the intervening period was the only obvious explanation for the maintenance of body weight, despite decreased energy intakes. The boys from the poorest social groups had the lowest intakes of protein, energy, calcium and iron. The results for the girls were different from those of the boys; no difference between the social groups was reported, except that girls in the lower social group in the 1971 survey had lower average calcium intakes and a higher intake of carbohydrate than girls from high and middle social groups. Dietary intakes by all sex and social groups met all of the then current UK dietary recommendations, except that of energy (Department of Health and Social Security, 1969). A criticism of this study, which the authors themselves highlight, was the small number of subjects from the lower social groups taking part in the survey. This was particularly so in the 1964 survey, when only 16 boys and 10 girls represented the lowest social group. Although the response rate was between 70 and 90%, the sample did not contain the same proportion of the poorest children compared with the other social groups. The probable unrepresentative nature of the sample may have introduced bias into the mean results for all subjects (Table 2.1).

The trend illustrated by Durnin et al. (1974) of reducing energy intake over time, was investigated by Whitehead et al. (1982). Energy intakes reported from dietary surveys of children, conducted between the late 1930's and 1980's, were reviewed. Whitehead et al. (1982) demonstrated a decline in energy intake over time which was explained as a consequence of a reduction in physical activity. Durnin et al. (1974) had speculated that the Recommended Daily Intakes for energy by children (Department of Health and Social Security, 1969) were too high since in their survey all Recommended Daily Intakes had been met, the only exception being that of energy. Recommended energy intakes were subsequently reduced in the 1979 review of Recommended Daily Amounts (RDA) (Department of Health and Social Security, 1979) - however, Whitehead et al. (1982) suggested that, in view of the then current levels of physical activity by adolescents, the new RDA for energy (published in 1979) continued to be too high.

These surveys used weighed records to measure intake; however, recent surveys have shown that weighed intakes are subject to under-reporting by adolescents (Livingstone et al., 1992). Yet a trend in declining energy intakes has been detected - this raises the question of whether adolescents in early surveys of the 1930's reported more fully than did the adolescents of the 1990's, or that there has indeed been a fall in energy intake over time. It may yet become apparent that the energy intake of this age group has been underestimated.

In 1976, concerns that children from poor families persisted to be shorter than average and suggestions that these children had a diet of borderline nutritional adequacy, prompted Nelson and Naismith (1979) to study the nutritional status of poor children living in London during 1976 (Table 2.1). One thousand households living in poor areas were surveyed, of which 112 households, who had children aged between 1 and 12 years considered to be at risk, were recruited. All the families were from social groups IV or V only. Eighty parents were asked to complete 7-day diaries, for one of their children, recording all food and drink intakes using household measures. Sixty records were successfully collected (75% response). A significant proportion of children were found to be below the normal distribution for growth and physical development - of the caucasian children studied, 21% were below the 10^{th} percentile for height. Dietary data for the children of shortest stature showed low intakes of energy and iron, and at least 11% of the children in the survey were judged to be mildly to moderately malnourished.

Nelson and Naismith (1979) concluded that whilst it was not possible to positively incriminate diet as responsible for low height attainment, it was likely that diet was a limiting factor. Although the sample was highly selected and the total number of subjects small, the results of this survey indicated that in the mid-1970's it could not be assumed that the nutritional intake of all children in Britain was adequate.

A two-year longitudinal nutritional survey, conducted between 1979 and 1981, of 405 children initially aged 11.5 years, was designed to measure dental caries increment and diet over a two year period (Hackett et al., 1984a). Nutritional data were collected by five repeated 3-day dietary diaries using household measures, each diary was followed by a private interview with a dietitian. Whilst the data would not allow valid comparisons of the diets of individuals, one of the aims of the survey was to compare the average nutrient intakes of different sex and social class groups (Table 2.1).

In common with other dietary surveys of the time, the average energy intakes recorded were below the RDA (Department of Health and Social Security, 1979). The average iron and vitamin A intakes were low (below RDA) for all groups, whilst average calcium intakes were just above the RDA. The effect of social class on nutrient intake was also assessed: few differences were found in the average nutrient intake between social class groupings; however the nutrient density (nutrients per unit energy) of the children's diets showed a social group trend with those of low social group having the poorest quality of diet. The authors expressed concern that if energy intakes continued to fall, a higher quality of diet would be necessary to maintain adequate nutrient intakes. The nutrient density of the diet of these children was compared with that of the children studied in the late 1930's by Widdowson (1947): with the exception of calcium, which had improved due to flour fortification, there had been little change in the quality of the diet.

The three studies discussed above (Durnin et al., 1974; Nelson and Naismith, 1979; Hackett et al., 1984a) were all regional studies; in addition, that of Nelson and Naismith was highly selective. Despite this, the results of Durnin et al. (1974) and Hackett et al. (1984a) were in broad agreement with each other and with other studies discussed, which suggests that the results of these regional studies were applicable nationally.

In 1983, a major national survey - 'The diets of British schoolchildren' - was commissioned by the Department of Health (1989a) (Table 2.1). The instigating factor for this survey was the 1980 Education Act (H.M. Government, 1980), which removed the statutory nutritional requirements of school meals, previously imposed on Local Education Authorities in England and Wales (Department of Education and Science, 1975). There was a need to monitor any nutritional consequences resulting from this change in legislation.

Seven-day weighed records were collected from 2697 children by a team of trained fieldworkers; this number represented a response rate of approximately 75%. The children were from two age groups - 10 to 11 years and 14 to 15 years. Children in the younger age group (10 to 11 years) who had unemployed fathers, or came from families in receipt of supplementary benefits, were significantly shorter in stature than children from higher social class families, demonstrating the persistence of a social class gradient in stature into the 1980's. Average energy intakes (boys 8.67 MJ, girls 7.57 MJ) were approximately 90% of the then current RDA (Department of Health and Social Security, 1979). The mean iron intakes recorded by all groups, with the exception of the older boys, were below the RDA of 12mg. Mean calcium intakes of the boys, of both age groups, exceeded the RDA (700mg). Whilst the mean calcium intake of the girls aged 10 to 11 years were just above the RDA, that of the older girls failed to meet it: 60% of girls aged 14 to 15 years had calcium intakes below 700 mg.

Nutrient intake by each sex and social class group was also investigated (Department of Health, 1989a). Energy intake was not found to be affected by social class. However, there was a trend toward lower nutrient intakes by the children from the lower social class groups, when compared with the other children. Low social group boys, aged 10 to 11 years, had lower intakes of calcium and vitamin C than boys from other social groups. For girls of the same age (10 to 11 years), average intakes of all nutrients fell with social class - low social class girls had the lowest intake of all nutrients. For adolescents aged 14 to 15 years, the boy's intakes of iron, thiamin and vitamin C fell with social class, while for girls, intakes of iron, thiamin, riboflavin, nicotinic acid and pyridoxine were all lowest for the girls from the low social class groups.

Unfortunately, this extensive survey using weighed intakes from the largest age-specific sample to date, did not investigate the total, added or natural sugars intake, or the unavailable carbohydrate intake of these children.

Controversy over nutrient intakes, vitamin and mineral supplements and intelligence in British schoolchildren, following a dietary supplementation study reported by Benton and Roberts (1988), prompted a study by Nelson et al. (1990). The nutritional survey component of this study only, is relevant here. Children (n=143) aged 11 to 12 years completed 7-day weighed records during 1988 and the results were analysed by age and sex but by not social class. For both sexes, low energy intakes were reported - boys 7.74 MJ, girls 7.45 MJ - compared with the then current RDA's (Department of Health and Social Security, 1979) of 9.5 to 11.0MJ for boys and 8.5 to 9.0MJ for girls. All other nutrient intakes, with the exception of iron, exceeded Recommended Daily Amounts.

2.4.1 Summary

The surveys in the UK of diets of young adolescents from the mid 1930's to date indicate several areas of concern, particularly low intakes of calcium and iron against a background of declining energy intake. Social class gradients, with children from lower social class groups recording the lowest intakes, have been reported for both nutrient intake and nutrient density (Cook et al., 1973, Hackett et al., 1984a). In addition, children from lower social class groups have been reported as being shorter in stature than children from other social class groups (Widdowson, 1947; Nelson and Naismith, 1979; Hackett et al, 1984a; Department of Health, 1989a).

The number of investigations into the diets of young adolescents is small. Of the surveys that have been reported, in some, the sample have been selected from specific sections of the population and therefore are probably not representative of young adolescents as a whole (Widdowson, 1947; Cook et al., 1973; Nelson and Naismith, 1979; Darke et al., 1980a; Darke and Disselduff, 1981) while, in others the sample sizes have been too small to allow nutrient intake to be reported for each sex and social class group separately (Darke et al., 1980a; Nelson et al., 1990).

One problem which is encountered in dietary surveys of children is whether the recording of the dietary data should be completed by a parent or the child. Adolescents of 11 to 12-years are able to record their intake, but would be unlikely to comply fully with a weighed record. Conversely, the parents of an 11 to 12-year old are unlikely to be present at all of the child's 'eating events'. The possibility of incomplete records must be considered against the loss in accuracy when using estimated, rather than measured weights (section 2.2). In the 'diets of British schoolchildren' survey (Department of Health, 1989a) each subject was given a second record book in which to record foods eaten outside of the home. Foods eaten outside the home were recorded using household measures, so a combination of weighed record and estimated weight record was used. Arrangements were made at schools to have scales available for children who took school meals. It is essential that considerable resources are available, as well as a large number of trained fieldworkers to provide the guidance and support needed during weighed intakes, particularly when this method is employed to measure the dietary intake of children.

The Recommended Daily Amounts (Department of Health and Social Security, 1979) have recently been extensively reviewed and replaced by Dietary Reference Values (DRVs) (Department of Health, 1991) (DRVs are discussed in section 2.7.2.3). For children aged 11 to 14 years, reference values for energy and protein have been reduced, whilst the reference values of calcium have been increased for both boys and girls, and that of iron has been increased for girls only. In view of reported decreases in energy intake, along with increases in the dietary reference values, particularly of calcium and iron, an increase in the nutrient density of children's diets will be necessary if all requirements are to be met. This is particularly relevant for children of lower social class who have been reported to have diets of the lowest nutrient density.

Table 2.1 Nutritional surveys of young adolescents - a summary by date of survey.

Author(s), aims, location, date of survey, response and completion rates* and number of subjects analysed	Main findings of survey and comments
Widdowson (1947) Main aims **To investigate diet in childhood.** Location London Year 1935-1939 Age group(years) 1-18 Response/completion rate (volunteers only) No of subjects 916	Main findings For 11 to 12-year-olds energy intakes high (boys 11.0MJ, girls 9.9MJ). Shorter stature children from lower income families. Comments Children were selected from middle s.c. families only. Age sub-groups were small.
Cook et al. (1973) Main aims **To investigate effect of s.c. on nutritional status.** Location Kent Year 1968-1970 Age group(years) 8-11 and 13-15 Response rate 90% Completion rate 84% No of subjects 778	Main findings Nutrient intake not associated with s.c. Low s.c. associated with lower nutrient density. Fatherless children found to have a diet of higher nutrient density. No overt signs of nutritional deficiency found. Comments Sample intentionally weighted to include high numbers of low s.c. and fatherless children. Pilot survey suggested recording may have improved intake.

Table 2.1 Nutritional surveys of young adolescents - a summary by date of survey.

Author(s), aims, location, date of survey, response and completion rates* and number of subjects analysed	**Main findings of survey and comments**
Darke et al. (1980a) Main aims **To investigate dietary intake of children from 1-parent families.** Location: Newcastle upon Tyne Year: 1970 Age group(years): 14-15 (110 matched pairs) Response rate: 71% Completion rate: 74% No of subjects: 163	Main findings No effect on nutrient intake or nutrient density found. Fatherless boys had higher intakes of energy and several nutrients. Comments No measure of time a family had been fatherless or s.c. of families. Intake of both low s.c. and 1-parent not measured.
Darke & Disselduff (1981) Main aims **To investigate effects of changes in school meal provision.** Location: Bristol, Croydon, Sheffield Year: 1971 Age group(years): 10-11 Response rate: not given Completion rate: not given No of subjects: 321	Main findings Nutrient intakes found not to be related to s.c. Intakes related to educational level of mother. School meals most important for children from large families or low s.c. Comments Included possibility of regional differences; none reported. Schools selected to include those at risk.

Table 2.1 Nutritional surveys of young adolescents - a summary by date of survey.

Author(s), aims, location, date of survey, response and completion rates* and number of subjects analysed	**Main findings of survey and comments**
Durnin et al. (1974) <u>Main aims</u> **To investigate change in intake over time, in the same age group** Location: Glasgow Year: 1964 and 1971 Age group(years): 14 Response rate: 70-90% Completion rate: not given No of subjects: 1964 n=192 1971 n=419	<u>Main findings</u> Decrease in energy and nutrient intake 1964 to 1971. Some social group trends detected, low s.c. children having lower intakes, except energy and carbohydrate. <u>Comments</u> Samples included low numbers of children from low s.c. families.
Nelson & Naismith (1979) <u>Main aims</u> **To measure dietary intake and nutritional status of poor children.** Location: London Year: 1976 Age group(years): 1-12 Response rate: not applicable Completion rate: 75% No of subjects: 60	<u>Main findings</u> 21% of sample were below 10^{th} percentile for height. Short children had lowest intakes of energy and iron. 11% of children mild to moderately malnourished. <u>Comments</u> Children highly selected to include only poor children at risk. Final sample small.

Table 2.1 Nutritional surveys of young adolescents - a summary by date of survey.

Author(s), aims, location, date of survey, response and completion rates* and number of subjects analysed	**Main findings of survey and comments**
Hackett et al. (1984a) Main aims **To measure diet and dental caries increment over 2 years. To compare nutrient intake by sex and s.c.** Location: Northumberland Year: 1979-1981 Age group(years): 11-13 Response rate: 59% Completion rate: 87% No of subjects: 405	Main findings Nutrient density showed s.c. trend - low s.c children had poorest quality of diet. Comments Low response and completion rates may be because of requirement to complete 5 3-day dairies over 2 years. Dietary data collected by one interviewer.
Department of Health and Social Security (1989a) Main aims **To monitor the effects of the 1980 Education Act and subsequent change in school meals.** Location: Great Britain Year: 1983 Age group(years): 10-11 and 14-15 Response rate: 53% Completion rate: 92% No of subjects: 2697	Main findings Social gradient in stature found. Low intakes of iron by boys and girls. Low intakes of calcium by girls. Low s.c. children had lowest nutrient intakes. Comments Largest age-specific sample to date. Dietary sources of sugars and 'fibre' not investigated.

Table 2.1 Nutritional surveys of young adolescents - a summary by date of survey.

Author(s), aims, location, date of survey, response and completion rates* and number of subjects analysed	Main findings of survey and comments
Nelson et al. (1990) <u>Main aims</u> To investigate the part played by diet in determining intelligence in children. (11 to 12-year old age group only relevant). Location London Year 1988 Age group(years) 11-12 Response rate not given Completion rate 81% No of subjects 143	<u>Main findings</u> (nutritional intake only) Low energy intakes reported (boys 7.74 MJ, Girls 7.45 MJ). Intakes of all measured nutrients, except iron, were adequate. <u>Comments</u> Intake not reported by s.c.

s.c. Social class

* Response rate is the per cent of those initially invited to participate who volunteered
* Completion rate is the per cent of volunteers who completed all parts of the dietary survey

2.5 Food consumed outside the home

> Simple Simon met a pie-man going to the fair.
> Said Simple Simon to the pie-man,
> "please let me taste your ware."

Eating outside the home and take-away food is not a new phenomenon, yet the part played by these foods in the total diet is increasing. As eating patterns within Britain change away from the traditional three meals a day eaten at home, increasing attention is being paid to foods which are purchased and consumed outside the home. From recent dietary surveys of adults, in which information on place of consumption has been recorded, it is recognised that surveys of food eaten at home can no longer represent complete dietary intakes.

Dietary surveys of children, which have included food consumed outside the home, have tended to focus on school meals: that is the uptake of school meals, the nutritional quality of the meals received and the contribution made by school meals to the total diet of schoolchildren.

2.5.1 School meals

Until 1980, the Department of Education and Science (1966 and 1975) laid down standards which were to be attained by school meals; the average meal for a 12-year old child was required to contain 29g of protein, 880kcal and 32g of fat. As discussed previously (section 2.4) Cook et al. (1973) conducted a dietary survey of 778 Kent schoolchildren, aged 8 to 11 years and 13 to 15 years, between 1968 and 1970. In addition to investigating total dietary intake, this survey explored the importance of school meals for these children (Cook et al., 1975). About 80% of the children took school meals - these meals broadly met the required standards, although the mean energy and protein intakes were slightly lower and fat content higher than stipulated (Department of Education and Science, 1966). In all sub-groups studied, with the exception of 13 to 15-year old girls, school meals provided higher intakes of energy and nutrients than the alternative types of lunch, for example packed lunches or lunches bought at take-away food outlets. Children of low social class, those from larger families and those from one-parent families were more likely to take a school lunch than other children. Cook et al. (1975) found that low social class children, who took school meals, derived a higher proportion of their weekday energy and nutrients from their school lunch than did their contemporaries from higher social class groups. The remaining weekday diet of these low social class children was low in nutrients. It was concluded that children from low social class families relied on the school meal to provide nutrients important for growth to a greater extent than other children (Cook et al., 1975).

The main findings of the study by Durnin et al. (1974) have already been discussed (section 2.4); this reported the results of a repeated cross-sectional nutrition study of 14-year old Glasgow children, conducted in 1964 and 1971. Again, school meals were the only 'outside of the home' food source considered to warrant specific attention. In 1964, no difference in mean total energy intake was found between the children who had a school dinner and those who obtained lunch from an alternative source. In 1971, lower social groups girls, but not boys, who ate school meals had a higher mean total energy intake than the lower social group children who had lunch elsewhere. The mean nutrient content of the school dinners or the lunches obtained from other sources were not reported.

Calculations from the results of Durnin et al. (1974) suggest that, in 1964, 34% of the children in this study had school meals, in 1971 this had fallen to 24%. These are very low values when compared with those collected by Cook et al. (1975) who reported 80% attendance at school meals. Durnin et al. commented on the small number of low social group children in their survey, particularly in 1971, whereas Cook had surveyed a sample specifically weighted to include high numbers of low social group children. In 1971, Durnin et al. collected dietary records from only 19 children who were both from low social group families and school meal consumers. It is likely that if school meals did affect total nutrient intake, this sample was too small to detect this.

In early 1980, an Education Act (H.M. Government, 1980) freed local authorities from the legal obligation to provide school meals, hence the nutritional requirements of school meals ceased to apply. In many schools, the traditional school dinner was replaced by a self-selection cafeteria style system. Following the findings of Cook et al. (1975) there was concern that the nutritional status of children of social classes IV and V may suffer as a result of this change. However, the data in the Kent survey had been collected in 1968-1970, since which time there had been considerable changes in the eating habits of Britain as a whole (Ministry of Agriculture, Fisheries and Food, 1991a). There was a need for more current data on the significance of school meals in the total dietary intake of children from low social class families.

Between 1977 and 1979, Nelson and Paul (1983) measured the nutritive contribution of school lunches and other midday meals to the total diets of 191 Cambridge children aged 5-10 years and 11-17 years. The target set by the Department of Education for the nutritive value of school meals at this time was - 33% of the Recommended Daily Amount for energy and 42% of the Recommended Daily Amount for protein (Department of Education and Science, 1975). This study sought to provide a baseline against which the effects of legislative changes to school meals could be monitored.

Nelson and Paul (1983) found that only 49% of midday meals taken by the children were school meals, considerably lower than 80% reported by Cook et al. (1975). School meals provided less than one quarter of the Recommended Daily Amount for energy and iron and less than one third of the Recommended Daily Amount for protein, calcium and vitamin C, and so failed to meet the set targets. School meals provided a smaller proportion of a day's total nutrient intake than any other kind of midday meal and average total energy intakes were lower on school-dinner days, than on other weekdays. This was completely the reverse of the findings of Cook et al. (1975). Despite these conclusions, Nelson and Paul (1983) found that school meals continued to play a most important role in the nutritional intake of children from lower income families. Low social class children ate larger school meals, and obtained a larger proportion of their total nutrient intake from that source, than children from the other social class groups.

The need to monitor the effect of the 1980 Education Act, prompted the Department of Health's survey of the Diets of British Schoolchildren (Department of Health, 1989a). The survey measured total diet, which has been previously discussed (section 2.4), but also investigated the source and nutrient content of weekday lunch-time meals taken by 2697 children in 1983. Weekday lunch-time meals were classified into seven categories which included: paid or free school meals, lunch at home, packed meals, and lunch from a cafe or take-away restaurant. When different kinds of school meals systems were investigated - cafeteria, traditional fixed price and sandwich meals - no major differences between the patterns of energy or nutrient intakes for any children in any age and sex group were apparent. When school meals were eaten, they contributed on average 30-43% of daily energy intakes. It was found that boys and girls in the 10 to 11-year old age group who had free school meals, were of shorter stature than those who paid for their school meal. There were no significant differences in the energy or nutrient intakes within the 10 to 11-year old boys or within the girls regardless of the type of midday meal taken. Only 2% of the children in this age group ate at cafes or take-away restaurants on schoolday lunch-times, but this increased to 13% in the 14 to 15-year old group.

For 14 to 15-year old boys, the type of lunch taken did not effect their total energy or nutrient intakes - the poor nutrient content of some lunches was compensated for at other times. For girls in this 14 to 15-year old age group, some differences were evident. Girls who went home for lunch consumed less energy than those who received a free school meal every day, while girls who ate at cafes or other take-away outlets for lunch (11 % of 14 to 15-year old girls) had the lowest intakes of iron, protein, calcium, retinol equivalent, nicotinic acid equivalent and vitamin D, although their daily energy intakes were similar to other groups. The average nutritional quality (nutrient density) of the total diet of these girls was lower than of any other group. The poor nutrient quality of cafe meals selected at lunch-time was also evident in the boys. However, boys compensated for these poor intakes at other meals, whereas girls only partially made up the deficit.

The Diets of British Schoolchildren survey (Department of Health, 1989a) showed that in 1983 on schoolday lunch-times, children's food intake 'away from home' was not confined to school meals. The significance of eating away from home, at times other than on schoolday lunchtimes, was not investigated in this survey. Schoolday lunches account for only one meal a day, for a maximum 220 days a year - this represents less than 55% of a child's midday meals. The place of purchase of the remaining 45% of midday meals, other meals and all casual non-meal food intakes in the diet of adolescents is not known, indeed no data on this subject exist for children. Recent surveys have begun to investigate the place of purchase of food by adults but, as yet, surveys of adolescents have not collected such information.

2.5.2 Food consumed outside the home by adults and the population as a whole

In the absence of more specific data on the food eaten outside the home by children, it is worthwhile to review briefly the small number of studies which have investigated food consumed outside the home by adults. Although the classification of foods as 'outside the home' is not consistent between surveys, the information collected is relevant to this thesis and so will be briefly discussed.

While the National Food Survey monitors trends in the diet of the population as a whole, it does not report nutrient intake of foods eaten away from home but gives the average number of meals purchased and consumed outside the home, per person, per week. These data indicate that eating patterns of the population have changed - in 1980 an average of 3.23 meals per person, per week, were purchased and eaten outside the home, while by 1990 this had increased to 3.76. It should be noted that these figures are for meals only and do not include casual non-meal food intakes such as soft drinks or confectionery. It was estimated that expenditure on foods bought and consumed outside the home accounted for approximately 20% of total food expenditure in 1980, which had increased to 30% in 1990 (Ministry of Agriculture Fisheries and Food, 1991a).

Loughridge et al. (1989) investigated the role of food bought and consumed outside of the home by 70 adults (aged 15-64 years) over a 3 day period. Packed meals and other food prepared at home but eaten elsewhere were considered to be home consumption. Ninety-one per cent of men and 83% of women ate outside the home over the recording period, which increased to 100% for both sexes when the youngest age group (15-24 years) only was considered. 'Outside the home' foods contributed 25% of the total energy intake along with a lower proportion of protein (22%) and dietary fibre (17%), and a higher proportion of fat (25%) and total sugar (26%). The authors concluded that foods purchased outside the home were significant contributors to the total nutrient intake.

In 1990, the Department of Health published the results of a large dietary survey of 2000 British adults, aged between 16 and 64 years (Gregory et al., 1990). One aspect of this extensive survey was to record the place of food consumption. Any food eaten outside the home was classified as 'away from home' regardless of where it was prepared - therefore, in this survey the packed lunch would have been recorded as food from 'outside the home'. During the 7-day study period over 90% of those surveyed derived some food energy from sources outside of the home. Excluding alcohol, 'away' foods contributed 31% of the total energy intake for men and 23% for women. Foods eaten outside of home provided less protein, dietary fibre, iron and vitamins per unit energy than food from 'home'. The average percentage of total intake obtained from outside of the home, for both sexes, was 29% for energy with similar proportions of fat (28%), carbohydrate (27%) and total sugars (30%), but lower proportions of protein (24%), dietary fibre (23%), iron (24%), calcium (26%) and vitamin C (23%). There was a social class gradient evident, with a smaller proportion of the lower social class groups eating out.

2.5.3 Summary

The preceding paragraphs have discussed the importance of food consumed outside the home in the diets of adults only - no such information exists on the diets of children. These studies have shown that eating outside the home makes a considerable contribution to the total energy and nutrient intakes of adults and also that 'diet' selected outside the home does not always have the same nutrient composition as the 'diet' eaten at home. The National Food Survey has demonstrated that the consumption of 'meals' away from home is increasing in the British population as a whole.

Limited data on schoolday lunches and their place of purchase are available for children - the most recent survey (Department of Health, 1989a) to investigate this, showed that school meals were not the only lunch-time source of food outside the home for young adolescents.

In 1979, 64% of children were eating school meals in England, but by 1991, this had fallen to 42% (Department of Education and Science, 1992). Calculations from data of the Department of Health's 1983 survey (Department of Health, 1989a) suggest approximately 56% of 10 to 11-year old children and 42% of 14 to 15-year old children took school meals, either free or paid, on all or most of the schooldays surveyed. The remaining children either returned home for lunch (13% of 10 to 11-year-olds, 23% of 14 to 15-year-olds), had a packed lunch (28% of 10 to 11-year-olds, 23% of 14 to 15-year-olds) or went to a cafe or take-away (2% of 10 to 11-year-olds, 13% of 14 to 15-year-olds).

No further information on food purchased by adolescents exists beside these limited data, which are restricted to schoolday lunches. More detailed information on foods eaten outside the home by adolescents, their purchasing habits and sources of food would be useful to help target future dietary education programmes. If children follow the purchasing patterns of adults, casual or snack intakes from shops and cafes, at times other than schoolday lunch-times need also to be measured. Eating outside the home is an important source of energy and nutrients for adults, similar information on the significance in the total diet of the foods purchased independently by children is not available.

2.6 Areas of nutritional concern in adolescents

> There is no human society that deals rationally with food in its environment, that eats according to the availability, edibility and nutritional value alone (Lavik, 1981).

Early adolescence marks the beginning of a period of profound physiological and social changes. The period of rapid growth, which occurs with the onset of puberty, demands increased nutritional intake relative to body weight and so calls for a diet of high nutrient density. At the same time, the social changes and increased independence associated with adolescence will affect food choice. Nutritional status is an important determinant of growth throughout childhood and adolescence, although social factors should not be discounted (Nelson, 1980).

Historical records show a progressive increase in the height and weight of schoolchildren (Tanner, 1966; Greenwood and Richardson, 1979). Dietary and anthropometric surveys have shown that low social class children have a lower nutrient intake and are shorter in stature than children from high social class (Widdowson, 1947; Nelson and Naismith, 1979; Rona et al., 1988) (section 2.4). Yet, the gap between the social groups has narrowed since 1936, when Boyd Orr reported that the average height of 14-year old boys in the lower social groups was 8cm below that of the 'artisan' groups and 15cm below that of boys from the 'professional' classes. In 1976, Nelson and Naismith (1979) found that 21% of 'poor' children were below the 10th percentile for height.

Despite apparent improvements in nutritional status, when increased needs of growth and development are combined with changes in eating behaviour, adolescents remain a group at potential risk of malnutrition - both deficiencies and excesses (section 2.4). Social pressures play a large part in dietary changes when, for the first time, a young person begins to take some responsibility for their own diet. These factors distinguish adolescents as a group worthy of continued monitoring. The main areas of concern are discussed below.

2.6.1 Missing meals

Missing meals is cited as an adolescent characteristic (Truswell, 1985) and this has prompted speculation and some investigation into the effect of meal skipping - particularly the effect of breakfast omission on classroom performance (Steele et al., 1952; Morgan et al., 1981; Dickie and Bender, 1982). To date, no conclusive evidence has been published to establish links between school performance and breakfast intake, indeed Dickie and Bender (1982) found that eating breakfast had no effect on the mental abilities of the children studied. Yet the debate continues, since accurate and conclusive measurements of mental ability and concentration are difficult. Truswell and Darnton-Hill (1981) suggested that the effects of breakfast omission are complex and hard to isolate partially due to increased consumption of snack foods - another dietary characteristic of this age group. Truswell and Darnton-Hill speculated that snack foods taken by adolescents compensate, at least in terms of energy intake, for breakfast omission.

Much of the data available on missing meals are from research conducted in North America during the late 1960's. It is the intention of this literature review to concentrate on British studies, however the conclusions of the American surveys are relevant here and will be discussed briefly. In 1968, Hueneman et al. (1968) working in the USA found that up to a third of the adolescents studied had 'highly irregular eating practices with many of the youngsters fending for themselves'. It was found that those who ate regular structured meals and snacks had better nutrient intakes than the irregular eaters and that snacks overall benefitted nutritional intakes. Leverton (1968) found that for American adolescents, there was little relationship between frequency of eating and overall nutrition, except for individuals who ate fewer than three times a day - for these infrequent consumers, total nutrient intake was low when compared with the other children.

2.6.2 Snacking, confectionery and soft drinks

These terms are often considered synonymous with adolescence. Concern has focused on snacks being 'empty calories', providing energy but few nutrients and so compromising the nutritional quality of the total diet (Walker and Cannon, 1984; Yudkin, 1986; Rugg-Gunn et al., 1991). Studies in the USA and Britain have shown adolescents to be frequent 'snackers' (Huenemann et al., 1968; Thomas and Call, 1973; Bull, 1985). However, far from contributing empty calories, snacks in some cases have been shown to provide valuable supplements to meals, improving the nutritional quality of the total intake (Huenemann et al., 1968). Bigler-Doughton and Jenkins (1987) found that snacks provided between a quarter and third of the energy intake of 11 to 18-year old American children - this energy from snacks was also accompanied by significant quantities of other nutrients, with the nutrient density of the snacks being comparable to meals for calcium, magnesium, vitamin C and vitamin A.

The concept of 'empty calories', although often applied to snack foods particularly those high in sugar, has seldom been investigated. Rugg-Gunn et al. (1991) explored this theory in the diets of 11 to 13-year old children, investigating the total nutrient intake of the extreme high and low added sugar consumers. It was found that high 'added' sugar consumers tended to have high energy intakes, and high intakes of all nutrients, as a result of large overall food consumption. Those with low 'added' sugar intakes had diets which were more nutrient dense (nutrient per unit energy). This, to some extent, supported the theory of 'empty calories', but this is only likely to lead to nutrient deficiency if high 'added' sugar consumption is associated with low total energy intake (Department of Health, 1989b).

Food has a sociological, as well as physiological role: adolescents eat food not nutrients, therefore fashions, peer group pressures, gustatory enjoyment and advertising are all stronger influences than nutrient density in food selection. Food plays an important part in the increasing social interaction of this age group. Consumption of 'junk' foods and 'fast' foods are associated with the 'food culture' of adolescents and are cited as possible areas of concern. Yet these terms are used to described a wide variety of foods, which have few nutritional features in common, except perhaps that they were not part of the 'traditional British diet'. Such foods vary enormously in their nutritional content making it impossible to make all encompassing judgements on their nutritional quality.

The consumption of soft drinks has increased markedly - these are particularly popular with adolescents (Truswell and Darnton-Hill, 1981). The annual 'fizzy' drink consumption in Britain rose from 36 litres per person in 1981 to 53 litres per person in 1986, and there is no reason to suggest that this trend has not continued (The Economist, 1987). As an alternative to alcohol (a problem of late adolescence) soft drinks are to be recommended. However, there is some concern that soft drinks are replacing milk as a drink, providing 'empty calories', and leading to reduced calcium intakes (Massey and Strang, 1982). In addition, soft drinks (unless artificially sweetened) have a high sugar content.

The role of sugar as a causative factor in dental caries is well established (Department of Health, 1989b); therefore, the increasing soft drink and confectionery consumption will have direct implications for the dental health of this age group. Dental decay is the most common childhood disease in the UK and dental caries is related to both the amount and frequency of consumption of non-milk extrinsic (NME) sugars (James, 1988; Department of Health, 1989b). In 1983, 93% of 15-year old children in the UK had one or more decayed teeth (Department of Health, 1989b). The incidence of dental decay has reduced in recent years due to widespread use of fluoride but prevalence would be reduced further if the amount and frequency of NME sugars consumption could be reduced (Department of Health, 1989b).

2.6.3 Energy intakes and nutritional deficiencies

Nutritional deficiency, its detection and prevention has traditionally been the primary concern of dietary surveys of children and adults. However, with increasing affluence, the problems of over-nutrition and malnutrition become more important.

Most adolescents go through a phase of high energy intakes (Truswell and Darnton-Hill, 1981). This may be an advantage in some individuals, protecting against nutritional deficiencies, since a diet of low nutrient density may still meet recommended dietary intakes if the total food intake is high (Department of Health, 1989b; Rugg-Gunn et al., 1991). Yet the increasing incidence of obesity amongst adults in Britain (Gregory et al., 1990), which may be reflected in weight gain in adolescents, is a nutritional concern.

The Royal College of Physicians (Black et al., 1983) concluded that overweight children are at increased risk of becoming overweight adults, carrying with it increased risk of stroke, coronary heart disease, hypertension and diabetes. Indeed, obese children have been shown to have higher levels of cholesterol and increased blood pressure than their lighter contemporaries (Berenson et al., 1991). In recent long-term (over a period of fifty years) follow-up study of obese adolescents into adulthood (Must et al., 1992), in was found that being overweight in adolescence was associated with a greater risk of mortality from all causes and an increased risk of morbidity. Obesity becomes more likely when high energy intakes are accompanied by low activity levels. Low levels of habitual activity were found amongst young adolescents by Armstrong et al. (1990) - if these reduced energy expenditures are not accompanied by an increase in nutrient density then nutrient intakes will fall, conversely reduced energy expenditure without a fall in energy intake will result in an increased prevalence of obesity.

A relatively new area of concern amongst adolescents, particularly girls, is the adoption of low calorie 'slimming diets' to control body weight, the diets of British schoolchildren survey (Department of Health, 1989a) found that 8% of 14 to 15-year old girls claimed they were reducing food intake to lose weight. Low energy intakes leave an adolescent vulnerable to nutritional inadequacies which may be exacerbated by high sugars intakes diluting nutrient intake (Rugg-Gunn et al., 1991).

As a result of increased requirements for growth and physiological changes, and perhaps due to some of the eating behaviours discussed above, adolescents are accepted as a group at potential risk of nutritional deficiencies, in particular deficiencies of iron, calcium, vitamin A, vitamin C and zinc (Greenwood and Richardson, 1979; Truswell, 1985). Adolescents are particularly susceptible to iron deficiency anaemia as a consequence of increased erythropoiesis and hence increased iron needs. Armstrong (1989) reported serum ferritin concentrations of 234 14 to 18-year old adolescents - 40% were iron depleted (serum ferritin concentration less than 10µg/l - reference range 10-330µg/l). In 1990, a study of 400 middle class children, aged 12 to 14 years, living in London found that the prevalence of anaemia was 14.5% in children with iron intakes less than the Lower Reference Nutrient Intake (see section 2.7.2.3) - anaemia was three times more common in girls than in boys (Nelson et al., 1993).

During the 19th and early 20th century, rickets, as a result of low calcium and vitamin D status, was endemic in Britain. No longer a problem, it has been superseded by the increasing incidence of osteoporosis in the elderly, with subsequent debilitating fractures and morbidity. Approximately 45% of adult bone mass accumulates during adolescence, so that it is essential that substantial mass is accumulated at this time and into early adulthood to prevent bone mass falling below a critical level in later life (James, 1988). Encouraging high calcium intakes and increased physical activity in adolescence is now one of the major lines of osteoporosis prevention (Boyle, 1991). The highest calcium requirements are in infancy and adolescence, yet there is concern that calcium intakes by adolescents are often inadequate and may be decreasing.

2.6.4 Summary

Early food habits are largely dictated by the family and the availability of food at home. As a child enters adolescence, external influences play an increasing part in determining total dietary intake. Three main factors exert their effects to varying degrees:

- peer group pressures
- the need to develop an individual personality, and
- the pressures of society in general, which include economic factors, food availability and advertising.

At an age nutritional needs increase, dietary habits may change. Erratic eating patterns, with high reliance on low nutrient density snacks, can lead to nutrient inadequacies. Snack foods tend to be low in iron and yet consumption of these foods may increase at the very time iron requirements become greater. Snack foods may supplement an adequate dietary intake but may jeopardise the nutritional content of the diet if low density snack foods are eaten to the exclusion of 'meals'. The increased requirements for some nutrients may be a direct result of eating habits, for example, high intakes of carbohydrate lead to an increased need for thiamin for carbohydrate metabolism. Soft drinks may replace milk as a beverage so compromising both calcium intake and dental health. Dental caries is particularly a risk if a high soft drink consumption is associated with increased intakes of high sugar foods or an increased frequency of sugar intake (Department of Health, 1989b). Whilst high energy intakes may protect against nutritional deficiencies, if such intakes are associated with low levels of energy expenditure, obesity and its associated problems will result. The nutrient intake of children, as they enter adolescence, needs to be monitored to assess the effects of all of these factors.

2.7 Dietary recommendations for the United Kingdom

> "Much of the field of nutrition is still unexplored or is only half explored. Today's knowledge is not the knowledge of yesterday, still less of tomorrow, and yet today's knowledge should be on record because it is the best we have by which to implement the basic facts of nutrition in terms of clinical medicine and public hygiene" (British Medical Association, 1950).

2.7.1 The reports

In 1950, when the council of the British Medical Association set up a committee on the nation's nutrition, it was not without it's critics. The opposition questioned the value of such a report since any recommendations made would have to anticipate results of ongoing research into nutritional requirements. The British Medical Association argued that inquiries of the nature of human requirements were never really completed, yet the knowledge as it stood at the time was of such practical application that a report, which was to be considered an interim report, was warranted. In the production of this document many of the recommendations were taken from the then current USA recommendations (National Research Council of the United States, 1948).

The committee reviewed the extensive literature on the nutritional requirements of the healthy individual and the recommendations made represented conclusions derived from consideration of these data. The recommendations were believed to be sufficient to establish and maintain a good nutritional state in representative individuals of the defined age groups. It was recognised that in every group there would be individuals where the need for one or other nutrient would be greater than that of the average. The recommendations made for the nutritional intake of boys and girls aged 11 to 14 years is given in Table 2.2.

It was emphasised that there was an urgent need for further extensive study of human nutritional requirements. The review of the literature had revealed many gaps in the existing knowledge of the quantitative aspects of man's needs. The committee concluded that it presented the report in the belief that it had achieved as full and accurate a measure the nation's nutritional requirement as the facts available permitted. Further, it stated that it made no attempt to conceal that the facts available were in some places too meagre to give conclusions that carried any great conviction, and in some instances recommendations represented best judgements. It is interesting to compare this statement with the statement made, forty years on, by the COMA panel on Dietary Reference Values

(Department of Health, 1991) - "For most nutrients the panel found insufficient data to establish any of the Dietary Reference Values with great confidence".

Despite the intention of the British Medical Association that their 1950 report be considered interim, their recommendations were used in Britain for almost twenty years. The accumulation of nutritional knowledge between 1950 and the mid 1960's warranted a review which was undertaken, for the first time, by the Department of Health and Social Security's Expert Panel on the Requirements of Protein, Calcium and other Nutrients. This was part of the Committee on Medical and Nutritional Aspects of Food Policy, which later became the Committee on Medical Aspects of Food Policy, which we know today as COMA. The panel reported in 1969 with 'Recommended Intakes of Nutrients for the United Kingdom' (Department of Health and Social Security, 1969). Again, this report was envisaged as an interim document which would be updated as further knowledge became available. The age range of recommendations for adolescents was changed from the previous report from 11 to 14-year-olds, to 9 to 11-year-olds and 12 to 14-year-olds, although no explanation for the change was given. The Recommended Nutrient Intakes (Department of Health and Social Security, 1969) for boys and girls aged 9 to 11 and 12 to 14 years are given in Table 2.2.

In 1979, national dietary recommendations were again reviewed by COMA and the report 'Recommended Daily Amounts of Food Energy and Nutrients for Groups of People in the United Kingdom' was published by the Department of Health and Social Security (1979). This report aimed to update the figures and, since the application of the 1969 recommendations had not always been consistent, to define more precisely the intended use of the recommendations. In the event, there was relatively little new information which the panel considered a basis for altering the 1969 recommendations, so that the final 'Recommended Daily Amounts' (RDA) (Table 2.2) were little altered from their predecessors.

Less than a decade later in 1987, the Department of Health again convened a panel of the Committee on Medical Aspects of Food Policy to review the recommendations. The results of this panels' deliberations were published in 1991 (Department of Health, 1991). It contained wide-ranging changes and included, for the first time, a full discussion of how individual values had been derived. The terminology was altered again, with the aim of more precisely defining the 'recommendations'. Four new terms were introduced, so that many nutrients now had three values which represented a range of requirements instead of the single value given in all previous reports. The age range for young adolescents was changed again to 11 to 14 years, the age range used in the 1950 report (British Medical Association, 1950) (Table 2.2).

2.7.2 Definitions and applications

Dietary recommendations for the United Kingdom have evolved over almost half a century and will continue to be reassessed; the need for re-examination of recommendations in the light of new findings is an essential part of the process. Early recommendations were used mainly by those working directly in the fields of medicine or nutrition, yet misinterpretation of the recommendations was common. In recent years recommendations have become more widely applied as the public and media interest in nutrition has increased - it is now commonplace for a food product to be labelled indicating the proportion of RDA provided by an average serving. The 1991 Dietary Reference Value report addressed the issues raised by this wider audience and looked closely at the applications of its reference values.

2.7.2.1 The period 1950 to 1979

Although the 1950 report made clear that many recommendations at best represented estimates of requirements, a precise definition of the recommendations was not given. This led to misuse of the recommendations which were taken to represent the absolute requirements of an individual.

In 1969 the Department of Health and Social Security gave guidance on the use of its dietary recommendations. A cautionary note was added that, by themselves, the recommendations could not be used for the assessment of the nutritional status of an individual, but they were a useful adjunct to clinical and other studies. The recommended intakes for nutrients, published in 1969, were defined as - "the amounts sufficient or more than sufficient for the nutritional needs of practically all healthy persons in a population".

The need for the recommendations, or a yardstick against which those working in the field of nutrition could judge results of their diet assessments, was evident. In producing the 1969 report, the panel was frank in its statement that "recommendations for intakes of nutrients can only be made by the exercise of judgement on limited data; in consequence they can only be provisional and subject to future revision". In the event, more problems were encountered over the use of the recommendations rather than their validity. In the absence of any other yardstick, the figures were frequently mistakenly used as recommendations for individuals. The definition was interpreted as being a minimum requirement to maintain health and therefore each individual should receive the recommended intake or more.

2.7.2.2 The 1979 report

The COMA panel of 1979 (Department of Health and Social Security, 1979) recognised the above problems and aimed to clarify the definition and so avoid misuse of its recommendations. The terminology was changed to Recommended Daily Amount (RDA) and defined as: "The average amount of the nutrient which should be provided, per head, in a group of people if the needs of practically all members of the group are to be met." In the case of energy, the recommended amount for a group was an estimate of the average requirement, whilst for nutrients, the recommended amount represented a judgement of the average requirement plus a margin of safety. In addition, the report outlined more fully than the 1969 report, the appropriate uses and applications of the recommendations.

The panel stated that Recommended Daily Amounts had a limited use in the evaluation of intakes of food by individuals. The distribution of requirements for nutrients was unknown, therefore it was not possible to estimate the probability that an individual be undernourished by comparing an intake with the recommendations. However, it was added that the greater the proportion of a group with intakes below the recommendations, the greater was the possibility that some individuals in that group would be undernourished. This indicates how the recommendations were intended to be used - for groups, not individuals. Despite attempts at clarification and the change in terminology, the RDA continued to be used in the assessment of individual's intake. The Recommended Daily Amount was interpreted to be just that and again perceived as the daily intake which should be achieved by each individual.

An increasing public and media interest in nutrition and food labelling during the 1980's further opened the possibility of misuse of the RDA. The general public were led to perceive the RDA as a personal target, particularly when RDA's began to feature widely on food labels. Yet, from epidemiological surveys, it was apparent that individuals with habitual intakes below the RDA, particularly those for energy, were not suffering from nutritional deficiencies. These recommendations stood until 1991.

2.7.2.3 The 1991 report

It was against this background that the third COMA panel on dietary recommendations was convened in 1987, only eight years after its predecessor had reported. The terms of reference of the panel were 'to review the Recommended Daily Amounts for food energy and nutrients for groups of people in the United Kingdom'. This panel became the panel on Dietary Reference Values and in 1991 produced a comprehensive document (Department of Health, 1991) which was considerably more than merely an update of the 1979 publication. Recommendations and deliberations of previous COMA panels on Diet and Cardiovascular Disease (Department of Health and Social Security, 1984) and Dietary Sugars and Human Disease (Department of Health, 1989b) were brought together for the first time. The panel considered forty nutrients, rather than the previous ten, and for the first time, the report gave the basis for many of the reference values.

In order to avoid the misinterpretations which had been made regarding the previous single values for each nutrient, the panel set a range of values, based on assessment of the distribution of requirement for each nutrient within each given population group: these values were termed Dietary Reference Values (DRVs).

The basis of the estimates of requirements were: the intakes of a nutrient required to maintain physiological parameters; the intakes by individuals or groups associated with absence of deficiency signs; the intakes of a nutrient needed to maintain nutritional balance, noting the period over which balance needs to be measured varies for different nutrients and between individuals; the intake of a nutrient needed to cure clinical signs of deficiency and, intake of a nutrient associated with an appropriate biological marker of nutritional adequacy.

Different criteria were used for each nutrient. Although many were not perfect, they were judged to be the best available information on which to base the DRVs. The term Dietary Reference Value is used to encompass all of the terms of the report:

- **Lower Reference Nutrient Intake (LRNI):** Lower Reference Nutrient Intake values were given for protein, a vitamin or mineral. These were defined as "the amount of the nutrient that is enough for only a few people (approximately 3%) in a group who have low needs". The LRNI represents the lowest intakes which will meet the needs of some individuals in the group.

- **Estimated Average Requirement (EAR):** The Estimated Average Requirement of a group of people for energy, protein, a vitamin, or a mineral - it was estimated that "about half the population will usually need more than and about half less" than the Estimated Average Requirement.

- **Reference Nutrient Intake (RNI):** RNI were given for protein, a vitamin or mineral. The RNI for each nutrient is defined as "an amount of a nutrient that is enough, or more than enough, for about 97% of people in a group. If the average intake of a group is equal to the RNI, then the risk of deficiency occurring in the group will be very small".

The appropriate applications of the DRVs are described clearly; again the DRVs refer to healthy people and the DRV for each nutrient assumes all other energy and nutrient requirements are met. In assessing the diet of an individual, the report states that even given a perfect measure of an individual's intake, which is difficult and seldom achieved, the DRVs can give no more than a guide as to the adequacy of the diet. Therefore, extreme caution is urged in their use for individuals. If the measured habitual intake of an individual lies between the LRNI and the RNI, it would be impossible to say whether that intake is adequate or not without biological measurements of the individual.

In assessing groups of individuals, the DRVs have greater application. Within groups, the imprecision caused by intra-individual day to day variability is reduced and, provided a group is large enough, then imprecision due to inter-individual variability is also decreased (Department of Health, 1991). It is possible to use the DRVs to assess the risk of a deficiency within a group by calculating the percentage of the group with intakes below the LRNI or RNI. If the percentage of the group with intakes below the RNI is zero then the risk of deficiency occurring in that group is very small - as the per cent of the group with intakes below the RNI increases then so does the risk of deficiency.

2.7.3 The basis of recommendations

In order to illustrate the development of the widely used 'reference values' and to investigate reasons for often considerable changes in recommendations, the determination of the recommended values for energy for adolescents (to include the 11 to 12-year old age group) have been followed from the earliest report (British Medical Association, 1950) to the most recent (Department of Health, 1991). In the early reports the sources of data and the deliberations of the panel were not usually included. The recommendations (1950 to 1991) for the nutrient intake of groups of 11 to 12-year old children for selected nutrients are given in Table 2.2. The selection of nutrients included has been made on the basis of the nutrients which are discussed in later chapters.

2.7.3.1 Estimates of energy requirements

In 1950, recommended energy intakes were based on consideration of a large mass of data on energy intakes. The energy requirements for periods of growth, were based on a smooth curve, drawn from dietary intake studies and unpublished records of the food consumption of well-nourished children. The sources of these data were not given.

In the 1969, report the recommendations for energy intake were again based on food consumption studies. Energy expenditure was considered although for adults only. Review of the current dietary intake studies resulted in a fall in the total energy intake recommendation for both boys and girls (Table 2.2).

By 1979, new studies of food consumption (Department of Health and Social Security, 1975; Black et al., 1976) indicated that, in line with adults, children were now eating less. Recommendations for energy intake by children of school age were based on recently published food consumption studies (Cook et al., 1973; Jacoby et al., 1975; Durnin et al., 1974) as well as Department of Health and Social Security surveys at that time unpublished. These surveys indicated that energy intakes of schoolchildren were still lower than suggested by 1969 evidence, and there was no indication of under-nutrition, indeed obesity in children was highlighted as a problem. As a consequence, the 1979 recommended daily amount for energy was again reduced from previous levels (Table 2.2). The recommendation assumed that, at the time of measurement, the population was, on average, in energy balance and that reported intakes were actual intakes. The problems associated with possible under-reporting were not considered.

The 1991 review of dietary requirements (Department of Health, 1991) introduced a range of recommendations for all nutrients, except energy (section 2.7.2.3). The RNIs for nutrients were set at an amount considered to be sufficient, or more than sufficient, to meet the needs of most individuals. For energy an Estimated Average Requirement only was given as any energy intake in excess of requirements would lead to obesity and so be harmful.

Until 1991, energy intakes of healthy populations had been the basis for calculating energy requirements, measurement of the energy expenditure was impractical for the large studies necessary to obtain a representative sample. The National Food Survey household consumption studies (Ministry Agriculture, Fisheries and Food 1980 to 1989) indicated that the population had energy intakes below the 1979 RDA's. In 1991, the COMA panel considered data from both energy intake and energy expenditure surveys before arriving at the Estimated Average Requirements (EAR) for energy.

In calculating the energy requirements of children and adolescents, energy expenditure data were used where possible rather than data on energy intake from dietary surveys. Energy expenditure provided a more direct basis for estimating energy requirements assuming that those measured were in energy balance, that is, neither gaining nor losing weight during the recording period. The major proportion of daily energy expenditure is accounted for by the basal metabolic rate (BMR) which can be calculated from sex, age and body weight information using standard equations (Schofield et al., 1985) (section 7.1.2.1). The other factor affecting energy expenditure is physical activity; therefore, total energy expenditure is expressed as a multiple of BMR, that multiple being determined by physical activity levels (PAL). For 10 to 18-year old children and adolescents, there were enough data on daily activities and the energy cost of those activities (physical activity ratios - P.A.R), to allow estimates of daily energy expenditure to be calculated (Department of Health, 1991). An average day was determined to have:

Time	Activity	Physical Activity Ratio (P.A.R)	
		Boys	Girls
8 hours	In bed	1.0*	1.0*
6 hours	At school	1.6	1.5
7 hours	Light activity	1.6	1.5
2.5 hours	Moderate activity	2.5	2.2
0.5 hours	High activity	5.0	5.0

Note: * equivalent to BMR

These calculations resulted in average daily energy requirements for boys of 1.56 x BMR and for girls of 1.48 x BMR. These figures, with a small allowance for growth (0.29MJ and 0.31MJ per day for 11.5-year old boys and girls respectively), gave the Estimated Average Requirement of energy. A validation study of EAR for energy was commissioned by the COMA dietary reference panel (International Dietary Energy Consultative Group, 1990). The energy expenditures measured for adolescents in these studies were high (1.76 x BMR for 12-year old boys; 1.75 x BMR 12-year old girls), higher than the calculated requirements of 1.56 x BMR for boys and 1.48 x BMR for girls. Small samples had been used in these studies (12 subjects in each age and sex group) and the panel suggested that the small sample used may have been unrepresentative of the population. Alongside these data, the results of a dietary survey of the energy intake of over two thousand 10 to 11-year old and 14 to 15-year old children (Department of Health, 1989a) were considered, in the light of which, the EARs of 1.56 x BMR and 1.48 x BMR were not increased, but the panel suggested the discrepancy gave grounds for caution.

2.7.4 Discussion

Forty years on from the British Medical Association's report in 1950, it is evident that many gaps still exist in nutritional knowledge. More research into nutritional requirements is needed before reference values for all nutrients can be given with certainty. For nutrients, dietary intake surveys must be considered alongside bioavailability studies and biochemical investigations for deficiency. The 1991 report is extensive and clear in its deliberations. The new dietary reference value range leaves no doubt that the needs of the individual within a group vary and this should to be considered when using the dietary reference values to assess dietary intake.

If dietary reference values are to be met by a group of adolescents, the nutrient density of iron in the diets of boys and girls may need to differ considerably. The British diet provides between 1.1 and 1.3mg of iron/MJ; a nutrient density of greater than 1.3mg of iron/MJ was considered to be impractical by the 1979 panel (Department of Health and Social Security, 1979). If the new EARs for iron and energy are considered together, boys will need to achieve an average diet of 0.95mg of iron/MJ, however girls will need to have an average intake of 1.43mg of iron/MJ. This increases to 1.86mg/MJ when the reference nutrient intake of iron for girls is considered. Whether such a diet is possible, or indeed practical, without either considerable changes in diet, or fortification of foods with iron, is doubtful.

New issues in nutrition have important implications for health - no longer is the main aim of nutrition education to prevent disease, but to promote health through nutrition. New research into anti-oxidant vitamins (vitamins E, C and carotenes), their role in deactivating free-radicals, and hence their importance in coronary heart disease and cancer prevention, is beginning to emerge. The 1991 COMA panel recognised some evidence existed to support the theories of the role of anti-oxidants in disease prevention, but felt it was not sufficiently strong to be the basis of recommendations - however it was suggested that this area be kept under review. It may be that reference values for micronutrients will be increased further in future reviews of dietary recommendations, as the role of nutrition in promoting optimum health emerges.

Table 2.2 Dietary recommendations and reference values for the United Kingdom for selected nutrients, 1950 - 1991, as applicable to children aged 11 to 12 years.

Year		Age range years	Energy MJ		Protein g		Calcium mg		Iron mg		Vitamin C mg		Retinol Equivalent µg	
			Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
1950[a]		11–14	11.5	11.5	102.0	102.0	1300	1200	13.5	13.5	30	30	900	900
1969[b]	RNI	9–12	10.5	9.6	63.0	58.0	700	700	13.0	13.0	25	25	575	575
	RNI	12–15	11.7	9.6	70.0	58.0	700	700	14.0	14.0	25	25	725	725
1979[c]	RDA	9–11	9.5	8.5	57.0	51.0	700	700	12.0	12.0	25	25	575	575
	RDA	12–14	11.0	9.0	66.0	53.0	700	700	12.0	12.0	25	25	725	725
	LRNI	11–14	-	-	-	-	480	450	6.1	8.0	9	9	250	250
1991[d]	EAR	11–14	9.14*	7.95*	33.8	33.1	750	625	8.7	11.4	22	22	400	400
	RNI	11–14	-	-	42.1	41.2	1000	800	11.3	14.8	35	35	600	600

a Report of the Committee on Nutrition, British Medical Association (1950).
b Recommended Intakes of Nutrients for the United Kingdom (RNI), Department of Health and Social Security (1969).
c Recommended Daily Amounts of food energy and nutrients for groups of people in the United Kingdom (RDA), Department of Health and Social Security (1979).
d Dietary Reference Values for food energy and nutrients for the United Kingdom, Department of Health (1991).
LRNI Lower Reference Nutrient Intake
EAR Estimated Average Requirement
RNI Reference Nutrient Intake
* Calculated from estimated Basal Metabolic Rate and Physical Activity Levels (section 8.2.2).

2.8 Overall summary of literature review

The early part of this century was a period of discovery of the importance of food - not only calories but 'accessory factors'. Much nutritional deficiency was a result of increasing urbanisation and poverty. Without an adequate food supply it became apparent that children could not learn and men would not be fit to fight. There was a realisation of the significance of the economic cost of poor health, caused by inadequate nutrition. The great steps taken between the wars in the field of nutrition and the increasing role of the Government in ensuring the food supply of the nation, was demonstrated by the success of the food policy in Britain during the Second World War. The Government food policies achieved what could never have been achieved by individuals (section 2.1).

The National Food Survey (section 2.3) describes 50 years of the British diet, showing that substantial dietary changes have occurred and illustrating that diet is not constant. This is encouraging, indicating the potential for dietary change in the future although some dietary components, for example per cent energy intake from fat, seem particularly resistant to change.

Following the war, various methods of measuring dietary intake were developed -their advantages and disadvantages have been discussed above (section 2.2). It is apparent that there is a need for several methods of collecting dietary data to meet the requirements of different survey situations and, as yet, no one best method of dietary survey exists. New developments are beginning to throw doubt on the energy intake measured in the majority of dietary surveys and it is important that the limitations of dietary surveys are acknowledged.

The surveys of young adolescents to date, described in section 2.4 suggest declining energy intakes and concern over intakes of calcium and iron (particularly for girls) especially for children from low social groups. The evidence suggests that there has been no change in the per cent of energy derived from fat, whilst no information exists to determine if there has been any change in the per cent energy derived from 'added' sugars. The food habits of adolescents make them vulnerable to potential nutritional problems (section 2.6). It has been shown that there is a national trend towards more food being consumed outside the home and that the uptake of school meals has declined. The importance of food consumed outside the home and the nutritional implications of this trend for children are not known (section 2.5).

The aim of this thesis is to record change in the diet of children of the same age attending the same schools in 1980 and 1990, using a repeated three-day diary and interview (section 2.2). The nutrient intake of the children in 1990 will be compared with national dietary reference values discussed in section 2.7 and the importance of foods from outside the home will be measured.

CHAPTER 3

BACKGROUND TO THE STUDY AND ITS AIMS

3.1 The 1979-1981 Northumberland diet and dental caries study

Between September 1979 and July 1981, a survey of diet and dental caries was undertaken in seven middle schools in south Northumberland. The main aim of this 1979-1981 study was to investigate the relationship between the occurrence of dental caries and dietary intake in young adolescents over a two-year period. The geographical area and the individual schools in the survey were chosen to represent a range of socio-economic groups. Of a possible 797 children, initially aged 11 years in these schools, 405 completed all aspects of the study.

During the study it became apparent that little age-specific dietary information existed for this age group in the United Kingdom and, therefore, the data obtained would be of considerable nutritional interest. Extensive analyses followed, the dietary intake of the children being reported in terms of nutrient intake, groups of food and their contribution to nutrient intake, by sex and social class (Hackett et al., 1983, 1984a, 1984b, 1984c, 1986; Rugg-Gunn et al., 1984, 1986, 1991).

3.2 Rationale for the 1989-1990 Northumberland diet study

Since 1979-81 there have been considerable changes in the range and availability of foods. In the same period, following the reports of the National Advisory Committee on Nutrition Education (1983) and the Committee on Medical Aspects of Food Policy - Diet and Cardiovascular Disease (Department of Health and Social Security, 1984) there has been an increase in the pressure of health education advocating dietary changes to promote health. A corresponding change in attitudes towards diet resulted in an unprecedented interest in 'healthy eating'. Other changes have had direct implications for schoolchildren only - in 1980, legislation removed the nutritional requirements of school meals, leaving Local Education Authorities free to move away from the traditional 'school dinner' with no nutritional obligation constraining its replacement (H.M. Government, 1980).

There was a need to measure the effects of these changes on a defined sample of young adolescents. The data collected in 1979-1981 had been extensively analysed by sex and social class and was therefore suitable for comparison. It was considered highly desirable that a repeat survey be carried out to record dietary habits and nutrient intakes of children of the same age, in the same location. Comparison between the 1979-81 and 1989-1990 surveys would indicate changes in the eating habits and the nutrient intake of young adolescents over a ten year period. Sex and social class had been shown previously to influence dietary intake (Hackett et al., 1984a) so that these data would again be collected to investigate any change in the effects of these two variables over time.

Surveys of the British population as a whole, adults and older adolescents (Ministry of Agriculture, Fisheries and Food, 1989; Loughridge et al., 1989; Gregory et al., 1990) have indicated that there has been an increase in the amount of food eaten outside of the home. It was important to discover whether young adolescents had also moved away from traditional eating patterns. Studies of food eaten outside the home by children had previously reported only the contribution of school meals (Nelson and Paul, 1983), or other mid-day meals (Department of Health, 1989a) to their total diet. It was speculated that if the contribution of foods purchased away from home were worthy of investigation, then knowledge of the relative importance of the different sources of food, together with total nutrient intake, would be valuable in understanding the eating habits of young adolescents in Britain in 1990.

In the event, due to limited funding, the repeat survey was restricted to one year. It was therefore decided to use the same three-day diary plus interview method which was used successfully in 1979-1981, but to record two 3-day diaries per child in that year - a total of six days dietary record for each child. In contrast, the 1979-1981 survey recorded five 3-day diaries per child, a total of 15 days dietary records per child over a period of two years. The results of the 1989-1990 survey would be compared with the results of the first two diaries only from the 1979-1981 survey - that is those collected 1979-1980. Thus the comparison would be of two 'snapshots' of the nutrient intake of adolescents (aged 11 to 12 years) collected during one school year so as to include winter and summer seasons in 1979-80 (to be known as the 1980 survey) and in 1989-90 (to be known as the 1990 survey).

No data on place of purchase of foods had been collected in 1979-1981.

3.3 Aims of the 1990 study

The aims were:-

Main aim

To measure the nutrient intake of a selected group 11 to 12-year-olds in south Northumberland in 1990.

Subsidiary aims

[1] To compare the nutrient intake and the nutrient density of the diet of 11 to 12-year-olds in 1990, with that of children of the same age, attending the same schools, ten years earlier.

[2] To attempt a theoretical validation of the dietary diary and interview method, as used in the 1980 and 1990 surveys, by comparison of measured energy intakes with estimated energy expenditures of 11 to 12-year old children.

[3] To compare the nutrient intake measured in 1990, with the Dietary Reference Values (1991) for this age group in the United Kingdom.

[4] To determine the contribution to nutrient intake made by foods obtained outside the home in 1990 for these children and to compare this with (a) reports of the contribution to nutrient intake made from foods obtained outside the home by adults in the UK and (b) assumptions made by the National Food Survey.

[5] To investigate further the 'place of purchase' of food obtained outside the home by 11 to 12-year-olds, and the importance of each place of purchase to their total dietary intake. To compare the nutrient density of the foods obtained from each place of purchase.

[6] To compare and report any significant differences between the intakes of boys and girls and between the intakes of high, middle and low social groups.

CHAPTER FOUR

OVERALL CONDUCT OF THE STUDY

4.1 The location of the survey and the subjects

4.1.1 The location

The location of the survey was south Northumberland. The towns selected were Ashington, Morpeth and Newbiggin - all areas being approximately 16 miles north of Newcastle upon Tyne, but less than 10 miles apart. These were the same three towns as in the 1980 survey. Morpeth is a predominately middle class area, whilst Ashington and Newbiggin are mainly working class (Figure 4.1).

4.1.2 The subjects

In 1979, seven of the eight middle schools in the three towns had participated in the survey, the eighth school had declined due to building refurbishment occurring at the time. The subjects in the 1990 study were all pupils attending the same seven middle schools. As in 1979, all children in year 7, that is aged 11 to 12 years in Autumn 1989, were invited to participate. The total number of eligible children at each school in October 1989 is given below:

Morpeth:	Newminster	85
	Chantry	110
Ashington:	Alexandra	60
	Hirst Park	75
	St. Benedict's	43
	Seaton Hirst	75
Newbiggin:	Newbiggin	98
	Total	**546**

4.1.3 Consent

Permission for the study was received from Northumberland Education Authority, the head teachers of the individual schools and the protocol approved by Northumberland Health Authority Ethics Committee. A letter explaining the purpose of the study and requesting written consent was sent to the parents of all year 7 children (Appendix 4.1). Before the dietary survey began, a letter further explaining the survey and the procedure of distributing and collecting the diaries was sent to the class teachers of the children taking part (Appendix 4.2).

4.2 Dietary assessment

4.2.1 Length of study

The survey was conducted over two school terms. The first diaries were collected during January to March and the second during April to July 1990. This ensured that any seasonal variation in intake was accounted for since a winter and summer diary was collected from each child.

4.2.2 Data collection

A principal aim of the 1990 study was to compare the nutrient intake of these children with the nutrient intake of children of the same age and schools as in the 1980 survey (section 3.3). It was therefore essential that the method used to collect the dietary data in 1990 was as similar as possible to that used in 1980. Details of the overall conduct of the study follow; further details of calibration of the investigators and their methods 1990 and 1980 are given in Chapter 6 (section 6.2.1).

4.2.3 The three-day diary method

In both studies, repeated 3-day dietary diaries followed by a private interview with the dietitian, were used. Efforts were made to make the six days recorded by each child different days of the week.

As the intention was to avoid unnecessary disruption to the school's programme, the initial order in which the schools were surveyed was determined largely by the individual school's own convenience. It was also important to avoid a social class gradient in the order of visiting the schools and this was taken into account. For the second survey in Summer term the order of the schools was reversed, with the aim of ensuring a similar mean age of all the children.

- **The diary**

Diaries were designed and printed to be similar to those used in the 1980 survey (Hackett et al., 1983). It was essential that the diaries be pocket-sized so the children could easily carry their diary with them throughout each recording period; with this in mind the diaries were also designed to be robust (Figure 4.2). Each diary was labelled with the child's name and the days and dates on which their intake was to be recorded. The content of the diaries provided ample pages on which to record intake, along with a written example of a record and columns clearly indicating the data to be recorded (Figure 4.3 and Figure 4.4).

- **Introduction and instruction**

At the beginning of the survey in the Spring term of 1990, each school was visited and all participating children were seen as a group. During this introductory session the purpose of the survey and the importance of their participation was explained. Full instruction was given as to how to complete the dietary diary and the importance of recording every item of food or drink taken over the three day period, at the time of consumption, was stressed. The children were encouraged to ask questions about the survey procedure but no dietary advice was given.

The day before the beginning of each 3-day recording period a diary was given to each child and at this time instruction on how to complete the diary was repeated for each child individually. This was a important stage, ensuring each child understood what was required and also providing an opportunity to give encouragement. Personal details (name, class, school and days to be surveyed) were entered onto the front cover of the pocket-sized diaries before they were given to the child (Figure 4.2). The dietitian was usually present in the school during the recording period, and so was available if any child had a particular problem or query during that time.

- **The interview**

An essential part of the method was a private interview by the dietitian, with each child, on the day immediately following the completion of each 3-day diary. The interview took approximately twenty minutes and fulfilled several purposes:

a) To ensure all items of food and drink were entered into the diary along with the time of consumption and bedtime for each day.

b) To clearly identify all food items, clearing up any ambiguities. The restrictions of the food tables which were to be used in the analysis had to be considered at this stage (section 4.4.2).

c) To estimate the weights of food and drink eaten in grams, with the aid of specifically designed three dimensional food models as shown in Figures 4.5 to 4.7 and described in section 4.3.

d) To determine the source of each food item and classify each item of food or drink by 'place of purchase' according to pre-determined criteria (Chapter 9, section 9.2).

e) To give praise and encouragement to the child in order to maintain enthusiasm for the next survey.

The children were put at their ease and the interviews were private and unhurried. Time was taken to ensure that each food or drink item was discussed. The child was encouraged to recall the event and circumstances of each eating event, using the dietary record as a guide. The pre-calibrated food models were then used by the child to indicate the size or amount of food eaten (Figures 4.5 and 4.7). No criticism, praise of food intake or dietary advice was given, only praise and thanks for the completion of the diary. It was important that all the interviews were conducted by the same dietitian so as to avoid any inter-investigator error.

Each child completed two 3-day diaries, each followed by a private interview. In the event of absence on the fourth day the interview was conducted on the following day, otherwise the diary was excluded. A new diary was given for each survey period. If a child lost a diary then, where possible, a new diary was given. Not all diaries collected were included in the analyses; data were rejected according to predetermined criteria (section 4.5.1).

4.3 Food models

A comprehensive food model set was produced: this included three dimensional models of a wide range of sizes and shapes, several cups, glasses, spoons and cans, all covering the range of these utensils available, and a set of food photographs which featured a wide selection of fat spreads, breads and milk bottle tops (Figures 4.5 to 4.7).

The three-dimensional shapes were cut from plain white polystyrene blocks using a hot knife, the shapes were various and included slices, wedges, blocks or cubes and rounds. These shapes were pre-calibrated with foods and therefore represented known weights of foods of various consistencies (Figure 4.7).

The model set included a range of cups with capacities from 200ml to 580ml, a range of glasses of various shapes with capacities from 180ml to 500ml and a cereal bowl. All of these items were plain white, with no patterns, which could have been attractive to the children and so promoted a particular response. The glasses and cups were pre-calibrated with liquids and 25ml, 50ml, 100ml, 150ml, 200ml etc graduations, marked but not labelled. Spoons ranging from a coffee spoon of capacity 4ml, to a large serving spoon of capacity 30ml, were an important part of the food model set. The spoons and bowl were pre-calibrated with both liquids and food items of various consistencies. The addition of cans in standard sizes and food photographs completed the set which was carried in a large case (Figure 4.5).

4.4 Data handling

4.4.1 Coding

All data collected from each child were coded for entry into a computer database (dBase III).

For each of the 6 days dietary record, the day of the week and the type of day, schoolday, holiday or sick-day, were recorded and coded. A holiday was defined as being any day on which a child was not at school but was not sick and so included weekend days; a sick-day was any day when a child was absent from school due to illness or reported illness during a holiday. The bedtime each day was also recorded; this was defined as the time the child got into bed, not the time of 'light's off'.

Each dietary item recorded was assigned a food code from the appropriate food table (section 4.4.2). The time of intake of each dietary item was coded as well as the sequential number of each intake in the day. An intake was defined as foods eaten at one time and so could consist of more than one food code - for example, cornflakes eaten with milk and sugar would have three food codes but was one intake.

The place of purchase of each food item was coded as either the child's home, a school meal, a home other than the child's, a school tuck shop, or another source (for example shop, cafe or restaurant) (Chapter 9).

Figure 4.8 shows one-day's intake recorded by a child in the survey: food weights and food codes have been entered into the diary. These data were transferred to a coding sheet before being entered into the computer database.

4.4.2 Food tables and food codes

Standard food tables giving a nutrient analysis of foods have been used in Britain for more than fifty years, these tables frequently need to be updated to keep pace with new and changing foods. The aim in this study was to use the most up-to-date food tables relevant to the United Kingdom.

For the 1980 survey, the most complete food tables available McCance and Widdowson's Composition of Foods (Paul and Southgate, 1978) were adapted by Dr. A. Hackett; new foods and additional nutrient fields were added. Since 1980, there have been several supplements to McCance and Widdowson's food tables, considerably extending the number of foods for which nutrient analysis data are available. The process of updating food tables is constant, new foods are being developed before a completed update to the food tables can be published. In an attempt to keep data on the nutrient analyses of foods up-to-date, food tables are now published as a series of tables, each one providing data for a group of related foods - for example, Cereal and Cereal Products (Holland et al., 1988).

Several computer software packages were available which reproduced the McCance and Widdowson's food tables and facilitate nutrient analysis. However, at the time of the study, these either did not include recent updates of the tables or were not designed to handle a data set as large as would be generated in this survey. In order to achieve a complete and current food table database, six separate food tables were used and adapted for the survey.

The integration of the various food tables was complex and was achieved by a data analysis programme purpose-written for the project by Mr T. Butler. The food tables used were:

- **McCance and Widdowson 4th Edition (Paul and Southgate, 1978):** This table was used including the adaptations made in 1980 by Dr. Hackett and with some new additions namely the non-starch polysaccharide values for fruit and vegetables. These were kindly provided by the Dunn Nutrition Unit in Cambridge based on their own food analyses. This information was not available elsewhere at the time although, since the analysis of this survey, a fruit and vegetable supplement to the 4th edition and a revised 5th edition of the McCance and Widdowson food tables have been published (Holland et al., 1991a and 1991b).

- **Cereal and Cereal Products (Holland et al., 1988):**
- **Milk Products and Eggs (Holland et al.,1989):**
- **Immigrant Foods (Tan et al., 1985):**
  These supplements to McCance and Widdowson's 4th edition (Paul and Southgate, 1978) considerably updated and extended the data available for these 'food groups'.

- **Dunn 1000 series (MRC Dunn Nutrition Unit, Cambridge):**
  This is a food table produced by the Dunn Nutrition Unit which contains analysis of some foods not included elsewhere; for example composite dishes and new foods. It is used by the Dunn Nutrition Unit in conjunction with McCance and Widdowson's food tables and was made available for this survey by kind permission.

- **Additional food table:**
  A further food table was created for any food eaten by a child in the survey for which no applicable code existed in any of the above tables. Food analyses were not possible and therefore nutrient data were obtained from the manufacturer or the food was dissected and a new food code created from several existing component codes. The additional food table comprised of only sixty codes in total, which were usually infrequently used and were predominately for new foods, for example, new breakfast cereals or instant snacks.

From the six food tables a total of 2426 food codes were available, of which 851 were used.

The main adaptation to the food tables was to create a distinction between different types of sugar. In 1980 sugar had been sub-divided into 'added' and 'natural' sugars, according to whether the sugar was added by the manufacturer or consumer or was naturally occurring within the food. Following the report of the COMA panel on dietary sugars and human disease in 1989 (Department of Health, 1989b) sugar has been classified as intrinsic or milk sugars (sugar found inside the cell of a food, or lactose) and non-milk extrinsic sugars (sugars found outside the cellular structure of a food). Additional complexities arose as the new classification was not quite the same as that used in 1980, for example, sugars in fruit juices are 'naturally' occurring sugars but as the cellular structure of the food is broken down the sugars become extrinsic. It is acknowledged that a degree of uncertainty exists as to the nature and classification of some sugars; for example, that of partially broken down foods such as stewed fruit, but for the purposes of this study all naturally present sugars were taken to be intrinsic or milk sugars with the exceptions of sugar in fruit juices or soft drinks which were classed as extrinsic. All other sugars were classified as non-milk extrinsic sugars. Two new fields were created in the food tables - intrinsic and milk sugars, and non-milk extrinsic sugars.

After the diaries had been collected from the children, each food item was allocated the most appropriate food code from one of the food tables according to the following criteria. An appropriate code for each food was first sought in the most recently updated food table. The immigrant food supplement and the Dunn 1000 series food tables were used only if no code was to be found in other tables. If no appropriate food code was available then a code was created in the additional food table. The allocated food code and weight of the food consumed was then entered into the computer database along with the child identification code, sex, social class and other variables recorded (section 4.4.1).

4.5 Control of errors

4.5.1 Rejection of data

It was necessary to reject some of the data collected where they did not comply with certain predetermined criteria:

- A diary collected more than 48 hours after completion: the diary would be collected but the data were not included in the analysis since the child's memory of the foods eaten could be expected to be poor.

- A lost diary was replaced only once in each survey. If the replacement diary was also lost the child would be excluded from the survey. It was thought that to pursue these children further was not worthwhile.

- Any diary considered by the interviewer not to reflect a true record would be excluded: for example a clean sparsely completed diary would suggest the child had not carried the diary with him for three days and had not recorded all food intakes - rather that it had been completed just prior to the interview. A child with such a diary would be carefully questioned before the diary would be included in the analyses.

- Any child from whom less than 6 complete days record were collected was rejected from the analyses.

4.5.2 Checks on data entry

A series of checks were built into the data entry system. Number ranges, predetermined to be relevant to each field, were assigned. During data entry, an alarm signal indicated when a range had been exceeded - the system then prevented further entry until the error had been rectified.

Once all the data from the diaries had been entered, the database was extensively screened for errors. A log of the database was produced which detailed every food code used and the food item to which that code referred, any erroneous food codes were then rejected. From this it was possible to return to the diaries and correct any errors. The log also indicated any entries of a food weight exceeding 1000g allowing a cross-check to confirm that a child had eaten a large portion of a particular food. This process of 'cleaning' the data was time-consuming, but essential to minimise errors in the results.

4.6 Nutrient analyses

The data analysis programme was specifically designed to integrate the several food tables used. In addition, the programme allowed flexibility so that data could be analysed in several ways - for example, total nutrient intake (Chapter 6), intake by place of purchase (Chapter 9) or place of purchase and time of day (Chapter 9).

The intakes of energy and the following nutrients were calculated for each day for each child:

Total carbohydrate
Total sugars
Non-milk extrinsic sugars (1990 study only)
Protein
Fat
Alcohol
Non-starch polysaccharides (1990 study only)
Unavailable carbohydrate (measured by the Southgate method)
Calcium
Iron
Retinol equivalent
Vitamin C

Vitamin D

The mean daily intake (over 6 days) of energy and each nutrient for each child was then calculated; that is, the child was the unit of analyses not the individual days recorded.

4.7 Discussion of the choice of nutrients

The nutrients listed above were chosen because the aim was not to measure the intake of all nutrients by these children, but rather to select certain 'marker' nutrients which would indicate the quality of diet consumed. The method of data collection, length of the survey and analysis by food composition tables meant that it would be inappropriate to attempt to measure the intake of some nutrients, for example trace elements which would be more accurately measured by chemical analysis.

Nutrients were selected for which there are recommended intakes against which the measured intake of the children could be assessed (Department of Health and Social Security, 1979; Department of Health, 1991). Unavailable carbohydrate intake was selected to allow any change between 1980 and 1990 to be measured, whilst non-starch polysaccharide intake was selected to provided some baseline data on the intake by adolescents and for comparison with reference values (Department of Health, 1991).

All macronutrients (including non-milk extrinsic sugars in 1990) were selected to allow the energy composition of the diet to be calculated. Micronutrients were selected to include minerals which have been identified to be risk nutrients in adolescents in previous surveys (for example, iron) and those for which increased needs have been identified (calcium) (Section 2.6.3). The selection of vitamins were to include both water-soluble (vitamin C and Beta carotene) and fat soluble vitamins (vitamin A). Beta-carotene and vitamin A intakes have been reported together as retinol equivalent.

4.8 Other data

4.8.1 Height and weight

In December 1989, before the start of the collection of the dietary data, the height and weight of each child who had volunteered to take part in the survey, were measured in a dental examination van, which visited each school in turn. All children were measured by the same person, height being measured vertically to the nearest 0.25cm in socks but without shoes, using a fixed scale with sliding headpiece. Weight was measured to the nearest 0.5 kg, with shoes and jacket removed, using a Seca 760 scale. This was the same equipment which had been used to collect the anthropometric data of children in the 1980 survey.

4.8.2 Age and sex

The date of birth and sex of each child was obtained from school records, all of the children were aged between 11 and 12 years at the start of the school year in September 1989. The mean age of the children was calculated from their age on April 1st 1990 - this being the approximate mid-point of the period of dietary data collection. The mean age for the analysis of the anthropometric data was calculated from the age on December 1st 1989 (section 4.8.1).

4.8.3 Social class grouping

At the end of the summer term, when collection of dietary data was complete, letters were sent to the parents or guardians of each child requesting information on the occupation of the head of the household. The classification of occupations (Registrar General, 1980) was used to place the children into social classes I to VIII. Those in social classes I and II were grouped together to give the social group 'high', social class III became social group 'middle', social classes IV and V became the 'low' social group, whilst those in social classes VI, VII, VIII and unclassified were grouped together as 'others'. A sample of 70 (ten children from each school) of the 1980 children were also classified in order to check for any inconsistencies in coding between 1980 and 1990.

4.9 Statistical analysis

The frequency distributions of the intakes of energy and of each nutrient were examined and found to be normally distributed; parametric statistical method were therefore employed in the analyses. The exception were data for retinol equivalent - the distribution of retinol equivalent intake was not normally distributed but was positively skewed and not amenable to simple transformations. Therefore median intakes have been reported for retinol equivalent intakes (Section 6.3.2.2). Statistical Package for Social Sciences (SPSSx, 1986) main frame computer package was used to calculate the mean nutrient intakes, standard deviations, standard errors of the means, median intake (for retinol equivalent) and the nutrient density of the dietary intakes.

Further details on the statistical methods used, specific to each analysis, will be given in the relevant chapters.

Figure 4.1 Map showing the geographical position of Ashington, Morpeth and Newbiggin in relation to Newcastle upon Tyne.

[Original in colour]

Figure 4.2 Front cover of the diary used by the children to record food intake (actual size).

UNIVERSITY

OF

NEWCASTLE UPON TYNE

DEPARTMENT OF ORAL BIOLOGY

Name: ______________________

School: ______________________

Class: ______________________

Survey Days: 1. ______________________

2. ______________________

3. ______________________

Figure 4.3 Page one of dietary diary giving instructions and an example day.

PLEASE REMEMBER TO:—

1. CARRY THIS BOOKLET WITH YOU EVERYWHERE FOR THE THREE DAYS.
2. WRITE DOWN EVERYTHING YOU EAT OR DRINK.
3. WRITE DOWN THE TIME THE FOOD OR DRINK WAS TAKEN, AND YOUR BEDTIME.
4. DO NOT FORGET SWEETS AND SNACKS, EVEN SMALL AMOUNTS ARE IMPORTANT.
5. WRITE DOWN THE AMOUNT OF FOOD OR DRINK TAKEN, FOR EXAMPLE:
   drinks as glasses, cups or mugfuls;
   breakfast cereals as tablespoons or cupfuls;
   jam or sugar as teaspoons or dessertspoons.

SOME EXAMPLES OF HOW TO FILL IN THE RECORD SHEET:

DAY

Monday January 15th

Please leave this section blank

CHILD CODE

DATE

SURVEY

HOLIDAY

DAY OF WEEK

TIME	FOOD or DR NK	AMOUNT EATEN
7.30	Cornflakes	½ bowlful
	Milk	½ cupful
	Sugar	2 teaspoons
12 o'clock	4 fruit gums	
12.15	1 large glass pop. lemonade	
6pm	Fish & Chips from 14th Avenue	½ fish
quarter past 10 bedtime		

Figure 4.4 Inner page of dietary diary.

DAY

....

Please leave this section blank

CHILD CODE ☐☐☐ DATE ☐☐☐☐

SURVEY ☐ HOLIDAY ☐

DAY OF WEEK ☐ ☐

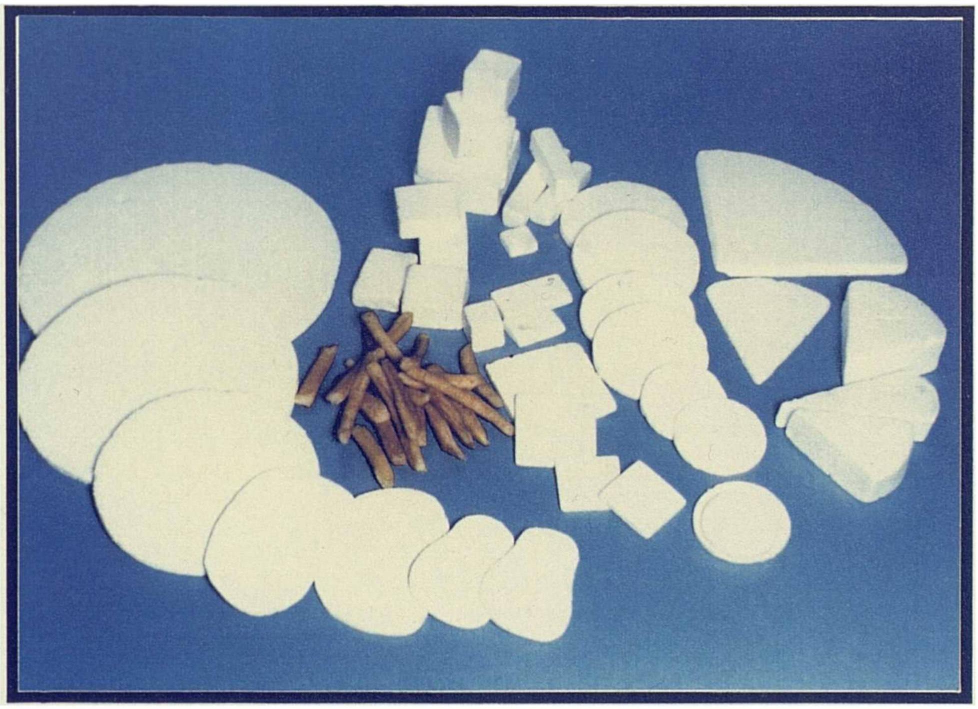
TIME	FOOD or DRINK	AMOUNT EATEN

Figure 4.5 Complete food model set.

[Original in colour]

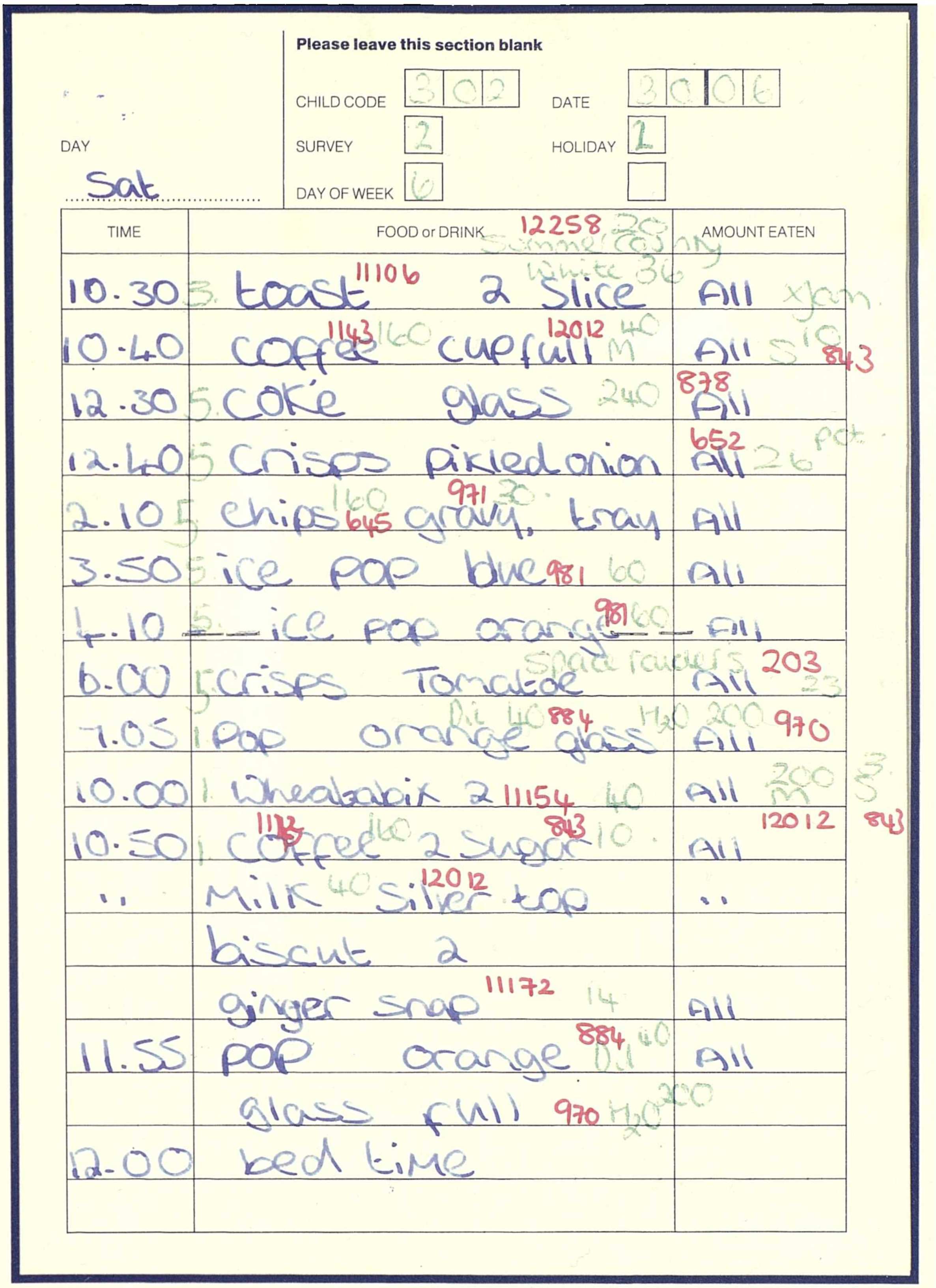
Figure 4.6 Photographs of foods used as part of the food model set.

Figure 4.7 Three dimensional polystyrene shapes used as part of the food model set.



[Originals in colour]

Figure 4.8 Example of a complete day's diary with food weights and place of purchase (green) and food codes (red) entered.



Please leave this section blank

CHILD CODE	302	DATE	3006
SURVEY	2	HOLIDAY	1
DAY OF WEEK	6		

DAY Sat

TIME	FOOD or DRINK 12258 20 Summer County	AMOUNT EATEN
10.30	3. toast 11106 2 slice White 36	All x jam
10.40	coffee 1143 160 cupfull 12012 40 M	All S 10 843
12.30	5. coke glass 240	878 All
12.40	5 crisps pikled onion	652 All 26 Pct.
2.10	5 chips 160 645 gravy 971 30 tray	All
3.50	5 ice pop blue 981 60	All
4.10	5 ice pop orange 981 60	All
6.00	5 crisps Tomatoe space raiders	203 All 23
7.05	1 Pop orange Di 40 884 glass H2O 200	All 970
10.00	1 Wheatabix 2 11154 40	All 200 M 3 S
10.50	1 coffee 1143 160 2 sugar 843 10	All 12012 843
..	Milk 40 silver top 12012	..
	biscuit 2	
	ginger snap 11172 14	All
11.55	pop orange 884 Di 40	All
	glass full 970 H2O 200	
12.00	bed time	

[Original in colour]

Appendix 4.1 **Letter sent to parents or guardians of all children in year 7 of the seven middle schools in the survey.**

THE UNIVERSITY OF NEWCASTLE UPON TYNE

DEPARTMENT OF CHILD DENTAL HEALTH

THE DENTAL SCHOOL
FRAMLINGTON PLACE
NEWCASTLE UPON TYNE NE2 4BW

October 1989

Dear Parent,

I write to ask if you would agree to your child taking part in a survey at school during this school year. The purpose is to discover what foods children eat. This information is needed so that nutritionists can work out the best advice to give to young teenagers. You may know that I carried out a very similar survey ten years ago. This study became quite famous, and its success was due to the great help we received from the children, their parents and the schools. Then, over 400 children aged 11-12 years in seven Middle Schools in Morpeth, Ashington and Newbiggin took part, and the results have been very helpful to many people in this area of northern England, as well as the rest of Britain and abroad. It will be interesting to see how the diets of children have changed over the past ten years.

Each child will be asked to keep a "food diary" for three days on two separate occasions (once during the first term and once during the second term). These "food diaries" will be issued by Miss Ashley Burton, our nutritionist, who will explain to each child how they should fill it in. It is most important that these diaries are kept really well.

In the study ten years ago, I also looked at the teeth of each child, and I would like to do so again in order to see how dental health has changed over the past 10 years.

The dental examination will be carried out by myself in school. It will be a simple examination, taking about 5 minutes. No X-rays will be taken and no dental treatment will be given. So as to understand a little more about dental health I will also ask each child to spit a little of their saliva into a small cup for analysis.

In the last survey, the children enjoyed taking part and I hope they will do so again. At the end of the project I look forward to telling you, the children and the staff of the schools, what we found out. The study is sponsored by the Medical Research Council of Great Britain and has the full approval of the School, the County Education Authority and the District Health Authority.

Thank you for reading this letter. I would be most grateful if you would complete the form below and return it to school tomorrow.

Yours sincerely,

Andrew Rugg-Gunn

Professor A.J. Rugg-Gunn

Child's Name: .... Class: ....
(please print)

agree*
I do not agree* to my child taking part in the survey of diet and health.

(*Please delete as necessary)

October 1989 Signed ....
(Parent or Guardian)

Appendix 4.2 **Letter sent to all class teachers of children taking part in the survey.**

THE UNIVERSITY OF NEWCASTLE UPON TYNE

THE DENTAL SCHOOL
FRAMLINGTON PLACE
NEWCASTLE UPON TYNE NE2 4BW
TELEPHONE: (091) 222 6000
Ext. 8241

Dear Class Teacher,

As you will be aware, pupils from your class have kindly volunteered to take part in a dietary survey. This is a comparative study following on from a survey conducted in seven middle schools in South Northumberland ten years ago. The same seven schools have once again kindly agreed to take part. The survey involves 420 children altogether.

The dental examinations which are part of the study are now completed, and we thank you for your help. From January 1990 the collection of dietary information will begin. This is the most important part of the study, as the main aim is to see how diets of schoolchildren have changed over the past ten years. It is very important, though, that the children do not try to change their diets just because a survey is going on.

Our dietitian, Miss Ashley Burton will be collecting the dietary information from all 420 children. We hope to be able to do this causing the least disruption to your class. The dietitian will visit your school initially to speak to all the children who have volunteered to take part. This will be to explain the importance of the survey and what they will be asked to do; it is expected that this will save considerable time later. During the following two weeks each child will be given a dietary diary to complete over three days, it is important they record <u>everything</u> they eat and drink during this period. On the fourth day the dietitian will interview each child individually: the interview will take approximately 20 minutes. The individual interview is an essential part of data collection as it will enable the dietitian to fill in any gaps and expand on the recorded information.

Each child will be asked to complete two 3 day diaries, one during January-April and the second April-July. It is hoped that the dietitian will be able to finish in each school well within the two weeks allocated in each term, with possible later visits to collect diaries of absentees.

We would like to thank you for your help in this study which we hope will produce results of national and international importance. We hope to be able to tell you the results this time next year.

Looking forward to your help

Miss Ashley Burton
The dietary survey team
University of Newcastle upon Tyne

Prof. Andrew Rugg-Gunn
Phone: 091 222 7859
091 222 6000 Ext. 8241

CHAPTER FIVE

THE SUBJECTS OF THE STUDY

5.1 Number of subjects

All 546 children in year 7 of the seven middle schools were invited to participate in the study, of which 418 (77%) volunteered to take part (Table 5.1). This fairly high volunteer rate was accompanied by a low withdrawal rate - only one child (0.2%) withdrew from the study. A further 38 children (9% of volunteers) were lost from the sample for other reasons: these included 26 children who completed only one 3-day record due to absenteeism or lost diaries, 7 children who moved away from the area during the survey and 5 children from whom at least one diary was considered inadequate and so rejected (section 4.5.1). The total number of children completing the study was 379, 91% of volunteers (Table 5.1). The volunteer rate in the 1980 survey was 59% of which 87% completed all aspects (5 diaries over 2 years).

5.2 Sex and social class groupings of the subjects

Forty-eight per cent of the final number of subjects in 1990 were boys: 184 boys and 195 girls completed the study. Only three children were non-caucasian in origin. In the 1980 study (Hackett et al., 1984a) 49% of the subjects were boys, and 1 child was non-caucasian in origin.

The children were sub-grouped into high, middle and low social groups according to the occupation of the head of household (section 4.8.3). The distribution by social group differed in 1990 (high 36%, middle 31%, low 18%) from that of 1980 (high 21%, middle 43%, low 29%) (Table 5.2). There was an increase in the per cent of children in the high social group (21% in 1980, 36% in 1990) but also in the per cent of children in the unclassified group (7% in 1980, 15% in 1990).

5.3 Number and distribution of days

The total number of days surveyed and the distribution of days of the week, are shown in Table 5.3. Since interviews could only be conducted on schooldays and were usually on the day immediately following the recording period, fewer Thursdays and Fridays compared with other days, were included. The proportions of each day surveyed were similar to those reported for the 1980 survey (Table 5.3).

Of the days surveyed in 1990, 62% were schooldays, 36% were holidays or weekends and 2% were sick-days. Sick-days were included in the analyses.

5.4 Age and anthropometric measurements

The mean age, height, weight and body mass index (BMI) of the children in 1989-1990 are given in Table 5.4. Boys and girls were of a similar mean age - 11 years 6 months and 11 years 7 months. In 1990, girls were slightly taller and heavier than the boys, although BMI were similar.

For purposes of comparison, the mean age, height, weight and body mass index of the children, in the 1980 survey, have been included in Table 5.4. The age of the children in both studies were similar. While the mean height of boys was little changed, the mean weight of boys had increased by approximately 1.5Kg. Girls in the 1990 study were taller (by 3cm) and heavier (by 2Kg) than in 1980. The mean body mass index rose by 0.41 in boys and 0.30 in girls between 1980 and 1990 (Table 5.4).

In the 1990 group of 379 boys and girls, sixteen children (4%) had a BMI of 25 or more. This shows an increase in the prevalence of obesity since 1980, when 9 children (2% of the sample) had a BMI of 25 or more.

5.5 Discussion

Falling school rolls between 1980 and 1990 reduced the possible sample size from 784 in 1980 to 546 in 1990. Higher consent and completion in 1990, meant that the final group sizes were similar (379 in 1990, 405 in 1980). The higher consent rates in 1990 were possibly due to the reduced length of the study and the absence of three comprehensive dental examinations, hence a reduced burden on the participants making them more willing to agree to participate.

The change in social group profile (a higher proportion of subjects being in the high social group) mainly at the expense of the middle social group, reflected a real change within the population of the area (District Dental Officer, personal communication).

Using schooldays only for interview resulted in more Sundays and fewer Thursday and Fridays being included in the survey. When the days surveyed were grouped as either schooldays or holidays (including weekends) then 62% of the days surveyed were schooldays; this can be compared with an average school year in which approximately 52% of days are schooldays. Therefore, although Thursday and Fridays were under-represented, schooldays were in fact slightly over-represented, but this was unavoidable since no interviews could be conducted on Saturday or Sunday.

The body mass index, although not strictly applicable to children, is included to facilitate an assessment of any change in the prevalence of obesity between 1980 and 1990. The BMI is used to assess the degree of obesity in adults: a BMI greater than 25 in an adult would indicate Grade I obesity and a BMI greater than 40 would be classified as grade III or severe obesity (Garrow, 1981). The average BMI of children in general is approximately 18 to 19, lower than that of adults where a BMI of between 20 and 25 is considered a desirable range. The increases in average BMI and prevalence of obesity suggest that the children in the 1990 study either consumed more energy, or had lower levels of energy expenditure, than the children in 1980. This will be discussed, along with mean energy intakes, in Chapter 6.

Table 5.1 Number of children involved in the 1990 study.

	Number	% of total	% of volunteers
Total number	546	100	-
Volunteers	418	76.6	100
Moved away	7	1.3	1.7
Withdrew	1	0.2	0.2
Absent or lost diary	26	4.8	6.2
Rejected	5	0.9	1.2
Completed all aspects	379	69.4	90.7

Table 5.2 Number of children in each social class in 1990 and per cent of children in each social class in 1990* and 1980**, by occupation of head of household.

Social group	Social class	Number of subjects 1990		Per cent 1990		Per cent 1980	
High	I	28	137	7	36	5	21
	II	109		29		16	
Middle	III	116		31		43	
Low	IV	49	70	13	18	24	29
	V	21		5		5	
Unclassified	VI VII VIII	56		15		7	
Total		379		100		100	

* Registrar General 1990.
** Registrar General 1980.

Table 5.3 Distribution (total number of days and per cent) of all days surveyed (379 subjects x 6 days) in 1990 compared with the per cent distribution in the 1980 study.

Study	1990		1980
	Number	%	%
Monday	430	18.9	20.6
Tuesday	450	19.8	18.8
Wednesday	288	12.7	13.0
Thursday	175	7.7	6.6
Friday	149	6.6	7.7
Saturday	317	13.9	14.2
Sunday	465	20.4	19.0
Total	2274	100	100

Table 5.4 Number of subjects, age and anthropometric data of boys and girls in 1990 and 1980 studies* (s.e.m).

Sex	Male		Female	
Study	1980	1990	1980	1990
Number of subjects	193	184	212	195
Age	11y 6.6mo (0.25mo)	11y 6.1mo (0.25mo)	11y 6.7mo (0.25mo)	11y 6.8mo (0.24mo)
Height (m)	1.46 (0.005)	1.47 (0.005)	1.47 (0.005)	1.50 (0.005)
Weight (kg)	39.02 (0.56)	40.46 (0.68)	39.88 (0.55)	41.93 (0.66)
Body mass index**	18.15 (0.19)	18.56 (0.23)	18.33 (0.19)	18.63 (0.23)

* At commencement of study

** Body mass index = weight(kg) / $(\text{height(m)})^2$

CHAPTER SIX

NUTRIENT INTAKE IN 1980 AND 1990

6.1 Introduction and aim

Only by monitoring change in diet over time is it possible to assess the effectiveness of health education and so decide future priorities. A repeated cross-sectional nutritional study of adolescents was conducted by Durnin et al. (1974) in 1964 and 1971, twenty years ago - no other such studies exist. Similar information on changes in the diet of the modern adolescent was desirable.

During 1979 to 1981 a nutritional survey of 405 11 to 12-year old children was conducted in Northumberland (Hackett et al., 1984a). In 1990, this survey was repeated - in this chapter the results are reported and compared with the results of the 1980 survey.

Thus the aims were:

- To measure the total nutrient intake of 11 to 12-year-olds in south Northumberland in 1990 and to compare the total nutrient intake and the nutrient density of the diet of 11 to 12-year-olds in 1990 with that of children of the same age, attending the same schools, ten years earlier in 1980.

- To investigate any differences between the dietary intakes of boys and girls, and between the high, middle and low social groups in 1990. Also, to measure any change in nutrient intake from 1980 to 1990 and to investigate whether the nutrient intake of some sex and social groups had changed more than others. That is, had the nutrient intakes of boys altered in a different way to the nutrient intakes of girls and had the nutrient intake of one social group changed differently from the others.

6.2 Method

6.2.1 Calibration of the method

It was unavoidable that the dietitian collecting the dietary information in 1990 was different to that in 1980. In order to ensure that the dietary data were collected in the same way, the 1990 dietitian undertook a one-week training period with Dr A.

Hackett who had been the dietitian in the 1980 survey (Hackett et al., 1984a). Training was achieved by means of a pilot study of ten 11-year old children attending a school in Liverpool. Diaries identical to those employed in the main study were used. The children were instructed as a group on how to complete the diaries, by both dietitians together. Each child was then given a 3-day diary to complete.

On the day immediately following the recording period (day 4), each child was interviewed by both dietitians, using the food model set used in the 1980 survey. The dietitians conducted alternative interviews whilst both recorded the weights of food items consumed; the weights recorded were then compared and discussed. This calibration study allowed both interview technique and the application of the food model set to be demonstrated.

During the training week, the 1990 dietitian was also instructed on the construction of a food model set similar to that used in 1980 (section 4.3).

6.2.2 Changes in nutrient classification and terminology 1980 to 1990

Non-milk extrinsic (NME) sugars intake in 1990 was calculated according to the definition of the COMA panel on Dietary Sugars and Human Disease (Department of Health, 1989b); these data were unavailable in 1980.

Non-starch polysaccharide (NSP) as measured by Englyst (Englyst et al., 1989) is a relatively new method of measuring the 'fibre' content of food. Previously, the most widely used and accepted method of assessing the 'fibre' content of food was that of Southgate (Wenlock et al., 1985). Southgate 'fibre' (referred to throughout as unavailable carbohydrate) includes cellulose, non-cellulosic polysaccharides (both soluble and insoluble), resistant starch and lignin. Whilst Englyst 'fibre' (NSP) excludes resistant starch and lignin. Resistant starch has been found to be highly dependant on food processing and therefore variable in a mixed diet, and as such it is not valid for inclusion in food tables. Lignin is excluded as its accurate measurement is difficult and since it is a very minor component of most foods - if accurately measured it would be quantitatively insignificant (British Nutrition Foundation, 1990).

In 1980, values for the non-starch polysaccharide content of foods were not yet published. Therefore unavailable carbohydrate intake has been included here to allow comparison of 'fibre' intakes in 1980 and 1990.

No other changes in the method of analysis of the nutrients or classification occurred between 1980 and 1990.

6.2.3 Calculation of nutrient density

Nutrient intakes per unit energy (MJ), that is the nutrient density of the diet, gives a measure of the quality of dietary intake which is independent of total energy intake.

$$\frac{\textit{intake of nutrient}}{\textit{energy intake (MJ)}} = \textit{intake of nutrient per MJ}$$

The nutrient density of each individual child's diet was first calculated, from which the average nutrient densities of the dietary intake of children in each sex and social group was determined.

6.2.4 Statistical analyses

Analysis of variance was by Generalised Linear Models using GLIM (Baker and Nelder, 1978) to test the effects of sex, social grouping and study (1980, 1990) for statistical significance. This method of statistical testing avoids the need for multiple t-tests that would be required for the number of variables in this study (2 sexes x 3 social groups x 2 surveys for each nutrient). Results significant at the 5% level ($p<0.05$) have been reported as significant although, as with all multiple testing, care must be taken in interpreting the results. Those results significant at the 1% level ($p<0.01$) have been given more emphasis in the text. Nutrient intakes in 1990 are first reported followed by a comparison of 1980 and 1990 results. P-values are used throughout the text to help the reader, while the results of the statistical analyses are summarised in Appendix 6.1.

6.3 Results

The total mean intakes of energy, macronutrients, total sugars, 'fibres' and micronutrients for boys and girls are given in Table 6.2 to Table 6.7, these results being presented by sex (Table 6.2 and Table 6.3) and by sex and social group (Table 6.4

to Table 6.7). The social group profile of the sample changed between 1980 and 1990; however, since the same criteria of classification were used, the sex and social groups sub-groups were directly comparable between surveys.

6.3.1 Energy composition of intake

6.3.1.1 Energy composition of intake in 1990

The contribution of macronutrients and sugars to energy intake is given in Table 6.1. Approximately 40% of energy was derived from fat and 48% from carbohydrate (22% from total sugars, 17% from NME sugars). No significant difference was found between boys and girls in the contribution of protein, fat and carbohydrate to energy intake, although for girls a slightly higher proportion of energy came from non-milk extrinsic sugars (17.7%) than for boys (16.6%).

6.3.1.2 Energy composition of intake 1980:1990

To allow comparison with the 1990 findings, the proportions of energy derived from each macronutrient by the children in the 1980 study are given in Table 6.1. The contributions of protein (11-12%), fat (39-40%), carbohydrate (48-49%) and total sugar (22-23%) to energy intake were little changed between 1980 and 1990. The per cent energy derived from NME sugars was not available for 1980. Energy intake from alcohol was negligible in both studies.

6.3.2 Energy and nutrient intake by sex

6.3.2.1 Energy and macronutrients

- **Energy and macronutrient intake in 1990**

Table 6.2 shows that, as expected, boys consumed significantly more total food energy than girls ($p<0.001$). This pattern was reflected in the intakes of protein, fat and unavailable carbohydrate and NSP although not total sugars, in which there was little difference (boys 117g, girls 119g).

- **Energy and macronutrient intake 1980:1990**

In comparison with the macronutrient intakes measured in 1980 (Hackett et al., 1984a) there was a small reduction in average intakes of energy although this was only significant in the boys ($p=0.014$). Fat and carbohydrate intake by boys had also fallen

($p<0.001$) whilst there was a small increase in the average intake of protein by both boys and girls ($p<0.001$). Of the macronutrients, only unavailable carbohydrate showed any appreciable change, increasing by about 2g per child per day for both boys and girls ($p<0.001$). There was no significant change in the intake of total sugars in either sex between 1980 and 1990.

6.3.2.2 Micronutrients

- **Retinol equivalent**

Unlike the other nutrients studied, the distribution of retinol equivalent intake were not found to be Normal. The data were positively skewed - a small number of children having large mean intakes. Mean daily retinol equivalent intake for all children was 689µg (s.d. 638µg), the range of intake was 108µg - 5489µg. Only 17 children had mean daily intake exceeding 1300µg. Large intakes were mainly due to the consumption of one retinol equivalent rich food on at least one of the survey days - most of the children with high intakes were found to have eaten liver at least once during the 6 days. Since the distribution was not Normal, median intakes (standard error of the median) have been reported for retinol equivalent in this chapter.

- **Micronutrient intake in 1990**

Boys had significantly higher mean calcium and iron intakes than girls ($p<0.001$), again reflecting their larger energy intake (Table 6.3). Vitamin C intake by both boys and girls were high, girls consumed slightly more than boys although these absolute amounts were not significantly different. There was no difference between boys and girls in the median intake of retinol equivalent or the mean intake of vitamin D. Vitamin and mineral dietary supplements were recorded by only 18 of the 379 subjects on one or more occasion during the six days surveyed in 1990, all supplements reported were included in the analysis.

- **Micronutrient intake 1980:1990**

Micronutrient intake of the children in the 1980 survey are also given in Table 6.3. Of the micronutrients intakes calculated, iron and vitamin C intakes increased significantly between 1980 and 1990 ($p<0.001$): iron by 1.6mg in the boys and 2.0mg in the girls and vitamin C by 14mg in the boys and 18mg in the girls.

Absolute calcium intakes by girls were unchanged whilst those of boys appeared to fall, yet neither the mean difference between 1980 and 1990, nor its interaction with sex was significant. It is possible that there was less of a difference between the boys and girls in 1990 than in 1980, with boys reducing their calcium intake whilst that of girls was unchanged. If this was so, it was probably a reflection of the decrease in energy intakes by boys between 1980 and 1990. There were no apparent changes in the median intakes of retinol equivalent.

6.3.3 Energy and nutrient intake by sex and social group

6.3.3.1 Nutrient intake by sex and social group in 1990

- **Macronutrients**

In 1990, mean energy intakes showed a significant social group trend for both boys and girls ($p=0.026$). Children from lower social groups had the highest energy intakes: for high, middle and low social groups respectively; boys, 8.3MJ, 8.7MJ and 9.2MJ; girls, 7.9MJ, 8.1MJ and 8.4MJ (Table 6.4 and Table 6.5). This gradient in energy intake was due to a difference in fat and carbohydrate intakes rather than of protein or alcohol. Children from low social groups had a significantly higher intake of fat ($p<0.001$) than children from high social groups. No consistent social group trends were apparent in mean total sugar or non-milk extrinsic sugar consumption, although there was considerable variation between groups. Middle social group boys were the highest sugar consumers with an average daily intake of 123g, whilst middle social group girls had the lowest average daily intake of 113g. Middle social group boys and low social group boys and girls were the highest consumers of non-milk extrinsic sugars, all with a mean daily intake of approximately 93g (Tables 6.4 and 6.5). No social group trends were apparent in unavailable carbohydrate or non-starch polysaccharide intakes.

- **Micronutrients**

Micronutrient intakes by sex and social group are given in Table 6.6 for boys and Table 6.7 for girls. Absolute intakes of calcium and vitamin C showed that for both boys and girls, children from low social groups had significantly lower intakes than children from high social groups ($p<0.01$). This was particularly so for vitamin C - high social group boys consumed an average of 6mg a day more and high social group girls 18mg a day more than low social group children of the same sex. No consistent social group trends were apparent for retinol equivalent intakes.

6.3.3.2 Nutrient intake by sex and social group 1980:1990

- **Macronutrients**

Table 6.4 and Table 6.5 include the mean macronutrient intakes by social group for 1980. The effect of social group on energy intake changed from 1980 to 1990 - in 1980, no effect of social group on energy intake was detected, while in 1990 social group had a significant effect ($p=0.02$). It is possible that the fall in energy intake, detected from 1980 to 1990, was mainly due to the marked decline in mean energy intake by the high social group children: boys, from 8.91MJ in 1980, to 8.34MJ in 1990 (Table 6.4), and girls from 8.48MJ in 1980, to 7.91MJ in 1990 (Table 6.5). Indeed energy intake by the low social group children may have increased; boys, from 8.75MJ in 1980 to 9.19MJ in 1990, and girls marginally from 8.32MJ in 1980 to 8.36 MJ in 1990. There has also been a change in the relation between social group and fat intake. A significant social group gradient in fat intake ($p=0.001$) had developed since 1980 for both boys and girls - the higher social group children had decreased their fat intake whilst children from the lower social groups had not (Table 6.4 and Table 6.5).

The average intake of unavailable carbohydrate increased between 1980 and 1990 - this occurred in all social groups and in both sexes ($p<0.001$). Non-starch polysaccharide intakes were not available for the 1980 survey and therefore no comparison was possible.

- **Micronutrients**

Micronutrient intakes for each sex and social group, in 1990 and 1980 are given in Table 6.6 for boys and Table 6.7 for girls. In most sex and social groupings, calcium intake in 1990 was lower than in 1980 although this was not found to be significant. Iron and vitamin C intakes had increased in all sex and social groups, whilst median retinol equivalent intakes had increased in most of the sex and social groups. Hackett et al. (1984a) had observed a general social group trend of lower nutrient intakes in lower social groups for both boys and girls in 1980; this was found to be still present in 1990. The possible exception to this was for iron intake - there was a significant rise in iron intake between 1980 and 1990 ($p<0.001$), an increase of approximately 2mg per day occurred across all social groups. Little difference in absolute intakes of iron between social groups, in either sex, was detected. Vitamin C intakes had increased markedly ($p<0.001$), this was so in both sexes and all social groups; however, a social group gradient still existed, with low social group children having the lower intakes ($p<0.001$).

6.3.4 Nutrient density of the diet

6.3.4.1 Nutrient density of the diet in 1990

When the diets of boys and girls were compared independently of energy intake, there were significant differences in the nutrient density of protein ($p<0.001$) and of fat ($p=0.004$); girls had an average diet lower in protein and higher in fat than boys, although the girls' diet was lower in fat in absolute terms (section 6.3.2.1). The average dietary intake of girls had a higher nutrient density of total sugars ($p<0.05$), NME sugars ($p<0.05$) and vitamin C ($p<0.05$) than boys, (Table 6.8 and Table 6.9).

Nutrient densities of calcium, iron or unavailable carbohydrate and non-starch polysaccharide were similar for both sexes, although boys ate more of these nutrients in absolute terms.

When considering differences between the social groups, for both boys and girls, the nutrient densities of protein, calcium and vitamin C were lower in the low social group than in the high social group ($p<0.01$). The nutrient density of fat was higher in the diets of low social group children ($p=0.004$). In all social groups, girls had a higher nutrient density of total sugar than boys in the corresponding social group. For both boys and girls, high social group children had the highest nutrient density of total sugars; this was also true for NME sugars although the social group trend was not consistent. Any social group gradient in iron intake was of borderline statistical significance, although it was in the direction to be expected from the evidence of other nutrients. Therefore, a social group gradient showing a less nutrient-dense diet in the lower social groups was evident.

6.3.4.2 Changes in nutrient density of the diet 1980:1990

When the average nutrient density of the diet in 1990 was compared with the results from the 1980 study (Table 6.8 and Table 6.9) nutrient density increased for protein ($p<0.001$), unavailable carbohydrate ($p<0.001$), iron ($p<0.001$), vitamin C ($p<0.001$) and retinol equivalent (p=0.014). Intakes for most nutrients, both absolute and per MJ, increased for the low social group children, the exception being calcium intake by boys. There was no inter-social-group difference in the nutrient density of unavailable carbohydrate in either boys or girls, the increase in intake between 1980 and 1990 being in all sex and social groups. A significant social group trend in fat intake had developed since 1980, high social group children had decreased both their absolute and relative fat intake while the low social group children had not.

Despite the increase in nutrient density in the diet of the low social group children, the social group gradient in nutrient density, detected in the 1980 study, remained significant in 1990.

6.4 Discussion

The average nutrient intakes, recorded in the 1990 survey, were in broad agreement with those of other contemporary surveys of this age group. The Department of Health in its publication 'Diets of British Schoolchildren' (Department of Health, 1989a) reported intakes of 1723 10 to 11-year old children in 1983, while Nelson et al. (1990) reported intakes of 143 11 to 12-year-olds in 1989. These authors reported energy intakes for boys of 8.76 MJ and 7.74MJ respectively (compared with 8.61 in our 1990 Northumberland survey) and for girls, energy intakes of 7.57MJ and 7.45MJ respectively (8.25MJ in our 1990 Northumberland survey). The contributions of protein, fat and carbohydrate to the total energy intake of the diet in 1990 were similar to those of the children surveyed in the two studies quoted, although the contribution of fat (40% of energy), was marginally higher than the value of approximately 38% reported by the Department of Health (1989a) and Nelson et al. (1990).

The Department of Health (1989a) and Nelson et al. (1990) also reported micronutrients intake. These authors reported for boys, calcium intakes of 833mg and 768mg respectively (compared with 786mg in 1990); iron 10.0mg and 11.2mg (11.7mg in 1990); vitamin C 49.3mg and 66.6mg (51.9mg in 1990). The higher intake of energy found in the Northumbrian girls in 1990 was reflected by higher intakes of other nutrients: calcium 702mg and 701mg (763mg in 1990); iron 8.6mg and 10.0 mg (11.2 in 1990) and vitamin C 49.0mg and 68.4mg (55.6mg in 1990).

The results of our dietary survey in 1990 can be compared with the results of the 1980 survey and also to the then current Recommended Daily Amounts (RDA) for 12 to 14-year old boys and girls (Department of Health and Social Security, 1979) (section 2.7).

Total energy intake by boys had fallen between 1980 and 1990. When investigated by social group, it was apparent that the fall in energy intake was due to a reduction in energy intake by the high social group boys and indeed the energy intake by low social group boys may have increased. Energy intakes by girls of the high social group had also fallen. Energy intakes reported were considerably lower than the RDA of 11.0MJ for boys and 9.0MJ for girls; 90% of boys and 65% of girls had mean energy intakes below the corresponding RDA. This could reflect under-reporting of intake, but comparisons with other recent surveys suggest that the RDA was too high for this age group with their then current levels of activity.

This fall in energy intake needs to be considered in the context of the increase in mean Body Mass Index and the prevalence of obesity reported in Chapter 5. Reduced energy intakes in conjunction with increased BMI can only be explained by a reduction in physical activity - in 1980 2.2% of the 405 children measured had a BMI of greater than 25; in 1990, 16 children had a BMI of greater than 25 representing 4.2% of the 379 children measured. These findings suggest an increase in the prevalence of obesity as well as reduced energy intakes.

Whitehead et al. (1982) reviewed dietary surveys of children and adolescents and demonstrated a long-term downward trend in total energy intake. This was explained by speculation of reducing physical activity levels. Armstrong et al. (1990) recently found low levels of habitual physical activity in 266 British children aged 11 to 16 years. The results reported here support this theory, and it may be that the lower energy intakes of the higher social groups in particular reflect a temporal change in energy intakes which has not yet occurred in the lower social groups. If this is a valid assessment of changes in energy intake and adolescents are indeed becoming more sedentary, then this is disappointing for health educators, who urge the population to take more exercise, and for the health of adolescents.

Despite the enormous amount of attention focused on diet by the media and health educators, contributions of fat, protein and carbohydrate to energy intake and mean intakes of fat and of total sugars were unchanged between 1980 and 1990. A diet with the same percentage of energy from fat (40%) was reported for Glasgow adolescents in 1964 and 1971 (Durnin et al., 1974). This comparison indicates that there has been no change in contribution of fat to energy intake in this age group in twenty-seven years. The fatty acid composition of the diet was not measured, and it is possible that this may have altered whilst the total fat intake remained static.

In 1984, the COMA panel on Diet and Cardiovascular Disease (Department of Health and Social Security, 1984) recommended, for adults and children over the age of five, that no more than 35% of energy should be derived from fat. This can be compared with the mean percentage energy derived from fat of 40% for the children in 1990. Although more children in 1990 than in 1980 achieved this recommendation for fat intake, these children were still a minority, found mainly in the middle and high social groups - indeed the proportion of children in the low social groups achieving this target fell. In 1990, for boys and girls respectively, 24% and 10% of high social group children met this target (7% and 3% in 1980), 20% and 10% of middle social group children (8% and 8% in 1980) and 6% and 5% of low social group children (12% and 6% in 1980).

In the average UK diet, between 15-20% of energy is derived from sugar (Department of Health, 1989b). Our results indicate that in 1990, sugar continued to contribute over 20% of the total energy intake of this age group, identifying them as among the highest consumers of sugar as a proportion of energy, in the UK. Sugar intake remained at approximately 120g per day despite the increased range of sugar-free products available and the efforts of health education to encourage a reduction.

Unavailable carbohydrate intake increased by approximately 2g per person per day to an average intake of approximately 15g. However, this was still below the average UK daily intake, for all age groups together, of 20g per day (Bingham and Cummings, 1980). Comparable survey data of 'dietary fibre' intakes are sparse. The survey of Diets of British Schoolchildren (Department of Health, 1989a) did not investigate 'dietary fibre'. The Dietary and Nutritional survey of British Adults (Gregory et al., 1990) reported mean daily unavailable carbohydrate intakes of 24.9g for men and 18.6g for women. This compares with 15.9g and 14.8 g of unavailable carbohydrate for boys and girls respectively in 1990. The National Food Survey of 1989 (Ministry of Agriculture, Fisheries and Food, 1990) estimated, from household purchases, the population average intake of non-starch polysaccharides as 12.4g, which compares with 9.4g and 9.0g, for boys and girls respectively in 1990. Comparison of children's 'fibre' intake with mean nutrient intakes based on the whole population, is difficult, since it cannot be expected that a child with a smaller total energy intake than an adult could achieve the same absolute intake of 'dietary fibre'. The dietary reference value report (Department of Health, 1991) recommended a average NSP intake of 18g/day for the adult population, since there was no data on the physiological function of NSP in children, it was recommended that children (over the age of two) should have a proportionately lower intake.

Deficiency of dietary iron and hence the occurrence of anaemia, is recognised as a world-wide nutritional problem. Adolescents are particulary susceptible to iron deficiency anaemia, due to increased erythropoiesis during this time of growth (Greenwood and Richardson, 1979). In view of this, the increase in iron intake between 1980 and 1990, is encouraging. The average diet in 1990 provided 1.4mg iron/MJ compared with 1.1mg/MJ in 1980; an important increase, as anaemia is usually prevented, in the general population, by an intake of 1.3mg/MJ (Department of Health and Social Security, 1979). Despite improvements in iron intakes between 1980 and 1990, in 1990, 50-60 per cent of boys and 65-80 per cent of girls still failed to achieve the RDA of 12mg. It is worthy of note that any value for dietary iron intake must be considered with some caution as the bioavailability of iron intake was not considered and the use of food tables can give poor estimates of iron intake (Marr, 1971).

No change in calcium intake by girls was found whilst for boys calcium intake fell. Calcium intake by this age group is particularly important, since the development of a high peak bone mass has been identified as a preventive measure against osteoporosis in later life. During adolescence, accumulation of bone mass is at its highest - approximately 45% of adult skeletal mass is formed during adolescence, the largest gains being between 10-14 years in girls and 12-16 in boys (Greenwood and Richardson, 1979; James, 1988).

Mean calcium intake in 1990, remained at just above the RDA of 700mg for both boys and girls although calcium intake by boys fell between 1980 and 1990. The RDA for calcium was achieved by at least 50% of all the sub-groups studied, however, the proportion of boys failing to meet the RDA increased between 1980 and 1990. Approximately 30-40% of boys and 40-50% of girls had calcium intakes below the RDA in 1990. Only in the low social group girls was the average calcium intake in 1990 higher than that of 1980. Recent studies indicate both nutritional and genetic factors influence bone growth in teenage girls, and therefore teenage girls may be at risk of skeletal inadequacy if their calcium needs at puberty are not met by an adequate calcium intake (Matkovic et al., 1990).

Some improvements in diet have occurred between 1980 and 1990. Unavailable carbohydrate, iron and vitamin C intakes have increased and the nutrient density of the diet improved in all sex and social groups. However, as in 1980, in 1990 children from the low social groups continued to consume the poorest quality of diet. With lower energy intakes, nutrient density of the diet becomes increasingly important if nutritional requirements are to be met. Whilst average energy intakes fell between 1980 and 1990, nutrient density had increased for many nutrients. This was true between 1980 and 1990, but also longer term when these data were compared with results reported by Widdowson (1947). In her study intakes for boys and girls respectively were: protein (g/MJ) 6.8, 6.9 (7.2, 6.9 in Northumberland in 1990); calcium (mg/MJ) 65,65 (91, 93 in 1990); iron (mg/MJ) 1.2, 1.2 (1.4, 1.4 in 1990); vitamin C (mg/MJ) 5.1, 4.4 (6.0, 6.7 in 1990). These comparisons of our 1990 survey with the data collected in Northumberland in 1980, and with nutritional data from children of a similar age in the 1930's are encouraging, indicating some long-term improvement in the nutrient density of the diets of adolescents in Britain.

An aspect of some concern is that a social group gradient still existed in 1990; the lower social group having diets with the lowest nutrient density and the highest intake of fat. The higher energy intakes reported for the lower social groups are not a reflection of a better quality of diet, rather a reflection of higher fat intakes (low social group boys) or higher fat and sugar intakes (low social group girls). This finding is in agreement with the results of Cook et al. (1973) who found that the higher social group children had higher intakes per unit energy of all nutrients than children of the lower social groups, with the exceptions of carbohydrate and added sugar.

6.5 Summary

The nutritional intakes reported above are in broad agreement with other national and regional studies and so there is no reason to suspect these children are unusual in their dietary habits. It follows that the results reported here can be considered representative of 11 to 12-year old children in Britain. Whilst there has been some increase in intakes of unavailable carbohydrate, iron and vitamin C, children in 1990 were consuming less energy but eating no less sugar or fat (as a proportion of energy) than adolescents ten years ago. There is evidence that children are becoming more sedentary and that the prevalence of obesity in this age group may be increasing. Social group gradients in nutrient intake and nutrient density of the diet, detected in 1980, were still present in 1990 suggesting that children from low social group families may be at greater risk of nutritional deficiencies.

Table 6.1 Mean per cent contributions (s.e.m) of macronutrients and sugars to total energy intake by sex and year of study.

Sex		Boys		Girls	
Year of study		1980	1990	1980	1990
(n)		(193)	(184)	(212)	(195)
Protein		11.7 (0.10)	12.4 (0.16)	11.1 (0.11)	11.9 (0.13)
Fat		39.3 (0.26)	39.3 (0.31)	40.3 (0.24)	40.1 (0.26)
Carbohydrate		48.9 (0.27)	48.2 (0.35)	48.6 (0.27)	48.0 (0.28)
	Total sugars	21.5 (0.30)	21.9 (0.39)	22.2 (0.33)	23.0 (0.32)
	NME* sugars	na	16.6 (0.40)	na	17.7 (0.37)

* Non-milk extrinsic sugars

na value not available

Table 6.2 The mean (s.e.m) daily intake of energy, macronutrients, sugars and 'fibres' by sex and year of study.

Sex	Male		Female	
Year of study	1980	1990	1980	1990
(n)	(193)	(184)	(212)	(195)
Energy (MJ)	8.90 (0.11)	8.61 (0.13)	8.27 (0.11)	8.25 (0.14)
Protein (g)	61.2 (0.87)	62.1 (0.97)	53.8 (0.75)	57.4 (0.96)
Fat (g)	94.9 (1.43)	90.8 (1.56)	90.0 (1.25)	88.9 (1.63)
Carbohydrate (g)	271.5 (3.56)	263.8 (4.81)	251.6 (3.65)	251.7 (4.45)
Total sugars (g)	119.4 (2.21)	117.4 (3.23)	115.0 (2.45)	118.5 (2.69)
NME* sugars (g)	na	89.3 (2.81)	na	91.2 (2.37)
Unavailable carbohydrate** (g)	13.9 (0.28)	15.9 (0.34)	13.0 (0.25)	14.8 (0.28)
Non-starch polysaccharides §(g)	na	9.4 (0.23)	na	9.0 (0.19)

* Non-milk extrinsic sugars

** Unavailable carbohydrate - estimated by the Southgate method (Wenlock et al., 1985).

§ Non-starch polysaccharides - estimated by the Englyst method (Englyst et al., 1989).

na value not available

Table 6.3 Mean (s.e.m) daily micronutrient intake by and sex and study.

Sex	Male		Female	
Study	1980	1990	1980	1990
(n)	(193)	(184)	(212)	(195)
Calcium (mg)	850.3 (17.4)	786.0 (18.9)	750.9 (15.0)	762.8 (16.2)
Iron (mg)	10.1 (0.17)	11.7 (0.24)	9.2 (0.14)	11.2 (0.27)
Retinol equivalent* (µg)	526.8 (60.0)	552.1 (65.5)	470.7 (52.4)	585.0 (50.3)
Vitamin C (mg)	38.0 (1.46)	51.9 (2.16)	37.7 (1.33)	55.6 (2.43)
Vitamin D (µg)	1.94 (0.08)	2.43 (0.09)	1.86 (0.07)	2.38 (0.09)

* Retinol equivalent expressed as median. Approximate standard error of the median (1.25 x s.e.m) given in parentheses (Kendall and Stuart, 1969).

Table 6.4 Mean (s.e.m) intakes of energy, macronutrients, sugars and 'fibres', by social group and study. Boys only.

Nutrient		Energy	Protein	Fat	Carbohydrate	Unavailable carbohydrate	NSP*	Total sugars	NME** sugars
Study	Social Group (n)	MJ	g	g	g	g	g	g	g
1980	High (46)	8.91 (0.21)	61.8 (1.6)	96.2 (2.9)	268.3 (7.0)	13.4 (0.6)	na	124.8 (5.1)	na
	Middle (86)	8.87 (0.17)	61.2 (1.5)	94.3 (2.1)	271.3 (5.3)	14.0 (0.4)	na	116.6 (3.2)	na
	Low (52)	8.75 (0.21)	60.0 (1.6)	93.3 (2.7)	267.6 (6.5)	13.9 (0.5)	na	117.1 (3.7)	na
1990	High (70)	8.34 (0.21)	63.0 (1.5)	85.6 (2.3)	258.2 (7.7)	15.1 (0.5)	9.2 (0.4)	119.3 (5.4)	88.7 (4.3)
	Middle (56)	8.73 (0.27)	62.9 (1.9)	91.8 (3.1)	269.1 (10.0)	16.8 (0.8)	10.3 (0.5)	122.6 (6.8)	92.9 (5.8)
	Low (32)	9.19 (0.16)	62.2 (2.3)	101.1 (3.5)	276.1 (10.4)	16.3 (0.8)	9.2 (0.5)	118.0 (6.0)	92.7 (5.8)

* Non-starch polysaccharides
** Non-milk extrinsic sugars
na value not available

Table 6.5 Mean intake (s.e.m) of energy, macronutrients, sugars and 'fibres', by social group and study. Girls only.

Nutrient		Energy	Protein	Fat	Carbohydrate	Unavailable carbohydrate	NSP*	Total sugars	NME** sugars
Study	Social Group (n)	MJ	g	g	g	g	g	g	g
1980	High (39)	8.48 (0.26)	56.2 (2.0)	93.2 (3.0)	254.7 (9.1)	13.8 (0.6)	na	122.8 (6.5)	na
	Middle (86)	8.08 (0.16)	52.5 (1.1)	87.1 (1.9)	247.6 (5.3)	12.6 (0.4)	na	113.9 (3.5)	na
	Low (66)	8.32 (0.20)	53.6 (1.3)	90.7 (2.4)	253.5 (6.7)	13.3 (0.5)	na	112.2 (4.5)	na
1990	High (67)	7.91 (0.22)	56.2 (1.5)	83.5 (2.5)	243.1 (7.6)	14.7 (0.5)	9.4 (0.3)	119.1 (4.8)	90.6 (4.0)
	Middle (60)	8.09 (0.23)	56.7 (1.7)	88.7 (3.0)	243.4 (6.9)	14.0 (0.5)	8.4 (0.3)	112.6 (4.2)	86.5 (3.7)
	Low (38)	8.36 (0.31)	57.8 (2.3)	90.4 (3.5)	256.2 (10.2)	15.5 (0.7)	9.2 (0.5)	120.7 (6.2)	93.2 (5.9)

* Non-starch polysaccharides
** Non-milk extrinsic sugars
na value not available

Table 6.6 Mean (s.e.m) daily intake of micronutrients, by social group and study. Boys only.

Nutrient Study	Social Group (n)	Calcium mg	Iron mg	Retinol equivalent* µg	Vitamin C mg
1980	High (46)	893.5 (35.6)	9.8 (0.29)	585.4 (41.3)	41.2 (3.24)
	Middle (86)	847.8 (28.3)	10.2 (0.26)	501.3 (87.4)	38.5 (2.35)
	Low (52)	816.6 (30.0)	10.0 (0.37)	457.4 (108.3)	35.3 (2.30)
1990	High (70)	817.7 (31.9)	11.9 (0.42)	549.1 (130.8)	54.7 (3.68)
	Middle (56)	807.9 (40.7)	12.3 (0.49)	573.4 (132.8)	55.9 (4.18)
	Low (32)	757.6 (32.2)	11.5 (0.46)	619.3 (52.7)	48.9 (4.95)

* Retinol equivalent expressed as median. Approximate standard error of the median (1.25 x s.e.m) given in parentheses (Kendall and Stuart, 1969).

Table 6.7 Mean (s.e.m) daily intake of micronutrients, by social group and study. Girls only.

Nutrient Study	Social Group (n)	Calcium mg	Iron mg	Retinol equivalent* µg	Vitamin C mg
1980	High (39)	819.1 (39.5)	9.9 (0.37)	550.4 (177.0)	38.6 (3.80)
	Middle (86)	744.2 (23.4)	8.8 (0.20)	437.8 (48.1)	38.6 (2.12)
	Low (66)	732.2 (26.4)	9.3 (0.28)	472.0 (56.8)	35.0 (1.94)
1990	High (67)	787.2 (31.0)	11.2 (0.38)	630.5 (71.4)	66.6 (5.38)
	Middle (60)	738.5 (26.0)	11.1 (0.63)	522.5 (128.4)	51.1 (3.76)
	Low (38)	744.1 (33.2)	10.9 (0.48)	552.7 (46.3)	48.7 (3.81)

* Retinol equivalent expressed as medians. Approximate standard error of the median (1.25 x s.e.m) given in parentheses (Kendall and Stuart, 1969).

Table 6.8 Mean nutrient density (nutrient/MJ) (s.e.m) of diet, by social group and study. Boys only.

Nutrient Study	Social group (n)	Protein g	Fat g	Unavailable carbohydrate g	NSP* g	Total sugars g	NME** sugars g	Calcium mg	Iron mg	Retinol equivalent µg§	Vitamin C mg
1980	All (193)	**6.90 (0.06)**	**10.6 (0.1)**	**1.57 (0.03)**	na	**13.4 (0.2)**	na	**95.6 (1.5)**	**1.14 (0.01)**	**58.4 (5.2)**	**4.30 (0.16)**
	High (46)	6.98 (0.13)	10.8 (0.2)	1.51 (0.06)	na	13.9 (0.4)	na	100.0 (3.1)	1.10 (0.02)	63.4 (4.1)	4.66 (0.36)
	Middle (86)	6.89 (0.09)	10.6 (0.1)	1.59 (0.04)	na	13.2 (0.3)	na	95.5 (2.4)	1.15 (0.02)	57.6 (9.8)	4.38 (0.27)
	Low (52)	6.88 (0.10)	10.6 (0.1)	1.59 (0.05)	na	13.4 (0.3)	na	93.5 (2.9)	1.14 (0.03)	52.4 (11.3)	4.04 (0.24)
1990	All (184)	**7.31 (0.09)**	**10.6 (0.1)**	**1.86 (0.04)**	**1.11 (0.03)**	**13.4 (0.2)**	**10.2 (0.2)**	**91.7 (1.6)**	**1.38 (0.03)**	**64.2 (8.1)**	**6.18 (0.27)**
	High (70)	7.64 (0.14)	10.3 (0.1)	1.84 (0.06)	1.12 (0.04)	13.9 (0.4)	10.4 (0.4)	97.8 (2.7)	1.43 (0.04)	64.9 (17.2)	6.64 (0.44)
	Middle (56)	7.32 (0.17)	10.5 (0.2)	1.94 (0.07)	1.20 (0.06)	13.7 (0.5)	10.4 (0.4)	92.9 (3.2)	1.43 (0.05)	64.6 (14.8)	6.71 (0.54)
	Low (32)	6.82 (0.19)	11.0 (0.2)	1.78 (0.06)	1.00 (0.05)	12.8 (0.5)	10.1 (0.5)	82.7 (2.7)	1.26 (0.04)	70.3 (5.2)	5.37 (0.53)

* Non-starch polysaccharides
** Non-milk extrinsic sugars
§ Retinol equivalent intake (/MJ) expressed as medians. Approximate standard error of the median (1.25 x s.e.m) in parentheses
na value not available

Table 6.9 Mean nutrient density (nutrient/MJ) (s.e.m) of diet by social group and study. Girls only.

Nutrient Study	 Social group (n)	Protein g	Fat g	Unavailable carbohydrate g	NSP* g	Total sugars g	NME** sugars g	Calcium mg	Iron mg	Retinol equivalent§ µg	Vitamin C mg
1980	**All (212)**	**6.55 (0.06)**	**10.9 (0.1)**	**1.58 (0.02)**	na	**13.8 (0.2)**	na	**91.1 (1.5)**	**1.12 (0.01)**	**60.9 (7.4)**	**4.62 (0.17)**
	High (39)	6.67 (0.16)	11.0 (0.2)	1.64 (0.06)	na	14.3 (0.5)	na	97.3 (4.0)	1.17 (0.03)	66.5 (20.1)	4.61 (0.41)
	Middle (86)	6.53 (0.11)	10.8 (0.1)	1.57 (0.03)	na	14.1 (0.3)	na	92.2 (2.2)	1.10 (0.02)	54.1 (6.0)	4.85 (0.29)
	Low (66)	6.50 (0.11)	10.9 (0.1)	1.59 (0.04)	na	13.3 (0.4)	na	88.0 (2.5)	1.13 (0.03)	56.4 (5.8)	4.29 (0.25)
1990	**All (195)**	**7.03 (0.08)**	**10.8 (0.1)**	**1.82 (0.03)**	**1.12 (0.03)**	**14.3 (0.2)**	**11.0 (0.2)**	**93.3 (1.5)**	**1.38 (0.04)**	**69.3 (7.0)**	**7.10 (0.33)**
	High (67)	7.17 (0.12)	10.6 (0.1)	1.90 (0.06)	1.23 (0.05)	14.8 (0.3)	11.3 (0.3)	99.6 (2.8)	1.43 (0.05)	76.9 (8.6)	8.58 (0.64)
	Middle (60)	7.07 (0.14)	10.9 (0.1)	1.76 (0.05)	1.06 (0.04)	13.9 (0.4)	10.6 (0.3)	92.3 (2.6)	1.39 (0.09)	65.7 (18.9)	6.75 (0.60)
	Low (38)	6.95 (0.17)	10.8 (0.2)	1.87 (0.06)	1.11 (0.05)	14.4 (0.5)	11.0 (0.4)	90.0 (2.9)	1.33 (0.05)	65.4 (5.3)	6.27 (0.61)

* Non-starch polysaccharides
** Non-milk extrinsic sugars
§ Retinol equivalent intake (/MJ) expressed as medians. Approximate standard errors of the medians (1.25 x s.e.m) given in parentheses
na value not available

Appendix 6.1

SUMMARY OF STATISTICAL ANALYSES

Analysis of variance was by a linear model using GLIM (Baker and Nelder, 1978) to test the effects of sex, social group and year of study (1980 *v.* 1990) for statistical significance both for absolute intakes and nutrient density. This method avoids the need for multiple t-tests which would otherwise have been required. The results are summarised below; p-values are given only where tests were significant ($p<0.05$). GLIM reduces the number of tests on the data. However, there are still a large number of p-values reported which calls for a degree of caution in interpretation.

Table 1 shows, for each nutrient and nutrient density, where significant differences were detected, either between boys and girls, between the social groups and/or between the studies 1980 *v.* 1990. The analyses also detected whether there was any social group-study interaction; that is, had the effect of social group on nutrient intake or nutrient density altered between 1980 and 1990.

Table 1 Summary of results, indicating significant differences in nutrient intake between boys and girls, social groups and study.

Nutrient Nutrient density	Sex boys girls	Social group high middle low	Study 1980 1990	Social group/study interaction*
Energy (MJ)	$0.001^{♂}$	-	0.014^{80}	0.026^{L}
Protein (g)	$0.001^{♂}$	-	0.012^{90}	-
Protein (g/MJ)	$0.001^{♂}$	0.004^{H}	0.001^{90}	-
Fat (g)	$0.004^{♂}$	-	0.001^{80}	0.001^{L}
Fat (g/MJ)	$0.006^{♀}$	-	0.004^{80}	0.004^{L}
Unavailable carbohydrate (g)	$0.001^{♂}$	-	0.001^{90}	-
Unavailable carbohydrate (g/MJ)	-	-	0.001^{90}	-
Calcium (mg)	$0.001^{♂}$	0.006^{H}	-	-
Calcium (mg/MJ)	-	0.001^{H}	-	-
Iron (mg)	$0.001^{♂}$	-	0.001^{90}	-
Iron (mg/MJ)	-	-	0.001^{90}	-
Vitamin C (mg)	-	0.001^{H}	0.001^{90}	-
Vitamin C (mg/MJ)	$0.014^{♀}$	0.001^{H}	0.001^{90}	-
Retinol equivalent (µg)	-	-	-	-
Retinol equivalent (µg/MJ)	-	-	0.014^{90}	-

The direction of the trends are indicated by the superscripted symbols next to the significant p-values.

♂ Significant difference between boys and girls, boys having the higher intake

♀ Significant difference between boys and girls, girls having the higher intake

H Significant social group trend, the high social group children having the higher intake

L Significant social group trend, the low social group children having the higher intake

80 Significant difference between 1980 and 1990, 1980 children having the higher intake

90 Significant difference between 1980 and 1990, 1990 children having the higher intake

* Indicates a significant change in the effect of social group from study to study, a difference between social groups in the effect of the passage of time.

CHAPTER SEVEN

VALIDATION OF THE METHOD AND RELIABILITY OF THE DATA

7.1 A theoretical validation of measured energy intake; measured energy intake and estimated energy expenditure compared

7.1.1 Introduction and aim

A common criticism of dietary surveys is that the process of recording food intake causes a change in food intake and/or biased reporting. If a dietary survey accurately measures habitual energy intake of a group, which is assumed to be in energy balance, it should record a mean energy intake which is equivalent to the mean energy expenditure of that group.

The total energy expenditure of an individual is dependant on basal metabolic rate, physical activity levels and dietary induced thermogenesis (the thermic effect of food is usually included in energy expenditure and not assessed separately). Basal metabolic rate (BMR) for an individual (assuming no growth) will remain constant, whilst the energy expenditure above BMR is dependant on individual levels of physical activity. The minimum energy expenditure compatible with normal, but sedentary, adult life is approximately 1.3 times BMR (Livingstone et al., 1990). Habitual energy intakes of a group of individuals found to be less than 1.4 times expected BMR are almost certainly under-estimates (Bingham, 1987) and therefore indicate either under-reporting of food intake or a change in diet for the recording period.

The aim of this study was to attempt to validate the 3-day dietary diary and interview method used in our survey of Northumbrian children by comparing average energy intakes, measured by this method, with the average estimated BMR of the children; and also comparing these data with the measured energy expenditure of a small sample of 11 to 12-year old children from Cambridge and Ireland (Davies et al., 1991) and with estimated physical activity levels for 11 to 12-year old children given in the dietary reference value report (Department of Health, 1991).

7.1.2 Method

7.1.2.1 Basal metabolic rate

Basal metabolic rate (BMR), for each age and sex group, can be calculated from body weight using standard equations determined by Schofield et al. (1985). For adolescents aged 10 to 18 years, the following equations are applied:

- **Boys**
  Basal metabolic rate (MJ) = (0.074 x weight(Kg)) + 2.754

- **Girls**
  Basal metabolic rate (MJ) = (0.056 x weight(Kg)) + 2.898

These equations are based on BMR measurements of 734 boys and 575 girls (standard error of the estimates are 0.440 for boys 0.466 for girls) (Schofield et al., 1985). Schofield et al. also investigated the effect of height as an independent variable and found that in most cases, with the exception of the under 3-year-olds and over 60-year-olds, height did not effect significantly basal metabolic rate.

Mean predicted BMRs for boys and girls in the 1990 and 1980 surveys were calculated from the mean body weights of the boys and girls separately. The children were weighed, to the nearest 0.5Kg, in indoor clothes with shoes removed (section 4.8.1). Before calculating the BMR, an allowance of 1.2Kg was deducted for the weight of the childrens' clothes. This allowance for clothes was determined from the mean weight of 5 sets of childrens' total indoor clothing, each including a lightweight sweater.

7.1.2.2 Estimated energy expenditure - doubly labelled water method

Before the development of the 'doubly labelled water' method, measuring energy expenditure was only possible using invasive techniques requiring the use of bulky equipment or whole body calorimeters, both of which hinder activity and therefore affect energy expenditure. Although the technique of the doubly labelled water method was first described by Lifson and McLintock (1965) its use was restricted to small animals because of the prohibitive costs of the isotope ^{18}O. The improvement of mass spectrometers reduced the required quantity of the isotope to an acceptable experimental cost leading to the first reports, in the early 1980's, of the measurement of energy expenditure in humans using the doubly labelled water method (Klein et al., 1984). The method has been developed further and validated for use on human subjects; much of this work being conducted at the MRC Dunn Nutrition unit, Cambridge (Klein et al., 1984; Prentice et al., 1986; Black et al., 1986; Livingstone et al., 1990; Davies et al., 1991).

The use of the doubly labelled water technique provides the first non-invasive method of measuring energy expenditure in free-living subjects. In brief, the method is as follows. Subjects are given a single oral dose of stable isotopes ^{2}H and ^{18}O; the deuterium labels the body's water pool and the oxygen-18 labels both the water and bicarbonate pools. Urine samples are collected daily from the subjects, from which the rate of carbon dioxide production can be measured from the differential disappearance of the isotopes. Energy expenditure can then be calculated using classic indirect calorimetry equations. The respiratory quotient values required in the calorimetry equations are determined from the composition of the diet (Black et al., 1986). Studies indicate that the method is accurate to +/- 2-3% if dietary composition is used to determine the respiratory quotient (Livingstone et al., 1990) or +/- 5% if dietary composition is not determined and the respiratory quotient is assumed to be 0.85 (Prentice et al., 1986).

The use of this method to measure energy expenditure to validate simultaneous measurement of energy intake must make the assumption that the individuals (or group of individuals) are in energy balance, that is neither gaining nor losing weight at the time of measurement. For adolescents this is unlikely to be true since due to growth, weight, however small an amount, will be gained daily. However, even at puberty, the proportion of total energy stored as new tissue for growth will be small, rarely exceeding a few per cent of energy requirements. Therefore, in short-term studies it is reasonable to assume that a group of adolescent individuals will be in energy balance (Livingstone et al., 1992).

7.1.3 Results

The average body weights of the children in the present survey were: boys, 40.5Kg and girls 41.9Kg with shoes and jackets only removed. An allowance of 1.2kg was made for the indoor clothes of these children, giving average body weights of 39.3Kg for boys and 40.7Kg for girls. From these weights, the mean BMR for the boys and girls in this study were calculated (Table 7.1):

- **Boys**

  Basal metabolic rate = (0.074 x 39.3) + 2.754

  Basal metabolic rate = 5.66MJ

- **Girls**

  Basal metabolic rate = (0.056 x 40.7) + 2.898

  Basal metabolic rate = 5.18MJ

The mean energy intakes reported (Measured Energy Intake) by the children in 1990 were 8.61MJ for all boys and 8.25MJ for all girls. However a social group trend in energy intakes was observed, with children from the lower social group having the highest energy intakes - 9.19MJ for boys and 8.36MJ for girls (Table 7.1).

The ratios of mean measured energy intake (MEI) to predicted BMR (that is, physical activity level - PAL) for the Northumbrian children were 1.52 for boys and 1.59 for girls (Table 7.1).

7.1.4 Discussion

Taking the theory of Livingstone et al. (1990) that an energy expenditure of 1.3 x BMR is the minimum compatible with a sedentary adult life and that of Bingham (1987) that recorded energy intakes for a group of less than 1.4 x BMR of a group, are almost certainly underestimates, the ratios of 1.52 for boys and 1.59 for girls of measured energy intake to BMR, are compatible with a normal, moderately active life.

The data were also analysed by social group and no differences in estimated BMR were detected. Social group variation was seen in the ratios of MEI:BMR - the high social group boys and girls having the lowest ratio. The high social group boys had a MEI:BMR ratio of 1.48 compared with 1.64 of low social group boys, girls of high social group had a MEI:BMR ratio of 1.53 compared with 1.60 of the low social group girls. This finding reflects the higher total energy intakes recorded by children from the low social groups (chapter 6).

The most likely explanation for these trends between social groups, is that the low social group children had higher levels of physical activity. Alternatively, the dietary records of the low social group children may have been more complete; low social group boys reporting more of their energy intake compared with the high social group boys. A less likely explanation could be that actual BMR differs slightly between social groups, perhaps due to a variation of body weights with social group. The number of obese children in this study was too small to investigate whether obesity was more prevalent in the low social groups, mean weights of the boys and girls did not show any significant differences, although for girls, there was a non-significant trend towards higher weights in the lower social groups.

The 1980 survey data were analysed in the same way, to compare reported energy intakes with estimated basal metabolic rate. The ratios were between 1.58 and 1.64 - no social group trend being apparent (Adamson et al., 1992a). The difference between the 1990 results and those for the 1980 survey could perhaps be explained by a reduction in the physical activity levels of the high social group children not yet reflected in lower social group children. This finding further supports the speculations of a temporal reduction in the physical activity of children (Whitehead et al., 1982) discussed in Chapter 6.

Livingstone et al. (1991) reported results of a comparison of simultaneous measurements of energy intake (MEI) by a seven-day weighed dietary record, and total energy expenditure by the doubly labelled water method for twelve 12-year-olds (number of boys and girls not specified); MEI as a ratio of total energy expenditure was reported as 0.89. This suggests that 89% of actual energy intake was recorded by the 12-year-olds studied. Livingstone et al. concluded that weighed dietary records are as prone to under-recording by adolescents, as had previously been reported for adults (Livingstone et al., 1990).

Davies et al. (1991) used the doubly-labelled water method to measure the total energy expenditure in 18 free-living 12-year old children from Cambridge and Belfast (8 boys and 10 girls). This measurement therefore included energy expended due to BMR, dietary induced thermogenesis and physical activity, but did not include an allowance for growth. The BMR of these children was estimated from their weight as predicted by the Schofield equations (section 7.1.2.1). The two measurements were then compared in order to estimate the ratio of total energy expenditure to BMR for these children - the mean total energy expenditure measured by the doubly-labelled-water method was compared with their mean BMR. The resulting ratios were high - 1.76 for boys and 1.75 for girls - suggesting high levels of physical activity in this group of adolescents - that is levels of physical activity equivalent to 76% of boys' and 75% of girls' basal metabolic energy expenditure. No standard deviations were expressed for these ratios; standard deviations for total energy expenditure were 1.47MJ for boys and

1.89MJ for girls. A further approximate standard error of the estimate of BMR from Schofield equations of 0.44MJ for boys and 0.47MJ for girls (Schofield et al., 1985) suggests that these ratios of 1.75 and 1.76 will be subject to significant variation. It is worthy of note that the mean weight of boys and girls measured by Davies et al. differed considerably - boys 39.7Kg, girls 49.3Kg (a difference of almost 10Kg or 25%). In the Northumbrian boys and girls in our 1990 survey the weight difference was less marked: boys 39.3Kg, girls 40.7Kg (a difference of 1.4Kg).

It is possible that the energy requirement of children could be calculated from estimates of total energy expenditure, measured by the doubly-labelled-water method, plus estimates of the energy value of new tissues deposited during growth (Department of Health, 1991). The COMA panel for the dietary reference values (Department of Health, 1991) although considering these new data commissioned by the Department of Health, urged caution in interpreting the results from this relatively new technique. In determining the estimated energy requirements of adolescents (aged 10 to 18 years) the COMA panel relied on information on the 24-hour time use and energy cost of activities of this age group. These calculations resulted in physical activity levels (PAL) of 1.56 for boys and 1.48 for girls, not including an allowance for growth (Department of Health, 1991) (Chapter 8).

The estimated PAL of the children in our 1990 survey can be compared with the PAL of the 12-year old children measured by Davies et al. (1991) and to the PAL estimated by the COMA panel for dietary reference values for adolescents aged 10 to 18 years (Department of Health, 1991). Davies reported PAL for 12-year old children of 116% for boys and 110% for girls of the PAL estimated for the boys and girls in our study. The DRV report gave estimated PAL equivalent to 102% of the PAL for boys and 93% of the PAL for girls in our survey.

It has been discussed above that weighed dietary records from adolescents are prone to under-recording (Livingstone et al., 1991, 1992). However, assuming that the dietary records of the children in the Belfast and Cambridge study and in our 1990 Northumbrian study were complete, it would appear that the children measured by Davies et al. (1991) had higher levels of physical activity than the Northumbrian children. The small sample in the Belfast and Cambridge study (18 children) means caution must be used in drawing conclusions from any comparison. Social groupings of this sample were not given, it may be that these children had activity levels more closely matched to the low social group children in our study, who recorded higher energy intakes and hence had higher PAL's (low social boys 1.64, low social group girls 1.60). The mean PAL estimated for the Northumbrian children (boys 1.52, girls 1.59) lies closer to the PAL's given in the dietary reference value report (boys 1.56, girls 1.48) (Department of Health, 1991). It is interesting to note that the boys in our 1990 study had a lower estimated PAL than the girls whilst the dietary reference report suggest that girls have a lower PAL due to lower intensity of activities. It may be that the girls' dietary diaries were more complete and hence recorded a higher energy intake in relation to their BMR than the boys. There was no indication during the survey that the girls' diaries were more complete. The wide age range of 10 to 18 years given for PAL in the dietary reference report may also help to explain some of the disparity.

It is concluded from these analyses that the dietary diary and interview method used for groups of adolescents, is a cost-effective method, allowing large sample sizes to be studied, which is at least as valid at estimating mean energy intake of groups by weighed dietary records. Measurement of BMR and simultaneous measurement of total energy expenditure and dietary intake of the Northumbrian children would be necessary to confirm this.

7.2 Estimates of reliability

7.2.1 Introduction

Reliability is a measure of the repeatability of the data. The reliability of an estimate of the mean value for an individual child is calculated as the ratio of the true variance between children to the observed variance between them. The true variance would be the same as the observed variance if there was no sampling error. This is important when the blocking variables (for example season) and sampling introduce extra variance into the system which, in this study, included the survey (that is 2 surveys) and the days studied (3 days within each survey). Using components of variance techniques, the contribution to the overall variation from each of the effects (survey, day, child) can be isolated and the ratio of true to observed variance calculated. From this the per cent reliability of the estimate of the mean for each individual child (mean of 6 days) can be readily deduced.

7.2.2 Method

7.2.2.1 Percentage variance

The total variance can be divided into the variation due to a number of components (Snedecor and Cochran, 1971). In this study:

$$\sigma^2_{children} + \sigma^2_{surveys} + \sigma^2_{days} = \sigma^2_{total}$$

$$\frac{\sigma^2_{children}}{\sigma^2_{total}} \times 100 = \%\ \textit{variance due to variance between children}$$

$$\frac{\sigma^2_{surveys}}{\sigma^2_{total}} \times 100 = \%\ \textit{variance due to variance between surveys}$$

$$\frac{\sigma^2_{days}}{\sigma^2_{total}} \times 100 = \%\ \textit{variance due to variance between days}$$

7.2.2.2 Reliability of the estimate of the mean

From the components of variance it is possible to calculate the reliability of the estimate of the mean for an individual. The reliability of the estimates of the mean have been calculated for energy, sugar, fat, calcium, iron, protein and carbohydrate (Table 7.2). Reliability was calculated from:

$$R = \frac{\sigma^2_{children}}{(\sigma^2_{children} + \frac{\sigma^2_{surveys}}{n_s} + \frac{\sigma^2_{days}}{n_s \times n_d})} \quad (x\ 100\ for\ \%)$$

R	reliability
$\sigma^2_{children}$	variance component between children
$\sigma^2_{surveys}$	variance component between surveys within children
σ^2_{days}	variance component between days within surveys and children
n_s	is the number of surveys
n_d	is the number of days in a survey

(Snedecor & Cochran, 1971)

If there was no variance between surveys or days then R would be equal to σ^2children/σ^2children (that is R = 100%). Due to the presence of variance between surveys and between days within the surveys, R would be less than 1 (100%). As the number of surveys or days within surveys, or both, increase then the factors:

$$\frac{\sigma^2 s}{n_s} \text{ and } \frac{\sigma^2 d}{n_s \times n_d}$$

become smaller and therefore the value of R increases to approach 1 (100%). That is, increasing the number of days or repeats of surveys will increase the reliability of the data.

7.2.2.3 **Precision of the data**

Reliability measures the reliability of the estimate of the mean intake of an individual. When the aim of a dietary survey is to measure the mean and distribution of the nutrient intake of a group of individuals, it is important to have some measure of the precision of the data - precision can be increased by increasing the number of surveys and the number of days within each survey. The standard error of the mean gives a measure of the precision of the mean for the group. The s.e.m. for the number of surveys and days within each survey can be estimated from:

$$S.E.M^{*} = \sqrt{\frac{\sigma^2_{children} + \dfrac{\sigma^2_{surveys} + \dfrac{\sigma^2_{days}}{n_{days}}}{n_{surveys}}}{n_{children}}}$$

* Standard error of the mean of ^{n}children measured on ^{n}days in each of ^{n}surveys.

(Snedecor & Cochran, 1971)

This equation has been applied to predict the standard error of the mean for carbohydrate and iron for 379 children for varying numbers of survey, and number of days within each survey, and the results are given in Table 7.3. Carbohydrate was chosen as a very widely available macronutrient and iron as a less widely available micronutrient.

7.2.3 Results

Table 7.2 shows that the largest per cent of variance was due to the variance between days within the surveys for all nutrients measured.

The percentage reliability of the mean intakes for an individual varied from 76% for carbohydrate to 63% for iron. These results could have been predicted since it may be expected that for energy or carbohydrate, both widely distributed in all foods, 6 days measurement will reflect intake well. Some micronutrients, for example iron, are less widely distributed in foods and the number of days surveyed will have a greater effect on the reliability of that measurement.

Table 7.3 shows that for both carbohydrate and iron the precision of the mean is increased by increasing the number of surveys, and days per survey. Repeating surveys would give a greater increase in the precision of the estimate of the mean than would increasing the number of days per survey. For example, for one survey of three days the estimated s.e.m. of carbohydrate would be 4.1g, whilst for three repeated surveys of one day the s.e.m would be 3.9g.

The s.e.m. of carbohydrate for ten surveys of ten days was estimated to be 3.3g (Table 7.3) - this can be taken to be an estimate of the variation between children. From this, it is apparent that for large sample sizes (n=379) increasing the number of surveys, or days per survey, beyond 2 surveys of three days would achieve little in increased precision of measurement of the mean (s.e.m from 3.6g to 3.3g). For iron, the s.e.m. for one survey of one day would be 0.34mg, this would be reduced to 0.22mg by two repeat surveys of three days. Whilst the precision of the measurement of the mean iron intake could be increased further (five surveys of three days - s.e.m. 0.20mg) a s.e.m. for iron of 0.18mg is an estimate of the variation which exists between children.

7.2.4 Discussion

The variation in an individual's dietary intake will vary according to the nutrient being measured - for the children in this survey, iron and protein showed the largest daily variation, being responsible for over 60% of the total variance compared with 26-30% due to the variance between children (Table 7.2). In dietary surveys there will always be variance between days and between surveys since an individual's dietary intake may vary quite widely on a daily basis particularly for nutrients less widely distributed in foods (for example, iron) (Bingham, 1987).

The precision of the data can be increased by increasing the number of days measured either by repeating surveys, or increasing the number of days per survey. The results show that greater precision is achieved by increasing the number of repeat surveys rather than increasing the number of days per survey. However, repeat surveys may not always be the most efficient in terms of fieldworker time. A compromise may have to be reached between repeated surveys (which is costly in terms of time) and increasing the number of days per survey (which may be more efficient). These findings support the conclusions of Hackett et al. (1983). The power of the survey to measure the mean nutrient intake depends on the number of subjects surveyed. In our survey of 379 children there was little to be gained in the precision of the measurement of the mean carbohydrate intake by extending the study beyond one survey of three days (measured mean intake for all 379 children 258g, estimated s.e.m. 1 x 3 day survey 4.1g, estimated s.e.m. 2 x 3 day survey 3.7g). For iron, a larger number of days need to be surveyed, two surveys of three days would give an estimate of the mean with an estimated s.e.m. of 0.22 (measured mean intake for all 379 children 11.4mg). There would little increase in precision by increasing the numbers of days measured beyond this. If the number of subjects were reduced a larger number of days would be required to achieve the same precision.

It is concluded that the repeated 3-day diary and interview method gave a good estimate of the mean nutrient intake and distribution of intakes for the group but that it may not be a reliable method for measuring the nutrient intake of the individual.

Table 7.1 Basal Metabolic Rate**, measured energy intakes and estimated Physical Activity Levels§ of Northumbrian children in 1990, by sex and social group.

Sex	Social group	n	Weight* Kg	Estimated Basal Metabolic Rate (BMR)** MJ	Measured Energy Intake (MEI) MJ	MEI:BMR (PAL)§
Boys	All	184	39.3	5.66	8.61	1.52
	High	70	38.9	5.63	8.34	1.48
	Middle	56	39.5	5.68	8.73	1.54
	Low	32	38.4	5.60	9.19	1.64
Girls	All	195	40.7	5.18	8.25	1.59
	High	67	40.5	5.17	7.91	1.53
	Middle	60	41.0	5.19	8.09	1.56
	Low	38	41.7	5.23	8.36	1.60

* Measured weight in indoor clothes minus 1.2kg (estimated allowance for clothes).

** Basal metabolic rate estimated from body weight. Schofield equations for males and females 10 to 18 years (Schofield et al., 1985).

§ MEI as a ratio of BMR to give estimated of Physical Activity Level (PAL).

Table 7.2 Percentages of total variance due to the three sources of variance and percentage reliability of the mean intakes of energy and nutrients.

Per cent of total variance attributable to each component of variance				Reliability
	Source of variance			
Nutrient	Children	Surveys	Days	%
Energy	39	10	51	74.6
Protein	30	8	62	67.0
Fat	32	10	58	69.3
Carbohydrate	42	9	49	76.1
Total sugars	40	9	51	75.3
Calcium	40	9	51	75.2
Iron	26	11	63	62.6

Table 7.3 Estimated standard error of the mean of carbohydrate and iron intake for 379 children measured by varying numbers of surveys and days per survey.

		S.E.M. Carbohydrate g				
Days (n)	Surveys (n)	1	2	3	5	10
1		5.0	4.2	3.9	3.6	3.4
2		4.3	3.8	3.6	3.5	3.3
3		4.1	3.7	3.5	3.4	3.3
5		3.9	3.6	3.5	3.4	3.3
10		3.7	3.5	3.4	3.3	3.3

		S.E.M. Iron mg				
Days (n)	Surveys (n)	1	2	3	5	10
1		0.34	0.27	0.24	0.22	0.20
2		0.28	0.24	0.22	0.20	0.19
3		0.26	0.22	0.21	0.20	0.19
5		0.24	0.21	0.20	0.19	0.18
10		0.22	0.20	0.19	0.19	0.18

CHAPTER EIGHT

A COMPARISON OF NUTRIENT INTAKES OF ADOLESCENTS IN 1990 WITH DIETARY REFERENCE VALUES PUBLISHED IN 1991

8.1 Introduction and aim

In 1991 the Department of Health published the report of the COMA panel on Dietary Reference Values for Food and Energy and Nutrients for the United Kingdom (Department of Health, 1991). For the first time this report gave a range of reference intakes for energy and nutrients, for different age and sex groups. The report addressed many nutrients for which no previous dietary recommendation had been made; in all, the dietary requirements of 40 nutrients were covered. Fat and non-milk extrinsic sugars were among the new dietary components to be included - both fat and sugar had each been the subject of previous reports (Department of Health and Social Security, 1984; Department of Health, 1989b), but had never before been included alongside recommendations for nutrient intakes - their inclusion reflects the change in emphasis in nutrition education towards promoting a diet for disease prevention as well as averting deficiency diseases.

The range of intakes for each nutrient given in the report reflects the knowledge that the nutritional needs of individuals within a group vary and therefore a low intake of a nutrient by an individual cannot be taken alone to indicate deficiency. A Normal distribution was assumed in the population's requirements for all nutrients (Figure 8.1), with the exception of iron for females of child bearing age, when a positively skewed distribution was assumed (Figure 8.7). The dietary reference values (DRVs) for the age group 11 to 14 years, offer the best comparison for this study, DRVs for selected nutrients are shown in Table 8.1 to Table 8.3. The lower reference nutrient intake (LRNI) is the amount of a nutrient which is considered to be enough to meet the needs of only approximately 3% of the individuals in any group, that is those with the lowest needs. The estimated average requirement (EAR) of a nutrient is the amount which is considered to be the average requirement of a group, that is approximately 50% the group will need more than the EAR and 50% will need less. The reference nutrient intake (RNI) is the amount of a nutrient that is enough, or more than enough, for approximately 97% of the individuals in a group. If the average intake of a group is equivalent to, or greater than, the RNI then the risk of deficiency of that nutrient occurring in the group would be very small. Conversely, if the average intake of a group is equivalent to or less than the LRNI for that nutrient then the risk of deficiency occurring in individuals in that group would be high. However, these assumptions rely on the Normal distribution of intakes within a population and the above conclusion may not be applicable if a population has a more variable intake than has been assumed for the dietary reference values.

The relationship between nutrient requirement and nutrient intake is not known; it may be that there is positive correlation between these two factors. The greater this correlation the lower the risk of deficiency in an individual with low intakes, while if there is no correlation between intake and requirement then an individual with a low intake of a nutrient would be at high risk of deficiency. It is likely that some positive relationship exists between intake and requirement: this may be through body size (Department of Health, 1991) - increased body size leads to an increase in energy intake which should lead to increased nutrient intake. However, the extent to which the nutrient intake is increased by increased energy intake will be dependant on the nutrient density of the diet (Chapter 6 and Chapter 9). If no positive correlation exists between requirement and intake then a mean intake within a group equivalent to the EAR would represent a significant risk of deficiency occurring within that group.

The report gives values to allow the estimated average requirement for energy for boys and girls to be calculated from mean body weight (section 8.2).

The aim of this chapter is to compare the measured energy and nutrient intake of 11 to 12-year old Northumbrian adolescents collected in 1990, with the 1991 dietary reference values for boys and girls aged 11 to 14 years (Department of Health, 1991) and then to determine and discuss any significant sex or social group differences. Whilst the dietary recommendations were not those current at the time of data collection it is more relevant to use the 1991 reference values than the 1979 recommended daily amounts as this will indicate the dietary improvements necessary if the mean nutrient intake of children in the 1990's are to meet the dietary reference values recommended by the COMA panel. It is worthy of note that the dietary reference values for each nutrient assumes that the intake of all other nutrients is adequate - this issue will also be addressed in this chapter (section 8.4).

8.2 Method

8.2.1 Nutrients and dietary composition

Dietary reference values for 11 to 14-year-olds have been used to assess the nutritional adequacy of the diet of the 11 to 12-year old children in this study.

8.2.2 Calculation of estimated average requirement for energy

The EAR for energy has been calculated from the mean body weights of the children using the values given in the dietary reference value report (Department of Health, 1991).

- Boys

$$(\textit{Basal metabolic rate}^{*} \times 1.56^{**}) + 0.29\,MJ^{¶}$$

$$(5.66\,MJ \times 1.56) + 0.29\,MJ = 9.12\,MJ$$

- Girls

$$(\textit{Basal metabolic rate}^{*} \times 1.48^{**}) + 0.31\,MJ^{¶}$$

$$(5.18\,MJ \times 1.48) + 0.31\,MJ = 7.98\,MJ$$

* Basal metabolic rate calculation given in section 7.1.2.1.

** Physical activity level (PAL) multiplication of basal metabolic rate (Department of Health, 1991).

¶ Energy allowance for growth (Department of Health, 1991)

Further explanation of the physical activity level (PAL) as a multiplication of the BMR has been given in chapter 7 (sections 7.1.1 and 7.1.4).

8.2.3 Method of analysis

Mean daily nutrient intakes for each sex and social group have been reported in Chapter 6. It would be possible to compare the mean intake of each sex and social group with the 1991 dietary reference values, but this would not indicate the proportion of the population which had intakes above or below the dietary reference values. If information on percentiles is available, the

Department of Health (1991) suggests that the reference nutrient intake (RNI) be used to assess the diet of a group of individuals by calculating the per cent of the group with intakes below the RNI. If this per cent is zero, then the risk of any deficiency occurring in that group would be very small. As the per cent of the population with intakes below the RNI increases, then the risk of dietary deficiency occurring in some individuals in that group would increase. This principle has been used to assess the diets of the 11 to 12-year old adolescents in our study.

Each individual's average nutrient intake (average of 6 days) was calculated and compared with the range of dietary reference values. From this it was possible to calculate the proportion of the subjects, in each sex and social group, which would have achieved nutrient intakes equivalent to the reference values and also the proportion which fell below.

8.3 Results and discussion

The proportion (per cent) of each sex, and each sex and social group, with dietary intakes falling below each dietary reference value are given in Table 8.1 to Table 8.3. Data for boys and girls are given separately since both requirements and intakes differ.

The results are also presented as figures - Figures 8.2 to 8.9 show the distributions of mean daily intakes of nutrients by boys and girls separately, as per cent frequency distributions. The figures show that the distribution of all nutrients, with the exception of retinol equivalent, can be considered to be Normal. Retinol equivalent intakes were skewed for both boys and girls and hence median rather than mean intakes have been reported for this nutrient as in previous sections (Chapter 6). The distributions of the retinol equivalent intakes using a $\log_{10}$ scale are given in Figure 8.9.

Superimposed on Figures 8.2 to 8.9 is the assumed population distribution on which the dietary reference values were based (estimated average requirement +/- 2 standard deviations), with the range of reference values (LRNI, EAR and RNI) indicated on the baseline by arrows. The mean daily intake of each nutrient by our subjects is indicated in each figure by a broken arrow. For retinol equivalent intake (Figure 8.9) the median intake is indicated in this way. The figures show the position of the mean daily intake of nutrients by our subjects compared with the range of dietary reference values for each nutrient.

Each nutrient will be considered briefly in turn.

8.3.1 Energy

For all nutrients, the RNI can be set at the upper end of the range of requirements, since intakes moderately in excess of requirements would have no adverse effects. Intake of energy in excess of requirements even in small amounts would, over time, result in obesity and therefore only estimated average requirements (EAR) are given. Calculations from the mean body weight gave EAR for energy of 9.12MJ for boys and 7.98MJ for girls (section 8.2). The DRVs for fat and NME sugar intake are given as the maximum mean per cent of energy which should be derived from fat and NME sugars by a population.

Sixty-six per cent of boys and 48% of girls had energy intakes below the EAR (Table 8.1) - the mean energy intake being 8.61MJ for boys and 8.25MJ for girls (Figure 8.2). It would be unlikely that any energy deficiency existed amongst the girls, however a greater proportion of boys had energy intakes below the EAR so increasing the possibility of energy deficiency in some individuals. Energy requirements are greatly influenced by physical activity levels, no energy expenditure measurements or activity diaries were collected for the children in this study, rather activity patterns were assumed from studies of other children (Department of Health, 1991). Measured anthropometric data are more reliably used to assess adequacy of energy intake. Heights and weights can be compared with standard charts of normal growth and weight gain (Tanner and Whitehouse, 1975). For boys, the mean height (1.47m) was between the 50^{th} and 75^{th} centile for age whilst mean weight (39.3Kg) was equivalent to the 75^{th} centile. For girls both mean height (1.50m) and weight (40.7Kg) were equivalent to the 75^{th} centile for age. Although it would highly unlikely that the average height and weight of these children would lie outside the normal distribution for this age group, this comparison shows that the height and weight for the boys and the girls were at similar centile indicating that on average, these children were a 'healthy' weight for height.

The percentages of individuals in each sex and social group with intakes below the EAR for energy are given in Table 8.1. As discussed in Chapter 6, children from the higher social groups had lower energy intakes, therefore fewer children in the high social groups had energy intakes which reached the EAR for energy. Seventy per cent of boys in the high social group had energy intakes below the EAR compared with 56% of boys in the lowest social group. This trend is also evident in girls, with only the high social group of girls having more than 50% of its members with energy intakes below their EAR. Despite differences in energy intake between the social groups for both boys and girls the mean heights and weights of the children in each group fell between the 50^{th} and 75^{th} centile.

8.3.2 Protein

Dietary reference values for protein are derived from estimates of basic nitrogen requirements with an additional allowance for growth - an EAR and RNI only are given (Table 8.1).

Mean protein intakes were high (boys 62.1g, girls 57.4g) when compared with Dietary Reference Values of 42.1g for boys and 41.2g for girls. Table 8.1 shows only 0.5% of boys and 2.1% of girls had intakes below their EAR. When intakes were compared with RNI, only a small per cent of the subjects had intakes which fell below (6% of boys and 10% of girls). Figure 8.3 shows the distribution curve of average protein intakes for boys and girls. The Dietary Reference Values are indicated and a Normal curve drawn around EAR and RNI assuming the lowest point to be two standard deviations away from the EAR. It is clear from Figure 8.3 that protein intakes of both boys and girls were in excess of requirements and the risk of any individual being deficient of protein is highly unlikely.

The highest risk of deficiency would be in middle and low social group girls where 13% had intakes below the RNI, compared with 7.5% of high social group girls (Table 8.1).

8.3.3 Fat

The dietary reference value for fat suggests that for a population no more than 35% of energy should be derived from fat. In our survey of 11 to 12-year old children, the average per cent energy derived from fat was 39.3% for boys and 40.1% for girls. The method of collection of the dietary data did not allow a valid assessment of the fatty acid composition of the children's diet - whilst acknowledging that the DRV for fat and for fatty acid composition are interrelated it was considered useful to study the total fat in relation to the DRV for the population. Eighty-three per cent of boys and 92% of girls obtained more than 35% of their energy intake from fat (Table 8.2). The distribution of mean daily fat intake for these subjects, the mean intake and relative position of the DRV are given in Figure 8.4. A social group trend was apparent for both boys and girls - more children from the high social groups had fat intakes of not more than 35% of energy intake than from the low social groups. However, even in the high social groups, 76% of boys and 90% of girls had fat intakes above the DRV (Table 8.2).

8.3.4 **Non-milk extrinsic sugars**

The dietary reference value for non-milk extrinsic sugars suggests that, excluding alcohol, for a population no more than 11% of energy should be derived from this source and indeed that NME sugars are not essential in the diet. Table 8.2 shows that the majority of children failed to meet this target - 83% of boys and 97% of girls had intakes of NME sugars which accounted for more than 11% of energy. The average per cent of energy derived from NME sugars was 16.6% for boys and 17.7% for girls. Figure 8.5 shows the distribution of the mean daily NME sugars intakes for these subjects and the relative position of the DRV. As with fat intake, a social group gradient was apparent - more children in the high social group achieved the DRV. Yet even amongst high social group children, over 80% of boys and over 95% of girls had intakes in excess of the DRV (Table 8.2).

There is some debate over whether it is practical for an individual to have a dietary intake which meets the 'healthy eating' target for both fat and NME sugars. It has been shown that few children in our survey would have met the DRV targets for fat and NME sugars individually. The per cent of children who had average dietary intakes which had both no more than 35% energy from fat and no more than 11% energy from NME sugar was calculated. Ninety-eight per cent of boys and all girls would have failed to meet the DRVs for both fat and NME sugars together: 4 boys from the 379 children surveyed achieved both DRVs (Table 8.2).

It is evident that the dietary intake of these adolescents were both high in fat and NME sugars when compared with reference values and radical changes in dietary composition will be required if these targets are to be reached by groups of adolescents.

8.3.5 **Calcium**

The mean daily calcium intakes were 786mg for boys and 783mg for girls. These can be compared with an RNI of 1000mg for boys and 800mg for girls, suggesting an adequate intake by girls and a low intake by boys. Table 8.3 shows that 83% of boys and 66% of girls had intakes below the RNI. This is illustrated in Figure 8.6.

The low social group boys had a mean daily intake of 758mg, with 88% of low social group boys having intakes below the RNI (Table 8.3). At least 63% of all sex and social groups had calcium intakes below the RNI. On the principle that the risk of deficiency within a group is small if the per cent below RNI is zero and that the risk of deficiency increases as the per cent below the RNI increases, it could be assumed that some individuals in our survey, particularly boys, would fail to meet their requirement for calcium. The LRNI is the amount considered adequate to meet the needs of only a small per cent (3%) of the population, 5.6% of girls had intakes below their LRNI of 450mg and 4.9% of boys had intakes below their LRNI of 480mg. These results suggest the possibility that the calcium needs of the adolescents in this study were not being met.

8.3.6 Iron

The DRVs for iron intake by girls assumes a positively skewed distribution, the EAR is set at the 75th centile rather than the 50th, this takes into account the iron requirements of menstruation for most females, those with high menstrual blood loss may need to supplement their iron intake by non-dietary means (Department of Health, 1991). The mean daily iron intakes by the children in our survey were 11.7mg for boys and 11.2mg for girls. This can be compared with an RNI of 11.3mg for boys and 14.8mg for girls. It would appear from these comparisons that the boys had an adequate iron intake. Table 8.3 shows the proportion of boys and girls with intakes below the RNI - 90% of all girls had intakes below 14.8mg and 56% of all boys had intakes below 11.3mg. Only 13% of boys failed to meet the EAR of iron, suggesting the needs of most of the boys would be met, however since 56% of boys had intakes below the RNI it is possible that the requirements of some boys with higher needs would not be met. Figure 8.7 illustrates the distributions of mean daily iron intake for boys and girls and the positions of the mean daily iron intake by boys and girls relative to the dietary reference values. Sixty-two per cent of girls had intakes below the EAR and 12% had intakes below the LRNI. The group with the highest proportion of individuals falling below the DRV was middle social group girls - 88% had intakes below the RNI, 68% failed to meet the EAR and 15% had intakes below the LRNI of 8.0mg.

These results suggest that whilst some boys may be at risk of iron deficiency, it is likely that a considerable proportion of the girls would be at risk, as suggested by previous surveys (section 2.6.3). It must be considered that the DRV for iron intakes by girls were set assuming that menarche had occurred. This information was not collected in this survey - it is likely that aged 11 to 12 years many of the girls would have been pre-menarcheal, although most would be approaching menarche in the next 12 months.

8.3.7 Vitamin C

The mean daily vitamin C intakes by both boys (52mg) and girls (56mg) in this survey were well in excess of 35mg which is the RNI for vitamin C (Table 8.3). None of the children had intakes below the LRNI of 9mg and only a small proportion had intakes below the EAR. Figure 8.8 shows the distribution of mean daily vitamin C intake for these subjects, the mean intake and relative position of the DRV for both boys and girls. The group with the lowest intake was the low social group girls, of which only 13% had intakes below the EAR. Thirty-six per cent of boys and 27% of girls had intakes below 35mg, suggesting, that although the mean intake of vitamin C was high, the possibility still exists that some children with high requirements of vitamin C may have been at risk of deficiency. This possibility would be greatest in low social group boys of which 41% had intakes below the RNI.

8.3.8 Retinol equivalent

Table 8.3 shows the proportion of the population with intakes equal to, or greater than the DRVs for retinol equivalent. It should be noted that the DRVs for retinol equivalent assume a Normal distribution (Figure 8.9) which was not found in our survey (section 6.3.2.2). The retinol equivalent intake of the boys and girls in our survey have been plotted on a $\log_{10}$ scale along with the DRVs for retinol equivalent (Figure 8.9). Considerably more than 50% of boys and girls had intakes greater than the EAR (74% of boys and 83% of girls). However 59% of boys and 54% of girls had intakes below the RNI so that, although unlikely, some children with high needs for retinol equivalent may have failed to meet their requirements.

8.4 Summary

The dietary reference values for each nutrient discussed above assume that the requirement of all other nutrients is being met (Department of Health, 1991). To investigate this assumption with the children in our survey, the proportion of children whose dietary intake met the DRVs of all the nutrients measured in this survey, was calculated. That is, the percentage of children who met the DRVs for energy (EAR), fat (as a proportion of energy intake, NME sugars (as a proportion of energy intake), protein, calcium, iron, vitamin C and retinol equivalent (RNI). None of the 379 children, had a mean dietary intake which simultaneously achieved the EAR for energy and the RNI for all these nutrients. In addition, none of the children had a dietary intakes which simultaneously met the EAR of these nutrients whilst also meeting the EAR for energy and the proportion of energy derived from fat and NME sugars.

Since it has already been established that many children in this study failed to meet the DRV for energy, fat and NME sugars (section 8.3), these three factors were excluded and the analysis described above repeated. Eleven per cent of boys and only 4% of girls had mean dietary intakes which met their RNI for protein, calcium, iron, vitamin C and retinol equivalent together. Only thirty-nine per cent of boys and 21% of girls had a mean dietary intake which simultaneously met with their EAR for these nutrients.

These findings have implications for nutritional requirements of the children since the needs of nutrients may be inter-related. Low intakes which fail to meet the requirement of one nutrient may in turn lead to increased needs of other nutrients, for example, low iron intakes will require higher vitamin C intakes to promote efficient absorption of the available iron, and low calcium intakes will be further affected by low vitamin D status or high intake of phytic acid or 'unavailable carbohydrate'. High protein intakes will promote renal calcium excretion and so increase calcium requirements.

There is no reason to suspect that the 11 to 12-year old Northumbrian children studied here, in 1990, had dietary intakes which differed greatly from the diet of other children of this age in Britain. Although the National Food Survey has detected regional variations in the diet of the population, which are apparently independent of social class, the results reported above for the children in our survey were not dissimilar from the results reported in the previous national survey of young adolescents (Department of Health, 1989a) (Chapter 6). It is unlikely that the dietary intake of 11 to 12-year-olds has changed since the publication of the dietary reference report in 1991 (Department of Health, 1991). It is evident from the results presented above that significant improvements in both nutrient intake and particularly in composition of the diet are required if the 'average' 11 to 12-year old is to meet with current dietary recommendations - in particular changes in the energy composition of the diet with a move towards a greater proportion of energy being derived from complex carbohydrate foods and a reduction in the proportion of energy derived from fat and NME sugars. Iron and calcium intakes are a cause of concern, particularly iron intake of girls. Calcium intakes may be further affected if the trends detected in the National Food Survey of reducing milk and white bread (fortified with calcium) consumption continue (Ministry of Agriculture, Fisheries and Food, 1991a). This is an example of health-motivated change - to reduce fat intake and eat wholemeal bread - having a possible adverse effect on nutrient intake. At current measured energy intake, diets of a higher nutrient density need to be encouraged amongst children of this age group if all needs are to be met.

Table 8.1 Dietary Reference Values (Department of Health, 1991) for energy and protein for 11-14-year-olds and per cent of 11 to 12-year old boys and girls with intakes below these Dietary Reference Values, by sex and social group.

Sex	Social group	Energy	Protein	
		EAR*	EAR**	RNI¶
Boys	DRV	9.12MJ	33.8g	42.1g
		%	%	%
	All	66.3	0.5	6.0
	High	70.0	0.0	4.3
	Middle	64.3	1.8	7.1
	Low	56.2	0.0	3.1
Girls	DRV	7.98MJ	33.1g	41.2g
		%	%	%
	All	48.2	2.1	9.7
	High	58.2	0.0	7.5
	Middle	46.7	3.3	13.3
	Low	44.7	5.3	13.2

* Calculated Estimated Average Requirement for energy (section 8.2)
** Estimated Average Requirement
¶ Reference Nutrient Intake

Table 8.2 Dietary Reference Values (Department of Health, 1991) for fat and non-milk extrinsic sugars and per cent of 11 to 12-year old boys and girls with intakes exceeding these Dietary Reference Values, by sex and social group.

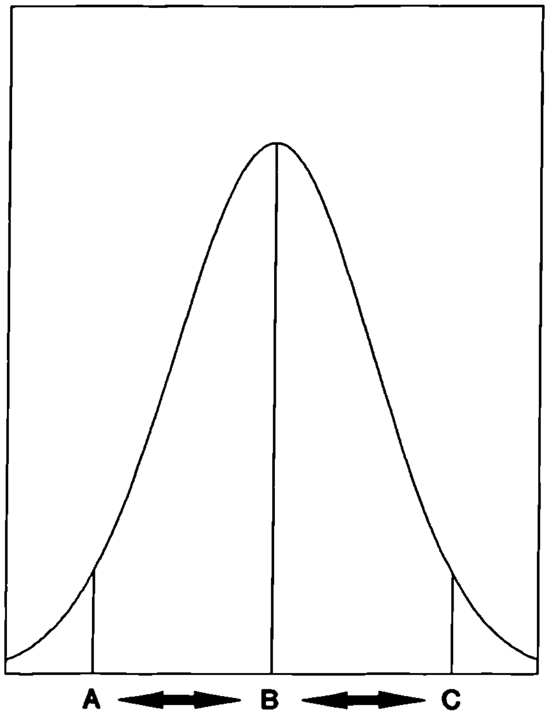
Sex	Social group	Fat	Non-milk extrinsic sugars	Fat and non-milk extrinsic sugars
	DRV	Not more than 35% of energy from fat	Not more than 11% of food energy from non-milk extrinsic sugars	Not more than 35% food energy from fat and 11% of energy from non-milk extrinsic sugars
		% above DRV	% above DRV	% above both DRVs
Boys	All	**82.6**	**83.2**	**97.8**
	High	75.7	81.4	97.1
	Middle	80.4	83.9	96.4
	Low	93.8	93.7	100
Girls	All	**91.8**	**96.9**	**100**
	High	89.6	95.5	100
	Middle	90.0	98.3	100
	Low	94.7	97.4	100

Table 8.3 Dietary Reference Values (Department of Health, 1991) for micronutrients for 11-14-year-olds and per cent of 11 to 12-year old boys and girls with intakes below these Dietary Reference Values, by sex and social group.

Sex	Social group	Calcium			Iron			Retinol equivalent			Vitamin C		
		LRNI*	EAR**	RNI¶	LRNI	EAR	RNI	LRNI	EAR	RNI	LRNI	EAR	RNI
Boys		480mg	750mg	1000mg	6.1mg	8.7mg	11.3mg	250µg	400µg	600µg	9mg	22mg	35mg
		%	%	%	%	%	%	%	%	%	%	%	%
	All	4.9	53.3	82.6	0	13.0	56.0	7.1	26.1	58.7	0	8.2	35.9
	High	4.3	47.1	78.6	0	14.3	54.3	8.6	28.6	60.0	0	5.7	30.0
	Middle	5.4	51.8	80.4	0	12.5	48.2	5.4	21.4	55.4	0	8.9	32.1
	Low	3.1	56.3	87.5	0	12.5	53.1	3.1	21.9	46.9	0	12.5	40.6
Girls		450mg	625mg	800mg	8.0mg	11.4mg	14.8mg	250µg	400µg	600µg	9mg	22mg	35mg
		%	%	%	%	%	%	%	%	%	%	%	%
	All	5.6	27.2	65.6	11.8	62.1	90.3	3.1	17.4	54.4	0	8.2	27.2
	High	5.9	25.4	62.7	11.9	58.2	91.0	4.5	11.9	43.3	0	7.5	20.9
	Middle	3.3	26.7	70.0	15.0	68.3	88.3	3.3	20.0	63.3	0	8.3	31.7
	Low	5.3	31.6	63.2	7.9	60.5	92.1	0	21.1	57.9	0	13.2	31.6

* LRNI Lower Reference Nutrient Intake
** EAR Estimated Average Requirement
¶ RNI Reference Nutrient Intake

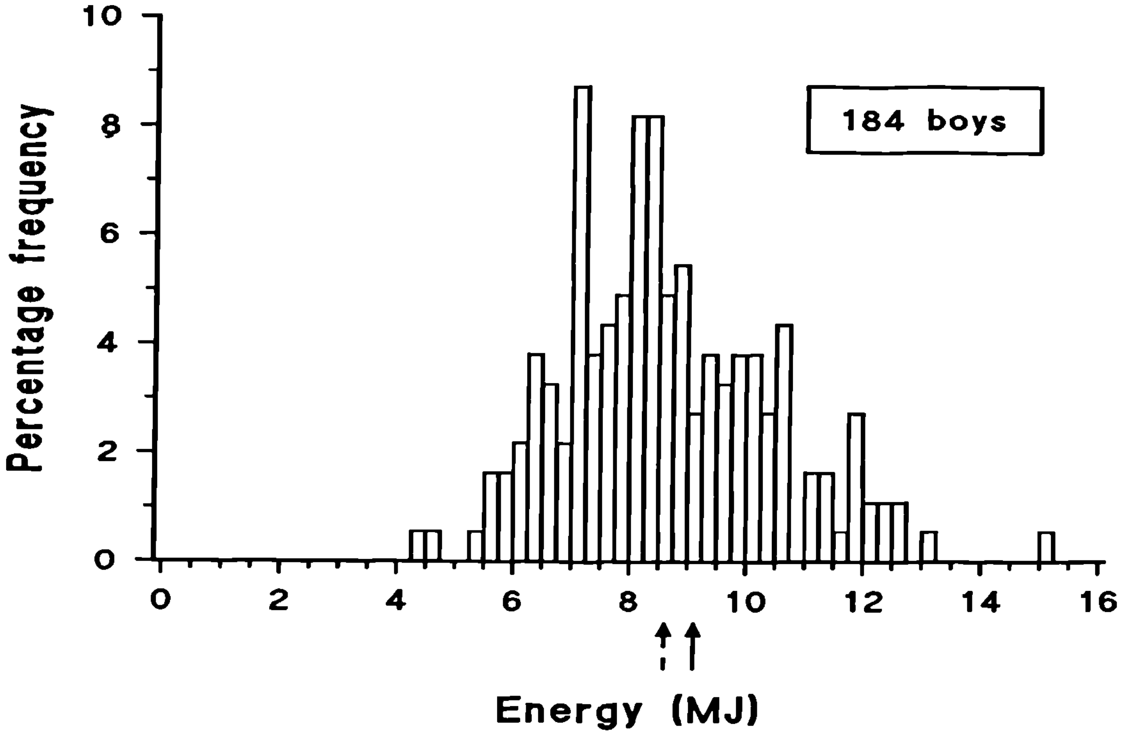
Figure 8.1 Normal distribution, mean and 2 standard deviations from the mean indicated showing the distribution of intakes and the basis for the range of Dietary Reference Values (Department of Health, 1991)



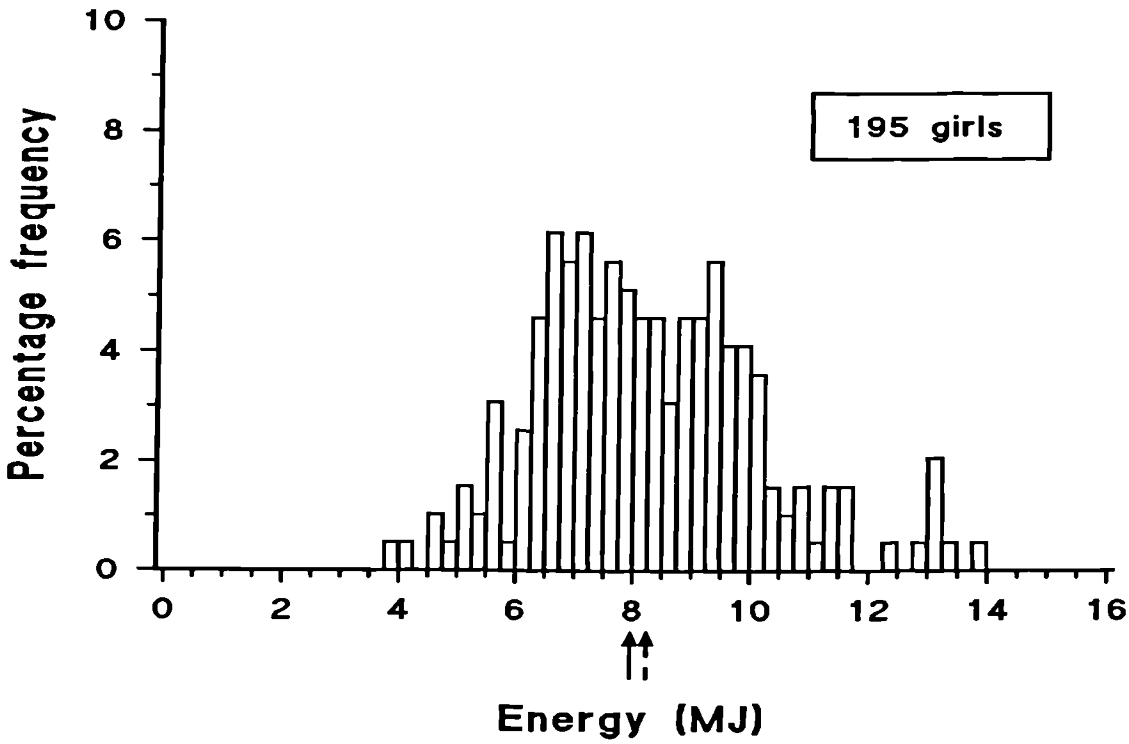
B:Estimated Average Requirement
A:Lower Reference Nutrient Intake
C:Reference Nutrient Intake

Figure 8.2 Percentage frequency distribution of mean energy intake for (a) boys and (b) girls. The mean intake of the group is indicated by the broken arrow and the solid arrows indicate the EAR for this age group and sex (Department of Health, 1991).

a)



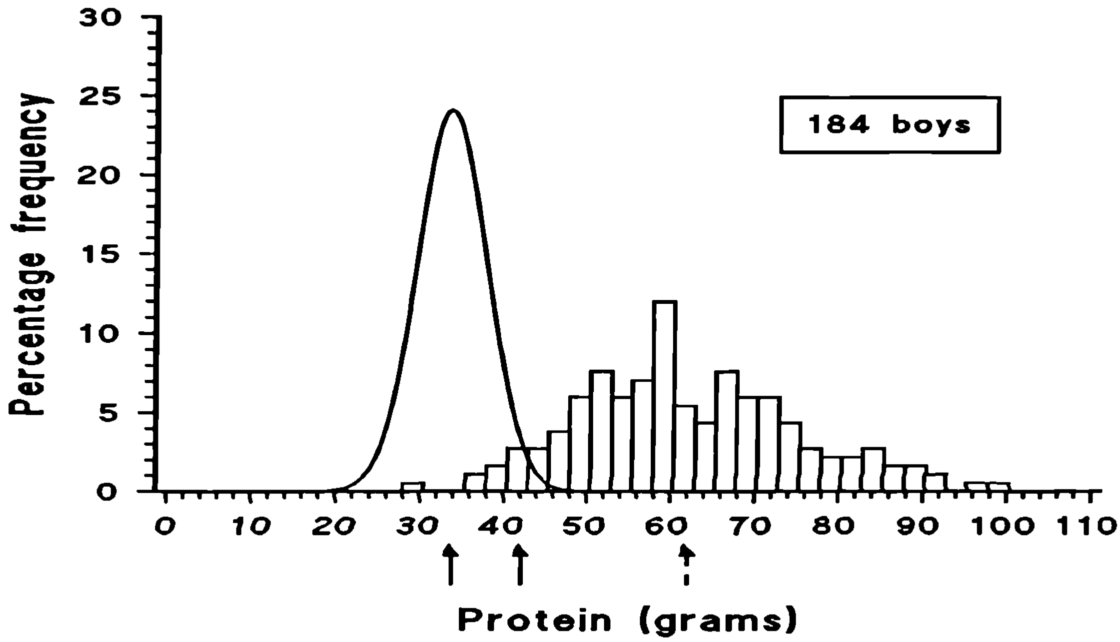
b)



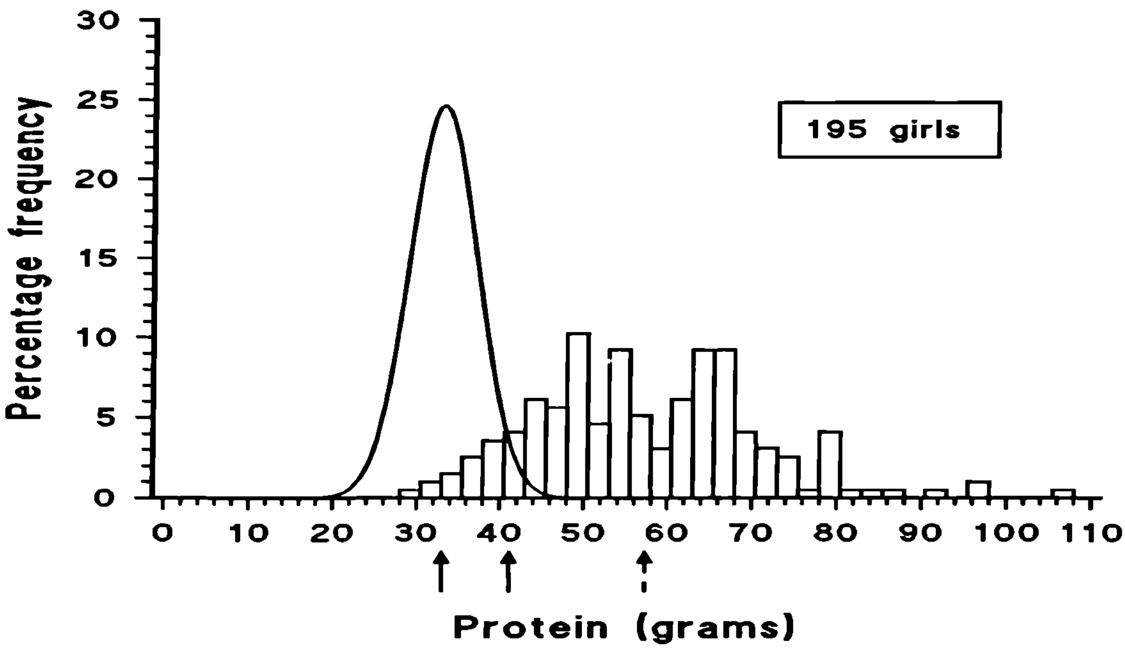
Solid arrows indicate dietary reference value; EAR for energy.
Broken arrows indicate observed mean intake of the group.

Figure 8.3 Percentage frequency distribution of mean protein intake for (a) boys and (b) girls. The mean intake of the group is indicated by the broken arrow. The continuous curve is the normal distribution of requirements (Department of Health, 1991) and the solid arrows indicate the EAR and RNI for protein for this age group and sex.

a)



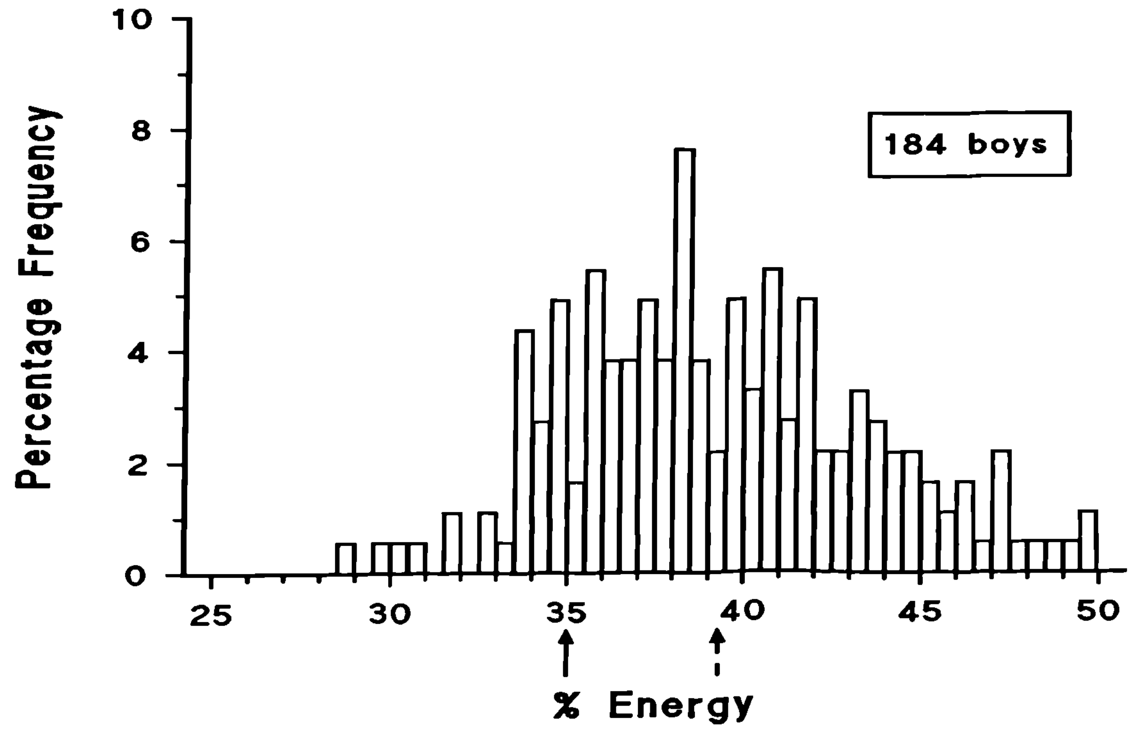
b)



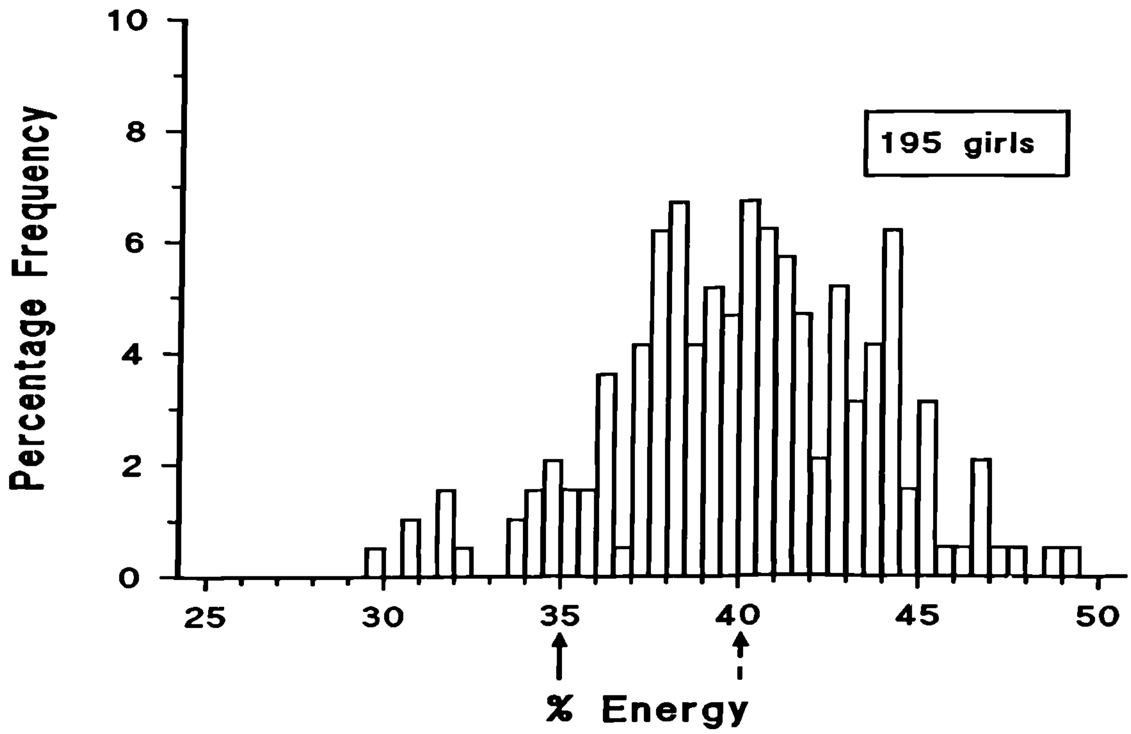
Solid arrows indicate dietary reference values; EAR and RNI for protein.
Broken arrows indicate observed mean intake of the group.

Figure 8.4 Percentage frequency distribution of mean percentage dietary energy derived from fat for (a) boys and (b) girls. The mean per cent energy from fat of the group is indicated by the broken arrow. The solid arrow indicates the DRV for per cent energy derived from fat for this age group and sex.

a)



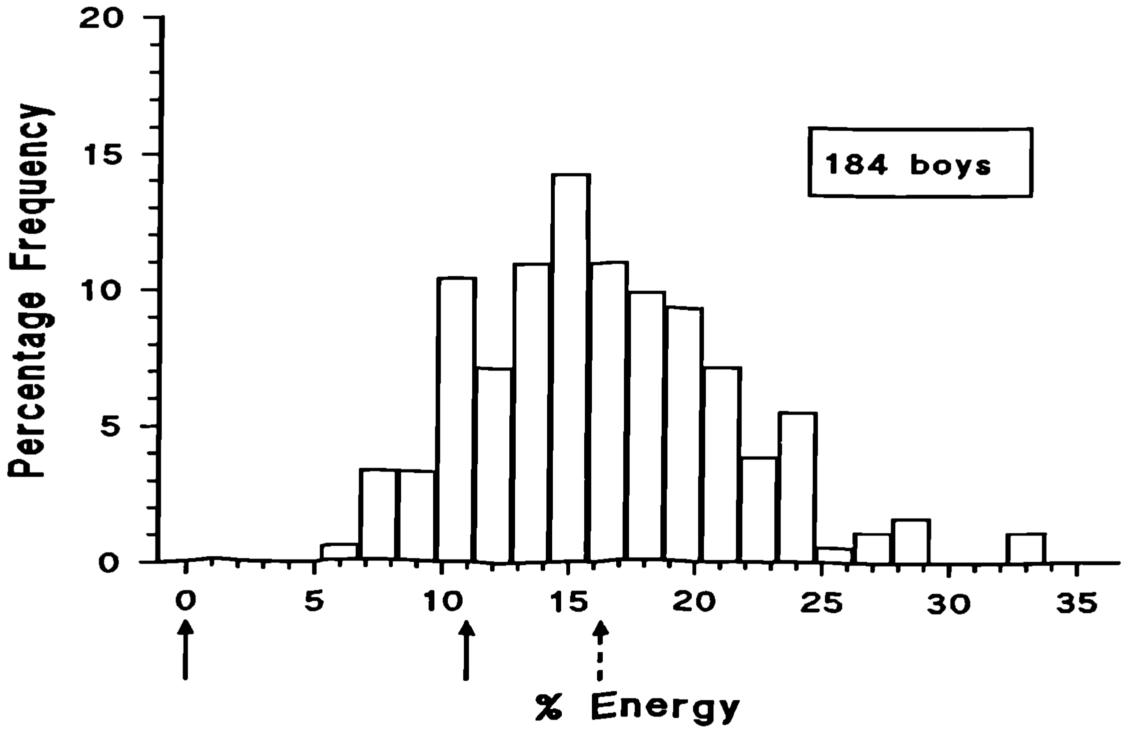
b)



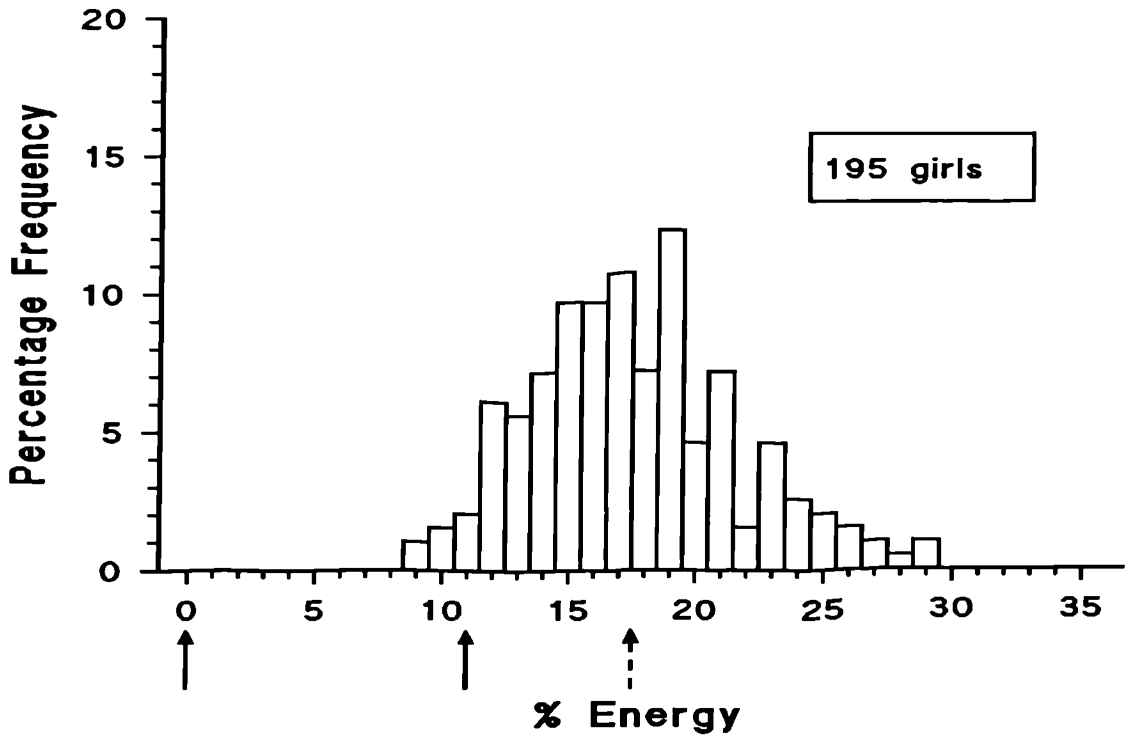
Solid arrows indicate dietary reference value for per cent energy from fat.
Broken arrows indicate observed mean per cent energy intake from fat of the group.

Figure 8.5 Percentage frequency distribution of mean percentage dietary energy derived from non-milk extrinsic sugars for (a) boys and (b) girls. The mean per cent energy from NME of the group is indicated by the broken arrow. The solid arrow indicates the DRV for per cent energy derived from NME for this age group and sex.

a)



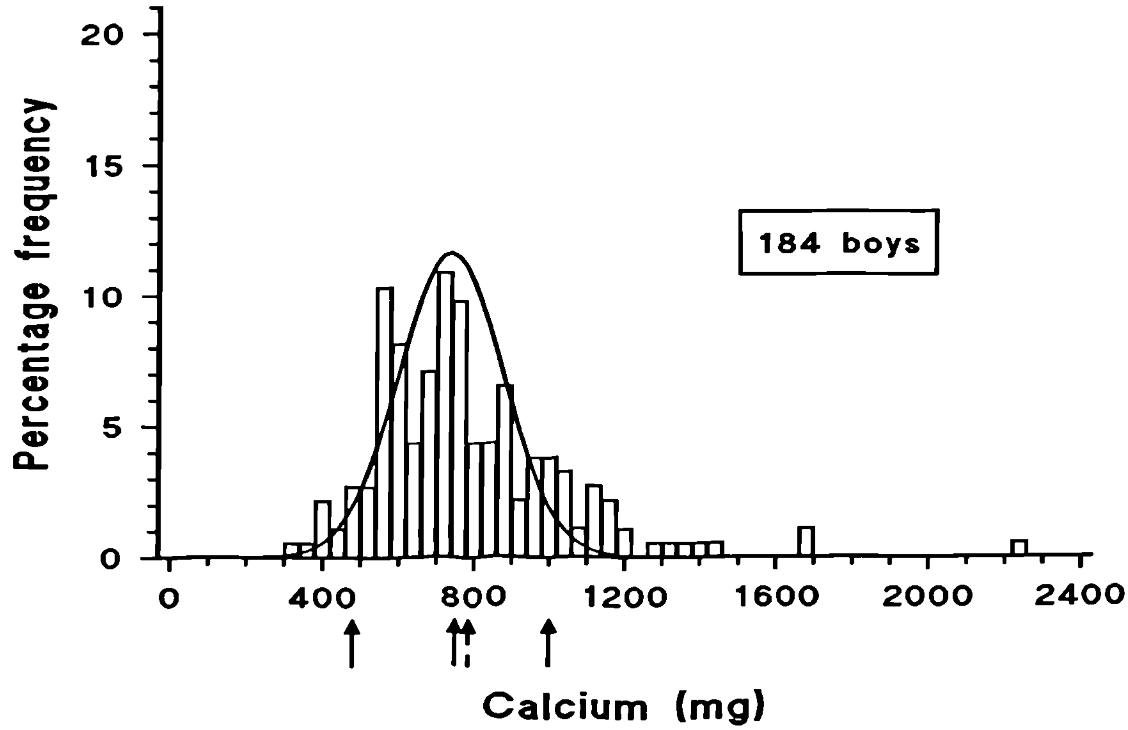
b)



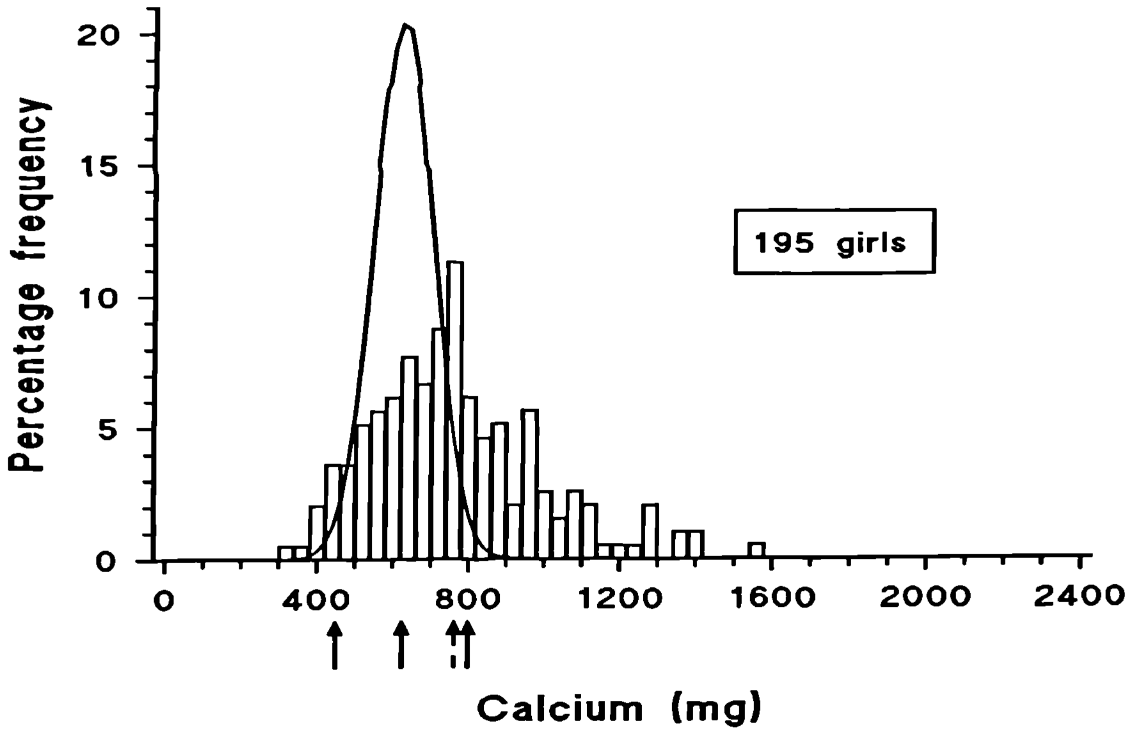
Solid arrows indicate dietary reference value for per cent energy from NME sugars.
Broken arrows indicate observed mean per cent energy intake from non-milk extrinsic sugars of the group.

Figure 8.6 Percentage frequency distribution of mean calcium intake for (a) boys and (b) girls. The mean intake of the group is indicated by the broken arrow. The continuous curve is the normal distribution of requirements (Department of Health, 1991) and the solid arrows indicate the LRNI, EAR and RNI for calcium for this age group and sex.

a)



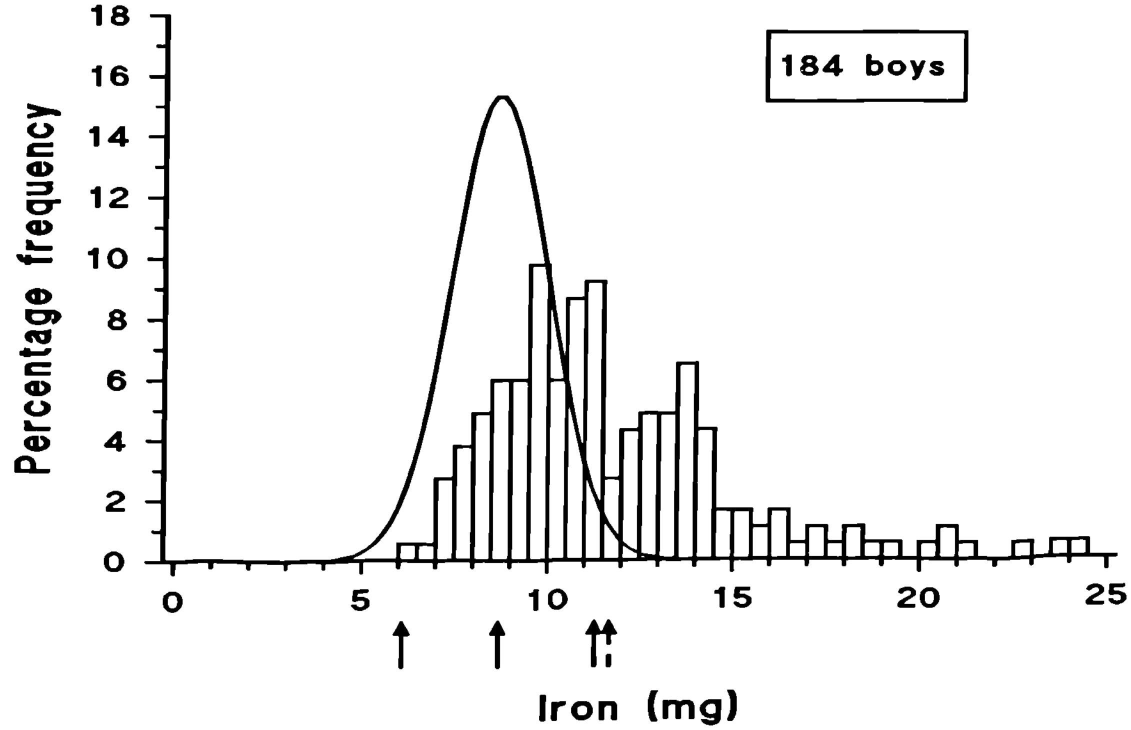
b)



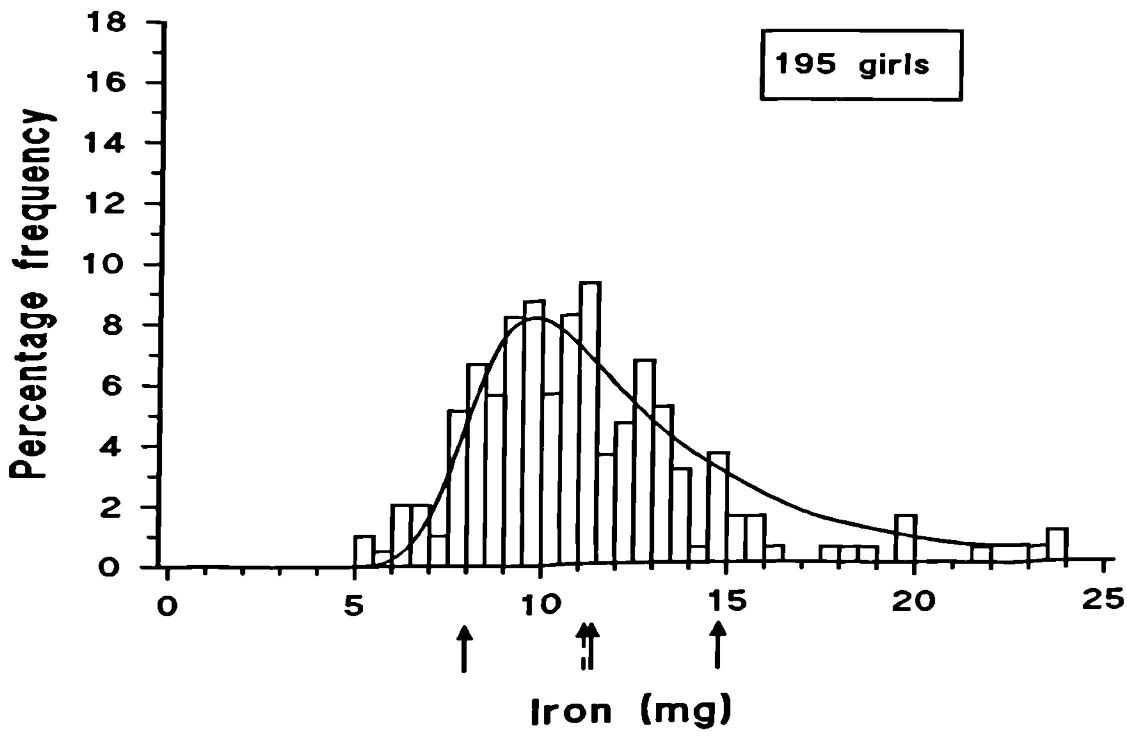
Solid arrows indicate range of dietary reference values; LRNI, EAR and RNI for calcium.
Broken arrows indicate observed mean intake of the group.

Figure 8.7 Percentage frequency distribution of mean iron intake for (a) boys and (b) girls. The mean intake of the group is indicated by the broken arrow. The continuous curve is the normal distribution of requirements (Department of Health, 1991), and the solid arrows indicate the LRNI, EAR and RNI for iron for this age group and sex (skewed distribution for girls).

a)



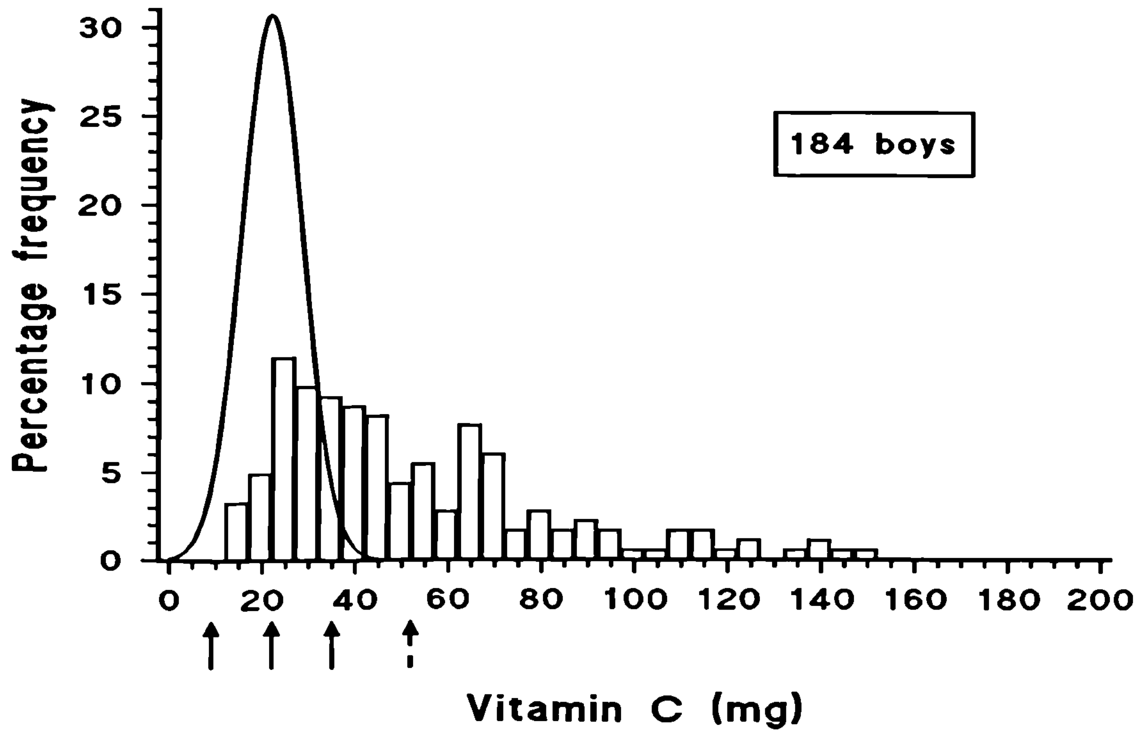
b)



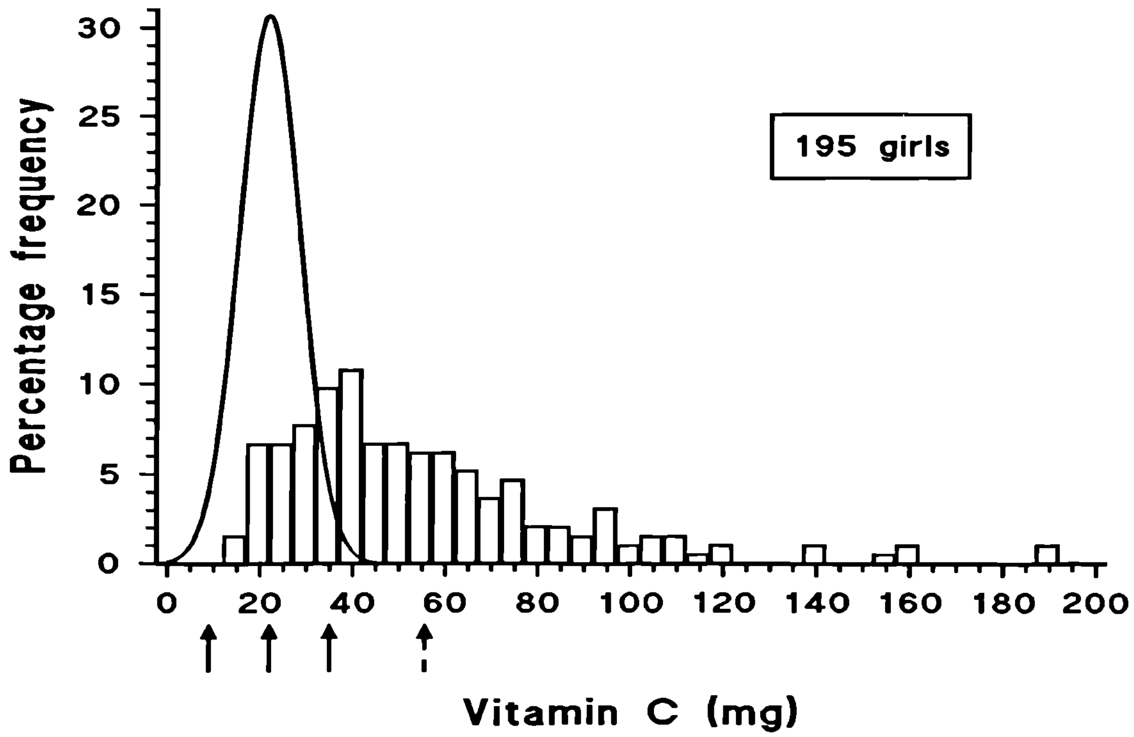
Solid arrows indicate range of dietary reference values; LRNI, EAR and RNI for iron.
Broken arrows indicate observed mean intake of the group.

Figure 8.8 Percentage frequency distribution of mean Vitamin C intake for (a) boys and (b) girls. The mean intake of the group is indicated by the broken arrow. The continuous curve is the normal distribution of requirements (Department of Health, 1991), and the solid arrows indicate the LRNI, EAR and RNI for Vitamin C for this age group and sex.

a)



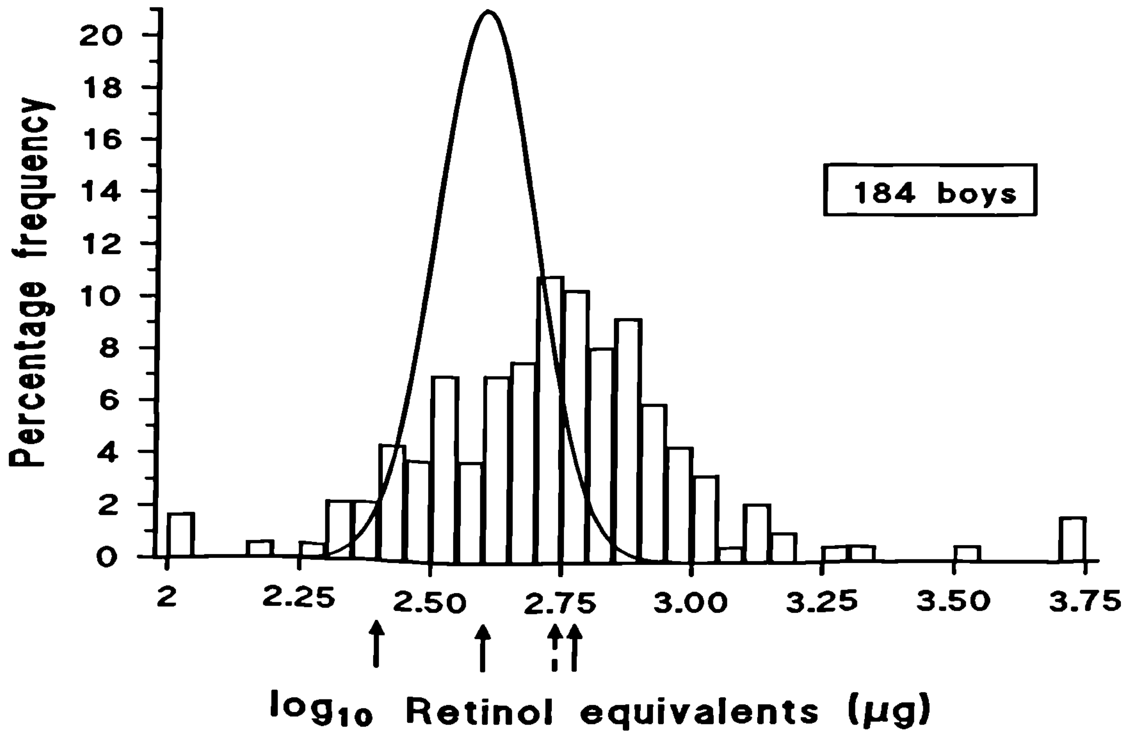
b)



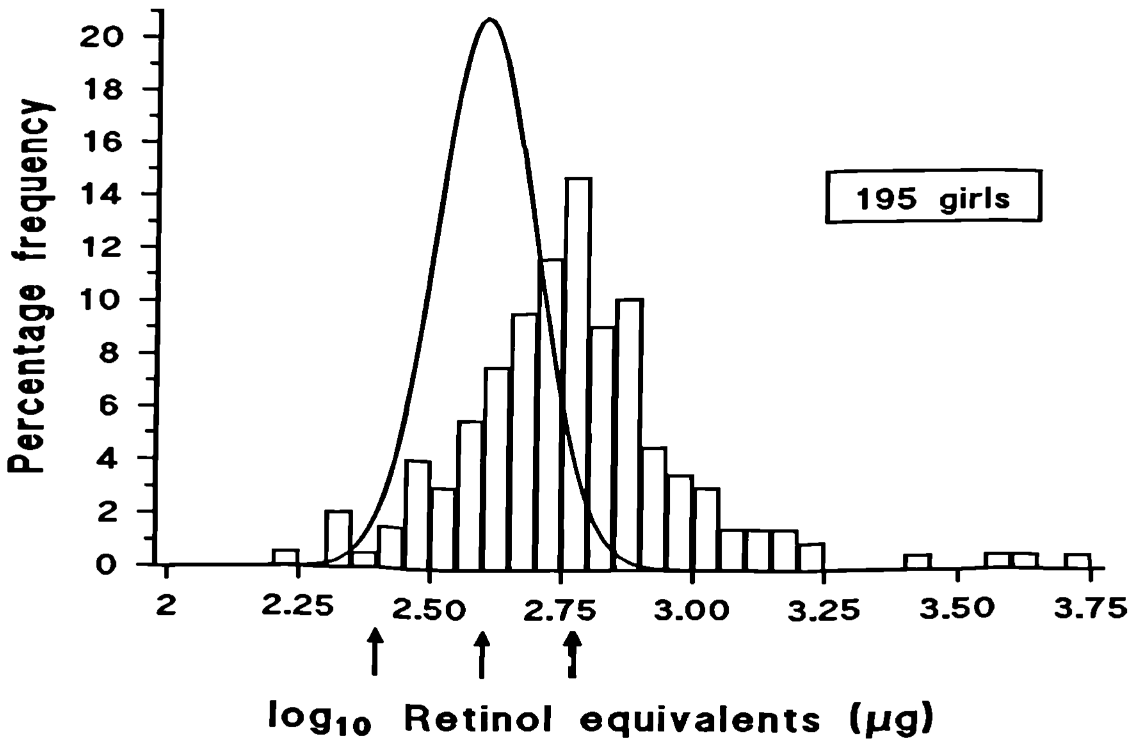
Solid arrows indicate range of dietary reference values; LRNI, EAR and RNI for vitamin C.
Broken arrows indicate observed mean intake of the group.

Figure 8.9 Percentage frequency distribution of mean retinol equivalent intake for (a) boys and (b) girls ($\log_{10}$). The mean intake of the group is indicated by the broken arrow. The continuous curve is the normal distribution of requirements ($\log_{10}$) (Department of Health, 1991), and the solid arrows indicate the LRNI, EAR and RNI for retinol equivalent for this age group and sex.

a)



b)



Solid arrows indicate range of dietary reference values; LRNI, EAR and RNI for retinol equivalent. Broken arrows indicate observed mean intake of the group.

CHAPTER NINE

THE CONTRIBUTION OF FOODS PURCHASED 'AWAY FROM HOME' TO THE NUTRIENT INTAKE OF YOUNG ADOLESCENTS

9.1 Introduction and aim

This study aimed to determine the relative importance of foods purchased outside the home in the total diet of adolescents, and to investigate the places of purchase of 'away from home' food. Previous studies have investigated the place of purchase of lunch-time food by adolescents (Nelson and Paul, 1983; Department of Health, 1989a), or all 'away from home' foods by adults (Loughridge et al., 1989; Gregory et al., 1990). This was the first survey to attempt to identify the places of purchase of foods outside of the home by children. If the contribution of foods from outside the home is found to be important in the total diet of adolescents, then data on the source of those foods and the quality of the intakes from each source, will shed further light on the eating habits of this age group, which will assist in targeting future dietary advice.

Thus the aims were:

- To determine the contribution to total nutrient intake made by foods purchased outside the home; and to compare this with reports of the contribution made by these foods to the nutrient intake of adults in the UK, and with assumptions made by the National Food Survey.

- To determine the place of purchase of foods obtained outside the home by 11 to 12-year-olds and the relative importance of each source to the total dietary intake; and to determine the nutrient density of the dietary intake from each place of purchase.

The place of purchase of foods, not necessarily the place of consumption, was the information sought in this study. This distinction was essential to separate the foods obtained at home, which would be influenced by parental control and other family factors, from the foods purchased independently by the children. The 'place of purchase' has been used throughout to describe the source of the food - whilst the food obtained from home by the children was not strictly 'purchased' and, of course, most foods are 'purchased outside the home' these terms have been used to describe the source of the food for the child, not the household.

9.2 Method

Information necessary to undertake these analyses was obtained as part of the interview (section 4.2.3). During the interview the child was asked to described the 'place of purchase' of each food item. Since the time of each 'eating event' had been recorded, recall of food intake was facilitated by taking the child through each day step by step; the child was asked to recall the 'eating event', where the food was eaten and the 'place of purchase' of each food item. The place of purchase reported by the child was then classified into one of five sources:

- Child's home
- School meal
- Home, other than child's home
- School tuck-shop
- Shop or cafe (restaurant, cinema etc).

The criterion used to judge to which of these food sources each food belonged was the 'place of purchase', irrespective of where that food was eaten. Therefore, packed meals prepared at home but eaten away from home were considered to be from a 'home' source. 'Take-away meals' were judged to be from a 'home' source if they were bought by the household, but were 'away foods' if they were bought independently by the child. Soft drinks and confectionery were considered in the same way as any other food; sweets or soft drinks brought into the home by the 'housewife' and eaten as part of a meal or a snack were judged to be from a 'home' source. All other sweets and drinks were 'away from home' foods and as such, were allocated to the appropriate 'away from home' source.

Once the 'place of purchase' had been determined, it was recorded in the diary next to each food item. This information was then entered into the computer database along with the time of consumption, the allocated food code and the weight eaten (section 4.4). The data analysis program allowed selection of food intakes by place of purchase. For the purposes of investigating food from all 'away from home' places of purchase, the data analysis system allowed 'away from home' places of purchase to be combined. Further sub-selections for analysis were also possible: to investigate the place of purchase and nutrient intake from schoolday lunches the analysis programme allowed food intakes recorded on selected days (schooldays) during a selected time period (11.30 - 13.30) and from selected places of purchase (school meal, home meal, shop/cafe) to be isolated.

9.2.1 Methods of analysis of place of purchase information

The results have been presented in three ways. First, the mean daily intake of the nutrients obtained from each place of purchase for each sex and social group are given. This information is limited in its application for interpreting the results, since the average total dietary intake of each sex and social group varied. Nor will this analysis allow useful comparison with national figures for the population, or with other data for adults, since total intake varies considerably between adults and children. However, the absolute amounts of nutrients obtained from each place of purchase are useful to allow a comparison with dietary reference values (Chapter 8).

Secondly, the percentage of total intake of energy and of each nutrient which was obtained from each place of purchase, by each sex and social group, has been calculated. This allows the relative magnitude of the contribution from each place of purchase to the total dietary intake of the group to be assessed; that is, the relative importance of each place of purchase as a nutrient source for the group. In addition, these results can be compared with the mean percentage of energy and nutrients assumed be purchased outside the home by the national food survey and the percentage contributed by 'away from home' food in surveys of adults. In the above two methods of interpretation of the results, the values given are mean values for all children in each sex and social group.

Finally, the nutrient density of the foods obtained from each place of purchase, by sex and social group, has been calculated. Nutrient density is defined as the amount of nutrient per MJ of energy (section 6.2.3). Since it is independent of energy intake, nutrient density gives a measure of the quality of the foods obtained from each place of purchase. This analysis differed from the above calculations of absolute amounts and percentage contributions, in that only those children who obtained any foods from that source were included. Since nutrient density measures the amount of nutrient consumed per MJ, it was necessary to exclude non-consumers since they obtained no energy from a source. The mean nutrient density from each place of purchase was calculated for each child, and thus also for the group. Since this analysis excludes non-consumers, the numbers of children in each sub-group was smaller than in the previous analyses and varied for each place of purchase. Table 9.1 shows the per cent of children obtaining any food energy from each place of purchase.

9.2.1.1 Statistical analyses

The data presented in this chapter are extensive and largely descriptive, the aim was to investigate and describe the role played by foods purchased from different food sources by these 11 to 12-year old children and not to test a specific hypothesis. In data of this nature extensive statistical analyses are unnecessary. The diets of British schoolchildren report (Department of Health, 1989a) included extensive data describing the nutrient intake of the children studied and yet the statistical analyses of these data were limited to arithmetic means, standard deviations and medians, the statistical significance of the difference in mean energy intakes by sex and social group only, was calculated. For descriptive data of this type, the inclusion of the standard deviation or the standard error of the mean is useful to allow the dispersion of data to be assessed.

Analysis of variance of the absolute nutrient intakes and nutrient density of foods from each place of purchase was by generalised linear models (Baker and Nelder, 1978), these were used to determine if the nutrient intakes and quality (nutrient density) differed in the foods obtained from each 'place of purchase', and also to investigate if intakes at each place of purchase varied between the different sex and social groups. Any differences in the proportion of children from each sex and social group, obtaining food from each place of purchase, were evaluated using the chi-square test for trends. The mean intakes and standard error of the means have been given in the tables, only those values shown to be statistically significantly ($p<0.05$) will be highlighted in the text.

9.3 Results and discussion

9.3.1 The places of purchase of food

Table 9.1 shows the per cent of all children and of boys and girls who reported obtaining any food from each 'place of purchase' over the 6 days surveyed. All girls and 99% of boys received some of their nutrient intake from sources outside the home. Home was the sole food source of food for only two children (both boys) of the 379 surveyed.

The majority of children (89% boys, 95% girls) obtained some food from a shop or cafe during the 6 days surveyed, this was the most common source of food 'outside the home' for these children. A high proportion of both boys and girls (75% of all children) ate at least one school meal during the six days. School tuck-shops were used less frequently, with only 12% of the children buying any food from this source, however this source was more popular amongst girls (16%) than boys (8%). Regular tuck-shops were available in only three of the seven schools taking part in the survey; therefore, this was found to be a less important food source for these children than had been expected. A home, other than the child's own home, was also a common source of food - 74% of all children obtained some food from this source during the 6 days surveyed. More girls (88%) than boys (59%) ate out at another home ($p<0.0001$) (Table 9.1).

A greater proportion of children from the high social group (77% of the boys, 81% of the girls) ate school meals than children from the middle or low social groups (low social group boys 69%, girls 63%) ($p=0.049$). Shop/cafe was more popular for the low social group boys (94%) than for boys from the high social group (83%) - this difference was not seen in girls and did not reach significance when all children were considered together.

School meals were available to all children in all of the schools but the lunch-time policy of the schools varied in the seven schools; two schools did not allow the children to leave the school grounds during lunch-time, thus restricting the children to either a school meal or packed lunch. Both of these schools, Newminster and Chantry Middle schools, were in Morpeth and had a higher proportion of children from high social group families than the other schools in the survey. The remaining five schools had no rules restricting the children's lunch-time activity, so enabling them to eat at local shops or cafes. It is likely that the different school policies will have been reflected in the proportion of each social group taking school meals (Table 9.1).

9.3.2 Nutrient intake from each place of purchase

9.3.2.1 Home and 'away from home'

Table 9.2 to Table 9.4 show the mean daily nutrient intake from the child's home and all 'away from home' places of purchase, by sex and social group. As expected the child's home was the largest source of energy and nutrients for both boys and girls (Table 9.2); however, 'away from home' foods sources contributed significant quantities of both energy and nutrients. The total dietary intake obtained from home fell below the Reference Nutrient Intake (RNI) for all measured nutrients for both boys and girls, with the exception of vitamin C (Department of Health, 1991) (Chapter 8), suggesting that foods purchased outside the home have a role to play in the nutrient intake of these adolescents.

In this survey, in common with other surveys of adolescents (Department of Health, 1989a), boys had a larger total energy and nutrient intake than girls (Chapter 6), but Table 9.2 shows that this difference between boys and girls, is only true for dietary intake at home (p=0.0002). Indeed, girls had the greater intake from 'places of purchase' outside the home. The higher energy intake at home by boys was reflected in significantly higher intakes of protein, fat, carbohydrate, unavailable carbohydrate, non-starch polysaccharides, calcium and iron ($p<0.05$) although not for total sugars, NME sugars, retinol equivalent or vitamin C. 'Away from home', girls obtained more energy and nutrients than boys. It was apparent that the greater total energy intake reported by boys was due to a larger energy intake at home, 6.14MJ compared with 5.52MJ for girls. That is, girls had lower intakes of energy and nutrients at home than boys, which they only partially compensated for by a higher intake of food outside the home.

Table 9.3 and Table 9.4 show the nutrient contribution of home and 'away from home' places of purchases by social group. Boys had higher energy intakes at home than girls in all social groups. The trend of higher total energy intakes by the children from the lower social group families (Chapter 6) was evident for boys both at home (Table 9.3) and 'away from home' (Table 9.4) places of purchase. For girls this was only apparent in food obtained at 'home' (Table 9.3) - there was no social group difference in energy intake from 'away from home' (Table 9.4). This trend of higher energy intakes at home by low social group children did not reach significance (p=0.13) but low social group children had significantly greater intakes of fat from home (p=0.005) whilst high social group children had higher intakes of vitamin C from this source (p=0.022).

9.3.2.2 All five places of purchase

It is important to note that this analysis describes the mean intake of nutrients for the group: it therefore includes some children who did not obtain any food at all from some of the places of purchase during the 6 days surveyed. School meals were less popular amongst low social group children, therefore a larger proportion of non-consumers in the low social group resulted in the mean intake from that source for low social group children being 'diluted'.

To investigate further the place of purchase of food by these adolescents, food sources outside the home were sub-divided to identify school meals, a home other than the child's own home, school tuck-shop, and shop/cafe etc (section 9.2). Table 9.5 and Table 9.6 show that, for both boys and girls, school meals and shop/cafe 'places of purchase' were the two most important food sources outside of the home. School meals contributed approximately 1.2MJ and shop/cafe approximately 1.0MJ to the average daily total diet of both boys and girls.

School tuck-shops were an unimportant place of purchase of food for these children, providing only an average of 0.01 - 0.02MJ for boys and girls respectively (Table 9.5 and Table 9.6). Energy and nutrients obtained from this source have been included in shop/cafe/ tuck-shop, 'place of purchase' in all subsequent analyses.

There was no difference detected in the mean energy and nutrient intakes from school meals between boys and girls (Table 9.5 and Table 9.6). Girls obtained more energy (0.56MJ) than boys (0.30MJ) from 'other homes' ($p=0.001$) (Table 9.5 and Table 9.6), reflecting the larger number of girls eating at this source (Table 9.1). The greater energy intake by girls from 'other homes' was also found for all other nutrients measured ($p<0.05$) with the exception of vitamin C, where no significant difference was found. There were no significant differences between boys and girls in the intakes obtained from shop/cafe/tuck-shop, either in energy or nutrient intake.

It is interesting to note that, although boys had a significantly higher total energy intake than girls, the energy obtained from each source outside the home did not differ between boys and girls; the only exception being that girls received more energy from 'other homes' than boys. This finding for energy was reflected by the intake of nutrients and sugars from each place of purchase.

The intake of nutrients from each place of purchase, by each sex and social group are shown in Table 9.7 to Table 9.10.

In dietary intake from school meals there was a non-significant trend towards a higher energy intake by high social group children than children from the lower social groups ($p=0.08$) (Table 9.7 and Table 9.8). No significant social group difference in nutrient intake from this source was detected, the only exception being non-starch polysaccharides - high social group children obtained larger intakes of non-starch polysaccharides than the low social group children from school meals (p=0.01) (Table 9.9 and Table 9.10).

No social group difference in intake from other homes in either sex was detected. For energy and nutrient intake from shop/cafe/tuck-shop a significant social group trend was apparent. Low social group children had significantly higher intakes of energy from this source than children from high social groups ($p<0.001$) (Table 9.7 and Table 9.8) which was reflected in the intakes of all nutrients measured ($p<0.05$) with exception of calcium (Table 9.9 and Table 9.10). However for energy, protein, fat, carbohydrate, unavailable carbohydrate and iron, this social group trend was not consistent across all sex and social groups - middle social group girls had larger intakes of energy (1.04MJ) from this source than low social group girls (0.91MJ) (Table 9.8). The social group trend was consistent for both boys and girls for total sugars, non-milk extrinsic sugars and vitamin C. The food purchased by boys from shop/cafe/tuck-shop contributed 0.64MJ daily for boys from the high social groups, and this rose to 1.47MJ a day for boys from the low social groups. This finding, along with higher energy intakes from home by the low social group boys, helps to explain some of the social group gradient in total energy intake for boys, since this difference was only partially compensated for by higher energy intakes from school meals by high social group boys. For girls the social group gradient in total energy intake was due to differences in energy intake from home.

The nutrient composition of the intakes from the different places of purchase outside the home differed considerably (Table 9.5 and Table 9.6); for example, school meals provided about 1.2MJ for both boys and girls and were an important source of protein (boys 7.4g, girls 7.7g), calcium (boys 104mg, girls 115mg) and of iron (approximately 1.5mg) but were less important sources of total sugars (approximately 12g) and NME sugars (approximately 8.5g). Shop/cafe/tuck-shop 'place of purchase' provided similar amounts of energy as school meals for both boys and girls (1.0MJ) but, with considerably less nutrients - calcium (boys 55mg, girls 60mg), iron (0.9mg) and more total sugars (21.7g) and NME sugars (20.7g). In the diet as a whole, NME sugars accounted for approximately 76% of total sugar intake, but this increased to 97% of total sugar intake when food purchased at shop/cafe/tuck-shop was considered. The proportion of the total intake and the quality of diet (nutrient density) obtained from each 'place of purchase' are reported and discussed in sections 9.3.3 and 9.3.4.

9.3.3 Per cent of total nutrient intake from each place of purchase

Different places of purchase provide different types of foods. Obviously, since foods are not homogeneous in their nutrient composition, the proportion of nutrients obtained from each place of purchase will not necessarily follow the same pattern as the proportion of energy obtained from that source. To establish the part played by the foods obtained from each 'place of purchase' to the total dietary intake and to investigate the nature of the foods purchased, the percentage of total nutrient intake obtained from each place of purchase by each sex and social group has been calculated.

9.3.3.1 Per cent of total intake from home and 'away from home' places of purchase

Table 9.11 to Table 9.13 show the mean per cent of the total intake of energy and nutrients from child's home and from all 'away from home' places of purchase together, for boys and girls (Table 9.11) and by social group (Table 9.12 and Table 9.13).

Foods obtained outside the home provided an important contribution to the total intake of energy and all nutrients for these children (Table 9.11). Girls obtained more food energy than boys (girls 33%, boys 29%) from food sources outside the home. 'Away from home' food sources also contributed 36% of girls' total sugars intake (32% for boys) and 41% of girls' non-milk extrinsic sugars intake (36% for boys) but no more than 30% of total protein, unavailable carbohydrate, non-starch polysaccharide, calcium, iron, vitamin C and retinol equivalent intakes for both boys and girls (Table 9.11).

Table 9.12 and Table 9.13 show the mean per cent of total intake from home and 'away from home' food sources by social group for boys and girls. Foods purchased outside the home contributed a slightly higher percentage to the total energy, calcium, iron, unavailable carbohydrate and retinol equivalent intake of boys from the low social groups compared with the boys from high social group (Table 9.12). For girls no consistent social group trend was apparent (Table 9.13).

The National Food Survey (Ministry of Agriculture, Fisheries and Food, 1990), as previously discussed (section 2.3) is confined to foods eaten at home and excludes certain foods items entirely. National food surveys have assumed firstly, that food eaten at home represents at least 85-90% of total food intake and, second, that patterns of consumption outside the home are similar to those at home (Derry and Buss, 1984). In the past, these assumptions may have been valid. However, the findings presented above indicate that, at least for 11 to 12-year old children, this is no longer true - these children obtained approximately 30% of their total energy intake outside the home. A survey of the dietary intake of these children using the methods used in the national food survey would have recorded only 70% of their total energy intake. The second assumption is also shown not to be true for these children - nutrient composition of foods purchased outside the home differed substantially from those at home. The extreme examples would be, first, that of non-milk extrinsic sugars of which, for girls, the national food survey would have recorded only 59% of the total intake and, second, that of retinol equivalent of which 77% would have been recorded (Table 9.11). In 1992, the National Food Survey is planned to record foods 'purchased' outside the home for the first time (section 2.3).

Loughridge et al. (1989) recorded the food bought outside the home by adults (aged 15-64 years). The closest comparable group to the children in our survey is the youngest age group (15-24 years) studied by Loughridge et al.. One hundred per cent of those studied in this young adult age group, obtained some food energy from outside the home during the 3-day recording period, but this fell to 91% of men and 83% of women when all adults (15-64 years) were considered. These values can be compared with 99% of the children in our survey, measured over 6 days during school term-time. For all adults studied by Loughridge et al., 'away from home' food contributed 25% energy (29-33% in our survey), 22% protein (22-27% in our survey), 26% total sugar (32-36% in our survey), and 17% of unavailable carbohydrate (23-27% in our survey). For children of school age, it is possible that the proportion of food purchased outside the home would vary, depending on whether a survey was conducted during term time or a holiday period. It may be that the proportion of food purchased outside the home would fall during holidays, although, it could be expected that a reduction in lunch-time food purchases would be, at least partially, compensated for by an increased intake from shop/cafe etc. In our survey, 62% of the days surveyed were schooldays, with weekends, holidays or sick-days (2%) accounting for 38% of the days surveyed.

9.3.3.2 Per cent of total intake from each place of purchase

Table 9.14 to Table 9.16 show the per cent of total intake derived from each place of purchase. As suggested from the absolute intakes (section 9.3.2.2) school meals and shop/cafe/tuck-shop are shown to be the largest 'away from home' food sources (Table 9.14). School meals provided 14% of total food energy for both boys and girls and a similar proportion of other nutrients, with the exception of vitamin C of which 18% came from this source. Food purchased by the children from the shop/cafe/tuck-shop 'place of purchase' contributed approximately 12% of the total energy, and only from 6 to 9% of protein, unavailable carbohydrate, non-starch polysaccharides, calcium, iron and vitamin C intakes and 3 to 4% of the total retinol equivalent intake. However, this place of purchase provided 18% of the total sugars intake and approximately 22% of the non-milk extrinsic sugars intake (Table 9.14).

Other homes were not a large source of food for these children. More girls than boys ate at this source - girls obtained more energy and nutrients and greater percentage of their total intake from this source (Table 9.14). This finding reflects a more food-orientated social behaviour in these 11 to 12-year old girls who frequently reported visiting each other's homes, eating and drinking with friends. The greater use of food in social situations by girls is also reflected in the larger proportion of girls eating at school tuck-shops and shop/cafe when compared with boys (Table 9.1). For both boys and girls 'other homes' provided a similar percentage of all other nutrients as for energy.

Some differences between social groups were apparent (Table 9.15 and Table 9.16). For boys in the high social group, school meals were more important and shop/cafe/tuck-shops less important, than for boys from the low social group (Table 9.15). Low social group boys obtained 16% of their total energy intake from shop/cafe/tuck-shop, whilst the same source provided high social group boys with only 8% of their mean energy intake. The reverse was true for school meals although the difference was less marked - high social group boys obtained a greater proportion of their total energy intake from this source (15%) than boys from low social groups (11%). Intake of other nutrients, fat and NME sugars followed this pattern. Although 16% of energy and 25% of non-milk extrinsic sugars were purchased from shop/cafe/tuck-shop by low social group boys, other places of purchase were more important as nutrient sources since only 9% of protein, 10% calcium, 12% iron and only 6% of retinol equivalent intake came from this source. For girls no consistent social group trends were apparent in intakes from shop/cafe/tuck-shop (Table 9.16); middle social group girls were the largest consumers from this place of purchase, obtaining 13% of their total energy intake along with 12% total fat intake and 21% NME sugars intake.

No social group trend was detected in the proportion of energy or nutrients obtained from 'other homes'; this source contributed approximately 6-9% of all nutrients in all social groups for girls, significantly more than for boys (2-6%).

The percentage of total intake obtained from each place of purchase shows not entirely unexpected results: home foods provided approximately 70% of energy but more than 70% protein, calcium, iron and retinol equivalent. School meals provided about 14% of total energy intake with slightly higher proportions of fat and lower proportions of non-milk extrinsic sugars. Foods bought at shops/cafe/tuck-shop are important as energy sources, providing approximately 11% and a similar percentage of fat, along with larger proportions of total and non-milk extrinsic sugars (approximately 18% and 22% respectively) but lower proportions of other nutrients (8% of calcium and iron) (Table 9.14).

9.3.4 Nutrient density of food from each place of purchase

In this analysis the mean nutrient density of each nutrient, for each child, from each place of purchase, was first calculated before the mean nutrient density for the group from each place of purchase could be determined. Therefore, it was necessary to consider only those children who obtained any food from each place of purchase, that is non-consumers were excluded. As a consequence, the total number of children in each group varies slightly from previous analysis described above (sections 9.3.2 and 9.3.3). The number of children obtaining any food from each of the places of purchase is given as a footnote in Figures 9.1 to 9.8.

9.3.4.1 Nutrient density of food fromn home and 'away from home' places of purchase

Nutrient density (nutrient/MJ) provides a measure of the quality of the diet which is independent of energy intake, and allows the quality of the diet obtained from each 'place of purchase' by boys and girls from each of the social groups to be assessed independently of the varying energy intakes obtained from these sources by each sex and social group. Table 9.17 shows the mean nutrient density of the food obtained from home and from all 'away from home' food sources by boys and girls. When all 'away from home' foods are grouped together, they have a lower nutrient density for protein, calcium, iron, vitamin C, retinol equivalent, unavailable carbohydrate and non-starch polysaccharides and a higher nutrient density of fat, carbohydrate, total sugars and non-milk extrinsic sugars than food 'purchased' from home. Foods obtained outside the home by these adolescents were higher in fat and sugar and lower in nutrients than foods from the home.

Table 9.18 and Table 9.19 show the nutrient density of home and 'away from home' foods for boys and girls by social group.

Food obtained from the 'home' will be considered first, followed by foods obtained 'away from home'. In food obtained from 'home', boys had a significantly greater nutrient density of protein than girls (p=0.01) whilst girls had higher nutrient density for both total sugars (p=0.008) and non-milk extrinsic sugars (p=0.014) (Table 9.17). No other sex differences were apparent. When social group differences were considered (Table 9.18 and Table 9.19) high social group children had higher nutrient densities than the low social group children for protein (high social group boys 8.4g/MJ, low social group boys 7.5g/MJ) (p=0.0003), non-starch polysaccharides (p=0.01), calcium, iron (high social group boys and girls 1.57mg/MJ and 1.58mg/MJ respectively, low social group boys and girls 1.35mg/MJ and 1.38mg/MJ respectively) (p=0.03), vitamin C (high social group boys and girls 6.4mg/MJ and 9.6mg/MJ respectively, low social group boys and girls 5.7mg/MJ and 5.8mg/MJ respectively) (p=0.001). The nutrient density of total sugar also showed a social group trend from high to low social group, high social group children having a diet of greater density in total sugars than low social group children. Low social group children had a diet at home which had a higher density of fat although this was never greater than 1g/MJ difference (p=0.0004). This is reflected in the nutrient density of the total diet discussed in Chapter 6.

The nutrient density of the food obtained 'away from home' was similar for all children regardless of social group (Table 9.18 and Table 9.19). This suggests that the social group gradient in nutrient density of total diet, with low social group children having diets of lowest nutrient density, is due to differences in the food obtained at home and therefore primarily influenced by family food choices, rather than outside of the home where food choices may be more influenced by peer group than social group.

9.3.4.2 Nutrient density of food obtained from each place of purchase

The nutrient density of the food obtained from each place of purchase for boys and girls are shown in Figures 9.1 to 9.8. The nutrient density of the food obtained from each place of purchase was also analysed by sex and social group: these results have not been given as tables, but any significant results are reported below.

Foods from home and school meals were of a similar quality for both boys and girls, although the nutrient density of protein in foods from home was higher than school meals, and school meals provided a higher nutrient density of fat and a lower nutrient density of non-milk extrinsic sugars. Unavailable carbohydrate, non-starch polysaccharides, iron and retinol equivalent densities were lower than that of the home diet, though school meals did compare well with the food from home for calcium and vitamin C (Figures 9.1 to 9.8).

In food purchased from school meals, few sex and social group differences were significant, the exceptions being that the school meals consumed by girls had a higher nutrient density of iron (p=0.005) and of retinol equivalent (p=0.02) than those consumed by boys (difference in nutrient density of calcium did not reach significance). In addition, school meals obtained by low social group children had a slightly higher nutrient density of protein (p=0.003) and of calcium (p=0.04) than those consumed by children from the high and middle social groups.

Food from other homes and from shop/cafe/tuck-shop, provided a lower quality of diet. The density of all nutrients investigated were low from both of these sources particularly foods from shop/cafe/tuck-shop. Food from shop/cafe/tuck-shop places of purchase provided a marginally lower density of fat (9.5g/MJ and 9.6g/MJ for boys and girls respectively) compared with 10.4g/MJ and 10.6g/MJ from home (Figure 9.1), but a considerably higher density of total and non-milk extrinsic sugars (approximately 26g/MJ compared with between 9g/MJ and 13g/MJ from home) (Figure 9.2). Nutrient density of protein, non-starch polysaccharides, calcium, iron, vitamin C and retinol equivalent from shop/cafe/tuck-shop were all low (Figures 9.3 to 9.8). This is in agreement with earlier findings (Table 9.14) that the percentage of energy from this place of purchase (11-12%) was not paralleled by the proportion of the other nutrients and was exceeded by the proportion of total and non-milk extrinsic sugars (section 9.3.3.2).

The nutrient density of food purchased from other homes showed no sex or social group differences.

In food purchased from shops/cafe/tuck-shop, there was no apparent difference in nutrient density between boys and girls. Low social group children had a higher nutrient density of fat (p=0.004) and of unavailable carbohydrate (p=0.013) than high social group children. This trend was particularly strong for boys - low social group boys had nutrient density of 10.4g of fat/MJ and 1.4g of unavailable carbohydrate/MJ compared with 8.4g of fat/MJ and 0.9g unavailable carbohydrate/MJ by boys from the high social group. This trend reversed in the nutrient density of both total sugars and non-milk extrinsic sugars - high social group children were found to have the highest nutrient density of sugars from this 'place of purchase'. Again this trend was more marked for boys - high social group boys purchasing food from shop/cafe/tuck-shop had a total sugars intake of 30.5g/MJ of which most was NME sugars (29.8g/MJ), compared with a total sugars intake of 22.8g/MJ and a NME sugars intake of 21.8g/MJ from this source by the boys from low social group families. For girls, no consistent social group trends were apparent; middle social group girls had lowest nutrient density of total and NME sugars in diet from this place of purchase. Low social group girls had higher nutrient density of vitamin C and lower nutrient density of calcium and retinol equivalent than girls from middle or high social groups.

Children from low social groups have been shown to have a total diet of lower nutrient density than children from the high social groups (Chapter 6), and a lower nutrient density in their diet obtained from home (section 9.3.4.1). This low nutrient density in the low social group children is further exacerbated for the low social group boys by the low nutrient density intake from shop/cafe/tuck-shop (which contributed 16% of the total energy intake of these low social group boys compared with 8% of the total energy intake of the high social group boys).

9.3.5 Mean nutrient intake and nutrient density from schoolday lunch-time food intakes from each place of purchase

9.3.5.1 Introduction

Schoolday lunch-time food purchases by the children was the most common time of food 'purchase' outside the home. Unless the child had lunch at home or had a packed lunch from home, then it could be assumed that the food selection was made by the child, without direct parental influence. It was considered worthwhile to investigate the nutrient intake and the nutrient density of the children's schoolday lunch-time meals from the available places of purchase.

9.3.5.2 Method

With the aim of investigating the nutrient intake from the various places of purchase available to the children at lunch-time - school meal, packed lunch, home or local shop/cafe - this analysis looked only at foods consumed by the children on schooldays. Only the largest energy source at each lunch-time, on each schoolday, for each child was included in this analysis. For example, if a child ate a school meal and then a confectionery item from a local shop, only the school meal would be included, since the shop was not the main 'place of purchase' of lunch.

9.3.5.3 Results and discussion

Table 9.20 shows the mean nutrient intake and nutrient density of a lunch-time meal from each of the possible 'places of purchase' available to the children. School meals were the highest source of protein, calcium, iron and vitamin C when compared with the other lunch-time food sources (Table 9.20). School meals also had the highest per cent of energy derived from fat. Lunches purchased from shop/cafe provided the lowest intake of protein, calcium, iron and retinol equivalent and were also highest in non-milk extrinsic sugars. Whilst school meals compared well with lunches provided by the child's home (either at home or as a packed lunch), lunches bought out of school at local shops/cafes provided a low nutrient intake which was also high in fat (although not as high in fat as school meals).

The mean energy content of the lunches purchased at the local shops or at school were similar (3.04MJ), whilst 'home' lunches were lower in energy (2.45MJ). The nutrient densities of school meals and 'home' meals were comparable - few differences in nutrient density were apparent. However, lunches purchased at shop/cafe had a low nutrient density of protein (4g/MJ compared with 7g/MJ from school), calcium (47mg/MJ compared with 96mg/MJ from school), iron (1.0mg/MJ compared with 1.3mg/MJ from school), vitamin C (5.3mg/MJ compared with 9.6mg/MJ from school) and retinol equivalent (14μg/MJ compared with 62μg/MJ from school) but a higher nutrient density of non-milk extrinsic sugars (11.3g/MJ compared with 7.7mg/MJ from school) (Table 9.20).

This analysis indicates that children who purchased their school lunch at a local shop rather than taking advantage of the school meal, or having lunch from home (either as a packed lunch or at home), had high energy intakes from their lunch, but had the lowest lunch-time nutrient intake. This finding supports the results of the national survey of 14 to 15-year-old's 'diets of British schoolchildren' (Department of Health, 1989a). In the diets of British schoolchildren survey the 14 to 15-year old girls eating low nutrient density lunches from shops/cafes failed to compensate for this poor intake at other meals, while boys obtaining lunch from this source compensated at later eating occasions.

Amongst the Northumbrian children in our survey, a high proportion stayed at school for lunch while fewer ate at local shops; this may be partially explained since two of the seven schools surveyed did not allow their children away from the school premises at lunch-time, leaving only the option of school meal or packed lunch.

The finding that children eating at local shops had a lower lunch-time nutrient intake is a cause for concern, since attendance at school meals nationally has fallen steadily over the last decade (Department of Education and Science, 1992). The shop/cafe 'place of purchase' was more popular amongst low social group children, fewer of whom had school meals. It has already been discussed that low social group children had diets of lower nutrient density at home, and this may be affected further by a low nutrient density lunch purchased from a shop or cafe.

9.4 Comment and summary

Several issues relating to food 'purchased' outside the home have been discussed in this chapter - this section will summarise briefly each aspect. New information on the food purchasing habits of children has been reported - food obtained outside the home has been shown to be important in the total dietary intake of these children. The quality of intake from each place of purchase varied considerably, some of this difference being related to the sex and social class of the children. This information, together with data presented in previous chapters, provides new evidence of the changing dietary habits of children and highlights the prospects for change to bring their diets into line with current dietary recommendations. Finally, the method used to collect the information on place of purchase will be discussed.

- **Extent of previously published data**

No previous published information was found on the place of purchase of food by children, data on both absolute amounts and per cent of total intake obtained 'away from home' has been reported in this chapter. For these adolescents foods purchased outside the home had a marginally greater relative importance to the total dietary intake than has been reported for adults (Loughridge et al., 1989; 25 per cent of total energy intake) or has been assumed by the National Food Survey (10-15 per cent of total energy intake) (Derry and Buss, 1984). 'Away from home' foods contributed a significant amount of energy (29-33 per cent) and nutrients or sugars (18-41 per cent) to the total dietary intake.

• **Critique of the method**

In this study 'place of purchase' rather than 'place of consumption' was chosen for investigation. Whilst place of consumption would reflect eating habits and food eaten outside the home, this would have included foods which had been prepared at home although eaten outside the home (for example, packed lunch). It is likely that such food would have been prepared by a 'parent' rather than the child and therefore, the child would have only partial control over the food choice. The aim in this study was to investigate the choices made by the children. This is an important distinction which should be clearly stated in future studies of 'away from home foods'.

The number of subjects in this study was 379. The smallest sub-group of subjects was for 'home not child's' at which 75% (281 children) children obtained some food over the 6 days surveyed. The poor nutritional quality of the food purchased at shop/cafe, particularly at lunch-time, calls for further investigation of a larger number of subjects - 53 such lunches were recorded in this study. This would doubtless increase if school policy allowed all the children to leave the school premises at lunch-time; this would have been likely if, as in the majority of Britain, these 11 to 12-year old children had been at secondary, rather than middle schools. It can concluded that this survey may have under-estimated the extent of eating outside the home for children of this age nationally.

The number of days surveyed for each child (6 days) and the type of day surveyed (school-day, weekend, holiday) should also be considered. It is likely that if the period of study had been extended then the proportion of children obtaining food from each place of purchase would have increased. The type of day surveyed may also have influenced the results of the study, since the place of food purchase would vary on different types of day. Of the 2274 days surveyed, 62% were schooldays and 36% were weekends or holidays - this can be compared with the full school week of 71% schooldays and 29% weekend days. The proportion of schooldays would be less than 71% if holidays were to be included in a survey period.

• **Food quality by place of purchase**

Foods purchased 'away from home' had a lower nutrient density of protein, calcium, iron, vitamin C, retinol equivalent, unavailable carbohydrate and NSP, and a higher nutrient density of fat and NME sugars, than foods 'purchased' at home.

The nutrient density of foods purchased from school meals compared well to that of home, whilst food from 'other homes' and shop/cafe was of a lower nutrient quality. Approximately 1MJ of energy was obtained from shop/cafe, 35% of which was derived from NME sugars (shop/cafe provided 26g NME sugars/MJ compared with 9-13g/MJ from home). The nutrient density of the food obtained from shop/cafe was low for all nutrients investigated; shop/cafe provided approximately 0.9mg of iron/MJ and 60mg of calcium/MJ compared with 1.50mg of iron/MJ and 99mg of calcium/MJ in the food obtained from home.

• **Influence of sex and social group**

The higher total energy intake by boys was found to be due to diet at home, girls had a higher energy intake than boys 'away from home' (2.73MJ compared with 2.47MJ). It was found that low social group children had diets of lower nutrient density at home than children from middle or high social groups. For both boys and girls from the low social group, 'home' diet was lower in protein, calcium, iron, vitamin C and retinol equivalent and higher in fat than that of children from the high social group (although high social group girls had a diet at home with the highest nutrient density of total sugars). Social group differences in nutrient intake and nutrient density of the total diet (Chapter 6) appeared to be due primarily to differences in the diet obtained from home, that is, diet potentially under the control of parents.

The nutrient density of the 'away from home' food was similar for all sex and social groups. It would seem that when making independent food choices, the nutrient content of food is not the main concern of children. Although the popularity of the 'away from home places of purchase' varied with sex and social group - low social group boys obtained more of their food energy from shop/cafe (1.47MJ, 16% of total energy intake) than boys from the high social groups (0.64MJ, 8% of total energy intake) - the children followed similar patterns as their peers at each place of purchase, regardless of social group or of eating behaviours/patterns taught at home. Some foods have particular importance for adolescents as 'peer foods' - confectionery, canned fizzy drinks, chips and crisps accounted for 28% of the total energy intake of these children (Adamson et al., 1992b). This finding suggests that parents have little control over food purchases made by this age group and so the children themselves would need to be the primary target of advice to facilitate any change in the foods purchased outside the home.

- **Prospects for change**

The strategy to influence change should be different depending on whether the aim was to change eating behaviour within the home - parent's/child's control, or outside the home - child's control. Home remains the main food source for these children (70 per cent of energy intake) and therefore should remain the primary target for change, since any changes made within the home will be likely to have the greatest effect on total diet. However, advice to change diet at home may be ineffective if other constraints apply. Food purchased into the home will be influenced by many factors which are beyond the scope of this thesis, but briefly these will include family preferences, financial constraints, cooking facilities and the education, cooking skills, time and desire to prepare food by the cook in the family.

School meals are available to most children and perhaps would provide a way of improving the nutrient density of the diets of the low social group children, since sex and social group differences in the school meals purchased by the children were few. This would depend on persuading children to take advantage of school meals rather than the local 'chip shop' at lunch-time, which in turn would have implications for the nutrition and pricing policies of school meals. School meals would need to compete with the 25 pence bag of chips from the local shops in both perceived value for money and attraction to the 11 to 12-year old. Further discussions of these issues are beyond the scope of this thesis - nutritional guidelines for school meals have recently been addressed by an expert group established by the Caroline Walker Trust (1992), and the implementation of its recommendations are currently being discussed by a Caroline Walker Trust expert panel.

If attempting to moderate fat or sugar intake, or indeed increase nutrient intake (calcium and iron), we need to know whether the highest proportion of fat or sugar is obtained from foods eaten at meal times (potentially under parental control) or from 'peer foods' or 'fun foods' which are eaten in a different context and not usually with parents. If 'peer foods' are not the main source of the high fat and sugar intakes then educational attacks targeting these foods may be not only ineffective but also detrimental since there is a strong identification with these foods. Foods with strong socialisation implications will be resistant to change and attempts to do so may lead to rejection of all 'nutrition education'.

Food choices made by the children from shop/cafe/tuck-shop are under the control of the children at the point of purchase. However more fundamental issues, such as food availability and advertising, need to be addressed before the children would be fully able to act on any recommendations to reduce fat and sugar intakes, and increase nutrient density of calcium and iron. The range of food choices available to children in the 'corner shops' adjacent to the schools were limited - sugar-free drinks, canned milk or fresh fruit were seldom stocked. School tuck-shops, a source of profit to the schools, were not immune to influence from food manufacturers. At the time of the study, in two of the schools, the children were sold a particular brand of crisps, in order to save the 10000 packets necessary to claim a new strip for the school football team. Whilst new alternative food products are now available in supermarkets, the corner shop and not supermarkets were the source of 'peer foods' by the children in this survey.

Table 9.1 Per cent of children obtaining any food energy from each place of purchase during the six days surveyed, by sex and social group.

Sex	Social group	Place of Purchase					
		Home	All 'away from home' sources	School meals	Home - not child's	School tuck-shop	Shop/cafe/other
	All	**100**	**99**	**75**	**74**	**12**	**92**
All children	High	100	100	79	75	7	88
	Middle	100	98	73	76	15	92
	Low	100	100	66	69	13	94
	All	**100**	**99**	**73**	**59**	**8**	**89**
Boys	High	100	100	77	60	2	83
	Middle	100	96	71	60	13	89
	Low	100	100	69	56	13	94
	All	**100**	**100**	**76**	**88**	**16**	**95**
Girls	High	100	100	81	90	12	94
	Middle	100	100	75	92	17	95
	Low	100	100	63	79	13	95

Table 9.2 Mean (s.e.m) daily energy, macronutrient, sugars and micronutrient intake from **'home'** and all **'away from home'** food sources, **by sex.**

Place of purchase	Sex (n)	Energy MJ	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Child's Home	Boys (184)	6.14 (0.12)	48.9 (1.0)	64.1 (1.5)	184.2 (4.0)	79.4 (2.4)	55.9 (1.8)	12.3 (0.3)	7.6 (0.2)	603.3 (17.7)	8.99 (0.23)	37.1 (1.8)	579 (51.8)
	Girls (195)	5.52 (0.12)	42.3 (1.0)	58.8 (1.5)	165.5 (3.8)	75.3 (2.3)	53.8 (1.8)	10.9 (0.3)	6.8 (0.2)	542.5 (14.8)	8.08 (0.3)	40.2 (2.3)	553 (39.8)
Away from home	Boys (184)	2.47 (0.98)	13.2 (0.6)	26.7 (1.1)	79.7 (3.3)	38.3 (2.1)	33.5 (1.9)	6.3 (0.2)	1.9 (0.1)	182.7 (8.8)	2.71 (0.11)	14.8 (1.1)	108 (8.6)
	Girls (195)	2.73 (0.11)	15.1 (0.7)	30.1 (1.3)	86.2 (3.6)	43.3 (1.9)	37.4 (1.7)	3.9 (0.2)	2.2 (0.1)	220.3 (10.1)	3.07 (0.1)	15.4 (1.0)	137 (7.6)

* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.3 Mean (s.e.m) daily energy, macronutrient, sugars and micronutrient intake from home, by sex and social group.

Sex	Social group (n)	Energy MJ	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Boys	High (70)	6.07 (0.19)	50.1 (1.6)	61.6 (2.3)	185.0 (6.5)	83.0 (4.0)	57.3 (3.1)	11.9 (0.5)	7.3 (0.3)	648.8 (29.5)	9.21 (0.37)	37.9 (2.6)	604.5 (103.9)
	Middle (56)	6.21 (0.21)	50.5 (1.9)	64.5 (2.6)	186.7 (7.2)	80.8 (4.4)	55.7 (3.2)	13.4 (0.8)	8.5 (0.5)	622.5 (36.3)	9.56 (0.46)	41.5 (3.7)	666.8 (104.5)
	Low (32)	6.46 (0.33)	47.5 (2.4)	71.4 (4.0)	189.1 (10.7)	77.8 (5.3)	58.1 (4.1)	11.9 (0.8)	7.1 (0.5)	561.5 (36.8)	8.59 (0.52)	36.3 (4.4)	515.7 (45.9)
Girls	High (67)	5.38 (0.21)	42.4 (1.6)	55.3 (2.3)	164.3 (7.1)	79.6 (4.5)	56.2 (3.7)	11.4 (0.5)	7.4 (0.4)	568.6 (27.8)	8.26 (0.41)	51.4 (5.2)	552.5 (53.0)
	Middle (60)	5.50 (0.24)	41.8 (2.0)	59.9 (3.0)	161.9 (6.7)	72.3 (3.6)	51.7 (2.8)	10.2 (0.5)	6.3 (0.4)	535.8 (26.1)	8.11 (0.67)	36.4 (3.7)	616.3 (102.6)
	Low (38)	5.82 (0.26)	43.5 (2.2)	63.0 (3.1)	174.3 (8.1)	79.5 (4.7)	58.0 (4.0)	11.4 (0.7)	7.0 (0.5)	546.7 (28.9)	8.01 (0.55)	32.5 (3.0)	468.7 (38.0)

* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.4 Mean (s.e.m) daily energy, macronutrient, sugars and micronutrient intake from **'away from home'** places of purchase, by sex and social group.

Sex	Social group (n)	Energy MJ	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* Sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Boys	High (70)	2.27 (0.15)	12.9 (1.0)	24.0 (1.6)	73.2 (5.1)	36.2 (3.0)	31.5 (2.7)	3.2 (0.3)	1.9 (0.2)	168.8 (14.4)	2.64 (0.19)	16.7 (2.0)	108.2 (16.6)
	Middle (56)	2.52 (0.20)	12.4 (1.0)	27.3 (2.2)	82.5 (6.9)	41.8 (4.7)	37.3 (4.5)	3.4 (0.3)	1.7 (0.2)	185.5 (16.7)	2.70 (0.21)	14.4 (2.2)	105.5 (14.1)
	Low (32)	2.73 (0.24)	14.7 (1.5)	29.8 (2.8)	87.0 (7.7)	40.2 (4.3)	34.6 (4.1)	4.4 (0.6)	2.1 (0.3)	196.1 (19.5)	2.93 (0.28)	12.6 (2.0)	106.2 (14.8)
Girls	High (67)	2.53 (0.18)	13.8 (1.1)	28.2 (2.1)	78.8 (5.4)	39.5 (2.8)	34.4 (2.5)	3.3 (0.3)	2.0 (0.2)	218.6 (17.8)	2.87 (0.20)	15.2 (1.5)	161.1 (14.4)
	Middle (60)	2.59 (0.21)	14.9 (1.4)	28.8 (2.5)	81.5 (6.5)	40.6 (3.3)	34.9 (3.0)	3.8 (0.4)	2.0 (0.2)	202.7 (17.6)	2.93 (0.23)	14.7 (1.7)	122.3 (14.2)
	Low (38)	2.54 (0.24)	14.2 (1.4)	27.4 (2.7)	82.0 (7.7)	41.3 (4.0)	35.3 (3.6)	4.1 (0.5)	2.2 (0.3)	197.4 (21.3)	2.90 (0.28)	16.2 (2.8)	113.8 (13.0)

* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.5 Mean (s.e.m) daily energy, macronutrient, sugars and micronutrient intake from **each place of purchase, boys only** (n=184).

Place of purchase	Energy MJ	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* Sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Child's home	6.14 (0.12)	48.9 (1.0)	64.1 (1.5)	184.2 (4.0)	79.4 (2.4)	55.9 (1.8)	12.3 (0.3)	7.6 (0.2)	603.3 (17.7)	8.99 (0.23)	37.1 (1.8)	576 (51.8)
School meal	1.17 (0.07)	7.4 (0.4)	13.4 (0.8)	34.4 (2.1)	11.5 (0.8)	8.3 (0.6)	1.8 (0.1)	1.1 (0.1)	103.9 (7.2)	1.44 (0.09)	9.7 (1.0)	71.2 (6.9)
Home-'not child's'	0.30 (0.04)	2.1 (0.3)	3.3 (0.4)	9.1 (1.1)	4.7 (0.6)	4.0 (0.6)	0.5 (0.1)	0.3 (0.05)	23.6 (3.1)	0.35 (0.05)	1.8 (0.5)	21.4 (3.8)
School tuck shop	0.01 (0.004)	0.03 (0.01)	0.2 (0.1)	0.4 (0.1)	0.3 (0.1)	0.3 (0.1)	0.02 (0.01)	0.01 (0.004)	0.5 (0.2)	0.01 (0.003)	0.03 (0.01)	0.06 (0.02)
Shop/cafe /other	0.99 (0.73)	3.7 (0.3)	9.8 (0.8)	35.8 (2.6)	21.8 (1.8)	20.9 (1.8)	1.2 (0.1)	0.5 (0.1)	54.7 (4.5)	0.91 (0.07)	3.3 (0.4)	15.0 (2.3)

* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.6 Mean (s.e.m) daily energy, macronutrient, sugars and micronutrient intake from **each place of purchase, for girls only** (n=195).

Place of purchase	Energy MJ	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Child's home	5.52 (0.12)	42.3 (1.0)	58.8 (1.5)	165.5 (3.8)	75.3 (2.3)	53.8 (1.8)	10.9 (0.3)	6.8 (0.2)	542.5 (14.8)	8.08 (0.28)	40.2 (2.3)	553 (39.8)
School meal	1.16 (0.07)	7.7 (0.5)	13.4 (0.8)	33.6 (1.9)	12.2 (0.7)	8.8 (0.5)	1.6 (0.1)	1.0 (0.1)	115.3 (7.7)	1.53 (0.09)	9.3 (0.9)	77.3 (5.6)
Home-'not child's'	0.56 (0.05)	3.6 (0.4)	6.2 (0.6)	17.3 (1.5)	9.2 (0.8)	7.5 (0.7)	0.9 (0.1)	0.6 (0.1)	43.6 (4.1)	0.64 (0.06)	2.6 (0.3)	38.5 (4.7)
School tuck shop	0.02 (0.04)	0.05 (0.01)	0.3 (0.1)	0.7 (0.1)	0.5 (0.1)	0.4 (0.1)	0.05 (0.01)	0.03 (0.01)	1.0 (0.3)	0.02 (0.004)	0.18 (0.07)	0.08 (0.03)
Shop/cafe/ other	0.98 (0.06)	3.9 (0.3)	10.2 (0.7)	34.6 (2.2)	21.6 (1.3)	20.6 (1.3)	1.3 (0.1)	0.6 (0.05)	60.2 (4.7)	0.88 (0.06)	3.3 (0.4)	21.2 (3.3)

* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.7 Mean (s.e.m) daily energy, macronutrient and sugars intake in total diet and from each place of purchase, by social group. Boys only.

Place of purchase	Social group (n)	Energy MJ	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g
	High (70)	8.34 (0.21)	63.0 (1.5)	85.6 (2.3)	258.2 (7.7)	119.3 (5.3)	88.7 (4.5)
All (total diet)	Middle (56)	8.73 (0.27)	62.9 (1.9)	91.8 (3.1)	269.1 (10.0)	122.6 (6.9)	92.9 (5.9)
	Low (32)	9.19 (0.29)	62.2 (2.3)	101.1 (3.5)	276.1 (10.4)	118.0 (6.0)	92.7 (5.7)
	High (70)	6.07 (0.19)	50.1 (1.6)	61.6 (2.3)	185.0 (6.5)	83.0 (4.0)	57.3 (3.1)
Home	Middle (56)	6.21 (0.21)	50.5 (1.9)	64.5 (2.6)	187.7 (7.2)	80.8 (4.4)	55.7 (3.2)
	Low (32)	6.46 (0.33)	47.5 (2.4)	71.4 (4.0)	189.1 (10.7)	77.8 (5.3)	58.1 (4.1)
	High (70)	1.28 (0.11)	8.0 (0.7)	14.7 (1.3)	37.8 (3.4)	12.1 (1.2)	8.8 (1.0)
School meals	Middle (56)	1.15 (0.14)	7.0 (0.9)	12.8 (1.6)	35.0 (4.3)	12.7 (1.7)	9.6 (1.3)
	Low (32)	0.98 (0.15)	6.4 (1.0)	11.5 (2.0)	27.6 (4.3)	9.4 (1.6)	6.2 (1.1)
	High (70)	0.35 (0.07)	2.3 (0.5)	3.6 (0.7)	10.8 (2.2)	6.2 (1.4)	5.3 (1.2)
Home 'not child's'	Middle (56)	0.30 (0.07)	1.8 (0.5)	3.5 (0.8)	8.9 (2.0)	4.3 (0.9)	3.7 (0.8)
	Low (32)	0.28 (0.07)	2.6 (0.8)	3.0 (0.8)	7.9 (1.9)	3.6 (0.8)	2.8 (0.7)
	High (70)	0.64 (0.07)	2.5 (0.4)	5.7 (0.8)	24.6 (2.7)	18.0 (2.2)	17.4 (2.1)
Shop/cafe/tuck-shop	Middle (56)	1.07 (0.15)	3.6 (0.5)	11.1 (1.7)	38.6 (5.6)	24.8 (4.3)	24.0 (4.3)
	Low (32)	1.47 (0.22)	5.7 (1.0)	15.3 (2.4)	51.5 (7.7)	27.2 (4.4)	25.6 (4.2)

* Non-milk extrinsic sugars

Table 9.8 Mean (s.e.m) daily energy, macronutrient and sugars intake in total diet and from each place of purchase, by social group. Girls only.

Place of purchase	Social group (n)	Energy MJ	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g
All (total diet)	High (67)	7.91 (0.22)	56.2 (1.5)	83.3 (2.5)	243.1 (7.6)	119.1 (4.8)	90.6 (4.1)
	Middle (60)	8.09 (0.23)	56.7 (1.7)	88.7 (3.0)	243.4 (6.9)	112.9 (4.2)	86.5 (3.6)
	Low (38)	8.36 (0.30)	57.8 (2.3)	90.4 (3.5)	256.2 (10.2)	120.7 (6.2)	93.2 (5.7)
Home	High (67)	5.38 (0.21)	42.4 (1.6)	55.3 (2.3)	164.3 (7.1)	79.6 (4.5)	56.2 (3.7)
	Middle (60)	5.50 (0.24)	41.8 (2.0)	59.9 (3.0)	161.9 (6.7)	72.3 (3.6)	51.7 (2.8)
	Low (38)	5.82 (0.26)	43.2 (2.2)	63.0 (3.1)	174.3 (8.1)	79.5 (4.7)	58.0 (4.0)
School meals	High (67)	1.16 (0.11)	7.0 (0.7)	13.7 (1.3)	33.8 (3.1)	12.0 (1.2)	9.4 (1.0)
	Middle (60)	1.01 (0.11)	6.9 (0.9)	11.5 (1.3)	29.0 (3.2)	10.7 (1.2)	7.6 (0.8)
	Low (38)	1.04 (0.15)	7.2 (1.1)	11.6 (1.8)	30.4 (4.5)	11.1 (1.7)	7.8 (1.2)
Home 'not child's'	High (67)	0.51 (0.07)	3.1 (0.5)	5.6 (0.8)	15.9 (2.2)	8.9 (1.3)	7.4 (1.1)
	Middle (60)	0.55 (0.10)	3.5 (0.8)	6.0 (1.1)	16.9 (2.8)	8.9 (1.4)	7.3 (1.2)
	Low (38)	0.59 (0.13)	3.8 (1.0)	6.7 (1.6)	17.6 (3.6)	8.5 (1.6)	6.6 (1.3)
Shop/cafe/tuck-shop	High (67)	0.85 (0.12)	3.8 (0.6)	8.9 (1.3)	29.1 (3.7)	18.6 (2.1)	17.6 (1.9)
	Middle (60)	1.04 (0.12)	4.4 (0.6)	11.3 (1.4)	35.6 (4.2)	21.1 (2.4)	20.0 (2.3)
	Low (38)	0.91 (0.12)	3.2 (0.6)	9.1 (1.3)	34.0 (4.6)	21.6 (3.1)	20.9 (3.0)

* Non-milk extrinsic sugars

Table 9.9 Mean (s.e.m) daily 'fibres' and micronutrient intake of total diet and from each place of purchase, by social group. Boys only.

Place of purchase	Social group (n)	Unavailable carbohydrate g	NSP* g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
All (total diet)	High (70)	15.1 (0.5)	9.2 (0.4)	817.7 (31.9)	11.85 (0.42)	54.7 (3.7)	713 (105)
	Middle (56)	16.8 (0.8)	10.3 (0.5)	807.9 (40.7)	12.27 (0.49)	55.9 (4.2)	771 (106)
	Low (32)	16.3 (0.8)	9.2 (0.5)	757.6 (32.2)	11.54 (0.46)	48.9 (4.9)	622 (42)
Home	High (70)	11.9 (0.5)	7.3 (0.3)	648.8 (29.5)	9.21 (0.37)	37.9 (2.6)	605 (104)
	Middle (56)	13.4 (0.8)	8.5 (0.5)	622.5 (36.3)	9.56 (0.46)	41.5 (3.7)	667 (105)
	Low (32)	11.9 (0.8)	7.1 (0.5)	561.5 (36.8)	8.59 (0.52)	36.3 (4.4)	516 (46)
School Meals	High (70)	2.1 (0.2)	1.3 (0.1)	102.5 (10.9)	1.58 (0.15)	12.5 (1.8)	72.5 (11.0)
	Middle (56)	1.7 (0.2)	1.0 (0.1)	99.7 (13.5)	1.43 (0.19)	9.2 (1.8)	70.6 (14.0)
	Low (32)	1.4 (0.2)	0.8 (0.1)	99.2 (18.1)	1.20 (0.20)	5.9 (1.4)	53.3 (10.4)
Home 'not child's'	High (70)	0.5 (0.1)	0.4 (0.1)	24.9 (5.2)	0.43 (0.09)	2.4 (0.7)	27.4 (8.5)
	Middle (56)	0.5 (0.1)	0.3 (0.1)	23.7 (6.4)	0.34 (0.09)	1.9 (1.3)	19.4 (5.2)
	Low (32)	0.7 (0.3)	0.4 (0.2)	24.4 (6.1)	0.34 (0.11)	1.4 (0.6)	20.7 (6.6)
Shop/cafe/tuck-shop	High (70)	0.6 (0.1)	0.3 (0.1)	41.5 (5.6)	0.63 (0.09)	1.8 (0.4)	8.3 (2.1)
	Middle (56)	1.2 (0.2)	0.4 (0.1)	62.1 (10.5)	0.94 (0.12)	3.3 (0.5)	15.5 (4.0)
	Low (32)	2.3 (0.4)	0.9 (0.2)	72.5 (11.0)	1.38 (0.21)	5.3 (1.2)	32.1 (9.6)

* Non-starch polysaccharides

Table 9.10 Mean (s.e.m) daily 'fibres' and micronutrient intake of total diet and from each place of purchase, by social group. Girls only.

Place of purchase	Social group (n)	Unavailable carbohydrate g	NSP* g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
All (total diet)	High (67)	14.7 (0.5)	9.5 (0.4)	787.2 (31.0)	11.15 (0.38)	66.6 (5.4)	714 (57)
	Middle (60)	14.0 (0.5)	8.4 (0.3)	738.5 (26.0)	11.05 (0.63)	51.1 (3.8)	739 (102)
	Low (38)	15.5 (0.7)	9.2 (0.5)	744.1 (33.2)	10.92 (0.48)	48.7 (3.8)	583 (37)
Home	High (67)	11.4 (0.5)	7.4 (0.4)	568.6 (27.8)	8.26 (0.41)	51.4 (5.2)	553 (53.0)
	Middle (60)	10.2 (0.5)	6.3 (0.3)	535.8 (26.1)	8.11 (0.67)	36.4 (3.7)	616 (102.6)
	Low (38)	11.4 (0.7)	7.0 (0.5)	546.7 (28.9)	8.00 (0.55)	32.5 (3.0)	469 (38.0)
School meals	High (67)	1.6 (0.2)	1.1 (0.1)	107.4 (11.5)	1.52 (0.14)	9.6 (1.3)	90.2 (10.5)
	Middle (60)	1.4 (0.2)	0.9 (0.1)	101.2 (14.2)	1.30 (0.15)	8.4 (1.5)	58.4 (9.3)
	Low (38)	1.6 (0.3)	0.9 (0.2)	106.5 (17.3)	1.39 (0.21)	10.2 (2.6)	68.6 (12.4)
Home 'not child's'	High (67)	0.7 (0.1)	0.5 (0.1)	41.5 (5.8)	0.58 (0.09)	2.8 (0.7)	38.7 (8.0)
	Middle (60)	0.9 (0.2)	0.6 (0.1)	41.2 (8.1)	0.64 (0.12)	2.6 (0.6)	41.1 (9.8)
	Low (38)	1.1 (0.3)	0.6 (0.2)	44.5 (10.4)	0.67 (0.16)	2.3 (0.8)	35.8 (9.6)
Shop/cafe/tuck-shop	High (67)	0.9 (0.2)	0.5 (0.1)	69.8 (11.2)	0.78 (0.11)	2.8 (0.7)	32.2 (7.5)
	Middle (60)	1.4 (0.2)	0.6 (0.1)	60.3 (7.1)	0.99 (0.12)	3.6 (0.6)	22.8 (5.8)
	Low (38)	1.4 (0.3)	0.6 (0.1)	46.3 (6.7)	0.84 (0.12)	3.7 (0.8)	9.4 (3.3)

* Non-starch polysaccharides

Table 9.11 Mean (s.e.m range for all values¶) per cent of total intake of energy, selected nutrients and sugars obtained from 'Home' and 'Away from home' places of purchase, by sex.

Place of purchase	Sex (n)	Energy	Protein	Fat	Carbohydrate	Total sugars	NME* sugars	Unavailable carbohydrate	NSP**	Calcium	Iron	Vitamin C	Retinol equivalent
Child's home	Boys (184)	71	78	71	70	68	65	77	79	76	76	72	82
	Girls (195)	67	73	67	66	64	59	73	75	71	71	70	77
Away from home	Boys (184)	29	22	29	30	32	35	23	21	24	24	28	18
	Girls (195)	33	27	33	34	36	41	27	25	30	29	30	23

¶ Range of s.e.m of percentages given in Table = 0.9 - 1.6
* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.12 Mean (s.e.m range for all values¶) per cent of total intake of energy, selected nutrients and sugars obtained from 'home' and 'away from home' food sources by social group. Boys only.

Place of purchase	Social group (n)	Energy	Protein	Fat	Carbohydrate	Total sugars	NME* sugars	Unavailable carbohydrate	NSP**	Calcium	Iron	Vitamin C	Retinol equivalent
Child's home	High (70)	73	79	72	72	70	66	78	79	79	78	72	83
	Middle (56)	72	80	71	71	68	63	78	81	77	77	74	83
	Low (32)	70	76	70	68	66	64	73	76	73	74	74	79
Away from home	High (70)	27	21	28	28	30	34	22	21	21	22	28	17
	Middle (54)	28	20	29	30	32	37	22	19	23	23	26	17
	Low (32)	30	24	30	32	34	36	27	24	27	26	26	21

¶ Range of s.e.m of percentages given in Table = 1.5 - 3.6
* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.13 Mean (s.e.m range for all values¶) per cent of total intake of energy, selected nutrients and sugars obtained from 'home' and 'away from home' places of purchase, by social group. Girls only.

Place of purchase	Social group (n)	Energy	Protein	Fat	Carbohydrate	Total sugars	NME* sugars	Unavailable carbohydrate	NSP**	Calcium	Iron	Vitamin C	Retinol equivalent
Child's home	High (67)	68	75	67	67	66	61	76	77	72	73	74	76
	Middle (60)	68	73	68	67	65	61	73	74	72	71	68	78
	Low (38)	70	75	70	69	67	63	74	76	74	72	70	79
Away from home	High (67)	32	25	33	33	34	39	24	23	28	27	26	24
	Middle (60)	32	27	32	33	35	39	27	26	28	29	32	22
	Low (38)	30	25	30	31	34	37	26	25	26	28	30	21

¶ Range of s.e.m of percentages given in Table = 1.8 - 3.9
* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.14 Mean (s.e.m range for all values¶) per cent of total intake of energy, selected nutrients and total sugars obtained from each place of purchase, by sex (boys n=184, girls n=195).

Place of purchase	sex	Energy	Protein	Fat	Carbohydrate	Total sugars	NME* sugars	Unavailable carbohydrate	NSP**	Calcium	Iron	Vitamin C	Retinol equivalent
Child's home	Boys	72	78	71	70	68	65	77	79	76	76	72	82
	Girls	67	73	67	66	63	60	73	75	71	71	70	77
School meals	Boys	14	12	15	13	10	10	12	12	13	12	18	12
	Girls	14	14	16	14	11	11	11	12	15	14	17	13
Home 'not childs'	Boys	4	3	4	4	4	5	3	3	3	3	3	4
	Girls	7	6	7	7	8	8	6	7	6	6	6	7
Shop/cafe /tuck-shop	Boys	11	6	11	13	18	21	8	6	8	8	7	3
	Girls	12	7	11	13	18	22	9	7	8	8	8	4

¶ Range of s.e.m of percentages given in Table = 0.4 - 1.6

Table 9.15 Mean (s.e.m range for all values¶) per cent of total intake of energy, nutrients and sugars obtained from each place of purchase, by social group. Boys only.

Place of purchase	Social group (n)	Energy	Protein	Fat	Carbohydrate	Total sugars	NME* sugars	Unavailable carbohydrate	NSP**	Calcium	Iron	Vitamin C	Retinol equivalent
Home	High (70)	73	79	72	72	70	66	78	79	79	78	72	83
	Middle (56)	72	80	71	71	68	63	78	81	77	77	74	83
	Low (32)	70	76	70	68	66	64	73	76	73	74	74	79
School meals	High (70)	15	13	17	15	10	10	14	14	13	13	20	12
	Middle (56)	13	12	14	13	10	11	11	11	12	12	17	11
	Low (32)	11	10	12	11	9	8	9	9	13	11	14	11
Home 'not childs'	High (70)	4	4	4	4	5	6	4	4	3	4	4	4
	Middle (56)	4	3	4	3	4	4	3	3	3	3	3	4
	Low (32)	3	4	3	3	4	4	4	4	4	3	2	4
Shop/cafe/tuck shop	High (70)	8	4	7	9	14	18	4	3	5	6	4	2
	Middle (56)	12	6	11	14	18	22	7	5	8	8	7	3
	Low (32)	16	9	15	18	22	25	14	10	10	12	11	6

¶ Range of s.e.m of percentages given in Table = 0.5 - 3.6
* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.16 Mean (s.e.m range for all values¶) per cent of total intake of energy, nutrients and sugars intake obtained from each place of purchase, by social group. Girls only.

Place of purchase	Social group (n)	Energy	Protein	Fat	Carbohydrate	Total sugars	NME* sugars	Unavailable carbohydrate	NSP**	Calcium	Iron	Vitamin C	Retinol equivalents
Home	High (67)	68	75	67	67	66	61	76	77	72	71	74	76
	Middle (60)	68	73	68	67	65	61	73	74	72	71	68	78
	Low (38)	70	75	70	69	67	63	74	76	74	72	70	79
School meals	High (67)	15	13	17	14	11	12	12	12	14	14	16	13
	Middle (60)	13	12	13	12	10	10	11	11	13	13	16	10
	Low (38)	13	13	13	12	10	9	10	11	14	13	17	13
Home 'not childs'	High (67)	7	6	7	7	8	9	5	6	6	6	5	6
	Middle (60)	7	6	7	7	8	8	7	7	6	6	7	7
	Low (38)	7	6	7	7	7	7	7	7	6	6	5	7
Shop/cafe/tuck shop	High (67)	10	6	10	12	16	19	6	5	9	7	4	5
	Middle (60)	13	8	12	14	17	21	10	8	9	10	9	4
	Low (38)	10	6	10	12	16	21	9	7	6	8	8	2

¶ Range of s.e.m of percentages given = 0.6 - 3.9
* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.17 Mean (range of s.e.m for each nutrient¶) daily **nutrient density** (nutrient/MJ) of food obtained **from home** and **'away from home', by sex.**

Sex	Place of purchase	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g	Unavailable Carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Boys n=184	Home	8.1	10.4	30.0	12.7	9.0	2.0	1.2	98.1	1.50	6.1	94.8
	'Away from home'	5.3	10.7	32.8	16.5	14.7	1.4	0.73	74.9	1.10	5.9	40.7
Girls n=195	Home	7.7	10.6	30.0	13.6	9.7	2.0	1.3	99.3	1.48	7.4	104.4
	'Away from home'	5.4	10.9	32.1	17.2	15.1	1.4	0.78	78.9	1.13	6.3	50.4
Range of s.e.m		0.1	0.1-0.2	0.2-0.4	0.2-0.7	0.2-0.7	0.05	0.03	1.8-2.4	0.03	0.4	2.9-8.8

¶ Similar s.e.m for each nutrient from 'home' and 'away from home' were found, these have been given as a range at the foot of each column.

* Non-milk extrinsic sugars

** Non-starch polysaccharides

Table 9.18 Mean (range of s.e.m of each nutrient¶) **nutrient density** (nutrient/MJ) of food obtained from **'home'** and **'away from home'** food sources, **by social group. Boys only.**

Place of purchase	Social group (n)	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Child's home	High (70)	8.4	10.1	30.4	13.4	9.3	2.0	1.2	106.7	1.57	6.4	101.3
	Middle (56)	8.2	10.3	30.1	12.8	8.9	2.1	1.4	99.5	1.57	6.8	107.0
	Low (32)	7.5	11.0	29.1	11.8	8.9	1.8	1.1	86.1	1.35	5.7	78.2
'Away from home'	High (70)	5.5	10.4	33.1	17.6	15.8	1.4	0.79	73.0	1.11	7.0	40.8
	Middle (54)	4.8	10.9	33.3	17.5	15.9	1.4	0.67	77.7	1.13	5.5	39.2
	Low (32)	5.6	10.9	31.7	14.7	12.5	1.5	0.75	74.2	1.08	4.9	41.7
Range of s.e.m		0.2-0.3	0.2-0.5	0.4-0.8	0.4-1.3	0.4-1.3	0.1	0.04-0.1	3.2-5.2	0.04-0.09	0.4-1.0	4.6-18.7

¶ Similar s.e.m for each nutrient from 'home' and 'away from home' were found, these have been given as a range at the foot of each column.
* Non-milk extrinsic sugars
** Non-starch polysaccharides

Table 9.19 Mean (range of s.e.m of each nutrient¶) nutrient density (nutrient/MJ) of food obtained from 'home' and 'away from home', by social group. Girls only.

Place of purchase	Social group (n)	Protein g	Fat g	Carbohydrate g	Total sugars g	NME* sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Child's home	High (67)	8.0	10.3	30.3	14.4	10.1	2.2	1.4	106.0	1.58	9.6	107.3
	Middle (60)	7.6	10.8	29.7	13.4	9.6	1.9	1.2	99.1	1.47	6.7	115.5
	Low (38)	7.5	10.8	30.0	13.6	9.8	2.0	1.2	95.3	1.38	5.8	80.1
'Away from home'	High (67)	5.2	11.0	31.8	16.9	15.0	1.3	0.79	82.9	1.13	6.9	61.8
	Middle (60)	5.6	10.9	32.0	16.8	14.9	1.4	0.77	75.8	1.15	6.3	46.0
	Low (38)	5.3	10.5	33.1	18.7	16.6	1.5	0.83	74.3	1.11	6.4	45.3
Range of s.e.m		0.2-0.3	0.2-0.3	0.4-0.9	0.4-1.6	0.4-1.7	0.1	0.04-0.1	3.1-3.9	0.03-0.11	0.6-1.2	5.2-22.7

¶ Similar s.e.m for each nutrient from 'home' and 'away from home' were found, these have been given as a range at the foot of each column.

* Non-milk extrinsic sugars

** Non-starch polysaccharides

Table 9.20 Mean (s.e.m) nutrient intake and nutrient density (per meal) from school day lunch-time places of purchase, boys and girls together (n=379).

Place of purchase (number of 'meals')	Energy MJ	Protein g	Fat g	Carbohydrate g	NME* sugars g	Unavailable carbohydrate g	NSP** g	Calcium mg	Iron mg	Vitamin C mg	Retinol equivalent µg
Absolute nutrient intakes											
School meal (279)	3.04 (0.05)	19.7 (0.3)	35.0 (0.6)	88.5 (1.5)	22.3 (0.7)	4.5 (0.1)	2.7 (0.1)	283.9 (7.9)	3.81 (0.1)	24.7 (1.4)	183.5 (8.0)
Shop lunch (53)	3.05 (0.15)	13.5 (0.9)	30.7 (1.7)	105.6 (6.4)	34.2 (5.3)	5.4 (0.4)	2.0 (0.2)	144.1 (13.2)	2.95 (0.2)	14.1 (2.0)	48.1 (10.8)
Home lunch (177)	2.45 (0.06)	17.5 (0.6)	28.7 (0.9)	69.8 (2.0)	21.8 (1.0)	5.3 (0.2)	3.2 (0.1)	211.5 (9.9)	3.05 (0.1)	14.1 (1.6)	178.4 (31.2)
Nutrient density											
School meal (279)	-	6.8 (0.1)	11.4 (0.1)	29.2 (0.2)	7.7 (0.2)	1.5 (0.04)	0.9 (0.02)	96.1 (2.3)	1.31 (0.02)	9.6 (0.6)	62.4 (2.9)
Shop lunch (53)	-	4.4 (0.2)	10.3 (0.4)	34.5 (0.9)	11.3 (1.6)	1.9 (0.2)	0.7 (0.1)	46.6 (3.4)	0.98 (0.04)	5.3 (1.2)	14.1 (3.1)
Home lunch (177)	-	7.3 (0.2)	11.4 (0.2)	29.0 (0.4)	9.1 (0.4)	2.3 (0.1)	1.4 (0.1)	87.3 (3.5)	1.29 (0.04)	6.5 (0.8)	71.3 (10.5)

* Non-milk extrinsic sugars
** Non-starch polysaccharides

Figure 9.1 Mean nutrient density (g/MJ) of **fat** from each place of purchase, for boys and girls*. Bars=1 s.e.m either side of mean.

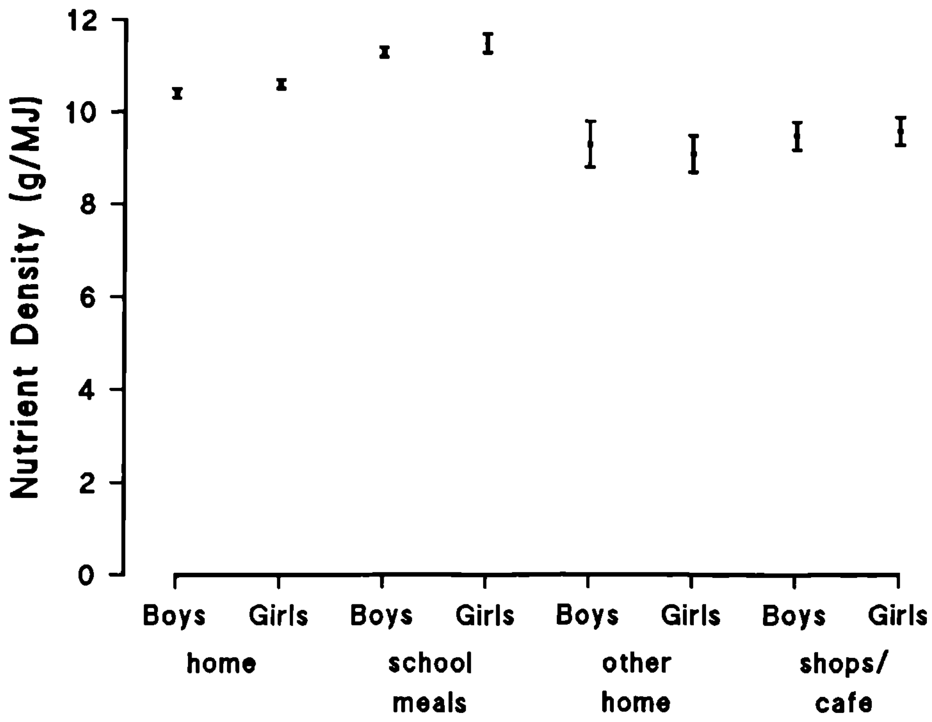
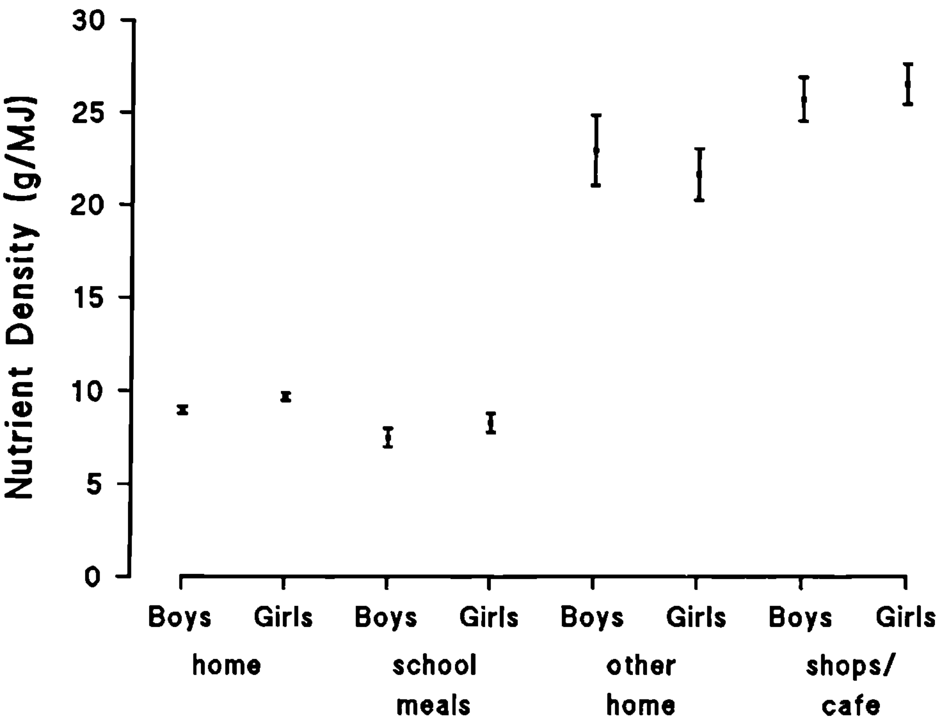


Figure 9.2 Mean nutrient density (g/MJ) of **non-milk extrinsic sugars** from each place of purchase, for boys and girls*.



* Number of subjects:
Boys: Home (184); School meals (135); Other home (109); Shop/cafe/tuck shop (164).
Girls: Home (195); School meals (149); Other home (172) and Shop/cafe/tuck shop (186)

Figure 9.3 Mean nutrient density (g/MJ) of **protein** from each place of purchase, for boys and girls. Bars=1 s.e.m either side of mean.

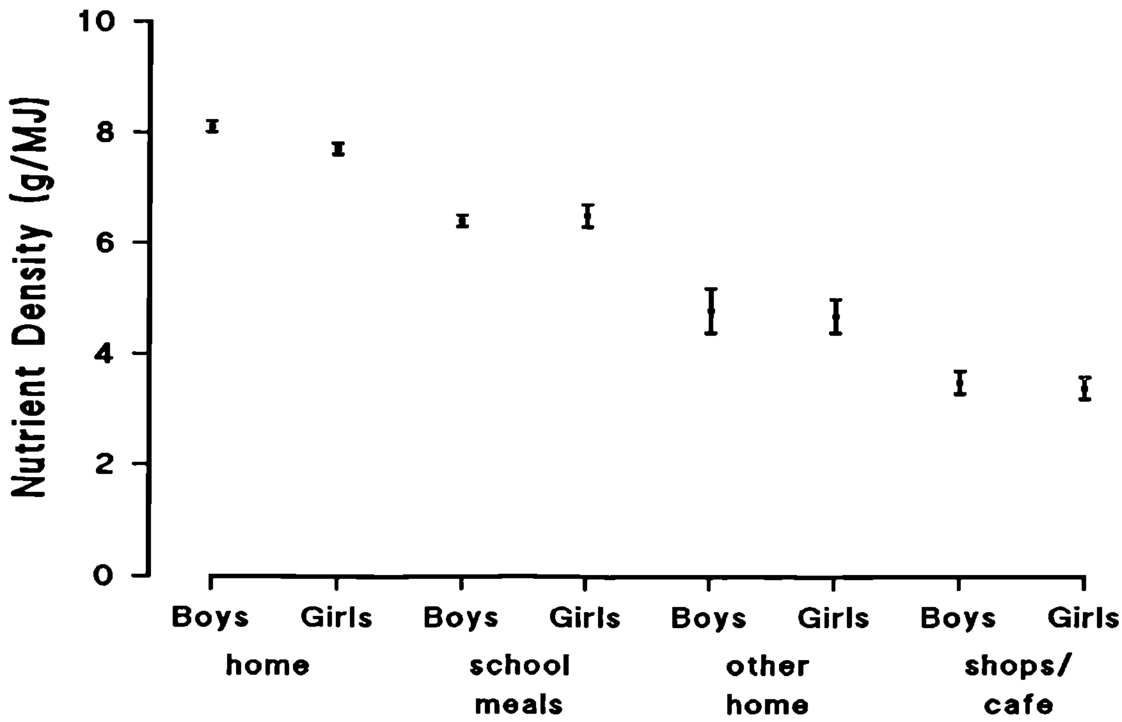
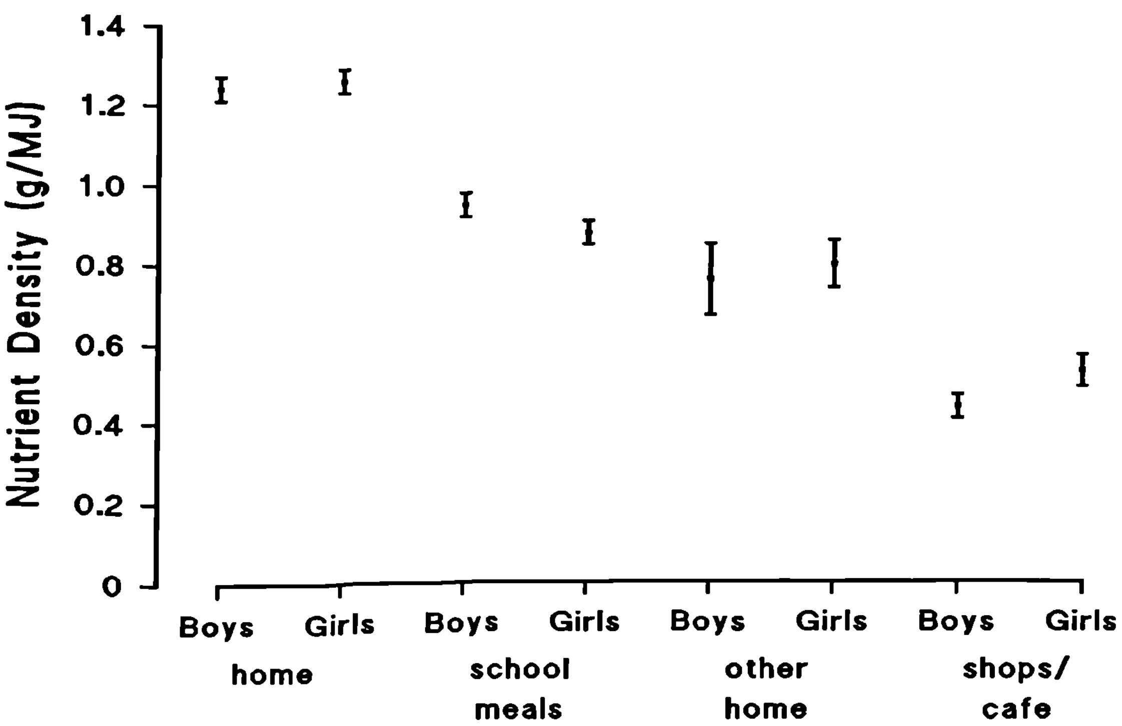


Figure 9.4 Mean nutrient density (g/MJ) of **non-starch polysaccharide** from each place of purchase, for boys and girls*.



* Number of subjects:
Boys: Home (184); School meals (135); Other home (109); Shop/cafe/tuck shop (164).
Girls: Home (195); School meals (149); Other home (172) and Shop/cafe/tuck shop (186)

Figure 9.5 Mean nutrient density (mg/MJ) of **calcium** from each place of purchase, for boys and girls*. Bars=1 s.e.m either side of mean.

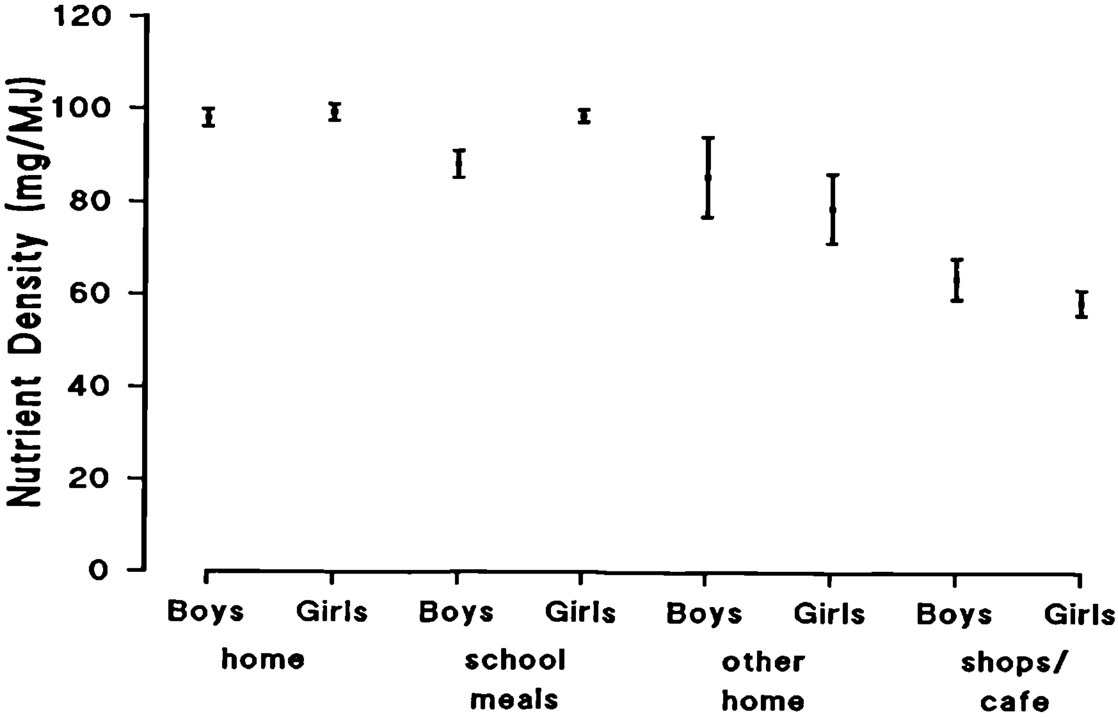
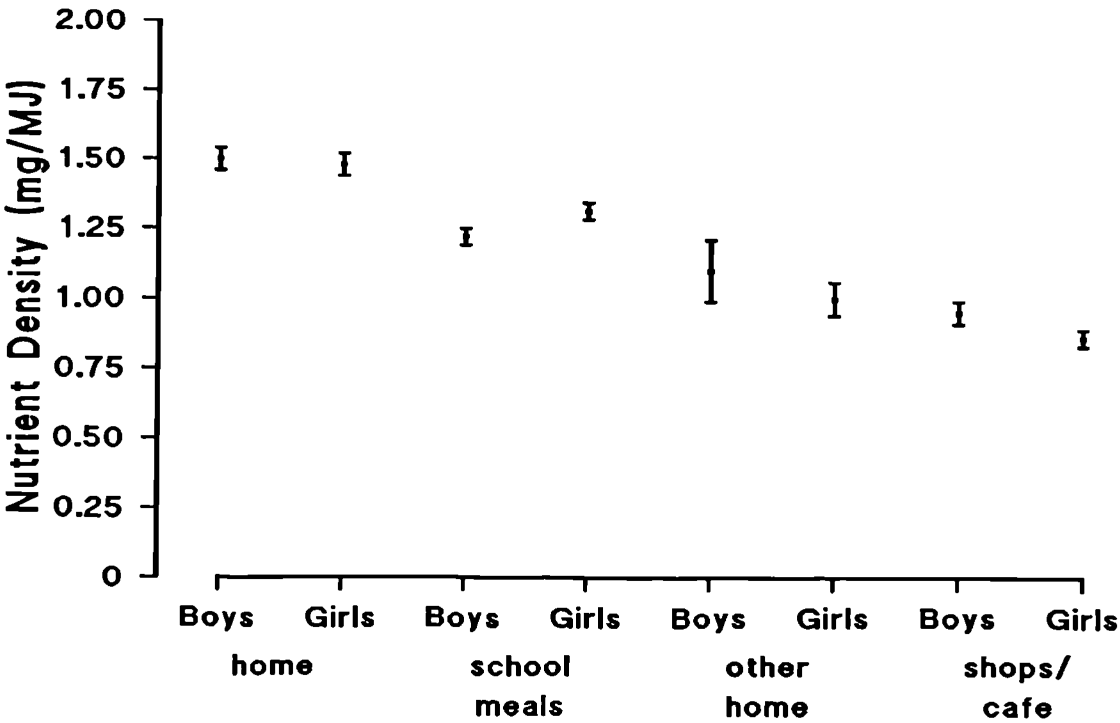


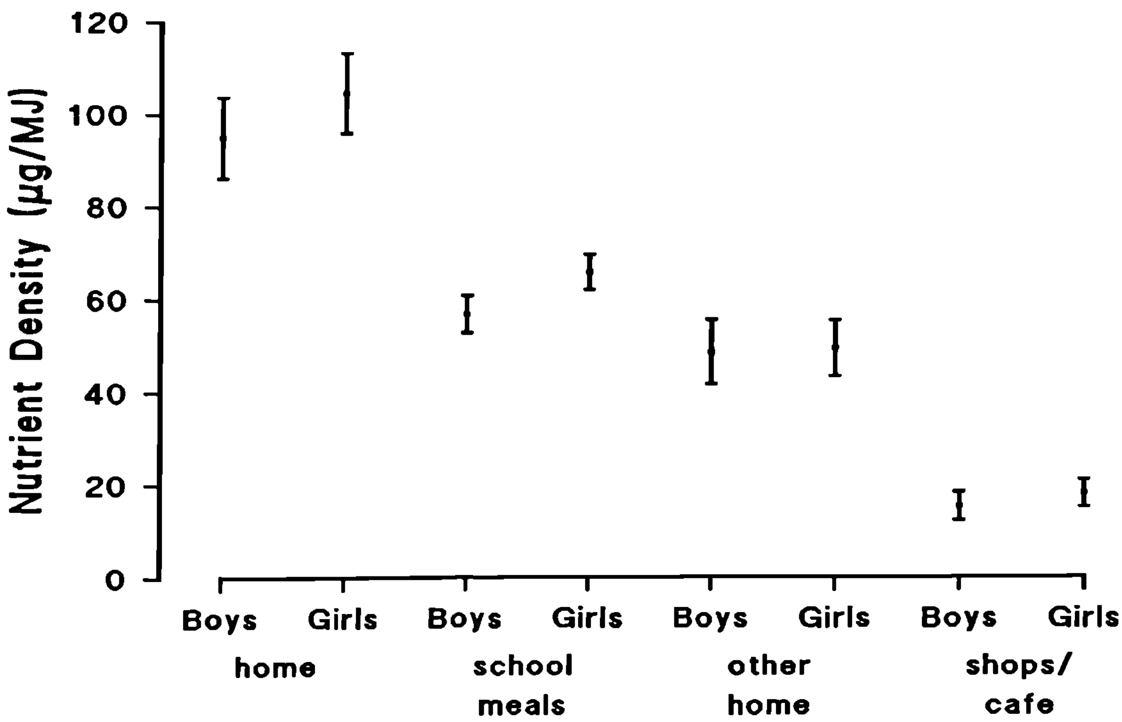
Figure 9.6 Mean nutrient density (mg/MJ) of **iron** from each place of purchase, for boys and girls*.



* Number of subjects:
Boys: Home (184); School meals (135); Other home (109); Shop/cafe/tuck shop (164).
Girls: Home (195); School meals (149); Other home (172) and Shop/cafe/tuck shop (186)

Figure 9.7 Mean nutrient density (mg/MJ) of **vitamin C** from each place of purchase, for boys and girls*. Bars=1 s.e.m either side of mean.

Figure 9.8 Mean nutrient density (µg/MJ) of **retinol equivalent** from each place of purchase, for boys and girls*.



* Number of subjects:
Boys: Home (184); School meals (135); Other home (109); Shop/cafe/tuck shop (164).
Girls: Home (195); School meals (149); Other home (172) and Shop/cafe/tuck shop (186)

Appendix 9.1

SUMMARY OF STATISTICAL ANALYSES

Analysis of variance was by linear models using GLIM (Baker and Nelder, 1978) (Appendix 6.1) to test the effect of sex and social group on nutrient intake and nutrient density from each 'place of purchase'. Chi-square test was used to detect trends in intake across the social groups. Tables 1 to 4 show the significant ($p<0.05$) differences between the nutrient intakes and nutrient density of intakes of boys and girls from each place of purchase and significant trends in intakes between high, middle and low social groups, from each place of purchase. The final test was to detect whether any trends between social group observed were consistent for both sex groups - absence of a significant result in the final column indicates that any social group trend detected was consistent for both boys and girls.

Table 1 Significant differences in nutrient intake in food obtained from home between boys and girls and between high, middle and low social groups.

Nutrient Nutrient density	Sex Boys Girls	Social group High Middle Low	Sex/Social group interaction*
Energy	0.001♂	–	–
Protein (g)	0.001♂	–	–
Protein (g/MJ)	0.01♂	0.001^{H}	–
Fat (g)	0.007♂	0.005^{L}	–
Fat (g/MJ)	–	0.001^{L}	–
Carbohydrate (g)	0.001♂	–	–
Carbohydrate (g/MJ)	–	–	–
Total sugars (g)	–	–	–
Total sugars (g/MJ)	0.008♀	0.01^{H}	–
NME sugars (g)	–	–	–
NME Sugars (g/MJ)	0.014♀	–	–
NSP (g)	0.04♂	–	–
NSP (g/MJ)	–	0.011^{H}	–
Calcium (mg)	0.007♂	–	–
Calcium (mg/MJ)	–	0.001^{H}	–
Iron (mg)	0.001♂	–	–
Iron (mg/MJ)	–	0.03^{H}	–
Vitamin C (mg)	–	0.02^{H}	–
Vitamin C (mg/MJ)	–	0.001^{H}	–
Retinol equivalent (µg)	–	–	–
Retinol equivalent (µg/MJ)	–	–	–

The direction of the trends are indicated by the superscripted symbols next to the significant p-values.

♂ Significant difference between boys and girls, boys having the higher intake

♀ Significant difference between boys and girls, girls having the higher intake

H Significant social group trend, the high social group children having the higher intake

L Significant social group trend, the low social group children having the higher intake

* Indicates a significant change in the effect of social group between boys and girls.

Table 2 Significant differences in nutrient intake in food obtained from **school meals** between boys and girls and between high, middle and low social groups.

Nutrient Nutrient density	Sex Boys Girls	Social group High Middle Low	Sex/Social group interaction*
Energy	–	–	–
Protein (g) Protein (g/MJ)	– –	– 0.003L	– 0.03
Fat (g) Fat (g/MJ)	– –	– –	– –
Carbohydrate (g) Carbohydrate (g/MJ)	– –	– –	– –
Total sugars (g) Total sugars (g/MJ)	– 0.04♀	– –	– –
NME sugars (g) NME Sugars (g/MJ)	– 0.03♀	– –	– –
NSP (g) NSP (g/MJ)	– –	0.01H –	– –
Calcium (mg) Calcium (mg/MJ)	– –	– 0.04L	– –
Iron (mg) Iron (mg/MJ)	– 0.005♀	– –	– –
Vitamin C (mg) Vitamin C(mg/MJ)	– –	– –	– –
Retinol equivalent (µg) Retinol equivalent (µg/MJ)	– 0.018♀	– –	– –

The direction of the trends are indicated by the superscripted symbols next to the significant p-values.

♂ Significant difference between boys and girls, boys having the higher intake

♀ Significant difference between boys and girls, girls having the higher intake

H Significant social group trend, the high social group children having the higher intake

L Significant social group trend, the low social group children having the higher intake

* Indicates a significant change in the effect of social group between boys and girls.

Table 3 Significant differences in nutrient intake in food obtained from **other home** between boys and girls and between high, middle and low social groups.

Nutrient Nutrient density	Sex Boys Girls	Social group High Middle Low	Sex/Social group interaction*
Energy	0.001♀	–	–
Protein (g)	0.022♀	–	–
Protein (g/MJ)	–	–	–
Fat (g)	0.001♀	–	–
Fat (g/MJ)	–	–	–
Carbohydrate (g)	0.001♀	–	–
Carbohydrate (g/MJ)	–	–	–
Total sugars (g)	0.001♀	–	–
Total sugars (g/MJ)	–	–	–
NME sugars (g)	0.002♀	–	–
NME Sugars (g/MJ)	–	–	–
NSP (g)	0.005♀	–	–
NSP (g/MJ)	–	–	–
Calcium (mg)	0.001♀	–	–
Calcium (mg/MJ)	–	–	–
Iron (mg)	0.007♀	–	–
Iron (mg/MJ)	–	–	–
Vitamin C (mg)	–	–	–
Vitamin C (mg/MJ)	–	–	–
Retinol equivalent (µg)	0.015♀	–	–
Retinol equivalent (µg/MJ)	–	–	–

The direction of the trends are indicated by the superscripted symbols next to the significant p-values.

♂ Significant difference between boys and girls, boys having the higher intake

♀ Significant difference between boys and girls, girls having the higher intake

H Significant social group trend, the high social group children having the higher intake

L Significant social group trend, the low social group children having the higher intake

* Indicates a significant change in the effect of social group between boys and girls.

Table 4 Significant differences in nutrient intake in food obtained from **shop/cafe/tuck-shop** by boys and girls and high, middle and low social groups.

Nutrient Nutrient density	Sex Boys Girls	Social group High Middle Low	Sex/Social group interaction*
Energy	–	$0.001^{L♂}$	0.003
Protein (g)	–	$0.04^{L♂}$	0.005
Protein (g/MJ)	–	–	–
Fat (g)	–	$0.001^{L♂}$	0.003
Fat (g/MJ)	–	0.004^{L}	–
Carbohydrate (g)	–	$0.001^{L♂}$	0.02
Carbohydrate (g/MJ)	–	–	–
Total sugars (g)	–	0.046^{L}	–
Total sugars (g/MJ)	–	0.012^{H}	–
NME sugars (g)	–	–	–
NME Sugars (g/MJ)	–	0.013^{H}	–
NSP (g)	–	$0.001^{L♂}$	0.006
NSP (g/MJ)	–	–	–
Calcium (mg)	–	–	0.003
Calcium (mg/MJ)	–	–	–
Iron (mg)	–	$0.002^{L♂}$	0.015
Iron (mg/MJ)	–	–	–
Vitamin C (mg)	–	$0.002^{L♂}$	–
Vitamin C (mg/MJ)	–	–	–
Retinol equivalent (µg)	–	–	0.001
Retinol equivalent (µg/MJ)	–	–	0.05

The direction of the trends are indicated by the superscripted symbols next to the significant p-values.

♂ Significant difference between boys and girls, boys having the higher intake

♀ Significant difference between boys and girls, girls having the higher intake

H Significant social group trend, the high social group children having the higher intake

L Significant social group trend, the low social group children having the higher intake

* Indicates a significant change in the effect of social group between boys and girls.

CHAPTER TEN

FINAL SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

This thesis has considered a number of aspects of the nutrition of adolescents. A review of the literature (Chapter 2) showed that the measurement of habitual diet is difficult and no one 'ideal' method exists by which to collect valid and reliable dietary data. Rather the advantages and disadvantages of each method must be considered, along with the age of subjects and the nature of information required (section 2.2). Information is available on the nutrient intake of the British population as a whole (section 2.3) and on several specific age groups. However, the number of dietary surveys on adolescents is small and only one repeated cross-sectional survey of adolescents in Britain had been reported to date - this being conducted in 1964 and 1971 by Durnin et al. (1974).

In recent years, public and media interest in diet and health has increased to unprecedented levels, media messages occasionally being over-simplified and sensationalist, leading to misleading or confusing information. Food manufacturers have been active in producing and promoting new products directed at the young and advertising messages have been strong. Since 1980, there has also been a change in school meal legislation (H.M. Government, 1980) removing statutory obligations for their nutritional content. Studies of the diets of adolescents have shown that, for some, particularly those from low social groups, there may be cause for concern, with dietary intakes falling short of contemporary recommendations (section 2.4). Changes in dietary intake have occurred over time - the most dramatic of which has been a fall in energy intake. Other changes have occurred - eating patterns of the population as a whole and of adults have changed, with an increase in food being 'purchased' outside the home (section 2.5). No information was found on the food purchasing habits and source of food for adolescents, an important age of growth and development, both physical and social, during which adequate nutrition is essential. Adolescence is also an important time to instill good eating habits which may persist into adulthood (section 2.6).

10.2 Summary and conclusions

From the review of the literature, a number of aims evolved (Chapter 3). This final chapter will examine the extent to which each of these aims has been accomplished and conclude by considering recommendations for action by various key organisations or groups. The main aim of the study was:

> **To measure the nutrient intake of a selected group of 11 to 12-year-olds in south Northumberland in 1990.**

This study measured the nutrient intake of three hundred and seventy-nine 11 to 12-year old children living in south Northumberland in 1990, using a repeated 3-day diary and interview. The results are reported and discussed in this thesis.

Energy composition of the children's diet was similar to that found in previous surveys - 40% energy was derived from fat and 48% from carbohydrate. It was also found that 17% of energy was derived from non-milk extrinsic sugars. As expected, boys consumed significantly more energy than girls and this was reflected in the intake of all other nutrients, although not in the intake of sugars.

Social group differences were detected - low social group children had a higher energy intake which was found to be due to higher intakes of fat and carbohydrate. Low social group children, both boys and girls, had lower intakes of calcium and vitamin C - although the mean intake of vitamin C of all groups exceeded requirements. Higher energy intakes and lower nutrient intakes by the low social group children were predictably reflected in the nutrient density of their diet. Low social group children had diets which had a lower nutrient density of protein, calcium and vitamin C and a higher nutrient density of fat than children from the high social group.

Fat and sugar (particularly NME sugars) intakes by these 11 to 12-year old children were high, whilst low calcium and iron intakes were also a cause for concern, particularly for the low social group girls. Dietary needs could be met by an increased energy intake with the same nutrient density, however, without a parallel rise in energy expenditure this would be likely to result in an increase in the number of children suffering from obesity. Alternatively, the nutrient density of the children's diet needs to be increased, either by increasing the nutrient density of the food obtained at shop/cafe/tuck-shop towards that of food 'purchased' at home, or increasing the nutrient density of foods 'purchased' at school, or increasing the nutrient density of the diet obtained by the children at home. The latter may not be realistic without supplementation of foods.

The study had the following subsidiary aims:

[1] **To compare the nutrient intake and the nutrient density of the diet of 11 to 12-year-olds in 1990, with that of children of the same age, attending the same schools, ten years earlier.**

The nutrient content and nutrient density of the intake of the children in 1990 has been compared with the nutrient intake and nutrient density of the diets of children of the same age, attending the same schools, ten years earlier (Chapter 6). This repeated cross-sectional study investigated change in nutrient intake over a ten year period, 1980 to 1990, and so allowed an assessment of the effectiveness of dietary related health education which has increasingly been part of the public domain over this decade. Since 1980, the Health Education Authority and others have been active in transmitting the conclusions and recommendations of the COMA panels (Department of Health and Social Security, 1984; Department of Health, 1989b), to the public.

No specific intervention was undertaken in the schools surveyed between 1980 and 1990, so that this study allowed the impact of general nutrition messages to be assessed, although it must be appreciated that it is not possible to know what the diet of these children would have been without the influence of nutritional health messages.

Energy intake by boys, but not girls, fell. The contribution of fat and total sugar to the energy intake of the children was unchanged at 40% and 22% respectively. Calcium intake by boys fell (to 786mg/day) but remained the same for girls (763mg). Some improvements in dietary intake were detected - intakes of iron, vitamin C and unavailable carbohydrate increased in both boys and girls. The nutrient density of the diet improved in all sex and social groups; however, a social group trend in nutrient density which had been detected in 1980 was still evident, with children from low social groups having the poorest-quality of diet.

[2] **To attempt a theoretical validation of the dietary diary and interview method, as used in the 1980 and 1990 surveys, by comparison of measured energy intakes with estimated energy expenditures of 11 to 12-year old children.**

The mean energy intakes measured for the boys and girls in 1990 have been compared with the estimated mean basal metabolic rate calculated from body weight (Chapter 7). Measured energy intakes were equivalent to 1.52 x BMR for boys and 1.59 x BMR for girls - these values of physical activity levels were found to be consistent with a normal moderately active life and similar to the physical activity levels reported by the Department of Health (1991) for children of this age group (boys 1.56 and girls 1.48).

[3] **To compare the nutrient intake measured in 1990, with the Dietary Reference Values (1991) for this age group in the United Kingdom.**

The nutrient intake and dietary composition of the children's diets in 1990 has been compared with the DRVs (Department of Health, 1991) for 11 to 14-year old children (Chapter 8). The EAR for energy was calculated from the measured body weight of the children, determining basal metabolic rate (Schofield et al., 1985) and assuming the physical activity levels for children of this age group given in the dietary reference value report. The mean energy intake by boys (8.61MJ) was below the EAR for energy (9.12MJ) whilst girls (8.25MJ) exceeded their EAR for energy (7.98MJ). The composition of the diet did not compare well with the dietary reference values; 40% of energy being derived from fat and 17% from NME sugars compared with DRVs of 35% of energy from fat and 11% from NME sugars.

There is some debate as to whether it is possible for the diet of individuals to meet the targets for a diet both low in fat and NME sugars, since studies of adults and children have shown that, without intervention, low sugar consumers tend to have higher intakes of fat (Gibney et al., 1989; Cade and Booth, 1990; Nicklas et al., 1992). For the Northumbrian children in 1990, confectionery accounted for approximately 11% of their total fat intake (an increase from 6% in 1980) and 33% of their total NME sugars intake (Adamson et al., 1992b). Replacement of some of this confectionery with high complex carbohydrate, low fat, low sugar alternatives would achieve a desirable reduction in the proportion of energy derived from both fat and NME sugar, and could also result in an increase in the nutrient density of calcium, iron and non-starch polysaccharides.

As an example of these possibilities, the dietary changes necessary to bring the diet of the 11 to 12-year-olds in this study into line with the dietary reference value for NME sugar are not large. Boys obtained 1.43MJ/day and girls 1.46MJ/day from NME sugars, which accounted for approximately 17% of total energy intake - this energy could be obtained from approximately 160g (or 4 slices) of bread. Just 1.5 slices of bread could replace sufficient energy from NME sugars to bring the proportion of energy from NME sugars down to 11% of energy, in line with the dietary reference value. Whilst this is a much over-simplification of the task, it is useful to demonstrate the food implications of nutrient targets.

Protein and vitamin C intakes were high - mean daily intakes being well in excess of the respective reference nutrient intakes. Calcium intakes were a cause of concern, particularly among the boys - 83% of boys and 66% of girls had calcium intake below the RNI. Mean iron intakes by boys exceeded the RNI whilst for girls the iron intakes were low - 90% of girls had mean iron intakes below the RNI.

The dietary reference values for each nutrient assume that the dietary requirements of all other nutrients are met. None of the children in this study met the EAR for energy whilst also meeting the targets for the proportion of energy derived from fat and NME sugars, and the RNI (or the EAR) for all the nutrients measured. Only 11% of boys and 4% of girls had a mean dietary intake which met the RNI for protein, calcium, iron, vitamin C and retinol equivalent together. These results suggest that some children may have been at potential risk of malnutrition, however, examination and biochemical investigation of individuals would be essential to confirm any dietary deficiency.

[4] **To determine the contribution to nutrient intake made by foods obtained outside the home in 1990 for these children and to compare this with (a) reports of the contribution to nutrient intake made from foods obtained outside the home by adults in the UK and (b) with assumptions made by the National Food Survey.**

Eating outside the home has been shown to be important in the diet of adults. This thesis has reported the importance of food outside the home for young adolescents for the first time - no previous study has investigated the importance of foods eaten outside the home by children, other than at school meals. At a time when national studies indicate a change in the eating behaviour of the nation and an erosion of traditional eating patterns, it is important to know the extent to which this has affected children. This study has given a baseline against which further surveys will be able to judge the changes in the food purchasing behaviour of children of this age group.

The contribution to the total diet of food 'purchased' outside the home for these 11 to 12-year old children is reported in this thesis (Chapter 9). Girls had a higher energy intake, both in absolute energy intake and as a proportion of total energy intake, 'away from home' than boys - boys and girls obtained 29% and 33% respectively of their energy intake outside the home. The proportion of other 'nutrients' obtained outside the home varied for boys from 35% of NME sugars to 18% of retinol equivalent, and for girls from 41% of total sugars to 23% for retinol equivalent. It was found that for these children food 'purchased' outside the home contributed a marginally greater proportion of total energy intake (29-33%) than had previously been reported for adults (25%) (Loughridge et al., 1989). These results show that eating outside the home is of greater significance to total dietary intake than has previously been assumed by the National Food Survey (Derry and Buss, 1984) and indeed, that the nutrient content of food 'purchased' outside the home differed significantly from food 'consumed' at home.

Social group inequalities were found in the diet obtained at home which was reflected in the total diet of these children (Chapters 6 and 9) - low social group children had a diet of lower nutrient density than children from higher social groups. In food purchased outside the home, no social group differences in nutrient density were detected, although there was a significant social group difference in the popularity of the different places of purchase. Targeting food purchased outside the home may be a way to affect children's total intake without the influence of any financial or family constraints which may apply at home - affecting eating behaviour outside the home, which may, in turn, influence food intake inside the home and influence eating habits into adulthood.

Truswell and Darnton-Hill (1981) reviewed dietary habits of adolescents and reported the views of a British sociologist, McKenzie (1976), who suggested that in future "food may be thought of as two groups, those for nourishment and those for fun". The 'fun foods' would not be part of meals and we need not concern ourselves with their nutritive value. In fact, it would be better if they had none. They should be fun to look at, have a nice taste and a good image". It is likely that these 'fun foods', in the present diets of adolescents, are those foods most often eaten 'away from home'. If this is the direction of eating patterns in the future, this has implications for the nutrient density of the food eaten at other times and from other places of purchase.

[5] **To investigate further the 'place of purchase' of food obtained outside the home by 11 to 12-year-olds, and the importance of each place of purchase to their total dietary intake. To compare the nutrient density of the foods obtained from each place of purchase.**

The dietary intake of the children has been analysed and reported by place of purchase (Chapter 9). School meals and shop/cafes were the largest 'outside the home' food source for these children, girls ate at 'other homes' more often than boys indicating more food related social behaviour in girls rather than boys. School tuck-shops were not an important source of food for these children.

Food obtained from home had the most desirable energy distribution (approximately 38% energy from fat and 15% energy from NME sugars) and the highest nutrient density of all the places of purchase. The nutrient density of the food obtained from school meals compared well with food obtained from home, school meals were lower in NME sugars (12% energy), protein, NSP, iron and retinol equivalent, but higher in fat (42% energy) and vitamin C with a similar nutrient density of calcium. Intake from 'other homes' was high in both fat (41% energy) and NME sugars (21% energy). Intake from shop/cafe/tuck-shop, although lower in fat (38% energy) was very high in NME sugars (34% energy) and had the lowest nutrient density of protein, NSP, calcium, iron, vitamin C and retinol equivalent.

[6] **To compare and report any significant differences between the intakes of boys and girls and between the intakes of high, middle and low social groups.**

Any significant differences in the dietary intake of boys and girls and of children from high, middle and low social groups have been reported in Chapters 6, 8 and 9.

In 1980, low social group children had been found to have diets of lower nutrient density than children from higher social groups; this was still found to be true in 1990. In both boys and girls, low social group children had the highest total energy intake and the lowest nutrient density for all nutrients measured (Chapter 6). In 1990, sex and social group differences in energy intake, nutrient intake and nutrient density appeared to be due primarily to the diet obtained at home (Chapter 9). Eating outside the home by these children showed few significant sex or social group differences, except that girls had higher energy and nutrient intakes outside the home than boys, and the shop/cafe 'place of purchase' was a more important energy source for boys from the low social group than from the high social group. When making their own food choices, children ate a diet similar to their peers, regardless of social class or of eating patterns taught at home - it is unlikely that this would be true for adults where it might be expected that the nutrient composition of diet outside the home would vary considerably with social group.

10.3 Comment

In order to be appropriate to the target population, health education messages intended to bring about a change in behaviour need to be based on knowledge of current behaviour and habits. The data presented in this thesis give information on three aspects relevant to health education:

- Change in nutrient intake by 11 to 12-year old children over a ten year period.

- Nutrient intake and energy composition of the diet of adolescents in 1990, which allows an assessment of aspects in the total diet which need to be considered in order to bring about desired changes - the results indicate that fat, NME sugars, calcium and, for girls, iron intakes need to be targeted for change.

- The 'place of purchase' of foods in the diet of these children has been reported. Information on the purchasing habits of these children and the importance of the various food sources in the total diet will allow dietary education to be targeted at the most appropriate food source, and indicate where change is likely to have the greatest impact. It has been shown that home is still the largest food source for these children, but that inequalities exist in the intake from home.

10.4 Recommendations

Recommendations for Government

- In order to be able to respond to health education, the individual must be able to understand the message and its implications. Whilst dietary targets may be set as nutrients, such as those of the dietary reference report and the 'Health of the Nation', those targets must be achieved by changes in the consumption of foods. Advice to reduce the total fat content of the diet to no more than 35% of total energy intake means little to most individuals and does nothing to facilitate change. Nutrition science and nutrient recommendations must be interpreted into recommendations for food choice.

- The healthy environment initiative of the 'Health of the Nation' should include food provision within schools, both in school meals (either as lunch or breakfast) and school tuck-shops, offering alternatives to the children from the limited choice available in local shops. A greater choice in quality foods available outside the home may help to address some of the social class inequalities which exist in nutrient density.

- School meals should be available to all children and ways of making the school meal an attractive alternative to the chip shop should be investigated. 'Healthy' school meals could be used as an education tool, with greater links between the science and health education taught at school and the food offered at lunch-time. The adoption of the nutritional guidelines for school meals (Caroline Walker Trust, 1992) would be an important step forward to bring into line practice in school catering with Government health promotion policy.

- Legislation to control labelling and the health and nutrient claims of products should be expedited, in addition to the Ministry of Agriculture, Fisheries and Food guidelines which currently exist. This would help to reduce the current confusion of the consumers and assist an informed choice.

Recommendations for health educators

- Health education messages intended to influence diet must be practical, positive and appropriate to the target population. Health education should continue to translate nutritional knowledge into simple and practical messages which are achievable by the general population.

- An increase in the intake of complex carbohydrate foods should be encouraged - parents should be encouraged to give more complex carbohydrate to their children. Health educators should continue to explode the widely held belief, which seems to have its roots in the 1960's, that starch makes you fat. Black (1990) suggested that the current emphasis of dietary advice was wrong - instead of advocating a reduction in fat and sugar intake, advice should focus on promoting bread and potatoes. If bread consumption increased, fat and sugar intakes would, in theory, be reduced automatically by appetite.

- The food and lifestyle habits acquired in childhood and early youth may be the habits of a lifetime. Considerable resources are being expended with the aim of reducing the fat content of the diet (Department of Health, 1992). If health education programmes are to be successful into the next generation, efforts should be focused now on changing the food habits and encouraging an increase in the physical activity of the young.

- The results presented in this thesis have shown the 'place of purchase' of food in the children's diets and has discussed the importance and nutritional quality of the food obtained from each source. From this, it is possible to determine the source of food which could be targeted for intervention to bring about favourable changes in the children's diet. Data of this nature will allow the health education messages to be specific and therefore more appropriate to the target population.

Recommendations for schools

- The individual must also be able to respond to dietary health education messages by having the basic nutritional knowledge and food preparation techniques needed. Practical, basic cooking skills are beginning to be lost (Price & Sephton, 1991). A survey in Newcastle (Ministry of Agriculture, Fisheries and Food, 1991a) used a food diary to explore meal patterns within households. It was found that 94 per cent of meals involved less than 10 minutes preparation time and 51 per cent involved no preparation time at all. Sixty-one per cent of meals needed no cooking and only 7 per cent of meals involved more than 20 minutes cooking time.

Basic food preparation should be part of the National Curriculum, combining science and nutrition with health education and translating this into domestic food preparation, ensuring that basic cooking skills are not lost, and as a way of introducing unfamiliar foods and new methods of food preparation to children. There is concern that basic cooking skills will no longer be taught at school with the intended change in the curriculum - "the approach to food will change from an emphasis on domestic to commercial production" (Department for Education, 1992). 'Healthy surroundings' part of the Health of the Nation initiative (Department of Health, 1992) includes schools - schools should promote healthy lifestyles and good nutrition not only through school meals but also through the curriculum.

- Introduction of 'healthy' school tuck-shops in line with the healthy school initiative of the 'Health of the Nation' offering snack foods to the children at competitive prices, but offering a choice - may provide funding for school equipment, such as new football strips, without encouraging the children to increase their intake of fat.

- Physical activity, both during and out of school hours should be encouraged and fostered. Increased physical activity may help to reduce the incidence of obesity in adolescence and so reduce morbidity in adulthood (Must et al., 1992). Increased energy expenditure, as a result of higher levels of physical activity, would allow an increase in food intake which may improve the total dietary intake of adolescents.

Recommendations for industry and marketing

- Foods available at the shops frequented by the children were limited - sugar-free drinks may be widely available in supermarkets but not in corner shops and cafe/chip shops where these children did their 'shopping'. Competitively priced items are needed to give children a choice.

- There should be an increase in the availability and attractiveness to the children of alternative snack foods already available. Many foods with a 'health image' are marketed at the adult consumer whilst children are targeted by the advertising of foods high in fat and sugar, with campaigns associating the products with fun and popularity.

Recommendations for research

- Murphy et al. (1993) found that for a group of Glasgow housewives, positive rather than negative messages enhanced persuasiveness which was reduced by use of technical language. The use of guilt-provoking messages did not enhance their persuasiveness. Similar information is needed on the acceptability of health messages to adolescents. It may be that for adolescents, coronary heart disease or osteoporosis prevention is irrelevant, whereas health, fitness and appearance may be more appropriate.

- There is a need for the development of new snack foods which are high in complex carbohydrate but low in fat and NME sugars, to increase the choice available to the adolescents and increase the nutrient density of their diet especially with regard to calcium and iron. This will need the co-operation of industry, food scientists, food manufacturers and those involved in dietary health education.

- Further research is needed into the acceptability of school meals to children - strategies to increase their appeal should be investigated.

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