A STUDY OF FOOD CONSUMPTION PATTERNS OF CHILDREN AND ADULTS IN IRELAND: IMPLICATIONS FOR THE DEVELOPMENT OF FOOD-BASED DIETARY GUIDELINES

By

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DECLARATION

This thesis is submitted by the undersigned to Trinity College, University of Dublin for the examination of the degree of Ph.D. The work herin is entirely my own, except where acknowledged and has not been submitted for a degree to any other university. The library may lend or copy this thesis upon request.

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SUMMARY

Food-based dietary guidelines (FBDG) are guidelines derived from nutrient targets which are translated into food-based guidelines so they can be adopted by the general population. In order for FBDG to be successful, they must be based on the prevailing food and nutrient intakes and set against the cultural context of the country for which they are being developed. The aim of this research was to construct and examine national food consumption survey databases for Irish adults and children for the purposes of examining food consumption patterns with a view to providing key information the formulation of FBDG.

Examination of staple foods in the diet is an obvious starting point for the development of FBDG. Chapter 2 details the intake of cereal and dairy products in Irish adults and their relative importance in the diet. Collectively, cereal and dairy products account for more than a third of energy intake. Dairy products also made important contributions to calcium and fat intakes, while cereal products made important contributions to carbohydrate, fibre, iron and folate intakes. Examination of nutrient intakes across tertiles of wholemeal bread, breakfast cereals, reduced fat milk and yoghurt showed that high consumers had better nutrient quality diets than low consumers of these foods or high consumers of white bread, cakes, pastries and buns, whole milk and cheese respectively. An example of FBDG that could be derived from this work could call for increased consumption of wholemeal bread, which could help decrease the percentage of energy from fat (by increasing the percentage of energy from carbohydrate) and increase intakes of iron, folate and fibre. Increasing the number of consumers, increasing the number of servings or serving size could achieve increased consumption. The substitution of wholemeal bread for white bread could also be encouraged.

The cultural context of food consumption, for the development of FBDG should include the time at which foods are consumed. Intakes of cereal and dairy products remained relatively constant over the course of the week. Examination of cereal and dairy intakes across time of the day revealed very distinctive meal and snack patterns. White and wholemeal bread, and full fat and reduced fat milk were consumed at morning, afternoon and evening times,

cakes, pastries and buns showed a snacking pattern throughout the day with no particular peak, whereas breakfast cereals showed a very definite morning peak. An example of FBDG could call for the increased consumption of breakfast cereals to improve fibre intakes. As they are mainly consumed in the morning, messages to increase consumption could be targeted later in the day. The different methodological and statistical issues in the temporal distribution of food intakes are also addressed in this thesis, which would provide much needed insight to the area for future researchers.

Chapter 4 describes the methodology used and main findings from the National Children's Food Survey. The main findings of public health importance are increased levels of overweight and obesity, inadequate fruit and vegetable intakes, fat intakes higher than recommended in 40% of the population, and inadequate calcium and folate intakes.

The location of food consumption also forms part of the cultural context of food consumption and so warrants examination for the development of FBDG. Seventy-seven percent of Irish children consumed foods outside the home, however the foods consumed outside the home accounted for only 6% of all eating occasions and 9% of the energy consumed (increasing to just 11% in consumers only). Outside the home, takeaways made the greatest contribution to energy and had the highest number of consumers. The main message to be derived from this work is that healthy eating guidelines should focus on the need to improve the diet in the home environment.

As temporal distribution of food intakes did not reveal any distinguishing patterns in Irish adults, the examination of food consumption patterns, broken down into meals and snacks was undertaken for children. Snacks contributed to 24% of energy intakes in the diets of Irish children, with afternoon and evening snacks playing a larger role in the diet than morning snacks. Small differences were observed between food and nutrient intakes from meals and from snacks, but no more than expected. Children in the highest quartile group for all eating occasions and for snacking had nutrient intakes which were very similar to mean population intakes, again indicating that increased frequency of eating or snacking was not problematic in this population. This work demonstrates there is no need for FBDG to specifically focus on snacks rather than meals, but to target improved food choices at all eating occasions.

This thesis has successfully provided evidenced based data on which to found health promotion strategies by demonstrating the potential uses of national food consumption survey databases in the development of culturally specific FBDG for Irish adults and children.

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ABBREVIATIONS

ANOVA	analysis of variance
BMI	body mass index
BMR	basal metabolic rate
CHD	coronary heart disease
CHO	carbohydrate
cm	centimeter
Cons	consumers
CSFII	Continuing Survey of Food Intake in Individuals (US)
CSO	Central Statistics Office (IRE)
DEFRA	Department for Environment, Food and Rural Affairs (UK)
DNSBA	Diet and Nutrition Survey in British Adults
EU	European Union
FAC	Food Advisory Committee (IRE)
FAO	Food and Agriculture Organisation
FBDG	food-based dietary guidelines
FFQ	food frequency questionnaire
FSAI	Food Safety Authority of Ireland
g	gram
h	hour
ICN	International Conference on Nutrition
INNS	Irish National Nutrition Survey
IRE	Ireland
IUNA	Irish Universities Nutrition Alliance
kcal	kilocalorie
kg	kilogramme
kJ	kilojoule
mg	milligramme
ml	millilitre
MJ	megajoule
n	number

NAG	Nutrition Advisory Group
NCFS	National Children's Food Survey (IRE)
NDNS	National Diet and Nutrition Survey (UK)
NFCS	Nationwide Food Consumption Survey (US)
NHANES	National Health and Nutrition Examination Survey (US)
NHIS	National Health Interview Survey (US)
ns	non significant
NSIFCS	North/South Ireland Food Consumption Survey (IRE)
NTD	Neural Tube Defect
p	probability
RDA	recommended daily allowance
SD	standard deviation
SPSS	statistical package for the social sciences
μg	microgram
UK	United Kingdom
US	United States
VERA	Verbundstudie Ernährungserhebung und Risikofaktorenanalytik
WHO	World Health Organisation
WISP	weighed intake software programme

PUBLICATIONS

The following publications have been derived from the work of this thesis:

Scientific Papers

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Abstracts

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SJ Burke, SN McCarthy, NA O'Dwyer, AJ Wallace, MJ Gibney (2002). Cereal intake in Ireland and its potential use for food-based dietary guidelines. *Proceedings of the Nutrition Society*, **61**(OCB): 87A

Chapter 1

Literature Review

1.1 FOOD AND NUTRITION POLICY

It is well established that diet is a contributing factor to many diseases of public heath importance such as coronary heart disease (CHD) and cancer. The promotion of good health, in particular through diet, is necessary to prevent these diseases. Effective public health nutrition strategies that aim to reduce the burden of disease should be derived from evidence-based nutrition policies.

1.1.1 Definition of food and nutrition policy

The Food Advisory Committee (FAC) of Ireland (1979) defined a food and nutrition policy as "a national strategy for improving the nutritional status of the population in a manner compatible with social, economic and cultural priorities". The World Health Organisation (WHO) also defined nutrition policy as "a concerted set of actions based on a government mandate, to ensure the health of the population through access to safe and adequate food" (WHO, 1988).

1.1.2 History of nutrition policy

Calls for comprehensive nutrition policies were made as early as 1937 by the League of Nations (Helsing, 1997). After the second World War, the United Nations shared the responsibility for nutrition between the Food and Agriculture Organisation (FAO) (whose responsibility is in relation to the production, distribution and consumption of food) and the WHO (whose responsibility is with the maintenance of health and the prevention of disease) (WHO, 1950). From the beginning, the joint FAO/WHO Expert Committee on Nutrition was concerned with "nutrition and degenerative diseases" (FAO/WHO, 1958) and in particular the role of fat and carbohydrate in the aetiology of certain cardiovascular and metabolic diseases (FAO/WHO, 1951). Even then, "planning of nutrition services" was seen as necessary in developed as well as developing countries.

During the 1960s, nutrition policy became part of development policies, as the emphasis moved away from chronic diseases, towards deficiencies and undernutrition. During this period, quantitative nutrition policies were developed to ensure that "the whole population has enough food, so that nutrient deficiency diseases are avoided". Simultaneously, qualitative nutrition policies were developed to ensure that "a proper balance of foods making up the food supply is achieved" (Helsing, 1997). However, it took some time for the concept of qualitative nutrition policy to be accepted. It was 1974 before the subject was raised at the World Food Conference. This led to the adoption of Resolution V by the conference which encourages all countries to 'formulate and integrate concerted food and nutrition plans and policies'. Almost two decades later, the International Conference on Nutrition (ICN) called for the dissemination of nutrition through 'sustainable food based approaches' (FAO/WHO, 1992), where nutrition policy is seen as a merger of quantitative and qualitative policies. And, in 1996, the report of a Joint FAO/WHO consultation was published on the Preparation and Use of Food Based Dietary Guidelines.

1.1.2.1 History of food and nutrition policy in Ireland

In 1979, the FAC published a report entitled "Considerations for a Food and Nutrition Policy in Ireland". In this report, they recommended that a body be set up at national level to formulate a "multi-sectoral nutrition policy" which would consider food supply, consumption patterns and health effects. Recommendations were also made for a national system for the continuous assessment of food and nutrition, the adequate staffing of institutional and community health services and nutrition education for schools and for the general public with high priority given to those training for medicine, dentistry and nursing (FAC, 1979).

In 1984, the FAC published another report with guidelines for those preparing advice for the general public on healthy eating. These guidelines were mainly quantitative. They recommended that: a varied diet, using a wide variety of foods, be consumed; ideal body weight be maintained by adjusting energy intake in relation to physical activity patterns; fat intake should not exceed 35% of total energy, with at least 3% of dietary energy in the form of essential fatty acids; dietary fibre intake should be between 22g and 35g per day; protein intake should be 1g/kg body weight/day; salt intake should be reduced to less than 9g/day; sugar intake be controlled to 10% of dietary energy and alcohol intake should not exceed 5% of total energy intake.

In 1995 the Nutrition Advisory Group (NAG) published recommendations for a food and nutrition policy for Ireland. They provided qualitative guidelines for the general population and special groups, namely babies, infants and toddlers, school children, adolescents, pregnant women, mature women and men, and older people. Qualitative guidelines were set because it was felt that there was inadequate information on nutrient intake or dietary change in Ireland to develop quantitative guidelines. Also, people have greater difficulty in understanding numeric targets. The guidelines proposed for the general population were: eat a wide variety of foods; balance energy intake with physical activity levels; eat plenty of fruit and vegetables (aim to eat at least four servings a day); starchy foods should be eaten daily (frequent consumption of foods containing sugar should be avoided, especially by children) and total fat intake should be reduced (with emphasis on reducing saturated fats).

1.1.3 Developing food and nutrition policies

It is recommended that the development of food and nutrition policies be a three-stage process: (Helsing, 1990a adapted from Nutrition Advisory Group, 1995). The three stages are defined as:

- problem definition and formulation of goals
- strategic planning based on these goals
- monitoring, evaluation and feedback.

Margetts *et al.* (2001) extended this process to a policy cycle. This policy cycle should begin with an evidence-based approach to identifying nutrition related health problems. From this a set of goals and objectives for the policy should emerge. A programme of work must then be established which should be implemented and evaluated. The results of the evaluation should be used by policy makers to revise the goals if necessary and the cycle should begin again.

1.1.4 Components of food and nutrition policy

The components of a national nutrition policy are shown in Table 1.1 (derived from Helsing, 1990a). The prerequisites for a food and nutrition policy are policy objectives and a 'Nutrition System'. A nutrition information system is needed to provide information on food and health at population and individual levels. It is necessary for convincing decision-makers about the importance of nutrition policies and for establishing objectives for the policy. It is also useful for monitoring the implementation of the policy when it has been established. Defining objectives for nutrition policy is necessary to set appropriate goals for food and health. This is usually done at three levels:

- the general level, expressing in general terms the desirability of a healthy dietary pattern
- the nutrient level where the desirable dietary pattern is described in terms of nutrients e.g. RDAs (recommended daily allowance)
- the food level, where desirable changes in the dietary pattern is described in terms of foods (Helsing, 1990b)

Table 1.1 Components of a national food and nutrition policy (derived from Helsing, 1990a)

Prerequisites	Nutrition policy objectives Nutrition information system
Food Quality	Food quality standards, fortification Food safety
Food Availability	Agricultural policy Food processing Prices, taxes and subsidies Mass catering Food trade
Knowledge	Professional training in nutrition Nutrition information to the public Nutrition labelling
Organisation	Co-ordinating body Advisory body Decision makers

Food quality relating to nutritional value and food safety is a major concern for the development of food and nutrition policies. Food fortification should be considered as one method of attaining nutrition policy objectives. A study by Cuskelly *et al.* (1999) shows that increasing the intake of folate rich foods does not attain the level of folate required to significantly reduce the risk of neural tube defects (NTDs), however increased intakes of foods fortified with folate does achieve this recommended level. This shows that fortification can play a role in improving food quality and could ultimately help achieve nutrient intakes as recommended by nutrition policy. Consumers today demand that the food they consume is of the highest standard. It is important that hazards such as food borne diseases and pesticides are monitored carefully so that consumers are not deterred from consuming certain foods (that nutrition policy tries to promote) because of food scares.

Food availability is another major component of food and nutrition policy which ought to be considered. This would include agricultural policy, food processing, prices, taxes and subsidies, mass catering and food trade. The food processing industry provides the population with a substantial amount of its food and as the industry has shown willingness to change their products, they should be involved in the development of food and nutrition policy. They could be encouraged to produce foods with e.g. lower fat or higher fibre content which would help the population attain nutritional goals for those nutrients. The adjustment of food prices, subsidies and taxes are ways in which food consumption has been affected by government. Price adjustment could be used in food and nutrition policy as a method of altering food consumption patterns e.g. in Norway, the price of skimmed milk is lower than that of full fat milk in an attempt to direct consumption (Downey, 1995). As eating outside the home is becoming more frequent, mass catering is another component of food and nutrition policy that should be addressed. Changes in the formulation of dishes (e.g. changes in the type or amount of fat) and changes in the process for heating and cooling foods could lead to improved nutritional quality of those foods consumed outside the home (Helsing, 1990b).

Knowledge of nutrition is another major component of food and nutrition policy and this involves professional training in nutrition, providing nutrition information to the public and understanding nutrition labelling. Nutrition education of health professionals other than those in the study of nutrition should be advocated, particularly for those studying medicine, dentistry and nursing. Nutrition information for the public is vital if the objectives of food and nutrition policies are to be achieved. Well-informed consumers will be able to choose more nutritious foods and achieve recommendations set out by food and nutrition policies. Well-informed, health conscious consumers are also more likely to demand healthier food choices from manufacturers. Proper nutrition labelling of foods is also very important so that consumers can make informed decisions about the foods they choose to buy (Helsing, 1990b).

The fifth and final component of Helsing's food and nutrition policy is organisation of the knowledge and components for the policy by the co-ordinating body. It is then the duty of the co-ordinating body to advise the government about establishing and implementing a national food and nutrition policy (Helsing, 1990b).

1.1.5 Food-based dietary guidelines

As discussed earlier, education of the public is a vital part of nutrition policy. This should take the form of health messages and guidelines for the general public and sub groups of the population most in need of specific guidelines. The ICN advised that "food-based approaches" be used for the promotion of public health nutrition messages (FAO/WHO, 1992). A joint FAO/WHO consultation took place in 1995 on the preparation and use of food-based dietary guidelines (FBDG). In their report, they discuss the rationale for developing and using FBDG (FAO/WHO, 1996).

1. Foods make up diets and are more complex than a collection of nutrients.
2. Nutrients interact differently when presented as foods.
3. Methods of food processing, preparation and cooking influence the nutritional value of foods.
4. There is good evidence that specific dietary patterns are associated with reduced risk of specific diseases.
5. FBDG could encourage increased consumption of foods with non-nutrient compounds e.g. flavanoids and phytoestrogens which may have health benefits.
6. Some food compounds may have biological functions that science has not yet identified.
7. Foods and diets have cultural, ethnic and social aspects that individual nutrients themselves do not have.
8. Higher than recommended intakes of certain nutrients may help lower the risk of non-communicable disease. FBDG can encourage dietary patterns to include these nutrients.

A review by Lichtenstein and Russell (2005) supports the view that foods and not single nutrients are related to dietary patterns. They demonstrate how single nutrient interventions have produced disappointing results using vitamin E and beta carotene as examples and suggest that other factors in food or the relative presence or absence of foods are more important than the level of the individual food consumed. This upholds the ICN suggestion that food-based approaches be used for the promotion of nutrition messages.

The FAO/WHO report also states that FBDG should be based on existing public health problems and should therefore be developed for each country individually (FAO/WHO, 1996). They present guidelines for developing successful FBDG:

1. Review diet related health patterns, diseases and mortality
2. Review food consumption patterns
3. Identify links between diet and health
4. Examine consistency with relevant national policies
5. Define the problem
6. Define the content of and target groups for FBDG
7. Define the purpose, goals and targets of the guidelines

In order for FBDG to be effectively implemented, they should be scientifically sound but also meaningful to the general public. They should be "short, simple, clear, easily remembered, culturally appropriate and communicated well through a variety of media" (FAO/WHO, 1996). The guidelines should be practical so that the general public will be able to use them. The recommended foods should be affordable, widely available and accessible. The guidelines should also be flexible and take account of different sub-groups of the population. The terminology used should be everyday language, food groups used should make sense to the public and visual aids should be easily understood.

Cultural acceptability of FBDG is also very important. Recommendations that go against religious beliefs or that propose radical changes to the whole diet will most likely be rejected. The language or dialect used or illustrations used for the presentation of FBDG could affect how readily they are accepted. Socio-demographic issues such as education level, geographical location and many more should also be considered when developing FBDG.

1.1.6 Eurodiet

In an attempt to marry all the concepts of FBDG highlighted above, the Eurodiet project was set up in 1998, with its objectives being "to contribute towards a co-ordinated European Union (EU) and member state health promotion program on nutrition, diet and healthy lifestyles by establishing a network, strategy and action plan for the development of European guidelines, which will provide a framework for the development of national food based dietary targets" (Eurodiet Core Report, 2001).

Although the aim of Eurodiet is to promote healthy diets and lifestyles throughout Europe, guidelines, for example FBDG, need to be developed and delivered at regional/national level, at least initially. Approaches to the practical development of FBDG were identified by the Eurodiet Working Party 2 (2001). These are:

1. Identification of major food sources of the nutrient of interest.
2. Identification of foods contributing to the intake of the target nutrient at population level. This should also be done for consumers of the food group and for quantiles of intake.
3. Identification of foods or food patterns discriminating opposite patterns of nutrient intakes (desirable versus undesirable). This can be done by comparing those in different quantiles of intake, comparing compliers with non-compliers, using discriminant analysis and/or using cluster/factor analysis.
4. Identification of key foods explaining variations in intakes between individuals and consumers/non consumers.
5. Formulation of FBDG into foods, portion sizes, frequency of intakes etc.

Nutrition education is vital to the success of nutrition policies. There is obviously a great need for more informed planning of nutrition policies through the use of food-based guidelines as demonstrated by the FAO/WHO and Eurodiet reports. The establishment of national food consumption databases are required for the development of FBDG, as they need to be based on the prevailing patterns of food and nutrient intake of the country for which they are being developed and be culturally appropriate and specific to the population.

1.2 ASSESSING FOOD AND NUTRIENT INTAKES FOR THE DEVELOPEMNT OF FOOD-BASED DIETARY GUIDELINES

FBDG should be based on existing public health problems such as obesity, osteoporosis and anaemia. The development of FBDG therefore commences with an examination of the diet to elucidate key discriminating factors associated with these diseases. The FAO/WHO (1996) stated that in developing effective FBDG, diet related patterns, disease and mortality should be reviewed and links between diet and health should be identified. National food consumption surveys can be used to identify public health concerns associated with food or nutrient intakes. It is also beneficial if these surveys include measures of obesity, physical activity, attitudes and health and lifestyle characteristics in the population. By including as many of these lifestyle and behaviour measurements as possible, more targeted, informed and holistic guidelines can be developed for the issue in question.

FBDG should commence with an examination of nutrient intakes in the population and compare these intakes with population goals that have been developed for the prevention of public health problems. One of the key goals for any population is 30% of food energy from fat (Eurodiet Core Report, 2001) which was set with the prevention of CHD in mind. Given that nutrients are consumed as foods, food intake patterns need to be assessed for the development of FBDG to encourage food consumption patterns to attain appropriate levels of that nutrient. The intakes of foods that are major sources of a nutrient of interest need to be identified, along with the foods that make the greatest contribution to nutrient intakes so that increased consumption of certain foods can be recommended to increase consumption of particular nutrients. The intakes of these foods need to be examined not only at a population level but also for consumers of the foods and to identify differences across people who are low or high consumers of the target food (Eurodiet Core Report, 2001).

Kearney *et al.* (2001) suggests that in considering the cultural context of food consumption, food intakes should also be examined in relation to when and where the foods are consumed. Section 1.3 of this review will deal with the temporal analysis of food consumption, while section 1.4 will deal with the role of the food service sector in the diet. Gibney & Wolever (1997) suggest that another aspect of the cultural context of FBDG extends to food consumption patterns within a country, particularly in the subject area of periodicity of eating. This area will be further examined in section 1.5 of this review by exploring snacking in the context of FBDG as a possible issue. In the ensuing sections, each of the studies are not discussed in individual detail, but rather are all discussed on a more broad scale. However, a summary for each of the studies discussed is presented in Table 1.2 for temporal analysis of food and nutrient intake; Table 1.3 for the role of the food service sector in the diet and Table 1.4 for the role of snacking in the diet.

1.3 TEMPORAL ANALYSIS OF FOOD AND NUTRIENT INTAKES

Examination of when foods are consumed is carried out by temporal analysis of food intakes which explores intakes of food over time of the day, day of the week, different months or different seasons. In order to formulate effective FBDG, the development of culturally specific guidelines should extend to the inclusion of when foods are consumed (Kearney *et al.*, 2001). Temporal analysis of nutrient intakes has been carried out to a certain extent but not in relation to the development of FBDG. There has been even less research on the temporal distribution of food intakes and again, not specifically for FBDG. Table 1.2 lists the studies that contain an aspect of temporal analysis.

1.3.1 Temporal analysis of nutrient intakes

In the published literature, temporal analysis of nutrient intakes covers intakes over day of the week, weekday versus weekend day, time of day etc. However, the temporal analysis of nutrient intakes has not been examined in relation to the formulation of FBDG. Knowledge of the temporal distribution of nutrient intakes could be used to demonstrate how a particular day of the week or time of the day could be helpful in promoting healthy eating guidelines through timed advertising campaigns e.g. alcohol intakes tend to increase at the weekend and in the evening time so messages to decrease alcohol intakes could be advertised at these times.

1.3.1.1 Nutrient intakes over day of the week

Nutrient intakes, in particular macronutrient intakes, have been found to vary over the course of the week. The majority of published data has demonstrated higher intakes of energy and macronutrients (in absolute terms) on weekend days rather than weekdays (Harrington, 2001, Maisey *et al.*, 1995, de Castro, 1991, Basiotis *et al.*, 1989, Thomson *et al.*, 1988, Richard and Roberge, 1982, Beaton *et al.*, 1979). However, when macronutrient intakes are expressed as a percentage of energy, the pattern is not so definite. Generally, increased alcohol consumption at the weekend affects the percentage of energy from other macronutrients but not in a consistent pattern (Haines *et al.*, 2003, Harrington, 2001, Maisey *et al.*, 1995, Tarasuk and Beaton, 1992, Thomson *et al.*, 1988). A significant day of the week effect for micronutrients has also been shown in some studies (Maisey *et al.*, 1995, Tarasuk and Beaton, 1992, de Castro, 1991, Richard and Roberge, 1982). These patterns have been found to vary according to sex and age group.

However, some studies did contradict these findings, Beaton *et al.* (1983) and Gibson *et al.* (1985) found no significant day of the week effect when nutrient densities were examined. St. Jeor *et al.* (1983) and Leverton and Marsh (1939) did not find any statistical differences across day of the week for nutrient intakes but did suggest that a day of the week effect exists. However, it is important to identify if a day of the week effect exists in order to effectively target nutrition guidelines.

1.3.1.2 Nutrient intakes over time of the day

Variation in nutrient intakes over the course of the day is also an important factor to elucidate patterns of nutrient consumption for the development of FBDG. Most of the studies that examined nutrient intakes over time of the day identified 3-meal peaks. The key difference between these studies is timing of the greatest peak. Bellisle *et al.* (2003) found that the highest peak was around noon, which corresponded to lunch, the most abundant meal in the traditional French diet. In Irish adults, Harrington (2001) found the greatest peaks occurred at 13.00-14.00 and 18.00-19.00 (corresponding to lunch and evening meal times), whereas, de Castro (2004) revealed peaks during the hours 10.00-14.00 and 18.00-22.00 in adult Americans. De Castro (2004) however aggregated hour to five time periods (of four hours each, from 06.00 to 02.00), whereas the other studies examined intakes at each hour.

In a study detailing consumption of foods at different locations, where a temporal aspect was included, O'Dwyer *et al.* (2005a) reported that the percentage contribution of fat to food energy was above recommended levels for nearly all hours outside the home. Within the home, the percentage of energy from fat was above the recommended levels at times corresponding to lunch and evening meal times.

Some of the reasons for looking at nutrient intakes over time of the day is that not only can we identify when the major meals are consumed but we can also identify when nutrient targets are or are not being achieved. One striking point from the studies described here is that patterns vary over the course of the day in different countries. This lends credence to the FAO/WHO guidelines that patterns of food intake should be examined in order to develop successful FBDG and very importantly that they should be developed for each country individually.

1.3.1.3 Seasonal temporal analysis

It is also important to examine seasonal variation in nutrient or food intakes due to food availability at different times. Haines *et al.* (2003) found that energy intakes varied across season in an American population but patterns varied with age group. However, Bellisle *et al.* (2003) found no significant effect of season on any food intake variable examined.

Basiotis *et al.* (1989) determined month effects from 1-year dietary records using April as the base month. The greatest difference was observed in August (with the average energy intakes increasing by 441kJ). Statistically significant increases were also observed in May, July, December and January. There were no significant differences between intakes in April and the other months.

1.3.2 Temporal analysis of food intakes

Similar to nutrient intakes, the published information that examines temporal patterns of food intake does not do so in relation to the development of FBDG but rather examines variability in intake and calculates the number of days that should be studied to estimate usual food and nutrient intakes etc. The available literature is only concerned with food consumption over day of the week and not time of the day.

From a recent survey on Irish adults, O'Dwyer *et al.* (2005a) determined the percentage contribution of food groups to fat intake at home and outside the home across day of the week. They found that the contribution of fresh meat, meat products, vegetables and vegetable dishes and creams, ice-cream and desserts to fat at home was highest on Saturday or Sunday. Chips and processed potatoes, creams, ice-creams and desserts, savoury snacks, and fruits, juices and nuts made the highest contribution to fat outside the home on

Saturday or Sunday. They identified the foods that contributed the greatest amount to fat intakes in terms of developing FBDG. They also implied that the information presented could be used to formulate FBDG but they did not develop this to its fullest potential i.e. they failed to actually demonstrate how the temporal aspect of their research could be used in the development of FBDG.

A limited number of other studies have examined food intakes over day of the week and found different patterns. Jula *et al.* (1999) described a significant day of the week effect for cereals, meat and meat products, vegetables and fruits and berries for Finnish adults. In a study exploring the variation of food group intake over day of the week in an elderly population, Maisey *et al.* (1995) found a significant day of the week effect for the intakes of (g/day) and percentage of consumers of meat, meat products, fish and fish products and vegetables but not for the remaining food groups.

Differences in food intakes across the day of the week have also been seen in children. Nicklas *et al.* (1997) reported that a significantly higher percentage of energy came from milk, mixed meats and fruit and fruit juices during the week compared to Sunday in 10-year-old children. In contrast, the percentage energy from egg, pork, vegetables/soups and poultry was significantly higher on Sunday. Lachapelle *et al.* (1989) showed that in 11-year-old children, foods generally considered to be more nutritious were eaten less on a weekend day than on a weekday. They found fruit juices, whole grain cereals, fresh fruits, milk and green and yellow vegetables were consumed significantly more during the week than at the weekend. Significant differences were also observed for soft drinks and pastries. Lowe *et al.* (2004) examined intakes of fruit and vegetables in children and found the intakes of fruit and vegetables to be higher on weekend days than weekdays. This study in itself demonstrates how weekdays rather than weekend days would be an ideal time at which to target messages promoting increased fruit and vegetable consumption in that population.

The fact that food intake patterns vary over the course of the week is invaluable in the development of nutrition policy. The information could be used in the strategic marketing and advertising of health messages e.g. decreased consumption of meat products could be promoted at the weekend. The importance of examining food intake patterns for each country was also demonstrated here as different patterns were observed in each study.

1.3.3 Issues arising when comparing studies that contain an aspect of temporal analysis

There has been recent interest in eating patterns within the field of nutrition (Oltersdorf, 1999). To a certain degree, this stems from the need for nutrition research to focus on food habits, as opposed to nutrient intakes for the development of food-based guidelines. A number of research areas fall within the realm of eating patterns e.g. meal patterns, periodicity of eating, usual meal times, temporal analysis of food and nutrient intakes etc.

The majority of published papers that investigate a temporal aspect do so in relation to day of the week. As mentioned previously, temporal analysis has not been carried out in relation to FBDG but rather to determine daily variation of nutrient intake, often with a view to establishing the number of days that should be used to estimate usual food intake and/or to establish if weekend days ought to be included (Nicklas *et al.*, 1997, Maisey *et al.*, 1995, Tarasuk and Beaton, 1992, McBride *et al.*, 1990, Thomson *et al.*, 1988, St. Jeor *et al.*, 1983, Jula *et al.*, 1999, Richard and Roberge, 1982, Leverton and Marsh, 1939).

Some studies have been carried out on meal times (Berteus Forslund *et al.*, 2002, Costa *et al.*, 1987) but have not looked at meal times in relation to the types of food ingested. A limited number of studies have examined nutrient intakes over time of the day (de Castro, 2004, Bellisle *et al.*, 2003, Harrington, 2001) but again have not focused on food intakes. None of these studies have been carried out with a view to creating FBDG.

Differences in methodology between food consumption surveys should be noted to possibly explain differences in results. The majority of studies described in this review used food diaries, but there is large variation in the number of days the records were kept. Food frequency questionnaire, diet histories and 24 hour recalls were also used in some of the surveys (see Table 1.2). Population characteristics such as age, social class and weight status also varies enormously between study groups which makes comparisons between studies difficult. Some of the studies described in this review are quite dated (Beaton *et al.*, 1983, St. Jeor *et al.*, 1983, McGee *et al.*, 1982, Richard and Roberge, 1982, Beaton *et al.*, 1979, Leverton and Marsh, 1939) which can make comparisons with more recent studies quite inappropriate.

There is inconsistency with the definition of terms used in various papers. One striking example is the term 'weekend day'. Harrington (2001), Tarasuk and Beaton (1992) and Richard and Roberge (1982) described weekend days as Saturday and Sunday, where as Haines *et al.* (2003) described weekend day as Friday, Saturday and Sunday. In the study by Matheson *et al.* (2004) the term weekend day was not defined at all. Similarly, differences arise when looking at intake over time. For example, Bellisle *et al.* (2003) and Harrington (2001) examined nutrient intakes across each hour, whereas de Castro (2004) used five 4-hour time periods to estimate food intake at a particular time.

Other information should also be included in research papers to make comparisons between studies easier. For example, a detailed description of how mean intakes were calculated (O'Dywer *et al.*, 2005a), whether or not and how under-reporters were accounted for (Harrington, 2001) and how the confounding effects of alcohol were dealt with (Thomson *et al.*, 1988) should all be included.

Table 1.2 Studies that contain a temporal aspect of food and/or nutrient intakes

Author	**Sample**	**Dietary assessment method**	**Temporal aspect of analysis**
O'Dwyer *et al.* (2005a)	958 Irish adults	7 day record	Food and nutrient intakes over day of the week and time of the day
de Castro (2004)	867 American adults	7 day record	Food intakes over time of the day
Lowe *et al.* (2004)	402 children, aged 4-11yrs, from the UK	24 hour recall	Food intakes on weekend days compared to weekdays
Matheson *et al.* (2004)	3rd and 5th grade children in the US	24 hour recall	Food and nutrient intakes on weekend days compared to weekdays
Bellisle *et al.* (2003)	54 French adults	7 day record	Nutrient intakes over times of the day and different seasons

Author	Sample	Dietary assessment method	Temporal aspect of analysis
Haines *et al.*(2003)	28156 individuals from the CSFII, aged 2+	24 hour recall	Nutrient intakes on weekdays compared to weekend days
Harrington (2001)	133 Irish adults	7 day record	Nutrient intakes over time of the day, day of the week and weekdays and weekend days
Jula *et al.* (1998)	317 hypertensive and 270 non hypertensive Finnish adults	4, 5 and 7 day records	Food and nutrient intakes over day of the week
Nicklas *et al.* (1997)	281 10-year old children from the Bogalusa Heart Study in the US	24 hour recall	Nutrient intakes and percentage energy from foods on weekdays compared to Sundays
Maisey *et al.* (1995)	145 elderly British subjects	5 and 7 day records	Food and nutrient intakes over day of the week
Tarasuk & Beaton (1992)	29 American adults	365 day record	Energy intakes on weekend days compared to week days
de Castro (1991)	315 American adults	7 day record	Food intakes over day of the week
McBride *et al* (1990)	36 Scottish males	7 day record	Energy intakes over day of the week
Basiotis *et al.* (1989)	29 American adults	365 day record	Energy intakes over day of the week and month
Lachapelle *et al.* (1989)	594 11-year old children	3 day record	Food intakes on weekend days compared to weekdays
Thomson *et al.* (1988)	164 Scottish males	7 day record	Nutrient intakes over day of the week
Post *et al.* (1987)	233 Dutch adolescents	Diet history	Nutrient intakes on school days compared to weekend days
Gibson *et al.* (1985)	14 female Canadian students	7 day record	Nutrient intakes over day of the week
St. Jeor *et al.* (1983)	16 American adults	28 day record	Nutrient intakes over day of the week
Beaton *et al.* (1983)	60 Canadian adults	24 hour recall	Nutrient intakes over day of the week

Author	Sample	Dietary assessment method	Temporal aspect of analysis
McGee *et al.* (1982)	329 Hawaiian males	7 day record	Nutrient intakes over day of the week
Richard & Roberge (1982)	359 Canadian adults	3 day record	Nutrient intakes on weekdays compared to weekend days
Beaton *et al.* (1979)	60 Canadian adults	24 hour recall	Nutrient intakes over day of the week
Leverton & Marsh (1939)	24 female American students	10 day balance study	Nutrient intakes over day of the week

1.4 THE ROLE OF THE FOOD SERVICE SECTOR IN THE DIET

One element of the cultural context of food consumption is where foods are consumed (Kearney *et al.*, 2001). The role of different locations on the diet has been studied to a small extent but generally not with the intention of developing FBDG. Table 1.3 lists the studies that examine the effect of different locations on diet.

As with all reviews, issues arise in making comparisons between published studies. As will be dealt with in section 1.4.1, different definitions used for foods outside the home makes comparisons quite arduous. Issues that regularly arise in relation to methodological differences between studies are different sample sizes, population groups (especially in relation to age), data collection methods etc. The vast majority of peer-reviewed papers in this subject area are from the US and the majority of these are from the Continuing Survey of Food Intakes for Individuals (CSFII). The CSFII and other studies have been criticized for collecting data over short time periods, making them subject to under-reporting of energy intakes. Very few of the studies discussed in this review recorded food intake data for 7 days. In general, the confounding effects of under-reporting or alcohol were not dealt with in the peer-reviewed papers in this area.

1.4.1 Definition of foods consumed outside the home

Despite different definitions used for foods consumed outside the home, the majority of studies describe foods consumed outside the home as foods prepared away from home, regardless of where it was consumed (e.g. a takeaway eaten at home). However a small number of studies use location to describe where consumption of the food took place, regardless of where it was prepared (Kearney *et al.*, 2001, Zoumas-Morse *et al.*, 2001, Gregory *et al.*, 1990).

In general, terms such as 'eating out' (DEFRA, 2004, Clemens *et al.*, 1999), 'foods eaten outside the home' (Le Francois *et al.*, 1996, Loughridge *et al.*, 1989), 'foods prepared outside the home' (Burns *et al.*, 2002), 'foods eaten away from home' (Gillis and Bar-Or, 2003), 'foods purchased away from home' (Thompson *et al.*, 2004) etc. have been used to describe food and nutrient intakes from the food service sector.

Other locations that have been included in studies include home, from home but eaten outside the home, restaurants, cafeterias, fast food locations, vending machine, somebody else's house, school, work, coffee shop, public house, social function, hotel, shop, takeaway, quick service food etc. It should also be noted that some published studies deal with only one aspect of the food service sector. Fast food establishments are examined most frequently (Bowman *et al.*, 2004, Satia *et al.*, 2004, Paeratakul *et al.*, 2003, French *et al.*, 2001, Crawford *et al.*, 2000, French *et al.*, 2000, Jeffrey and French, 1998), with consumption at restaurants examined to a lesser extent (McCrory *et al.*, 1999, Purath *et al.*, 1995).

1.4.2 Growing importance of the food service sector

The food service sector is growing in importance in today's society. There was an 8% increase in consumer expenditure on food service in Ireland from 1999 to 2002. When food service expenditure was examined per capita, the Irish were found to be second biggest spenders worldwide (Euromonitor, 2004). During this time period, there was also a 9% increase in the number of food service establishments in Ireland (Euromonitor, 2004). Consequently, the proportion of people frequenting these establishments must be increasing. Almost 90% of people consumed foods from outside the home (Nicklas *et al.*, 2004, Satia *et al.*, 2004, Thompson *et al.*, 2004, O'Dwyer *et al.*, 2002, French *et al.*, 2001, Loughridge *et al.*, 1989). The percentage of people who consume foods at different locations outside the home is varied because of the different location categories examined in each study. However, in general, 30-40% of people were found to consume foods from a fast food/takeaway establishment (Bowman *et al.*, 2004, Paeratakul *et al.*, 2003, O'Dwyer *et al.*, 2002).

1.4.3 Number of eating occasions

From most studies it appears that approximately 70-80% of all eating occasions occurred at home, with 20-30% occurring at other locations (Kearney *et al*., 2001, French *et al*., 2000, Lin *et al*., 1999, 1998, Magarey *et al*., 1987a, Ries *et al*., 1987). The main source of food outside the home was school in American (Lin *et al*., 1999) and Australian children (Magarey *et al*., 1987a) and restaurants in American adults (Ries *et al*., 1987). Some studies also examined the frequency of eating occasions at different locations. Approximately 40% of American (Kant and Graubard, 2004) and Chinese (Yao *et al*., 2003) adults reported consuming 3 or more meals outside the home. French *et al*. (2000) reported that 76% of respondents visited fast food outlets at least once per week. Also, Clemens *et al*. (1999) found that 44% of adults consumed foods outside the home more than 6 times per week.

In terms of the actual number of eating occasions, just under 3 meals per week were consumed outside the home in adult populations (Kant and Graubard, 2004, McCrory *et al*., 1999, Loughridge *et al*., 1989) with men generally having more eating occasions per week outside the home than women. Irish adults tended to have a higher number of eating occasions outside the home: 6.2-9.2 for Irish men and 3.4-3.6 for Irish women (O'Dwyer *et al*., 2002). The number of eating occasions at takeaways for Irish adults was similar to those of American adults at 1.7 (Crawford *et al*., 2000, French *et al*., 2000, Jeffrey and French, 1998). The fact that roughly a quarter of all eating occasions are occurring outside the home highlights the importance of the food service sector in the diet and the need to include it as a factor for consideration in the formulation of FBDG.

1.4.4 Nutrients from outside the home

Given that FBDG are developed to help achieve nutrient targets, it is essential to provide information as to where the nutrients are being consumed. By examining the contribution of the food service sector to the diet we can achieve one of the cultural aspects of FBDG. Investigation of the contribution of foods consumed outside the home to nutrient intakes will determine whether or not this area should be researched in a particular country for the purpose of developing FBDG.

1.4.4.1 Energy Intakes

Energy intakes at various locations have been presented in many studies. Many studies have found that approximately a quarter of total energy is attributed to foods and drinks consumed outside the home in adults (IUNA, 2001, Gregory *et al.*, 1990, Loughridge *et al.*, 1989). Burns *et al.* (2002) found that foods prepared outside the home contributed to just approximately 13% of food energy in Australian adults, however for the consumers of foods prepared outside the home only, this increased to 36%. O'Dwyer *et al.* (2005b) further examined energy intakes from foods consumed outside the home in Irish adults and found that the majority of energy from outside the home came from pub/restaurant, followed by takeaways and finally deli/coffee shop.

From the 1994-96 CSFII, Lin *et al.* (1999) reported that foods consumed at home accounted for 69% of food energy for boys and 66% for girls. From the foods consumed outside the home, fast food establishments contributed to 9% in both boys and girls; schools provided 11% in boys and 12% in girls; restaurants provided 4% for boys and 3% for girls and other locations (which included vending machines and somebody else's house) contributed 7% in boys' and 10% in girls' to food energy intakes. Thompson *et al.* (2004) reported that 26% of girls received 0.1-5.9% of their energy from foods eaten away from home whereas 60% derived $\geq$ 6% of their energy from foods away from home. The majority of energy came from foods consumed at quick service establishments and restaurants but not coffee shops.

In terms of actual energy intakes, Zoumas-Morse *et al.* (2001) found that restaurants provided significantly more energy (3221±1861 kJ) than home (1781±1445 kJ), work/school/day care (1651±1470 kJ), friend's home (1550±1449 kJ), other locations (1331±1537 kJ) or transit (659±848 kJ). Bowman *et al.* (2004) found energy intake from fast food establishments was 2268 kJ for 4-8 year old children and 3137 kJ for 9-13 year old children.

Higher energy intakes from foods outside the home have been found in young adults and adolescents. Nielsen *et al.* (2002b) found that 60.5% of adolescents' energy and 52.7 % of young adults' (19-29 years) energy was from home, with restaurants/fast food establishments providing the greatest amount of energy from foods consumed outside the home in both cases (19.3% in adolescents and 31.5% in young adults). The percentage energy from foods consumed at home has decreased since the 1977-78 and 1989-91 surveys with the greatest increase in percentage energy from restaurants/fast food. Similar trends have been seen in all age groups from the CSFII (Guthrie *et al.*, 2002, Nielsen *et al.*, 2002a).

The literature discussed here shows how the food service sector contributes differently to energy intakes for different sub groups of the population and to those from different countries. This again lends credence to the FAO/WHO guidelines that FBDG need to be based on the prevailing conditions of the country for which they are being developed. Generally, the food service sector was shown to be important in the diet in relation to energy intake. This should be further explored to examine the macro- and micronutrient intake from foods consumed outside the home.

1.4.4.2 Macronutrient intakes

Examination of macronutrient intakes from foods consumed outside the home could identify potential problems in nutrient intakes that may substantiate the need for FBDG in relation to where foods are consumed. The majority of studies have found fat intakes to be higher outside the home than at home and to be higher than recommended outside the home (O'Dwyer *et al.*, 2005b, DEFRA, 2004, Zoumas-Morse *et al.*, 2001, Lin *et al.*, 1999, Gregory *et al.*, 1990, Ries *et al.*, 1987). Generally carbohydrate intakes were found to be lower outside the home than at home. Studies from the CSFII have shown how the percentage energy from fat and saturated fat has been declining since the 1977-79 CSFII but the decline has been much greater in foods consumed at home than foods consumed away from home (Guthrie *et al.*, 2002 and Lin *et al.*, 1998). Outside the home, fast food restaurants/takeaways were found to make the greatest contributions to fat intakes

Foods consumed away from home generally appear to make quite a high contribution to fat intakes. Fat intakes from foods consumed away from home appear to be higher than those from foods consumed at home and also higher than recommended intakes. The food service sector would therefore be an ideal location for targeting healthy eating messages to reduce fat intakes.

1.4.4.3 Fibre and micronutrient intakes

As foods consumed at different locations contribute differently to macronutrient intakes, it is probable that intakes of fibre and micronutrients also vary by location. Generally foods consumed away from home were found to be less nutrient dense than those consumed at home. For boys and girls (6-11 years) from the CSFII 1994-96, sodium was higher in foods consumed away from home, with fibre and iron intakes lower from foods consumed away from home than those consumed at home. Calcium intakes were marginally higher in foods consumed at home for boys and higher in foods consumed away from home in girls (Lin *et al.*, 1999).

O'Dwyer *et al.* (2005b) examined the fibre and micronutrient densities of foods consumed at various locations in a sample of Irish adults. They found fibre intakes to be highest at home, calcium intakes highest at work and iron intakes highest outside the home for men and at home for women. Outside the home, fibre intakes were highest from takeaways for men and from pubs for women and calcium and iron were highest from pub/hotel and restaurant. Lower nutrient densities in foods consumed outside the home were also reported by Kearney *et al.* (2001) and Ries *et al.* (1987). Loughridge *et al.* (1989) also reports higher intakes of thiamin, riboflavin, vitamin C, vitamin A, calcium, and iron from foods consumed at home than foods consumed away but did not control for energy intakes. The higher intakes at home would be expected in this case as a higher proportion of eating occasions occur at home than away from home.

The few studies discussed that examine the intake of micronutrients at various locations generally agree that nutrient intakes are higher at home than outside the home, even when energy intake is controlled for. This again shows that the food service sector would be an ideal location for targeting healthy eating messages, in this case to improve micronutrient intakes by improving food choice.

1.4.5 Diet quality

Some of the studies that examine foods consumed outside the home do so in relation to the effect those foods can have on diet quality. This could be useful for the development of FBDG for identifying discriminating patterns between different sub-groups of the population e.g. those that eat outside the home compared to those that do not. Diet quality can relate to overall nutrient intake or overall food intake, so this review will deal with these two issues separately.

1.4.5.1 Overall nutrient intake

Consumption of foods outside the home has been associated with poorer nutrient quality diets. Gonzales *et al.* (2002) found that children who usually ate breakfast in a location other than home or school had the highest percentage of energy from saturated fat. They also found that energy adjusted saturated fat intake was strongly associated with the frequency of eating a late night snack prepared away from home. Purath *et al.* (1995) found a significant relationship between cholesterol levels and the number of times the child reported eating out in a restaurant each week. Bowman *et al.* (2004) examined the nutrient quality of children's diets according to whether they had fast food or not over the course of the survey. After adjusting for energy and possible confounding socio-demographic factors, they found fast food consumption to be significantly positively associated with total energy, total fat, saturated fat, total carbohydrate and added sugars and significantly inversely associated with fibre intake. Schmidt *et al.* (2005) also found that fast food intake was positively associated with intakes of energy, sodium, total fat and saturated fat in adolescent girls.

Paeratakul *et al.* (2003) examined the effect of fast food consumption on the nutrient intake profile of children and adults from the CSFII 1994-96. The overall nutrient intake of children and adolescents who reported consuming fast food was compared to those who did not report eating fast food. The children who reported eating fast food had significantly higher intakes of total energy and fat and lower intakes of protein, vitamin A and beta-carotene than those who did not report consuming fast foods. The group went on to assess the nutrient intake of fast food consumption on a day when they did not consume fast food (for adults and children together). They found that on the day the fast food was eaten, the intakes of energy, fat, saturated fat, calcium and sodium were higher and the intakes of carbohydrate, protein, dietary fibre, vitamin A, vitamin C and beta carotene were lower than on the day fast food was not eaten.

Many studies have also demonstrated that consumption of foods consumed outside the home is associated with poorer nutrient diets in adults. Kearney *et al.* (2001) found that those eating fewer of their foods from outside the home obtained a lower proportion of their food energy from fat and protein and a higher proportion from carbohydrate. Kant and Graubard (2004) found that in the NHANES from 1987, 1992 and 1999-2000, the frequency of consuming commercially prepared meals was positively associated with the intakes of energy and percentage energy from total fat and saturated fat and negatively associated with percentage energy from carbohydrate. Similar observations have been made by Clemens *et al.* (1999), Burns *et al.* (2002) and Haines *et al.* (1992).

A number of studies have identified nutrient intake patterns in adults associated with eating out at particular locations, usually fast food restaurants. The number of fast food meals eaten per week was positively associated with total energy intake and percentage energy from fat in a number of studies (Jeffrey and French, 1998, French *et al.*, 2000). The study by French *et al.* (2000) also found that those in the lowest tertile of fast food use had higher intakes of fibre than those in the highest tertile. No difference was observed in calcium intakes between the two groups. Satia *et al.* (2004) also showed that the frequency of eating at fast food restaurants was positively associated with total fat and saturated fat intakes. McCrory *et al.* (1999) found that the frequency of consuming restaurant food (usually fast food restaurant types) was positively associated with total energy, total fat, saturated and monounsaturated fat intakes and negatively associated with fibre intakes.

1.4.5.2 Overall food intake

Gillis and Bar-Or (2003) showed that children who ate more foods outside the home consumed more meat and alternatives and grains. The intake of fruit, vegetables, fruit and vegetables combined and milk and milk products was not correlated with foods eaten away from home. Bowman *et al.* (2004) found that fast food consumption was significantly and positively associated with the intake of sugar-sweetened beverages and significantly and negatively associated with consumption of milk, fruit and non-starchy vegetables.

A study by Paeratakul *et al.* (2003) which examined the dietary and nutrient profile of children and adults from the CSFII found that children and adolescents who reported eating fast food had lower intakes of bread and cereals, dark green vegetables, other vegetables, other fruits and juices, milk and legumes than those who did not consume fast food. They also had higher intakes of fried potato, chicken, meat mixture (dishes that consist mainly of meat) and carbonated soft drinks. When comparing the food intake of both adults and children on a day when fast food was consumed compared to a day when fast food was not consumed, it was found that on the day fast food was consumed the respondents ate less grains, cereals, fruits, vegetables, milk and legumes. They also ate more grain mixture (dishes that consist mainly of grain, including pizza and lasagne), meat mixture, chicken, fried potato and carbonated soft drinks.

A study by Satia *et al.* (2004) found that frequency of eating at fast food restaurants was inversely related to vegetable intake. But there was no statistically significant association between eating at fast food restaurants and the intake of fruit or total fruit and vegetables. A study by French *et al.* (2000) found that those in the highest tertiles of fast food consumption had more servings per day of hamburgers, french fries and soft drinks. Intakes of milk, fried chicken, fried fish, other fish, beef, bacon, sausage and egg did not differ by frequency of fast food use. Taveras *et al.* (2005) also demonstrated that children and adolescents who consumed greater amounts of fried food away from home were more likely to have poorer diet quality.

The published studies discussed in this review demonstrate that consumption of foods away from home is associated with poorer nutrient quality diets and consumption of less healthy foods. This information could be beneficial in the planning of nutrition guidelines in that more healthy lifestyles could be promoted by eating more frequently at home and making better food choices when consuming food away from home.

1.4.6 Weight status

The evidence concerning the relationship between obesity and consumption of foods away from home in children is not conclusive. Gillis and Bar-Or (2003) and Thompson *et al.* (2004) found that a positive association between the consumption of foods away from home and BMI existed. Taveras *et al.* (2005) found that American adolescents who increased their consumption of fried food away from home over 1 year gained weight over and above the expected weight gain for the adolescent period and that adolescents who consumed greater amount of fried food away from home were heavier. However, Nicklas *et al.* (2004) did not find any significant association between meal patterns and overweight status. They included ‘consuming meals away from home/school’ and ‘lunch away from home' as the patterns relating to location. Ebbeling *et al.* (2004) attempted to explain this paradox and found that overweight adolescents were less likely to compensate for the higher energy intakes from fast foods, by adjusting their energy intake throughout the day, than their lean counterparts.

Similarly, the relationship between consumption of foods away from home and obesity is inconclusive in adults. Increased frequency of eating breakfast or dinner away from home has been associated with increased prevalence of obesity (Ma *et al.*, 2003). Burns *et al.* (2002) found that when the population was divided into WHO standards for body weight, the difference in relative energy intake from food prepared outside the home were large, particularly in men. However, after adjustment for age and income, no relationship between foods prepared outside the home and BMI was observed. This was also the case for Irish adults (McCarthy, 2003). A study by Kant and Graubard (2004) examined trends in eating out in America and found that in 1987 and 1992, self reported BMI was unrelated with weekly frequency of consuming commercially prepared meals. This was also the case for self reported and measured BMI in males in 1999-2000 but there was a modest positive association in females. Clemens *et al.* (1999) found that their Low Eating Out group and High Eating Out group did not have significantly different BMIs. However, the group means were quite far apart and large variability lead them to suspect that statistical power was a problem and a larger sample might yield a significant results.

Studies that examined the effect of eating at fast food establishments (and restaurants to a lesser extent) have found associations between obesity and eating at the aforementioned locations. This has been seen in populations from different countries (Satia *et al.*, 2004, Yao *et al.*, 2003, McCrory *et al.*, 1999). In some cases an association between fast food consumption and BMI was been found in women but not in men (Binkley *et al.*, 2000, French *et al.*, 2000, Jeffrey and French, 1998). Crawford *et al.* (2000) also found that successful weight maintenance was associated with the number of fast food meals consumed. The possible association between consumption of foods outside the home and obesity lends further weight to the idea that FBDG should be formulated in relation to the consumption of foods consumed outside the home.

1.4.7 Food types consumed outside the home

If health messages are to be targeted towards foods consumed away from home, examination of food intake patterns at various locations needs to be undertaken. To date, there is very little information on the types of foods consumed outside the home by children or indeed adults. In the Expenditure and Food Survey 2002-03 carried out by the Department for Environment, Food and Rural Affairs (DEFRA) in the UK, a separate eating out survey was conducted on food and drink consumed outside the home. They estimated that meat and meat products were consumed in the greatest quantity outside the home, followed by potatoes, sandwiches, vegetables, ice cream, desserts and cakes, cheese and egg dishes and pizza, confectionery and ethnic meals. In terms of drinks, alcoholic drinks were consumed in the greatest quantity, followed by soft drinks including milk and finally beverages such as tea and coffee (DEFRA, 2004). Nielsen *et al.* (2004) also reported beverage intakes from outside the home in the whole population from the 1994-96 CFSII, with children being included in the population sample. They found that for all age groups, intakes of sweetened beverages and milk were consumed in greatest proportions at home, followed by restaurant/fast food locations. The intake of sweetened beverages has increased for every age group at every location, while the intake of milk has decreased since the 1977/8 CFSII.

The above studies included children and adults, however there is somewhat more information available on foods consumed from outside the home by adult populations only. O'Dwyer *et al.* (2005b) explored the contribution of food groups to fat intake outside the home in Irish adults. They found that the highest contributions came from chips and processed potatoes, meat products, fresh meat, butter and full fat spreads, creams, ice-creams and desserts and biscuits, cakes and pastries. A study carried out by Loughridge *et al.* (1989) found that the types of foods eaten out were alcoholic beverages, biscuits and cakes and snack foods (crisps, chocolate etc.), rolls and sandwiches and takeaways. More recently, Burns *et al.* (2002) reported that the top energy contributing foods prepared outside the home as consumed by an Australian adult population were potatoes (including potato dishes and potato products), filled rolls and hamburgers, pizza, savoury pastry products and chicken. Le Francois *et al.* (1996) reported the highest intake of foods from outside the home in a French population was pasta, rice and potatoes, bread and biscuits, fruit, meat and pastries. In terms of beverages, water was consumed in the greatest quantity, followed by tea, coffee and drinking chocolate. Knowledge of the types of foods consumed at various locations is paramount for the establishment of effective FBDG. This is evident from the fact that it appears to be less healthy foods that are consumed outside the home. Differences between population groups are also evident which again demonstrates the need for FBDG to be established for each country individually.

This review has shown the growing importance of the food service sector in today's culture. It is therefore an area that should be considered in the development of FBDG. This is supported by the fact that a significant proportion of energy is consumed outside the home. Also, these foods appear to be less healthy and of lower nutrient quality than foods consumed at other locations. Consequently, the food service sector is an ideal target for the promotion of public health nutrition messages.

Table 1.3 Studies that examined the influence of eating location on the diet.

Author	Sample	Data collection methods	Locations studied	Factors examined
O'Dwyer *et al.* (2005b)	958 Irish adults	7 day record	All locations	Nutrient intakes
Schmidt *et al.* (2005)	2379 American adolescent girls	3 day record	Fast food	Diet quality
Taveras *et al.* (2005)	14355 American children, aged 9-14 years at baseline	FFQ	Foods consumed away from home	Association between fried food consumed away from home with diet quality and body weight status
Thompson *et al.* (2004)	101 8-12 year old American girls	7 day record	Quick service food, coffee shop and restaurant	Body weight status
Bowman *et al.* (2004)	6212 American children, aged 4-19 years (CSFII)	24 hour recall	Fast food	Diet quality
DEFRA, 2004	16965 British individuals	Household budget survey	All locations	Food and nutrient intakes
Ebbeling *et al.* (2004)	54 American adolescents	Observational study	Fast food	Differences in food intake in overweight and lean individuals
Kant & Graubard (2004)	38779 American adults (NHIS & NHANES)	FFQ	Commercially prepared meals	Trends in eating out, nutrient intakes, body weight status
Nicklas *et al.* (2004)	1584 American children, aged 10 years	24 hour recall	All locations	Trends in eating out, body weight status
Nielsen *et al.* (2004)	73345 Americans, aged 2+ (NFCS & CSFII)	24 hour recall	All foods outside the home	Trends in eating out
Satia *et al.* (2004)	658 African American adults	FFQ	Fast food	Diet quality, body weight status
Gillis and Bar-Or (2003)	181 Canadian children, aged 4-16 years	24 hour recall, FFQ, 3 day record	Food bought at school, restaurant, fast food or take out	Food intake, body weight status

Author	Sample	Data collection methods	Locations studied	Factors examined
Ma *et al.* (2003)	499 American adults	24 hour recall	Foods away from home	Body weight status
Paeratakul *et al.* (2003)	17370 Americans, aged 2+ (CSFII)	24 hour recall	Fast food	Diet quality
Yao *et al.* (2003)	130 Chinese adults	3 day record	Foods outside the home	Nutrient intakes, body weight status
Burns *et al.* (2002)	10863 Australian adults	24 hour recall	Food prepared outside the home	Nutrient intakes, food intakes, body weight status
Gonzales *et al.* (2002)	325 American children, 5th grade	FFQ	All locations	Nutrient intakes
Guthrie *et al.* (2002)	27791 Americans, aged 2+ (NFCS & CSFII)	24 hour recall	All food prepared outside the home	Trends in eating out, nutrient intakes
Nielsen *et al.* (2002a)	63380 Americans, aged 2+ (NFCS & CSFII)	24 hour recall	All food outside the home	Trends in eating out
Nielsen *et al.* (2002b)	16810 Americans, aged 12-29 years (NFCS & CSFII)	24 hour recall	All food outside the home	Trends in eating out
French *et al.* (2001)	4746 American adolescents	FFQ	Fast food	Nutrient intakes, food intakes, body weight status
Kearney *et al.* (2001)	2197 British adults	7 day record	All foods eaten outside the home, regardless of where they are prepared.	Nutrient intakes
Zoumas-Morse *et al.* (2001)	802 American children, aged 7-17 years	24 hour recall	Where food consumption took place	Nutrient intakes
Binkley *et al.* (2000)	16103 American adults (CSFII)	24 hour recall	Foods away from home	Body weight status
Crawford *et al.*(2000)	854 American adults	FFQ	Fast food	Body weight status
French *et al.* (2000)	891 American females	FFQ	Fast food	Diet quality

Author	Sample	Data collection methods	Locations studied	Factors examined
Clemens *et al.* (1999)	129 American premenopausal women	7 day record	Eating out if prepared in a commercial establishment	Diet quality
Lin *et al.* (1999)	4780 American children, aged 2-19 years (CSFII)	24 hour recall	All food outside the home	Nutrient intakes
McCrory *et al.* (1999)	73 adult Americans	FFQ	Restaurants (generally fast food types)	Body weight status
Jeffery & French (1998)	1059 American adults	FFQ	Fast food	Body weight status
Lin *et al.* (1998)	Americans 2+ (CFSII & NFCS) *n* not reported	24 hour recall	All locations	Trends in eating out, nutrient intakes
Le Francois *et al.* (1996)	629 French people ≥15 years	7 day food questionnaire	Food outside the home (excluding food taken from home or at friends home)	Food and nutrient intakes
Lin *et al.* (1996)	3010 American children, aged 2-17 years (CSFII)	24 hour recall, 2 day record	All food outside the home	Nutrient intakes
Purath *et al.* (1995)	357 American children, grades 1-7	Questionnaire	Restaurant	Nutrient intakes
Haines *et al.* (1992)	1120 American females (CSFII)	24 hour recall	All food outside the home	Eating patterns
Gregory *et al.* (1990)	2197 adults from the UK	7 day record	All foods eaten outside the home, regardless of where they are prepared.	Nutrient intakes
Loughridge *et al.* (1989)	70 British adults	3 day record	All food purchased outside the home	Food and nutrient intakes
Ries *et al.* (1987)	3499 Americans ≥15 years (NFCS)	24 hour recall, 2 day record	Food eaten in commercial establishments	Nutrient intakes
Magarey *et al.* (1987a)	141 8-year old Australian children	4 day record	All locations	Percentage distribution of where meals were eaten

1.5 THE ROLE OF SNACKING IN THE DIET

As discussed earlier, the cultural context of food consumption needs to be considered for the development of effective FBDG (Eurodiet Core Report, 2001). One aspect of the cultural context of food consumption is the structure of eating habits into eating occasions such as meals and snacks (Oltersdorf *et al.*, 1999). As mentioned in the temporal section of this review (section 1.3), research in relation to eating patterns has been carried out on meal and snacking patterns, periodicity of eating, temporal distribution of food and nutrient intakes etc. There is quite a large volume of literature available in the subject area of meal and snacking patterns but the use of this information in the development of FBDG has not been discussed.

1.5.1 Definition of eating patterns

The issue of defining eating patterns has been discussed and reviewed in the literature (Oltersdorf *et al.*, 1999, Gatenby, 1997), where the need for a standardised method of defining eating patterns has been documented. The majority of studies base their definition of meal or snack on the time and/or nutrient composition of the eating occasion. For example, using data from the NFCS, Longnecker *et al.* (1997) defined an eating occasion with greater than 45-minute intervals and greater than 90 kcals or greater than 150 kcals. A similar method was used by Redondo *et al.* (1997). Meals are generally described as the main eating occasion throughout the day i.e. breakfast, lunch and dinner, with snacks described as eating occasions that occur outside the usual meal times (Waller *et al.*, 2003, Ruxton *et al.*, 1996, Basdevant *et al.*, 1993, McCoy *et al.*, 1986).

Many studies use the term meal or snack as defined by the respondent (Bellisle *et al.*, 2003, Francis *et al.*, 2003, Winkler *et al.*, 1999). The basis for defining meals or snacks also include social definition i.e. the presence or absence of other diners (Rotenberg, 1981) and food quality, for example, more than a single food (Ezell *et al.*, 1985) or the consumption of warm food (Roos and Prattala, 1997). A study by Field *et al.* (2004) describes the intake of snack food, rather than snacks as an eating occasion.

1.5.2 Percentage of snack consumers

A very obvious way to examine the role of snacking in the diet is to examine the proportion of the population that consume snacks. Most of the studies discussed in the present review report that the vast majority of respondents consume snacks. Jahns *et al.* (2001) revealed that 91% of American children aged 6-11 years consumed snacks. This figure increased from 76% in 1976-77. A similar percentage was also reported for children of other age groups. A number of studies carried out on adolescents and young adults estimate the prevalence of snacking to be 73-91%, with afternoon and evening times much more popular for snacking that morning times (Driskell *et al.*, 2005 Zizza *et al.*, 2001, McCoy *et al.*, 1986 and Ezell *et al.*, 1985).

The literature also reflects cultural differences in relation to snacking. Bellisle *et al.* (2000) reported 86% of French children consumed an afternoon snack which is traditional in the French diet. Waller *et al.* (2003) revealed that only 11% of Chinese children reported consuming snacks foods, whereas all of the Mexican preschool children surveyed by Eastwood-Garcia *et al.* (1990) consumed snacks. Snacks are obviously an important part of the diet and so the extent to which snacking plays a role in the diet should be examined for the implementation of healthy eating guidelines. The data discussed here also reflects how guidelines should be based on the country for which they are being developed as cultural differences in relation to snacking are evident.

1.5.3 Number of eating occasions

Several peer-reviewed papers have calculated the mean number of eating occasions and meals and snacks consumed by the respondents. The number of snacking occasions per day in American children (6-11 years) as reported by the CSFII was 2.0 (Jahns *et al.*, 2001). Francis *et al.* (2003) also reported similar figures in 9-year-old girls: 1.8 and 1.9 in girls with overweight and non-overweight parents respectively. Again, cultural differences are evident, with Mexican preschool children having 13.5 eating occasions per day (Eastwood-Garcia *et al.*, 1990).

The number of snacks reported by adults tends to be lower with French adults consuming 1.3 (Bellisle *et al.*, 2003), while the average number of meals consumed was 2.7. A study of Swedish adults found the number of main meals consumed was 1.2-1.4, the number of light meals/breakfast was 1.2-1.3 and the number of snacks was 1.3-2.0 (Berteus-Forslund *et al.*, 2005). This study in particular highlights the difficulty in making comparisons between studies with the introduction of the term 'light meal/breakfast'. Irish adults reported 5.8 eating occasions per day (Harrington, 2001), with Scottish adults reporting 4.3-4.4 eating occasions per day (Drummond *et al.*, 1998) and American adults reported 3.5 – 3.9 eating occasions per day (Ma *et al.*, 2003, Longnecker *et al.*, 1997).

1.5.4 Eating frequency

Cross *et al.* (1994) reported that the majority of children (59%) snacked 2-3 times a day, with 15% snacking 4 times a day. Another American study found that 58% of children had 5 or more eating occasions a day (Devaney *et al.*, 1995). These studies also suggest morning is the least common snacking time. This is slightly lower than the study by Morgan *et al.* (1983) which found that 50% of American children averaged 4 eating occasions a day, with 26% averaging 5 eatings per day. Forty-nine percent of Irish teenagers reported consuming an afternoon and evening snack five or more times a week (Hurson and Corish, 1997). Five to six was the most frequently reported number of eating occasions per day in Swedish adults (Berteus Forslund *et al.*, 2005) and young adults in Australia (Dugdale *et al.*, 1988). Over 70% of Irish men and women had more than 5 eating occasions per day, with as few as 3% of women and no men eating less than or equal to 4 eating occasions per day (Harrington, 2001). People are obviously consuming more than three square meals per day. Further examination of this extra prandial intake is necessary to determine its effect on the diet.

1.5.5 Nutrient intakes from snacking

As snacks are consumed by the majority of people and consumed quite frequently, it is most likely that they make important contributions to the diet. The present review describes the contribution of snacks to energy and nutrient intakes and compares the nutrient quality of meals and snacks.

1.5.5.1 Energy

Snacks contributed to 24% of energy intakes in 6-11 year old American children from the CSFII (Jahns *et al.*, 2001). This was also roughly equal to that of Scottish children (Ruxton *et al.*, 1996), Australian children (Magarey *et al.*, 1987b), American adolescent girls (Zizza *et al.*, 2001, McCoy *et al.*, 1986), English adolescents and middle-aged adults (Summerbell *et al.*, 1995). Slightly lower energy intakes from snacks (approximately 15-20%) were found in young English adults (mean age 31 years) and elderly English subjects

(Summerbell *et al.*, 1995), German men (Winkler *et al.*, 1999) and French children (Bellisle *et al.*, 1988). Snacking was even less common in Chinese children, contributing to just 8% of energy (Waller *et al.*, 2003). Another different culture reflects a very different pattern with 45% of energy intakes in Mexican preschool children coming from snacks (Eastwood-Garcia *et al.*, 1990). Snacks were also particularly high contributors to energy intakes (32-34%) in adult Finns (Roos and Prattala, 1997) and snack foods contributed to almost 33% of energy intakes in children in the UK (Livingstone *et al.*, 1991).

1.5.5.2 Contribution of snacks to nutrient intakes

As snacking makes a large contribution to energy intakes, it is not surprising that it also makes an important contribution to the intakes of other nutrients. In Scottish children, snacks accounted for 14% of protein, 29% of fat, 26% of carbohydrate, 27% of sugar, 27% of NSP fibre and 6-20% of micronutrient intakes (Ruxton *et al.*, 1996). Similar results were described by Magarey *et al.* (1987b) for Australian children except that the contribution of snacks to sugar was higher (38%) and the contribution to fat was lower (18-21%). The contribution of snacks to nutrient intakes in American adolescent girls (McCoy *et al.*, 1986) was very similar to those described by Magarey *et al.* (1987b). In Finnish adults, snacks made a larger contribution to the diet, contributing to 30-31% of fat intakes, 36-39% of carbohydrate intakes, 50-53% of sugar intakes and 25-26% of protein intakes (Roos and Prattala, 1997). Micronutrient intakes were not examined. However in American adult females, snacks contributed to just 26% of fat and 11% of saturated fat intakes, which was lower than that contributed by midday and evening meals (Ballard-Barbash *et al.*, 1994).

1.5.5.3 Comparison of nutrient intakes at meals and snacks

Differences have been observed in nutrient intakes from meals and snacks. Jahns *et al.* (2001) reported that snacks consumed by American children were less micronutrient dense than meals. These findings support those of Ruxton *et al.* (1996) who also found that snacks were higher in fat, carbohydrate and sugar. McCoy *et al.* (1986) also found that meals had a higher micronutrient density and were higher in fat than snacks consumed by adolescent girls in the US. This was also seen in Finnish adults (Roos and Prattala, 1997), French adults (Bellisle *et al.*, 2003) and English people of different age groups

(Summerbell *et al.*, 1995). Drummond *et al.* (1998) examined macronutrient intakes (as a percentage of energy) from meals and snacks and found that snacks were higher in carbohydrate and sugar but lower in protein than meals. Fat intakes were quite similar. As differences in nutrient densities between meals and snacks are evident, with snacks being less nutrient dense than meals, snacks could be an eating occasion at which to target improved food intakes in order to improve nutrient intakes.

1.5.6 Weight status

Snacking is sometimes considered a 'bad habit' because it could lead to the choice of low nutrient quality foods and consumption of more food in general, possibly leading to weight gain (Gatenby, 1997). However there is no consensus in the literature in relation to snacking and overweight status. In a study of American girls aged 9-years, Francis *et al.* (2003) found no significant difference in snacking frequency between girls from overweight families and non-overweight families. Waller *et al.* (2003) also found no significant differences in the percentage of energy from snacks among Chinese children of different weight status. This was also the case in 7-8 year old Scottish children as described by Ruxton *et al.* (1996). Morgan *et al.* (1983) also found no general relationship between eating patterns and the occurrence of obesity in American children. From a prospective study of American children and young adults, Field *et al.* (2004) reported that snack food was not associated with weight change. However, in a study of French children divided into five body weight groups, the obese and fat children ate less in the afternoon snack than lean, slim and average children (Bellisle *et al.*, 1988). Elgar *et al.* (2005) also found that BMI was positively associated with the number of snacks consumed per day in Welsh adolescents.

BMI did not differ significantly between snacker types as defined by Hampl *et al.* (2003) (from the CSFII in American adults). No significant differences in BMI were found between 'snackers' and 'non-snackers' in a group of obese French women, although significantly more non-snackers were losing weight (Basdevant *et al.*, 1993). Booth *et al.* (2004) also reported that the avoidance of energy between meals was significantly associated with weight loss. Berteus Forslund *et al.* (2005) found that an obese group of Swedish adults consumed snacks more frequently than a reference population. However a study of free-living American adults found that a greater number of eating episodes per day was associated with a lower risk of obesity (Ma *et al.*, 2003). The existence of an association between snacking and weight status in a population of interest would provide further support to the formulation of FBDG in relation to snacking for that population.

1.5.7 Food intakes

As mentioned above, snacking has been associated with the consumption of low nutrient quality foods (Gatenby, 1997). Several studies have examined food consumption at snack times and such examinations would be vital to the development of effective of food based guidelines. Bellisle *et al.* (2000) examined food intakes of 9-11 year old children at the traditional French afternoon snack period. They found that biscuits, cakes, bread and butter, pastries, water, fruit juice and sodas were the most commonly consumed foods at this time. Snacks were found to be the major source of sweets and soft drinks in Australian children (Magarey *et al.*, 1987b). Fruit was found to be the most preferred snack food consumed at morning and afternoon snacks by American children, followed by salty/crunchy foods (e.g. chips, pretzels) and baked goods (e.g. cookies, cakes). At the evening snack, salty/crunchy foods, baked goods and dairy foods were most commonly consumed by the children (Cross *et al.*, 1994). Conversely, American adolescents rarely consumed fruit during snack times as reported by Ezell *et al.* (1985). They found milk, bread and cereals were consumed more often in the afternoon where as candies and salty snacks were more popular at morning snacks. Carbonated beverages and dessert type foods were consumed at all occasions throughout the day.

In a study of snacking patterns of four different age groups (adolescents through to elderly), different patterns were seen for different age groups. In general, chocolate confectionery, biscuits, cakes, milk, sugar, bread and butter were consumed most frequently. Fizzy drinks, cordials, fruit juices and sweet confectionery did not make significant contributions to energy at snack times (Summerbell *et al.*, 1995). The most popular foods and drinks consumed at snacks by older Europeans were coffee/tea, water, milk and milk products, fruits and vegetables, fruit juices, alcoholic drinks and cakes and pastry (Haveman-Nies *et al.*, 1998). Bellisle *et al.* (2003) and Roos and Prattala (1997) showed how foods such as meats, potatoes and pasta were consumed more frequently at meals, where as foods such as biscuits, soft drinks etc. were consumed more frequently at snacks.

As mentioned, examination of food intakes at snack times is vital for the development of healthy eating guidelines that are to be directed at snacks. For example, lower consumption of sweets, fizzy drinks etc. could be encouraged where appropriate. Different patterns of intake have been described for different sub-groups of the population at snacks times which should also been considered in the planning of health messages.

1.5.8 Different snacking groups

In an attempt to further elucidate snacking patterns, many studies categorise respondents into different snacking groups. Ruxton *et al.* (1996) found very few significant differences in nutrient densities for meals and for snacks consumed by high or low snackers in a sample of 7-8 year old Scottish children. They also found that more children from manual social class were in the high snacking group. In another study of Scottish children 'unhealthy snacking' was more likely among children living in deprived areas and whose mother had no qualifications (Sweeting and West, 2005).

In American adolescents, snackers had significantly higher intakes of carbohydrate, fat and saturated fat than non-snackers (Zizza *et al.*, 2001). Berteus Forslund *et al.* (2005) observed that in obese and reference populations increased snacking frequency was associated with increased consumption of sandwiches, cakes/cookies, candies/chocolate and desserts (obese populations only). The studies discussed here do not reveal many differences between snacking groups. However, this type of discriminatory analysis is important in the development of FBDG to determine whether or not differences between groups exist.

This review has demonstrated that snacking is quite common and that snacks contribute to a large proportion of energy consumed. Snacks also tend to be of lesser nutrient quality than meals and tend to be made of less healthy foods. Therefore, snack times would seem to be another ideal opportunity to target healthy eating guidelines to promote better food choice.

Table 1.4 Studies that examined the influence of snacking on the diet

Author	Sample	Data collection methods	Meal or snack definition	Factors examined
Berteus Forslund *et al.* (2005)	5351 Swedish adults	Questionnaire	Defined by respondent	Number of eating occasions, nutrient and food intakes from snacks for obese and normal weight
Driskell *et al.* (2005)	258 American students, aged 19-25 years	Questionnaire	Not described	Percentage of consumers
Elgar *et al.* (2005)	355 Welsh adolescents	Questionnaire	Not described	Association between snacking and body weight status
Sweeting & West (2005)	2146 Scottish children, aged 11 years	Questionnaire	Snack foods	Association between unhealthy snacking and other variables
Booth *et al.* (2004)	Approx. 600 British females	Questionnaire	Pre-defined by the researcher	Association between snacking and weight loss
Field *et al.* (2004)	14977 American children, aged 9-14 years	Questionnaire	Snack foods	Association with weight change
Bellisle *et al.* (2003)	54 French adults	7 day food record	Defined by respondent	Number of eating occasions, nutrient and food intakes at meals and snacks
Francis *et al.* (2003)	173 American girls, aged 5-9 years at baseline	24 hour recall	Defined by respondent	Relationship between snacking and TV watching and body weight status
Hampl *et al.* (2003)	3267 American adults (CSFII)	24 hour recall	Defined by respondent	Relationship between snacker type e.g. morning/multiple and nutrient and food intakes

Author	Sample	Data collection methods	Meal or snack definition	Factors examined
Ma *et al.* (2003)	499 American adults	24 hour recall	Eating occasion provides greater than 210 kJ and interval between episodes of at least 15 minutes	Number of eating occasions and association with body weight status
Waller *et al.* (2003)	880 Chinese children, aged 6-11 years	Household food intakes, 24 hour recall	Snacking defined as foods consumed outside of usual meal times	Percentage of consumers, energy from snacks, body weight status
Berteus Forslund *et al.* (2002)	177 Swedish women	Questionnaire	Pre-defined by the researcher	Number of eating occasions, times of food consumption
Harrington (2001)	133 Irish adults	7 day record	An eating occasion was defined as having greater than 0MJ of energy	Number of eating occasions
Jahns *et al.* (2001)	21,236 American children, aged 2-18 years (CSFII)	24 hour recall	Defined by respondent with 15 minute span	Percentage of consumers, number of snacks, energy from snacks, micronutrient densities of meals compared to snacks
Zizza *et al.* (2001)	8493 young adults, aged 19-29 years (CSFII)	24 hour recall	Defined by respondent with 15 minute span	Percentage of consumers, comparison of nutrient intakes by snacking status, percentage contribution of snacks to nutrient intakes
Bellisle *et al.* (2000)	approx 1000 French children, aged 9-11 years	Questionnaire	Not described	Percentage of consumers, location of snack intake, food intake whether TV was on/off when snacks were consumed
Winkler (1999)	899 Germen men, aged 45-64 years	7 day record	Defined by respondent, coded to 3 meals and 3 snack times	Percentage of consumers, nutrient intakes

Author	Sample	Data collection methods	Meal or snack definition	Factors examined
Drummond *et al.* (1998)	95 Scottish adults	7 day record	Eating occasions separated by 15 min intervals	Number of eating occasions, nutrient intakes
Havemen-Nies *et al.* (1998)	807 elderly Europeans	3 day record	Snacking defined as foods consumed outside of usual meal times	Cluster analysis by snacker type
Hurson & Corish (1997)	390 Irish teenagers	7 day dietary history	Not described	Frequency of meal/snack consumption
Longnecker *et al.* (1997)	4078 American adults (NFCS)	24 hour recall, 2 day records	Eating occasions were defined based on energy intake	Number of eating occasions
Redondo *et al.* (1997)	150 Spanish elderly adults	5 day record	Eating events were defined based on energy intake and time elapsed between each event	Percentage of consumers
Roos & Prattala (1997)	1689 Finnish adults	3 day record	Defined by respondent	Nutrient and food intakes from meals and snacks
Ruxton *et al.* (1996)	136 Scottish children, aged 7-8 years	7 day record	Snack defined as food not eaten at recognised meal time	Nutrient intakes and body weight status of low and high snackers
Devaney *et al.* (1995)	3550 American students, aged 6-18 years	24 hour recall	Defined by researcher based on time	Percentage of consumers, number of eating occasions
Summerbell *et al.* (1995)	187 British of four different age group (>13 years)	7 day record	Snack defined as food eaten at a time other than a meal.	Percentage contribution of meals and snacks to energy, food and nutrient intakes from meals and snacks

Author	Sample	Data collection methods	Meal or snack definition	Factors examined
Ballard-Barbash *et al.* (1994)	1032 American women (CSFII)	24 hour recall	Pre-defined by the researcher	Fat and saturated intakes from meals and snacks
Cross *et al.* (1994)	1675 American adults and children	Questionnaire	Snack defined as any food, excluding beverages, eaten at a time other than a meal.	Frequency of snack intake, food intake from snacks
Basdevant *et al.* (1993)	273 obese French women	Diet history	Snack defined as food eaten between usual meal times	Comparison of body weight status and energy and macronutrient intakes in snackers and non snackers, food intake at snack period.
Eastwood-Garcia *et al.* (1990)	45 Mexican children, aged 2.5-5 years	Child-following' procedure	Eating events were defined as consumption of food separated in time by another event by at least 5 minutes	Frequency of eating
Dugdale *et al.* (1988)	591 Australians, aged 11-25 years	Questionnaire	Not described	Percentage of consumers, frequency of eating
Magarey *et al.* (1987b)	141 Australian 8-year old children	4 day record	Not described	Energy and nutrient intakes from meals and snacks
McCoy *et al.* (1986)	1224 American girls, aged 12,14 and 16 years	24 hour recall	Snacks were defined as all food not consumed as a meal	Percentage of consumers, location of snack intake, nutrient contribution of snacks to diet
Ezell *et al.* (1985)	225 adolescents, aged 15-18 years	1 day record	Snacks defined by researcher, based on time, type and quantity of food	Percentage of consumers, food and nutrient intakes from snacks
Morgan *et al.* (1983)	972 American children, aged 5-18 years	7 day record	Not described	Frequency of eating, relationship between eating pattern and body weight status

1.6 CONCLUSION

In conclusion, there has been extensive analysis of food consumption databases in many different areas of nutrition research. However, the use of this information for the development of health strategies has not been a priority in the peer review system. Examination of food consumption databases, particularly on a national level, provides an ideal opportunity for the informed planning of nutrition policies. Food and nutrient intakes of the population can be assessed and then associated with socio-demographic and health factors for the development of culturally specific food-based dietary guidelines.

1.7 AIMS AND OBJECTIVES OF THIS THESIS

The aim of this thesis is to examine food consumption databases with a view to formulating food-based dietary guidelines. Two national food consumption databases for Ireland were used in this thesis. Data for the first two research chapters were generated from the North/South Ireland Food Consumption Survey (NSIFCS). The NSIFCS was a cross-sectional food consumption survey of Irish adults that was carried out between 1997-1999. Food and nutrient intakes, anthropometric measurements, physical activity and health and lifestyle information were collected and relational databases were generated. Data for 958 respondents from the Republic of Ireland were used in the analyses. The National Children's Food Survey (NCFS) used similar methodology to collect the same information on a sample of 594 children, also from the Republic of Ireland between 2003 and 2004. Data from the NCFS were used for the last three research chapters.

The specific objectives of this thesis are as follows:

1. To assess the role of cereal and dairy products in the diets of Irish adults
2. To examine the temporal distribution of cereal and dairy products in the diets of Irish adults
3. To describe the main findings from the NCFS
4. To assess the role of the food service sector on the diets of Irish children
5. To examine the meal and snack patterns in the diets of children in Ireland

and to discuss the implications of these findings for the development of food-based dietary guidelines.

1.8 PERSEONAL CONTRIBUTION TO THIS THESIS

The NSIFCS was carried out by the Irish Universities Nutrition Alliance (IUNA) between 1997 and 1999. During that time period, data was collected on food and nutrient intakes, attitudes, health and lifestyle and anthropometric measurements were also taken on 958 respondents from the Republic of Ireland (aged 18-64 years). This information was exported to a database in the computer programme SPSS. I was personally responsible for analysis on the role of cereal and dairy products in the diets of Irish adults from this database. This involved extensive restructuring of the food consumption database, examining the contribution of cereal and dairy products to nutrient intakes, examining nutrient intakes across tertiles of cereal and dairy consumption and exploring the temporal aspects of cereal and dairy consumption (Chapters 2 and 3).

The IUNA (centres at Trinity College Dublin and University College Cork only) also carried out the NCFS from 2003-2004. During this period I was employed as a field worker and was responsible for collecting data on 97 of 594 respondents. I worked within the survey team in designing the food diary and questionnaires and I was personally responsible for researching and developing the procedures and protocols for taking anthropometric measurements. As a member of the research team I was responsible for data collection, coding and data entry for each respondent I recruited. After generation of the NCFS, I was responsible for quality control and data cleaning of the questionnaire database.

Chapter 4 presents the main findings from the NCFS and was written as a joint paper by the entire survey team, which is necessary in such collaborative work. I made a significant contribution to the paper not only from the survey work that I carried out but also for some of the methodology and results within the paper. Lead authorship for the paper was taken by the project co-ordinator Dr. Sinead McCarthy.

I was personally responsible for the analytical and statistical work on the role of the food service sector (Chapter 5) and the role of snacking (Chapter 6) on the diets of Irish children.

Each of the chapters was researched under the supervision of Professor Mike Gibney and Dr. Sinead McCarthy. Guidance on statistical analysis was sought from Dr. John Kearney (DIT) for Chapter 3.

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Chapter 2

The influence of cereal and dairy consumption on the Irish diet: implications for developing food-based dietary guidelines

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2.1 Introduction

Food-based dietary guidelines (FBDG) are guidelines derived from nutrient targets or dietary goals that are translated into 'food-based guidelines' in order to be adopted by the general population (Eurodiet Working Party 2, 2001). FBDG need to consider the total diet, be based on prevailing patterns of food and nutrient intake, be culturally acceptable, and recognise the prevailing social and economic conditions that affect food availability. They should also be flexible and suit different subgroups of the population if necessary.

The advent of the North/South Ireland Food Consumption Survey (NSIFCS) will facilitate the development of culturally specific, evidence-based FBDG that will shape public health nutrition in Ireland in the medium term. Whereas it is perfectly appropriate to prepare summary data of the primary findings of an all-Ireland dietary survey outside the peer review system (www.iuna.net), detailed analysis of such databases to inform governmental and non-governmental organisations about preferred evidence-based public health nutrition strategies should be subject to the peer review system.

Figures from the Central Statistics Office (CSO, 2001) show that increasing amounts of money are being spent on food in Ireland, and this holds true for cereal and dairy products. Preliminary analysis of the primary data of the NSIFCS shows that the food categories of cereal and dairy products together make important contributions to energy, macronutrient and micronutrient intakes in the Irish population (IUNA, 2001). Clearly these staples shape major elements of the Irish diet and merit a progressively more detailed analysis in the context of FBDG. Comparable studies in the UK (Henderson *et al.*, 2002a) and Italy (Turrini *et al.*, 2001) reveal similar conclusions regarding their quantitative importance in the diet.

Published research from the NSIFCS has highlighted areas of public concern for the Irish population. This work has shown a need to reduce intake of dietary fat and increase intakes of carbohydrate (Harrington *et al.*, 2001a), fibre (Galvin *et al.*, 2001), folate, riboflavin, and vitamins A and D (O'Brien *et al.*, 2001), along with intakes of certain minerals such as iron, calcium, copper and zinc (this is especially true for women) (Hannon *et al.*, 2001), in the Irish population. The information presented in this paper on the role of cereal and dairy products in the Irish diet may potentially be used to formulate FBDG in order to try and combat some of these public health nutrition problems.

The present study represents one of several such analyses of the NSIFCS database, which includes analyses covering breakfast cereals (Galvin *et al.*, 2003), meats (Cosgrove *et al.*, 2005), fruits and vegetables (O'Brien *et al.*, 2003) and meals outside the home (O'Dwyer *et al.*, 2005) in addition to the present study of cereal- and dairy-based foods. This study sets out to provide a basic but systematic analysis of the role of cereal and dairy products in the Irish diet. It also aims to examine the quality of the diet in those who are high, medium and low consumers of cereal and dairy products, as well as examining the potential uses of this information for FBDG.

2.2 Methods

2.2.1 Survey sample and data collection

The NSIFCS was a cross-sectional study of food and nutrient intakes in a random representative sample of adults aged 18–64 years from Northern Ireland and the Republic of Ireland. A more detailed account of the sampling procedures and methodologies is provided elsewhere (Harrington *et al.*, 2001b and Kiely *et al.*, 2001). In brief, a 7-day food diary (estimated) was used to measure food intakes. Subjects recorded the amount of each item of food and drink consumed and details of recipes used were requested. The food diaries were analysed using WISP© (Weighed Intake Software Program; Tinuviel Software, Anglesey, UK). WISP© uses McCance and Widdowson's food tables (Holland *et al.*, 1995) and published supplements (Chan *et al.*, 1996, Chan *et al.*, 1995, Chan *et al.*, 1994, Holland *et al.*, 1996, Holland *et al.*, 1993, Holland *et al.*, 1992, Holland *et al.*, 1991, Holland *et al.*, 1989 Holland *et al.*, 1988) to generate nutrient data. New food codes were generated for new products on the market and for recipes. Subsequently, a recipe database was generated so that analysis of recipes could be carried out. Additional information on health and lifestyle, physical activity and attitudes to food and health was collected using self-administered questionnaires. Anthropometric measurements were also taken (McCarthy *et al.*, 2001). For this analysis, only data obtained for the Republic of Ireland were used ($n = 958$).

2.2.2 Database

The main nutrient database comprised approximately 160 000 rows of data that described every food and drink item consumed by each respondent for every meal for each of the seven recording days. For each item consumed, the day, time of consumption, meal number in the day, meal definition, weight of food/drink and a full nutrient breakdown for the amount consumed were recorded in the database. Each cereal and dairy product consumed by the respondents of the survey was identified. All cereal and dairy products from identifiable sources (e.g. when the respondent recorded eating rice) and from recipes (e.g. the cheese in an omelette) were used to form a new cereal and dairy database. Each food in the new database was categorised to form one of 16 food groups including total cereals and total dairy. A detailed description of the cereal and dairy food groups formed and the foods in each group can be found in Table 2.1. Because of the large percentage consumers of milk, it was possible to create full-fat and reduced-fat milk groups. However, this was not feasible for the other dairy food groups because of the low percentage consumers of low-fat varieties in each dairy food group.

2.2.3 Data Analysis

Data analysis was carried out using SPSS ® version 10.0 (SPSS Inc., Chicago, IL, USA). Mean ± standard deviation (SD) was calculated for mean daily intakes of cereal and dairy products, mean daily intakes of nutrients from cereal and dairy products (absolute amounts and nutrients per 10 MJ of energy) and the percentage contribution of cereal and dairy products to the mean daily intakes of nutrients. Analysis was done according to gender, age group (18–35 years, 36–50 years, 51–64 years), location, marital status, body mass index (BMI) and social class. Only variables that showed significant differences in previous analysis for this database were included here. The mean daily intakes of cereal and dairy products (g day $^{-1}$) were categorised into tertiles (for consumers only), and mean ± SD values of percentage energy from macronutrients and of micronutrient and fibre intakes (per 10 MJ of energy) from the whole diet were calculated for low, medium and high consumers of cereal and dairy products.

2.2.4 Statistical Analysis

Statistical differences between groups were assessed using parametric tests if the data were normally distributed. If the data were not normally distributed, they were transformed using the square-root or the natural-log (ln) transformation. If the transformed data produced a normal distribution, parametric tests were performed on the transformed data. However, if the transformed data did not give a normal distribution, nonparametric tests were carried out on the original data. For data that were normally distributed, independent t-tests were used to assess differences between gender and between location and marital status within each sex. One-way analysis of variance was used to determine whether significant differences in mean values existed between age groups, BMI categories and social class within each sex. Where significant differences existed, homogeneity of variance was tested using Levene's test. Comparisons were made using the Scheffe *post hoc* comparisons test to identify which means differed when the values satisfied Levene's test. For values that did not comply with Levene's test, the Tamhane *post hoc* multiple comparisons test was used to identify the means that differed. For data that were not normally distributed, the Mann–Whitney test was used to determine significant differences between means. Values of $P < 0.05$ were taken as significantly different.

2.3 Results

Data on the intakes of cereal and dairy products, their contribution to macronutrient intakes, and fibre and micronutrient intakes from cereal and dairy products are presented in Tables 2.2–2.4 for consumers of the food group. In general, men consumed significantly more cereal and dairy products than women. Men consumed significantly more white bread than women ($P<0.01$), and women aged 18–35 years consumed significantly more white bread than women aged 51–64 years ($P<0.01$). White bread made the greatest contribution of cereals to energy and macronutrients. Consumption of wholemeal bread increased with increasing age in both men and women. Wholemeal bread made a significantly lower contribution to the mean daily intakes of macronutrients for 18–35-year-old men than for 36–64-year-old men ($P<0.05$), while it made a significantly higher contribution to macronutrient intakes in women aged 51–64 years than in all younger age groups ($P<0.01$). However, older men and women (51–64 years) had significantly higher fibre and micronutrient intakes from wholemeal bread than younger men and women ($P<0.01$). The greatest cereal contributors to the mean daily intake of fat were cakes, pastries and buns at 6% and biscuits at 4%. The percentage contribution of breakfast cereals to energy and macronutrients, and fibre and micronutrient intakes from breakfast cereals per 10 MJ, increased with increasing age in men and women, but these differences were not always significant.

Full-fat milk was the highest dairy contributor to mean daily energy, macronutrient and micronutrient intakes. Younger men (18–35 years) consumed more reduced-fat milk than older men, whereas younger women consumed significantly less reduced-fat milk than older age groups ($P<0.05$). Women aged 18–35 years also had a significantly lower percentage contribution to mean daily intake of all macronutrients, and lower micronutrient intakes per 10 MJ from reduced-fat milk than older women ($P<0.05$). Men aged 51–64 years consumed significantly less cheese than men aged 18–35 years ($P<0.001$) and, in general, cheese contributed less to the intakes of macro- and micronutrients in older men ($P<0.05$). The intakes of cereal and dairy products and their contribution to nutrient intakes were also analysed by sociodemographic variables, but no particular patterns were observed across different sociodemographic groups.

The intakes of a wide range of nutrients were analysed for low, medium and high consumers of selected cereal products, but are presented here only for protein, fat and carbohydrate (as a percentage of food energy) and dietary fibre, calcium, iron and folate per 10 MJ of energy (Table 2.5). In general, high consumers of cereal products (>317g for men, >244g for women) had higher intakes of energy, carbohydrate and dietary fibre than did low consumers, while their intakes of protein and fat were lower. The intake of calcium increased with increasing consumption of cereals; however, intakes of zinc, thiamin, folate and vitamin B12 were highest in low consumers of cereal products. Although some of the differences were statistically significant, the actual difference between the highest and lowest tertile was not of nutritional significance (e.g. 11.1mg vs. 10.3mg of zinc for women). Because of the small differences, it is difficult to identify food patterns to explain this. Higher intakes of white (>118g for men, >80g for women) and wholemeal (>93g for men, >66g for women) bread were associated with higher energy intakes. High consumers of wholemeal bread had significantly lower fat intakes than low consumers ($P<0.05$ for men, $P<0.01$ for women). Intakes of dietary fibre were significantly lower in high consumers of white bread, but significantly higher in high consumers of wholemeal bread ($P<0.05$). Intakes of micronutrients tended to decrease with increasing consumption of white bread, while increasing with greater consumption of wholemeal bread. In general, energy and fat intakes were higher while protein and micronutrient intakes were lower (*P*<0.01) in high consumers of other breads (>42g for men, >36g for women), biscuits (> 25g for men, >18g for women), and cakes, pastries and buns (>34g for men, >29g for women), compared with low consumers. Intakes of fat (*P*<0.01 for men, *P*<0.001 for women) were lower while intakes of carbohydrate, dietary fibre (*P*<0.01) and micronutrients were higher in high consumers of breakfast cereals (>55g for men, >45g for women) compared with low consumers.

The intakes of a wide range of nutrients were analysed for low, medium and high consumers of selected dairy products, but are presented here only for protein, fat and carbohydrate (as a percentage of food energy) and dietary fibre, calcium, iron and folate per 10 MJ of energy (Table 2.6). High consumers of dairy products (>380g for men, >310g for women) had significantly higher energy (*P*<0.05), calcium and riboflavin (*P*<0.001) intakes than low consumers. Intakes of protein (*P*<0.001 for men) and dietary fibre (*P*<0.05) decreased with increasing dairy consumption. Food patterns were assessed, but could not identify any reasons for this. Intakes of other micronutrients were not consistent across tertiles. High consumers of full-fat milk (>317g for men, >195g for women) had significantly higher intakes of energy (*P*<0.001), fat (*P*<0.01), calcium (*P*<0.001) and riboflavin (*P*<0.001 for men) than low consumers, while intakes of protein, fibre (*P*<0.001) and other micronutrients decreased with increasing consumption (*P*<0.001). For women, intakes of fat were significantly lower (*P*<0.01) while intakes of most micronutrients were significantly higher in high consumers of reduced-fat milk (>212 g). High consumers of cheese (>23g for men, >15g for women) had significantly higher energy (*P*<0.001), fat (*P*<0.01), calcium (*P*<0.001) and vitamin A (*P*<0.01 for women) intakes and lower iron, potassium, thiamin and biotin (*P*<0.05 for men) intakes than low consumers of cheese. High yoghurt consumers (>64g for men, >53g for women) had significantly lower fat intakes (*P*<0.01) and higher intakes of nearly all micronutrients analysed than low consumers of yoghurt (differences were not always significant). In general, energy and fat intakes were higher in high cream consumers (>9g for men and women) (*P*<0.05) than in low cream consumers. Nutrient intakes across tertiles were not significantly different for men. However, females who were high consumers of cream had significantly lower intakes of potassium, thiamin and riboflavin (*P*<0.05), phosphorus (*P*<0.01) and calcium (*P*<0.001) than low consumers. Differences across tertiles of ice cream consumption were not significant for men for intakes of any nutrient analysed. Among women, high consumers (>22g) of ice cream had significantly higher energy and lower protein, dietary fibre and zinc intakes than low consumers ($P<0.05$).

2.4 Discussion

The current analysis of the NSIFCS takes the form of multiple peer-reviewed papers which, both on an individual level and collectively, will help form national strategies for public health nutrition and education. The present study is one of this series of research papers, with the others covering breakfast cereals (Galvin *et al.*, 2001), meat and meat products (Cosgrove *et al.*, 2005), fruits and vegetables (O'Brien *et al.*, 2003), and the food services sector (O'Dwyer *et al.*, 2005). Taken together, cereal and dairy products account for more than one-third of all energy consumed, which represents a significant element of nutrient intake and is thus deserving of detailed analysis.

The majority of published papers in this field examine food intakes, nutrient intakes or the contribution of foods to nutrient intakes for the diet as a whole. Given that the focus of this paper is on only two food staples, the level of detail in the present paper is much greater than that of other studies. This paper therefore has the advantage of being able to present information on the intakes of cereal and dairy products, the contribution of these food groups to nutrient intakes, and nutrient intakes across tertiles of cereal and dairy consumption in one publication.

Comparisons between this and other peer-reviewed papers based on national dietary surveys are of limited value for a number of reasons. As with all published papers, differences in data collection methods make comparisons difficult. A 7-day record was used in this study whereas other regional or national nutrition surveys have used other data collection methods. For example, the Austrian (Elmadfa *et al.*, 1999) and Spanish (Serra-Majem *et al.*, 1996) surveys used a 24-hour recall, the Australian study (Australian Bureau of Statistics, 1995) used a food-frequency questionnaire, and the previous Irish study (Lee and Cunningham, 1990) and a study carried out in East Germany (Hermann-Kunz and Thamm, 1999) used diet histories. Nutrition surveys are carried out on populations of different age groups, which again makes comparisons with the present adult population

(18–64 years) difficult. For example, the Italian nutrition survey was carried out on individuals from the age of 1 year (Turrini *et al*., 2001) whereas the national dietary survey in Belgium was carried out on adults aged 25–74 years (De Backer, 1984). Another factor to be taken into account is that results can be presented as means, medians, frequency, total or serving size, which again makes comparisons between studies very difficult (Henderson *et al.*, 2002a, Turrini *et al*., 2001, Anttolainen *et al*., 1998). Survey duration is also a major source of variability in food consumption surveys when data are presented for consumers only (Lambe et *al*., 2000) and should be taken into account when making comparisons with other studies. Comparisons of recent nutrition studies (e.g. NSIFCS) with older, more dated studies (e.g. VERA (Verbundstudie Ernährungserhebung und Risikofaktorenanalytik) in West Germany in 1987/8) (Heseker *et al.*, 1992) can be misleading, as dietary patterns may have changed within the country since the survey was carried out and should be noted when comparing different studies.

One of the major methodological differences between studies is that the classification of foods is different in every study, again making comparisons between studies arduous. For example, in the present study, dairy products included full-fat milk, reduced-fat milk, cheese, yoghurt, cream, and ice cream. In the NDNS (National Diet and Nutrition Survey) in Britain, dairy products contained whole milk, semi-skimmed milk, skimmed milk, other milk, cream, cottage cheese, other cheese, fromage frais, yoghurt, ice cream, and other dairy desserts (Henderson *et al*., 2002a), whereas in a comparable study in Italy, dairy products included milk, yoghurt, cream, and cheese (Turrini *et al*., 2001). Great difficulties arise therefore when comparing, for example, the intake of lower-fat milk in Ireland with intakes in Britain and Italy. A common food classification system is needed to make data between studies comparable. This could be achieved with the use of a food coding system such as Eurocode 2 in all nutrition surveys (Ireland *et al*., 2002).

Another of the main methodological differences between this study and other published work is that results for consumers only are presented here, while the vast majority of other studies present the main results for the total population (Turrini *et al*., 2001, Pryer *et al.*, 2001, Aranceta *et al.*, 1998). Intakes of a given food for the total population can contain a significant number of zero values that will lower the overall mean intake. For example, in Ireland, the intake of reduced-fat milk for the total population was 60 g but only 33% of the population consumed it. When the intake for consumers only was examined, the mean intake increased three-fold to 179 g. This illustrates the importance of having information for consumers of the food groups. This is particularly important for the development of FBDG, as strategies for increasing food intake can focus on (1) increasing the number of consumers, (2) increasing the frequency of intake among consumers or (3) increasing serving size among consumers (Gibney, 1999).

Allowing for difficulties in making comparisons with other studies as mentioned above, some broad comparisons can be made. Intakes of cereal and dairy products in Ireland appear to have decreased since 1990. The INNS (Irish National Nutrition Survey) (Lee and Cunningham, 1990) reported higher intakes of nearly all cereal and dairy products than are reported here; however, different methodologies were used for food intake measurements in both studies. In general, quantities of cereal and dairy products consumed in Ireland were very similar to those consumed in Britain (Henderson *et al.*, 2002a). Notable differences were observed for the consumption of bread, in particular wholemeal bread where Irish people consumed 4–6 slices more per week. Men and women in Ireland also consumed 300–800 ml more full-fat milk per week than their British counterparts. British women appear to consume slightly more cheese and yoghurt than Irish women, but the maximum difference would be the equivalent of one portion per week. Comparisons of the percentage contribution of cereal and dairy products to macronutrient intake showed very little difference between the British study and the present study (Henderson *et al.*, 2002b). The present study also found that high consumers of wholemeal bread and breakfast cereals had lower fat and higher fibre and micronutrient intakes than did low consumers. High consumption of reduced-fat milk and yoghurt was also associated with lower fat and higher fibre and micronutrient intakes, particularly in women. However, a study in Spain found very little differences in nutrient intakes between low and high yoghurt consumers (Capdevila *et al.*, 2003).

Previous analysis of the NSIFCS database has highlighted areas of public health concern for the Irish population. Fat intakes were above the recommendation, while carbohydrate and fibre intakes were below the recommended level in Irish men and women (Galvin *et al.*, 2001, Harrington *et al.*, 2001a). Also, a substantial proportion of the population had folate, iron and calcium intakes which were below the average requirement (Hannon *et al.*, 2001, O'Brien *et al.*, 2001). Results from this paper may potentially be used to help alleviate some of these concerns through the development FBDG. For example, recommendations calling for increased consumption of wholemeal bread could help reduce the percentage energy from fat (by increasing the percentage energy from carbohydrate), increase fibre, folate and iron intakes, and would appear to result in a diet with better nutrient quality. This analysis also shows that 76% of the population consumed wholemeal bread and their mean daily intake of wholemeal bread was 66.8 g (almost two servings). Thus the number of consumers of wholemeal bread could be increased slightly, or the number of servings or serving size could be increased to increase wholemeal bread consumption. The substitution of wholemeal bread for white bread could also be encouraged in an attempt to increase wholemeal bread consumption.

FBDG could also encourage increased consumption of breakfast cereals, as high consumption of breakfast cereals was also associated with better nutrient intakes. Increased breakfast cereal consumption could also improve fibre, folate and iron intakes. In terms of recommendations for dairy products; increased consumption of reduced fat milk and yoghurt were associated with higher nutrient intakes. Increased consumption of these foods could also be advocated to increase calcium intakes without compromising fat intakes. The substitution of reduced fat milk for full fat milk could also be encouraged. However, before any such guidelines are definitively set in place, further analysis on the displacement of certain foods is required. For example, if a person increases breakfast cereal consumption in line with recommendations, what food are they replacing breakfast cereal with, and what effect will it have on their diet overall?

In conclusion, examination of the contribution of individual staple foods to the diet provides very detailed analysis that can be used for the development of health strategies. Future analysis on food and nutrient intakes should be carried out for consumers of the food groups only, as consumer-only information is essential for the development of effective FBDG.

Table 2.1 Components of cereal and dairy food groups

Cereal and dairy food group	Components of cereal and dairy food group
White bread	White sliced and unsliced bread, white soda bread and white rolls
Wholemeal bread	Wholemeal and brown sliced and unsliced bread, homemade brown bread and wholemeal and brown rolls
Other breads	Scones, croissants, pizza, savoury breads, bread from recipes etc.
Biscuits	Sweet biscuits, savoury biscuits and biscuits from recipes
Cakes, pastries and buns	Cakes, pastries and buns
Rice and pasta	Rice, cous cous, pasta, noodles from identifiable sources and from recipes*
Ready to eat breakfast cereals**	Ready to eat breakfast cereals
Other breakfast cereals**	Other breakfast cereals e.g. porridge and ready brek
Total cereals	Total of all aforementioned cereal products
Full fat milk	Whole milk from identifiable sources and whole milk from recipes
Reduced fat milk	Low fat and skimmed milk from identifiable sources and from recipes
Cheese	Full fat and reduced fat cheese from identifiable sources and cheese from recipes
Yoghurt	Full fat and reduced fat yoghurt from identifiable sources and yoghurt from recipes
Cream	Cream from identifiable sources and cream from recipes
Ice Cream	Ice cream from identifiable sources and ice cream from recipes
Total dairy	Total of all aforementioned dairy products

* Cereal and dairy products from identifiable sources are those that the respondent recorded eating (e.g. rice), and cereal and dairy products from recipes are the portions found in recipes (e.g. the cheese in an omlette)

** The food groups ready to eat breakfast cereals and other breakfast cereals were aggregated for nutrient analysis

Table 2.2 Mean daily intakes (g) of cereal and dairy products for men and women from the Republic of Ireland of different age groups

		All			Males						Females					
	% Cons	18-64 years			18-35 years		36-50 years		51-64 years		18-35 years		36-50 years		51-64 years	
		Mean	(SD)	‡	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
White bread	93.2	84.5	(58.1)	***	103.0	(66.4)	103.5	(61.9)	105.3 ^{NS}	(78.3)	67.4 ^{a}	(34.5)	68.8 ^{a}	(37.2)	56.1 ^{b} #	(43.8)
Wholemeal bread	75.6	66.8	(64.3)	***	60.5 ^{a}	(69.4)	85.5 ^{b}	(76.9)	97.1 ^{b} *	(90.8)	42.8 ^{a}	(32.6)	52.8 ^{a}	(41.1)	70.2 ^{b} **#	(46.4)
Other breads	65.7	33.4	(31.2)	*	43.0	(43.1)	32.6	(27.9)	36.0 ^{NS}	(34.2)	32.1	(27.7)	29.8	(26.3)	27.2 ^{NS}	(23.4)
Biscuits	78.7	19.1	(19.0)	***	26.0	(26.4)	23.7	(22.0)	18.9 ^{NS}	(21.2)	13.9	(12.5)	16.9	(14.0)	16.4 ^{NS}	(13.9)
Cakes, pastries and buns	60.0	29.6	(26.9)	**	27.7 ^{a}	(32.4)	38.5 ^{b}	(33.0)	32.8 ^{ab}	(28.9)	25.3	(20.0)	26.7	(20.1)	27.4 ^{NS}	(24.3)
Rice and pasta	58.0	47.4	(40.6)	*	61.5	(46.5)	46.6	(34.7)	43.8 ^{NS}	(33.0)	44.7	(34.2)	47.8	(49.2)	31.9 ^{NS}	(27.8)
Ready to eat breakfast cereals	66.5	28.1	(23.8)	***	33.8	(29.6)	30.9	(25.8)	28.7 ^{NS}	(22.9)	22.7	(16.9)	26.2	(22.2)	26.7 ^{NS}	(21.9)
Other breakfast cereals	18.0	114.3	(95.9)	NS	80.0	(79.0)	155.0	(131.5)	128.3 ^{NS}	(114.1)	72.0	(47.6)	90.8	(55.3)	112.7 ^{NS}	(74.7)
Total cereals	99.9	251.0	(116.2)	***	262.6	(121.8)	292.9	(132.8)	300.2 ^{NS}	(142.9)	201.4 ^{a}	(72.5)	227.4 ^{b}	(91.5)	227.1 ^{ab}	(90.1)
Full fat milk	92.1	215.5	(196.4)	***	273.4	(219.7)	287.1	(256.6)	213.4 ^{NS}	(146.4)	158.2	(136.6)	171.0	(156.6)	175.1 ^{NS}	(174.5)
Reduced fat milk	33.4	178.8	(138.7)	NS	202.6	(191.8)	174.0	(118.5)	171.8 ^{NS}	(110.6)	138.1 ^{a}	(145.4)	203.0 ^{b}	(125.9)	185.8 ^{b} ^	(119.0)
Cheese	76.9	17.3	(15.8)	***	24.0 ^{a}	(19.4)	20.9 ^{a}	(20.2)	15.0 ^{b}	(12.3)	15.5	(12.7)	14.6	(12.0)	12.3 ^{NS}	(11.1)
Yoghurt	32.8	47.4	(40.9)	*	58.3	(66.7)	51.2	(36.9)	57.7 ^{NS}	(39.8)	36.2 ^{a}	(29.6)	43.4 ^{ab}	(26.7)	50.8 ^{b}	(42.0)
Cream	38.5	8.9	(9.2)	NS	9.2	(7.7)	9.3	(9.0)	10.9 ^{NS}	(16.0)	8.1	(6.0)	8.4	(7.2)	7.3 ^{NS}	(5.4)
Ice cream	38.7	20.3	(16.0)	NS	21.8	(17.2)	23.6	(16.2)	17.7 ^{NS}	(13.5)	21.2	(19.7)	18.0	(13.8)	17.6 ^{NS}	(11.8)
Total dairy	99.8	299.0	(196.2)	***	349.0 ^{ab}	(232.4)	354.4 ^{a}	(247.0)	275.6 ^{b} #	(137.0)	248.0	(169.9)	278.3	(155.5)	275.1 ^{NS}	(169.7)

‡ Comparison of means between men and women: *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$; NS, not significant ($P \geq 0.05$)

^{a,b,c} Different superscripts are significantly different ($P<0.05$) between age groups within each sex: ^, $P<0.01$ between 18-35 and 36-50; *, $P<0.01$ between 18-35 and 51-64; **, $P<0.001$ between 18-35 and 51-64; #, $P<0.01$ between 36-50 and 51-64; NS, not significant ($P \geq 0.05$)

Table 2.3 Percentage contribution of cereal and dairy products to mean daily macronutrient intakes in men and women from the Republic of Ireland

	Males (18-64 years)					Females (18-64 years)				
		Energy	Protein	Fat	CHO		Energy	Protein	Fat	CHO
	n	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	*n*	Mean ‡ (SD)	Mean ‡ (SD)	Mean ‡ (SD)	Mean ‡ (SD)
White bread	445	9.2 (5.3)	8.7 (5.1)	1.7 (1.2)	17.0 (9.7)	448	8.9 NS (5.3)	8.4 NS (5.2)	1.7 NS (1.3)	16.0 NS (9.8)
Wholemeal bread	345	6.7 (6.4)	7.1 (6.5)	2.3 (2.5)	10.9 (10.0)	379	6.6 NS (5.1)	7.0 NS (5.2)	2.2 NS (2.1)	10.6 NS (7.8)
Other breads	474	2.4 (3.6)	2.0 (3.4)	2.2 (3.3)	3.1 (4.7)	480	3.4 *** (4.0)	2.7 *** (3.5)	3.1 *** (4.2)	4.2 *** (4.9)
Biscuits	330	3.8 (3.8)	1.3 (1.5)	4.3 (4.5)	4.8 (4.7)	414	3.9 NS (3.2)	1.4 NS (1.3)	4.1 NS (3.5)	4.8 NS (4.0)
Cakes, pastries and buns	272	4.3 (3.5)	1.7 (1.6)	5.2 (4.6)	5.0 (4.1)	303	4.9 * (3.8)	1.9 * (1.6)	6.0 * (5.1)	5.5 NS (4.1)
Rice and pasta	179	3.6 (2.6)	2.4 (1.8)	0.9 (0.8)	7.0 (5.0)	218	3.7 NS (2.8)	2.7 NS (2.3)	0.8 NS (0.9)	7.0 NS (5.2)
Breakfast cereals	338	4.7 (3.4)	3.3 (2.6)	1.5 (2.4)	7.9 (5.3)	362	5.3 NS (4.1)	3.8 * (3.0)	1.8 ** (2.4)	8.6 NS (6.2)
Total cereals	475	25.8 (9.1)	20.5 (7.6)	12.8 (7.8)	41.4 (12.1)	482	28.9 *** (8.7)	22.5 *** (7.7)	15.4 *** (8.1)	44.6 *** (11.3)
Full fat milk	435	6.4 (4.8)	8.3 (6.3)	9.7 (7.0)	4.1 (3.2)	425	5.9 NS (5.3)	7.6 NS (6.8)	8.6 * (7.6)	3.7 NS (3.4)
Reduced fat milk	111	3.7 (3.0)	6.7 (5.1)	3.3 (3.2)	3.5 (2.8)	201	4.5 * (3.3)	8.3 * (5.7)	3.7 NS (3.6)	4.2 * (3.1)
Cheese	345	2.8 (2.4)	4.7 (3.9)	5.9 (4.5)	0.0 (0.0)	368	2.9 NS (2.3)	4.8 NS (4.0)	5.8 NS (4.7)	0.0 NS (0.1)
Yoghurt	111	1.9 (1.5)	2.6 (2.3)	1.2 (1.1)	2.3 (1.9)	194	2.0 NS (1.6)	2.9 * (2.2)	1.2 NS (1.5)	2.3 NS (1.9)
Cream	110	2.3 (3.8)	0.4 (0.7)	5.9 (8.4)	0.2 (0.4)	120	2.1 NS (1.5)	0.3 NS (0.3)	5.4 NS (3.8)	0.2 NS (0.2)
Ice cream	175	1.7 (1.1)	0.8 (0.6)	2.2 (1.7)	1.7 (1.2)	196	2.1 *** (1.6)	1.0 ** (0.8)	3.0 ** (2.5)	2.1 ** (1.6)
Total dairy	474	10.4 (5.8)	13.6 (7.3)	16.5 (9.3)	5.9 (3.6)	482	11.4 ** (5.7)	15.5 *** (7.7)	16.6 NS (8.8)	6.9 *** (4.1)

‡ Comparison of means between men and women: *, $P < 0.05$; **, $P < 0.01$; ***, $P < 0.001$; NS, not significant ($P \geq 0.05$)

Table 2.4 Fibre and micronutrient intakes from cereal and dairy products per 10 MJ of food energy in men and women from the Republic of Ireland

		Male (18-64)																	
		Dietary fibre (g)		Calcium (mg)		Iron (mg)		Phosphorous (mg)		Zinc (mg)		Riboflavin (mg)		Biotin (µg)		Folate (µg)		Vitamin A (µg)	
	n	Mean ‡	(SD)	Mean ‡	(SD)	Mean ‡	(SD)	Mean ‡	(SD)	Mean ‡	(SD)	Mean ‡	(SD)	Mean ‡	(SD)	Mean ‡	(SD)	Mean ‡	(SD)
White bread	445	3.8 NS	(2.2)	108.8 NS	(66.9)	1.6 NS	(0.9)	89.6 NS	(60.7)	0.6 NS	(0.3)	0.1 NS	(0.0)	1.0 *	(0.6)	20.1 NS	(11.6)	38.7 NS	(59.8)
Wholemeal bread	345	4.8 NS	(4.7)	61.9 NS	(59.7)	1.9 NS	(1.8)	154.6 NS	(150.7)	1.3 NS	(1.3)	0.1 NS	(0.1)	4.0 NS	(4.0)	25.7 NS	(25.4)	9.5 NS	(9.3)
Other breads	474	0.6 ***	(0.9)	32.7 ***	(53.1)	0.3 ***	(0.5)	49.5 ***	(86.6)	0.2 ***	(0.3)	0.0 ***	(0.0)	0.5 ***	(1.1)	3.3 ***	(5.8)	26.5 **	(38.1)
Biscuits	330	0.6 **	(0.8)	19.4 NS	(18.3)	0.4 NS	(0.5)	23.3 NS	(29.8)	0.2 NS	(0.2)	0.0 NS	(0.0)	0.5 NS	(1.5)	1.6 *	(3.3)	12.4 NS	(20.8)
Cakes, pastries and buns	272	0.6 NS	(0.5)	19.7 NS	(16.6)	0.4 *	(0.3)	33.0 NS	(27.6)	0.2 *	(0.1)	0.0 NS	(0.0)	1.3 NS	(1.1)	3.1 **	(3.3)	31.6 *	(29.6)
Rice and pasta	179	1.1 NS	(0.8)	8.9 NS	(7.3)	0.3 NS	(0.3)	40.4 NS	(32.7)	0.4 NS	(0.3)	0.0 NS	(0.0)	0.5 NS	(0.4)	3.4 NS	(3.0)	0.5 **	(0.3)
Breakfast cereals	338	2.3 *	(2.6)	18.1 ***	(40.5)	2.4 *	(2.0)	73.0 ***	(80.9)	0.5 ***	(0.6)	0.3 *	(0.3)	2.6 NS	(3.0)	56.1 NS	(56.7)	61.1 NS	(65.8)
Total cereals	475	10.4 ***	(4.7)	220.4 ***	(88.4)	5.5 ***	(2.6)	347.7 ***	(182.8)	2.4 ***	(1.4)	0.4 **	(0.3)	6.3 ***	(4.9)	81.5 **	(57.5)	42.0 ***	(43.6)
Full fat milk	435	0.0 NS	(0.0)	281.5 **	(205.1)	0.1 **	(0.1)	225.2 **	(164.1)	1.0 **	(0.7)	0.4 **	(0.3)	4.7 **	(3.4)	13.7 **	(10.5)	132.5 *	(106.6)
Reduced fat milk	111	0.0 NS	(0.0)	263.6 *	(216.8)	0.1 *	(0.1)	197.4 *	(162.0)	0.8 *	(0.7)	0.4 *	(0.3)	4.1 *	(3.4)	20.2 *	(28.9)	60.7 NS	(76.2)
Cheese	343	0.0 NS	(0.0)	126.2 NS	(105.2)	0.1 NS	(0.1)	107.6 NS	(89.9)	0.4 NS	(0.4)	0.1 NS	(0.1)	0.6 NS	(0.5)	4.4 NS	(4.1)	67.6 NS	(56.0)
Yoghurt	111	0.0 NS	(0.0)	87.7 NS	(81.0)	0.1 **	(0.1)	73.4 NS	(68.5)	0.3 NS	(0.3)	0.2 *	(0.2)	1.1 NS	(0.8)	7.1 NS	(6.4)	14.7 NS	(11.8)
Cream	110	0.0 NS	(0.0)	10.6 NS	(17.8)	0.0 NS	(0.0)	9.9 NS	(16.5)	0.1 NS	(0.1)	0.0 NS	(0.0)	0.2 NS	(0.4)	1.1 NS	(1.8)	92.2 NS	(155.7)
Ice cream	175	0.1 NS	(0.2)	24.1 **	(17.1)	0.0 **	(0.1)	20.8 **	(14.6)	0.1 **	(0.1)	0.0 **	(0.0)	0.5 ***	(0.4)	1.5 **	(1.1)	22.7 NS	(19.7)
Total dairy	474	0.1 NS	(0.2)	444.0 **	(234.8)	0.2 ***	(0.1)	358.2 **	(188.0)	1.5 **	(0.8)	0.6 ***	(0.3)	6.1 **	(3.5)	23.0 ***	(17.9)	217.9 NS	(150.9)

		Female (18-64 years)																	
		Dietary fibre (g)		Calcium (mg)		Iron (mg)		Phosphorous (mg)		Zinc (mg)		Riboflavin (mg)		Biotin (µg)		Folate (µg)		Vitamin A (µg)	
	n	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
White bread	448	3.6	(2.1)	102.0	(61.9)	1.5	(0.9)	83.4	(50.2)	0.5	(0.3)	0.0	(0.0)	0.9	(0.5)	19.2	(11.7)	33.6	(46.1)
Wholemeal bread	379	4.6	(3.7)	60.3	(50.1)	1.9	(1.4)	146.2	(119.1)	1.2	(1.0)	0.1	(0.1)	3.7	(3.1)	25.7	(21.3)	8.5	(7.7)
Other breads	480	0.9	(1.1)	42.7	(55.8)	0.4	(0.5)	72.6	(108.9)	0.2	(0.4)	0.0	(0.0)	0.7	(1.0)	4.4	(6.5)	34.9	(40.3)
Biscuits	414	0.7	(0.8)	19.6	(15.9)	0.4	(0.4)	23.9	(23.6)	0.2	(0.2)	0.0	(0.0)	0.4	(0.7)	2.0	(3.0)	15.0	(20.4)
Cakes, pastries and buns	303	0.6	(0.6)	23.1	(21.9)	0.4	(0.3)	38.8	(34.3)	0.2	(0.2)	0.0	(0.0)	1.5	(1.4)	3.6	(4.6)	43.4	(44.9)
Rice and pasta	218	1.2	(1.1)	8.6	(7.4)	0.3	(0.4)	40.9	(33.1)	0.4	(0.3)	0.0	(0.0)	0.5	(0.3)	3.3	(3.4)	1.8	(0.8)
Breakfast cereals	362	3.2	(4.0)	25.3	(43.2)	3.7	(4.7)	97.7	(97.9)	0.8	(0.9)	0.4	(0.4)	3.0	(3.4)	65.5	(77.6)	68.4	(75.1)
Total cereals	482	11.7	(5.1)	238.8	(85.8)	6.8	(4.5)	401.2	(185.3)	2.7	(1.4)	0.5	(0.4)	7.2	(4.7)	93.4	(72.7)	56.8	(52.7)
Full fat milk	425	0.0	(0.0)	252.1	(225.4)	0.1	(0.1)	201.7	(180.3)	0.9	(0.8)	0.4	(0.3)	4.2	(3.7)	12.2	(11.5)	119.8	(114.2)
Reduced fat milk	201	0.0	(0.0)	322.6	(231.6)	0.1	(0.1)	242.0	(175.5)	1.0	(0.7)	0.5	(0.4)	5.0	(3.7)	25.1	(30.9)	69.9	(84.0)
Cheese	366	0.1	(0.0)	123.3	(102.9)	0.1	(0.1)	101.1	(82.5)	0.4	(0.3)	0.1	(0.1)	0.6	(0.5)	4.8	(5.2)	66.8	(56.6)
Yoghurt	194	0.1	(0.0)	93.2	(74.5)	0.1	(0.1)	78.3	(61.8)	0.3	(0.2)	0.2	(0.1)	1.2	(1.1)	7.5	(6.6)	16.4	(15.3)
Cream	120	0.0	(0.0)	9.1	(6.9)	0.0	(0.0)	8.5	(6.4)	0.0	(0.0)	0.0	(0.0)	0.2	(0.1)	1.0	(0.7)	83.3	(62.1)
Ice cream	195	0.1	(0.2)	29.4	(20.5)	0.1	(0.1)	26.0	(18.3)	0.1	(0.1)	0.1	(0.0)	0.7	(0.5)	1.8	(1.4)	27.3	(23.4)
Total dairy	482	0.1	(0.2)	502.2	(263.8)	0.3	(0.1)	399.2	(207.3)	1.7	(0.9)	0.7	(0.4)	6.9	(4.0)	28.8	(24.9)	222.4	(132.8)

‡ Comparison of means between men and women: *, $P<0.05$; **, $P<0.01$; ***, $P<0.001$; NS, not significant ($P\geq 0.05$)

Table 2.5 Macronutrient (% energy from food), fibre and micronutrient intakes (g/mg/ug per 10MJ of food energy) from the total diet for tertiles of cereal consumption for men and women (18-64 years) from the Republic of Ireland

		Males						Females					
		Low		Medium		High		Low		Medium		High	
Food group	Nutrient	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
White bread	Protein (%)	17.3 [a]	(3.2)	16.4 [b]	(2.4)	15.7 [b] **	(2.6)	16.8 [a]	(2.8)	16.1 [ab]	(2.6)	15.4 [b] **	(2.8)
	Fat (%)	37.3	(5.6)	37.4	(5.1)	37.1 [NS]	(4.8)	36.1 [a]	(6.7)	38.1 [b]	(5.2)	37.8 [ab]	(5.7)
	CHO (%)	45.1 [a]	(5.2)	45.9 [ab]	(5.2)	46.9 [b]	(5.2)	46.6	(6.1)	45.7	(4.5)	46.6 [NS]	(5.9)
	Dietary fibre (g)	24.4 [a]	(7.4)	22.7 [ab]	(6.0)	22.0 [b]	(5.0)	28.5 [a]	(8.2)	23.7 [b]	(5.4)	22.8 [b] ^^**	(4.6)
	Calcium (mg)	910.3	(233.1)	862.6	(210.6)	886.2 [NS]	(201.9)	1019.9 [a]	(258.4)	962.4 [ab]	(266.0)	925.9 [b] **	(246.8)
	Iron (mg)	14.7 [a]	(4.0)	13.3 [b]	(3.0)	12.5 [c] ^**	(2.5)	15.4 [a]	(5.6)	13.8 [b]	(3.4)	12.4 [c] **#	(2.9)
	Folate (µg)	338.5 [a]	(122.3)	308.7 [ab]	(95.1)	293.8 [b] *	(74.8)	342.6 [a]	(126.1)	303.1 [b]	(89.6)	289.8 [b] ^**	(84.8)
Wholemeal bread	Protein (%)	16.2	(3.1)	16.7	(2.9)	16.9 [NS]	(2.8)	15.9	(2.6)	16.2	(2.9)	16.6 [NS]	(2.8)
	Fat (%)	37.2	(5.4)	36.9	(5.4)	35.4 [NS]	(6.1)	37.9 [a]	(5.7)	37.4 [a]	(6.1)	35.4 [b] *	(6.2)
	CHO (%)	46.6	(5.4)	46.0	(5.3)	47.4 [NS]	(5.7)	46.0	(5.3)	46.0	(5.9)	47.5 [NS]	(5.5)
	Dietary fibre (g)	22.5 [a]	(7.7)	23.9 [a]	(5.2)	28.6 [b] **~	(7.4)	23.6 [a]	(5.4)	26.2 [b]	(6.3)	29.8 [c] ^**~	(8.6)
	Calcium (mg)	866.6	(219.3)	921.2	(216.1)	895.7 [NS]	(199.7)	950.3	(246.8)	987.7	(245.0)	1012.3 [NS]	(257.4)
	Iron (mg)	13.4 [a]	(3.3)	14.2 [a]	(3.4)	15.2 [b] **	(3.4)	13.5 [a]	(4.0)	14.3 [ab]	(4.4)	15.5 [b] **	(4.8)
	Folate (µg)	323.1	(122.5)	314.3	(100.0)	343.8 [NS]	(106.2)	304.1	(96.1)	317.1	(100.5)	336.7 [NS]	(120.1)
Cakes, pastries and buns	Protein (%)	16.6 a	(2.8)	16.1 [ab]	(2.5)	15.4 [b] *	(2.1)	16.9 a	(3.1)	15.5 b	(2.6)	14.9 [b] ^**	(2.3)
	Fat (%)	37.0	(5.3)	37.2	(4.7)	37.7 [NS]	(4.7)	35.8 [a]	(6.9)	38.5 [b]	(5.0)	37.7 [ab] ^	(5.1)
	CHO (%)	45.8	(5.2)	46.3	(4.8)	46.5 [NS]	(5.1)	47.2	(5.5)	45.7	(4.8)	46.9 [NS]	(5.0)
	Dietary fibre (g)	23.3	(5.8)	23.0	(6.1)	22.8 [NS]	(6.0)	25.9	(6.8)	24.9	(5.6)	24.1 [NS]	(5.9)
	Calcium (mg)	900.1	(213.4)	886.9	(208.0)	845.9 [NS]	(183.9)	1068.3 [a]	(315.0)	924.1 [b]	(211.9)	910.2 [b] ^*	(213.1)
	Iron (mg)	13.3	(2.9)	13.5	(2.9)	12.8 [NS]	(2.9)	14.6	(4.8)	13.6	(4.0)	13.8 [NS]	(4.8)
	Folate (µg)	316.9 [a]	(89.2)	298.0 [ab]	(88.6)	280.1 [b]	(72.2)	335.7 [a]	(115.2)	304.2 [ab]	(94.1)	278.4 [b] **	(80.3)
Breakfast cereals	Protein (%)	16.6	(3.2)	16.4	(2.8)	16.3 [NS]	(2.7)	15.8	(2.3)	16.4	(2.9)	16.5 [NS]	(3.3)
	Fat (%)	37.5 [a]	(5.6)	36.1 [ab]	(5.4)	35.3 [b]	(5.5)	37.7 [a]	(5.2)	35.9 [b]	(5.9)	34.8 [b] **	(6.4)
	CHO (%)	45.5 [a]	(5.2)	47.0 [ab]	(5.4)	48.1 [b] *	(5.6)	46.1 [a]	(5.0)	47.1 [ab]	(5.3)	48.3 [b] *	(5.9)
	Dietary fibre (g)	22.7 [a]	(6.7)	24.1 [a]	(6.6)	26.7 [b] **	(8.9)	23.8 [a]	(6.1)	27.3 [b]	(8.0)	27.7 [b] ^**	(8.2)
	Calcium (mg)	903.1	(234.6)	923.8	(229.8)	929.8 [NS]	(227.5)	925.7 [a]	(231.2)	1031.4 [b]	(244.8)	1043.2 [b] ^*	(262.0)
	Iron (mg)	13.1 [a]	(3.3)	14.3 [b]	(3.4)	15.0 [b] ^**	(3.5)	12.9 [a]	(2.8)	15.4 [b]	(4.6)	16.3 [b] ^^**	(6.3)
	Folate (µg)	306.1 [a]	(113.6)	334.9 [b]	(96.7)	335.7 [ab]	(119.0)	302.2 [a]	(86.9)	352.2 [b]	(112.2)	344.1 [b] ^	(126.9)

[abc] Different superscripts are significantly different ($P<0.05$) between low, medium and high consumers within each sex. ^, $P<0.01$ between low and medium consumers; ^^, $P<0.001$ between low and medium consumers; *, $P<0.01$ between low and high consumers; **, $P<0.001$ between low and high consumers; #, $P<0.01$ betwen medium and high consumers; ~, $P<0.001$ between medium and high consumers; NS, not significant ($P\geq0.05$)

Table 2.6 Macronutrient (% energy from food), fibre and micronutrient intakes (g/mg/ug per 10MJ of food energy) from the total diet for tertiles of dairy consumption for men and women (18-64 years) from the Republic of Ireland

		Males						Females					
		Low		Medium		High		Low		Medium		High	
Food Group	Nutrient	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Full fat milk	Protein (%)	17.1 ^{a}	(3.1)	16.4 ^{a}	(2.5)	15.6 ^{b} **	(2.4)	16.9 ^{a}	(3.0)	16.3 ^{a}	(3.0)	15.3 ^{b} **	(2.4)
	Fat (%)	36.3 ^{a}	(5.8)	37.2 ^{ab}	(4.7)	38.2 ^{b} **	(5.1)	36.0 ^{a}	(5.9)	37.8 ^{b}	(5.6)	38.6 ^{b} **	(5.3)
	CHO (%)	46.2	(5.6)	46.1	(5.0)	45.9 ^{NS}	(5.5)	46.9	(5.7)	45.5	(5.1)	45.8 ^{NS}	(5.1)
	Dietary fibre (g)	25.4 ^{a}	(7.6)	22.9 ^{b}	(5.5)	21.6 ^{b} ^**	(5.6)	27.0 ^{a}	(7.2)	25.0 ^{b}	(6.4)	22.9 ^{c} **#	(6.1)
	Calcium (mg)	817.4 ^{a}	(216.4)	836.1 ^{a}	(138.7)	1021.4 ^{b} **~	(212.3)	983.3 ^{a}	(294.5)	913.8 ^{a}	(233.2)	1039.7 ^{b} **	(233.9)
	Iron (mg)	14.3 ^{a}	(3.7)	13.5 ^{ab}	(3.1)	12.8 ^{b} *	(3.1)	15.3 ^{a}	(5.4)	13.4 ^{b}	(3.2)	13.1 ^{b} ^**	(4.5)
	Folate (µg)	326.8	(113.6)	315.7	(100.6)	301.1 ^{NS}	(86.2)	337.5 ^{a}	(122.7)	300.1 ^{b}	(84.7)	298.0 ^{b} *	(90.9)
Reduced fat milk	Protein (%)	17.2	(3.0)	17.9	(3.1)	17.1 ^{NS}	(3.2)	15.6 ^{a}	(2.6)	17.7 ^{b}	(3.4)	17.5 ^{b} ^^*	(2.7)
	Fat (%)	36.7	(6.4)	33.9	(5.1)	34.6 ^{NS}	(6.5)	37.4 ^{a}	(5.6)	33.3 ^{b}	(6.4)	33.9 ^{b} ^^*	(5.6)
	CHO (%)	45.7	(5.4)	47.8	(5.5)	47.9 ^{NS}	(6.0)	46.6	(5.2)	48.8	(6.5)	48.4 ^{NS}	(5.6)
	Dietary fibre (g)	24.7	(7.0)	28.3	(8.6)	25.1 ^{NS}	(7.2)	27.0 ^{a}	(7.7)	30.4 ^{b}	(9.3)	26.6 ^{a}	(6.7)
	Calcium (mg)	885.2 ^{a}	(213.7)	923.5 ^{a}	(242.2)	1094.4 ^{b} ^**	(262.3)	930.1 ^{a}	(210.2)	1042.0 ^{b}	(170.1)	1261.2 ^{c} ^**~	(259.9)
	Iron (mg)	14.2	(3.9)	15.0	(3.6)	14.5 ^{NS}	(4.1)	13.9 ^{a}	(3.3)	17.0 ^{b}	(6.9)	15.6 ^{b} ^	(4.2)
	Folate (µg)	337.6	(117.0)	333.7	(94.4)	343.6 ^{NS}	(121.4)	304.4 ^{a}	(86.3)	370.4 ^{b}	(150.4)	371.3 ^{b} ^**	(94.2)
Cheese	Protein (%)	16.6	(2.5)	16.4	(2.7)	15.9 ^{NS}	(2.7)	16.2	(2.9)	16.0	(2.9)	15.8 ^{NS}	(2.3)
	Fat (%)	36.4 ^{a}	(5.6)	37.5 ^{ab}	(4.8)	39.0 ^{b} *	(5.0)	36.3 ^{a}	(6.2)	37.1 ^{a}	(5.4)	39.7 ^{b} **#	(5.4)
	CHO (%)	46.7 ^{a}	(5.5)	45.7 ^{ab}	(5.1)	44.7 ^{b}	(5.7)	47.3 ^{a}	(601.0)	46.5 ^{a}	(5.0)	44.2 ^{b} **#	(5.2)
	Dietary fibre (g)	23.5	(7.9)	23.4	(6.3)	22.8 ^{NS}	(6.3)	25.5	(7.2)	25.3	(6.8)	25.0 ^{NS}	(7.4)
	Calcium (mg)	867.4 ^{a}	(212.8)	880.6 ^{a}	(187.8)	995.1 ^{b} **~	(231.0)	924.5 ^{a}	(247.5)	977.3 ^{a}	(243.3)	1081.3 ^{b}	(247.8)
	Iron (mg)	14.0 ^{a}	(3.5)	13.6 ^{a}	(3.3)	12.6 ^{b} *	(2.9)	13.8	(3.8)	14.0	(4.3)	14.0 ^{NS}	(4.4)
	Folate (µg)	325.9	(117.5)	315.5	(92.6)	301.0 ^{NS}	(91.9)	317.1	(113.9)	310.5	(92.3)	306.4 ^{NS}	(97.3)
Yoghurt	Protein (%)	16.3 ^{ab}	(2.1)	15.4 ^{a}	(2.4)	17.6 ^{b}	(3.8)	15..6 ^{a}	(2.8)	15.6 ^{a}	(2.8)	17.2 ^{b} *#	(2.8)
	Fat (%)	37.6 ^{a}	(4.7)	37.8 ^{a}	(4.8)	33.5 ^{b} *#	(6.1)	37.4 ^{a}	(5.6)	36.4 ^{a}	(7.0)	33.4 ^{b} *	(6.0)
	CHO (%)	45.6	(5.2)	46.6	(5.0)	48.4 ^{NS}	(6.1)	46.8	(5.2)	47.3	(6.6)	49.0 ^{NS}	(5.6)
	Dietary fibre (g)	23.7 ^{a}	(6.1)	24.7 ^{ab}	(7.2)	28.9 ^{b}	(11.0)	26.0 ^{a}	(6.3)	25.5 ^{a}	(7.8)	30.8 ^{b} *#	(9.7)
	Calcium (mg)	944.0	(272.3)	987.6	(249.2)	1032.9 ^{NS}	(202.2)	936.3 ^{a}	(229.1)	1057.4 ^{b}	(240.5)	1166.8 ^{b} ^**	(265.8)
	Iron (mg)	14.0	(3.6)	13.8	(3.8)	14.4 ^{NS}	(3.1)	14.1 ^{a}	(4.3)	13.7 ^{a}	(4.1)	17.3 ^{b} *~	(6.4)
	Folate (µg)	293.8 ^{a}	(86.2)	291.5 ^{a}	(62.4)	364.6 ^{b} *#	(137.4)	320.2 ^{a}	(90.7)	309.5 ^{a}	(97.2)	383.5 ^{b} #	(149.5)

^{abc} Different superscripts are significantly different (P <0.05) between low, medium and high consumers within each sex: ^, P <0.01 between low and medium consumers; ^^, P<0.001 between low and medium consumers; *, P <0.01 between low and high consumers; **, P <0.001 between low and high consumers; #, P<0.01 betwen medium and high consumers; ~, P<0.001 between medium and high consumers; NS, not significant (P≥0.05)

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Chapter 3

Analysis of the temporal intake of cereal and dairy products in Irish adults: implications for developing food-based dietary guidelines

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1.1 Introduction

In 1995, a joint Food and Agriculture Organization/World Health Organization consultation called for the establishment of food-based dietary guidelines (FBDG) to translate nutrient goals into food-based guidelines. It also declared that FBDG need to be based on prevailing patterns of food and nutrient intake of the country and be practical, comprehensible, and culturally acceptable to the population for which they are being developed (FAO/WHO, 1996). The Eurodiet project was set up to define practical European guidelines for diet-related disease prevention and health promotion (Eurodiet Working Party 2, 2001). As set out by the Eurodiet series, one of the considerations of defining FBDG within a cultural context covers 'not only eating patterns in terms of what foods are commonly or randomly consumed, but also, when they are consumed' (Kearney *et al.*, 2001).

Although temporal analyses of nutrient intakes have been carried out (Harrington, 2001, Basiotis *et al.*, 1989), a temporal analysis of food intakes has not been carried out in relation to FBDG. Only three studies found in the literature examine food intake over day of the week, but do so in relation to survey duration and not the development of FBDG (Jula *et al.*, 1999, Nicklas *et al.*, 1997, Maisey *et al.*, 1995). This paper is the first of its kind to examine the temporal distribution of food intakes in Ireland with a view to formulating FBDG.

Temporal analysis of food intakes could be very useful for the development of health strategies. Policy-makers would know whether to target increased consumption of certain foods during the week or at weekends, or whether, at certain times of the day, different macronutrient balances require specific attention. For example, previous research has shown that calcium and fibre intakes are lower than recommended in a substantial proportion of the Irish population (Galvin *et al.*, 2001, Hannon *et al.*, 2001), and that dairy products are an important source of calcium while cereal products are an important source of fibre in the Irish diet (Burke *et al.*, 2005). A temporal analysis of cereal and dairy products could potentially show when intakes of cereal and dairy products could be increased, or when the percentage of consumers of these foods could be increased, in order to increase the intakes of calcium and fibre in the population. The North/South Ireland Food Consumption Survey (NSIFCS) database can facilitate the temporal analysis of food consumption, as it provides information on the day and time of every eating occasion throughout the survey week. The present paper sets out to describe the intakes of cereal and dairy products over time of the day and day of the week for potential use in the formulation of FBDG, and to examine the methodological issues that arise during a temporal analysis of food intakes.

3.2 Methods

3.2.1 Survey sample and data collection

The NSIFCS collected food intake data from a random representative sample of adults (aged 18–64 years) from Northern Ireland and the Republic of Ireland. Data were collected from 1997 to 1999, with no particular time period excluded. Data collection was seasonally balanced and divided into two seasons: winter (September–February) and summer (March–August). A 7-day food diary (estimated) was used to record food intake, and details of the time and day of food consumption were also collected. The food records were analysed using WISP© (Weighed Intake Software Program; Tinuviel Software, Anglesey, UK). WISP© uses McCance and Widdowson's food composition tables (Holland *et al.*, 1995) and published supplements (Chan *et al.*, 1996, Chan *et al.*, 1995, Chan *et al.*, 1994, Holland *et al.*, 1996, Holland *et al.*, 1993, Holland *et al.*, 1992, Holland *et al.*, 1991, Holland *et al.*, 1989 Holland *et al.*, 1988) to generate nutrient data. Only data from the Republic of Ireland (n = 958) were used in the present study. A more detailed account of the sampling procedure and methodologies for this survey has been given elsewhere (Harrington *et al.*, 2001a, Kiely *et al.*, 2001).

3.2.2 Database

The main nutrient database (food file) consists of approximately 160,000 rows of data that describe every food and drink item consumed by each respondent for every meal for each of the seven recording days. It also contains the day of the week and the time of the day at which the food was consumed. For the purposes of the present study, a new variable 'hour' was created which represented the 30 minutes before and the 29 minutes after the hour (e.g. all foods consumed between 06.30 and 07.29 hours were re-coded as having been consumed at 07.00 hours). As foods consumed between the hours of 01.00 and 06.00 (inclusive) accounted for only 1.6% of the total food consumed and there were few consumers at each time point, foods consumed during that time period have been excluded from these analyses.

3.2.3 Food groups

All cereal and dairy products in the food file were aggregated to form one of 11 food groups. Within the groups of cereal foods, wholemeal bread contained wholemeal and brown bread and rolls; cakes contained cakes, pastries, buns, scones, and biscuits; breakfast cereals contained ready-to-eat breakfast cereals and other breakfast cereals; and total cereals was all cereal products reported along with other breads such as pizza, pitta bread, and tomato bread. Within the groups of dairy foods, reduced-fat milk contained skimmed and low-fat milks, and total dairy contained full-fat milk, reduced-fat milk, cheese, yoghurt, cream, and ice cream. Cereal and dairy products from recipes were not included in this analysis because to do would not give a true representation of the times at which cereal or dairy products were consumed, as people consume whole foods and not ingredients.

3.2.4 Data analysis

Data analysis was carried out using SPSS version 10.0 (SPSS Inc., Chicago, IL, USA). Means and standard deviations were determined for intakes of cereal and dairy products (g) for each day and hour. The mean values were determined for consumers of the food group only and not for the total population. Intakes of cereal and dairy products by day of the week were calculated by summing the amount of each food group consumed every day by each respondent, then calculating the mean per day for these consumers. Thus, the total amount consumed on a particular day could be compared with the total amount consumed on any other day. The percentage of consumers of each food group was also calculated for each day.

In contrast to the above, intakes per hour were computed by calculating the mean amount of cereal and dairy products consumed by each respondent at each hour, then calculating the mean per hour for these consumers. Thus, the amount consumed per hour reflected the average amount consumed at the hour regardless of the day, and did not show the total amount of the food group consumed at that hour over the course of the week. The percentage of consumers was also calculated for each hour. To control for the small number of consumers at some hours, the amount of each food group consumed at each hour was expressed as a percentage of the total food group consumed over the week for each individual.

Mean intakes of cereal and dairy products by day and by hour were also examined by tertiles of cereal and dairy consumption and tertiles of fat (percentage contribution to energy) and fibre (g per MJ of energy) intake. These two nutrients were chosen because of their public health nutrition importance in Ireland as found by Harrington *et al.* (2001b) and Galvin *et al.* (2001).

3.2.5 Statistical analysis

The data were assessed for normality. As they did not fit a normal distribution, the data were transformed using a square-root transformation to normalise them, which allowed for parametric tests to be performed. A two-way analysis of variance (ANOVA) was used to determine whether significant differences in food group intakes existed between day of the week and sex and whether an interaction effect was present between the variables (i.e. day of the week and sex). A three-way ANOVA was used to determine whether significant differences in food group intake existed between day of the week, sex and age group or tertile groups (of cereal and dairy consumption, fat intake or fibre intake), and whether an interaction effect was present between the variables. When significant differences existed, homogeneity of variance was tested using Levene's test. For values that complied with Levene's test, the Scheffe *post hoc* test was used to identify the mean values that differed significantly. The Tamhane *post hoc* was used for those that did not comply with Levene's test. Values at $P<0.05$ were taken as significantly different.

3.3 Results

Table 3.1 shows the mean intake (g) and percentage of consumers for each of the cereal and dairy food groups over day of the week. Two-way ANOVA identified significant main effects for sex and weekday but there was no significant interaction effect between them. Men had significantly higher intakes of all cereal and dairy products than women (data not shown) ($P<0.05$). The intake of white bread on Sunday was significantly lower than on all other days except Saturday ($P<0.001$). The intake of total cereals was significantly lower on Sunday than all other days of the week ($P<0.001$). The intake of full-fat milk on

Sunday was significantly lower than intakes on Monday to Thursday ($P< 0.01$), while intakes of total dairy on Saturday and Sunday were significantly lower than intakes on Monday to Thursday ($P<0.01$). Intakes of breakfast cereals, cheese, and yoghurt also decreased very slightly at the weekend, but not significantly so. Intakes of wholemeal bread, cakes, rice and pasta, and reduced-fat milk showed little variation over the course of the week. The percentage of consumers for nearly all cereal and dairy food groups also decreased on Saturday and/or Sunday. Three-way ANOVA did not identify any significant interaction effects for age, sex and weekday or age and weekday (data not shown).

Table 3.2 presents the mean intake (g) and percentage of consumers for each cereal and dairy food group over hour of the day. Mean intakes of cereal and dairy products across hour of the day did not show clear patterns, as small numbers of consumers at certain hours skewed the data. However, when percentage of consumers was examined, definite temporal patterns emerged for each of the food groups. The percentage of consumers of white bread, wholemeal bread, total cereals, full-fat milk, reduced-fat milk, and total dairy showed consistent mealtime peaks for morning (07.00–11.00 hours), afternoon (13.00–15.00 hours), and early evening (18.00–20.00 hours). Percentage of consumers of cakes showed a snacking pattern throughout the day. Rice and pasta consumers demonstrated a slight afternoon and a main early evening peak. Percentage of consumers of breakfast cereals showed a definite morning peak. Cheese and yoghurt consumers demonstrated mainly afternoon peaks along with smaller peaks in the evening.

In an attempt to further clarify patterns of cereal and dairy consumption throughout the day, the intake of cereal and dairy products at each hour was expressed as a percentage of the total of each food group consumed over the week (Table 3.3). Intakes of white bread showed the same mealtime peaks as had percentage of consumers, but with intakes in the afternoon much higher than in the morning or early evening. Wholemeal bread also showed the same pattern, but with intakes in the morning and afternoon higher than intakes in the evening. Cakes still demonstrated a snacking pattern, but with slightly higher intakes in the earlier part of the day. Rice and pasta, breakfast cereals, total cereals, and full-fat milk showed very similar patterns as were shown with percentage of consumers. Reduced-fat milk still showed mealtime patterns, but with consumption in the morning much higher than at the other mealtimes. Cheese and yoghurt also showed the same afternoon and early evening peaks, but clearly higher consumption in the afternoon. They also showed a slight late morning (10.00–11.00 hours) peak. Total dairy revealed the same mealtime peaks as percentage of consumers.

Intakes of cereal and dairy products by day of the week were analysed by tertile of cereal and tertile of dairy product consumption, and are presented in Tables 3.4 (cereal products) and 3.5 (dairy products). For low (i.e. those in the first tertile) and medium (i.e. those in the second tertile) consumers of white bread, wholemeal bread, cakes, rice and pasta, breakfast cereals, full-fat milk, and cheese, the intakes remained relatively constant over the course of the week. However, high consumers (i.e. those in the third tertile) of white bread, breakfast cereals, full-fat milk, and reduced-fat milk had lower intakes at the weekend than during the week. All consumers of total cereals and total dairy had lower intakes on Saturday and/or Sunday regardless of tertile. A three-way ANOVA showed main effects of sex and tertile for all cereal and dairy products and main effects of weekday for white bread, total cereals, full-fat milk, reduced-fat milk and total dairy. It also showed interaction effects of weekday and tertile of consumption for white bread ($P<0.001$), full-fat milk ($P<0.01$), and total dairy ($P<0.01$). Further examination of the interaction effect revealed that differences across day of the week were significant only for high consumers of white bread, high consumers of full fat milk, and medium and high consumers of total dairy.

Intakes of cereal and dairy products over day of the week were also examined by tertile of percentage energy from fat and tertile of fibre intake (per MJ of energy) (data not shown). A three-way ANOVA did not show an interaction effect of weekday, and tertile of fat or fibre. Overall, a decrease at the weekend was observed for intakes of white bread, breakfast cereals, total cereals, full fat milk, cheese (for tertiles of fibre intake only), and total dairy.

Mean intakes of cereal and dairy products by tertile of intake, (percentage energy from) fat or fibre (per MJ of energy) per hour did not show any clear patterns due to small numbers of consumers at certain hours. Again, this was controlled for by expressing the intakes of cereal and dairy products at each hour as a percentage of the total consumed for each of the tertiles. In general, the same mealtime patterns emerged for all cereal and dairy products as described above for Table 3.3, regardless of tertile. However, low fibre consumers tended to have a slightly later morning peak for consumption of wholemeal bread, breakfast cereals, total cereals, reduced-fat milk, and total dairy than medium and high consumers. Intakes of breakfast cereals and yoghurt by tertiles of intake, fat, and fibre are presented in Figures 3.1 and 3.2 to demonstrate how the same mealtime patterns emerge when the number of consumers is controlled for. Even when the patterns vary slightly over the course of the day according to different tertiles (e.g. yoghurt), the same basic mealtime patterns (e.g. main peak at lunch with slight peak at late morning and evening) can be seen for each tertile.

3.4 Discussion

FBDG need to be based on prevailing dietary patterns and must account for the socio-economic and cultural factors of the country for which they are being developed (FAO/WHO, 1996). The cultural context of food consumption should include, among other factors, the time at which foods are consumed, that is the temporal distribution of food intake (Kearney *et al.*, 2001). A temporal analysis of food intakes is potentially important in understanding patterns of food consumption and could therefore be very important for the development of effective FBDG.

The present temporal analysis of food intakes includes analysis of day of the week and time of the day at which foods were consumed. Examining food intakes over time of the day is a novel method of analysis, which also avoids between-subject variation that might be found if food intake were examined based on meal occasion. As there is no scientific definition of meal occasion, it was self defined by the respondents in the present study and so assessing food intakes by time of day was deemed a more precise method of analysis. A number of studies were found in the literature which examine the temporal distribution of nutrients (Harrington, 2001, Basiotis *et al.*, 1989). Three studies were found that present information on food intake for day of the week, only one of which presents data for an adult population (Jula *et al.*, 1999). Of the two other studies, one was based on an elderly population (Maisey *et al.*, 1995) and one was based on 10-year-old children (Nicklas *et al.*, 1997) where data were presented as the percentage contribution of foods to energy and not as absolute food intakes. Moreover, these studies examined large aggregated food groups, which makes comparisons with the present study very difficult. The focus of these studies was not to present detailed results that could be used in the development of FBDG, but rather to conclude that weekend days need to be included in food consumptions surveys to characterise food consumption patterns accurately.

Many methodological issues arise when examining the temporal distribution of food groups; however, this is not reported in the majority of published papers. The first issue in temporal analysis is whether mean intakes should be examined for the total population or for consumers of the food group. Mean intakes for the total population could include a large number of zero values at certain time points, which would lower the overall mean intakes and therefore not give a true representation of intakes for those who consume the foods. In the present study, it was decided to examine both percentage of consumers of the target foods and mean intakes for consumers only, given that – for temporal analysis or FBDG – interest lies only with those who consume the foods.

Many different calculation methods can be used when analysing the temporal distribution of foods and should be taken into account when making comparisons with other peer-reviewed papers. However, most publications do not give detailed accounts of how mean intakes were calculated. In the present study, calculation of the mean intakes over day of the week was performed by summing the amount of each food group consumed every day by each respondent, and then computing the mean per weekday for these consumers. This allowed comparison of the amount of the food groups consumed on one day with the amount consumed on any other day of the week. However, when calculating mean intakes over time of the day, a different approach was used. Intakes per hour were assessed by calculating the mean amount of each food group consumed by each respondent at the hour and then computing the mean per hour for these consumers. This method calculated the average amount of the food group consumed at that hour over the course of the week, regardless of the day. For example, if a person consumed 70g of white bread at 13.00 hours every day for 5 days, calculating the mean per respondent and then the mean for the population tells us that the average amount consumed by that respondent is 70g. This method was used so that the amount consumed per hour reflected the average amount consumed at the hour regardless of the day, and did not show the total amount of the food group consumed at that hour over the course of the week. Mean food group intakes over hour of the day were confounded by small numbers of consumers at certain hours, which tended to skew the data. Additional analyses were carried out to try to control for this confounding factor. The amount of the food group consumed at each hour was expressed as a percentage of the total food group consumed over the week, which gave a more realistic pattern of consumption over the course of the day and showed either a definite mealtime or snacking pattern for all food groups.

One of the major methodological issues with the present study was statistical analysis. It was deemed inappropriate to carry out statistical analysis on mean intakes over the hour. Statistical analysis of 11 different food groups over 18 hours would involve too many combinations to find a meaningful statistical significance. Statistical analysis could not be carried out on food groups consumed at each hour. This was because the most meaningful comparisons involved expressing the amount of the target food consumed at the hour as a percentage of the total consumed, which generated one value at each hour as opposed to a range of values. For the present study, trends were deemed more important than statistically significant differences.

Maisey *et al.* (1995) and Jula *et al.* (1999) reported little variation in intakes of cereals and dairy products over day of the week. These results support the findings of the present study. Although intakes of total cereal products and total dairy products were found to be significantly lower at the weekends, the largest difference was 53g for cereals and 50g for dairy products, which is not a substantial amount in terms of establishing FBDG. For example, 50g of total dairy products or total cereal products contributes to approximately 2.4g and 2.5g of fat respectively in Irish adults, which is not a considerable amount relative to achieving fat guidelines. Intakes of full-fat milk and white bread were also significantly lower at the weekend, but not by a large amount. In the present study, intakes of cereal and dairy products over time of the day (when controlled for the numbers of consumers) showed clear mealtime or snacking patterns, but do not show anything different to what would be expected. Temporal analysis on the intakes of cereal and dairy products by tertile of intake, tertile of percentage energy from fat and tertile of fibre intake (per MJ) did not show radical differences between low, medium and high consumers of the foods or nutrients, and showed little variation across day of the week and time of the day.

Food intake data are generally presented as mean intakes; however, a lot of important information relating to food consumption patterns can be lost this way. This problem could be minimised by presenting intakes over day of the week or time of the day. Temporal analysis of food intakes could be extremely useful in the development of FBDG, and the need for such has been highlighted in the reports of the Eurodiet project (Kearney *et al.*, 2001). Data presented in this paper could be used when developing FBDG. For example, the intake of dairy products does not vary much over the course of the week so policies to increase dairy product consumption in order to increase calcium intakes would be very general and not call for increased intakes on any particular day of the week. However, policies to increase fibre intakes could be more specific. Breakfast cereals are a good source of fibre (Burke *et al.*, 2005) and so increased breakfast cereal consumption could be promoted to increase fibre intake. These messages could be targeted later in the day as breakfast cereals are primarily consumed in the morning.

In conclusion, whereas temporal analysis of the distribution of food intake seemed an attractive possibility in deriving FBDG, the present study, which focused on cereal and dairy intake, did not reveal a considerable amount of useful data in this respect. The study has revealed the difficult methodological and statistical issues in temporal distribution studies that have not been addressed in the limited literature available. However, analysis of the intakes of other food groups might prove useful before discarding the idea of temporal patterns of food intake for use in deriving FBDG.

Table 3.1 Mean intake of cereal and dairy products (g) over day of the week for consumers only from the Republic of Ireland

	White Bread			Wholemeal Bread			Cakes			Rice & Pasta			Breakfast Cereals			Total Cereals		
	Mean	(SD)	% Cons	Mean	(SD)	% Cons	Mean	(SD)	% Cons	Mean	(SD)	% Cons	Mean	(SD)	% Cons	Mean	(SD)	% Cons
Monday	118 ^{a}	(76)	73	117	(77)	57	79	(69)	58	196	(114)	26	84	(92)	71	248 ^{a}	(156)	99
Tuesday	120 ^{a}	(82)	70	120	(84)	59	81	(68)	61	203	(110)	32	83	(86)	69	260 ^{a}	(162)	99
Wednesday	120 ^{a}	(81)	72	122	(94)	55	82	(60)	61	206	(111)	24	83	(91)	71	256 ^{a}	(162)	99
Thursday	121 ^{a}	(76)	77	123	(83)	56	79	(61)	62	178	(75)	21	83	(91)	71	256 ^{a}	(159)	99
Friday	121 ^{a}	(81)	74	123	(96)	57	78	(67)	57	190	(111)	27	82	(83)	68	258 ^{a}	(163)	99
Saturday	111 ^{ab}	(70)	76	122	(88)	52	85	(72)	51	203	(115)	24	76	(80)	63	242 ^{a}	(160)	98
Sunday	99 ^{b}	(61)	69	114 ^{ns}	(84)	54	74 ^{ns}	(62)	52	209 ^{ns}	(108)	16	72 ^{ns}	(73)	54	207 ^{b}	(137)	96

	Full Fat Milk			Reduced Fat Milk			Cheese			Yoghurt			Total Dairy		
	Mean	(SD)	% Cons	Mean	(SD)	% Cons	Mean	(SD)	% Cons	Mean	(SD)	% Cons	Mean	(SD)	% Cons
Monday	260 ^{a}	(211)	84	224	(157)	83	46	(39)	38	136	(55)	44	307 ^{a}	(215)	96
Tuesday	258 ^{a}	(228)	86	219	(159)	83	43	(29)	39	141	(59)	39	309 ^{a}	(229)	96
Wednesday	263 ^{a}	(232)	85	229	(180)	84	44	(32)	39	141	(65)	39	312 ^{a}	(238)	97
Thursday	259 ^{a}	(228)	85	221	(184)	82	45	(34)	42	132	(52)	39	305 ^{a}	(235)	97
Friday	247 ^{ab}	(244)	87	206	(175)	85	44	(28)	43	136	(53)	37	299 ^{ab}	(247)	96
Saturday	232 ^{ab}	(213)	82	211	(155)	78	44	(34)	37	140	(70)	29	271 ^{bc}	(214)	96
Sunday	217 ^{b}	(186)	80	206 ^{ns}	(147)	81	39 ^{ns}	(29)	31	127 ^{ns}	(55)	22	259 ^{c}	(195)	96

^{abc} Different superscripts are significantly different($P<0.05$) over day of the week by two way ANOVA; NS, not significant

Table 3.2 Mean intake of cereal and dairy products (g) over time of the day in consumers (cons) only from the Republic of Ireland

	White Bread			Wholemeal Bread			Cakes			Rice & Pasta			Breakfast Cereals			Total Cereals		
	Mean	(SD)	% cons	Mean	(SD)	% cons	Mean	(SD)	% cons	Mean	(SD)	% cons	Mean	(SD)	% cons	Mean	(SD)	% cons
07.00	55	(30)	11	71	(42)	10	38	(22)	2	0	.	0	68	(67)	20	62	(44)	22
08.00	52	(25)	30	70	(48)	26	49	(36)	4	0	.	0	76	(82)	48	66	(54)	54
09.00	54	(25)	37	70	(33)	35	62	(55)	5	0	.	0	75	(78)	52	66	(46)	62
10.00	63	(33)	41	74	(41)	31	59	(41)	16	0	.	0	74	(85)	41	69	(50)	65
11.00	63	(32)	36	79	(44)	24	52	(37)	32	42	.	0	70	(75)	26	64	(42)	65
12.00	66	(33)	24	81	(49)	13	54	(46)	21	129	(89)	2	59	(48)	11	66	(43)	45
13.00	78	(30)	56	87	(41)	41	52	(34)	37	154	(95)	13	87	(115)	5	77	(42)	76
14.00	80	(37)	46	82	(40)	30	51	(38)	34	160	(85)	11	60	(41)	3	78	(43)	67
15.00	72	(33)	20	67	(30)	10	48	(37)	23	179	(107)	5	43	(14)	1	67	(52)	39
16.00	70	(32)	13	77	(47)	7	46	(34)	30	157	(71)	4	26	(11)	1	60	(40)	40
17.00	77	(42)	16	79	(44)	10	48	(38)	24	161	(79)	8	48	(29)	1	71	(50)	37
18.00	74	(36)	36	85	(50)	29	50	(38)	33	193	(107)	30	66	(46)	1	87	(60)	65
19.00	76	(34)	38	91	(51)	26	55	(49)	32	210	(92)	36	58	(46)	1	93	(67)	67
20.00	71	(33)	22	82	(44)	18	51	(48)	27	211	(120)	16	77	(61)	2	85	(70)	49
21.00	69	(35)	18	83	(48)	13	46	(34)	26	218	(111)	13	56	(33)	2	76	(64)	43
22.00	67	(32)	23	67	(38)	11	44	(31)	34	188	(93)	4	51	(38)	4	61	(47)	50
23.00	56	(25)	14	66	(38)	7	46	(32)	21	224	(101)	2	45	(28)	4	60	(47)	34
24.00	70	(32)	9	66	(33)	4	47	(33)	9	190	(118)	1	39	(12)	2	61	(41)	17

Table 3.2 contd Mean intake of cereal and dairy products (g) over time of the day in consumers (cons) only from the Republic of Ireland

	Full Fat Milk			Reduced Fat Milk			Cheese			Yoghurt			Total Dairy		
	Mean	(SD)	% cons	Mean	(SD)	% cons	Mean	(SD)	% cons	Mean	(SD)	% cons	Mean	(SD)	% cons
07.00	80	(57)	21	74	(43)	21	35	(25)	2	89	(31)	1	77	(54)	24
08.00	72	(47)	46	73	(43)	54	34	(28)	4	117	(52)	6	72	(45)	56
09.00	69	(47)	54	73	(43)	55	32	(20)	5	104	(38)	7	70	(44)	64
10.00	65	(67)	59	76	(64)	54	41	(30)	10	115	(34)	9	66	(60)	68
11.00	60	(57)	60	63	(57)	55	38	(23)	11	131	(27)	8	61	(50)	67
12.00	61	(63)	44	56	(49)	33	31	(13)	8	152	(85)	8	61	(54)	51
13.00	72	(74)	66	61	(58)	58	39	(24)	41	124	(35)	31	66	(58)	79
14.00	79	(114)	60	64	(75)	49	38	(22)	33	123	(33)	20	71	(93)	74
15.00	71	(82)	39	64	(86)	29	37	(24)	12	123	(33)	7	67	(74)	46
16.00	61	(79)	43	69	(93)	35	33	(16)	7	123	(44)	10	63	(74)	51
17.00	70	(81)	39	72	(86)	31	34	(27)	8	110	(37)	10	69	(77)	48
18.00	79	(87)	58	76	(80)	54	36	(21)	21	120	(38)	17	76	(76)	73
19.00	81	(88)	57	72	(70)	53	35	(20)	23	136	(38)	20	78	(76)	72
20.00	70	(88)	41	81	(106)	35	36	(23)	14	121	(44)	12	71	(84)	52
21.00	66	(87)	41	54	(46)	36	38	(29)	12	131	(48)	11	65	(75)	52
22.00	66	(74)	44	58	(59)	38	33	(28)	14	137	(36)	8	63	(66)	55
23.00	62	(65)	29	77	(94)	29	36	(24)	7	118	(35)	5	65	(70)	37
24.00	73	(79)	16	84	(98)	15	31	(15)	4	141	(44)	3	74	(80)	20

Table 3.3 Cereal and dairy products consumed at each hour as a percentage of the total consumed

Hour	White Bread	Wholemeal Bread	Cakes	Rice & Pasta	Breakfast Cereals	Total Cereals	Full Fat Milk	Reduced Fat Milk	Cheese	Yoghurt	Total Dairy
07.00	2.2	3.0	0.3	0.0	8.9	2.8	3.7	4.4	0.8	0.4	3.4
08.00	5.9	9.6	1.1	0.0	32.2	9.4	9.5	13.6	2.3	2.4	9.3
09.00	6.8	11.9	1.6	0.0	27.5	9.5	9.6	11.6	1.9	3.7	9.1
10.00	9.1	9.7	5.5	0.0	14.7	8.4	7.8	9.3	6.0	5.1	7.7
11.00	7.0	5.7	9.2	0.0	6.8	6.2	6.3	5.8	5.1	5.1	5.9
12.00	4.1	3.6	4.8	0.7	2.3	3.4	4.0	2.8	2.8	4.0	3.7
13.00	16.3	14.1	10.7	6.9	1.7	11.2	9.8	8.0	21.7	22.5	10.7
14.00	11.0	7.7	8.2	5.8	0.5	7.6	7.5	4.9	14.1	9.8	7.7
15.00	3.3	1.8	4.6	2.4	0.2	2.6	3.1	2.4	4.3	3.0	3.1
16.00	2.1	1.2	6.2	2.0	0.1	2.3	3.4	3.1	2.0	4.1	3.4
17.00	2.6	2.1	5.2	4.2	0.2	2.8	3.6	3.8	2.6	3.4	3.7
18.00	7.2	9.5	8.5	22.8	0.2	8.4	7.9	8.5	8.0	8.6	8.2
19.00	7.8	7.8	8.2	28.9	0.2	9.0	7.6	6.9	8.7	9.9	7.8
20.00	3.4	3.9	5.8	11.7	0.4	4.7	3.3	3.5	5.6	5.2	3.7
21.00	2.6	3.5	5.5	9.2	0.4	3.8	3.4	2.9	4.7	4.8	3.5
22.00	3.6	2.1	7.1	2.7	0.8	3.5	3.7	3.2	4.3	3.7	3.7
23.00	1.9	1.2	4.5	1.6	0.6	2.1	2.2	2.9	2.2	2.0	2.3
24.00	1.3	0.7	1.8	0.6	0.3	1.0	1.5	1.3	1.1	1.1	1.4

Table 3.4 Mean intake of cereal products (g) over day of the week by tertiles of intake

	White Bread *									Wholemeal Bread									Cakes etc.								
	Low cons			Medium cons			High cons			Low cons			Medium cons			High cons			Low cons			Medium cons			High cons		
	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)
Day																											
Monday	69	180	(38)	104	224	(49)	166	248	(88)	65	105	(29)	99	158	(44)	172	148	(93)	35	139	(24)	64	172	(39)	126	184	(85)
Tuesday	67	165	(37)	103	217	(47)	171	246	(97)	64	113	(29)	94	144	(39)	181	168	(98)	38	139	(26)	66	182	(38)	123	204	(83)
Wednesday	67	187	(32)	106	216	(51)	176	237	(95)	62	108	(27)	99	142	(48)	189	147	(117)	40	137	(27)	70	190	(38)	122	199	(69)
Thursday	69	192	(37)	108	239	(55)	172	257	(84)	58	101	(28)	103	147	(42)	184	155	(94)	36	151	(22)	68	189	(38)	123	192	(72)
Friday	67	188	(35)	106	229	(54)	176	244	(94)	60	105	(28)	97	147	(44)	189	161	(117)	38	142	(25)	66	170	(37)	121	180	(84)
Saturday	64	200	(33)	101	234	(53)	157	247	(77)	56	88	(26)	99	133	(44)	179	153	(103)	37	121	(25)	77	140	(45)	124	178	(87)
Sunday	67	174	(38)	90	213	(44)	132	227	(72)	60	107	(28)	92	137	(43)	174	150	(102)	36	125	(24)	62	159	(38)	115	165	(75)

	Rice and Pasta									Breakfast Cereals									Total Cereals *								
	Low cons			Medium cons			High cons			Low cons			Medium cons			High cons			Low cons			Medium cons			High cons		
	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)
Day																											
Monday	99	34	(43)	187	41	(46)	322	29	(120)	30	142	(8)	51	167	(19)	154	185	(118)	146	311	(79)	223	317	(98)	372	319	(174)
Tuesday	118	40	(62)	188	47	(44)	301	42	(121)	29	136	(8)	49	158	(14)	151	186	(106)	148	308	(78)	238	319	(112)	390	318	(174)
Wednesday	120	30	(59)	204	34	(52)	285	33	(131)	29	149	(8)	50	162	(21)	155	187	(114)	152	312	(90)	238	316	(110)	376	318	(181)
Thursday	119	26	(53)	179	29	(40)	231	29	(81)	30	153	(8)	47	148	(16)	153	193	(113)	151	310	(72)	238	317	(102)	376	318	(185)
Friday	91	34	(49)	185	37	(50)	286	37	(113)	30	140	(9)	47	150	(16)	150	184	(100)	149	308	(81)	245	317	(118)	377	318	(181)
Saturday	115	30	(57)	185	32	(48)	300	33	(127)	30	135	(7)	50	140	(17)	136	164	(105)	139	313	(83)	234	311	(112)	351	315	(186)
Sunday	110	14	(64)	185	32	(38)	321	19	(118)	30	121	(7)	50	119	(18)	127	140	(95)	122	298	(72)	194	312	(101)	300	313	(157)

* denotes significant combined effect of day and tertile using three-way ANOVA

Table 3.5 Mean intake of dairy products (g) over day of the week by tertiles of intake

	Full Fat Milk *									Reduced Fat Milk									Cheese								
	Low cons			Medium cons			High cons			Low cons			Medium cons			High cons			Low cons			Medium cons			High cons		
	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)
Day																											
Monday	83	188	(67)	209	259	(114)	427	277	(223)	94	73	(57)	183	96	(70)	370	91	(162)	23	72	(10)	40	99	(17)	70	97	(52)
Tuesday	75	196	(58)	195	263	(99)	448	278	(249)	92	74	(57)	182	91	(68)	355	93	(175)	23	82	(11)	38	93	(13)	65	103	(35)
Wednesday	81	186	(59)	207	267	(112)	436	280	(267)	93	78	(62)	186	92	(88)	387	93	(197)	23	84	(11)	38	89	(16)	66	105	(39)
Thursday	76	193	(58)	197	264	(94)	449	275	(254)	84	76	(44)	170	89	(69)	387	90	(211)	22	77	(10)	36	104	(16)	68	117	(41)
Friday	71	203	(51)	183	265	(102)	436	279	(292)	76	80	(47)	179	90	(89)	340	95	(208)	24	97	(11)	37	98	(14)	67	114	(32)
Saturday	70	180	(52)	182	253	(118)	386	273	(243)	82	68	(54)	179	88	(73)	343	87	(168)	22	73	(11)	39	92	(14)	65	100	(44)
Sunday	74	171	(67)	172	252	(100)	349	269	(211)	87	66	(50)	174	93	(91)	323	93	(155)	21	82	(10)	35	70	(16)	63	71	(37)

	Yoghurt									Total Dairy *								
	Low cons			Medium cons			High cons			Low cons			Medium cons			High cons		
	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)	Mean	*n*	(SD)
Day																		
Monday	92	25	(38)	125	68	(2)	181	40	(76)	131	286	(83)	274	315	(126)	498	318	(217)
Tuesday	102	26	(31)	127	50	(16)	181	44	(78)	127	281	(80)	261	318	(111)	519	319	(241)
Wednesday	103	28	(34)	125	53	(3)	192	37	(92)	133	291	(86)	273	319	(120)	516	317	(268)
Thursday	93	30	(41)	125	57	(1)	181	33	(68)	120	294	(74)	261	315	(117)	519	318	(251)
Friday	105	23	(36)	125	61	(10)	183	29	(80)	120	286	(75)	254	315	(115)	504	318	(292)
Saturday	90	22	(37)	125	33	(2)	190	32	(91)	111	287	(78)	237	312	(120)	449	319	(237)
Sunday	93	21	(44)	125	29	(1)	172	18	(79)	117	283	(79)	225	316	(111)	420	315	(218)

* denotes significant combined effect of day and tertile using three-way ANOVA

Figure 3.1 Intake of breakfast cereals at each hour as a % of total consumed for tertiles of breakfast cereal intake, tertiles of fat intake and tertiles of fibre intake

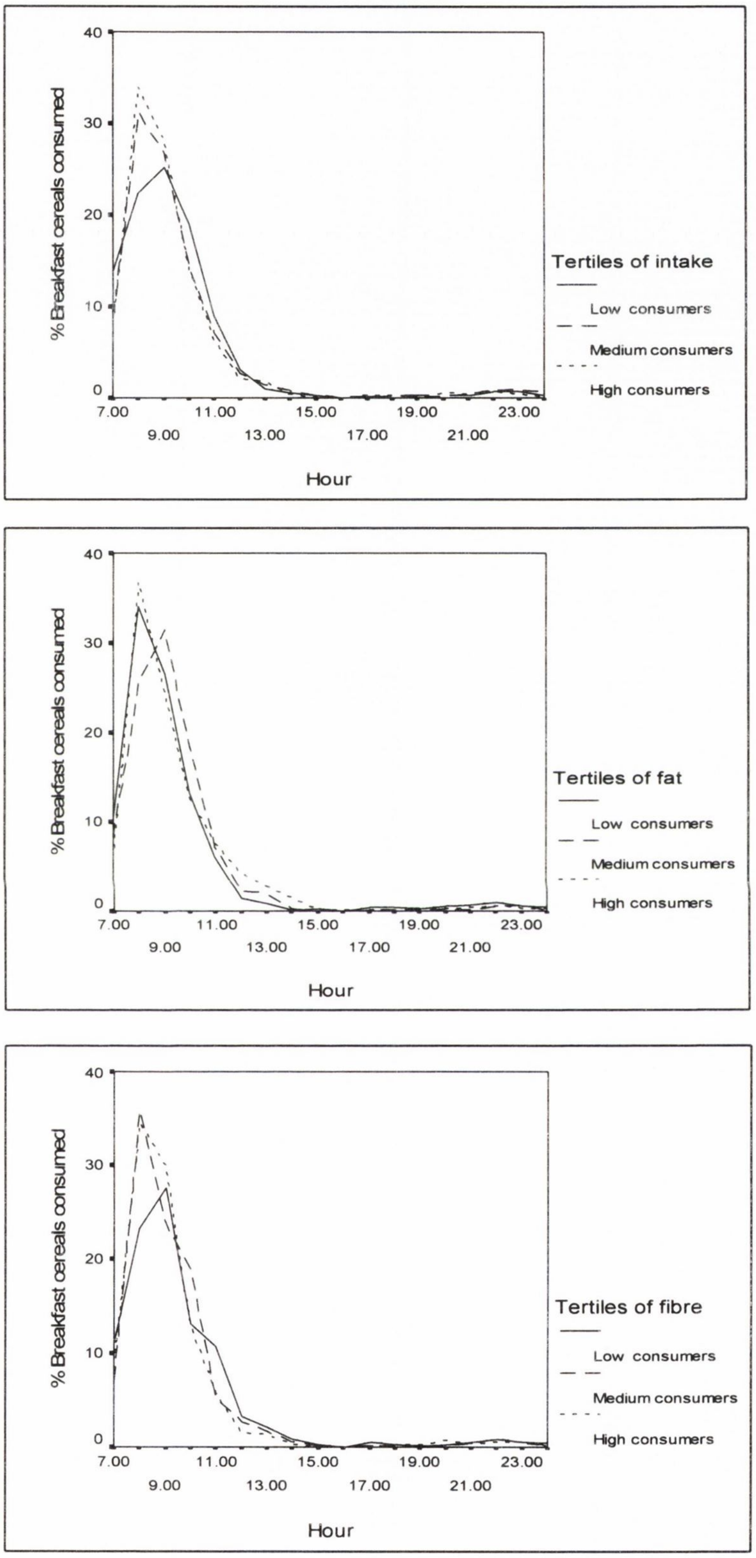
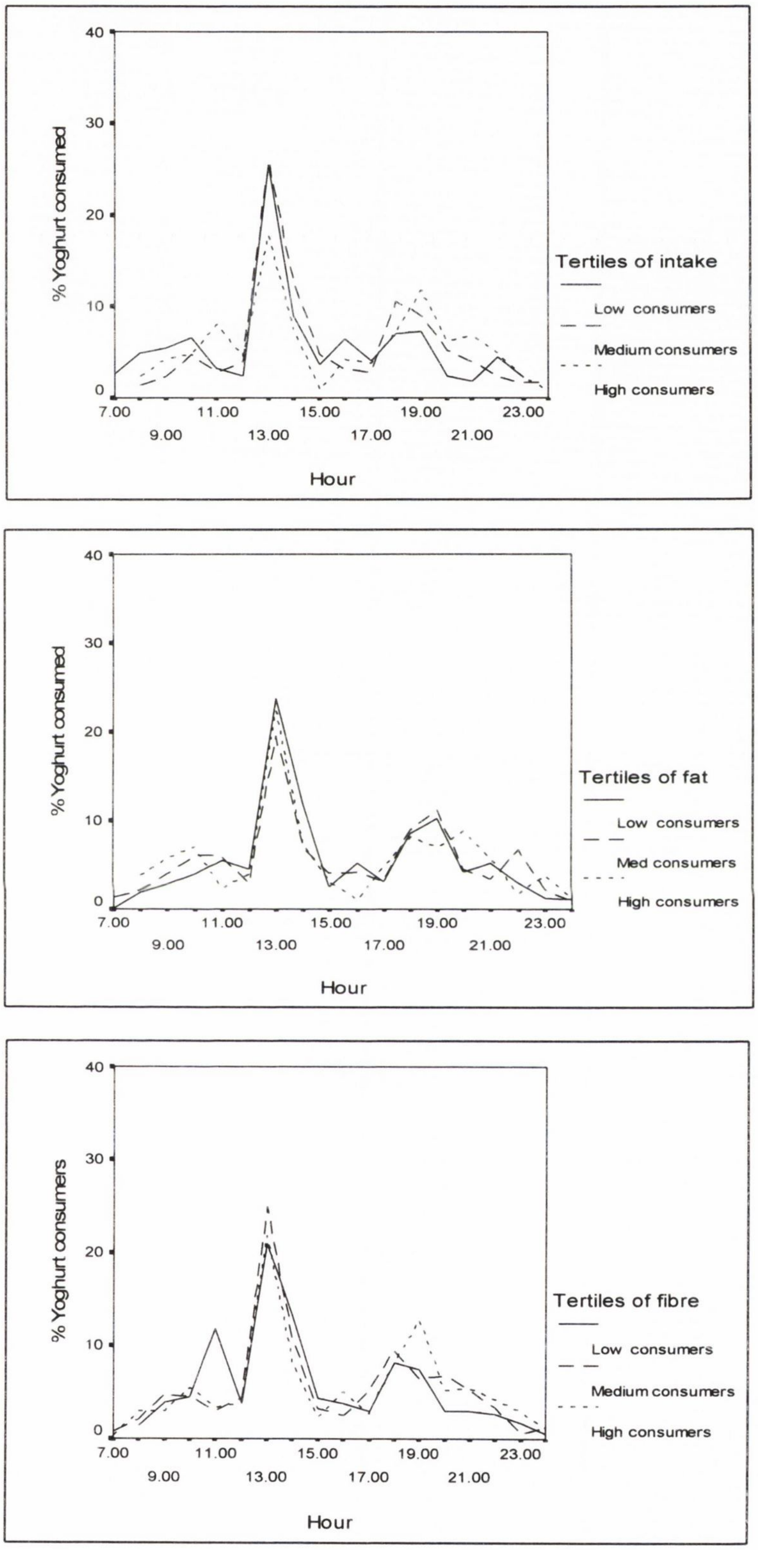


Figure 3.2 Intake of yoghurt at each hour as a % of total consumed for tertiles of yoghurt intake, tertiles of fat intake and tertiles of fibre intak



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Chapter 4

Key findings from the National Children's Food Survey of Irish children aged 5-12 years

4.1 Introduction

The relationship between diet and health is complex and it is recognised that health is influenced by interactions between diet and other factors, including: adiposity; lifestyle; and physical activity levels. In addition, education level and attitudes to food and health are important influences on eating behaviour and dietary change. For these reasons, the National Children's Food Survey (NCFS) was designed to provide quantitative food consumption data separately for all eating occasions over each of seven days at the level of the individual. It is therefore suitable for a wide range of applications related to food safety and nutrition. The extensive electronic database, which has been compiled from this survey based on a representative sample of 5-12 year old children from the Republic of Ireland, is the most complete and up-to-date collection of food consumption data available for children in Ireland and is one of the most comprehensive of its kind in Europe. It represents a very valuable resource, which will be used by agencies concerned with public health policy and planning, and consumer health protection in Ireland and Europe, and by the food industry.

This aim of this summary paper is to describe the methods used and the key findings with regard to food and beverage consumption, nutrient intakes, and anthropometry from the survey.

4.2 Methods

4.2.1 Sampling

The analysis for this paper is based on data from the NCFS, a cross-sectional study that was carried out between March 2003 and March 2004 by the nutrition units in University College Cork and Trinity College Dublin, which form part of the Irish Universities Nutrition Alliance (IUNA). Children aged 5-12 years (293 boys, 301 girls) were selected from 28 primary schools throughout the Republic of Ireland.

4.2.2 Selection of schools

Schools were selected from a database of primary schools available from the Department of Education and Science. All schools in the database that contained at least 8 students in each of the eight classes *(n=1194)* were classified according to (a) size ('large' (more than 300 pupils), 'medium' (100 to 300 pupils) or 'small' (fewer than 100 pupils)) (b) gender served ('all boys', 'all girls' or 'mixed') (c) whether disadvantaged or not disadvantaged and (d) location (urban or rural). A number of schools were randomly selected from each category (e.g. medium, mixed, not disadvantaged, urban schools), so that in the final sample, the percentage of children surveyed attending each of the categories of schools was equal to the percentage of children attending each of these categories of schools according to the database. All urban schools selected were located in Cork or Dublin and all rural schools selected were located outside Cork or Dublin.

4.2.3 Respondent recruitment

An introductory letter and information about the survey was posted to the principal of each selected school. This was followed up by a phone call from the coordinating nutritionist in each centre. If the principal agreed to his/her schools participation in the survey, a suitable date and time for the coordinating nutritionist to visit the school was arranged. Over 90% of schools selected agreed to participate in the survey. The school principal in each school was given detailed instructions as to how to select children for participation in the survey. For example, if a sample of 16 boys and 16 girls was required from each school, 2 boys and 2 girls would be needed from each class. In the case of first class with 12 boys and 16 girls, the principal was instructed to select every 2^{nd} boy (n = 6) and every 3^{rd} girl (n = 5) from the school roll to ensure that two 7 year old boys and two 7 year old girls would be recruited from the class. The principal was instructed not to select more than one child from a household. The principal was given an envelope to give to all selected children to bring home to their parents/guardians. This envelope contained an introductory letter, an information brochure, and a reply slip. If the parent/guardian and the selected child were interested in finding out more about participating in the survey they were instructed to fill out their contact details on the reply slip and return it to the school. Selected children who returned a reply slip were excluded if they were not between the ages of 5 and 12 years or if they belonged to an age/sex/location/socio-demographic category for which the appropriate number of children had already been recruited. A researcher in each centre contacted the parents/guardians of all eligible children who returned a reply slip and if they agreed to participate in the survey a suitable time and date for a fieldworker to visit was arranged. The response rate was 66%. Analysis of the demographic features in this sample has shown it to be a representative sample of the Irish population with respect to age, sex, and geographical location. The sample was also representative with respect to social class and education, however the sample had a higher proportion of third level educated and social class 1 respondents compared to the recent census data from Ireland for 2002 (Central Statistics Office, 2003). More detailed information comparing the NCFS to the census data is presented in the main report of the findings from the survey on www.iuna.net (IUNA, 2005).

4.2.4 Data collection

A 7-day weighed food diary was used to collect food and beverage intake data. The researcher made four visits to the respondent and his/her parent/guardian during the 7 day period: a training visit to show how to keep the food diary and how to use the weighing scales; a second visit 24-36 hours into the recording period to review the diary, check for completeness and clarify details regarding specific food descriptors and quantities; a third visit 4 or 5 days into the recording period to check the previous 2 or 3 days and to encourage completion; and a final visit 1 or 2 days after the recording period to check the last days and to collect the diary.

The respondents and/or their parents/guardians were asked to record detailed information regarding the amount and types of all foods, beverages and nutritional supplements consumed over the 7-day period and where applicable the cooking method used, the brand name of the food consumed, packaging size and type, who weighed the food/beverage, and details of recipes and any leftovers. Data was also collected on the time of each eating or drinking occasion, the respondent's definition of each eating or drinking occasion (e.g. morning snack, lunch etc.) and the location of the preparation or source of the meal or snack consumed (e.g. home, school, takeaway etc.).

4.2.5 Food quantification

A quantification protocol that had been established by the IUNA for the North/South Ireland Food Consumption Survey (NSIFCS) (Harrington *et al.*, 2001) was adapted for the NCFS.

(1) *Weighing* - A portable food scales (Soehnle Vita (1000×1g)) was given to each respondent or parent/guardian. The fieldworker gave detailed instructions

(including a demonstration) as to how to use the food scales to respondents and/or parents/guardians during the training session. Over 75% of foods and drinks consumed in the NCFS were weighed.

(2) A *Photographic Food Atlas* (Nelson *et al.*, 1997) was used to quantify 5% of foods/beverages consumed.

(3) *Manufacturer's Information* - Weights of over 10% of foods/beverages consumed were derived from weights printed on food packaging. To facilitate collection of such data, fieldworkers asked respondents to collect all packaging of food and beverages consumed in a storage box provided

(4) *IUNA Information* - Average portions that had been ascertained for certain foods by the IUNA survey team for the NSIFCS were used. This method was used to quantify 1% of foods/beverages consumed.

(5) *Food Portion Sizes* (Ministry of Agriculture, Fisheries and Food, 1997) was used to quantify 3% of foods /beverages consumed.

(6) *Household Measures* e.g. teaspoon, tablespoon, pint etc. were used to quantify almost 2% of foods/beverages.

(7) *Estimated* - Food quantities were defined as estimated if the fieldworker made an assessment of the amount likely to have been consumed based on their knowledge of the respondents general eating habits observed during the recording period. Weights of 3% of foods/beverages consumed were estimated.

4.2.6 Nutrient composition of foods and estimation of nutrient intake

Food intake data were analysed using WISP© (Tinuviel Software, Anglesey, UK). WISP© uses data from McCance and Widdowson's The Composition of Foods, sixth (Food Standards Agency, 2002) and fifth (Holland *et al.*, 1995) editions plus supplemental volumes (Chan *et al.*, 1996, Chan *et al.*, 1995, Chan *et al.*, 1994, Holland *et al.*, 1996, Holland *et al.*, 1993, Holland *et al.*, 1992, Holland *et al.*, 1991, Holland *et al.*, 1989, Holland *et al.*, 1988) to generate nutrient intake data. Both during the NSIFCS and the NCFS, modifications were made to the food composition database: 993 extra new foods were added during the NSIFCS and a further 564 foods were added during the NCFS. These included recipes of composite dishes, nutritional supplements, generic Irish foods that were commonly consumed and new foods on the market.

4.2.7 Questionnaires

In total the parents and children were asked to complete seven questionnaires.

Children's Health and Lifestyle Questionnaire: The parents completed this questionnaire which covered a broad range of details regarding the child, from birth weight and infant feeding practices to allergies, dieting practices, parent's attitudes to their child's diet, vitamin and supplement usage, and childminding.

Parent Health and Lifestyle: This questionnaire included information on socio-demographics, education level and attitudes of parents to their own diet. This questionnaire was administered to both mother and father when possible. Social class and education level was coded for the higher parent.

Child's Questionnaire: A questionnaire was also administered to the older children, aged 9-12 years, in an attempt to identify the attitudes of the children. The questionnaire was intended to be self administered by the child and therefore only targeted to the older children.

Physical Activity: Parents and children completed physical activity questionnaires to assess levels of customary physical activity. The questionnaires consisted of three sections: activity at home; work or school; and recreation. In the children's version of the questionnaire, the differences between school holidays and term time was also examined

Eating Behaviour: This questionnaire was completed by the parents and examined the eating behaviour of both the parents and children, including neo-phobia and variety seeking behaviour of the respondents.

Evaluation Questionnaire: This questionnaire was administered by the fieldworker at the last survey visit. This identified whether the child's eating habits or physical activity patterns changed during the week.

4.2.8 Anthropometry

Weight, height, waist and hip circumference, and leg length, were measured for both children and their parents by qualified nutritionists. Weight was measured in duplicate using a Seca 770 digital personal weighing scale (Chasmores Ltd, UK), to the nearest 0.1kg. Respondents were weighed whilst wearing light clothing, without shoes and after voiding. Height was measured to the nearest 0.1cm, using the Leicester portable height measure (Chasmores Ltd, UK), with the respondent's head positioned in the Frankfurt Plane. Waist circumference was measured in duplicate using a non-stretch tape measure and taken at the naked site where possible. Firstly, the iliac crest (top of hip) and the bottom of the rib cage (10th rib) were identified and marked. Waist circumference was then measured at the midpoint, to the nearest 0.1cm. Hip circumference was measured again in duplicate to the nearest 0.1cm, using a non-stretch tape measure. This measurement was taken over light clothing, at the widest part of the buttocks at the level of the greater trochanter. Leg length was measured in duplicate to the nearest 0.1cm, using a non-stretch tape measure. The respondent was in a standing position with legs straight, placed symmetrically and with the pelvis square. The measurement was taken on the left leg, from the anterior superior iliac spine to the distal tip of the lateral malleolus (ankle).

4.2.9 Defining overweight and obesity in children

Body Mass Index (BMI) was used to indirectly assess adiposity and was calculated by weight (kg) divided by height squared (m^2). Age-and-sex-specific BMI charts were used to determine the prevalence of overweight and obesity in this sample of Irish children. These BMI charts are used to compare a child's BMI to the BMI distribution of a reference sample of children of the same age (Flegal *et al.*, 2002). Due to the absence of age-and-sex-specific BMI charts for an Irish reference population, the UK 1990 BMI reference curves for boys and girls (UK90) were used (Cole *et al.*, 1995). In addition, the International Obesity Task Force (IOTF) age-and-sex-specific BMI cut-offs for defining overweight and obesity between 2-18 years were also used so that international comparisons could be made (Cole *et al.*, 2000).

4.2.10 Physical activity and accelerometer

Each child wore an accelerometer for 4 days of the survey period, usually 2 weekdays and 2 weekend days (RT3 Tri-axial accelerometer, Stayhealthy.com). The RT3 is the size of a pager and is worn on the waist. It continuously tracks activity through the use of piezo-electric accelerometer technology that measures motion in three dimensions and provides tri-axial vector data in activity units, metabolic equivalent units (METs) or kilocalories. The Stayhealthy software and RT3 docking station was used to upload the data from the accelerometer into an excel spreadsheet for each subject. One of the disadvantages of most accelerometers is the inability to record motion while the subject is cycling, bathing or swimming. Therefore the time spent at these activities was also recorded in an accelerometer diary. An additional hurdle was also the design of the accelerometer. It is designed to clip on the waist band of clothing but in the situation of dresses (especially school pinafores for girls) we had to provide a belt for the accelerometer to be clipped on to.

4.2.11 Quality control

Quality control of both questionnaires and diary data entry also took place. In order to ensure consistency and compatibility across centres a detailed diary entry protocol was developed. This included default McCance and Widdowson's codes for foods, quantification procedures and guidelines. Once the data entry was completed by the fieldworker, all diaries were re-checked and subsequently every fifth diary was rechecked by a different field worker.

A detailed coding manual was also developed for the questionnaires, and all questionnaires were assimilated using customised questionnaire software (Q-Builder, Tinuviel Software, Anglesey, UK). Correct data entry was ensured by using a dual data-entry method and rules based validation processes, where only the answers from the coding manual are permitted. The consolidated data was exported as an asci file for importing into SPSS. Once imported into SPSS, all of the databases imported were analysed for errors and outliers

4.2.12 Validation of food intake data

Several steps were taken to ensure the validity of the food intake data. The child's body weight was taken at the beginning and end of the survey week to allow any weight loss over the 7 days to be determined. At the end of the survey week, the child's parents were asked if the child's food intake was the same as usual, less than usual or more than usual during the preceding week. If their intake was different to usual, the parent was asked if the child was unwell or if there was another reason for the unusual pattern of food intake. The parent was also asked if the child was on a weight-reducing diet while participating in the survey. Finally, the fieldworker was asked to comment on their opinion of the respondent's food diary. The diary was rated as 1-accurate and complete, 2-inaccurate and complete, 3-accurate and incomplete and 4-inaccurate and incomplete.

More exact methods of validation will be carried out in the future. Cut-off points based on basal metabolic rate (BMR) in children will be used to identify over and under reporting as described by Torun *et al.* (1996). The data will subsequently be analysed excluding individuals who are found to under or over report their food intake. The use of accelerometers during the survey will also enable exact measures of the child's physical activity levels to be calculated. This will be used to calculate a more exact measure of the child's energy expenditure, which will be used to develop more accurate BMR cut offs specific to an Irish population. For the purpose of this and the following two chapters, the effects of under and over reporting have not been considered.

4.2.13 Databases

The food intake database from the NCFS comprises of approximately 72,000 rows of data that describe every food and drink item consumed by each of the respondents, at every eating occasion, for each of the seven recording days. For each item consumed, the database records the actual day of the week and meal number in the day, the definition of the eating occasion, the time and location of consumption, the weight of food/drink consumed, the brand information, packaging type and packaging size, and a full nutrient breakdown for the amount of food consumed. Each food was assigned to one of 144 food groups in the database. For the purposes of the present study, these food groups were reduced to 19 groups and this database can be aggregated to examine day by day intakes and mean daily intakes of foods and nutrients

4.2.14 Statistics

All statistical analyses were conducted using SPSS® Base Version 12 (SPSS Inc., Chicago, IL). Mean and standard deviations (SD) were computed for foods, nutrients, and anthropometry. Differences in mean values between boys and girls and age groups were assessed using independent-samples t-test. Significance was defined as $P<0.05$.

4.3 Results

Table 4.1 presents the mean daily energy, macronutrient, and micronutrient intakes for Irish children. Boys had significantly higher intakes of macronutrients, minerals, and most vitamins compared to girls. Mean daily energy intake was 7MJ with fat contributing 34%, protein 14% and carbohydrate 52% to energy. It appears that both macronutrient (expressed as a percentage of energy) and micronutrient intakes are adequate in Irish children at a population level. However, when the sample was examined at an individual level, it was found the 40% of children did not achieve the fat target of <35% energy from fat (Department of Health UK, 1991). Inadequate intakes of nutrients were also suspected for folate, calcium and iron in more than 30% of girls, while more than 20% of boys were suspected to have inadequate intakes of calcium, vitamin A and folate. This is based on the estimated average requirement calculated from the Food Safety Authority of Ireland's recommended daily allowances for children (FSAI, 1999).

Table 4.2 presents the intakes of food groups and their contribution to the diet in Irish children. Milk and yoghurt, sugars, confectionery, preserves and savoury snacks, and meat and meat products made the greatest contribution to the diet overall in terms of energy and fat intake. Meat and meat products followed by milk and yoghurts made the highest contribution to protein intakes while bread and rolls, and sugars, confectionery, preserves and savoury snacks were the main contributors to carbohydrate intakes Fruit and vegetable consumption was low, accounting for only 5% of energy in the diet with a mean daily consumption of 224g. This is well below the 400g of fruit and vegetables per day recommended by the WHO (FAO/WHO, 2005).

Table 4.3 presents the mean anthropometric data for Irish children. Among boys aged 5-12 years, the mean weight, height and BMI were 32.3kg, 1.3m and 17.6kg/m^2, respectively. In girls, the mean weight, height and BMI were 33.7kg, 1.3m and 18.4kg/m^2, respectively. For all girls age 5-12 years, BMI was significantly higher than boys and this trend was also observed across the age groups ($P<0.05$). Waist to hip ratio (WHR) was also significantly lower in girls ($P<0.05$), illustrating the differences in body shape between boys and girls. Each of the body measurements was significantly higher in the 9-12 age group compared to the 5-8 age group ($P<0.001$). The proportion of children categorised as normal, overweight and obese is presented in Table 4.4. Overall 11% of Irish children were defined as overweight according to the UK 90 cut-offs and a further 11% obese.

4.4 Discussion

The National Children's Food Survey is the most detailed investigation into children's eating habits ever undertaken in Ireland. The results will provide much needed information for use in nutrition policy and planning by health professionals for children all over Ireland. The key findings from the survey have highlighted many areas that require focus from a public health perspective in Ireland. These issues include obesity, inadequate vitamin and mineral intakes in addition to the high fat content and low fruit and vegetable consumption in the diets of young children. These are issues of great concern for children considering that dietary patterns developed in childhood could lead to diseases in adulthood.

Energy and macronutrient intakes appear to be adequate in the diets of Irish children. Energy intakes in both boys and girls compare favourably with intakes in children from the UK (Gregory *et al.*, 2000)). While it appears that children are meeting the population target for <35% energy from fat, when the sample is examined at an individual level, it was found that 40% of children had intakes greater than this value. Although mean daily intakes of most vitamin and minerals appear to meet with recommendations, inadequate intakes were suspected for folate, calcium and iron in more 25% of the sample

The results have also clearly demonstrated that the prevalence of obesity in Irish children is alarmingly high. In the UK, when using the IOTF definition, the prevalence of overweight and obesity for 4-18 year olds was 15% and 4% respectively, similar to that found in this study (Jebb *et al.*, 2004). Childhood obesity is associated with a number of health problems, including type 2 diabetes, increased cardiovascular disease risk factors, respiratory problems, sleep apnoea, gall bladder disease, orthopaedic and psychosocial problems (National Taskforce on Obesity, 2005, Must and Strauss, 1999, Dietz, 1998, World Health Organization, 1998).

These preliminary findings from the National Children's Food Survey have highlighted areas of public health importance for policy makers in Ireland. Further analyses of the databases from the survey will provide a deeper understanding and insight into the patterns of food consumption associated with obesity and achieving dietary targets for fat, and fruit and vegetables in Irish children.

Table 4.1: Mean and standard deviation (SD) values of daily energy, macronutrient, vitamin and mineral intakes from all sources† for Irish children aged 5-12 years

	Total Population (*n*=594)		Below recommended levels	Boys (*n*=293)		Girls (*n*=301)		
	Mean	(SD)	%	Mean	(SD)	Mean	(SD)	*P*
Macronutrients & Fibre								
Energy (MJ)	7.0	(1.5)		7.4	(1.6)	6.7	(1.3)	***
Protein (g)	56.7	(15.2)		59.8	(16.4)	53.7	(13.2)	***
Fat (g)	63.1	(16.5)		65.5	(17.9)	60.8	(14.7)	***
CHO (g)	231.3	(53.3)		245.5	(56.4)	217.4	(46.0)	***
% total energy from protein	13.6	(2.2)		13.6	(2.2)	13.6	(2.1)	ns
% total energy from CHO	52.0	(4.8)		52.5	(5.0)	51.5	(4.5)	*
% total energy from fat	33.9	(4.2)		33.4	(4.4)	34.4	(4.0)	**
NSP (g)	9.4	(3.2)		10.0	(3.5)	8.8	(2.8)	***
Vitamins*								
Retinol (μg)	365.8	(407.9)		376.3	(387.0)	355.6	(427.6)	ns
Carotene (μg)	2121.5	(1949.2)		2357.0	(2138.2)	1892.3	(1718.5)	**
Total Vitamin A (μg)	719.4	(537.6)	24	769.2	(544.2)	670.9	(527.5)	*
Vitamin D (μg)	2.3	(2.3)		2.2	(2.2)	2.3	(2.3)	ns
Vitamin E (mg)	6.4	(4.3)		6.8	(4.6)	6.1	(3.9)	*
Thiamin (mg)	1.5	(1.6)		1.6	(0.6)	1.5	(2.2)	ns
Riboflavin (mg)	1.9	(1.6)		2.0	(0.8)	1.8	(2.2)	ns
Pre-formed Niacin (mg)	17.1	(6.6)		18.4	(6.7)	15.9	(6.3)	***
Total Niacin Equivalents (mg)	28.4	(8.8)		30.3	(9.1)	26.6	(8.1)	***
Vitamin B6 (mg)	2.0	(1.7)		2.1	(0.8)	1.9	(2.2)	ns
Vitamin B12 (μg)	4.4	(2.4)		4.7	(2.3)	4.2	(2.6)	*
Folate (μg)	224.6	(97.9)	28	242.6	(102.7)	207.0	(89.8)	***
Biotin (μg)	25.4	(24.2)		26.9	(22.9)	23.9	(25.4)	ns
Pantothenate (mg)	5.3	(2.6)		5.7	(2.2)	4.9	(2.9)	**
Vitamin C (mg)	87.2	(67.6)		86.1	(72.5)	88.3	(62.5)	ns
Minerals*								
Calcium (mg)	862.2	(299.7)	32	917.8	(318.1)	808.1	(270.4)	***
Magnesium (mg)	193.9	(52.7)		206.0	(58.3)	182.2	(43.7)	***
Phosphorous (mg)	1025.5	(287.4)		1089.9	(305.9)	962.8	(253.4)	***
Iron (mg)	9.4	(3.5)	40	10.3	(3.8)	8.5	(2.8)	***
Copper (mg)	0.8	(0.4)		0.8	(0.4)	0.8	(0.4)	*
Zinc(mg)	6.6	(2.3)	32	7.1	(2.7)	6.2	(1.7)	***

† All sources including dietary supplements

*Significant differences between boys and girls: *$P<0.05$, ** $P<0.01$, *** $P<0.001$, ns = non significant

Table 4.2: Mean daily intakes of food groups for consumers only, and their contribution to mean daily energy and macronutrient intakes in 594 Irish children aged 5-12 years

	Intakes g/d			Energy		Fat		CHO		Protein	
	% Cons	Mean	(SD)	kcal/d	%	g/d	%	g/d	%	g/d	%
Milk & yoghurt	99	318	(194)	218	13.1	11.3	18.0	19.4	8.5	10.8	19.1
Sugars, confectionery, preserves & savoury snacks	99	47	(28)	212	12.7	8.9	14.4	31.6	13.5	2.5	4.6
Meat & meat products	98	107	(54)	209	12.6	11.9	18.9	7.5	3.4	18.3	31.7
Bread & rolls	100	82	(39)	200	12.0	2.3	3.7	40.3	17.5	7.0	12.6
Potatoes & potato products	99	99	(57)	134	8.1	4.6	7.3	22.2	9.8	2.4	4.4
Breakfast cereals	94	41	(36)	124	7.4	1.1	1.7	27.1	11.5	2.7	4.8
Biscuits, cakes & pastries	95	27	(19)	109	6.5	4.8	7.6	15.7	6.8	1.6	2.9
Grains, rice, pasta & savouries	89	65	(48)	93	5.6	2.7	4.3	14.6	6.4	3.3	5.9
Beverages	100	482	(261)	83	4.9	0.1	0.1	21.3	9.0	0.2	0.3
Fruit & fruit juices	94	174	(136)	70	4.2	0.2	0.3	17.3	7.5	0.8	1.4
Butter, spreading fats & oils	94	10	(7)	54	3.2	6.0	9.2	0.1	0.0	0.1	0.1
Creams, ice-creams & chilled desserts	76	35	(31)	53	3.1	2.7	4.3	6.4	2.8	0.9	1.7
Cheeses	59	13	(10)	27	1.6	2.2	3.3	0.2	0.1	1.8	3.1
Vegetables & vegetable dishes	92	50	(45)	27	1.6	0.8	1.3	3.8	1.6	1.3	2.3
Soups, sauces & miscellaneous foods	89	32	(34)	18	1.1	1.0	1.7	2.5	1.1	0.4	0.7
Fish & fish products	48	19	(15)	16	1.0	0.8	1.2	0.8	0.4	1.4	2.5
Eggs & egg dishes	42	18	(14)	15	0.9	1.2	1.8	0.0	0.0	1.0	1.6
Nuts & seeds, herbs & spices	14	6	(6)	5	0.3	0.4	0.6	0.1	0.0	0.2	0.3

Table 4.3: Mean anthropometric measurements for boys and girls aged 5-12 years (n = 596) from the National Children's Food Survey

		All			Boys			Girls			
		n	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)	
All	Weight (kg)	596	33.0	(11.3)	295	32.3	(10.0)	301	33.7	(12.5)	
	Height (m)	596	1.34	(0.1)	295	1.34	(0.1)	301	1.33	(0.1)	
	BMI (kg/m^{-2})	596	18.0	(3.0)	295	17.6	(2.6)	301	18.4	(3.4)	**
	Waist (cm)	587	62.4	(9.0)	291	62.1	(8.2)	296	62.7	(9.8)	
	Hip (cm)	588	74.0	(10.1)	292	73.0	(9.3)	296	75.1	(10.8)	*
	WHR	587	0.84	(0.1)	291	0.85	(0.1)	296	0.84	(0.1)	***
5-8 years	Weight (kg)	297	25.7	(5.8)	146	25.5	(5.6)	151	25.9	(6.0)	
	Height (m)	297	1.22	(0.1)	146	1.23	(0.1)	151	1.22	(0.1)	
	BMI (kg/m^{-2})	297	17.0	(2.2)	146	16.7	(2.0)	151	17.2	(2.3)	*
	Waist (cm)	293	58.0	(6.0)	145	58.0	(5.8)	148	58.0	(6.2)	
	Hip (cm)	293	67.7	(6.5)	145	67.2	(6.3)	148	68.2	(6.8)	
	WHR	293	0.86	(0.1)	145	0.86	(0.0)	148	0.85	(0.1)	*
9-12 years	Weight (kg)	299	40.3	(10.8)	149	39.0	(8.9)	150	41.6	(12.3)	*
	Height (m)	299	1.45	(0.1)	149	1.45	(0.1)	150	1.45	(0.1)	
	BMI (kg/m^{-2})	299	19.0	(3.4)	149	18.5	(2.8)	150	19.5	(3.9)	**
	Waist (cm)	294	66.8	(9.4)	146	66.2	(8.2)	148	67.3	(10.5)	
	Hip (cm)	295	80.3	(9.0)	147	78.8	(8.0)	148	81.9	(9.6)	**
	WHR	294	0.83	(0.1)	146	0.84	(0.1)	148	0.82	(0.1)	**

Significant differences between boys and girls at * $P<0.05$, ** $P<0.01$ and *** $P<0.001$,

† All of the anthropometric measurements wrere significantly higher in the 9-12 year old group compared to 5-8 year old group for the total sample and for boys and girls

Table 4.4: The proportion of Irish children aged 5-12 years defined as normal, overweight and obese using IOTF and UK 1990 cut-offs by age group

Age group	Cut-off	All boys and girls			
		n	%		
			Normal	Overweight	Obese
All	IOTF	596	75.8	17.4	6.7
	UK 90		77.9	11.1	11.1
5-8y	IOTF	297	75.1	18.2	6.7
	UK 90		79.1	10.4	10.4
9-12y	IOTF	299	76.6	16.7	6.7
	UK 90		76.6	11.7	11.7

IOTF - age and sex specific BMI cut-offs (Cole*et al.* , 2000)

UK 90 - BMI reference curves for the UK 1990 (Cole*et al.* , 1995)

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Chapter 5

The influence of eating location on the diets of Irish children

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5.1 Introduction

The food service industry has become increasingly important in today's society. Euromonitor (2004) found that between 1999 and 2003, the global number of food service outlets grew at a rate of 4% per annum to an estimated 11.2 million units. This increase has also occurred in Ireland with the number of outlets increased from 12,541 to 13,644 in the same time period, an increase of 8.8%. The Annual Services Inquiry published by the Central Statistics Office (CSO) has also demonstrated this increase. Between 2001 and 2002 the number of food service units increased from 10,500 to 11,775 (CSO, 2004). Correspondingly, the amount of money spent on the food service sector is also increasing. An 8% increase in expenditure in the food service sector worldwide was reported from 1999 to 2002 (Euromonitor, 2004). In Ireland, the household budget survey estimated the average weekly household expenditure on foods consumed away from home to be €14.01 in 1994/95 (CSO, 1995), and this increased to €22.35 in 1999/2000 (CSO, 2001).

The role of the food service sector in the diet has been examined to a small extent and in general has been found to be associated with higher fat intakes and poorer dietary habits in adults (Satia *et al*., 2004, Burns *et al*., 2002, French *et al*., 2000, McCrory *et al*., 1999, Le Francois *et al*., 1996, Loughridge *et al*., 1989). Foods eaten outside the home contributed to 24% of energy intakes in Irish adults (IUNA, 2001) and were also found to make a substantial contribution to fat intakes in the Irish population (O'Dwyer *et al*., 2005).

There has been even less research into the role of the food service sector in the diets of children. The literature is mainly from the US, along with Canada and Australia. These studies suggest that consumption of foods from outside the home has an adverse effect on diet quality and may lead to increases in body mass index (BMI) (Bowman *et al*., 2004, Thompson *et al*., 2004, Zoumas–Morse *et al*., 2001, Lin *et al*., 1999). To date, there has been no published data examining the role of the food service sector in children in Ireland but given the expansion of the food service sector, a study in this area is clearly warranted for sensitive public health nutrition programmes aimed at children.

The National Children's Food Survey (NCFS) is a national food consumption survey which was carried out in Irish children, and also included information on the location of every food and drink item consumed over a 7-day period. This allows for the first time, an examination of the influence of location on the diets of Irish children. The aim of the present paper is to assess the number of eating occasions and compare nutrient intakes across the locations; home, other people's home and outside the home, and across various locations outside the home. In addition, this study aims to determine the types of food consumed at various locations outside the home and to examine the diet quality across quantiles of eating outside the home. The implications of the findings in relation to the development of food-based dietary guidelines (FBDG) will also be discussed.

5.2 Methods

5.2.1 Survey sample and data collection

The NCFS was a cross-sectional study of food and nutrient intakes of a representative sample of 594 Irish children aged 5-12 years. A 7-day weighed food record was used to measure food and beverage intakes. Respondents recorded the day, time, location and meal type for each eating occasion, along with a detailed description of the food, the weight of the food and cooking method. Details of leftovers and recipes used were also requested. The foods were coded using McCance and Widdowson's 'The Composition of Foods' (Foods Standards Agency, 2002, Holland *et al.*, 1995) and published supplements (Chan *et al.*, 1996, Chan *et al.*, 1995, Chan *et al.*, 1994, Holland *et al.*, 1996, Holland *et al.*, 1993, Holland *et al.*, 1992, Holland *et al.*, 1991, Holland *et al.*, 1989 Holland *et al.*, 1988). Nutrient intakes were calculated using WISP© (Weighed Intake Software Program; Tinuviel Software, Anglesey, UK). New food codes were generated for new foods on the market, generic Irish foods, supplements and for recipes. A series of questionnaires were used to collect additional information on health and lifestyle and the physical activity of the respondent and his/her parents. Questions on the frequency of consumption at food service sector establishments were also included in the questionnaires. Anthropometric measurements (weight, height, waist circumference, hip circumference and leg length) were taken for both the respondent and his/her parents.

5.2.2 Locations

In the present study, eating location refers to where the food was prepared or obtained rather than where the food was consumed. For example, foods purchased in a takeaway and eaten at home were coded as takeaway, whereas lunch prepared at home and brought to/consumed in school was coded as home. In the case where food was obtained from more than one location, location was coded as the one that provided the most food. Fourteen different location categories were used when coding the food diaries: (1) at home; (2) at a friend's home; (3) at a relative's home; (4) at a restaurant/hotel; (5) at a coffee shop/sandwich bar/delicatessen; (6) at a takeaway (non-ethnic); (7) bought in a shop; (8) at the child minder's; (9) at a public house or bar; (10) at an ethnic takeaway; (11) at the cinema; (12) at a social function; (13) at school and (14) at a fast food chain. For the present study, these locations were aggregated to: (1) at home (respondent's own home); (2) at other people's home (friend's home, at a relative's home and at the child minder's) and (3) outside the home (all other locations outside the home). For the foods consumed outside the home, this category was further divided into: (1) takeaway (at a takeaway (non-ethnic)/at an ethnic takeaway/at a fast food chain); (2) restaurant (at a restaurant/hotel/public house or bar); (3) from a shop; and (4) other locations outside the home (at a coffee shop/sandwich bar/delicatessen/at the cinema/at a social function/at school). Food is generally not provided in primary schools in Ireland, so schools make a very small contribution to food and nutrient intakes. For this reason school has been included in the category 'other locations'. Shop bought generally refers to when the respondent purchased and consumed food from a local shop. It does not include weekly shopping purchased for home use.

5.2.3 Data Analysis

Data analysis was carried out using SPSS® version 10.0 (SPSS Inc., Chicago, IL, USA). Many different methods for calculating mean values were considered, for example, means for the total population or for consumers only at a given location or mean daily intakes over seven days or the number of days for which a food was consumed. For the present study data analysis was carried out for those who were consumers of food at a given location, except where stated. Mean values were calculated as means per day over a total of seven days, except for the number of eating occasions which was calculated as the mean number of eating occasions per week. Means and standard deviations (SD) were calculated across different locations for eating occasions over the week and the percentage contribution of each location to mean daily energy and nutrient intakes (as percentage energy from macronutrients, fibre and micronutrient intakes per 10MJ). The association between socio-demographic and other health parameters (e.g. sex, age, social class, education level, location of residence, BMI, and physical activity level) on the number of eating occasions and the contribution of location to energy intakes was also examined.

Food intakes at each location outside the home were assessed in several ways. Firstly, the percentage of consumers of each food group was determined. Then, the mean daily food group intakes (g) were calculated, along with the mean intake of each food group (g) per eating occasion. Finally the percentage contribution of the food group to energy at each location was examined. Total mean daily nutrient intakes (at all locations) were analysed according to frequency of eating outside the home. Nutrient intakes of non consumers of foods outside the home were compared to nutrient intakes of high, medium and low consumers of foods consumed outside the home. Different tertile groups were categorised, firstly based on frequency of eating outside the home and secondly based on the percent contribution of foods consumed outside the home to energy intakes.

The percentage of respondents who consumed food at locations outside the home (from the food consumption database) were compared with the percentage of children who responded to the question of how often they ate at each location in the health and lifestyle questionnaire. These latter responses were aggregated to (1) less than once a fortnight and (2) once a fortnight or more frequently.

5.2.4 Statistical Analysis

One-way ANOVA was used to examine whether significant differences existed between locations, and across the variables: social class, education level, physical activity level and BMI. Where significant differences existed, homogeneity of variance was examined using Levene's test. For values that satisfied Levene's test, the Scheffe *post hoc* test was used to determine which means differed. The Tahmane *post hoc* test was used for values that did not satisfy the Levene's test. Independent *t*-tests were used to determine significant differences between sex, age and location of residence across each of the locations. Pearson's chi-square was used to determine whether or not there was a relationship between socio-demographic and health related variables and being a non, low, medium or high consumer of foods from outside the home. Initial examination did not reveal differences between the sexes; therefore results have been presented for boys and girls together. Values of $P<0.05$ were taken as significantly different.

5.3 Results

Table 5.1 shows the percentage of consumers, mean number of eating occasions per week and the percentage contribution to energy from foods consumed at home, other people's home and outside the home. The results are also given for locations outside the home: at takeaways, at restaurants, at shops and at other locations. All respondents consumed foods at home, with 58% and 77% of the population having at least one eating occasion at other people's home and outside the home respectively over the course of the survey week. For the average of 35 eating occasions per week, only 2.5 of these were consumed outside the home. In terms of the percentage of all eating occasions over the week, almost 90% occurred at home, with less than 6% taking place at other people's home and outside the home. The percentage contribution of foods to energy at each location showed similar patterns, with only 9% coming from foods outside the home. When this was further examined for consumers at each location, only 11% of energy was consumed outside the home. Regarding specific locations outside the home, the highest percentage of consumers was at takeaways (48%), followed by shops (31%) and restaurants (26%). Outside the home, takeaways made the greatest contribution to energy at 4%, with the other locations each contributing to less than 2%. When this was examined for consumers only at each location, 7-8% of energy was consumed at takeaways/restaurants, with 5-6% consumed at shop and other locations. No particular patterns were observed across different socio-demographic groups for eating at various locations, except for differences across age groups. Older children had significantly more eating occasions and higher energy intakes outside the home than younger children ($P<0.05$), particularly in takeaways and shop ($P<0.01$) (percentage contribution to energy only)(data not shown).

The mean percentage energy from macronutrients and intakes of fibre and selected micronutrients (per 10 MJ) at each location is presented in Table 5.2. The intakes of a wide range of nutrients were analysed, but only intakes of fibre, calcium, iron, folate and vitamin C are shown here. The percentage energy from protein significantly decreased while the percentage energy from fat significantly increased from foods consumed at home, to other people's home to outside the home. Outside the home, the percentage of energy from fat was higher, while the percentage energy from carbohydrate was lower at takeaways and restaurants compared to shops and other locations. However, the percentage of energy from sugar was significantly higher at shops and other locations. Intakes of all micronutrients examined were highest at home, followed by other people's home and lowest outside the home. In the case of some nutrients (e.g. calcium, iron, thiamin, riboflavin, vitamin B12, folate and vitamin C per 10MJ) intakes at home were twice as high as intakes from outside the home. Comparing intakes across locations outside the home does not reveal a very clear pattern. However, overall the highest micronutrient intakes were consumed in a restaurant whereas the lowest micronutrient intakes occurred in a shop.

Food intake was analysed for each location outside the home and is presented as the percentage of consumers of each food group, the percentage contribution of food to energy and the grams of food per eating occasion in Table 5.3. The foods consumed at takeaways and restaurants which were most important in terms of the number of consumers and/or the contribution to energy were: chips and processed potatoes; meat products; soups, sauces and miscellaneous foods; beverages; savouries; whole milk, and poultry and poultry dishes. The most important foods consumed at shops and other locations outside the home were: cakes, pastries and buns; sugars and confectionery; savoury snacks; beverages; creams, ice-creams and desserts; chips and processed potatoes; meat products; savouries, and whole milk.

Total nutrient intakes (from all locations) were analysed according to quantiles of the percentage of energy consumed outside the home. The percentage of energy from macronutrients and fibre and selected micronutrient intakes per 10 MJ (from the total diet) for non consumers of foods outside the home were compared to consumers of foods outside the home with low (< 6.5%), medium (6.5-12.1%) and high (>12.1%) percentage energy from foods consumed outside the home (Table 5.4). Intakes of fat were higher, whereas intakes of protein, carbohydrate, fibre and micronutrients were lower in high consumers of foods from outside the home than low consumers (statistically significant in 60% of cases). In general, the intake of micronutrients decreased with increasing frequency of consumption of foods outside the home. Nutrient intakes were also examined by tertiles of eating occasions outside the home and the findings were consistent for those described for tertiles of percentage energy. The characteristics of each group were compared using Pearson's Chi^2. A higher proportion of non consumers were found to be boys (P<0.05) and younger children (5-8 years) (P<0.05). Correspondingly, a higher proportion of high consumers were older children (9-12 years) ($P<0.05$). In addition, a larger proportion of non consumers had parents with a lower education level, while a larger proportion of medium and high consumers had parents with higher education levels ($P<0.01$). A number of other socio-demographic and health related variables were also examined but no associations were found. Intakes of a wide range of micronutrients were analysed but are not presented here (in general the same pattern was observed as for the nutrients presented).

Responses in a questionnaire on the frequency of consumption at various locations outside the home were analysed and compared with the actual frequency of consumption at those locations from the food diaries (Table 5.5). For the majority of locations, there was a tendency to under-report eating occasions in the questionnaire compared to the food diary. At least twice as many respondents consumed foods at a hotel/restaurant, fast food restaurant, public house/bar and cinema and 1.5 times as many consumed foods from a local chip shop during the course of the survey (from the food diaries) as were reported in the questionnaire. The number of respondents who reported consuming foods in a coffee/shop and ethnic takeaway and actually did consume foods from these locations was comparable.

5.4 Discussion

Examination of the role of the food service sector in the diet is important for the development of practical food-based dietary guidelines. In order for FBDG to be effective, they need to be based on the prevailing patterns of the country for which they are being developed, and take into account the social and cultural elements of that society (Eurodiet, 2001). One aspect of the cultural context of the development of FBDG extends to 'where' foods are consumed (Kearney *et al.*, 2001). The NCFS is the most detailed investigation into food and nutrient intakes that has been carried out on children in Ireland. The fact that information on where the food was consumed was also collected creates the unique opportunity for the first examination of the role of the food service sector on the diets of Irish children. Foods consumed outside the home have been shown to be of importance in the diets of children in other countries (Bowman *et al.*, 2004, Thompson *et al.*, 2004, Zoumas–Morse *et al.*, 2001, Lin *et al*, 1999) and these prompted the present study. Although 77% of Irish children consumed foods from outside the home, foods consumed at these locations accounted for just 6% of all eating occasions and only 9% of total energy intake in the sample population. Nutrient intakes from foods consumed outside the home were less favourable than from foods consumed at home and food intakes reflected less healthy choices outside the home.

In the present study, 77% of children consumed food from outside the home on at least one occasion during the survey week. This is comparable to 71% of 8-12 year old girls who consumed food away from home in a study conducted in the US (Thompson *et al.*, 2004). However, other studies examining fast food consumption in children and adolescents in the US found 30-42% were consumers on one or two survey days (Bowman *et al.*, 2004, Paeratakul *et al.*, 2003) which is much higher than 48% of Irish children who were consumers at takeaways in general, on at least one eating occasion during the week (and 25% from fast food establishments). This could be due to the older age group of these populations. Nicklas *et al.* (2004) found that 5.4% of 10-year-old children from the Bogalusa study in the US consumed foods at a sit down or fast food restaurant on the day they were surveyed. This appears to be similar to the number of consumers over the week in the present study. The present study found that children appear to consume more meals at home than other published surveys (Zoumas-Morse *et al.*, 2001, Lin *et al.*, 1999, Magarey *et al.*, 1987), which is probably in part due to the fact that lunches are generally not provided at schools in Ireland. In the present study lunches consumed at school would have originated at home and would therefore have been coded as home. Eating occasions outside the home in Irish children accounted for just under 6% of the total number of eating occasions. The percentage of eating occasions at restaurants/fast food establishments in the present study was similar to that in American studies by Zoumas-Morse *et al.* (2001) and Lin *et al.* (1999). Magarey *et al.* (1987) reported much lower consumption at these locations in Australian children but that study is almost 20 years old. Lower consumption of foods away from home was also reported in 4-16 year-old Canadian children (Gillis and Bar-Or, 2003) but this data was collected using a questionnaire, which from the findings of the present study, would tend to indicate that consumption at locations outside the home may be under-reported.

Foods consumed outside the home contributed to just 8.6% of the energy intake of children in Ireland in the whole sample and just 11% in those that consumed food outside the home (excluding those that did not eat outside the home). Energy intakes from foods consumed outside the home in the present study appear to be similar to those reported by Thompson *et al.* (2004). However, energy intakes from studies conducted by Bowman *et al.* (2004), Zoumas-Morse *et al.* (2001) and Lin *et al.* (1999) are higher than those in the present study. This could be due to the fact that older children (2-19 years) were included in those studies or that different methodologies were used i.e. mean intakes from 24-hour recall as opposed to mean daily intakes from a 7-day record. Also, as in the present study, Zoumas-Morse *et al.* (2001) and Lin *et al.* (1999) found higher fat (in terms of percentage of food energy) and lower micronutrient intakes from foods outside the home than at home. These findings for micronutrient intakes are not surprising given that a wider variety of food is usually consumed at home than outside the home, which would give rise to higher micronutrient intakes at home. The overall diet quality of high consumers of foods consumed from outside the home was slightly poorer than that of non or low consumers for Irish children. This was similar to findings in other studies (Bowman *et al.*, 2004, Paeratakul *et al.*, 2003, Gonzales *et al.*, 2002).

As with all studies, there are difficulties in making comparisons due to methodological differences, some of which have been briefly mentioned. The definition of foods consumed outside the home is the first problem that arises when comparing published data. The majority of studies base the definition on where the food was prepared or obtained, as in this study, but some base the definition on where the food was consumed, regardless of the where it was prepared (Zoumas-Morse *et al.*, 2001). The location categories in the present study were chosen to suit the Irish population, as would be expected but it makes comparisons between studies quite difficult if different categories are used for each study. This is particularly true in the case of school as a location. Foods consumed at school by Irish children made a minute contribution to the Irish diet as breakfasts or lunches are usually not provided in schools in Ireland. However, many of the peer-reviewed papers discussed in this paper are based in the US where food is generally provided in schools. Another difficulty is that some studies are designed to examine the food service sector as a whole, where as some studies just examine a particular element of it, for example fast food chains (Bowman *et al.*, 2004, Paeratakul *et al.*, 2003). Other issues which make comparisons difficult are different data collection methods (e.g. 24 hour recall, and 7-day record), various sample sizes and different age categories used in studies etc. In terms of data analysis, another problem is that many published papers do not provide enough information on the calculation of mean intakes e.g. are the intakes based on a mean of 7 days or the days on which the food was consumed at a given location and does the mean represent the intakes for the total population or just the sub-population who consumed at a given location (i.e. consumers only). There is a limited amount of published literature which examines the contribution of foods consumed outside the home and particularly in children. The work on children is confined to the US (Bowman *et al.*, 2004, Thompson *et al.*, 2004, Zoumas–Morse *et al.*, 2001, Lin *et al.*, 1999), Canada (Gillis and Bar-Or, 2003) and Australia (Magarey *et al.*, 1987). Some other work includes children and adults together but does not present the results for sub-groups of the population to examine the effects of foods away from home on the diets of children, adolescents and adults separately (DEFRA, 2004).

One very interesting finding from this study is that the percentage of respondents who reported consuming foods from various locations outside the home from the questionnaires was much lower (twice as low in some cases) than actually occurred during the survey week. Aggregation of the questionnaire data erred on the lower side of intakes (more than once a fortnight rather than once or twice a week) so as not to be conservative. Researchers that assess food and nutrient intakes outside the home solely based on questionnaires should be aware that intakes might be under-reported using this method. This information could also be used in the development of health promotion strategies in that people are not aware or do not acknowledge they consume foods outside the home as often as they do. The investigation into food intakes at locations outside the home in the present paper could also be useful in the establishment of FBDG for children in Ireland. Foods such as chips, meat products, savouries, sugars and confectionery and savoury snacks were of greatest importance at locations outside the home, with some being more prominent at certain locations. Guidelines to improve nutrient intakes from these locations could, for example, try to reduce the number of consumers and the amount of savoury snacks consumed at shops, or the amount of chips and meat products at takeaways and/or restaurants. These could serve as strategies to increase the number of children who achieve <35% of their energy from fat, since 40% of children did not achieve the target (as discussed in Chapter 4), which was set by the Department of Health, UK (1990). Also, health promotion messages to target foods consumed outside the home would not need to focus on any particular subgroups of the population, but rather on the population as a whole because in general, differences were not found between socio-demographic groups.

In conclusion, the number of meals consumed outside the home by Irish children is relatively low and this results in foods consumed outside the home contributing to only 9% of energy intakes in the total population and only 11% in those who do eat outside the home. Consumption of foods outside the home however, results in higher fat and sugar intakes and lower micronutrient intakes than consumption of foods at home and those who eat outside the home at the highest level show a statistically significant but relatively small decline in nutrient intakes. Although health promotion strategies could promote improvements in food choice outside the home as a means of improving nutrient intakes, healthy eating guidelines for children in Ireland that are to be derived from this work should focus on the need for improving the diet in the home environment.

Table 5.1: Percent consumers, mean number of eating occasions per week (and SD), % of eating occasions and the % contribution to energy at all locations for Irish children aged 5-12 years

	n	% Consumers	Mean	(SD)	% of eating occasions	% of eating occasions outside the home	% contribution to energy	
							Total Population	Consumers Only
At home	594	100.0	29.6	(7.0)	89.0	-	85.1	85.1
At other people's home	349	58.8	3.1	(2.7)	5.4	-	6.3	10.7
Outside the home	459	77.3	2.5	(1.8)	5.8	-	8.6	11.2
Takeaway	288	48.5	1.4	(0.7)	2.0	35.2	4.0	8.2
Restaurant	157	26.4	1.3	(0.6)	1.0	17.4	1.9	7.2
Shop	182	30.6	1.9	(1.3)	1.7	29.7	1.4	4.7
Other locations	136	22.9	1.5	(1.2)	1.0	17.7	1.3	5.7

Table 5.2: Intakes of macronutrients (as a % of energy), fibre and selected micronutrients (per 10 MJ) at home, at other people's home and outside the home, and at various locations outside the home for Irish children aged 5-12 years

	In the home				Outside the home									
	Home (*n* = 594)		Other home (*n* = 348)		All locations (*n* = 458)		Takeaway (*n* = 288)		Restaurant (*n* = 157)		Shop (*n* = 182)		Other (*n* = 134)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
% Energy from:														
Protein	13.8 [x]	(2.3)	12.9 [y]	(6.8)	10.9 [z]	(5.3)	12.9 [a]	(5.1)	13.3 [a]	(6.6)	5.5 [b]	(4.0)	7.9 [c]	(5.2)
Fat	33.4 [x]	(4.6)	35.4 [y]	(10.6)	36.9 [z]	(10.3)	38.6 [a]	(7.4)	37.8 [ab]	(9.2)	34.5 [bc]	(16.2)	33.5 [c]	(13.4)
Saturates	14.3	(2.8)	14.3	(6.0)	13.7 [ns]	(5.8)	13.1 [a]	(4.5)	13.9 [ab]	(5.4)	15.0 [b]	(9.0)	12.9 [ab]	(7.7)
Carbohydrate	52.3	(5.2)	51.3	(12.6)	51.2 [ns]	(12.3)	47.7 [a]	(9.4)	48.4 [a]	(11.1)	58.4 [b]	(17.4)	57.2 [b]	(15.9)
Sugars	24.0	(5.6)	24.2	(15.0)	25.6 [ns]	(16.2)	17.5 [a]	(10.8)	22.2 [b]	(14.3)	41.8 [c]	(21.1)	35.6 [d]	(19.6)
Intakes per 10MJ:														
Fibre (g)	13.7 [x]	(3.8)	13.1 [x]	(10.1)	10.0 [y]	(6.3)	10.4 [a]	(5.5)	12.5 [b]	(7.9)	6.5 [c]	(6.8)	10.8 [ab]	(9.5)
Calcium (mg)	1335.5 [x]	(361.4)	908.6 [y]	(567.7)	602.1 [z]	(462.1)	563.2	(445.5)	631.9	(485.2)	629.8	(508.6)	690.7 [ns]	(989.8)
Iron (mg)	14.2 [x]	(4.6)	11.1 [y]	(11.6)	7.4 [z]	(4.1)	8.1	(3.9)	8.7	(4.2)	5.7	(6.0)	7.6 [ns]	(24.3)
Folate (µg)	355.4 [x]	(149.6)	236.3 [y]	(203.2)	164.4 [z]	(90.6)	193.4 [a]	(82.3)	199.1 [a]	(111.2)	101.4 [b]	(131.4)	120.5 [b]	(101.3)
Vitamin C (mg)	141.1 [x]	(107.4)	97.0 [y]	(208.5)	62.4 [z]	(96.9)	47.1	(57.2)	72.5	(113.1)	85.0	(257.1)	80.9 [ns]	(156.2)

[xyz] Different superscripts are significantly different ($P < 0.05$) between locations: home, other people's home and outside the home

[abc] Different superscripts are significantly different ($P < 0.05$) between locations outside the home: takeaway, restaurant, shop, other locations

[ns] Not significant ($P \geq 0.05$)

Table 5.3: Number and percent consumers for food groups consumed at various locations outside the home, mean percentage contribution of food groups consumed outside the home to energy consumed outside the home, and mean food group intakes (g) per eating occasion outside the home for Irish children aged 5-12 years

	Takeaway						Restaurant					
	n	% cons*	% contribution to energy		g/eating occasion		*n*	% cons	% contribution to energy		g/eating occasion	
			Mean	(SD)	Mean	(SD)			Mean	(SD)	Mean	(SD)
Savouries	61	21.2	26.1	(21.1)	141.8	(113.6)	32	20.4	26.6	(19.3)	190.2	(143.1)
Bread & rolls	24	8.3	13.0	(14.5)	49.5	(32.4)	36	22.9	13.3	(10.8)	66.1	(38.8)
Cakes, pastries & buns	19	6.6	9.5	(10.2)	38.0	(37.6)	18	11.5	13.1	(12.5)	57.1	(56.6)
Whole milk	57	19.8	18.4	(13.3)	250.3	(114.0)	16	10.2	9.6	(4.9)	201.6	(101.9)
Creams, ice creams & desserts	44	15.3	14.9	(10.1)	129.0 [a]	(88.3)	41	26.1	16.0	(13.9)	109.8 [ab]	(81.8)
Potatoes	0	0.0	0.0	(0.0)	0.0	(0.0)	33	21.0	13.8	(13.6)	175.8	(83.7)
Chips & processed potatoes	236	81.9	27.8	(17.5)	121.9	(79.9)	85	54.1	21.9	(17.1)	133.5	(81.5)
Vegetables	3	1.0	0.7	(0.3)	46.3	(28.9)	41	26.1	2.1	(3.0)	72.7	(57.0)
Red meat & dishes	17	5.9	16.6	(15.5)	100.9	(105.6)	39	24.8	14.8	(10.3)	105.3	(101.8)
Poultry & game & dishes	39	13.5	21.4	(21.2)	144.1	(108.0)	30	19.1	16.5	(11.5)	150.7	(80.4)
Meat products	209	72.6	25.0 [x]	(14.8)	111.8 [a]	(55.5)	53	33.8	18.1 [y]	(15.0)	90.3 [ab]	(64.4)
Sugars & confectionery	27	9.4	16.0 [x]	(14.8)	40.3	(32.2)	35	22.3	13.8 [x]	(9.8)	46.0	(39.7)
Savoury snacks	22	7.6	15.9	(12.2)	25.3 [a]	(13.7)	21	13.4	13.2	(11.6)	30.4 [ab]	(12.6)
Soups, sauces & misc	89	30.9	3.8	(4.7)	42.6 [a]	(46.2)	60	38.2	4.3	(6.6)	84.8 [b]	(96.3)
Beverages	212	73.6	8.5	(7.0)	315.2 [a]	(168.4)	131	83.4	7.5	(8.5)	328.0 [a]	(181.7)
Other	73	25.3	12.3	(13.7)	139.3	(123.0)	55	35.0	11.9	(11.6)	113.2	(112.4)

* cons - consumers

[xy] Different superscripts are significantly different (P <0.05) between locations outside the home for % contribution to energy

[ab] Different superscripts are significantly different (P <0.05) between locations outside the home for g/eating occasion

Table 5.3 contd: Number and percent consumers for food groups consumed at various locations outside the home, mean percentage contribution of food groups consumed outside the home to energy consumed outside the home, and mean food group intakes (g) per eating occasion outside the home for Irish children aged 5-12 years

	Shop								Other							
	n	% cons	% contribution to energy			g/eating occasion			*n*	% cons	% contribution to energy			g/eating occasion		
			Mean		(SD)	Mean		(SD)			Mean		(SD)	Mean		(SD)
Savouries									3	2.2	35.6	ns	(9.9)	123.3	ns	(39.9)
Bread & rolls	20	11.0	11.1		(10.1)	69.9		(49.6)	28	20.6	12.2	ns	(9.1)	91.7	ns	(138.0)
Cakes, pastries & buns	33	18.1	13.7		(17.6)	45.0		(41.8)	38	27.9	17.7	ns	(18.6)	42.4	ns	(30.1)
Whole milk	6	3.3	5.2		(4.0)	169.4		(152.0)	17	12.5	21.1	ns	(28.7)	255.7	ns	(221.4)
Creams, ice creams & desserts	54	29.7	18.1		(19.2)	77.8	b	(38.5)	17	12.5	17.9	ns	(19.3)	67.8	b	(28.5)
Potatoes	0	0.0	0.0		(0.0)	0.0		(0.0)	0	0.0	0.0		(0.0)	0.0		(0.0)
Chips & processed potatoes	8	4.4	25.8		(31.7)	153.8		(90.0)	31	22.8	23.5	ns	(20.5)	114.2	ns	(65.7)
Vegetables	3	1.6	0.1		(0.1)	11.0		(1.7)	4	2.9	1.6	ns	(1.3)	86.3	ns	(34.7)
Red meat & dishes	4	2.2	5.4		(6.2)	29.0		(6.9)	9	6.6	8.5	ns	(8.4)	98.4	ns	(153.5)
Poultry & game & dishes	1	0.5	5.0		(0.0)	140.0		(0.0)	6	4.4	10.3		(11.1)	127.2		(108.0)
Meat products	19	10.4	18.5	xy	(15.4)	92.0	ab	(81.6)	33	24.3	19.0	xy	(20.6)	71.1	b	(46.6)
Sugars & confectionery	123	67.6	28.5	y	(28.2)	57.4		(56.6)	72	52.9	17.8	x	(16.4)	47.2	ns	(49.0)
Savoury snacks	70	38.5	18.5		(22.7)	30.3	a	(16.4)	54	39.7	17.5	ns	(13.4)	41.4	b	(25.9)
Soups, sauces & misc	31	17.0	5.9		(18.0)	54.4	a	(71.0)	22	16.2	4.0	ns	(4.4)	86.4	a	(104.7)
Beverages	95	52.2	12.1		(16.3)	427.0	b	(320.0)	97	71.3	11.0	ns	(11.6)	391.5	ab	(334.2)
Other	28	15.4	12.1		(20.9)	115.9		(112.9)	37	27.2	11.2	ns	(10.1)	153.7	ns	(152.3)

* cons - consumers

[xy] Different superscripts are significantly different ($P<0.05$) between locations outside the home for % contribution to energy

[ab] Different superscripts are significantly different ($P<0.05$) between locations outside the home for g/eating occasion

[ns] Not significant ($P\geq0.05$)

Table 5.4: Mean number of eating occasions per week outside the home and intakes of nutrients (from the total diet) in non consumers of foods outside the home with consumers of foods outside the home ranked according to tertiles of % energy from foods eaten outside the home for Irish children aged 5-12 years

	Non consumers (n = 135)		Low consumers (n = 153)		Medium consumers (n = 153)		High consumers (n = 153)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Eating occasions outside the home/week	0.0	(0.0)	1.30 [x]	(0.7)	2.2 [y]	(1.3)	4.10 [z]	(2.0)
Energy in MJ	7.1	(1.6)	7.0	(1.5)	7.1	(1.6)	6.9 [ns]	(1.5)
% energy from protein	13.9	(2.1)	13.7	(2.2)	13.4	(2.2)	13.4 [ns]	(2.1)
% energy from fat	33.1 [a]	(4.5)	33.5 [ab]	(3.9)	34.4 [ab]	(4.4)	34.7 [b]	(4.0)
% energy from carbohydrate	52.6	(5.0)	52.3	(4.4)	51.7	(5.3)	51.4 [ns]	(4.5)
% energy from sugar	23.4	(4.8)	24.2	(5.0)	24.3	(6.1)	23.6 [ns]	(5.1)
Fibre per 10 MJ (g)	14.5 [a]	(3.9)	13.5 [ab]	(3.6)	13.2 [b]	(3.4)	12.6 [b]	(2.9)
Calcium per 10 MJ (mg)	1304.6 [a]	(326.6)	1312.7 [a]	(364.9)	1235.0 [ab]	(298.9)	1144.3 [b]	(295.3)
Iron per 10 MJ (mg)	14.8 [a]	(5.4)	13.9 [a]	(3.9)	12.7 [b]	(3.3)	12.7 [b]	(3.4)
Folate per 10 MJ (ug)	358.5 [ab]	(149.0)	362.7 [a]	(142.4)	318.4 [bc]	(108.8)	295.1 [c]	(100.8)
Vitamin C per 10 MJ (mg)	143.4 [a]	(126.0)	142.7 [a]	(105.8)	136.7 [ab]	(83.4)	107.4 [b]	(68.0)

[xyz] Different superscripts are significantly different (P <0.05) eating occasions between different tertile groups

[abc] Different superscripts are significantly different (P <0.05) nutrient intakes between non consumers and different tertile groups

[ns] Not significant ($P \geq 0.05$)

Table 5.5: Comparison of questionnaire reported consumption at food service establishments and actual intake from food diary in Irish children aged 5-12 years

	Coffee Shop / Deli	Hotel / Restaurant	Local chip shop	Fast food restaurant	Pub	Cinema	Ethnic takeaway
% who reported intake at each location:							
less than once per fortnight	91.3	91.0	85.0	88.0	97.4	97.9	89.3
once per fortnight or more frequently	8.7	9.0	15.0	12.0	2.6	2.1	10.7
Actual intake at each location:							
% consumers at each location over survey week	7.7	22.1	23.2	24.7	5.9	5.7	11.1

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Chapter 6

Meal and snack patterns of Irish children

6.1 Introduction

The study of food habits and eating patterns is essential for the informed planning of food-based dietary guidelines (FBDG), which need to be based within the cultural context of the population for which they are being developed (FAO/WHO, 1996). One aspect of the cultural context of food consumption is the structure of eating habits into eating occasions such as meals and snacks (Oltersdorf, 1999).

Snacking has been found to be very important in the diets of children and adults, contributing 20-30% of energy intakes in addition to many nutrients (Jahns *et al.*, 2001, Zizza *et al.*, 2001, Roos and Prattala, 1997, Winkler *et al.*, 1999, Ruxton *et al.*, 1996, Summerbell *et al.*, 1995, Magarey *et al.*, 1987). It has also been demonstrated in the US that snacking is on the increase, especially in children and young adults (Jahns *et al.*, 2001, Zizza *et al.*, 2001). Most people tend to eat five to six times a day, with the range of eating occasions extending from two to nine per day (Gibney and Wolever, 1999).

Increased frequency of eating has been associated with improved physiological changes such as reduced blood cholesterol, improved glucose tolerance and even improved body weight control in adults. However, snacking is not always considered healthy as it could lead to the choice of low nutrient quality foods and consumption of more foods in general, possibly leading to weight gain (Gatenby, 1997).

The National Children's Food Survey (NCFS) is the first survey of its kind to be carried out in children in Ireland. Information was collected on the type of meal or snack consumed and so this survey provides the opportunity for the first examination of snacking patterns in Irish children and its impact on their diet. The aim of the present study is to assess the contribution of meals and snacks to food and nutrient intakes and to assess the quality of the diet across quartiles of eating occasions. The implications of these findings for the development of FBDG will also be discussed.

6.2 Methods

6.2.1 Survey sample and data collection

The NCFS was a cross-sectional study of food and nutrient intakes of a random sample of 594 Irish children aged 5-12 years. A weighed 7-day food record was used to measure food and beverage intakes. Respondents recorded the day, time, location and meal type for each eating occasion, along with a detailed description of the food, the weight of the food, the quantification method and cooking method. Details of leftovers and recipes used were also collected. The foods were coded using McCance and Widdowson's 'The Composition of Foods' (Foods Standards Agency, 2002, Holland *et al.*, 1995) and published supplements (Chan *et al.*, 1996, Chan *et al.*, 1995, Chan *et al.*, 1994, Holland *et al.*, 1996, Holland *et al.*, 1993, Holland *et al.*, 1992, Holland *et al.*, 1991, Holland *et al.*, 1989 Holland *et al.*, 1988). Nutrient intakes were calculated using WISP© (Weighed Intake Software Program; Tinuviel Software, Anglesey, UK). New food codes were generated for new foods on the market, generic Irish foods, supplements and for recipes. A series of questionnaires was used to collect additional information on health and lifestyle and physical activity. Anthropometric measurements (weight, height, waist circumference, hip circumference and leg length) of the children and their parents were taken.

6.2.2 Meal types

The meal type was self-defined by the respondent and was assigned to one of nine different categories when coding the food diaries: (1) breakfast; (2) lunch (light meal); (3) lunch (main meal); (4) evening meal (light meal); (5) evening meal (main meal); (6) morning snack; (7) afternoon snack; (8) evening snack and (9) beverage. Morning, afternoon and evening snacks were aggregated to describe 'snacks', and breakfast, lunch (light and main meal) and evening meal (light and main meal) were aggregated to describe 'meals'. All nine meal types combined were used to describe 'all eating occasions'.

6.2.3 Data analysis.

Data analysis was carried out using SPSS® version 12.0.1 (SPSS Inc., Chicago, IL, USA.). Mean (± standard deviation) food, energy and nutrient intakes were calculated at all eating occasions, at all meals and at all snacks, as well as at the individual snacking occasions in the morning, afternoon and evening. The percentage contribution of meals and snacks and each snacking period individually to nutrient intakes was also assessed. The mean number of all eating occasions, snack eating occasions and meal eating occasions per day were calculated (based on an energy value greater than 0kJ) and quartile groups of eating occasions were generated based on these values. Total energy and nutrient intakes were then analysed according to quartiles of all eating occasions, snack eating occasions and meal eating occasions. Patterns of food intake across quartiles of eating occasions were examined for percentage consumers, mean daily intakes (g) of food groups and percentage contribution of each food group to energy.

6.2.4 Statistical analysis

Independent t-tests were used to determine significant differences between all meals and all snacks and across socio-demographic variables with two categories i.e. sex, age group and urban/rural location. One-way analysis of variance (ANOVA) was used to examine whether significant differences in the number of eating occasions, food intakes and nutrient intakes existed between morning, afternoon and evening snacks and between different quartile groups. As will be discussed, repeated measures analysis was also carried out. One–way ANOVA was also used to determine significant differences between socio-demographic and other variables with three or more categories e.g. education level, social class, BMI group etc. Where significant differences existed, homogeneity of variance was examined using Levene's test. For values that satisfied Levene's test, the Scheffe *post hoc* test was used to determine which means differed. The Tahmane *post hoc* test was used for values that did not satisfy the Levene's test. Pearson's chi square was used to determine whether or not there was a relationship between socio-demographic variables and quartile groups. Initial examination did not reveal differences between the sexes for eating occasions; therefore results have been presented for boys and girls together. Values of $P<0.05$ were taken as significantly different.

6.3 Results

Table 6.1 presents energy and nutrient intakes for all eating occasions and separately for meals and snacks as well as morning, afternoon and evening snacks individually. Meals contributed to 76% of energy intakes, with snacks contributing 24%. The percentage of energy from fat ($P<0.01$), carbohydrate, saturated fat and sugars ($P<0.001$) were significantly higher at snacking occasions, whereas the percentage of energy from protein and fibre and micronutrient intakes (per 10MJ) ($P<0.001$) were significantly higher at meals (except for vitamin E). Morning snacks were least important in the diets of Irish children contributing to just 4% of total energy compared to 10-11% contributed by afternoon and evening snacks. No consistent trend was observed in nutrient intakes across different snacking time periods. Energy intakes at meals and snacks were also assessed across various socio-demographic groups but few significant differences were observed. Boys had significantly higher energy intakes from meals ($P<0.001$) and evening snacks ($P<0.05$) than girls; older children (9-12 years) had significantly higher energy intakes from meals, snacks and in particular evening snacks than younger children (aged 5-8 years) ($P<0.001$); and children whose parents had higher levels of education had significantly higher energy from afternoon snacks than children whose parents had lower levels of education ($P<0.05$).

Food intakes were also examined for meals and snacks (Table 6.2). The percentage of consumers was higher at meals than snacks for all food groups except for savoury snacks. The mean daily food intake (g/day) and percentage contribution of food to energy was significantly higher ($P<0.05$) at meals than snacks for almost all food groups examined except for sugars and confectionery and savoury snacks which were higher from snacks. As expected, the percentage of consumers of all food groups was higher for afternoon and evening snacks than morning snacks. The greatest contributors to energy intake at all snacking occasions throughout the day were bread and rolls, sugars and confectionery, cakes, pastries and buns and savoury snacks. Savouries, chips and processed potatoes, breakfast cereals and cream, ice-creams and desserts also made important contributions to energy intakes at afternoon and evening snacks.

The mean number and range of eating occasions for the total population and across quartile groups of all eating occasions, meal occasions and snack occasions is shown in Table 6.3. The mean daily number of all eating occasions was 4.7, with 3.0 the mean number of meals and 1.6 the mean number of snacks consumed per day. Examination of the number of eating occasions by demographics revealed very little except that children whose parents had a higher level of education had a significantly higher number of all eating occasions ($P<0.01$) and meals ($P<0.05$) than those whose parents had lower levels of education. Examining patterns across increasing frequency of snacking, the mean number of all eating occasions increased, while the mean number of meals decreased. The number of all eating occasions also increased with increasing frequency of meals, but no significant difference in snacks was observed. Examination of the characteristics of each quartile group revealed little difference except that children with parents of higher education levels had a higher number of all eating occasions and a higher number of meals than children whose parents had lower levels of education ($P<0.05$).

Intakes of nutrients across quartile groups are presented in Table 6.4. Only those which showed statistically significant differences across quartiles groups are presented here. In general, the actual differences observed between quartile groups were very small, even if they were statistically different in some cases. Energy intakes increased significantly with increasing number of all eating occasions and meal occasions. The percentage of energy from protein decreased with increasing number of all eating and snacking occasions, but increased with increasing number of meal occasions. In general, the intakes of micronutrients tended to increase by a small (and sometimes significant) amount with increasing number of meal occasions.

Mean daily food intake (g/day) and percentage energy from food across quartiles of eating occasions, meal occasions and snack occasions are shown in Tables 6.5 and 6.6. Because of the large number of food groups assessed, only the food groups where significant differences existed are presented here. Similar to nutrient intakes, there were generally very small differences in food intake or percent energy from food between different quartile groups. Cakes, pastries and buns increased with increasing eating frequency for all quartile groups. Fruit intake (g/day) increased with increasing number of all eating and meal occasions. Intakes of whole milk and reduced fat milk also increased with increasing number of meal occasions. In general, increased consumption of snack type foods (e.g. savoury snacks and sugars and confectionery) and decreased consumption of meal type foods (red meat and red meat dishes, and potatoes) were associated with increased snacking frequency.

Other profiles were examined in relation to meal patterns for this sample. Five percent of meals and 8% of snacks were consumed outside the home e.g. at takeaways, restaurants etc. Thirty-nine percent of the sample consumed snacks every day. However, the children tended not to consume snacks during the same time period every day, but rather consumed snacks at different time periods on different days e.g. only 8% consumed afternoon snacks every day. There were no significant differences in the number of all eating occasions, snacking occasions and meal occasions across BMI categories or tertiles of physical activity levels (defined from the physical activity questionnaire). Children who watched the greatest amount of television were found to consume significantly less ($P<0.05$) meals than other children (in the order of approximately 0.2 meals/day). Differences were not significant for all eating occasions or snacks according to categories of television viewing. Demographics for quartiles of snacking occasions are presented in Table 6.7.

6.4 Discussion

A joint FAO/WHO consultation called for the development of FBDG in order to translate nutrient goals into more meaningful food-based guidelines. It also stated the need for culturally acceptable guidelines for the countries for which they are being developed (FAO/WHO, 1996). One aspect of the cultural context of FBDG extends to food consumption patterns within a country (Gibney and Wolever, 1997). The NCFS presents the first occasion for the examination of meal and snack patterns in a nationally representative sample of Irish children. The present study examined the role of meals and snacks in the diet and examined the quality of children's diets across quartiles of eating occasions. Snacks were consumed by nearly 100% of the sample and they contributed to almost a quarter of the energy consumed. Morning time was the least important snacking period. Food and nutrient intakes were examined across quartiles of all eating occasions, quartiles of snacking occasions and quartiles of meal occasions. Differences across quartile groups were relatively small and nutrient intakes in the highest quartiles for all eating occasion and snacking occasions were quite comparable with mean population intakes.

Similar to the present study, the vast majority of children and adolescents in other studies were found to snack at least once (Jahns *et al.*, 2001, Cross *et al.*, 1994, Livingstone, 1991, Dugdale *et al.*, 1988, McCoy *et al.*, 1986, Ezell *et al.*, 1985). The mean daily number of snacks consumed in the present study (1.6) was very similar to that of girls aged 9 years from the US (1.8-1.9) (Francis *et al.*, 2003), but was lower than the 2.0-2.3 snacks consumed by children and adolescents in the US from the CSFII 1994-1996 (Jahns *et al.*, 2001). The contribution of snacks to energy in the present study was almost a quarter, which is very similar to other studies based on children and adolescents (Jahns *et al.*, 2001, Ruxton *et al.*, 1996, Magarey *et al.*, 1987, McCoy *et al.*, 1986). However, snack foods were reported to contribute one third of British school children's energy intakes (Livingstone, 1991). Different patterns relating to snacking have also been seen in children from different cultures. Only 11% of Chinese children reported snacking, with the contribution to energy of just 8% (Waller *et al.*, 2002). Mexican children consumed up to 45% of their energy from snacks and had a much higher number of eating occasions (up to thirteen times) (Eastwood Garcia *et al.*, 1990). Afternoon and evening snacks were much more common than morning snacks in Irish children. This is similar to studies by Devaney *et al.* (1995), Cross *et al.* (1994), McCoy *et al.* (1986) and Ezell *et al* (1985). This could be due to the fact children spend the morning period at school with less access to food that they could potentially snack on.

As expected, snacks were found to be less nutrient dense than meals. This has also been shown by Jahns *et al.* (2001), Ruxton *et al.*, 1996 and McCoy *et al.* (1986). Relative to the percent contribution to energy, snacks contributed less to protein, cholesterol, vitamin and mineral intakes in Irish children. These findings are supported by Ruxton *et al.*, (1996), Magarey *et al.* (1987) and McCoy *et al.* (1986). The percentage of energy from fat is slightly higher from snacks than meals: however, the percentage of energy from sugar is more than 50% higher in snacks than meals. The implications of higher sugar intakes at snacks in the aetiology of dental caries have been well documented (Moynihan and Petersen, 2004).

Increased frequency of eating has been associated with beneficial physiological changes such as improved body weight and decreases in blood cholesterol in adults. However, snacking has also been considered a bad habit, which might lead to the choice of low quality snack food and therefore result in a poorer nutrient profile (Gatenby, 1997). Some of the recent interest in snacking, particularly in relation to children has stemmed from the possible association with overweight and television viewing. The present study did not find any difference in the number of eating occasions across BMI groups or physical activity levels. There were no significant differences in the number of all eating occasions or snacks across time categories of television watching in Irish children. However, the number of meals was found to be lower in the group that watched the most television. Waller *et al.* (2003) did not find any differences in the percentage of energy from snacks by overweight status in Chinese children, however, snacking accounted for only a small percentage of their overall energy intake. Francis *et al.* (2003) also found no difference in snacking frequency between girls from overweight and non overweight families in the US. However, girls from overweight families reported eating more snacks while watching television. Ruxton *et al.* (1996) and Morgan *et al.* (1983) did not find a significant association between the frequency of snacking and obesity.

As with all studies, there are difficulties in making comparisons due to methodological differences. The difficulties associated with defining an eating occasion have been well documented (Gatenby *et al.*, 1997). Meals and snacks have been defined based on time, type of food consumed, energy intake etc. In the present study eating occasions were defined by the respondent. The results show that respondents were able to define snacks as eating occasions of smaller size and at times other than regular meal times i.e. breakfast, lunch, evening meal. Other issues which also make comparisons between studies difficult include different data collection methods (e.g. 24 hour recall, 7-day food record), various sample sizes and different age categories used in the studies. Also, some of the peer-reviewed papers discussed here are quite dated (Dugdale *et al.*, 1988, Magarey *et al.*, 1987, McCoy *et al.*, 1986, Ezell *et al.*, 1985) and patterns within those countries may have changed since then. The matter of under-reporting is also of great concern in the study of meals and snacks (Gatenby, 1997).

The case could be made that statistical analysis using repeated measures ought to be carried out on this data as meals and snacks are not independent of each other, nor are morning, afternoon and evening snacks independent. This issue was addressed and found that the detail of analysis and the overall conclusions drawn from this work were not different, except for the significance level which changed occasionally. However this application significantly reduced the number of subjects (by nearly a half when comparing morning, afternoon and evening snacks). From the point of view of understanding food patterns, the maximum number of consumers possible should be used. While it can be wise to look at repeated measures, it is also wise to use alternatives to maximise the number of respondents to demonstrate a relationship. For these reasons, the data were presented with statistical analysis based on independent samples.

Examination of food and nutrient intakes across quartiles of all eating occasions, snacking occasions and meal occasions revealed very few differences and certainly no more than was expected. This supports the findings of Ruxton *et al.* (1996). Those in the highest quartile groups had nutrient intakes very similar to the mean population intakes. Respondents in the highest quartiles of all eating occasions or snacking occasions did not have problems in relation to micronutrient intakes or fat intakes. Those in the highest tertile of snacking occasions did have a significantly higher percentage energy from sugar, which might create a problem in relation to the development of dental caries. Snacking accounts for almost 25% of energy intake in Irish children, but perhaps there is a need for this extra energy to support the higher energy intake per kg/body weight required for growth and development. In general, FBDG do not need to specifically focus on snacks rather than meals to improve food choice in Irish children. Snacks could however be targeted as an eating occasion at which to improve sugar intakes. The Nutrition Advisory Group (1995) suggested the 'frequent consumption of foods containing sugar should be avoided, especially by children'. As fruit and vegetable intakes are quite low in Irish children (Chapter 4), FBDG to increase fruit intakes at snack times, or to replace confectionery with fruit could help improve fruit intakes, and reduce the intakes of extrinsic sugars. Also, in relation to the development of FBDG in this area, recommendations can be made to the general population as opposed to different subgroups of the population as differences were generally not found across different socio-demographic groups.

In conclusion, the examination of meal patterns, particularly snacking patterns in a sample of Irish children seemed an ideal opportunity for deriving FBDG for this population. However, the data did not reveal very useful information in this respect. Snacks contributed significantly to the energy intake but did not really influence food and nutrient intakes other than what was expected. Guidelines to reduce the number of snacks consumed may even compromise energy/nutrient intakes in children. Examination of food and nutrient intakes across quartiles of snacking occasions and indeed all eating occasions did not reveal many differences or differences compared with the mean population intakes. This again suggests that guidelines specifically in relation to snacking would not be practical. Although health promotion messages derived from this work could promote a reduction in sugar intake at snack times, FBDG, specifically in relation to snacking, will not be helpful in this population. Health promotion messages should target improved food choices at all eating occasions i.e. meals and snacks.

Table 6.1: Intakes of energy, macronutrients (percentage contribution to energy), fibre and micronutrients (per 10MJ) for all eating occasions, for meals only and for snacks only and with snacks presented separately as morning, afternoon and evening snacks for Irish children aged 5-12 years.

	All eating occasions (*n* =594)		*Meals (*n* =594)		Snacks (*n* =586)		Morning snack (*n* =355)		Afternoon snack (*n* =554)		Evening snack (*n* =543)	
	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Energy (MJ)	7.0	(1.5)	5.3	(1.4)	1.7	(0.9)	0.3 ^{a}	(0.3)	0.8 ^{b}	(0.5)	0.7 ^{c}	(0.7)
Protein (%)	13.6	(2.2)	15.1	(2.4)	8.8	(2.8)	8.4 ^{ab}	(5.0)	8.3 ^{a}	(3.6)	9.0 ^{b}	(3.6)
Fat (%)	33.9	(4.2)	33.7	(4.6)	34.6	(7.2)	32.4	(14.9)	34.3	(9.6)	34.4 ^{ns}	(10.9)
Saturates (%)	14.3	(2.6)	13.8	(2.7)	15.6	(4.5)	14.4 ^{a}	(8.5)	15.1 ^{ab}	(5.7)	16.0 ^{b}	(6.9)
Carbohydrate (%)	52.0	(4.8)	50.8	(5.2)	55.9	(7.4)	58.6 ^{a}	(16.4)	56.6 ^{ab}	(10.3)	55.8 ^{b}	(11.4)
Sugars (%)	23.9	(5.3)	20.9	(5.3)	33.1	(9.9)	37.2 ^{a}	(22.5)	34.4 ^{ab}	(14.2)	33.8 ^{b}	(15.0)
Fibre (g)	13.4	(3.5)	14.3	(4.0)	11.1	(5.3)	13.0 ^{a}	(14.0)	11.0 ^{b}	(7.0)	12.2 ^{ab}	(15.2)
Calcium (mg)	1247.5	(328.8)	1293.1	(356.6)	1065.3	(467.8)	973.9 ^{a}	(736.4)	938.5 ^{a}	(632.7)	1252.9 ^{b}	(777.4)
Iron (mg)	13.5	(4.1)	15.0	(4.8)	9.0	(5.0)	8.6 ^{ab}	(8.9)	8.3 ^{a}	(12.7)	10.1 ^{b}	(9.5)
Zinc (mg)	9.4	(2.2)	10.5	(2.7)	5.9	(2.0)	5.6 ^{a}	(3.3)	5.5 ^{a}	(2.8)	6.4 ^{b}	(3.1)
Vitamin D (μg)	3.3	(3.4)	3.7	(4.1)	1.8	(3.9)	3.7	(17.7)	1.5	(3.7)	1.9 ^{ns}	(5.4)
Vitamin E (mg)	9.2	(5.9)	8.9	(6.5)	10.1	(8.0)	11.1	(24.3)	9.9	(8.2)	10.6 ^{ns}	(11.3)
Thiamin (mg)	2.2	(2.2)	2.5	(2.3)	1.3	(0.8)	1.4 ^{ab}	(1.9)	1.2 ^{a}	(1.0)	1.5 ^{b}	(1.4)
Riboflavin (mg)	2.6	(2.3)	2.8	(2.3)	1.9	(1.2)	1.6 ^{a}	(2.0)	1.6 ^{a}	(1.3)	2.4 ^{b}	(2.0)
Niacin (mg)	24.9	(8.8)	28.5	(9.8)	13.3	(10.6)	14.7	(40.4)	12.0	(12.3)	14.1 ^{ns}	(15.6)
Vitamin B6 (mg)	2.9	(2.3)	3.3	(2.4)	1.7	(1.2)	2.0 ^{ab}	(4.5)	1.5 ^{a}	(1.3)	1.9 ^{b}	(1.8)
Vitamin B12 (μg)	6.3	(3.0)	6.9	(3.5)	4.0	(3.4)	2.9 ^{a}	(4.2)	3.1 ^{a}	(3.7)	5.0 ^{b}	(5.1)
Folate (μg)	332.9	(129.0)	370.3	(146.4)	214.1	(171.3)	219.2 ^{ab}	(322.8)	179.7 ^{a}	(154.8)	269.5 ^{b}	(350.3)
Vitamin C (mg)	132.2	(98.2)	140.9	(119.4)	107.6	(156.4)	182.9 ^{a}	(397.4)	104.5 ^{b}	(232.8)	132.8 ^{ab}	(357.5)

* Nutrient intakes were significantly different (P <0.05) between meals and snacks for all of the nutrients presented

^{abc} denotes significant differences (P <0.05) between morning, afternoon and evening snacks

^{ns} Not significant ($P \geq 0.05$)

Table 6.2: Percentage of consumers and food intake (mean g/day and mean % energy from food) at meals and snacks for Irish children aged 5-12 yea

	% Consumers		Weight of food (g)					% Energy from food				
	Meals	Snacks	Meals		Snacks			Meals		Snacks		
			Mean	(SD)	Mean		(SD)	Mean	(SD)	Mean		(SD)
Rice & pasta, flours, grains & starches	64.8	4.5	39.3	(31.0)	18.9	*	(10.6)	2.8	(2.3)	1.3	*	(0.7)
Savouries	67.7	17.3	39.0	(33.1)	28.2	*	(22.5)	4.6	(4.1)	3.1	*	(2.2)
Bread & rolls	99.7	71.4	67.0	(34.1)	21.4	*	(17.2)	9.8	(4.5)	3.1	*	(2.4)
Breakfast cereals	93.4	27.3	37.8	(34.0)	12.4	*	(11.2)	7.1	(4.3)	2.7	*	(2.1)
Cakes, pastries & buns	79.0	81.8	16.9	(13.2)	14.8	*	(11.7)	4.3	(3.3)	3.8	*	(2.8)
Whole milk	89.7	59.3	224.2	(143.0)	67.6	*	(64.0)	8.9	(5.3)	2.7	*	(2.3)
Reduced fat milks	16.8	7.9	135.6	(127.4)	51.4	*	(48.2)	3.6	(3.2)	1.4	*	(1.2)
Creams, ice creams & desserts	57.4	50.3	26.7	(22.5)	23.0	*	(22.9)	3.0	(2.7)	2.8	*	(2.6)
Cheese	55.1	25.9	10.8	(8.7)	6.8	*	(5.8)	2.3	(1.8)	1.4	*	(1.2)
Yoghurt	60.4	39.2	43.5	(32.1)	31.6	*	(27.7)	2.7	(2.0)	2.0	*	(1.8)
Eggs & egg dishes	40.2	4.5	18.1	(13.8)	10.7	*	(5.3)	2.0	(1.7)	1.2	*	(0.7)
Butter & spreads	79.3	45.1	7.8	(7.1)	2.7	*	(2.3)	3.0	(2.4)	1.0	*	(0.9)
Low fat spreads	23.9	13.5	5.4	(3.8)	1.9	*	(1.9)	1.2	(0.8)	0.4	*	(0.4)
Potatoes	88.2	0.8	59.5	(47.5)	27.3	*	(11.3)	2.8	(2.3)	1.1	ns	(0.5)
Chips & processed potatoes	91.9	18.0	45.5	(32.4)	19.9	*	(15.7)	5.6	(4.0)	2.4	*	(1.7)
Vegetables & pulse dishes	21.0	1.5	24.4	(38.0)	4.8	ns	(1.6)	1.9	(2.1)	0.5	*	(0.4)
Vegetables	91.1	13.5	43.0	(35.4)	15.3	*	(14.1)	1.3	(1.8)	0.4	*	(0.5)
Fruit juices	64.5	35.5	114.5	(91.7)	46.9	*	(42.4)	2.7	(2.1)	1.1	*	(0.9)
Fruit	70.7	64.0	58.9	(43.0)	42.7	*	(38.0)	1.7	(1.3)	1.3	*	(1.2)
Fish & fish dishes	46.5	4.4	18.0	(14.3)	12.6	ns	(11.4)	1.9	(1.4)	1.3	*	(1.2)
Red meat & dishes	89.9	10.9	46.2	(36.7)	8.7	*	(10.6)	4.9	(3.6)	1.0	*	(1.0)
Poultry & game (& dishes)	76.6	5.2	30.3	(28.5)	12.6	*	(11.7)	2.6	(2.1)	1.1	*	(0.9)
Meat products	92.1	36.7	37.4	(24.4)	12.2	*	(12.5)	5.8	(3.9)	1.8	*	(1.9)
Sugars & confectionery	92.8	89.7	16.7	(13.7)	20.4	*	(18.6)	4.2	(3.3)	5.3	*	(4.6)
Savoury nnacks	56.9	76.6	8.3	(6.3)	11.1	*	(8.8)	2.6	(2.0)	3.5	*	(2.8)
Soups, sauces & misc foods	86.2	35.0	26.9	(30.9)	16.9	*	(21.4)	1.3	(1.5)	0.8	*	(1.3)
Beverages	98.8	89.9	328.7	(187.0)	133.8	*	(103.6)	3.2	(3.0)	1.6	*	(1.7)

* Food intakes were significantly different ($P < 0.05$) between meals and snacks

ns Not significant ($P \geq 0.05$)

Table 6.3: Mean number (and SD) and range of eating occasions for the total population and quartile groups based on the number of all eating occasions, snack occasions and meal occasions for Irish children aged 5-12 years.

		Total Population	Quartile 1	Quartile 2	Quartile 3	Quartile 4
All eating occasions	*n*	594	163	142	144	145
	Range of all eating occasions	2.6-8.1	<4.0	4.0-4.6	4.6-5.1	>5.1
	Mean number of all eating occasions	4.7	3.6 [a]	4.4 [b]	4.9 [c]	5.9 [d]
	(SD of all eating occasions)	(0.9)	(0.4)	(0.2)	(0.2)	(0.6)
	Mean number of snack occasions		0.8 [a]	1.2 [b]	1.7 [c]	2.5 [d]
	Mean number of meal occasions		2.7 [a]	3.1 [b]	3.1 [b]	3.2 [b]
Snack occasions	*n*	586	137	170	146	133
	Range of all snack occasions	0.1-4.4	<1	1-1.4	1.4-2	>2
	Mean number of all snack occasions	1.6	0.6 [a]	1.2 [b]	1.8 [c]	2.7 [d]
	(SD of all snack occasions)	(0.8)	(0.2)	(0.2)	(0.2)	(0.6)
	Mean number of all eating occasions		3.8 [a]	4.3 [b]	4.9 [c]	5.8 [d]
	Mean number of meal occasions		3.1 [a]	3.0 [ab]	3.0 [ab]	2.9 [b]
Meal occasions	*n*	594	160	96	178	160
	Range of all meal occasions	0.9-4.4	<2.7	2.7-3	3-3.3	>3.3
	Mean number of all meal occasions	3.0	2.5 [a]	2.9 [b]	3.1 [c]	3.5 [d]
	(SD of all meal occasions)	(0.4)	(0.3)	(0.0)	(0.1)	(0.2)
	Mean number of all eating occasions		4.3 [a]	4.5 [ab]	4.8 [b]	5.1 [c]
	Mean number of snack occasions		1.6	1.5	1.6	1.4 [ns]

[abc] denotes significant differences $P<0.05$) between quartile groups

[ns] Not significant ($P \geq 0.05$)

Table 6.4: Intakes of nutrients[#] (percentage energy from macronutrients and fibre and micronutrients per 10 MJ) from the total diet showing statistically significant differences across quartiles of all eating ocasions, quartiles of snacking occasions and quartiles of meal occasions for Irish children aged 5-12 years.

		Quartile 1		Quartile 2		Quartile 3		Quartile 4	
		Mean	(SD)	Mean	(SD)	Mean	(SD)	Mean	(SD)
Quartiles of all eating occasions	Energy (MJ)	6.3^{a}	(1.5)	7.3^{b}	(1.6)	7.3^{b}	(1.4)	7.3^{b}	(1.4)
	Protein (%)	13.9^{a}	(2.2)	13.9^{a}	(2.3)	13.4^{ab}	(2.1)	13.1^{b}	(2.0)
	Sugars (%)	22.5^{a}	(5.5)	23.4^{a}	(5.1)	24.2^{ab}	(5.2)	25.7^{b}	(4.8)
	Niacin (mg)	26.3^{a}	(9.8)	25.6^{ab}	(8.8)	24.2^{ab}	(8.5)	23.3^{b}	(7.6)
Quartiles of snacking occasions	Protein (%)	14.2^{a}	(2.1)	13.7^{a}	(2.0)	13.5^{a}	(2.2)	12.8^{b}	(2.0)
	Carbohydrate (%)	51.2^{a}	(4.9)	52.1^{ab}	(5.0)	51.2^{a}	(4.5)	53.4^{b}	(4.5)
	Sugars (%)	22.1^{a}	(5.5)	23.7^{ab}	(4.9)	23.9^{b}	(5.0)	26.3^{c}	(4.9)
	Zinc (mg)	9.8^{a}	(2.4)	9.4^{ab}	(2.0)	9.4^{ab}	(2.2)	9.0^{b}	(2.4)
	Niacin (mg)	26.6^{a}	(9.6)	26.1^{ab}	(9.6)	23.6^{bc}	(8.2)	23.0^{c}	(7.0)
Quartiles of meal occasions	Energy (MJ)	6.6^{a}	(1.5)	7.0^{ab}	(1.5)	7.1^{b}	(1.5)	7.4^{b}	(1.5)
	Protein (%)	13.2^{a}	(2.2)	13.5^{ab}	(2.3)	13.7^{ab}	(2.2)	13.9^{b}	(2.1)
	Fibre (g)	12.7^{a}	(3.4)	13.3^{ab}	(3.8)	13.6^{ab}	(3.4)	14.0^{b}	(3.4)
	Calcium (mg)	1160.3^{a}	(306.3)	1230.8^{ab}	(309.0)	1280.0^{b}	(316.6)	1308.4^{b}	(357.9)
	Folate (μg)	312.7^{a}	(117.9)	332.6^{ab}	(133.6)	324.9^{ab}	(127.5)	362.3^{b}	(134.6)

[abc] denotes significant differences (P <0.05) between quartile groups

[#] Nutrients examined were energy, protein, carbohydrate, fat, saturated fat, carbohydrate, sugar, fibre, calcium, iron, zinc, vitamin D, vitamin E, thiamin, riboflavin, niacin, vitamin B6, vitamin B12, folate and vitamin C

Table 6.5: Mean daily food[#] intakes (g/day) across quartiles of all eating occasions, quartiles of snacking occasions and quartiles of meal occasions for Irish children aged 5-12 years

		Quartile 1			Quartile 2			Quartile 3			Quartile 4		
		n	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)
Food Intake													
Quartiles of all eating occasions	Beverages	162	439.1[a]	(237.7)	141	482.5[ab]	(237.5)	144	483.5[ab]	(277.1)	145	527.0[b]	(284.1)
	Cakes, pastries & buns	147	20.8[a]	(14.0)	131	27.6[b]	(17.5)	140	29.5[b]	(20.0)	144	30.3[b]	(21.9)
	Fruit	122	67.6[a]	(47.4)	123	79.9[ab]	(56.1)	129	79.1[ab]	(57.6)	133	95.9[b]	(71.2)
	Savoury snacks	129	12.8[a]	(8.5)	122	14.0[ab]	(9.6)	128	17.4[b]	(12.5)	135	17.1[b]	(11.7)
	Sugars & confectionery	157	28.5[a]	(19.5)	142	31.5[ab]	(26.7)	143	38.9[bc]	(23.4)	142	39.7[c]	(25.1)
Quartiles of snack occasions	Cakes, pastries & buns	128	21.4[a]	(14.8)	157	27.3[b]	(18.3)	143	29.1[b]	(21.1)	128	29.7[b]	(19.6)
	Creams, ice-creams & desserts	103	32.1[ab]	(27.4)	131	35.0[ab]	(36.1)	109	30.7[a]	(24.2)	105	44.0[b]	(34.3)
	Potatoes	125	70.8[a]	(54.7)	153	59.2[ab]	(49.4)	127	51.4[b]	(32.4)	114	56.7[ab]	(47.7)
	Savoury snacks	104	11.9[a]	(8.5)	147	14.3[ab]	(8.8)	134	17.1[bc]	(13.1)	125	17.8[c]	(11.4)
	Sugars & confectionery	132	26.1[a]	(17.4)	169	30.8[a]	(22.5)	144	39.2[b]	(25.8)	132	43.3[b]	(26.5)
Quartiles of meal occasions	Bread & rolls	160	69.4[a]	(35.2)	96	86.2[b]	(39.0)	178	85.4[b]	(40.8)	160	88.5[b]	(39.0)
	Cakes, pastries & buns	144	22.8[a]	(15.0)	91	26.2[ab]	(16.1)	170	29.7[b]	(21.1)	157	28.4[b]	(20.6)
	Fruit	128	66.3[a]	(55.5)	78	77.1[ab]	(58.2)	161	87.1[b]	(60.6)	140	89.4[b]	(61.0)
	Reduced fat milks	26	89.7[a]	(76.4)	21	134.1[ab]	(177.5)	33	169.7[ab]	(175.9)	26	219.4[b]	(164.6)
	Whole milk	145	234.8[a]	(177.9)	91	270.6[ab]	(170.3)	162	270.2[ab]	(154.4)	148	304.4[b]	(209.4)

[#] Only food intakes with significant differences across quartile groups are presented here.

[abc] denotes significant differences (P <0.05) between quartile groups

Table 6.6: Mean daily contribution of foods[#] to energy across quartiles of all eating occasions, quartiles of snacking occasions and quartiles of meal occasions for Irish children aged 5-12 years

		Quartile 1			Quartile 2			Quartile 3			Quartile 4		
		n	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)	*n*	Mean	(SD)
% contribution of food to energy													
Quartiles of all eating occasions	Cakes, pastries & buns	147	5.9 [a]	(3.7)	131	6.9 [ab]	(4.1)	140	7.3 [b]	(4.6)	144	7.5 [b]	(5.4)
	Chips & processed potatoes	155	7.1 [a]	(4.7)	131	6.2 [ab]	(4.3)	133	5.7 [bc]	(3.9)	129	4.8 [c]	(3.0)
	Meat products	150	7.3 [a]	(4.5)	137	6.2 [ab]	(4.0)	137	6.3 [ab]	(4.0)	135	5.8 [b]	(3.8)
	Potatoes	141	3.4 [a]	(2.4)	131	2.9 [ab]	(2.3)	127	2.7 [ab]	(2.4)	126	2.3 [b]	(1.7)
	Poultry & game (&dishes)	121	3.3 [a]	(2.6)	115	2.5 [b]	(1.7)	113	2.4 [b]	(1.9)	114	2.4 [b]	(2.0)
	Red meat & dishes	142	5.9 [a]	(4.0)	130	5.5 [ab]	(4.1)	132	4.4 [bc]	(2.9)	131	4.2 [c]	(3.1)
Quartiles of snack occasions	Cakes, pastries & buns	128	5.7 [a]	(3.7)	157	7.0 [b]	(4.4)	143	7.4 [b]	(5.0)	128	7.3 [b]	(4.6)
	Potatoes	125	3.5 [a]	(2.7)	153	2.9 [ab]	(2.3)	127	2.4 [ab]	(1.6)	114	2.5 [b]	(2.1)
	Red meat & dishes	126	5.4 [a]	(3.5)	149	5.6 [a]	(4.0)	134	4.7 [ab]	(3.6)	121	4.2 [b]	(3.1)
	Savouries	95	6.0 [a]	(6.0)	121	5.2 [ab]	(3.5)	105	4.9 [ab]	(4.0)	99	4.1 [b]	(3.5)
	Savoury snacks	104	3.9 [a]	(2.8)	147	4.6 [ab]	(2.9)	134	5.3 [b]	(4.2)	125	5.3 [b]	(3.4)
	Sugars & confectionery	132	7.1 [a]	(4.8)	169	8.0 [ab]	(5.2)	144	9.7 [bc]	(6.2)	132	10.9 [c]	(6.4)
Quartiles of meal occasions	Beverages	160	6.0 [a]	4.2	96	4.9 [ab]	4.1	177	4.4 [ab]	3.5	159	4.5 [b]	4.2
	Bread & rolls	160	10.9 [a]	5.0	96	12.7 [b]	5.1	178	12.5 [b]	5.3	160	12.1 [ab]	4.7
	Chips & processed potatoes	151	6.9 [a]	4.5	85	6.3 [ab]	4.3	166	5.7 [ab]	4.2	146	5.4 [b]	3.4
	Meat products	152	7.3 [a]	4.6	88	6.8 [ab]	4.2	172	5.9 [b]	3.7	147	5.8 [b]	3.7
	Reduced fat milks	26	2.3 [a]	1.8	21	3.8 [ab]	4.6	33	4.6 [ab]	4.5	26	5.6 [b]	4.1
	Sugars & confectionery	158	9.9 [a]	6.8	95	9.3 [ab]	6.0	174	8.6 [ab]	5.9	157	7.7 [b]	4.3

[#] Only food intakes with significant differences across quartile groups are presented here.

[abc] denotes significant differences ($P < 0.05$) between quartile groups

Table 6.7: Demographics for quartiles of snacking occasions

Quartiles of snacking occasions	Total Population	Quartile 1		Quartile 2		Quartile 3		Quartile 4	
Sex of child									
% Boys	49.3	51.1		48.2		47.3		52.6	
% Girls	50.7	48.9		51.8		52.7		47.4	
Age group of child									
% 5-8 years	49.8	51.1		48.8		50.0		49.6	
% 9-12 years	50.2	48.9		51.2		50.0		50.4	
Parents education level									
% Intermediate/Junior certificate	18.5	23.5		19.4		15.3		15.9	
% Leaving certificate	38.9	33.8		41.2		40.3		37.9	
% Degree/diploma	42.6	42.6		39.4		44.4		46.2	
Foods consumed outside the home									
% Consumers	77.3	73.7		80.0		76.0		78.9	
Mean number of eating occasions	2.5	1.5	a	2.0	ab	1.9	ab	2.4	b
Weight status									
Mean BMI	18.0	18.2		17.8		18.1		17.8	ns
% Normal weight	77.8	77.4		79.4		74.0		81.2	
% Overweight	11.1	10.2		11.8		11.6		9.8	
% Obese	11.1	12.4		8.8		14.4		9.0	
TV viewing									
Mean number of hours watched on a weekday	1.8	1.7		1.7		1.8		1.8	ns
Number of days a snack was consumed									
% 1-3 days	10.4	44.5		0.0		0.0		0.0	
% 4-6 days	50.3	55.5		83.5		38.4		15.8	
% 7 days	39.2	0.0		16.5		61.6		84.2	
Fat recommendation <35% energy									
% Not achieving recommendation	39.9	39.4		37.6		52.1		30.8	
% Achieving recommendation	60.1	60.6		62.4		47.9		69.2	
Carbohydrate recommendation >50% energy									
% Not achieving recommendation	35.7	39.4		32.9		47.9		21.1	
% Achieving recommendation	64.3	60.6		67.1		52.1		78.9	

[abc] denotes significant differences $P<0.05$) between quartile groups

[ns] Not significant ($P \geq 0.05$)

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Chapter 7

General Discussion

7.1 General discussion

FBDG need to be based on the prevailing patterns of the country for which they are being developed and set in the cultural context of that country (FAO/WHO, 1996). The use of food consumption databases provides an ideal opportunity to examine the issues of public health nutrition importance for a population. The problems of the population in relation to food and nutrient intakes can be defined, which is the first step towards solving the problem. Inadequate micronutrient intakes can be determined, as indeed can intakes greater than recommended and these intakes can be related to overweight status, physical activity, attitudes and other health and lifestyle characteristics if the data permits. The NSIFCS has demonstrated issues of public health significance for Irish adults, namely high intakes of fat (Harrington *et al.*, 2001) and low fibre (Galvin *et al.*, 2001), folate (O'Brien *et al.*, 2001), iron and calcium (Hannon *et al.*, 2001) intakes. As demonstrated in Chapter 4, public health nutrition issues for Irish children are low fruit and vegetable intakes, fat intakes greater than recommended in more than 40% of the population and inadequate intakes of calcium and folate.

The assessment of food intakes is vital to the formulation of successful guidelines, firstly, in knowing the intake of a major source of a nutrient and secondly in knowing the intake of a food that contributed greatly to the intake of a nutrient in the population of interest. Chapter 2 has demonstrated how detailed analysis of a staple food group, using groups in quite a dis-aggregated format, can be extremely beneficial in the development of FBDG. One major consideration in the development of FBDG not dealt with in this thesis is the displacement of certain foods by the promotion of others. For example, as suggested in Chapter 2, if increased consumption of wholemeal bread is encouraged, what food might it displace in the diet? A risk-benefit analysis is vital in this case to ensure no adverse effects would occur due to the promotion of wholemeal bread and the subsequent displacement of other foods.

There are many aspects to the development of FBDG by use of food consumption data that have not been discussed in this thesis due to time limitations. Many types of statistical analysis e.g. cluster/factor analysis and logistic regression can be used to determine factors that influence food consumption and the characteristics of people who consume certain types of food. A major aspect that has been dealt with is the use of culturally based information for the development of FBDG. A non-standard approach of investigating the time of food intakes provides a thorough picture of eating habits of the Irish population. The information that meals are consumed at familiar times and that different subgroups of the population follow the same patterns (as described in Chapter 3) is in itself informative. This novel approach and the methodological issues associated with it will be invaluable to other researchers in this area. As temporal distribution of food intakes did not reveal any distinguishing patterns in Irish adults, the examination of food consumption patterns, broken down into meals and snacks was undertaken for children. This is another major cultural element of the diet which warranted further exploration for the development of FBDG.

Another feature of the cultural context of food consumption is where foods are consumed. The food service sector was found to play an important role in the diets of Irish adults (IUNA, 2001). There was a need therefore to examine its role in the diet of other age groups to assess whether or not it made the same contribution. It has been demonstrated in this thesis that foods consumed outside the home are not especially important in the diets of Irish children. This finding in itself is useful and has resulted in a nutrition strategy being put in place by the Department of Health on the need to improve food and nutrient intakes in the home environment.

A universal problem with food consumption surveys is that of under-reporting. There are no definitive recommendations on how to deal with the impact of under-reporting on the interpretation of food and nutrient intakes. Previous work in this research group has demonstrated that no single food group can be identified as being under-reported by Irish adults, all food groups are under-reported (McCarthy, 2003). As this thesis is concerned with food consumption patterns it was deemed unnecessary to examine the influence of under-reporting in this population. Under-reporting is also a problem in surveys of children (Gregory *et al.*, 2000), but the identification of under-reporters in the NCFS was beyond the scope of this thesis.

Notwithstanding the extensive research carried out in this thesis for the formulation of FBDG, there are many other elements of the diet that need to be assessed before FBDG are devised. The work presented in this thesis needs to be considered with a body of wide-ranging research for the development of successful FBDG. Issues such as those discussed in Chapter 1 including changes in food processing, education of the public, nutrition labelling, formulation of guidelines that are easily understood, monitoring of food habits to evaluate the response to the guidelines etc., also need to be addressed. For the Irish population, initial challenges in this area include the construction of food consumption databases and evaluation of food intake patterns for all age groups of the population. The process then requires the assembling of a policy that covers needs and recommendations for all subgroups. Once this has been successfully completed for each country individually, it is hoped that it can be done on European basis (Eurodiet, 2001). This brings with it the further challenges in the need for standardised methodologies and the use of common food classification systems between countries etc.

To ensure the same methodologies are carried out, it is important for all researchers to document extensively what procedures were followed. This includes a detailed description of how mean intakes are calculated. Throughout this thesis, every effort was made to document whether mean intakes were calculated for consumers only or the total population, and to clarify that mean values were calculated for daily intakes or not etc. More detail has been given when necessary as in the case of Chapter 3 where intakes by day and intakes per hour were calculated using different methods. There is generally a paucity of information as to how mean values are calculated in published literature. For the development of health strategies from evidenced-based nutrition, there is a need for information to be collected at the most disaggregated level, that is the level of eating occasions. Collecting data at that level presents challenges as to determining the most appropriate calculation method, some of which have been described by Harrington (2001). Researchers in the study of eating patterns should describe in more detail the calculation method used to enable more efficient collaboration between groups.

Reports compiled by the FAO/WHO (1996) and Eurodiet (Eurodiet Core Report, 2001) have identified the issues in relation to the development of FBDG, for example, the examination of food intake patterns and the development of guidelines in a cultural context. The establishment of food consumption databases that document habitual intake in individual countries means we can begin to tackle these issues. The NSIFCS and NCFS are the most comprehensive studies of this kind in Ireland and Europe. Establishment of databases from both surveys provides the resources for the development of evidence-based nutrition strategies through which FBDG can be formulated.

7.2 References

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Appendix I

Sample diary page from the NSIFCS

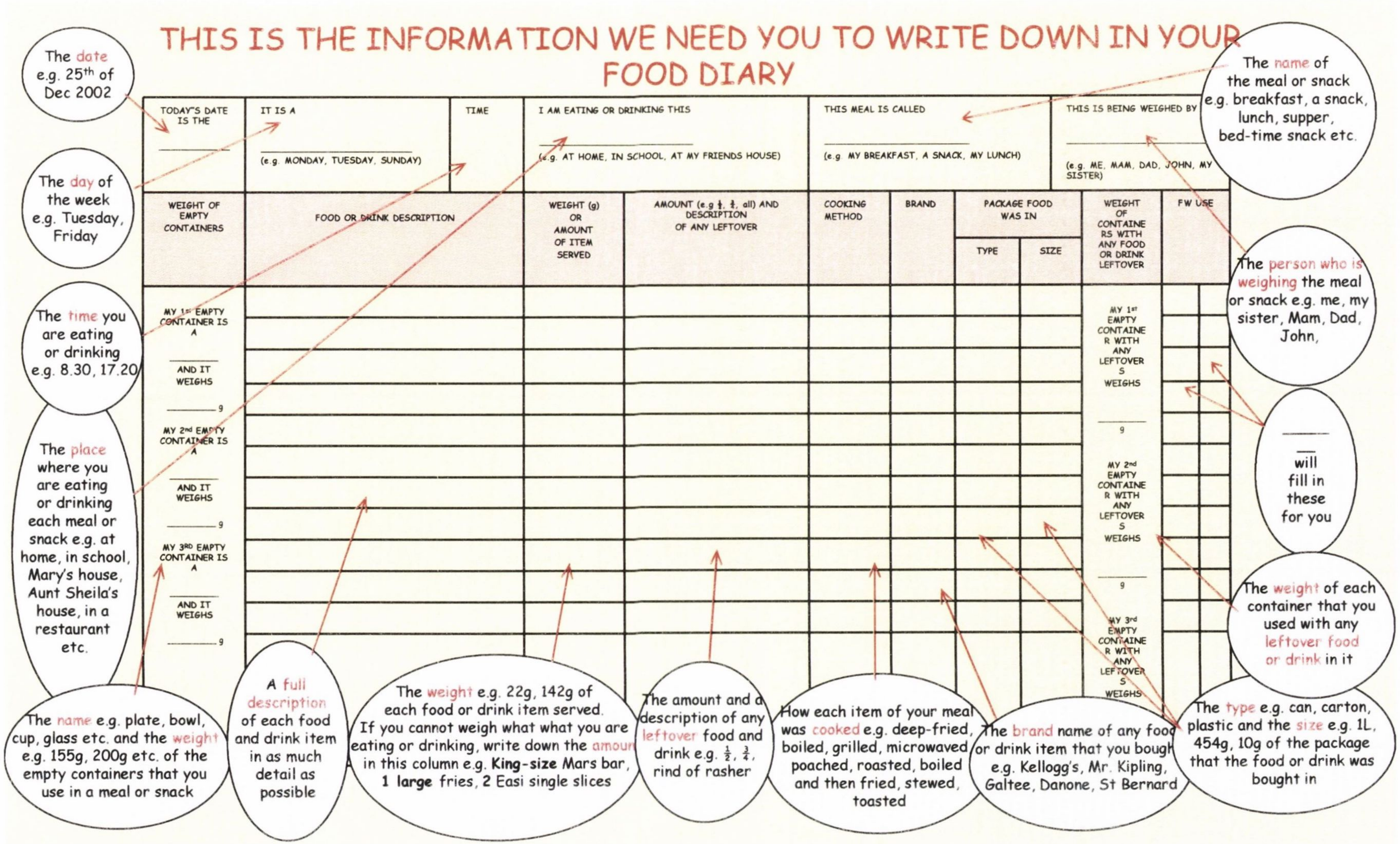
DATE	DAY	TIME	LOCATION	MEAL/SNACK

AMOUNT	FOOD/DRINK DESCRIPTION	BRAND	COOKING METHOD	PACKAGE

LEFTOVERS	

Appendix II

Sample diary pages from the NCFS


THIS IS THE INFORMATION WE NEED YOU TO WRITE DOWN IN YOUR FOOD DIARY
TODAY'S DATE IS THE
IT IS A
(e.g. MONDAY, TUESDAY, SUNDAY)
TIME
I AM EATING OR DRINKING THIS
(e.g. AT HOME, IN SCHOOL, AT MY FRIENDS HOUSE)
THIS MEAL IS CALLED
(e.g. MY BREAKFAST, A SNACK, MY LUNCH)
THIS IS BEING WEIGHED BY
(e.g. ME, MAM, DAD, JOHN, MY SISTER)
WEIGHT OF EMPTY CONTAINERS
FOOD OR DRINK DESCRIPTION
WEIGHT (g) OR AMOUNT OF ITEM SERVED
AMOUNT (e.g ½, ¼, all) AND DESCRIPTION OF ANY LEFTOVER
COOKING METHOD
BRAND
PACKAGE FOOD WAS IN
TYPE
SIZE
WEIGHT OF CONTAINERS WITH ANY FOOD OR DRINK LEFTOVER
FW USE
MY 1st EMPTY CONTAINER IS A
AND IT WEIGHS
g
MY 2nd EMPTY CONTAINER IS A
AND IT WEIGHS
g
MY 3RD EMPTY CONTAINER IS A
AND IT WEIGHS
g
MY 1st EMPTY CONTAINER WITH ANY LEFTOVERS WEIGHS
g
MY 2nd EMPTY CONTAINER WITH ANY LEFTOVERS WEIGHS
g
MY 3rd EMPTY CONTAINER WITH ANY LEFTOVERS WEIGHS
The date e.g. 25th of Dec 2002
The day of the week e.g. Tuesday, Friday
The time you are eating or drinking e.g. 8.30, 17.20
The place where you are eating or drinking each meal or snack e.g. at home, in school, Mary's house, Aunt Sheila's house, in a restaurant etc.
The name of the meal or snack e.g. breakfast, a snack, lunch, supper, bed-time snack etc.
The person who is weighing the meal or snack e.g. me, my sister, Mam, Dad, John,
will fill in these for you
The weight of each container that you used with any leftover food or drink in it
The name e.g. plate, bowl, cup, glass etc. and the weight e.g. 155g, 200g etc. of the empty containers that you use in a meal or snack
A full description of each food and drink item in as much detail as possible
The weight e.g. 22g, 142g of each food or drink item served. If you cannot weigh what what you are eating or drinking, write down the amount in this column e.g. King-size Mars bar, 1 large fries, 2 Easi single slices
The amount and a description of any leftover food and drink e.g. ½, ¾, rind of rasher
How each item of your meal was cooked e.g. deep-fried, boiled, grilled, microwaved, poached, roasted, boiled and then fried, stewed, toasted
The brand name of any food or drink item that you bought e.g. Kellogg's, Mr. Kipling, Galtee, Danone, St Bernard
The type e.g. can, carton, plastic and the size e.g. 1L, 454g, 10g of the package that the food or drink was bought in

TODAY'S DATE IS THE ______	IT IS A ______ (e.g. MONDAY, TUESDAY, SUNDAY)	TIME	I AM EATING OR DRINKING THIS ______ (e.g. AT HOME, IN SCHOOL, AT MY FRIENDS HOUSE)	THIS MEAL IS CALLED ______ (e.g. MY BREAKFAST, A SNACK, MY LUNCH)	THIS IS BEING WEIGHED BY ______ (e.g. ME, MAM, DAD, JOHN, MY SISTER)

WEIGHT OF EMPTY CONTAINERS	FOOD OR DRINK DESCRIPTION	WEIGHT (g) OR AMOUNT OF ITEM SERVED	AMOUNT (e.g ½, ¼, all) AND DESCRIPTION OF ANY LEFTOVER	COOKING METHOD	BRAND	PACKAGE FOOD WAS IN		WEIGHT OF CONTAINERS WITH ANY FOOD OR DRINK LEFTOVER	FW USE
						TYPE	SIZE		
MY 1st EMPTY CONTAINER IS A ______ AND IT WEIGHS ______ g								MY 1st EMPTY CONTAINER WITH ANY LEFTOVERS WEIGHS ______ g	
MY 2nd EMPTY CONTAINER IS A ______ AND IT WEIGHS ______ g								MY 2nd EMPTY CONTAINER WITH ANY LEFTOVERS WEIGHS ______ g	
MY 3RD EMPTY CONTAINER IS A ______ AND IT WEIGHS ______ g								MY 3rd EMPTY CONTAINER WITH ANY LEFTOVERS WEIGHS ______ g	