Project Code **S14034**

DERIVING AND INTERPRETING DIETARY PATTERNS IN THE SCOTTISH DIET: FURTHER ANALYSIS OF THE SCOTTISH HEALTH SURVEY AND EXPENDITURE AND FOOD SURVEY

Dr Julie Armstrong[1]

Dr Andrea Sherriff[2]

Dr Wendy L Wrieden[4]

Dr Yvonne Brogan[1]

Ms Karen L Barton[3]

[1] School of Life Sciences, Glasgow Caledonian University

[2] Department of Dentistry and Medicine, University of Glasgow

[3] Centre for Public Health Nutrition Research, University of Dundee

[4] Health Services Research Unit, University of Aberdeen

Date 15.01.09

Steering Committee

Dr Julie Armstrong, Public Health Nutrition, Glasgow Caledonian University

Dr Andrea Sherriff, Epidemiology and Statistics, University of Glasgow

Dr Wendy Wrieden, Public Health Nutrition, University of Aberdeen

Dr Yvonne Brogan, Research Fellow, Glasgow Caledonian University

Karen Barton, Research Fellow, University of Dundee

Anne Milne, Food Standards Agency Scotland

Professor Annie Anderson, Professor of Food Choice, University of Dundee

Dr Chris Dibben, Geography and Geosciences, University of St Andrews

Jim Holding, Statistician, Department of Environment, Food and Rural Affairs,York

Contents

Glossary

AOR	Adjusted Odds Ratio
BMI	Body Mass Index
CI	Confidence Interval
COMA	Committee on Medical Aspects of Food Policy
DBP	Diastolic Blood Pressure
DQI	Diet Quality Index
DRV	Dietary Reference Value
EFS	Expenditure Food Survey
FAO	Food and Agriculture Organisation
FFQ	Food Frequency Questionnaire
FSA	Food Standards Agency
HDL	High Density Lipids
NMES	Non Milk Extrinsic Sugars
NS-SEC	National Statistics Socio-Economic Classification
OR	Odds Ratio
PCA	Principal Component Analysis
SACN	Scientific Advisory Committee on Nutrition
SDT	Scottish Dietary Target
sds	Standard Deviation Score
SES	Socio-Economic Status
SHS	Scottish Health Survey
SIMD	Scottish Index of Multiple Deprivation
WHO	World Health Organisation
WCRF	World Cancer Research Fund

Tables

Figures

1.0 Introduction

A nutritionally adequate diet is central to achieving and sustaining good health and supporting prosperous development at an individual and population level. The strategy paper *Improving Health in Scotland-The Challenge (Scottish Executive, 2003)* identifies diet as one of the four key priority areas for health improvement in Scotland. *Eating for Health-Meeting the Challenge* (Scottish Executive, 2004) gives a vision for achieving this towards the year 2010, recommending actions focusing on improving dietary intake and dietary patterns in the most vulnerable groups in the population. This challenge articulates closely with a key objective of successive Scottish Governments to tackle poverty and disadvantage *(Scottish Executive, 2006; Scottish Government, 2008a)*. The current Scottish Government has reiterated that the underlying principles and goals established in the Scottish Diet Action Plan remain valid and that the impact of current dietary improvement activity should continue to be monitored (*Scottish Government 2008b*).

Scottish Health surveys and other studies have shown that the poorest diet is found in the most deprived areas which have the highest prevalence of diet related chronic diseases (Scottish Executive, 2001; Scottish Executive, 2005); Tunstall-Pedoe & Woodward, (2006). Moreover, there is evidence that the gap in healthy diet between the most affluent and most deprived groups increased between 1986 and 1995 (Wrieden *et al.*, 2004); a gap which does not appear to have closed in more recent years (Wrieden *et al.*, 2006). As part of the strategy to reduce inequalities in health, improving diet and nutrition will benefit everyone in Scotland; however, the most vulnerable groups (whether this is due to stage of life e.g. children, older adults, or due to social disadvantage) are those likely to benefit the most.

An essential component of the strategy to improve diet is the surveillance and monitoring of diet, food and nutrition in Scotland, and this is undertaken by Food Standards Agency Scotland. Regular surveillance of dietary habits is necessary to assess how official dietary guidelines at the nutrient and food level are met by populations and population sub-groups. The findings from this surveillance can contribute to the evaluation of the impact of policy and the development of strategies and action plans for dietary improvement. In addition, the findings can inform the future direction of food and health policy. For this reason, the information for monitoring diet must be generated from valid databases with dietary information, using transparent and robust techniques.

In Scotland, the government formally established dietary guidelines for the population as Scottish Dietary Targets (SDT). The SDT were informed by the detailed *Scottish Diet* report in 1993 and were part of the Scottish Office action plan on food and health, *Eating for Health: A Diet Action Plan for Scotland (Scottish Office, 1996)*.

At present there is no single method for assessing food and nutrition that provides a full picture of the diet of the population in Scotland, i.e. one robust dietary assessment methodology that provides information on both nutrient and food intake at both a population and sub-group level. Currently, a variety of surveys are used to generate the information. In 2004, the report of The Working Group on Monitoring (WGM) Scottish Dietary Targets identified the need to establish a process for monitoring nutrition and diet in Scotland and to assess progress towards the SDT. The working group concluded that the Expenditure Food Survey (EFS) and Scottish Health Survey (SHS) were major national surveys which could provide data for this process. The two surveys generate very different information; however, both provide valuable and complementary data.

The SHS provides information on health and health-related behaviours of individuals (children and adults) living in private households. The sample is cross-sectional and survey findings have been published for 1995, 1998 and 2003. One of the aims of the SHS is to estimate the prevalence of a range of health conditions and to monitor progress toward Scottish health and dietary targets. The SHS reports provide both descriptive analysis (stratified by age and gender) and some univariate analysis (socio-economic status) for a number of factors including information on food items from the eating habits module, other lifestyle factors and some parameters of health.

The design of the eating habits module has changed over the three surveys. For the most recent survey there were two food components to the survey: a limited food inventory (frequency over one month) and, for the first time in the 2003 survey, a full 24 hour recall schedule on fruit and vegetable intake for the previous day.

In contrast, the EFS is an annual household budget survey designed to collect information about household food and expenditure. The EFS provides a valuable source of information about the food consumption and nutrient intake of the population. However, it is not designed to measure nutrient intakes of specific individuals. The EFS collects household food purchase data from every person over 7 years of age in each household for a 14 day period. The length of time the food diaries are kept (14 days) is a major strength of this study since for most foods and nutrients the balance of intake is over more than 7-10 days. The steering group felt it was reasonable to assume that food and drink purchased by the household is mainly for consumption by the household and, therefore, can be used to assess the quality of the overall household's diet. However, it was recognised that household data could not be extrapolated directly to the diet of individuals. Further details about the design of the EFS are discussed in a previous report (Wrieden et al., 2003).

The project reported here advances the dietary surveillance work already undertaken by Food Standards Agency Scotland. The report describes the generation of dietary patterns and the establishment of a Dietary Quality Index (DQI) in the population and sub-groups of the population for the SHS and EFS. The method is grounded in the principals of nutritional epidemiology and current research on deriving dietary patterns. The establishment of dietary patterns and a DQI from the main national databases on food and nutrition enables more complex analysis to provide information on the relationship between the Scottish diet, socio-economic status and health outcomes while adjusting for lifestyle behaviours and other confounding factors.

Dietary patterns are multiple dietary components organised as a single exposure or ‘type of diet’. Studying dietary patterns as an indication of the quality of the overall diet, rather than single nutrients or food groups, acknowledges that foods are eaten together and not in isolation and helps to account for the complex interrelations of foods and nutrients in the context of the effect of the ‘overall diet’. Generating distinct dietary patterns to show which foods tend to be consumed together and how the patterns relate to other factors (for example, socio-economic status, lifestyle behaviour and cardiovascular risk factors) helps in setting priorities for changing dietary habits in the population (van Dam, 2005). Through identifying *healthy* and *less healthy* patterns of consumption in different groups, nutrition promotion activity can be tailored to the needs of specific population groups.

Dietary pattern analysis as a method of assessing dietary exposure has been increasingly used in this way in a series of recent studies in Europe (Huijbregts *et al.*, 1997; Osler *et al.*, 2001; Togo *et al.*, 2001; Trichopoulou *et al.*, 2003; van Dam, 2005; Lagiou *et al.*, 2006; Schulze & Hoffmann, 2006), USA (Dubois *et al.*, 2000; Kant *et al.*, 2000; Kant & Graubard, 2005) and further a field (Mishra *et al.*, 2002). In addition, dietary patterns have been used to explore social patterning of different types of diets within populations. The various methodologies used to derive dietary patterns and their application have been the subject of two recent reviews (Kant, 2004; Schulze & Hoffmann, 2006). The use of dietary quality indices have also been recently reviewed (Waijers *et al.*, 2007)

There are many advantages of using dietary pattern analysis over the traditional presentation (i.e. single food groups or items) of dietary information. Dietary patterns:

- reflect real-life dietary grouping of foods which can differ by age group, gender and socio-economic status (Mishra *et al.*, 2002);

- take into account the cumulative and interactive effect of foods consumed together which can explain a particular diet profile (e.g. high correlation between intakes of various nutrients or food items) (Hu *et al.*, 2000; Osler *et al.*, 2001);

- are particularly useful in the context of preventing nutrition-related diseases where multiple dietary components (as opposed to one) are relevant, e.g. cancer, cardiovascular disease, osteoporosis (Lagiou *et al.*, 2006; Schulze & Hoffmann, 2006);

- can be used to show trends in the ‘overall diet’ of a population over time and assess the impact of any population based dietary interventions;

- allow the diet to be entered as an independent exposure in multivariable models which can then be statistically adjusted for potential confounders, e.g. other lifestyle behaviours (Northstone & Emmett, 2005);

- are used to assess how official dietary guidelines at the nutrient and food level are met by populations and sub-groups thereof (Huijbregts *et al.*, 1997; Dubois *et al.*, 2000);

- are useful to evaluate and inform public policy on food availability, food consumption and food expenditure.

Dietary patterns can be derived by a variety of means. The most commonly cited methods are:

- Principal Component Analysis (PCA) which identifies foods or food groups that are frequently consumed together and thus provides information on key food patterns in the population. This is a method of data reduction that forms linear combinations of the original observed variables; the correlated variables are then grouped together and can identify any underlying dimensions in the data.

- Deriving a Dietary Quality Index (DQI) or a Healthy eating index or any score which, as defined by Schulze and Hoffman (2006) is, "a summary measure of the degree to which an individual's diet conforms to specific dietary recommendations".

- Food clusters analysis. In this method individuals are allocated to distinct groups based on the similar dietary characteristics. Individuals within each cluster group tend to be similar but differ from individuals in another cluster. For example, clusters might be fruit/vegetable, high-fat, high sugars and each individual can only belong to one cluster. Thus, there is a risk of misclassification of the individual which is not present for PCA analysis.

PCA analysis and Dietary Quality Index are the methods which were used in this study.

2.0 Dietary patterns by age and gender from the Scottish Health Survey (SHS) 2003 derived using Principal Component Analysis (PCA)

The project was registered with the UK Data archive in April 2007. The SHS 2003 database was downloaded to a dedicated PC at Glasgow Caledonian University in SPSS format. Data from the SHS 2003 Eating Habits module were used, which included a limited food frequency questionnaire (FFQ) and a fruit and vegetable 24-hour recall. Alcohol intake was obtained from the SHS Drinking Habits module.

2.1 Sample Design and Data Preparation

The 2003 Scottish Health Survey (SHS) used a multi-stage stratified probability sampling design, with postcode sectors selected at the first stage (primary sampling unit) and addresses at the second (strata).

Further details on the design of the sample can be obtained from the full SHS report at: http://www.sehd.scot.nhs.uk/scottishhealthsurvey/.

Weights were applied to these data in order to match population estimates for age/sex distributions within health boards and to adjust for differential non-response for interviews and nurse visits. The weights were calculated for adults and children separately and applied to the data within the current project as appropriate. Where appropriate we provide results of the weighted analysis alongside the unweighted bases.

Food items from the eating habits module of the Scottish Health Survey 2003

The list of foods considered for analysis from the SHS food inventory is presented in Table 1. For the majority of foods the questionnaire recorded how often they were consumed using the following options:

(i) less often or never,
(ii) 1 to 3 times per month,
(iii) once a week,
(iv) 2 to 4 times per week,
(v) 5 or 6 times a week,
(vi) once a day,
(vii) 2 to 3 times a day,
(viii) 4 or 5 times a day,
(ix) 6 or more times a day

In order to apply quantitative meaning to the frequency categories, these data were numerically transformed into times per week as follows (using midpoints where appropriate):

(i) 0,
(ii) 0.5,
(iii) 1,
(iv) 3,
(v) 5.5,
(vi) 7,
(vii) 17.5
(viii) 31.5,
(ix) 42.

Very few foods were consumed 6 or more times per day. The questionnaire also asked about the usual type of bread (high fibre, brown or other and low fibre) and the number of rolls and/or slices of bread consumed each day. Consumption of bread was recorded on a daily basis using the following options:
(i) less than one slice per day
(ii) one slice a day,
(iii) 2-3 slices a day,
(iv) 4-5 slices a day and
(v) 6 slices a day or more.

These data were numerically transformed into times per day as follows:
(i) 0,
(ii) 1,
(iii) 2.5,
(iv) 4.5,
(v) 6.

The usual type of breakfast cereal and how often breakfast cereal was eaten was recorded as well as the usual type of milk (full fat, semi-skimmed, skimmed or other) and spread used (butter, margarine, low fat or other), though no indication of frequency was reported. Participants also recorded whether or not they added salt to food.

Fruit and Vegetables

Participants completed a 24-hour recall for their fruit and vegetable consumption. They were asked to record how much of the following vegetables they had consumed: salad (cereal bowls); pulses (tablespoons); vegetables (tablespoons); vegetables in composite dishes (tablespoons). The questionnaire also asked about fruit as follows: fresh fruit (slices, handfuls or number); dried fruit (tablespoons); frozen fruit (tablespoons); and fruit juice (number of small glasses).

Alcohol

The amount of alcohol consumed in units per week was derived from a full drinking habits module.

Table 1. Food items, coding and transformations used in PCA of SHS dietary data 2003

Food Item	Values	Transformation
1. Sweets and chocolates	Frequency of consumption	Frequency per month
2. Crisps and other savoury snacks	Frequency of consumption	Frequency per month
3. Biscuits	Frequency of consumption	Frequency per month
4. Ice cream	Frequency of consumption	Frequency per month
5. Cakes, scones, sweet pies or pastries	Frequency of consumption	Frequency per month
6. Chips	Frequency of consumption	Frequency per month
7. Cheese	Frequency of consumption	Frequency per month
8. Soft drinks	Frequency of consumption	Frequency per month
9. Red meat e.g. lamb, pork, beef	Frequency of consumption	Frequency per month
10. Meat products e.g. sausages, meat pies, bridies	Frequency of consumption	Frequency per month
11. Poultry e.g. chicken and turkey	Frequency of consumption	Frequency per month
12. White fish	Frequency of consumption	Frequency per month
13. Oily fish	Frequency of consumption	Frequency per month
14. Canned tuna	Frequency of consumption	Frequency per month
15. Vegetables	Quantity in last 24 hours	Portions per day
16. Vegetables in composite dishes	Quantity in last 24 hours	Portions per day
17. Pulses	Quantity in last 24 hours	Portions per day
18. Salad	Quantity in last 24 hours	Portions per day
19. Fresh fruit	Quantity in last 24 hours	Portions per day
20. Fruit in composite dishes	Quantity in last 24 hours	Portions per day
21. Dried fruit	Quantity in last 24 hours	Portions per day
22. Frozen and canned fruit	Quantity in last 24 hours	Portions per day
23. Fruit juice	Quantity in last 24 hours	Portions per day
24. Breads	Usual type/quantity	Frequency per day
25. Milks	Usual type	
26. Breakfast cereals	Usual type/quantity	Frequency per month
27. Spread	Usual type	
28. Potatoes, pasta or rice	Frequency of consumption	Frequency per month
29. Salt	Used at table	Yes/No
30. Alcohol	Units per week	

Exclusion criteria

Participants who had 10 or more dietary items missing (n= 35) were excluded from the analysis. If fewer than 10 items were missing, the assumption was made that the participant(s) never consumed the item and it was given a value of 0. In addition, we planned to exclude dietary items which were consumed by <5 % of the sample; however, none of the food variables met this criterion. Children younger than 5 years of age were not included in the analysis as this group had not completed the fruit and vegetable module and the under 2s did not complete any eating habits information. Information on alcohol consumption was asked of those aged 16 years and over.

Age distribution

The age distribution for the sample is presented in Table 2. The age groups were broadly based on developmental stage in the lifecycle. For the children this approximated to a pre-pubertal, primary school age group 5-10 years followed by pubertal secondary school age group 11-15, older children and young adults 16-24, adults 25-64 and older adults >64. The large adults group (25-64) was consistent with the adults age group used in the SHS report.

As the SHS surveys a wide range of age groups, whose diet may vary, it was decided to perform PCA within pre-specified age groups (**Table 2**). Where resulting patterns were similar age groups were combined after consultation with the project group.

Table 2. Age groups and numbers of the Scottish Health Survey sample by gender (unweighted and weighted)

Sex	Frequency (unweighted)	Frequency (weighted)
Male		
5-10 years	608	630
11-15 years	545	595
16-24 years	334	578
25-64 years	2423	2594
> 64 years	833	663
Total	4743	5060
Female		
5-10 years	624	619
11-15 years	546	547
16-24 years	403	566
25-64 years	3051	2756
> 64 years	1072	959
Total	5696	5447

Food item standardisation

Variables from the eating habits module (times per day), the fruits and vegetables 24-hour recall consumption and the alcohol module were measured on different scales. Therefore, all variables were standardised by computing z-scores (subtracting the mean for each variable and dividing by the standard deviation).

2.2 Statistical methodology for PCA

Principal Component Analysis (PCA) was carried out using SPSS 15 for Windows (SPSS Inc., Chicago, Illinois). After data preparation, PCA of the weighted standardised data was undertaken for each age group in four steps:

1. The data were reduced by forming linear combinations of the original observed variables grouping together correlated variables, thus identifying underlying dimensions/structure in the data.

2. The number of components (a component being a group of foods) which best represented the data were selected using the scree plots in which eigenvalues were plotted against each component (in order of highest to lowest, the plots and explanation are found in Appendix 1). Where the number of components was not clear these were considered by the project team who examined the scree plots, the eigenvalues and the resulting components.

3. Varimax rotation (Appendix 1) was then applied in order to obtain the simplest factor structure. The coefficients defining the linear combinations after rotation are called the *factor loadings* and represent the correlations of each variable with that dietary component.

4. A factor score was produced for each individual participant for each of the dietary components identified. These were calculated by multiplying the factor loadings by the corresponding standardised value for each food and summing across food types. Each score has a mean zero, standard deviation=1.

5. **A higher score indicates that the subject's diet is closer to that dietary pattern than an individual with a lower score for that component.**

Principal component analysis was carried out for all participants followed by analysis for only those participants who stated that consumption of fruit was *usual* for that day (n=4122). There was no difference found from these two samples so the analysis reported was carried out for **all** participants.

Food items with a factor loading $\geq$ 0.3 (or $\leq$ -0.3) on a component were considered to be important, however, all food groups were used in calculating the factor score for each individual. **The factor scores were used as the outcome variables in further analysis**.

2.3 Results of dietary patterns from the SHS using PCA analysis

After exclusions the sample size was 10,439 (4,743 males; 5,696 females: 10,507 weighted). The factor loadings for the final components in each age group can be seen in **Appendix 2**. The PCA analyses revealed three distinct components (patterns) from the scree plots for each age group, except for age group 5-10 years where there were only two patterns. **Table 3** presents a summary of the dietary patterns which emerged with food factor loadings with ≥0.3 or ≤ -0.3; (+) denotes the food is strongly positively associated with the pattern and (-) denotes that the food is strongly negatively associated. The % variance shown for each pattern is the proportion of variation in 30 foods and food groups that is explained by each of the dietary patterns (the **principal components**).

The patterns shown in **Table 3** represent distinct dietary patterns in the Scottish diet derived from the limited food inventory and 24-hour recall used in the 2003 SHS. The foods most positively (or negatively) associated with a particular pattern varied across the age groups; however, there was some consistency in the findings. For example, one pattern in each age group was positively associated with the frequency of consumption of foods of high energy density (e.g. meat products, biscuits, cakes/scones/sweet pies/sweet pastries, sweets/chocolates, crisps/savoury snacks and soft drinks). Conversely, in each age group there was a pattern positively associated with the frequency of consumption of healthier foods (fresh fruits, vegetables, and potatoes/rice/pasta). The energy dense pattern explained the highest amount of variance in the 5-10 years olds (8.8%), in the 11-15 years olds (9.6%) and 25-64 years olds (8.6% and 4.5%). The patterns suggest that the consumption of meat products was associated with the consumption of other energy dense foods. This feature was fairly consistent across the age groups with the exception of those > 64 years of age.

Appendix 1 gives details of all the foods and their corresponding factor scores. **Appendix 2** provides more detail on the factor loadings for all the foods entered into the PCA analysis in all age groups. The Excel tables are colour coded to enable easy reference to the food factor loadings.

Table 3. Dietary patterns emerging from SHS 2003 eating habits module, according to age group (factor loadings ≥0.3 and ≤-0.3 only).

Dietary Patterns: foods with factor loadings ≥0.3 and ≤-0.3 only		% of Variance	Label for dietary pattern
5-10 years			
Component 1	Sweets and chocolates (+), crisps and savoury snacks (+), meat products (+), biscuits (+), soft drinks (+), ice-cream (+), cheese (+), cakes, scones sweet pies and pastries (+), red meat (+), chips (+)	8.81	**Energy Dense/ Snacking**
Component 2	Vegetables (+), fresh fruit (+), potatoes, rice or pasta (+), oily fish (+), tinned tuna (+), fruit juice (+), salad (+), Soft drinks (-)	5.76	**Healthy with Fish**
11-15 years			
Component 1	Sweets and chocolates (+), meat products (+), crisps and savoury snacks (+), soft drinks (+), biscuits (+), ice cream (+), cakes, scones sweet pies or pastries (+), chips (+), cheese (+) Lower fat milks (-)	9.59	**Energy Dense/ Snacking**
Component 2	White fish (+), salad (+), oily fish (+), potatoes, rice and pasta (+), fresh fruit (+), wholegrain/brown breads (+) Soft drinks (-), chips (-)	6.51	**Healthy with Fish**
Component 3	Vegetables (+), pulses (+), chips (+), frozen and canned fruit (+), fruit juice (+), tinned tuna (+), fresh fruit (+)	4.69	**Healthy**
16-24 years			
Component 1	Salad (+), fresh fruit (+), vegetables (+), fruit juice (+), poultry (+), oily fish (+), vegetables in composite dishes (+), potatoes, rice and pasta (+), tinned tuna (+)	9.51	**Healthy with Fish**
Component 2	Biscuits (+), cakes, scones sweet pies and pastries (+), crisps and savoury snacks (+), soft drinks (+), sweets and chocolates (+), meat products (+), ice-cream (+)	6.08	**Energy Dense/ Snacking**
Component 3	Lower fat milks (+), spreads (+), higher fibre breakfast cereals (+), wholegrain and brown breads (+), Crisps and savoury snacks (-), soft drinks (-), meat products (-), salt (-), chips (-)	5.06	**Healthy**
25-64 years			
Component 1	Meat products (+), chips (+), red meat (+), soft drinks (+), alcohol (+), salt (+) Wholegrain and brown breads (-), low fat spread (-), lower fat milks (-)	8.64	**Energy Dense**
Component 2	Vegetables (+), fresh fruit (+), oily fish (+), higher fibre breakfast cereals (+), salad (+), white fish (+), Crisps and savoury snacks (-)	5.47	**Healthy with Fish**
Component 3	Biscuits (+), cakes, scones sweet pies and pastries(+), sweets and chocolates (+), ice-cream (+), crisps (+)	4.54	**Energy Dense/ Snacking**
> 64 years			
Component 1	Fresh fruit (+), spread (+), lower fat milks (+), wholegrain and brown breads (+), tinned tuna (+) Meat products (-), soft drinks (-), salt (-)	7.27	**Healthy**
Component 2	Cakes, scones sweet pies and pastries (+), sweets and chocolates (+), ice-cream (+), biscuits (+) Alcohol (-)	5.42	**Energy Dense/ Snacking**
Component 3	Red meat (+), potatoes, rice and pasta (+), white fish (+)	4.96	**Traditional**

3.0 Dietary patterns from the SHS according to socio-economic status and lifestyle

The following analyses aimed to assess:

(i) the overall association between dietary patterns and a number of different measures of socio-economic status (SES) and lifestyle factors;
(ii) possible trends in these relationships;
(iii) measure(s) of SES most strongly associated with dietary patterns.

Methods

Measures of socio-economic status

There are a number of different measures of SES which may be associated with dietary patterns in different ways. We examined: Scottish Index of Multiple Deprivation (SIMD), an area based measure of social deprivation (categories are listed in **Table 4**); Equivalised Income, a measure of household income which is adjusted for the number of people living in the household; Level of Education which is based on the highest level of recognised qualifications in school, further or higher education (only in adults); National Statistics-Social Economic Classification (NS-SEC) which is a measure based on occupation. In all measures of SES we arranged the categories from **least** deprived to **most** deprived (e.g. for education from highest qualification through to lowest qualification) and these are detailed in **Table 4**.

Measures of lifestyle

The lifestyle variables used in the analysis were those most likely to be associated with diet. These included physical activity, screen viewing and smoking (for adults only). Screen viewing was derived by individuals being asked about the average number of hours spent sitting in front of a television or computer screen during leisure time, ie. not in work or school. It is used by investigators as a proxy measure of sedentary behaviour. Physical activity was measured using an activity questionnaire which determines the time in minutes spent in activities at different levels of intensity. This was transposed into categories for low, medium and high levels of activity (**Table 4**). Screen viewing (hours per day) and levels of physical activity in both children and adults were analysed (categories are listed in **Table 4**). Daily number of cigarettes smoked was also analysed in adults (16+).

Table 4. Definitions and categories for SHS socio-economic and lifestyle variables used in the analysis

Variables	Definition	Factor level for analysis
Scottish Index of Multiple Deprivation (SIMD)	Area based measure of deprivation. Derived from the quintiles of SIMD score variable	Least deprived (1) to most deprived (5) Quintiles
National Statistics Socio-Economic Classification (NS-SEC)	Occupational based classification. Based on the occupation details of the household reference person.	1. Managerial and professional occupations. 2. Intermediate occupations 3. Small employers and own account workers. 4. Lower supervisory and technical occupations. 5. Semi-routine occupations.
Equivalised Income	Adjusted household income to take into account the number of persons in the household. Quintiles	1. >£32,000 2. >=£21,511<£32,500 3. >=£14, 322<£21511 4. >=£9,100<£14,322 5. <£9,100
Smoking status	Current and past smoking status asked to all ≥16 years.	1. non-smoker 2. less than 20 a day 3. 20 or more a day
Education	Highest educational qualification. Ages ≥25 years used.	Level 1-Degree or professional qualification or higher. Level 2-HNC/HND or equivalent. Level 3-'H' grade/A level or equivalent. Level 4-'O' Grade or equivalent. Level 5-None of these
Physical Activity	**Children** 5-10 years and 11-15 years	**Low** Less than 30 minutes on at least 5 days **Medium** 30-59 minutes on at least 5 days **High** 60+ minutes on at least 5 days
Physical Activity	**Adults** 16-24 years and 25-64 years and >64 years	**Low** Moderate or vigorous < 30miutes per week **Medium** Moderate or vigorous ≥30 minutes on 1-4 days **High** Moderate or vigorous activity on at least 5 days per week
Screen Viewing	**Children** 5-10 years 11-15 years	Tertiles : 1=0-1.5 hrs/day 2=2-2.5 hrs/day 3=3+ hrs/day
Screen Viewing	**Adults** 16-24 years and 25-64 years and >64 years	Tertiles : 1=0-2 hrs/day 2=2.5 - 3.5 hrs/day 3=4+ hrs/day

Statistical analyses

The factor scores for individuals for each pattern in each age group were calculated and, by definition, were normally distributed with mean=0, standard deviation=1. Higher factor scores for an individual for a particular dietary pattern indicate that the individual's diet is closer to that dietary pattern when compared to someone with lower factor scores for that particular dietary pattern. However, the factor scores for different dietary patterns are independent, and it is therefore possible for an individual to score high on more than one dietary pattern.

Due to the complex sampling design of the Scottish Health Survey (clustered, stratified, multi-stage design), statistical adjustments had to be made to the standard errors of the estimates when testing the hypotheses. The **cluster** and **strata** variables for the SHS 2003 survey were used within linear regression models which were run within the **survey** command within Stata (v10, StataCorp). When assessing associations between factor scores and SES/lifestyle variables, the individual factor scores for each dietary pattern in each age group were considered as the outcome (dependent). Variables in the analysis and the SES/lifestyle factors were considered to be the explanatory (independent) variables. Dummy variables were created for categorical SES/lifestyle variables. Overall, p-values based on the F-test are presented along with p-values for linear trend. R squared values explained the proportion of the variance in factor score attributed to the particular variable analysed.

3.1 Summary of findings of dietary patterns according to gender, socio-economic status and lifestyle

Gender

There were some gender differences in dietary patterns. In the youngest children (5-10 years), girls scored higher for both the *Healthy with fish* pattern and the *Energy dense/snacking* patterns when compared to boys. There were no gender differences for dietary patterns in older children (11-15 years). In young people (16-24 years) and adults (25-64 years), males followed the *Energy dense* patterns more closely than females. In the older adult group (>64 years), males followed the *Traditional* pattern more closely than females, while females scored higher for the *Healthy* pattern.

Socio-economic influences on dietary patterns

When reporting trends in dietary patterns with SES the changes in factor scores for each dietary pattern in each age group were considered when moving from higher SES to lower SES, e.g. for SIMD from lowest quintile of deprivation to highest quintile of deprivation. Confidence intervals are shown in the tables and figures.

There was significant social patterning for most of the dietary patterns within each age group. The effects of SIMD, Equivalised Income and NS-SEC on dietary patterns were broadly consistent across all age groups. In children (5-15 years), the *Energy dense/snacking* pattern was socially patterned (increasing linear trend of factor scores with lower SES). The *Healthy with fish* pattern was associated with SES measures in the opposite direction (decreasing linear trend of factor score with lower SES). Interestingly, the *Healthy* pattern in the 11-15 years old did not appear to be patterned by SES.

In adults (16-24 and 25-64 and 65+), the *Energy dense* patterns were associated with all measures of SES (increasing linear trend of factor scores with lower SES). Conversely, the *Healthy* dietary patterns were associated in the opposite direction (decreasing linear trend of factor score with lower SES). The *Energy dense/snacking* pattern which emerged in all the adult age groups did not appear to be socially patterned, irrespective of the SES measure used. The *Traditional* pattern within the 65+ group followed a similar pattern as the *Healthy* component (decreasing linear trend of factor score with lower SES). In summary, **in all age groups it was the healthy type patterns which were most strongly and consistently associated with different measures of SES**.

Lifestyle influences on dietary patterns

When reporting trends in dietary patterns with lifestyle factors, the changes in factor scores for each dietary pattern in each age group were considered when moving from lowest risk group to highest risk group e.g. for screen viewing from low levels of screen viewing to high levels. Confidence intervals are shown in the tables and figures.

Screen viewing in children and young people (5-10 and 11-15 years) was negatively associated with the *Healthy with fish* pattern (decreasing factors scores with higher level of screen viewing). In the very young children (5-10 years), increased screen viewing was positively associated with the *Energy dense/snacking* pattern, but this was not significant for that pattern in the 11-15 years age group. There was no consistent association with measures of physical activity and the *Energy dense/snacking* pattern in the 5-10 years or 11-15 years age groups. The *Healthy* patterns in both age groups showed higher factors scores with higher levels of physical activity.

In adults higher levels of physical activity were associated with the higher factors scores for *Healthy* and *Traditional* patterns. However, in all adult age groups physical activity was not associated with the *Energy dense/snacking* pattern. In adults non-smokers followed more closely a *Healthy* dietary pattern than smokers who had higher factors scores for the *Energy dense/snacking* pattern.

Conclusion

Overall, in children, young people and in adults there was a remarkably consistent association between the different measures of socio-economic status (SES) used in the analysis and dietary patterns such that **individuals who were less vulnerable based on their SES tended to follow more closely the healthier dietary patterns**. Based on the R squared values, associations with NS-SEC were weaker than for SIMD, equivalised income and education. Since these are measures of SES at different levels (SIMD=postcode, Equivalised Income=household), both measures were used in the multivariable analyses with health outcomes.

3.2 Details of dietary patterns according to socio-economic status and lifestyle factors

Due to the large number of tables and figures required for this report (5 age groups x 3 dietary patterns x 4 SES x 3 Lifestyle factors), the focus of the body of the report is on two age groups: the 11-15 year olds and the 25-64 year olds.

The following is a detailed description of the results of the analysis of social patterning and lifestyle influences on dietary patterns in the children (11-15 years) and the largest age group studied (adults aged 25-64 years). The full tables of results for each age group are in **Appendix 4.**

3.2.1 Dietary Patterns in Children aged 11-15 years

There were three distinct dietary patterns established in 11-15 year olds, the first was the *Energy dense/snacking pattern* which explained 9.6% of variance. This pattern was characterised by the following foods:

> *sweets and chocolates; meat products; crisps and savoury snacks; soft drinks; chips; cheese; cakes, scones, sweet pies and pastries; ice-cream, biscuits.*

The second was *Healthy with fish* pattern which explained 6.5% of variance and was characterised by the following foods:

> *white fish; salad; oily fish; potatoes, rice and pasta; fresh fruit; wholegrain and brown breads.*

The third was a *Healthy* pattern which explained 4.7% variance and was characterised by the following foods:

> *vegetables; fresh fruits; frozen and canned fruits; salad; fruit juice; pulses; tinned tuna; chips.*

Dietary patterns for children (5-10 years), adults (16-24 years, 25-64 years) and older adults (>64 years) are detailed in **Table 3** and **Appendix 2**.

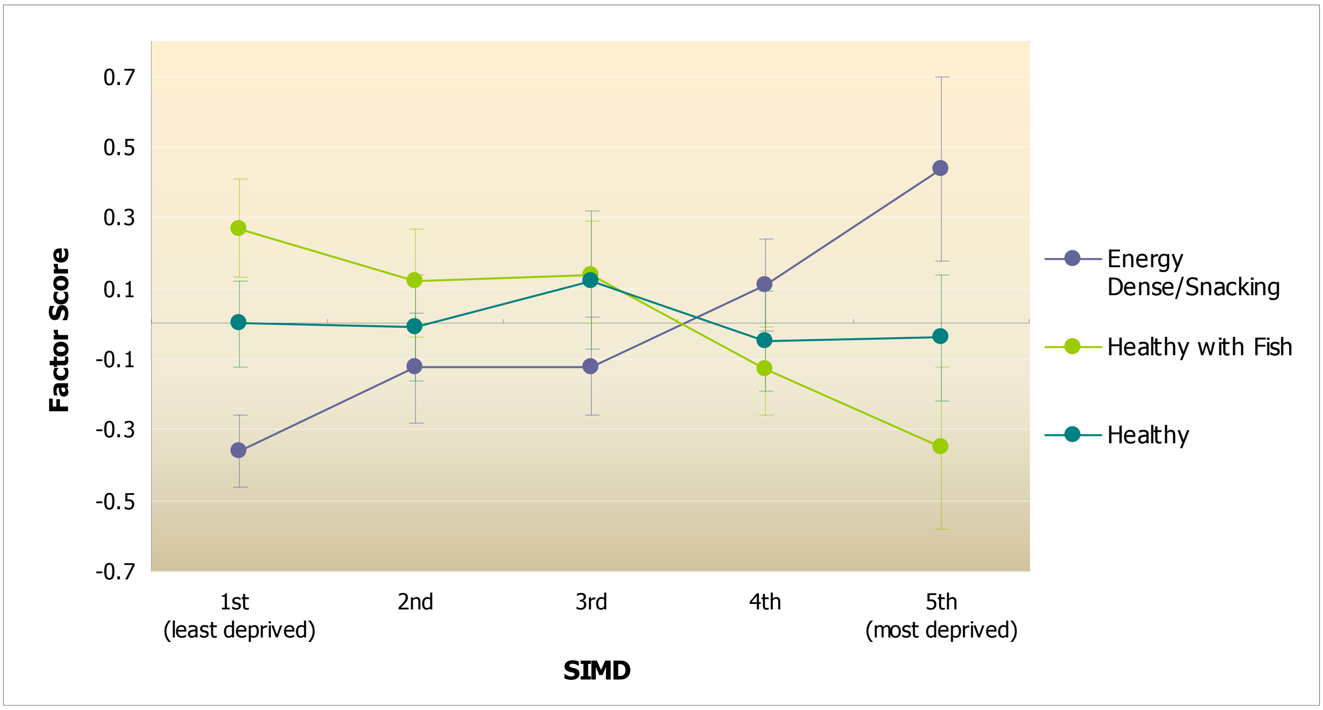
There were no gender differences for dietary patterns in the older children (11-15 years).

Dietary patterns in children aged 11-15 years and measures of socio-economic status (SES) and lifestyle

Scottish Index of Multiple Deprivation (SIMD)

There was an increasing linear trend between the *Energy dense/snacking* pattern and SIMD (least deprived to most deprived) (p-value for trend <0.0001). The children in the most deprived quintile of SIMD followed this particular pattern more closely than those who were less deprived. SIMD explained 7.8% of the variation in factor scores for this *Energy dense/snacking* pattern. Conversely, there was a linear trend between the *Healthy with fish* pattern and SIMD in the opposite direction (p-value for trend <0.0001). The children in the least deprived quintile of SIMD followed this particular pattern more closely than those in the most deprived quintile. SIMD explained 5.3% of the variation in factor scores for this *Healthy with fish* pattern. The third *Healthy* pattern appeared not to be strongly influenced by SIMD (p=0.71). **Figure 1** (full details in **Appendix 4**).

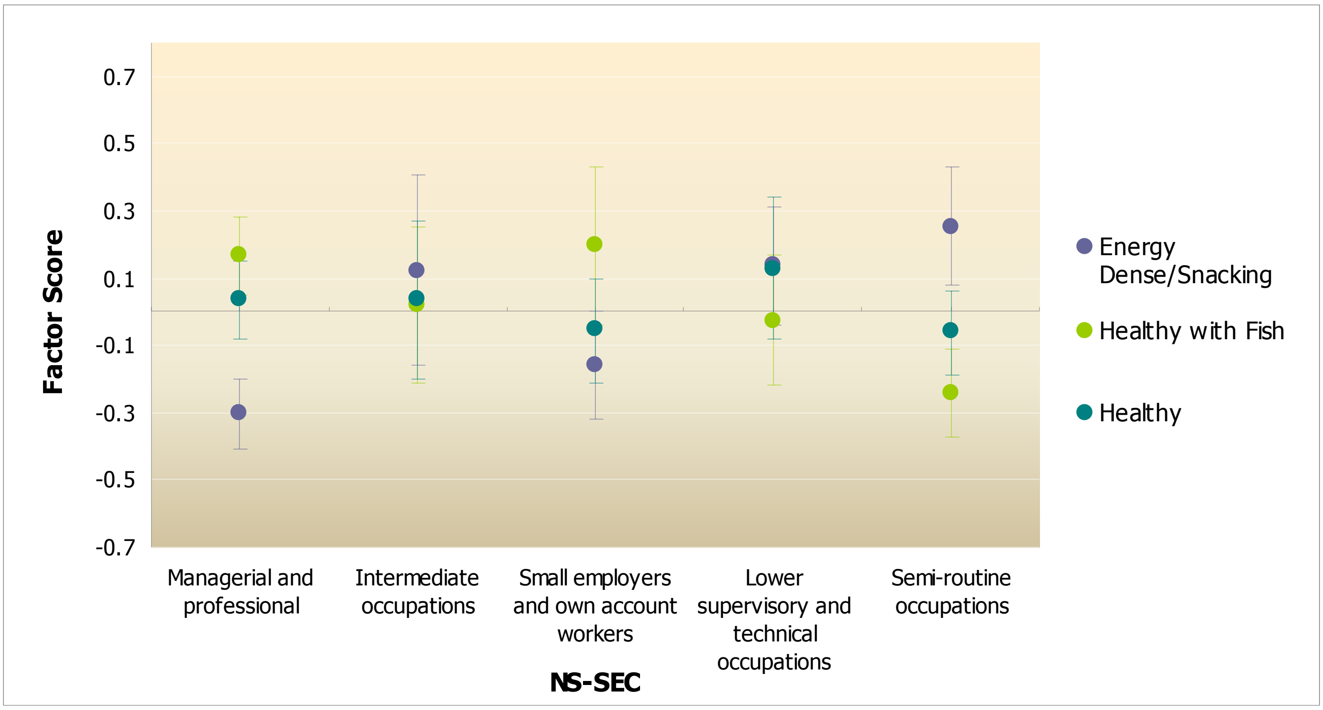
Figure 1. Dietary patterns in 11-15 year olds according to SIMD



National Statistics Socio-Economic Classification (NS-SEC)

There was a linear trend between the *Energy dense/snacking* pattern and NS-SEC (highest to lowest) (p-value for trend <0.0001). The children living in households with the lowest NS-SEC followed this particular pattern more closely than those living in households with the highest NS-SEC. NS-SEC explained 6.2% of the variation in factor scores for this *Energy dense/snacking* pattern. Conversely, there was a decreasing linear trend between the *Healthy with fish* pattern and NS-SEC (p<0.0001). The children in the highest NS-SEC followed this particular pattern more closely than those in the lowest NS-SEC. NS-SEC explained 3.6% of the variation in factor scores for this *Healthy with fish* component. The third, *Healthy* pattern, did not appear to be strongly influenced by NS-SEC (p=0.36). **Figure 2** portraits these findings (full details in **Appendix 4**).

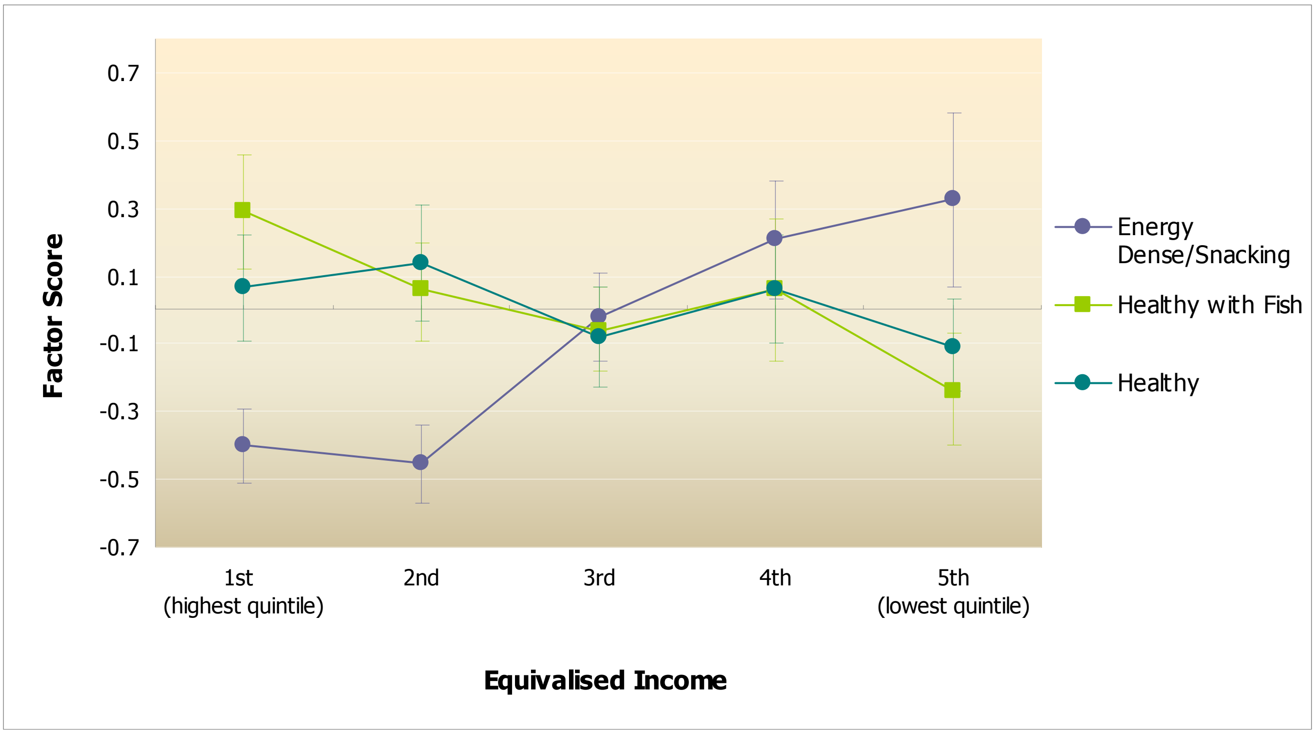
Figure 2. Dietary patterns in 11-15 year olds according to NS-SEC



Equivalised Income (Income)

There was a linear trend between the *Energy dense/snacking* pattern and income (p<0.0001 for trend). The children in the lowest income households followed this particular pattern more closely than those in higher income households. Income explained 9.6% of the variation in factor scores for this *Energy dense/snacking* pattern. Conversely, there was a linear trend between the *Healthy with fish* pattern and income in the opposite direction (p=0.0002 for trend). The children in the highest income households followed this particular pattern more closely than those in the lower income households. Income explained 2.9% of the variation in factor scores for this *Healthy with fish* pattern. The third, *Healthy* pattern, although going in the same direction as the *Healthy with fish*, was not as strongly associated with income (p=0.06 for trend). **Figure 3** visualises these findings (full details in **Appendix 4**).

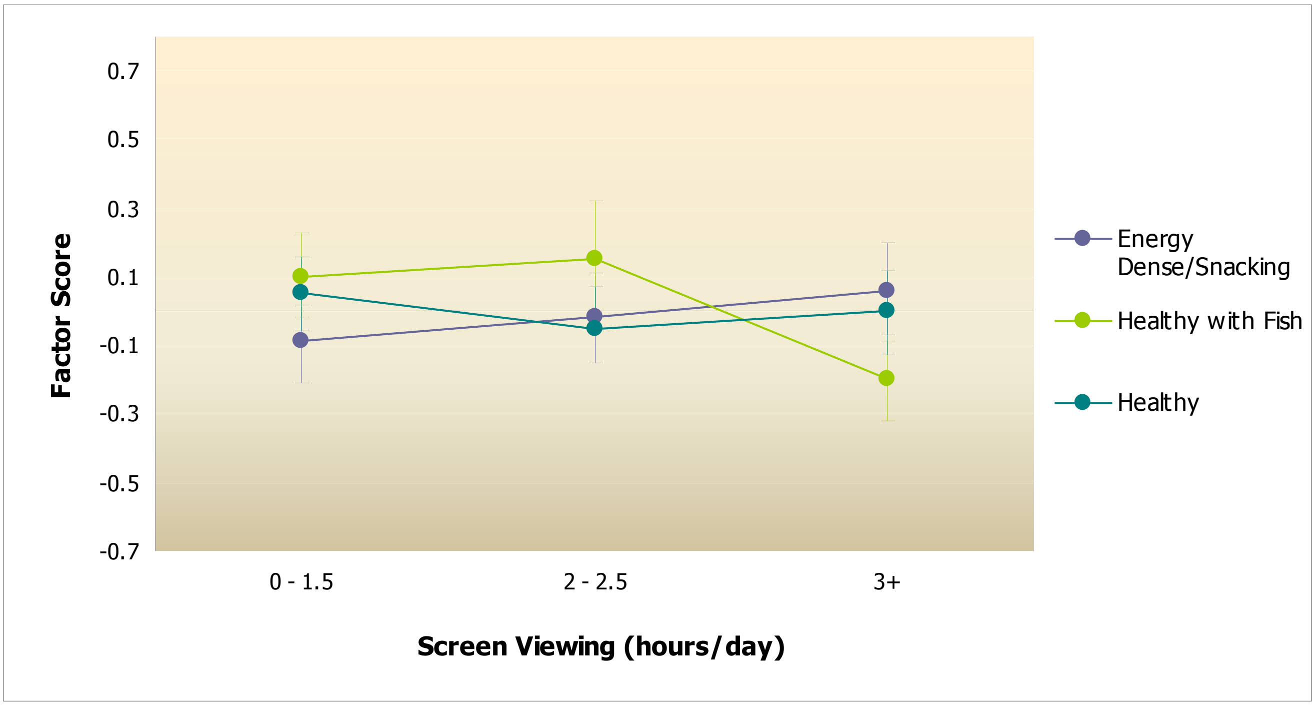
Figure 3. Dietary patterns in 11-15 year olds according to Equivalised Income



Screen Viewing

The *Energy dense/snacking* pattern did not appear to be influenced by screen viewing (p=0.19). However, there was a decreasing linear trend between the *Healthy* pattern and higher screen viewing (p=0.0001 for trend). The children engaged in the lowest amount of screen viewing followed this particular pattern more closely than those engaged in the highest amounts of screen viewing (3+ hours per day). Screen viewing explained 2.6% of the variation in factor scores for the *Healthy with fish* component. The third, *Healthy* pattern, did not appear to be strongly influenced by screen viewing (p=0.51). **Figure 4** charts these results (full details in **Appendix 4**).

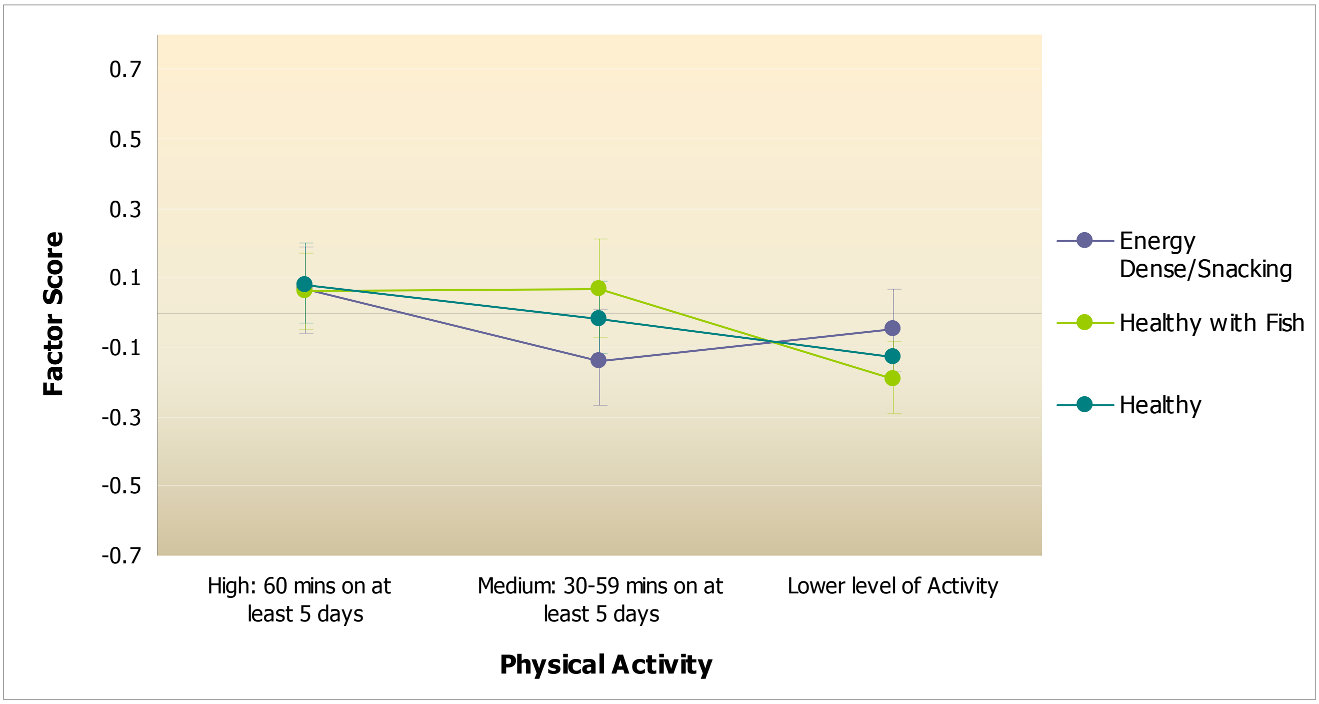
Figure 4. Dietary patterns in 11-15 year olds according to Screen Viewing



Physical Activity

The *Energy dense/snacking* pattern did not appear to be strongly influenced by the levels of physical activity (p=0.12 for trend)**.** However, there was a linear trend between the *Healthy with fish* component factor score and physical activity (p<0.003 for trend). The children with the highest level of physical activity followed this particular pattern more closely than less physically active. Physical activity explained 1.1% of the variation in factor scores for this *healthy with fish* component. There was an increasing linear trend between the *Healthy (third)* pattern and physical activity (p=0.003 for trend). The children with the highest level of physical activity followed this particular pattern more closely than those who were less physically active. Physical activity explained 0.8% of the variation in factor scores for this *Healthy* pattern. **Figure 5** describes the findings (full details in **Appendix 4**).

Figure 5. Dietary patterns in 11-15 year olds according to Physical Activity



3.2.2 Dietary Patterns in Adults aged 25-64 years

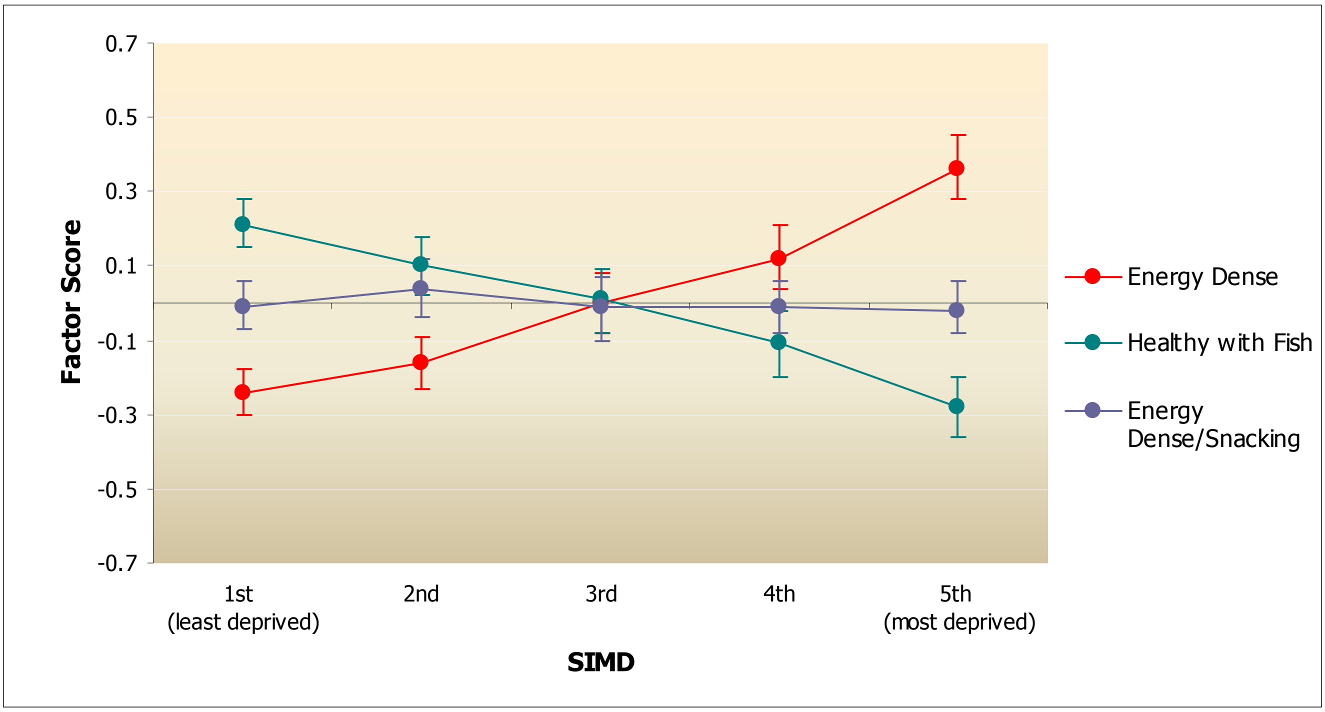
There were three distinct dietary patterns in 25-64 years old. First, an *Energy dense* pattern (explained 8.6% of variance), characterised by the following foods: meat products, red meat, chips, soft drinks, alcohol and salt; second, a *Healthy* pattern (5.5% of variance), characterised by: vegetables, oily fish, fresh fruit, higher fibre breakfast cereals, white fish and salad; and the third, an *Energy dense/snacking* pattern (4.5% variance), characterised by biscuits, cakes, scones, sweet pies and pastries, sweets and chocolates, ice-cream, crisps and savoury snacks. Dietary patterns for children (5-11 years), younger adults (16-24 years) and older adults (>64 years) are detailed in **Table 3** and **Appendix 2**.

Dietary patterns in adults 25-64 years and socio-economic status (SES) and lifestyle factors

Scottish Index of Multiple Deprivation (SIMD)

There was a linear trend between the *Energy dense* pattern and SIMD (least to most deprived) ($p<0.0001$ for trend). The individuals in the most deprived quintile of SIMD followed this pattern more closely than those in the less deprived quintiles. SIMD explained 4.5% of the variation in factor scores for this pattern. There was a linear trend between the *Healthy with fish* dietary pattern and SIMD in the opposite direction ($p<0.0001$ for trend). The individuals in the least deprived quintile of SIMD followed this pattern more closely than those in the more deprived quintile. SIMD explained 2.8% of the variation in factor scores for this pattern. The third *Energy dense/snacking* pattern was not influenced by SIMD ($p=0.86$ for trend). **Figure 6** has the details of these results (full details in **Appendix 4**).

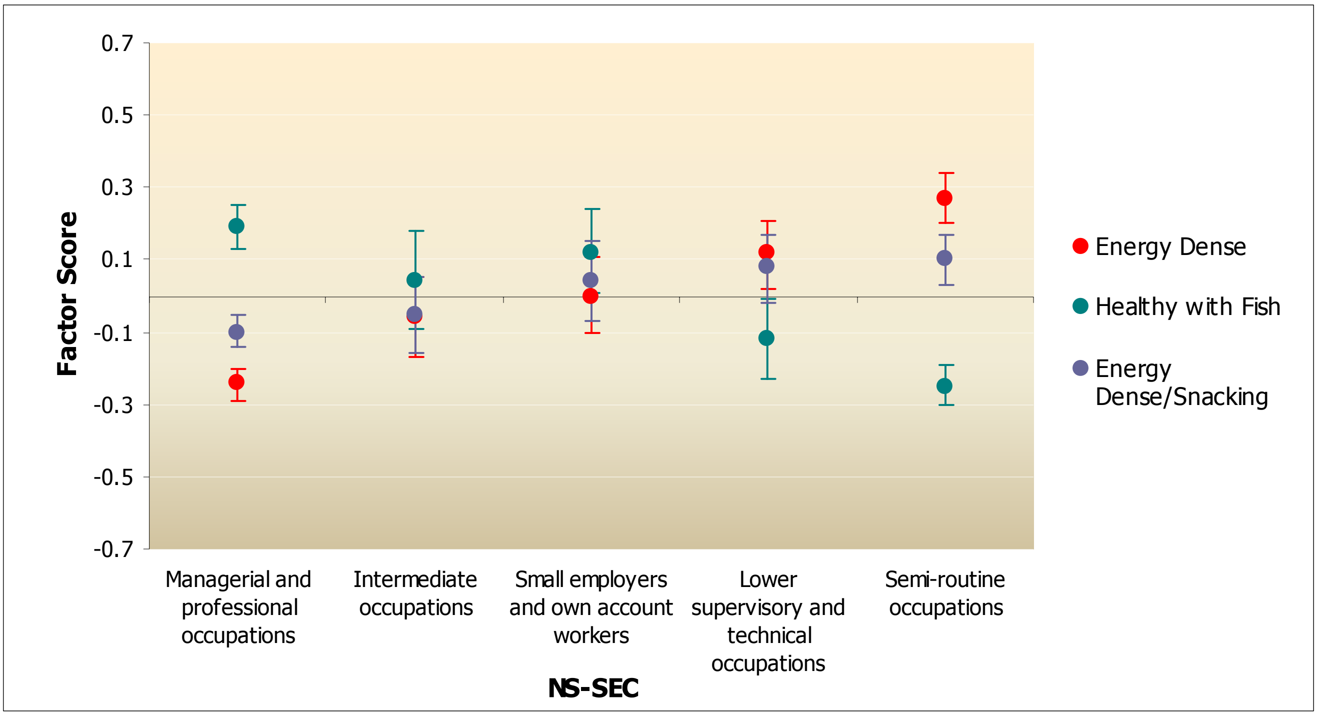
Figure 6. Dietary patterns in 25-64 year olds according to SIMD



National Statistics Socio-Economic Classification (NS-SEC)

There was a linear trend between the *Energy dense* pattern and NS-SEC (p<0.0001 for trend). The individuals with the lowest NS-SEC followed this particular pattern more closely than those with the highest NS-SEC. NS-SEC explained 4.8% of the variation in factor scores for this pattern. Conversely, there was a linear trend between the *Healthy with fish* pattern and NS-SEC in the opposite direction (p<0.0001 for trend). The individuals with highest level of NS-SEC followed this particular pattern more closely than those with the lowest NS-SEC. NS-SEC explained 3.6% of the variation in factor scores for this *healthy* component. The third pattern, *Energy dense/snacking* pattern, also showed a linear trend with NS-SEC (p<0.0001 for trend) in the same direction as the *Energy dense* (first) pattern, as seen in **Figure 7** (full details in **Appendix 4**).

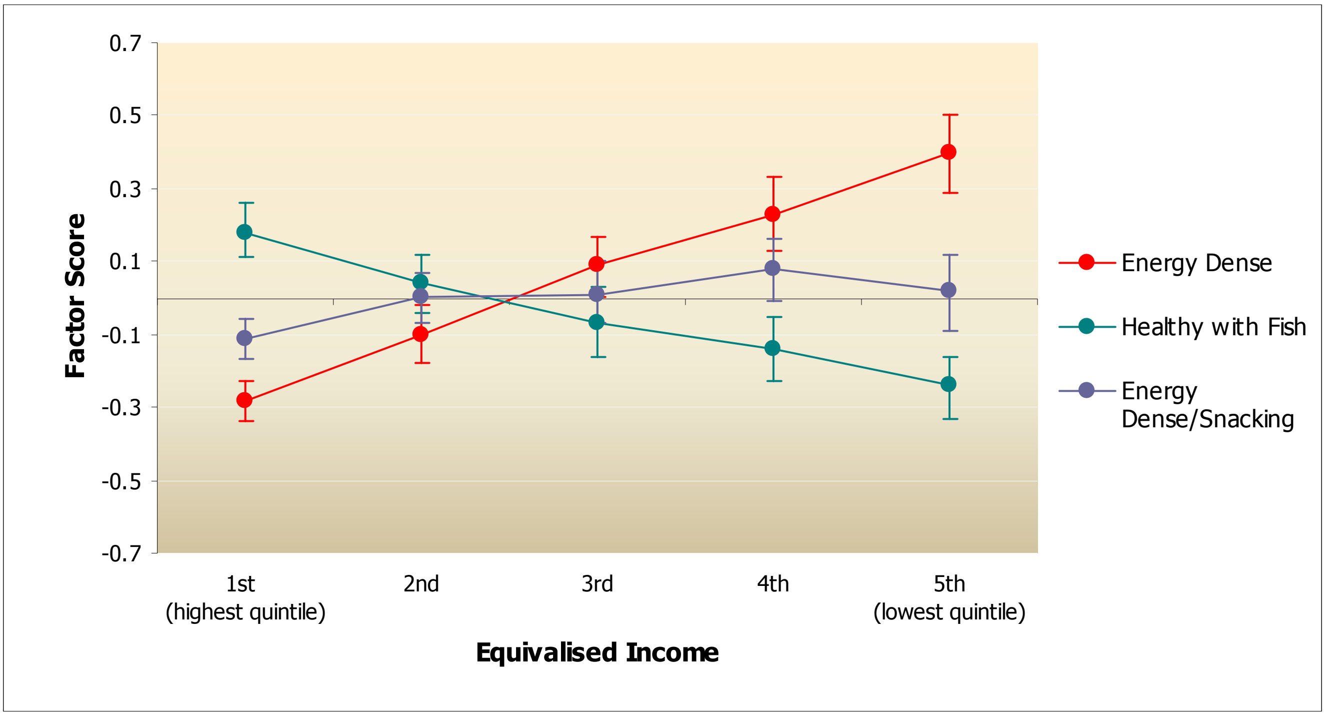
Figure 7. Dietary patterns in 25-64 year olds according to NS-SEC



Equivalised Income

There was a linear trend between the *Energy dense* pattern and income (p<0.0001 for trend). The individuals with the lowest income followed this particular pattern more closely than those with higher incomes. Income explained 5.9% of the variation in factor scores for this *Energy dense* pattern. Conversely, there was a linear trend between the *Healthy with fish* dietary pattern and income in the opposite direction (p<0.0001 for trend). The individuals with highest income followed this particular pattern more closely than those with lower incomes. Income explained 2.3% of the variation in factor scores for this *Healthy with fish* component. The third *Energy dense/snacking* component also showed an increasing linear trend with lower income (p=0.002 for trend) similar to the *Energy dense* (first) pattern, **Figure 8** (full details in **Appendix 4**).

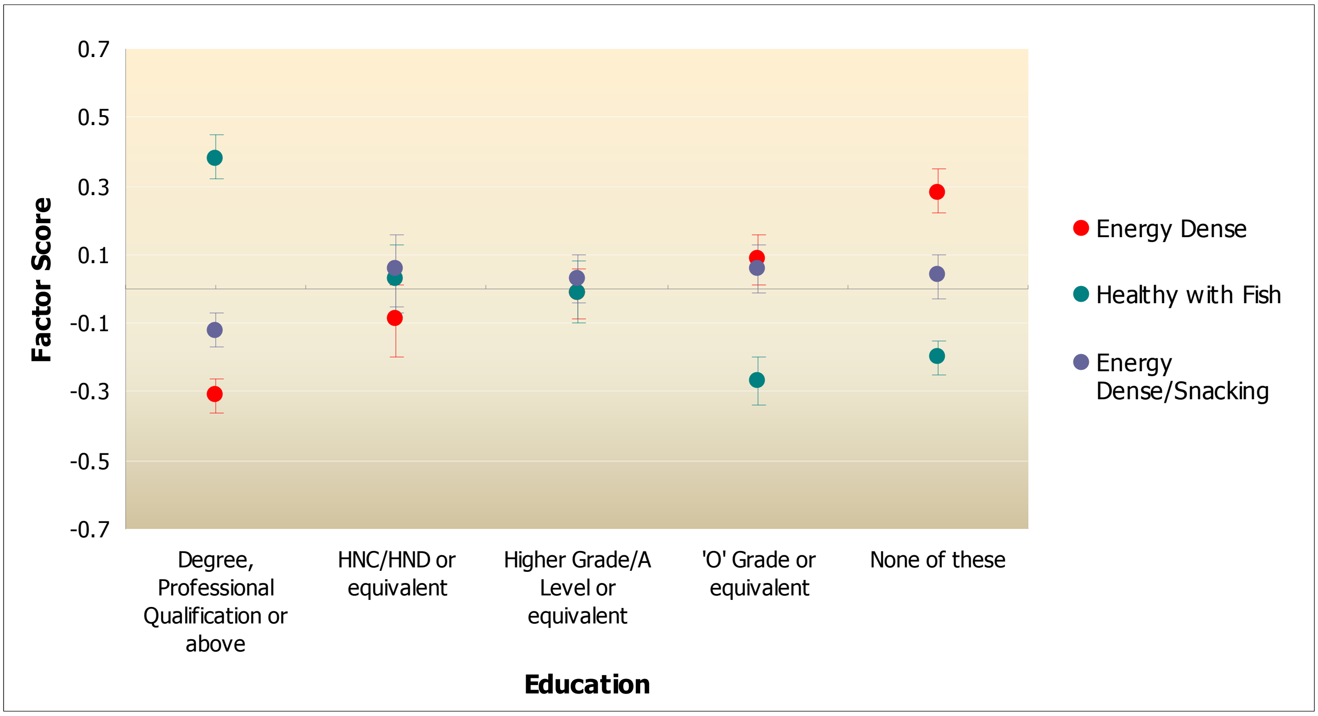
Figure 8. Dietary patterns in 25-64 year olds according to Equivalised Income



Level of Education

There was a linear trend between the *Energy dense* pattern and education (p<0.0001 for trend). The individuals with the lowest level of education followed this particular pattern more closely than those with higher levels of education. Education explained 5.1% of the variation in factor scores for this *Energy dense* pattern. Conversely, there was a linear trend between the *Healthy* pattern and education in the opposite direction (p<0.0001 for trend). The individuals with the highest level of education followed this particular pattern more closely than those with lower incomes. Education explained 6.4% of the variation in factor scores for this *Healthy with fish* pattern. The third *Energy dense/snacking* component also showed a linear trend with education (p=0.0001 for trend) similar to the *Energy dense* (first) pattern, **Figure 9** (full details in **Appendix 4**).

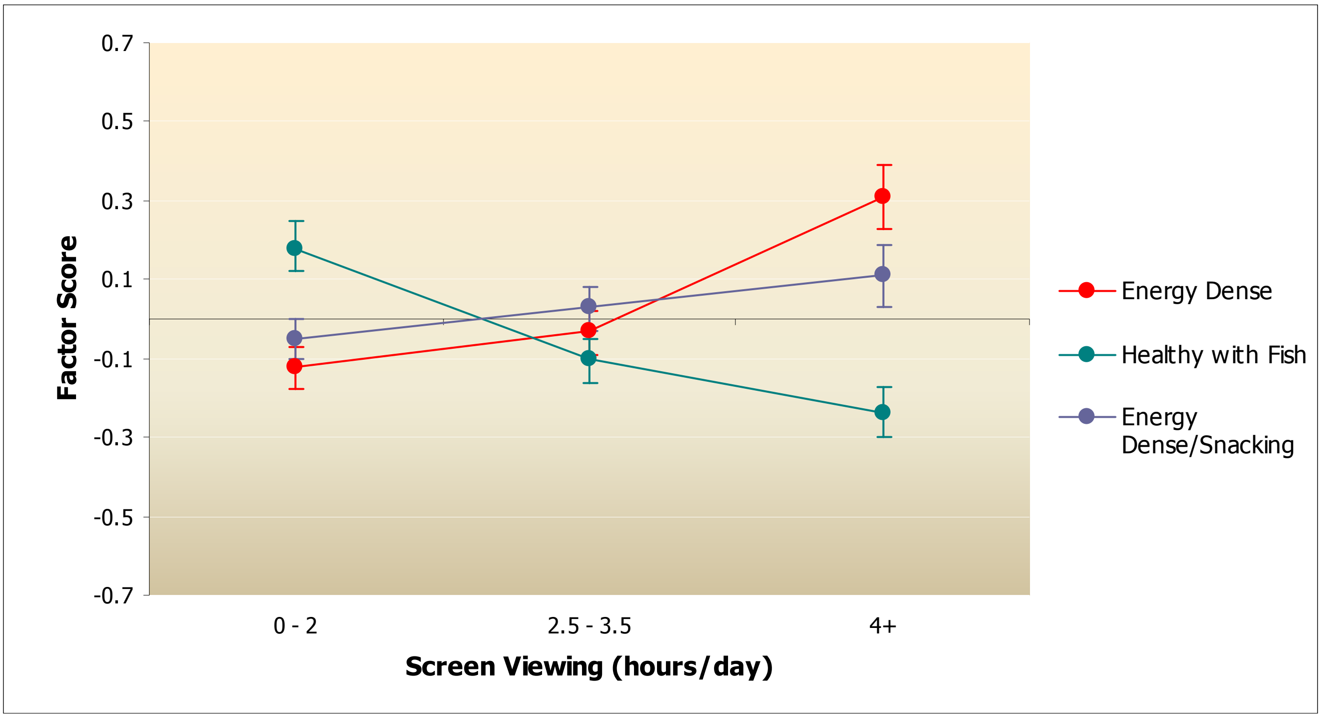
Figure 9. Dietary patterns in 25-64 year olds according to Education



Screen Viewing

There was an increasing linear trend between the *Energy dense* pattern and higher levels of screen viewing (during leisure time) (p<0.0001 for trend). The individuals who engaged in the highest amount of screen viewing (4+ hours per day) followed this particular pattern more closely than those engaged in less screen viewing. Screen viewing explained 2.9% of the variation in factor scores for this *Energy dense* pattern. Conversely, there was a linear trend between the *Healthy with fish* pattern and screen viewing in the opposite direction (p for trend <0.0001). The individuals with the lowest amount of screen viewing followed this particular pattern more closely than those engaged in higher levels of screen viewing. Screen viewing explained 3.1% of the variation in factor scores for this *Healthy* pattern. The third, *Energy dense/snacking,* component also showed an increasing linear trend with more screen viewing (p<0.001 for trend), **Figure 10** (full details in **Appendix 4**).

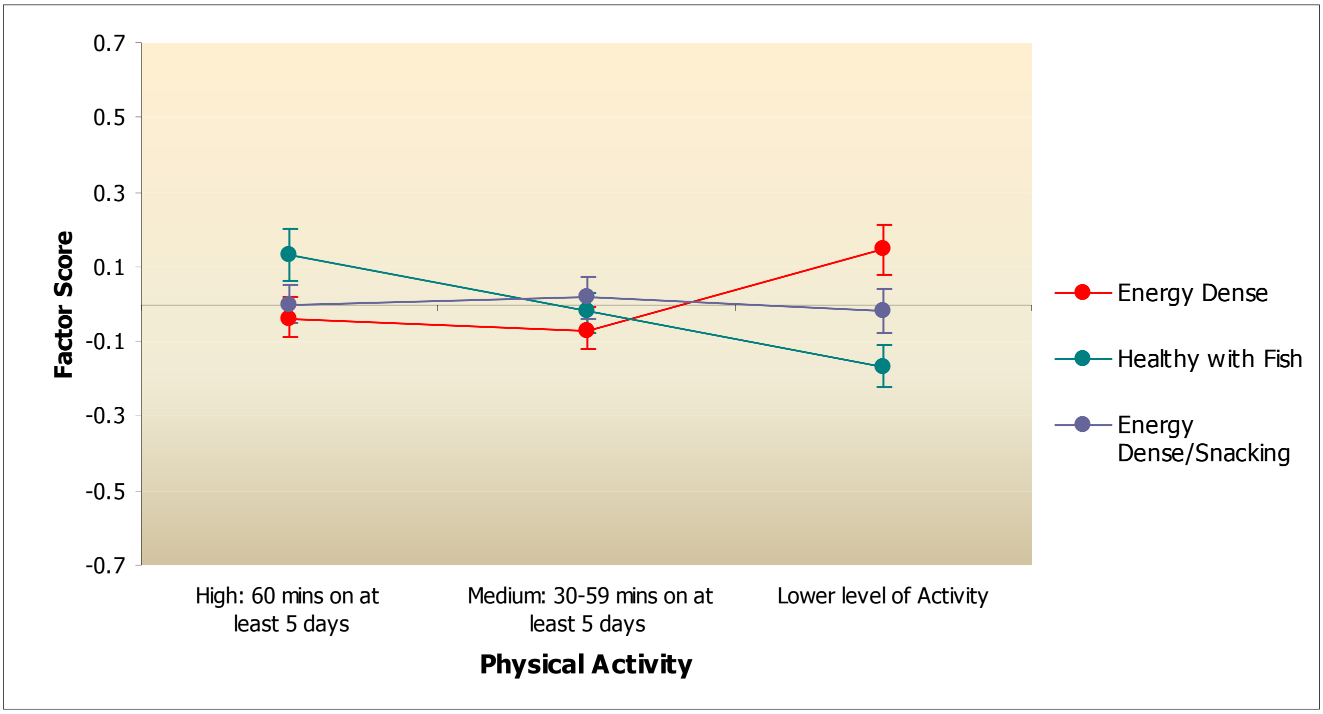
Figure 10. Dietary patterns in 25-64 year olds according to Screen Viewing



Physical Activity

There was a linear trend between the *Energy dense* pattern and physical activity ($p<0.0001$ for trend). The individuals who engaged in the lowest amount of physical activity followed this particular pattern more closely than those engaged in higher levels of activity. Physical activity explained 0.7% of the variation in factor scores for this *Energy dense* pattern. Conversely, there was an increasing linear trend between the *Healthy with fish* pattern and higher levels of physical activity ($p<0.0001$ for trend). Physical activity explained 1.4% of the variation in factor scores for this *Healthy with fish* pattern. The third, *Energy dense/snacking,* pattern appeared not to be related to physical activity ($p=0.52$ for trend), **Figure 11** (full details in **Appendix 4**).

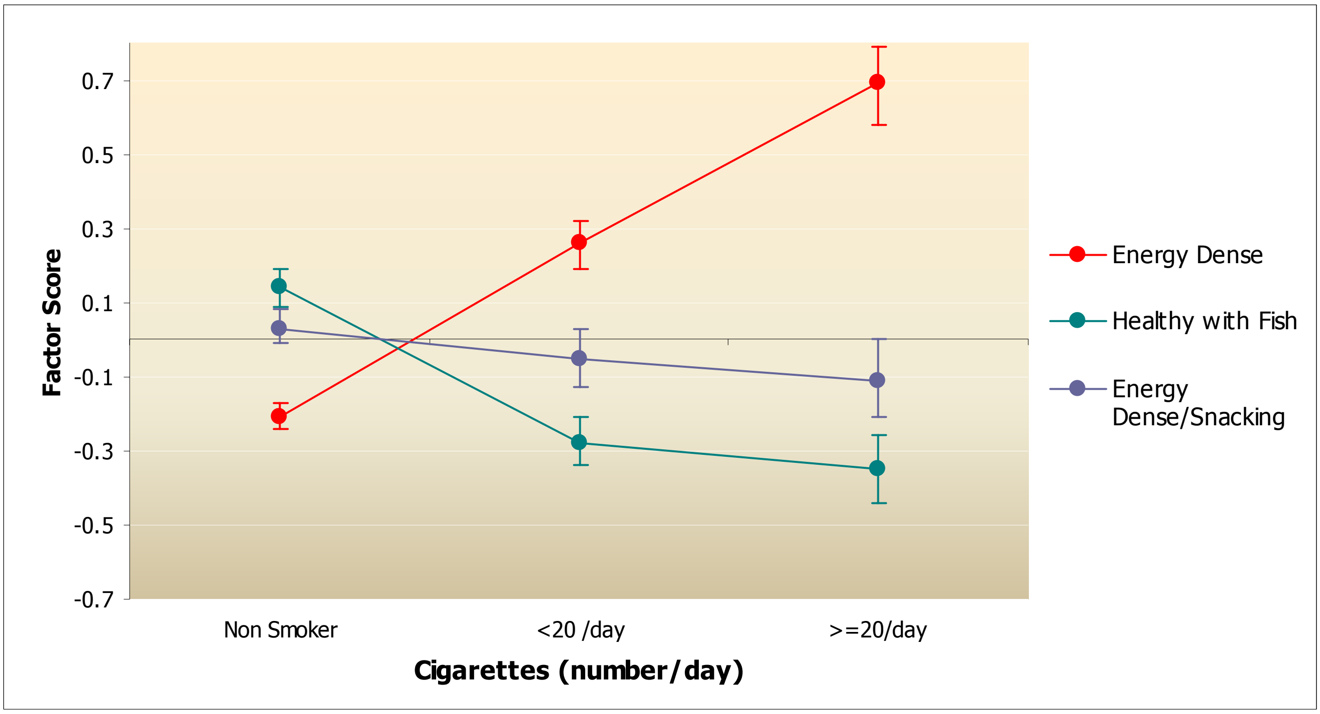
Figure 11. Dietary patterns in 25-64 year olds according to Physical Activity



Smoking

There was a strong increasing linear trend between the *Energy dense* pattern and high levels of smoking (p<0.0001 for trend). The individuals who smoked followed this particular pattern more closely than those who did not smoke. Smoking explained 10.0% of the variation in factor scores for this *Energy dense* pattern. Conversely, there was a decreasing linear trend between the *Healthy with fish* pattern factor score and smoking (p<0.0001 for trend). Smoking explained 4.2% of the variation in factor scores for this *Healthy with fish* component. The third, *Energy dense/snacking,* pattern also showed a decreasing linear trend with smoking (p=0.003 for trend) similar to the *Energy dense* (first) pattern, **Figure 12** (full details in **Appendix 4**).

Figure 12. Dietary patterns in 25-64 year olds according to Smoking



4.0 Dietary patterns from the Scottish Health Survey and health outcomes

The following analyses aim to assess the relationships between dietary patterns and health outcomes (obesity, diabetes, hypertension and total cholesterol: HDL ratio).

Methods

The health outcomes: obesity, diabetes, and high total cholesterol:HDL ratio are dichotomous variables and blood pressure is a continuous variable (**Table 5**). The factor scores from each dietary pattern for each age group were grouped into quintiles (Q1 individuals have low factor score for this pattern; Q5: individuals have high factor score for this pattern). Those in Q5 follow dietary pattern more closely than Q1. Analysis was carried out in three stages: (i) univariable analysis to obtain unadjusted odds ratio (OR) and 95% confidence intervals (95% CI) for quintiles of dietary pattern factor score and the health outcome; (ii) assessment of the effect of dietary patterns on health outcome after adjusting for SES using SIMD, equivalised income and education (adults); (iii) final multivariable model analysis to assess the effect of dietary patterns on health outcome adjusting for SES and lifestyle factors (physical activity) to give adjusted OR (AOR) and 95% CI.

Table 5. Health Outcome Variables from the Scottish Health Survey 2003

Variables	Definition	Factor level for analysis	Adjustments in final multivariable model
Obesity	Adults BMI ≥30 (WHO definition) Children BMI sds > 95th centile (based on UK national BMI centile, 1990)	Dichotomised	SIMD, Equivalised Income, physical activity
Diabetes	Doctor Diagnosed Diabetes	Dichotomised	SIMD, Equivalised Income, physical activity
Diastolic Blood Pressure (DBP)	DBP measured in mmHg	Continuous	Age, gender, height, SIMD, equivalised income, physical activity
Systolic Blood Pressure (SBP)	SBP measured in mmHg	Continuous	Age, gender, height, SIMD, equivalised income, physical activity
High Total cholesterol:HDL ratio	Blood sample measure of total cholesterol and HDL cholesterol. Definition for a high ratio >5	Dichotomised	SIMD, equivalised income, physical activity

4.1 The Relationship between Dietary Patterns and Health Outcomes

Overall, the relationship between dietary patterns and health outcomes were inconsistent and in many cases counter-intuitive. For example, in adults with diabetes the highest factor scores were for healthy patterns. Likewise, the risk of obesity was higher in those following a healthy diet. A more consistent finding was found for the total cholesterol:HDL ratio, a high ratio being more closely associated with an *Energy dense/snacking pattern.* The *Healthy with fish* pattern may protect against a high ratio. These findings are partly a function of exploring health outcomes with cross sectional data. The full results of the analysis with unadjusted and adjusted odds ratio and 95% confidence intervals are tabulated in **Appendix 5**.

Obesity

There was no overall consistent relationship between the prevalence of obesity according to dietary patterns. In a number of groups the results were counter-intuitive, for example, in children aged 11-15 the risk of obesity was reduced in individuals who followed more closely an *Energy dense/snacking pattern* (AOR Q5 vs. Q1: 0.46, 95% CI 0.22,0.98), p=0.06 for trend). Likewise, in the same age group the risk of obesity was increased in individual who followed a *Healthy diet with fish* pattern more closely (AOR 3.30, 95% CI 1.52, 7.17, p=0.008 for trend). However, the relationship was not clear as the AOR was also high in the 3rd quintile. These findings are in the opposite direction of what you might expect. A similar finding was found for obesity in 16-24 year olds for the *Energy/dense snacking pattern* (AOR 0.33, 95% CI 0.09, 1.16), p=0.02 for trend). In the older adults and younger children there were no consistent findings (**Appendix 5**).

Diabetes

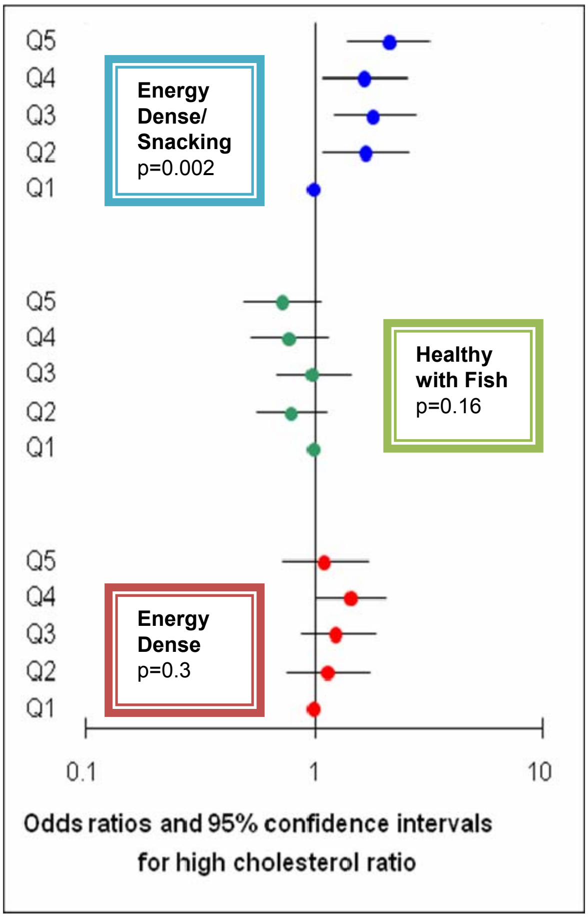
Adults aged 25-64 who followed more closely a *Healthy with fish* dietary pattern were more likely to have diabetes (AOR Q5 vs Q1: 2.30, 95% CI 1.14, and 4.65). The prevalence of diabetes was higher in the group in the highest quintile of factor score for this *Healthy with fish* dietary pattern compared to those in the lowest quintile (3.4% v 2.3%, p for trend 0.004). However, compared to those in the lowest quintile for the *Energy dense/snacking* pattern, those in the highest quintile were less likely to have diabetes (AOR Q5 vs Q1: 0.21, 95% CI 0.08 to 0.53).

Likewise, older adults aged >64 who followed more closely a *Healthy* dietary pattern were more likely to have diabetes (AOR 3.67, 95% CI 1.81, 7.42). The prevalence of diabetes was highest in the group who followed this *Healthy* dietary pattern compared to the lowest quintile group (12.4% v 6.3%, p=0.002 for trend). Those who most closely followed the *Energy/dense snacking* pattern were less likely to have diabetes (AOR Q5 vs Q1: 0.25, 95% CI (0.11, 0.56), p=0.0007 for trend). The effect sizes were considerable suggesting a strong relationship between diabetes and healthy dietary patterns **(Appendix 5)**.

High Total Cholesterol: HDL ratio

A high total cholesterol: HDL ratio was more prevalent in 25-64 year olds who followed more closely the *Energy dense/snacking pattern* (AOR 2.13, 95% CI 1.40, 3.23; p=0.002 for trend). The prevalence of a high ratio was highest in the group who closely followed this *Energy dense/snacking pattern* dietary pattern compared to those in the lowest quintile group (21.9% v 12.4%, p=0.002 for trend). A similar relationship was apparent for the *Energy dense* pattern for 25-64 year olds while a *Healthy with fish* pattern appeared to offer some protection from high total cholesterol: HDL ratio (AOR 0.73, 95% CI 0.49, 1.07). The prevalence of high ratio was lowest in the group who closely followed this *Healthy with fish* dietary pattern compared to those in the lowest quintile group (13.7% v 22.5%, p=0.16 for trend).

Figure 13. Odds ratios and 95% confidence intervals for high cholesterol level



Adjusted odds ratios (95% CI) for the relationship between dietary patterns (quintiles of factor score) and total cholesterol:HDL ratio in 25-64 year olds (blue is the Energy dense/snacking pattern, green is the Healthy with fish pattern, red is the Energy dense pattern). The results table is in **Appendix 5.**

Blood Pressure

The 5-10 year old children who scored highest for the *Healthy with fish* dietary pattern had a lower mean diastolic (DBP) and lower systolic blood pressure (SBP) compared to those who scored lowest for this pattern (DBP p=0.03 for trend and SBP p=0.02 for trend). The differences in blood pressure for children in highest quintile for *Healthy with fish* dietary pattern compared to the lowest quintile were DBP 63.2 vs 65.5 mmHg and SBP 104.0 vs 107.4 mmHg. The results for adults were less consistent, for example 25-64 years olds who followed more closely an *Energy dense* dietary pattern had a higher mean systolic blood pressure (SBP) (p=0.05 for trend) compared to those who scored lowest for this pattern and the difference was mean SBP 129.3 v 125.8 mmHg.

5.0 Dietary Quality Index from the SHS (2003)

A Dietary Quality Index (DQI) was devised using the Scottish Dietary Targets (SDT), and guidelines from the Food Standards Agency, Scientific Advisory Committee on Nutrition (SACN), World Cancer Research Fund (WCRF) and World Health Organisation (WHO) to inform which food indicators were to contribute to the relative score (**Table 6**). The recommended intakes for population groups for each food were derived using guidelines and the score gauges the extent to which an individual's diet conforms to the collective food indicators.

The scoring system that was used is shown in **Table 6**, providing details of the foods which were included, how the score for each food was derived and the reference to justify the inclusion of that component. The definitive DQI for adults comprised 8 food components: Fish, Red Meat and Meat products, Starchy Foods, Fibre in Foods, Sugary foods, Fatty foods, Alcohol, Fruit and Vegetables. For children <16 years alcohol was not included, so there were only 7 food components, i.e. the DQI for adults included a component for alcohol which was not included in the DQI scoring for the children. Therefore to enable comparison of the DQI between adults and children the scores were expressed as a %. The DQI scores for each age group were normally distributed, as illustrated in **Appendix 6**.

Table 6. List of Food Components and coding for the Dietary Quality Index from the Scottish Health Survey

Food Component Steps to scoring	Scoring	Max score	Rationale
Fish 1.Add white fish frequency 2.Score added frequency 3.Score oily fish 4.Add white fish score + oily fish score 5.Recode to give a max score of 10 pts	>=1portion/wk =5 pts 0.5 portions/wk = 2.5 pts <0.5 portions/wk = 0 pts > 1 portion/wk = 10 pts 1 portion/wk = 5 pts 0.5 portions/wk =2.5 pts <0.5 portions = 0 pts	10 points	SACN – two 140g portions of fish per week of which 1 should be oily
Red meat & meat products 1.Score red meat 2.score meat products 3.Add the two scores together	<=5-6 portions/wk=5 > 5-6 portions = 0 0 portions/wk = 5 > 0 portions/wk = 0	10 points	World Cancer Research Fund Report 2007
Starchy foods 1.Transform bread frequencies into times per week 2.Add the bread + potatoes/pasta/rice + breakfast cereal frequencies. 3.Score added freq	=>28 times/week = 10 pts 14-27 times/week = 5 pts <14 times/week = 0 pts	10 points	SDT increase starchy foods
Fibre in foods 1.Score bread 2.Score cereals 3.Divide fruit & vegetable score by 2 4.Add bread, cereals & f&v score 5.Recode as follows	Higher fibre bread = 5 pts Lower fibre bread = 0 pts Higher fibre cereal = 5 Lower fibre cereal = 0 >= 15 pts = 10 pts 10-14.99 pts = 7.5 pts 5-9.99 pts = 5 < 4.99 pts = 0	10 points	COMA, SDT increase intake of foods with fibre
Sugary foods 1.Add sugar food frequency 2.Score frequency	=< 7 times per week = 5 pts > 7 times per week = 0 pts	5 points	WHO/FAO reduce NMES, SDT reduce NMES In children
Fatty foods 1.Add fatty food frequencies 2.Recode milk (whole milk=1, lower fat milk=0) 3.Recode spreads (higher fat spreads=1, lower fat spreads=0 4.Add fatty foods 5.Score frequencies	=< 7 times per week = 5 pts > 7 times per week = 0 pts	5 points	COMA / SDT /WHO

Alcohol (Adults only 16+) 1.Score as follows	**Males=<21 units/wk=5 pts** **>21 units/wk =0pts** **Females=<14 units/wk=5pts** **>14 units/wk=0 pts**	**5 points**	**Food Standards Agency**
Fruit and veg 1.Compute total portions of fruit 2.Compute portion of pulses 3.Compute total veg portions 4.Compute total fruit and veg portions 5.Score fruit & veg portions on a sliding scale 6.Adjust this score (>=5pts=10 pts)	**=>5 = 10 pts**	**10 points**	**SDT = > 400g /day WHO /FAO consultation on Diet, Nutrition and Chronic Disease**

Key:
SACN: Scientific Advisory Committee on Nutrition / SDT: Scottish Dietary Targets
COMA: Committee on Medical Aspects of Food / FAO: Food and Agricultural Organisation
NMES: Non milk Extrinsic sugars / WHO: World Health Organisation

Table 7 shows the Dietary Quality Index (DQI) expressed as a percentage. It increased with age with the lowest % DQI in the 11-15 year olds. The difference between age groups was significant (p<0.001).

Table 7. Mean % (SD) Dietary Quality Index in each Age Group for males and females separately

	Weighted N	Mean DQI %	SD	MIN	MAX
Males					
5-10	630	44.3	12.8	5.0	83.3
11-15	595	42.7	13.1	8.3	81.1
16-24	570	44.9	14.7	15.4	84.6
25-64	2583	52.0	15.6	6.2	100
>64	659	56.6	13.9	21.5	100
Females					
5-10	619	42.9	12.8	8.3	75.8
11-15	547	40.9	13.9	0	83.3
16-24	566	46.1	15.1	7.7	92.3
25-64	2747	54.8	15.9	14.6	100
>64	956	57.9	14.3	15.4	100

6.0 Dietary Quality Index from the SHS (2003) according to Gender, Age, Socio-Economic Status and Lifestyle

The following analyses aimed to assess: (i) the overall association between dietary quality index and measures of socio-economic status (SES) and lifestyle factors; (ii) possible trends in these relationships; and (iii) which measure(s) of SES were most strongly associated with dietary quality index.

Methods

Socio-economic status and lifestyle factors

The measures used for socio-economic status (SIMD. NS-SEC, Equivalised Income, Education) and lifestyle factors (screen viewing, physical activity, smoking) used in the analysis were detailed earlier in section 2.0, **Table 4**.

Statistical analyses

All analyses were carried out in Stata v10 using the survey regression commands, which adjusted the standard error estimates for the complex survey design of the SHS 2003. Linear regression models were run within the survey command using the cluster and strata variables for the SHS 2003. The dietary quality index for each age group was calculated as a percentage. The higher the dietary quality index the more closely the individual's diet met the criteria (**Table 6**) set for the maximum dietary quality score of 100% in children and adults.

In each age group the dietary quality index (DQI) as a continuous score was considered the outcome (dependent) variable in the analysis, and the SES/lifestyle factors were considered the explanatory (independent) variables which were categorical. Dummy variables were created in Stata for these. Overall p-values based on the F-test were presented along with p-values for linear trend. R squared values explained the proportion of the variance in dietary quality score attributed to the particular variable we were analysing.

6.1 Summary of findings of the DQI according to gender, socio-economic status and lifestyle

Gender

Dietary quality scores were very similar in males and females. In the children aged 11-15 years the males had a slightly higher score (42.7% vs 41.0%, p=0.05). The opposite was true in adults aged 25-64 and >64 where females had a marginally higher dietary quality scores (52.0 vs 54.8%, p>0.0001) and (56.6% vs 57.9%, p=0.03). Although statistically significant, these differences are small and probably not significant in the context of the overall quality of the diet. However, they are consistent with the results from the PCA analysis in that they suggest adult females scored higher than males for the healthy type dietary patterns.

Table 8. Dietary Quality Index according to Gender

	DQI Gender Analysis			
Age 5-10 years	Male	Female	*p-value*	*Adjusted R^2*
Mean	44.3	43.0	***0.12***	***0.3%***
Lower 95% confidence limit	43.2	41.6		
Upper 95% confidence limit	45.5	44.3		
Age 11-15 years				
Mean	42.7	41.0	***0.05***	***0.4%***
Lower 95% confidence limit	41.5	39.5		
Upper 95% confidence limit	43.9	42.4		
Age 16-24 years				
Mean	44.9	46.1	***0.29***	***0.2%***
Lower 95% confidence limit	43.0	44.4		
Upper 95% confidence limit	46.8	47.9		
Age 25-64 years				
Mean	52.0	54.8	***<0.0001***	***0.8%***
Lower 95% confidence limit	51.2	54.0		
Upper 95% confidence limit	52.8	55.5		
Age >64 years				
Mean	56.6	57.9	***0.03***	***0.2%***
Lower 95% confidence limit	55.6	56.9		
Upper 95% confidence limit	57.6	58.9		

Socio-economic influences on DQI

There was a significant social patterning of the dietary quality index according to SES within each age group. In the children (5-10 years, 11-15 years) there was a linear trend for a higher *dietary quality index* with higher SES. This relationship was consistent across all measures of SES used (SIMD, Equivalised income, NS-SEC). Likewise, in the adult groups (16-24 years, 25- 64 years and >64 years), there was a linear trend for a higher *dietary quality index* with higher SES. This relationship was consistent across all measures of SES used (SIMD, NS-SEC, Equivalised Income, Education), **Tables 9-12**. Comparing the R squared values for the largest adults group 25-64 years, the associations with SIMD and Education were the strongest.

Lifestyle influences on DQI

In children (5-10 years, 11-15years) more time spent screen viewing (during leisure time) was associated with a lower DQI (**Table 13).** This relationship was weaker in the older children. Physical activity was also associated with the dietary quality index, children in the most active groups had on average the highest dietary quality index (**Table 14)**.

The results for the adult groups (16-24 years, 25- 64 years and >64 years) were similar to children with a decreasing linear trend for a lower dietary quality index with more time spent screen viewing (during leisure time). Physical activity was also associated with the dietary quality index; the most active groups generally had the highest dietary quality index. In the adult groups there was a decreasing linear trend for a lower dietary quality index with smoking (**Table 15).**

Conclusion

The DQI was similar to the dietary patterns in that a better quality of diet as measured using the index was associated with higher socio-economic status in children and adults. Overall, in children, young people and in adults there was a remarkably consistent association between levels of physical activity and screen viewing and the dietary quality index, such that individuals who were more sedentary (more screen viewing) and less physically active had poorer dietary quality scores. In adults smoking was associated with a poorer dietary quality score. The full results are given in **Tables 9 to15.**

6.2 Detailed analysis of Dietary Quality Index according to gender, socio-economic status and lifestyle

The tables below show the p-value, p-value for trend and R squared, which is the proportion of variance in DQI score explained by each of the explanatory variables.

Scottish Index of Multiple Deprivation (SIMD)

In the children (5-10 years, 11-15 years) DQI was the highest in the least deprived group and the lowest in the most deprived (p<0.0001 for trend). In the 11-15 years olds the dietary quality indices for the least and the most deprived group were 44.6% and 37.8% respectively. This relationship was consistent in the young people and adults (16-24 years, 25-64 years and >64 years), a linear trend between the dietary quality index and SIMD with a higher dietary quality index in the least deprived group and the lowest in the most deprived (p<0.0001, p<0.0001 and p<0.0001 for trend respectively). In the 25-64 years olds the dietary quality indices for the least and the most deprived group were 57.6% and 48.1% respectively (**Table 9, Figure 14**).

Table 9. Dietary Quality Index according to SIMD

Scottish Index of Multiple Deprivation (SIMD)							
	1st (least deprived)	2nd	3rd	4th	5th (most deprived)	*p-value* *p-value trend**	*R^2 value*
Age 5-10 years							
Mean	45.3	45.9	44.5	42.9	39.8	***<0.0001***	***3.2%***
Lower 95% confidence limit	43.4	44.2	42.4	40.7	38.0	***<0.000****	
Upper 95% confidence limit	47.1	47.5	47.2	45.2	41.5		
Age 11-15 years							
Mean	44.6	43.7	44.9	39.2	37.8	***<0.0001***	***4.9%***
Lower 95% confidence limit	42.5	41.7	42.9	37.1	35.4	***<0.0001****	
Upper 95% confidence limit	46.7	45.8	46.9	41.3	40.1		
Age 16-24 years							
Mean	49.6	45.8	48.0	43.5	41.7	***0.001***	***3.8%***
Lower 95% confidence limit	46.6	42.6	45.3	40.6	38.9	***0.0001****	
Upper 95% confidence limit	52.6	49.0	50.7	46.4	44.5		
Age 25-64 years							
Mean	57.6	55.6	53.6	51.1	48.1	***<0.0001***	***4.3%***
Lower 95% confidence limit	56.4	54.5	52.3	49.9	46.9	***<0.0001****	
Upper 95% confidence limit	58.8	56.6	54.8	52.3	49.3		
Age >64 years							
Mean	61.4	59.0	58.2	55.7	53.0	***<0.0001***	***4.1%***
Lower 95% confidence limit	59.9	57.3	56.7	54.3	51.3	***<0.0001****	
Upper 95% confidence limit	63.0	60.7	59.8	57.2	54.6		

National Statistics Socio-Economic Classification (NS-SEC)

In the children (5-10 years, 11-15 years) there was a linear trend between dietary quality index and NS-SEC with a higher dietary quality index in the highest NS-SEC group compared to the lowest NS-SEC (p<0.0001 and p<0.0001 for trend respectively). In the 11-15 years olds the dietary quality index for the highest and the lowest NS-SEC were 44.4% and 38.8%. This relationship was consistent in the young people and adults (16-24 years, 25-64 years and >64 years), a linear trend between the dietary quality index and NS-SEC with a higher DQI in the highest NS-SEC group compared to the lowest NS-SEC (p=0.004, p<0.0001 and p<0.0001 for trend respectively). In the 25-64 years olds the dietary quality index for the least and most deprived group were 56.9% and 49.3% (**Table 10, Figure 15).**

Table 10. Dietary Quality Index according to NS-SEC

National Statistics Socio-Economic Classification (NS-SEC)							
	Managerial and professional	Intermediate occupations	Small employers and own account workers	Lower supervisory and technical occupations	Semi-routine occupations	*p-value overall p-value trend**	R^2 *value*
Age 5-10 years							
Mean	46.6	42.4	45.2	40.7	41.5	***<0.0001***	***3.7%***
Lower 95% confidence limit	45.0	40.0	42.4	38.2	40.9	***<0.0001***	
Upper 95% confidence limit	48.1	45.3	47.9	43.1	42.9		
Age 11-15 years							
Mean	44.4	42.3	43.3	41.3	38.8	***0.003***	***3.2%***
Lower 95% confidence limit	42.7	39.4	39.9	39.0	37.1	***<0.0001***	
Upper 95% confidence limit	46.1	45.1	46.6	43.6	40.5		
Age 16-24 years							
Mean	47.6	45.8	47.9	44.8	42.9	***0.04***	***2.1%***
Lower 95% confidence limit	45.1	41.8	43.8	42.0	40.7	***0.004****	
Upper 95% confidence limit	50.1	49.7	52.0	47.6	45.0		
Age 25-64 years							
Mean	56.9	53.6	54.2	51.4	49.3	***<0.0001***	***4.2%***
Lower 95% confidence limit	56.1	51.7	52.4	49.9	48.4	***<0.0001***	
Upper 95% confidence limit	57.9	55.5	55.9	52.9	50.2		
Age >64 years							
Mean	60.9	60.9	60.4	56.2	53.9	***<0.0001***	***5.3%***
Lower 95% confidence limit	59.7	58.4	58.1	54.3	52.8	***<0.0001***	
Upper 95% confidence limit	62.2	63.5	62.7	58.2	55.0		

Equivalised Income (Income)

In the children (5-10 years, 11-15 years) there was a linear trend between dietary quality index and income with a higher dietary quality index in the highest income groups and the lowest in the low income group (p=0.0002 and p<0.0001 for trend respectively). In the 11-15 years olds the dietary quality index for the highest and the lowest income groups were 45.5% and 38.5% respectively. This relationship was consistent in the young people and adults (16-24 years, 25-64 years and >64 years), a decreasing linear trend between the dietary quality index and income, with a higher dietary quality index in the highest income group and lowest in the lowest income group (p=0.03, p<0.0001 and p<0.0001 for trend respectively). In the 25-64 years olds the dietary quality index for the highest and the lowest income group were 56.9% and 48.8% respectively (**Table 11, Figure 16)**.

Table 11. Dietary Quality Index according to Equivalised Income

	Equivalised Income						
	1st (highest quintile)	2nd	3rd	4th	5th (lowest quintile)	*p-value* *p-value trend**	*R^2 value*
Age 5-10 years							
Mean	47.2	44.5	44.1	42.1	41.9	***0.001***	***2.0%***
Lower 95% confidence limit	45.3	42.5	42.0	40.3	39.7	***0.0002****	
Upper 95% confidence limit	49.2	46.5	46.1	44.0	44.1		
Age 11-15 years							
Mean	45.5	43.4	41.3	42.1	38.5	***0.0002***	***3.0%***
Lower 95% confidence limit	43.0	41.1	39.3	39.6	36.7	***<0.0001****	
Upper 95% confidence limit	48.1	45.6	43.3	44.7	40.4		
Age 16-24 years							
Mean	50.5	46.1	42.3	41.8	45.7	***0.0002***	***4.1%***
Lower 95% confidence limit	47.1	43.1	39.6	39.1	42.4	***0.03****	
Upper 95% confidence limit	53.9	49.0	45.0	44.4	48.9		
Age 25-64 years							
Mean	56.9	54.0	52.6	50.8	48.8	***<0.0001***	***3.2%***
Lower 95% confidence limit	55.7	52.9	51.3	49.5	47.4	***<0.0001****	
Upper 95% confidence limit	58.0	55.1	53.8	52.2	50.2		
Age >64 years							
Mean	63.1	61.1	58.1	56.4	54.1	***<0.0001***	***3.2%***
Lower 95% confidence limit	60.0	58.7	56.3	55.1	51.1	***<0.0001****	
Upper 95% confidence limit	66.2	63.4	60.0	57.6	56.1		

Level of Education (Education)

Data on the level of education was available for the adult groups 25-64 and >64 years. There was a linear trend between the dietary quality index and the level of education, with a higher dietary quality index in the highest education group and lower in the lowest education group (p<0.0001 for trend). In the 25-64 years olds the dietary quality index for the highest and the lowest education group were 59.8% and 49.9% (**Table 12, Figure 17)**.

Table 12. Dietary Quality Index according to Education

	Education						
Age 25-64 years	Level 1 Degree or professional qualification or higher	Level 2 HNC/HND or equivalent	Level 3 'H' grade A level or equivalent	Level 4 'O'Grade or equivalent	Level 5 None of these	*p-value p-value trend*	*R^2value*
Mean	59.8	54.1	52.7	49.5	49.9	***P<0.0001***	***7.0%***
Lower 95% confidence limit	58.8	52.6	51.5	48.4	49.0	***<0.0001****	
Upper 95% confidence limit	60.8	55.5	54.0	50.7	50.8		
Age >64 Years							
Mean	63.4	62.2	61.2	60.8	55.6	***<0.0001***	***4.5%***
Lower 95% confidence limit	61.7	58.1	58.9	57.7	54.7	***<0.0001****	
Upper 95% confidence limit	65.0	66.4	63.5	64.0	56.5		

Screen Viewing

In the children (5-10 years, 11-15 years) there was a linear trend between dietary quality index and screen viewing with dietary quality index decreasing with more screen viewing (p<0.0001 and p=0.05 for trend respectively). In the 11-15 years olds the dietary quality index for the groups with most and least screen viewing were 43.0% and 40.7%. This relationship was consistent in the young people and adults (16-24 years, 25-64 years and >64 years), a linear trend between dietary quality index and screen viewing with dietary quality index decreasing with more screen viewing (p=0.0002, p<0.0001 and p<0.0001 for trend respectively). In the 25-64 years olds the dietary quality index for the groups with most and least screen viewing were 46.5% and 48.3% (**Table 13, Figure 18).**

Table 13. Dietary Quality Index according to Screen Viewing

	Screen Viewing				
	0-2 hrs /day	2.5-3.5 hrs/day	4+ hrs/day	*p-value* *p-value trend**	*R^2 value*
5-10 years					
Mean	45.5	42.0	39.6	***<0.0001***	***3.7%***
Lower 95% confidence limit	44.1	40.4	37.9	***<0.0001****	
Upper 95% confidence limit	46.8	43.6	41.3		
11-15 years					
Mean	43.0	42.3	40.7	***0.10***	***0.6%***
Lower 95% confidence limit	41.5	40.4	39.0	***0.05****	
Upper 95% confidence limit	44.6	44.2	42.3		
16-24 years					
Mean	48.4	45.9	41.4	***0.0001***	***4.1%***
Lower 95% confidence limit	45.8	43.7	39.3	***0.0002****	
Upper 95% confidence limit	50.9	48.0	43.5		
25-64 years					
Mean	56.3	52.6	48.3	***<0.0001***	***3.9%***
Lower 95% confidence limit	55.4	51.7	47.2	***<0.0001****	
Upper 95% confidence limit	57.1	53.5	49.5		
>64 years					
Mean	60.1	57.5	55.0	***<0.0001***	***2.0%***
Lower 95% confidence limit	58.6	56.2	53.7	***<0.0001****	
Upper 95% confidence limit	61.5	58.8	56.4		

Physical Activity

In the children 11-15 years, but not in 5-10 years there was a linear trend between dietary quality index and level of physical activity, with dietary quality index decreasing with less physical activity (p=0.0002 for trend). In the 11-15 year olds the dietary quality index for the groups with the highest and the lowest level of physical activity were 48.9% and 42.9%. This relationship was consistent in the young people and adults (16-24 years, 25-64 years and >64 years), a linear trend between dietary quality index and level of physical activity, with dietary quality index decreasing with less physical activity (p<0.0001, p<0.0001 and p<0.0001 for trend respectively). In the 25-64 years olds the dietary quality index for the groups with the highest and the lowest level of physical activity were 50.5% and 55.2% (**Table 14, Figure 19)**.

Table 14. Dietary Quality Index according to Physical Activity

	Physical Activity				
	Low none or less than medium	Medium 30-59mins on at least 5 days	High 60 mins on at least 5 days	*p-value p-value trend*	*R^2 value*
Age 5-10 years					
Mean	42.3	44.5	43.7	***0.39***	***0.2%***
Lower 95% confidence limit	40.0	42.2	42.7	***0.45****	
Upper 95% confidence limit	44.7	46.7	44.7		
Age 11-15 years					
Mean	38.9	43.1	42.9	***0.0003***	***1.8%***
Lower 95% confidence limit	37.0	40.9	41.7	***0.0002****	
Upper 95% confidence limit	40.7	45.3	44.1		
ADULT LEVELS	**Low*	*Medium*	*High*		
Age 16-24 years					
Mean	40.5	44.9	48.2	***<0.0001***	***4.2%***
Lower 95% confidence limit	38.1	42.6	46.3	***<0.0001****	
Upper 95% confidence limit	42.8	47.2	50.1		
Age 25 – 64 years					
Mean	50.5	53.5	55.2	***<0.0001***	***1.4%***
Lower 95% confidence limit	49.6	52.6	54.3	***<0.0001****	
Upper 95% confidence limit	51.5	54.4	56.2		
Age >64 years					
Mean	55.9	59.0	60.8	***<0.0001***	
Lower 95% confidence limit	55.0	57.6	59.0	***<0.0001****	
Upper 95% confidence limit	56.8	60.4	62.7		

**Low = moderate or vigorous <30 min per week*

Medium = moderate or vigorous ≥ 30 min on 1-4 days

High = moderate or vigorous on at least 5 days per week

Smoking

Data on smoking behaviour was available for the adults groups; 16-24, 25-64 and >64 years. There was a strong linear trend between dietary quality index and smoking, with dietary quality index decreasing with smoking (p<0.0001, p<0.0001 and p<0.0001 for trend respectively). In the 25-64 years olds the dietary quality index for the groups who did not smoke and those who smoked >20 per day were 56.5% and 44.2% (**Table 15, Figure 20)**.

Table 15. Dietary Quality Index according to Smoking

	Smoking				
	Non Smoker	*Less than 20/day*	20 or more/day	*p-value p-value trend**	R^2 *value*
Age 16-24 years					
Mean	46.5	43.3	39.1	***0.0003***	***1.6%***
Lower 95% confidence limit	44.8	41.3	35.2	***0.0001****	
Upper 95% confidence limit	48.3	45.3	43.1		
Age 25-64 years					
Mean	56.5	48.7	44.2	***<0.00001***	***8.3%***
Lower 95% confidence limit	55.8	47.6	42.8	***<0.0001****	
Upper 95% confidence limit	57.2	49.9	45.5		
Age >64 years					
Mean	58.8	52.0	49.2	***<0.00001***	***4.5%***
Lower 95% confidence limit	57.9	50.1	46.4	***<0.0001****	
Upper 95% confidence limit	59.6	53.8	51.9		

6.3 Graphs of Dietary Quality Index according to socio-economic status and lifestyle

Figure 14. DQI in all age groups according to SIMD pattern

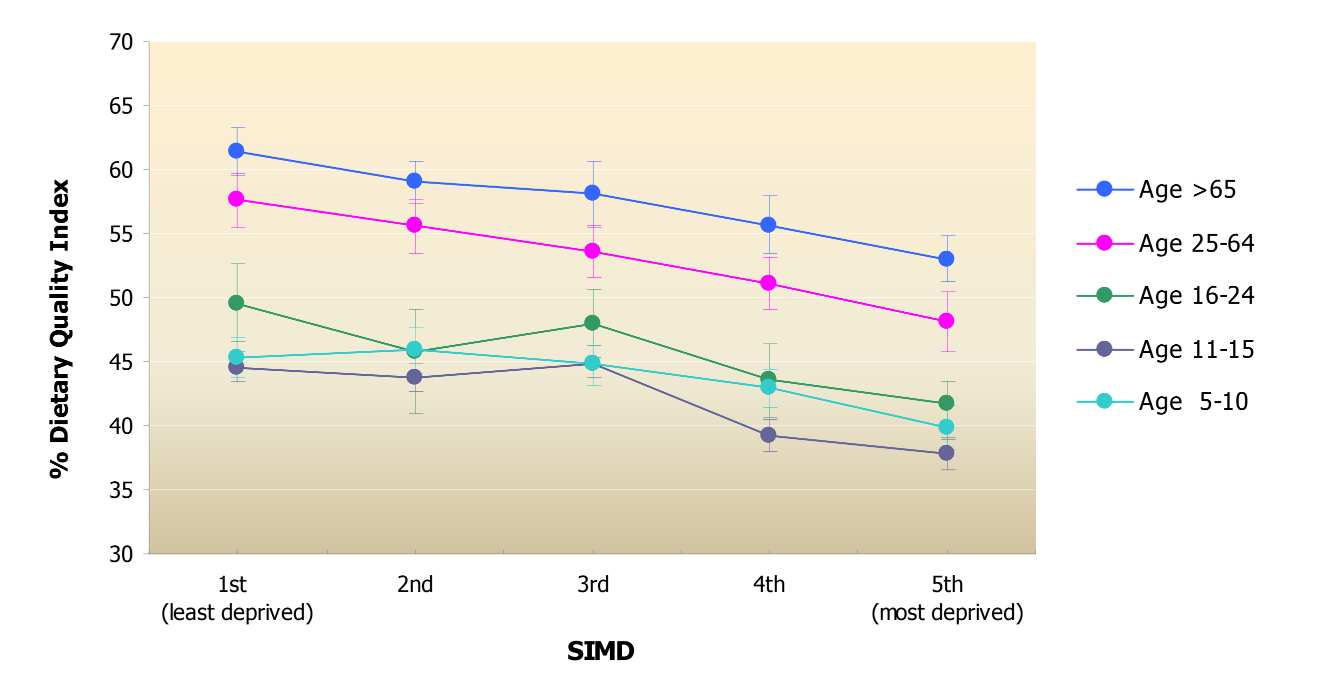


Figure 15. DQI in all age groups according to NS-SEC pattern

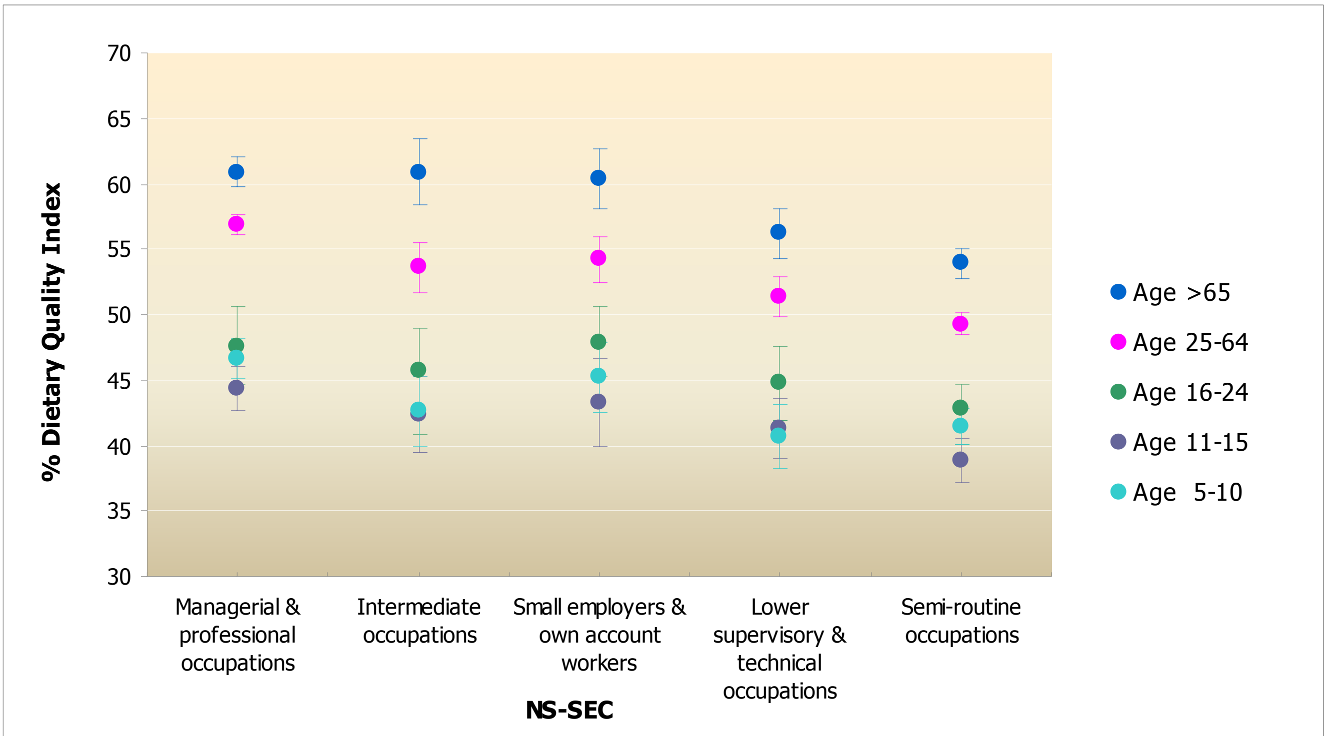


Figure 16. DQI in all age groups according to Equivalised Income pattern

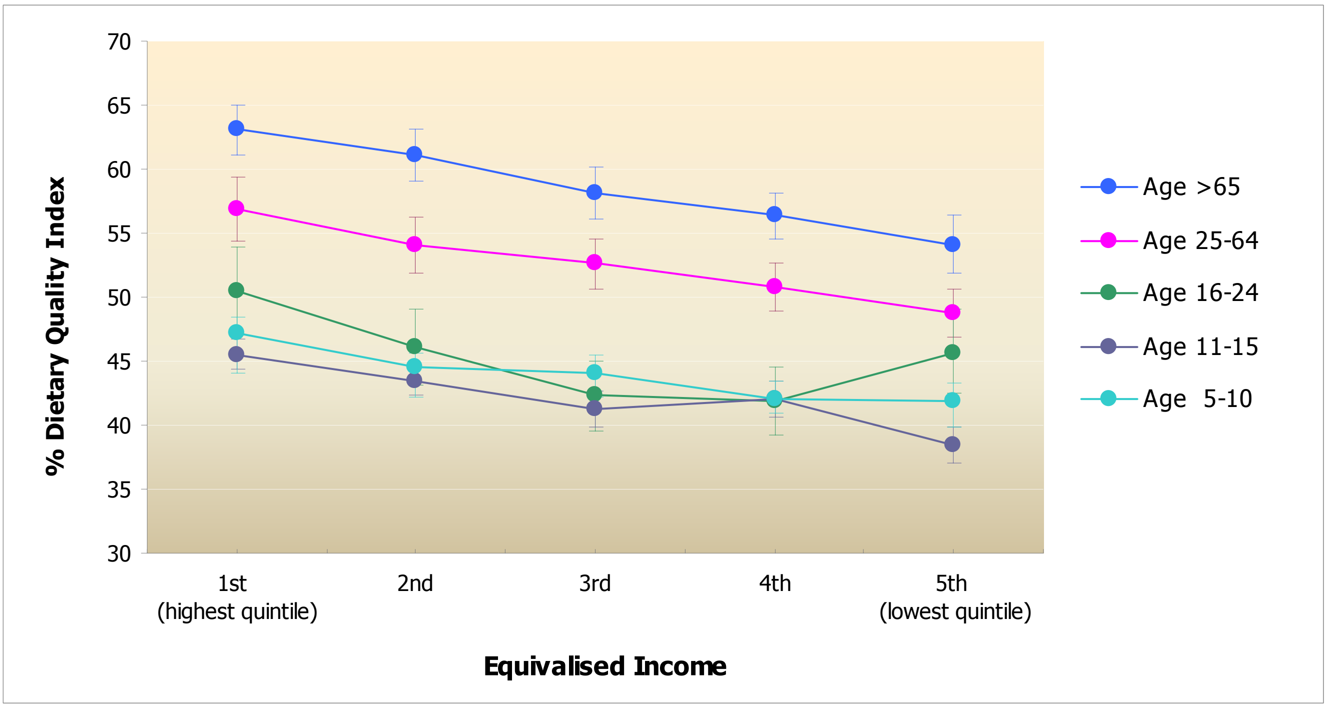


Figure 17. DQI in all age groups according to Educational pattern

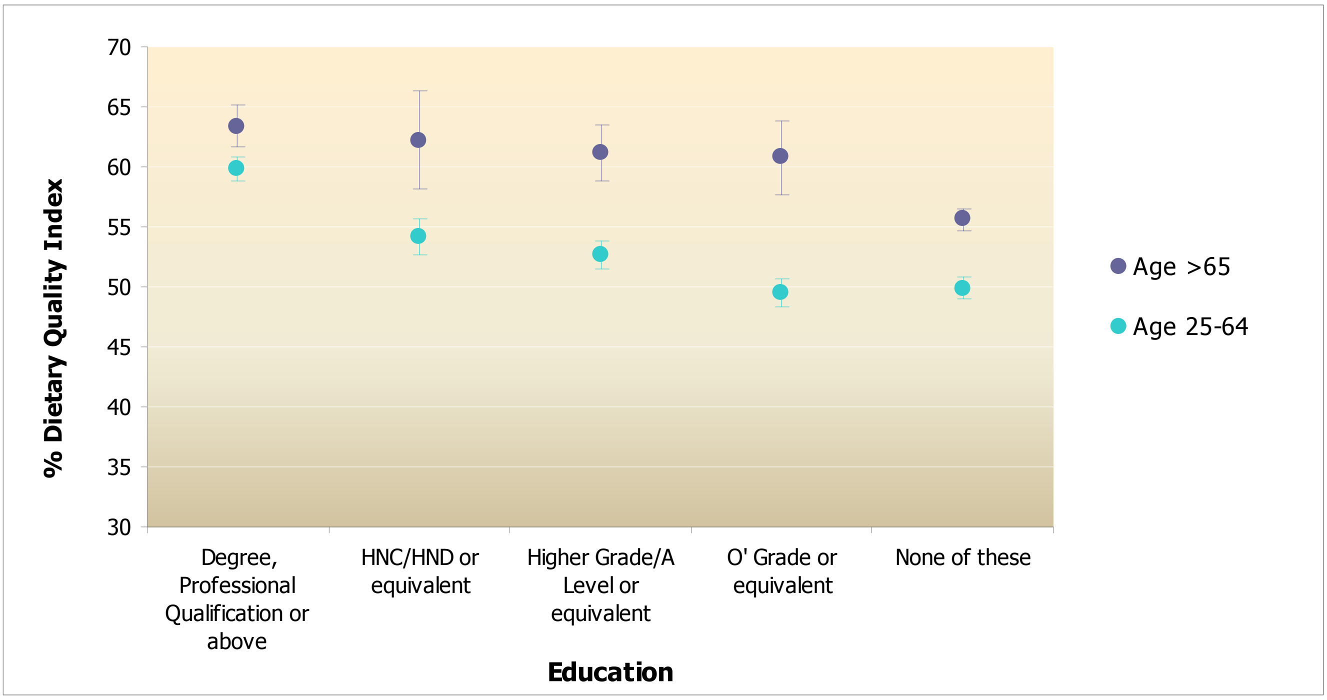


Figure 18. DQI in all age groups according to Screen Viewing

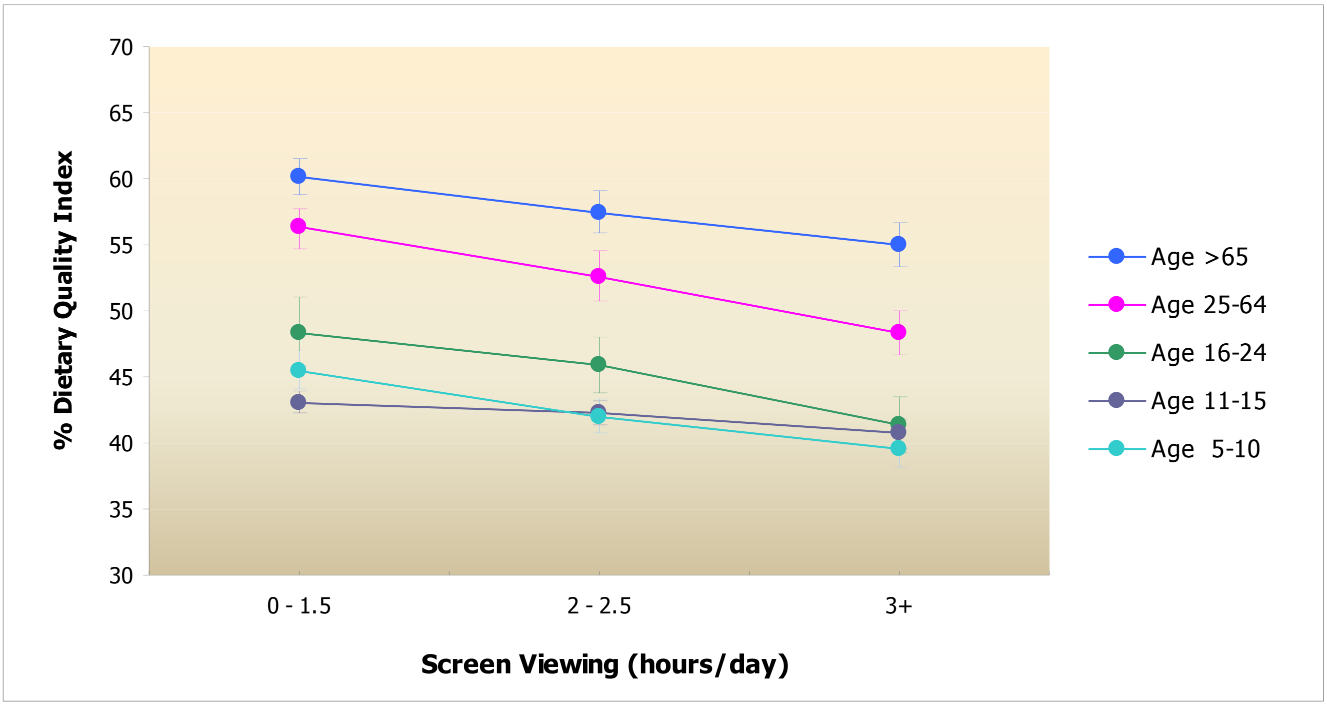


Figure 19. DQI in all age groups according to Physical Activity

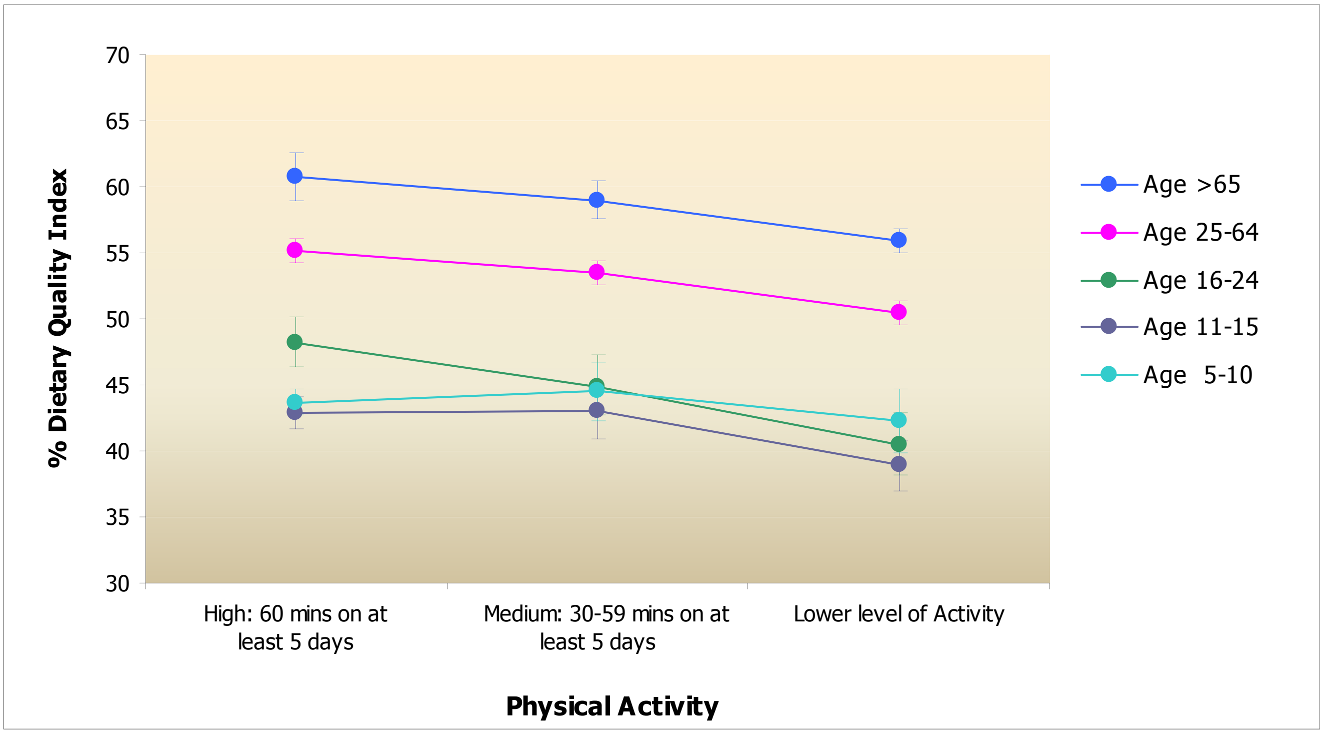
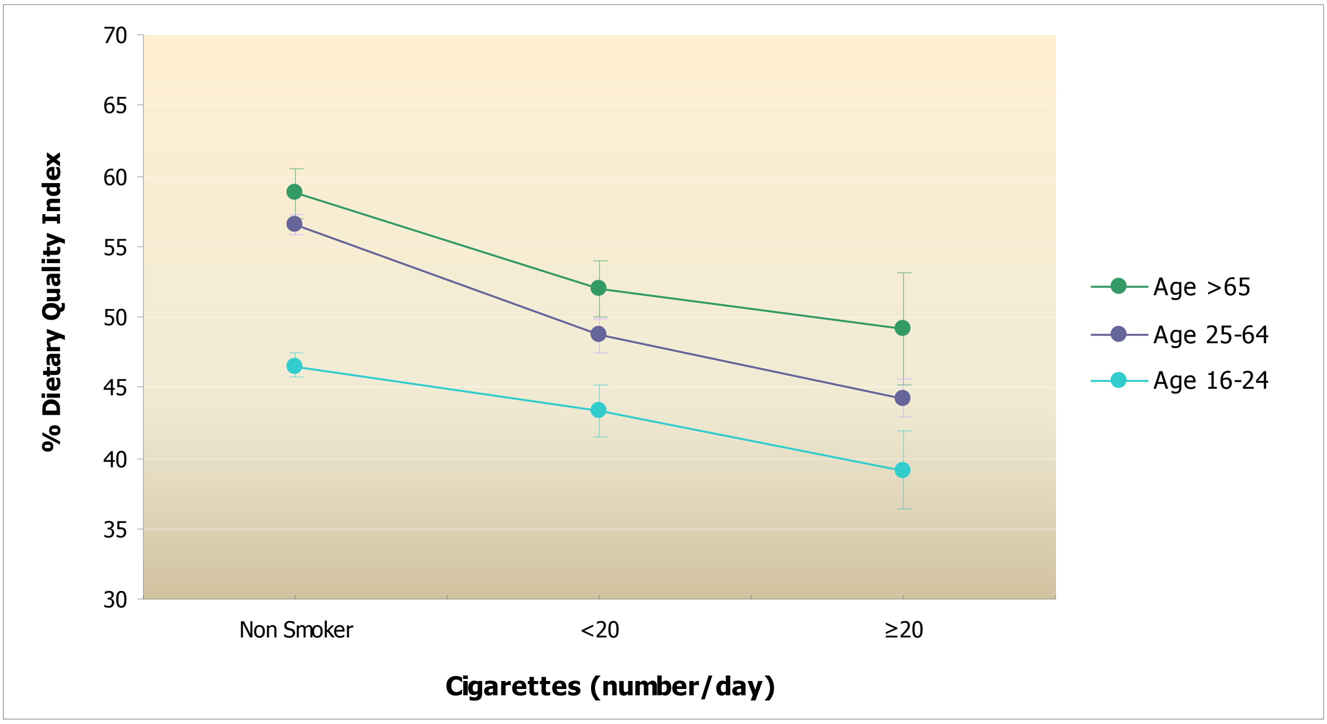


Figure 20. DQI in all age groups according to Smoking pattern



6.4 Dietary Quality Index and health outcomes from the Scottish Health Survey 2003

The following analyses aimed to assess the relationship between the dietary quality index (DQI) and health outcomes (obesity, diabetes, hypertension and total cholesterol: HDL ratio). In this analysis, the health outcome was the dependent variable and the DQI in quintiles the explanatory (independent) variable. The statistical analyses are described earlier in section 2.0 and the results tables are shown in **Appendix 7**.

There was a strong relationship between Diabetes and DQI for both 25-64 years olds and >64 years, with high effect sizes for diabetics having a higher DQI. In addition, 25-64 year olds with a high DQI had a lower total cholesterol:HDL ratio suggesting a protective effect of high quality diet. This effect was similar but weaker in older adults. Overall, the relationships between the dietary quality indices and health outcomes were not consistent; the results tables are given in **Appendix 7**. Obesity was not significantly related to dietary quality index in children or adults and like with the dietary patterns analysis the direction of effect was not as expected.

Obesity

There was no overall consistent relationship between the prevalence of obesity and DQI (**Appendix 7)**.

Diabetes

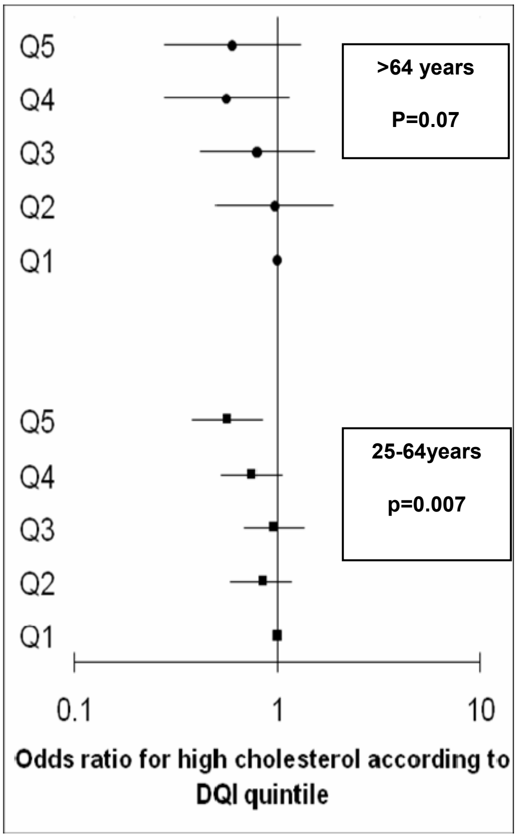
Those in the highest quintile of DQI at 25-64 years were more likely to have diabetes than those in the lowest quintile of DQI (AOR 5.60, 95% CI (2.24, 13.96)). The prevalence of diabetes in the adults in the highest and the lowest DQI quintile group were 3.4% v 1.6%, p<0.0001 for trend. Likewise, in older adults >64 years there was a strong relationship between having diabetes and dietary quality index (AOR 2.47, 95% CI (1.18, 5.18)). The prevalence of diabetes in the older adults in the highest and the lowest DQI quintile group were 11.9% v 8.4%, p=0.01 for trend. The effect sizes were considerable suggesting a strong relationship between diabetes and DQI (**Appendix 7)**.

High Total Cholesterol: HDL ratio

In adults 25-64 years those with a DQI in the highest quintile were less likely to have high total cholesterol: HDL ratio (AOR 0.56, 95% CI (0.38, 0.84)). The prevalence of high ratio in the highest and the lowest DQI quintile groups were 12.6% v 24.2%, p=0.007 for trend. Likewise, in older adults >64 years a high DQI appeared to be protective against high total cholesterol: HDL ratio (AOR 0.60, 95% (CI 0.28, 1.31)). The prevalence of a high ratio in the highest versus the lowest DQI quintile group was 12.0% v 19.7%, p=0.07 for trend. The effect sizes were considerable suggesting a strong relationship between DQI and total cholesterol:HDL ratio.

Figure 21 shows the relationship between DQI and total cholesterol:HDL ratio, adjusted odds ratio (95% CI) for quintiles of dietary quality index in adults age 25-64 and older adults >64 years. The lowest quintile is used as the reference category. The results are tabulated in **Appendix 7**.

Figure 21. Relationship between Total Cholesterol: HDL Ratio and DQI



Blood Pressure

There was no consistent relationship between mean diastolic (DBP), mean systolic blood pressure (SBP) and dietary quality index (**Appendix 7**).

7.0 The association between dietary patterns (PCA) and Dietary Quality Index (DQI) from the Scottish Health Survey

In this section the aim was to test the association between the empirically derived PCA scores and the DQI score (DQI was informed by dietary targets and nutritional expertise). Correlation coefficients between the factor scores derived from the PCA analysis and the DQI score for each individual were calculated. This indicated whether the factors scores and the DQI were related and if the direction of the relationship was as expected (e.g. we would expect the factor score for a healthy dietary pattern to be positively associated with a high DQI score). **Table 16** shows the results for the correlation between PCA factors scores and DQI for the dietary patterns in age groups.

For all the healthy dietary patterns from PCA in children and in adults, the correlations with DQI were high and positive (R ranged from +0.39 to +0.70). The traditional pattern in >65 age group was moderately positively correlated with DQI, whereas the less healthful dietary patterns from PCA were all negatively correlated with DQI, ranging from -0.05 to -0.46.

Table 16. Correlation coefficient (R) and R-squared for the association between PCA factor scores and DQI

Scottish Health Survey :Dietary Patterns		Correlation coefficient (R) for PCA factor score v DQI score	R-squared
5-10 years	**Energy dense/snacking**	-0.16	0.03
5-10 years	**Healthy with fish**	0.70	0.49
11-15 years	**Energy dense/snacking**	-0.23	0.05
11-15 years	**Healthy with fish**	0.59	0.35
11-15 years	**Healthy**	0.39	0.15
16-24 years	**Healthy**	0.59	0.35
16-24 years	**Energy dense/snacking**	-0.05	0.00
16-24 years	**Healthy**	0.47	0.22
25-64 years	**Energy dense**	-0.46	0.21
25-64 years	**Healthy with fish**	0.60	0.36
25-64 years	**Energy dense/snacking**	-0.14	0.02
≥ 65 years	**Healthy**	0.68	0.46
≥ 65 years	**Energy dense/snacking**	-0.12	0.01
≥ 65 years	**Traditional**	0.26	0.07

8.0 Distinct dietary patterns from the Expenditure and Food Survey 2001-2004 using principal component analysis (PCA)

8.1 Sample and Data Preparation

The data used was household and takeaway/eaten out food consumption data which was derived from weighed diaries of foods and drinks purchases for the Expenditure and Food Survey 2001/02-2003/04 (combined). A coding frame was devised grouping similar foods for analysis e.g. chicken and turkey food codes were grouped to form poultry. Food groupings were not considered if weights were not available for the food items e.g. dried herbs and spices or if the food grouping was consumed by less than 5% of the population (n<87). The definitive list comprised 104 food groupings and a breakdown of these can be found in **Appendix 8**.

As quantities of food in the EFS are recorded as household purchases these were adjusted to an average adult consumption figure for the household as g/2000kcal. All variables were standardised by computing z-scores (subtracting the mean for each variable and dividing by the standard deviation).

8.2 Statistical Methodology

PCA was carried out using SPSS 15 for Windows (SPSS Inc., Chicago, Illinois). All statistical analysis described below was carried out with the EFS weighting factor for each household applied to the data to make it representative of the UK population. This also makes it representative of the Scottish Population. After data preparation, principal component analysis (PCA) of the weighed food groupings for each household was undertaken:

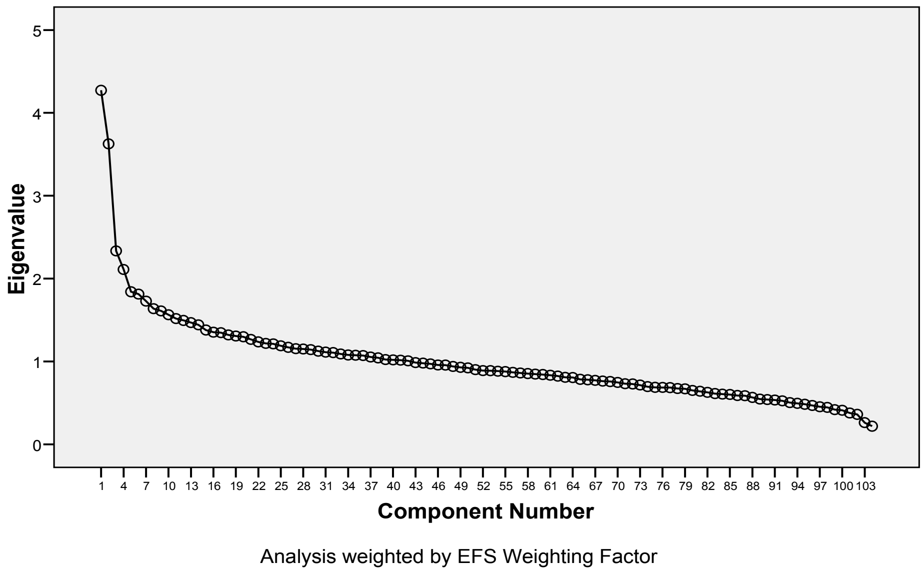
1. Firstly the data were reduced by forming linear combinations of the original observed variables; grouping together correlated variables thus identifying underlying dimensions/structure in the data.

2. Secondly, the number of components that best represent the data were chosen by the researchers using the Scree plot (**Figure 22**) which plots the eigenvalues against each component (in order of highest to lowest). Any borderline decisions were considered by the wider project team who examined the scree plots, the eigenvalues and the interpretability of the resulting components.

3. Varimax rotation was then successfully applied in order to obtain the simplest factor structure. The coefficients defining the linear combinations after rotation are called the factor loadings and represent the correlations of each variable with that component.

4. Finally, a factor score was produced for each individual participant for each of the components identified. These were calculated by multiplying the factor loadings by the corresponding standardised value for each food and summing across food types. Each score has a mean zero and a standard deviation of one. A higher score indicates that subject's diet is closer to that dietary pattern.

Figure 22. Scree Plot of Initial Condensation of EFS 2001/02 – 2003/04



The scree plot is of the eigenvalues for each of the components generated from the PCA (the eigenvalue is the amount of variance that is accounted for by a given component). The importance of a component (dietary pattern) is reflected in its eigenvalues which indicates the components (patterns) which best represent the data.

8.3 Results

Combining the 3 years of EFS data (2001/02, 2002/03 and 2003/04) provided data on 1750 households, of which 486 (28%) households were single occupancy households, 669 (38%) were double occupancy, 509 (29%) had 3 or 4 occupants and the remaining 86 (5%) had between 6 and 12 occupants.

Table 17. Summary of foods loading highly (using factor loadings of ≥ 0.3**)** from PCA of EFS data

Component 1 Takeaway/Eaten Out	**Component 2 Healthy with fruit and vegetables**	**Component 3 Cakes, pastries, buns, scones, cereals, bread**	**Component 4 Traditional**
Variance Explained 4.1%	**Variance Explained 3.5%**	**Variance Explained 2.2%**	**Variance Explained 2.0%**
Foods with Factor Loadings ≥0.3			
Takeaway and Eaten Out	Fruit Other Fresh	Cakes and Pastries	Onions
Meat Dishes Traditional Eaten Out	Vegetables Lettuce and Cucumber	**Factor Loadings ≥0.25 to 0.29**	Tomatoes
Ethnic Main Meal Dishes Takeaway / Eaten Out	Yoghurt/Fromage Frais	Buns, scones, teacakes and muffins/crumpets	Fresh Potatoes
Processed Meat Products Takeaway/Eaten Out	Vegetables Other Fresh and Frozen	White fish	Wine
Wine Consumed Outside Home	Fruit and Vegetable Juice	Breakfast cereals wholegrain/high fibre	Vegetables Root Fresh
Oily Fish Dishes Eaten Out	Other Bread	Butter	Red Meat
White Fish Dishes Eaten Out	Mineral Water	Bread brown/wholemeal	Vegetables Green
Sauces Eaten Out	Fruit Citrus Fresh	Sweet biscuits	Vegetables Other Fresh and Frozen
Prepared Sandwiches/Filled Rolls	**Factor Loadings ≥0.25 to 0.29**	Vegetables green	**Factor Loadings ≥0.25 to 0.29**
Meat Pies/Pasties Takeaway/Eaten Out	Salad dressings, sauces, pickles and mayonnaise	Sugar and preserves	Fresh herbs
Lager/Beer/Cider Consumed Outside Home	Fresh herbs		
Salad Main Meal Eaten Out	Cheese		
Eggs	Bread brown/wholemeal		
Eaten Out Chips Fast Food Outlet	Wine consumed outside home		
Factor Loadings ≥0.25 to 0.29	Oil rich fish		
Cocktails / spirits / liqueurs and mixers consumed outside home	Savoury biscuits		
	Tomatoes		
Foods with Factor Loadings ≤-0.3			
	Milk Whole	Pasta	
	Bread White	Pizza	
		Soft Drinks Not Low Calorie	
		Processed Meat Products Takeaway/Eaten Out	
		Salad Dressings, Sauces, Pickles and Mayonnaise	
		Crisps and Savoury Snacks	

The components shown in **Table 17** represent four distinct dietary patterns in the Scottish Diet derived from the food purchase diaries used in the Expenditure and Food Survey. These were the four dietary patterns identified on the scree plot (**Figure 22**) which explained the highest amount of variance in the diet. The labels given to the components are for descriptive purposes only. PCA identified four distinct dietary components (patterns) from the household purchasing data. The foods most positively and negatively associated with each particular pattern varied, and a full list of the factor loadings are shown in **Appendix 9**.

The first pattern, Takeaway/Eaten Out (**Table 17**), was characteristic of a diet highly dependent on foods and drinks as takeaway (eaten wherever) and food eaten out of the home (dining out). It was positively associated with purchases of the following foods as takeaway or eaten out of home: chips, meat dishes, ethnic main meals, processed meat, oily and white fish, sauces, sandwiches and filled rolls, meat pies, pasties, salad, eggs, fast food chips. It also loaded highly for alcoholic drinks (wine, lager and beer) consumed outside the home and explained 4.1% of the variance. The second pattern, Healthy with Fruit and Vegetables (**Table 17**) explained 3.5% of the variance and was characteristic of a health conscious dietary pattern, predominating in the purchasing of fruits, salad vegetables, yoghurt, vegetables, fruit and vegetable juices, breads and citrus fruits. The third pattern, Cakes, Pastries, Buns, Scones, Cereals and Bread, (**Table 17**) explained 2.2% of the variance and was characterised by starchy carbohydrate cereal (wheat) based foods. Although it only had one food grouping (cakes and pastries) with a factor loading ≥0.3, other foods which also represented this pattern (i.e. with factor loadings ≥ 0.25 to 0.29) included: buns, scones, teacakes and muffins/crumpets, white fish, wholegrain breakfast cereals, butter, brown/wholemeal bread, sweet biscuits, green vegetables, sugar and preserves. This pattern was negatively associated with crisps and savoury snacks, salad dressings, processed meat products eaten out, soft sugary drinks, pizza and pasta. Finally, the fourth pattern, labelled Traditional, (**Table 17**) was characterised by onions, tomatoes, potatoes, wine, root vegetables, red meat and all other types of vegetables.

8.4 Dietary patterns from the Expenditure and Food survey (EFS) according to socio-economic status and lifestyle

Statistical Methods

Due to the complex sampling design of the EFS (clustered, stratified, multi-stage design), statistical adjustments had to be made to the standard errors of the estimates when testing hypotheses. The **cluster** and **strata** variables for the SHS 2003 survey were used within linear regression models which were run within the **survey** command on Stata (v10, StataCorp). When assessing associations between factor scores and SES/lifestyle variables, the individual factor scores for each dietary pattern in each age group were considered the outcome (dependent). Variables in the analysis and the SES/lifestyle factors were considered to be the explanatory (independent) variables. Dummy variables were created for categorical SES/lifestyle variables. Overall p-values based on the F-test are presented along with p-values for linear trend. R squared values explained the proportion of the variance in factor score attributed to the particular variable analysed.

The factor scores for individuals for each pattern in each age group were calculated and, by definition, were normally distributed with mean=0, standard deviation=1. Higher factor scores for an individual for a particular dietary pattern indicate that individual's diet is closer to that dietary pattern, when compared to someone with lower factor scores for that particular dietary pattern. However, the factor scores for different dietary patterns are by definition independent, and it is therefore possible for an individual to score high on more than one dietary pattern.

Table 18. Definitions and categories for EFS socio-economic variables used in the analysis

Variable	Definition and Derivation of Variable	Value Definition	Range	5th and 95th Percentile
Scottish Index of Multiple Deprivation (SIMD)	Area based measure of deprivation. In this instance the deciles were combined to give quintiles and reversed to follow the same format as the SHS. The SIMD decile of each HH has been provided by the Office of National Statistics.	1=Least deprived 5=Most deprived	N/A	N/A
Equivalised income	Adjusted household income to take into account the number of persons in the household. Derivation: The McClements Score for each HH member was applied according to their age and number of people in HH. This was then summed and the annual gross normal income for the HH was divided by the McClements Score Sum. The equivalised income was then split into quintiles of income.	1=Most Affluent Quintile 5=Least Affluent Quintile	32848-278965 22968-32847 15681-22967 10078-15680 0-10077	33401-93867 23488-32054 16092-22532 10317-15334 3833-9856
National Statistics Socio-Economic Classification (NS-SEC5)	Occupational based classification. Based on the occupation of the household reference person. NS-SEC8 from EFS re-categorised to NS-SEC5	1=Managerial and professional occupations 2=Intermediate occupations 3=Small employers and own account workers 4=Lower supervisory and technical occupations 5=Semi-routine occupations 6=Never worked and long-term unemployed	N/A	N/A
Smoking Purchases per week	Tobacco purchases adjusted by the number of individuals in the household over 16 years. Households with smoking purchases were then selected and the adjusted amount spent on tobacco was split into tertiles.	0=No tobacco purchases 1=Lowest tertile of tobacco purchases 2=Middle tertile of tobacco purchases 3=Highest tertile of tobacco purchases	N/A 0.14–5.75 5.76–12.93 12.94–64.40	N/A 0.35–5.52 6.06–12.75 13.41–39.99
Alcohol purchases per week	Alcohol purchases adjusted by the number of individuals in the household over 16 years. Households with alcohol purchases were then selected and the adjusted amount spent on alcohol was split into tertiles.	0=No alcohol purchases 1=Lowest tertile of alcohol purchases 2=Middle tertile of alcohol purchases	N/A 0.16–4.37 4.38–11.67 11.68–124.21	N/A 0.50–4.10 4.65–11.33 12.24–49.66

In the following Figures 23-27 the trends in dietary patterns according to socio-economic status or lifestyle factors (smoking and alcohol) are arranged so that the factor scores for each dietary pattern are considered when moving from higher SES to lower SES, e.g. for SIMD from lowest quintile of deprivation to highest quintile of deprivation.

Scottish Index of Multiple Deprivation

The *Takeaway/eating out* pattern showed a weak linear trend (p=0.006 for trend) with SIMD and SIMD explained 1.0% of the variance in the factor scores. The households in the least deprived quintile of SIMD followed this particular pattern more closely and the middle quintile of SIMD had the lowest mean score for *Takeaway/eating out* pattern. There was a strong linear trend between the *Healthy with fruit and vegetables* pattern and SIMD (p<0.0001 for trend) with this pattern being followed most closely by the least deprived households. SIMD explained 11.6% of the variance in the factor scores for this pattern. The third, *Cakes, pastries, buns, scones, cereals and bread* pattern showed a similar trend to *Healthy with fruit and vegetables* (p<0.0001 for trend, SIMD explained 1.6% of variance). The traditional pattern was not significantly influenced by SIMD (**Table 19, Figure 23**).

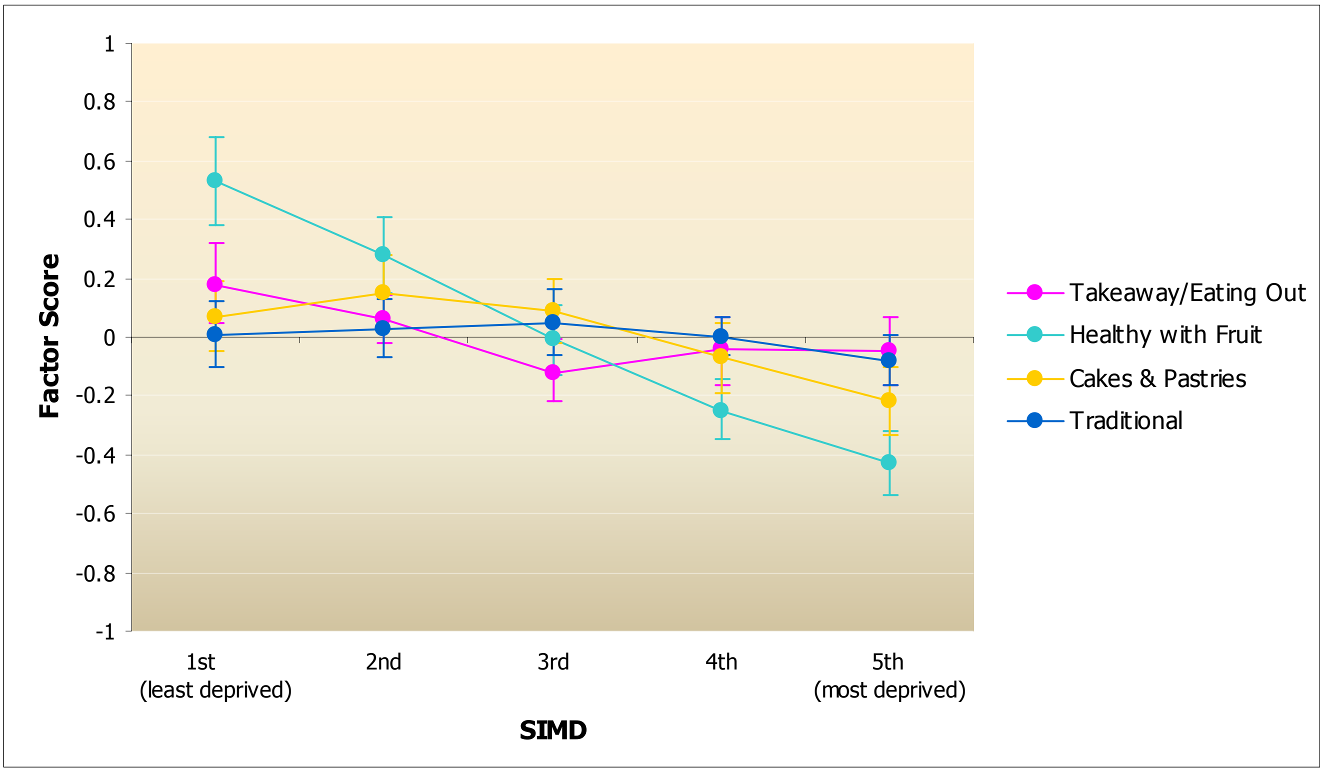
Table 19. Dietary patterns in all Scottish households according to SIMD

Principal Component Analysis	**Scottish Index of Multiple Deprivation**						
Scottish Households	1st (least deprived)	2nd	3rd	4th	5th (most deprived)	*p-value overall p-value trend**	*R^2 value*
Pattern 1-Takeaway/Eating Out							
Mean	0.18	0.06	-0.12	-0.04	-0.05	***0.007***	***1.0%***
Lower 95% confidence limit	0.05	-0.02	-0.22	-0.16	-0.16	***0.006****	
Upper 95% confidence limit	0.32	0.14	-0.01	0.07	0.07		
Pattern 2-Healthy with Fruit							
Mean	0.53	0.28	-0.01	-0.25	-0.43	***<0.0001***	***11.6%***
Lower 95% confidence limit	0.38	0.15	-0.13	-0.35	-0.54	***<0.0001****	
Upper 95% confidence limit	0.68	0.41	0.11	-0.14	-0.32		
Pattern 3-Cake & Pastries							
Mean	0.07	0.15	0.09	-0.07	-0.22	***0.0004***	***1.6%***
Lower 95% confidence limit	-0.05	0.03	-0.02	-0.19	-0.33	***<0.0001****	
Upper 95% confidence limit	0.19	0.28	0.20	0.05	-0.10		
Pattern 4-Traditional							
Mean	0.01	0.03	0.05	0.00	-0.08	***0.345***	***0.2%***
Lower 95% confidence limit	-0.10	-0.07	-0.06	-0.06	-0.16	***0.181****	
Upper 95% confidence limit	0.12	0.13	0.16	0.07	0.01		

Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

Figure 23. Dietary patterns in all Scottish households according to SIMD



NS-SEC

The *Takeaway/eating out* pattern was not significantly associated with NS-SEC. There was a linear trend between the *Healthy with fruit and vegetables* pattern and NS-SEC (p<0.0001 for trend) with this pattern being followed most closely by the least deprived households. NS-SEC explained 16% of the variance in the factor scores for this pattern. The third and fourth dietary patterns were not significantly influenced by NS-SEC (**Table 20, Figure 24**).

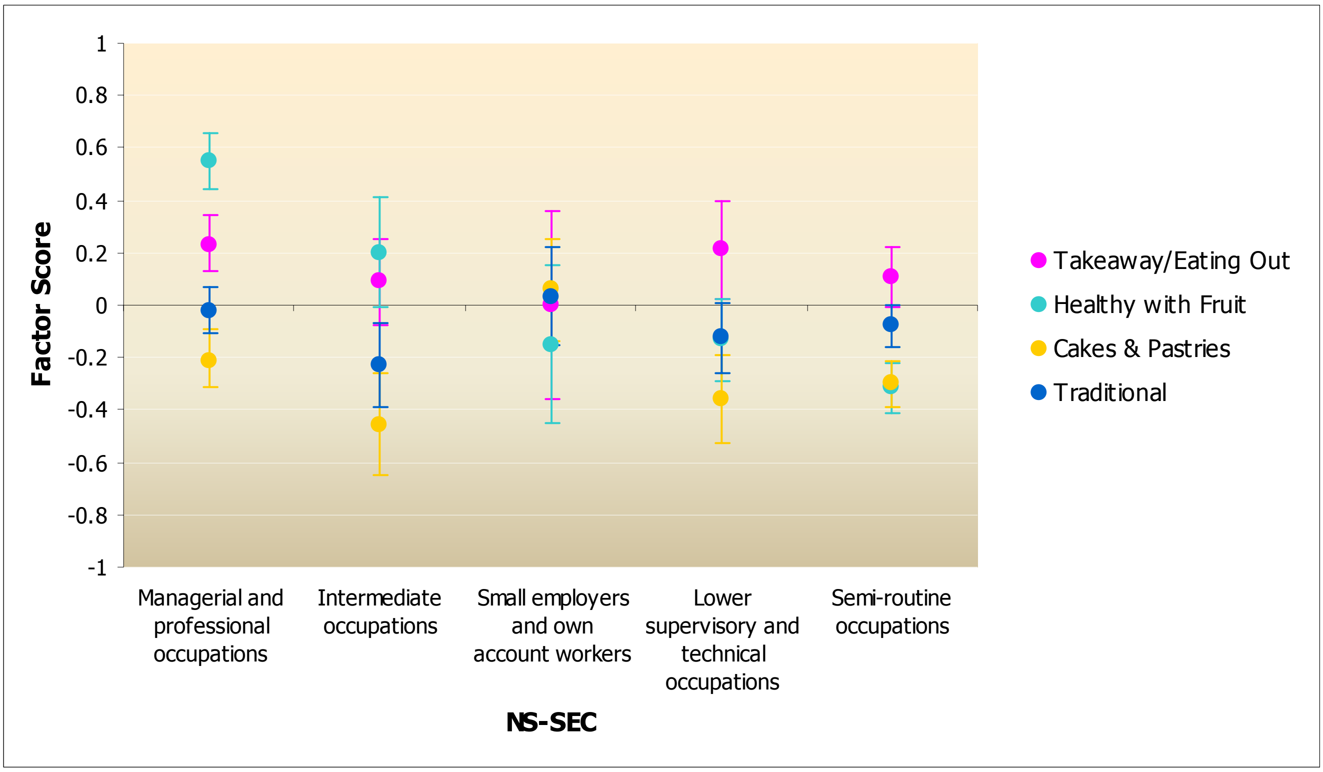
Table 20. Dietary patterns in all Scottish households according to NS-SEC

Principal Component Analysis	**NS-SEC**						
Scottish Households	Managerial and professional occupations	Intermediate occupations	Small employers and own account workers	Lower supervisory and technical occupations	Semi-routine occupations	*p-value overall p-value trend**	*R^2 value*
Pattern 1-Takeaway/Eating Out							
Mean	0.23	0.85	-0.001	0.21	0.11	***0.19***	***0.8%***
Lower 95% confidence limit	0.13	-0.08	-0.36	0.02	-0.01	*0.12**	
Upper 95% confidence limit	0.34	0.25	0.36	0.4	0.22		
Pattern 2-Healthy with Fruit							
Mean	0.55	0.2	-0.15	-0.13	-0.31	***<0.0001***	***16%***
Lower 95% confidence limit	0.44	-0.01	-0.45	-0.29	-0.41	***<0.0001****	
Upper 95% confidence limit	0.66	0.41	0.15	0.02	-0.22		
Pattern 3-Cake & Pastries							
Mean	-0.21	-0.46	0.06	-0.36	-0.3	***0.0008***	***1.7%***
Lower 95% confidence limit	-0.31	-0.65	-0.14	-0.53	-0.39	***0.19****	
Upper 95% confidence limit	-0.09	-0.26	0.25	-0.19	-0.21		
Pattern 4-Traditional							
Mean	-0.02	-0.23	0.34	-0.12	-0.8	***0.26***	***0.6%***
Lower 95% confidence limit	-0.11	-0.39	-0.51	-0.26	-0.16	***0.43****	
Upper 95% confidence limit	0.07	-0.07	0.22	0.01	0		

Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

Figure 24. Dietary patterns in all Scottish households according to NS-SEC



Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

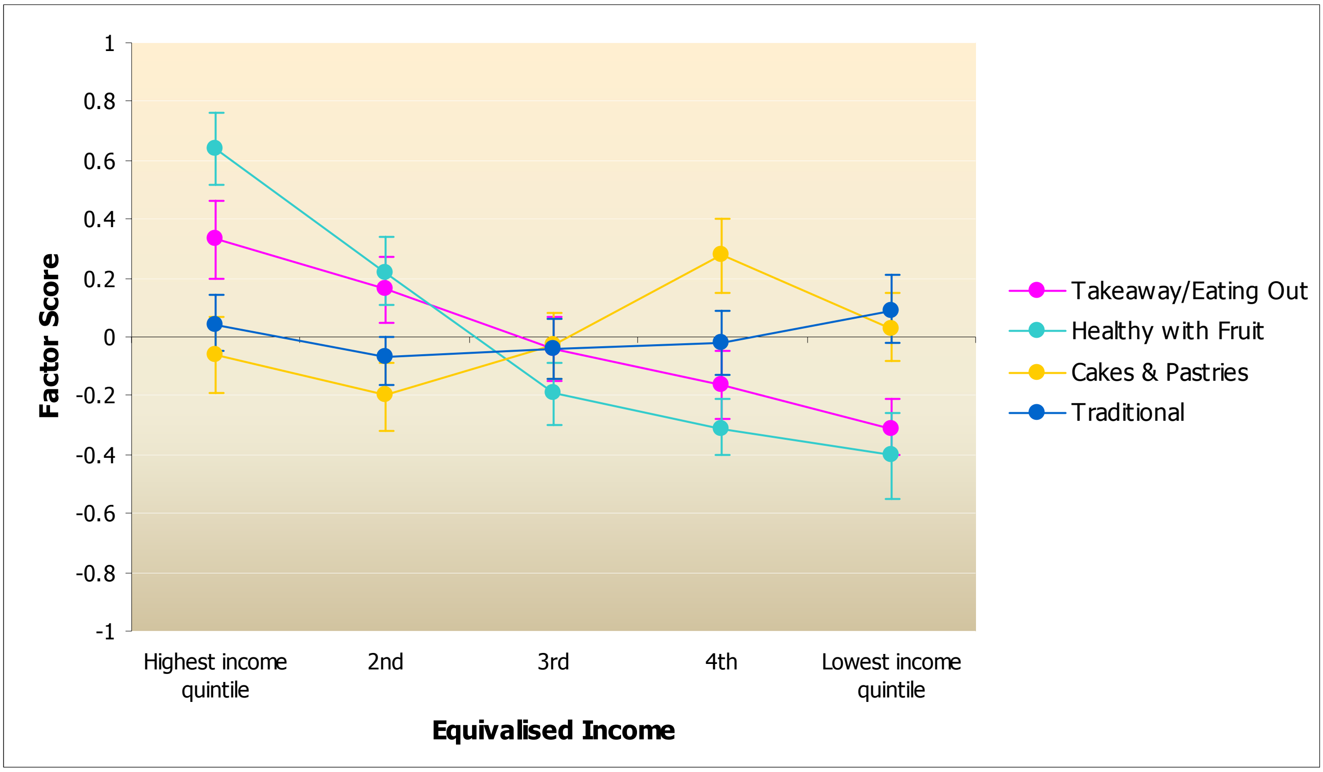
Equivalised Income

The *Takeaway/eating out* pattern showed a strong linear trend (p<0.0001 for trend, income explained 5.1% of the variance). The households with the highest income followed this particular pattern more closely compared to lower incomes. Similarly, the *Healthy with fruit and vegetables* pattern was followed more closely by the highest income group (p<0.0001 for trend, income explained 15.2% of the variance). The third patterns, *Cakes, pastries, buns cereals and bread* and the fourth pattern, *Traditional,* did not show a consistent relationship with income (**Table 21, Figure 25**).

Table 21. Dietary patterns in all Scottish households according to Equivalised Income

Principal Component Analysis	**Equivalised Income**						
Scottish Households	Highest income quintile	2nd	3rd	4th	Lowest income quintile	*p-value overall p-value trend**	*R^2 value*
Pattern 1-Takeaway/Eating Out							
Mean	0.33	0.16	-0.04	-0.16	-0.31	***<0.0001***	***5.1%***
Lower 95% confidence limit	0.20	0.05	-0.15	-0.28	-0.40	***<0.0001****	
Upper 95% confidence limit	0.46	0.27	0.07	-0.05	-0.21		
Pattern 2-Healthy with Fruit							
Mean	0.64	0.22	-0.19	-0.31	-0.40	***<0.0001***	***15.2%***
Lower 95% confidence limit	0.52	0.11	-0.30	-0.40	-0.55	***<0.0001****	
Upper 95% confidence limit	0.76	0.34	-0.09	-0.21	-0.26		
Pattern 3-Cake & Pastries							
Mean	-0.06	-0.20	-0.03	0.28	0.03	***<0.0001***	***2.5%***
Lower 95% confidence limit	-0.19	-0.32	-0.14	0.15	-0.08	***0.003****	
Upper 95% confidence limit	0.07	-0.09	0.08	0.40	0.15		
Pattern 4-Traditional							
Mean	0.04	-0.07	-0.04	-0.02	0.09	***0.123***	***0.4%***
Lower 95% confidence limit	-0.05	-0.16	-0.14	-0.13	-0.02	***0.397****	
Upper 95% confidence limit	0.14	0.00	0.06	0.09	0.21		
Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'							
Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'							

Figure 25. Dietary patterns in all Scottish households according to Equivalised Income



Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

Alcohol Purchases

The *takeaway/eating out* pattern showed a strong linear trend (p<0.0001 for trend) and alcohol purchases explained 13.2% of the variance in the factor scores for this pattern. The households with the highest purchases of alcohol followed this particular pattern more closely. Likewise, although not as strong a relationship, the *healthy with fruit and vegetables* pattern and *traditional patterns* showed a trend in the same direction (p<0.0001 for trend, 3.3% and 3.9% of the variance). Conversely, the third pattern, *cakes, pastries, buns cereals* went in the opposite direction in that it was followed most closely by the households with the lowest alcohol purchases (p<0.0001 for trend, 4.3% of the variance) (**Table 22, Figure 26**).

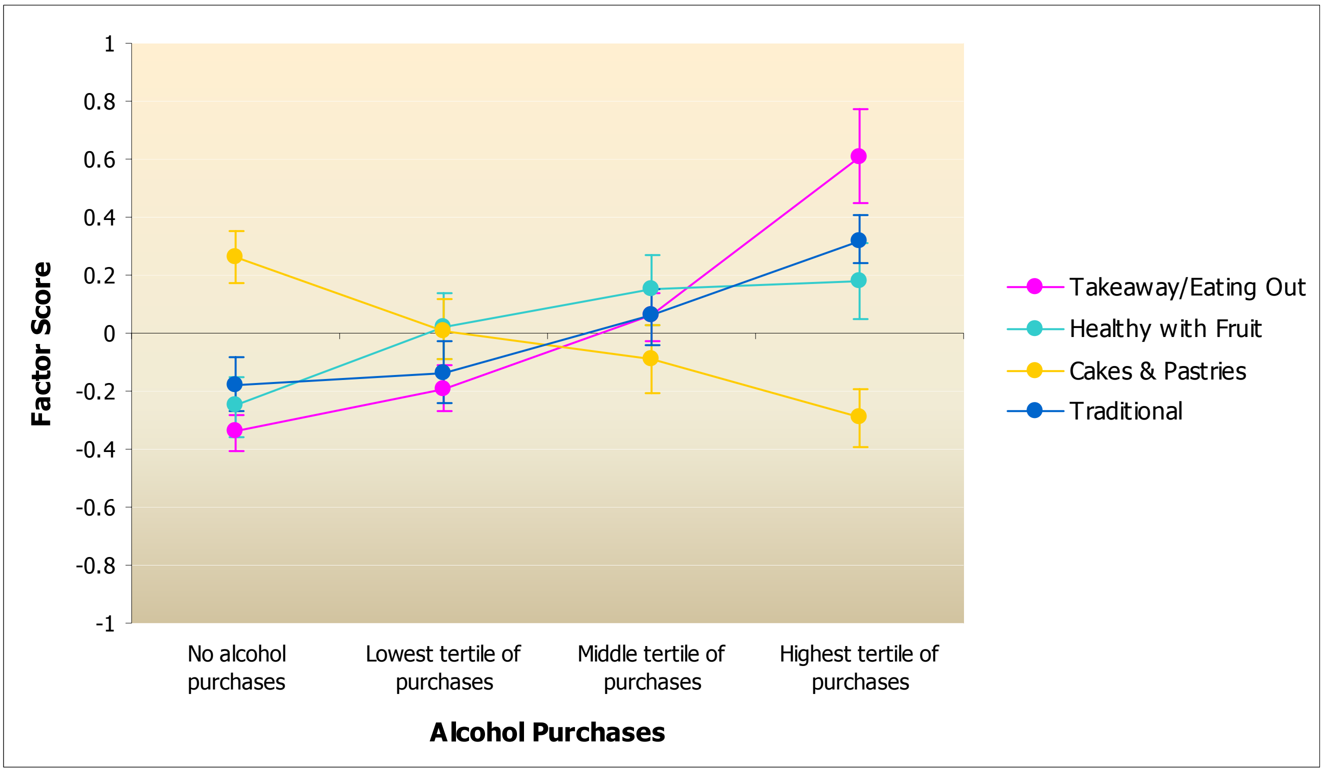
Table 22. Dietary patterns in all Scottish households according to Alcohol Purchases

Principal Component Analysis	**Alcohol Purchases**					
Scottish Households	No alcohol purchases	Lowest tertile of purchases	Middle tertile of purchases	Highest tertile of purchases	*p-value overall* *p-value trend**	R^2 *value*
Pattern 1-Takeaway/Eating Out						
Mean	-0.34	-0.19	0.06	0.61	***<0.0001***	***13.2%***
Lower 95% confidence limit	-0.41	-0.27	-0.03	0.45	***<0.0001****	
Upper 95% confidence limit	-0.28	-0.11	0.14	0.77		
Pattern 2-Healthy with Fruit						
Mean	-0.25	0.02	0.15	0.18	***<0.0001***	***3.3%***
Lower 95% confidence limit	-0.36	-0.09	0.03	0.05	***<0.0001****	
Upper 95% confidence limit	-0.15	0.14	0.27	0.31		
Pattern 3-Cake & Pastries						
Mean	0.26	0.01	-0.09	-0.29	***<0.0001***	***4.3%***
Lower 95% confidence limit	0.17	-0.09	-0.21	-0.39	***<0.0001****	
Upper 95% confidence limit	0.35	0.12	0.03	-0.19		
Pattern 4-Traditional						
Mean	-0.18	-0.14	0.06	0.32	***<0.0001***	***3.9%***
Lower 95% confidence limit	-0.27	-0.24	-0.04	0.24	***<0.0001****	
Upper 95% confidence limit	-0.08	-0.03	0.15	0.41		

Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

Figure 26. Dietary patterns in all Scottish households according to Alcohol Purchases



Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

Smoking Purchases

The *Takeaway/eating out* pattern showed a weak linear trend with increasing smoking purchases (p=0.001 for trend, 0.8% of the variance). Conversely, the *Healthy with fruit and vegetables* pattern showed a strong linear trend (p<0.0001 for trend, 9.4% of the variance) such that households with no smoking purchases followed this pattern more closely compared to households with smoking purchases. The third patterns, *Cakes, pastries, buns cereals and bread* showed a similar trend (p<0.0001 for trend, 3.5% of the variance). The *Traditional* pattern was not significantly influenced by smoking purchases (**Table 23, Figure 27**).

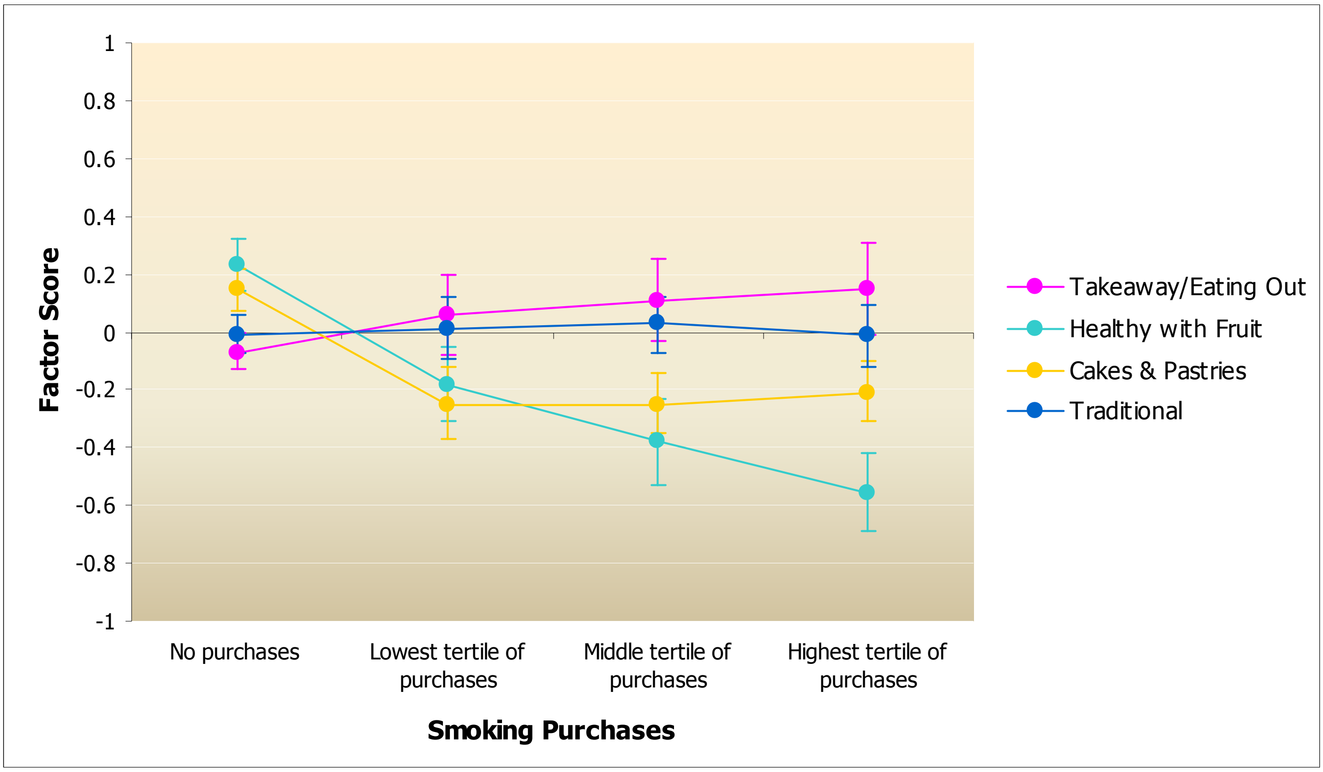
Table 23. Dietary patterns in all Scottish households according to Smoking Purchases

Principal Component Analysis	**Smoking Purchases**					
Scottish Households	No purchases	Lowest tertile of purchases	Middle tertile of purchases	Highest tertile of purchases	*p-value overall* *p-value trend**	R^2 *value*
Pattern 1-Takeaway/Eating Out						
Mean	-0.07	0.06	0.11	0.15	***0.002***	***0.8%***
Lower 95% confidence limit	-0.13	-0.08	-0.03	-0.01	***0.001****	
Upper 95% confidence limit	-0.00	0.20	0.25	0.31		
Pattern 2-Healthy with Fruit						
Mean	0.23	-0.18	-0.38	-0.56	***<0.0001***	***9.4%***
Lower 95% confidence limit	0.14	-0.31	-0.53	-0.69	***<0.0001****	
Upper 95% confidence limit	0.32	-0.05	-0.23	-0.42		
Pattern 3-Cake & Pastries						
Mean	0.15	-0.25	-0.25	-0.21	***<0.0001***	***3.5%***
Lower 95% confidence limit	0.07	-0.37	-0.35	-0.31	***<0.0001****	
Upper 95% confidence limit	0.22	-0.12	-0.14	-0.10		
Pattern 4-Traditional						
Mean	-0.01	0.01	0.03	-0.01	***0.951***	***0.0%***
Lower 95% confidence limit	-0.07	-0.09	-0.07	-0.12	***0.877****	
Upper 95% confidence limit	0.06	0.12	0.12	0.09		

Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

Figure 27. Dietary patterns in all Scottish households according to Smoking Purchases



Healthy with Fruit = Dietary pattern 'Healthy with fruit and vegetables'

Cakes and Pastries = Dietary pattern 'Cakes, pastries, buns, scones, cereals and bread'

9.0 The comparison between PCA dietary patterns derived from the SHS and EFS

The PCA dietary patterns are statistically driven from the database. The Scottish Health Survey provides dietary data for a sample of individuals living in households in Scotland aged 5-75. The EFS provides dietary data for food and drink purchased into a sample of households in Scotland. For this reason it is difficult to compare the dietary patterns derived from the two very different datasets. To enable comparison **Table 24** shows the type of pattern and the % of the variance within the diet explained by that pattern by age group for the SHS and for households for the EFS.

In the SHS there were two (5-10 year olds) or three (all other age groups) distinct dietary patterns with at least one energy dense and one healthy type dietary pattern in each age group. The energy dense/snacking patterns explained the highest amount of the variance for dietary patterns derived from the SHS in children aged 5-10 years (8.81%), 11-15 years olds (9.59%) and adults aged 25-64 years (8.64%). The EFS generated four distinct dietary patterns: one which was based on takeaway and eating out foods, many of which were energy dense type foods, this pattern explained the highest amount of the variance (4.11%) in the EFS; the second dietary pattern was a healthy type pattern based on fruit and vegetables; the third pattern was difficult to describe but scored highly for cakes and pastries and low for processed type convenience and snack foods; lastly, there was a traditional type dietary pattern which explained 2.03% of the variance.

Table 24. Comparison of the dietary patterns derived using PCA analysis from the Scottish Health Survey and the Expenditure and Food Survey

Scottish Health Survey Dietary Patterns		% of Variance	Expenditure and Food Survey: Dietary Patterns. Households all ages	% of Variance
5-10 years	Energy dense/	8.81	Takeaway/Eaten out	4.11
5-10 years	Healthy with fish	5.76	Healthy with fruit and vegetables	3.49
11-15 years	Energy dense/snacking	9.59	Cakes, pastries, buns, scones, cereals and bread	2.24
11-15 years	Healthy with fish	6.51	Traditional	2.03
11-15 years	Healthy	4.69		
16-24 years	Healthy	9.51		
16-24 years	Energy dense/snacking	6.08		
16-24 years	Healthy	5.06		
25-64 years	Energy dense	8.64		
25-64 years	Healthy with fish	5.47		
25-64 years	Energy dense/snacking	4.54		
≥65 years	Healthy	7.27		
≥65 years	Energy dense/snacking	5.42		
≥65 years	Traditional	4.96		

10.0 Dietary Quality Index (DQI) from the Expenditure and Food Survey based on dietary targets set in the Scottish diet action plan.

10.1 Data Preparation

Data on Household and Eaten Out food consumption, based on purchase data, for the EFS 2001/02 - 2003/04 combined were used. A scoring system was devised and is detailed in **Table 25**, providing details of the foods and nutrients to be included in the DQI and the scoring methodology and rationale for each component. The definitive index comprised 3 food scores and 6 nutrient scores with a total score out of 85. For the purposes of comparison with the Scottish Health Survey this was converted to a percentage score. The coding frames (including multiplication factor) devised for project S14035 (Monitoring Dietary Targets) were used for the food elements of the index (see **Appendix 11**).

Table 25. Components of the EFS Diet Quality Index and Scoring System

FOOD	SCORING	RATIONALE
FRUIT AND VEGETABLES		
A sliding score from 0 to 10 was used to score intake. Total weight adjusted to one portion of fruit juice (150ml=80g fruit) & one portion of baked beans per person per day	Weight divided by 400gx10 Min Score=0; Max Score=10	SDT=≥400g/day WHO/FAO expert consultation on diet, nutrition and prevention of chronic diseases.
FISH		
Addition of scores from Oily and White Fish	Sliding scale from 0 to 10, any scores between 10 and 15 adjusted to 10 Min Score=0; Max Score=10	SACN - 2 140g portions of cooked fish per week of which 1 should be oily
Oily Fish	Weight divided by 280g x 10	
A sliding score form 0 to 10 was used to score intake	Min Score=0; Max Score=10	
White Fish		
A sliding score form 0 to 5 was used to score intake	Weight divided by 140gx5 Min Score=0; Max Score=5	
MEAT AND MEAT PRODUCTS		
Addition of Scores from Red Meat and Processed Meat	Score out of 10	WCRF, 2007
Red Meat		
A score of 0 or 5 was used to score intake	≤71.4g/day=5 >71.4g/day=0 0g/day=5	Consumption to be <500g per week, very little if any to be processed
Processed Meat		
A score of 0 or 5 was used to score intake	>0g/day=0 0g/day=5 Min Score=0; Max Score=10	
NUTRIENT	**SCORING**	**RATIONALE**
Fat		
A score of 0 or 10 was used to score intake	≤35% food energy=10 >35% food energy=0	SDT and DRV ≤35% food energy
Saturated Fat		
A score of 0 or 10 was used to score intake	≤11% food energy=10 >11% food energy=0	SDT and DRV ≤11% food energy
Starch		
A score of 0 or 10 was used to score intake	≥39% food energy=10 <39% food energy=0	DRV ≤39% food energy
NME Sugars		
A score of 0 or 10 was used to score intake	≤11% food energy=10 >11% food energy=0	DRV ≤11% food energy
NSP		
A sliding score from 0 to 10 was used to score intake	Weight divided by 18gx10 Min Score=0; Max Score=10	DRV
ALCOHOL		
A score of 0 or 5 was used to score intake	≤5% total energy=5 >5% total energy=0	

10.2 Food Elements of the DQI

Data on the quantity of each food purchased (adjusted by 10% to take account of wastage) for each of the food elements of the Diet Quality Index was adjusted to an average adult consumption figure for the household as g/2000kcal using Microsoft Access. Orange juice and baked beans were then adjusted to a maximum of one portion per day. For orange juice the total intake was divided by 150ml and multiplied by 80g in line with Department of Health "5 a Day" guidelines on portion size, any resulting figure above 80g was reduced to 80g. For baked beans any amount above 80g was reduced to an 80g portion. Data on individual foods within each of the food elements of the DQI were then summed to provide a total per 2000kcal for each household.

10.3 Nutrient Elements of the DQI

Nutrient composition tables for each of the EFS food codes were obtained from the UK Data Archive and multiplied by the weight of each food (adjusted by 10% to take account of wastage) to obtain the nutrient intake per food. The individual nutrient intakes for each food were then summed and either expressed per 2000kcal or as a percentage of food energy (with the exception of alcohol which was expressed as a percentage of total energy).

10.4 Assignment of Scores

A score was assigned to each household for each of the 3 food and 6 nutrient elements as per the scoring system (**Table 25**). These scores were then summed out of 85 and then adjusted to a percentage score.

10.5 Statistical Analysis

Statistical analyses were carried out using SPSS 15 for Windows (SPSS Inc., Chicago, Illinois). All statistical analysis was carried out with the EFS weighting factor for each household. This was carried out in Stata using the cluster command applied to the data to make it representative of the UK population.

10.6 Dietary Quality Index (DQI) from the Expenditure and Food Survey (EFS) according to socio-economic status and lifestyle

The DQI was evenly distributed and the average DQI for the total population was 32.8%, SD 13.0.

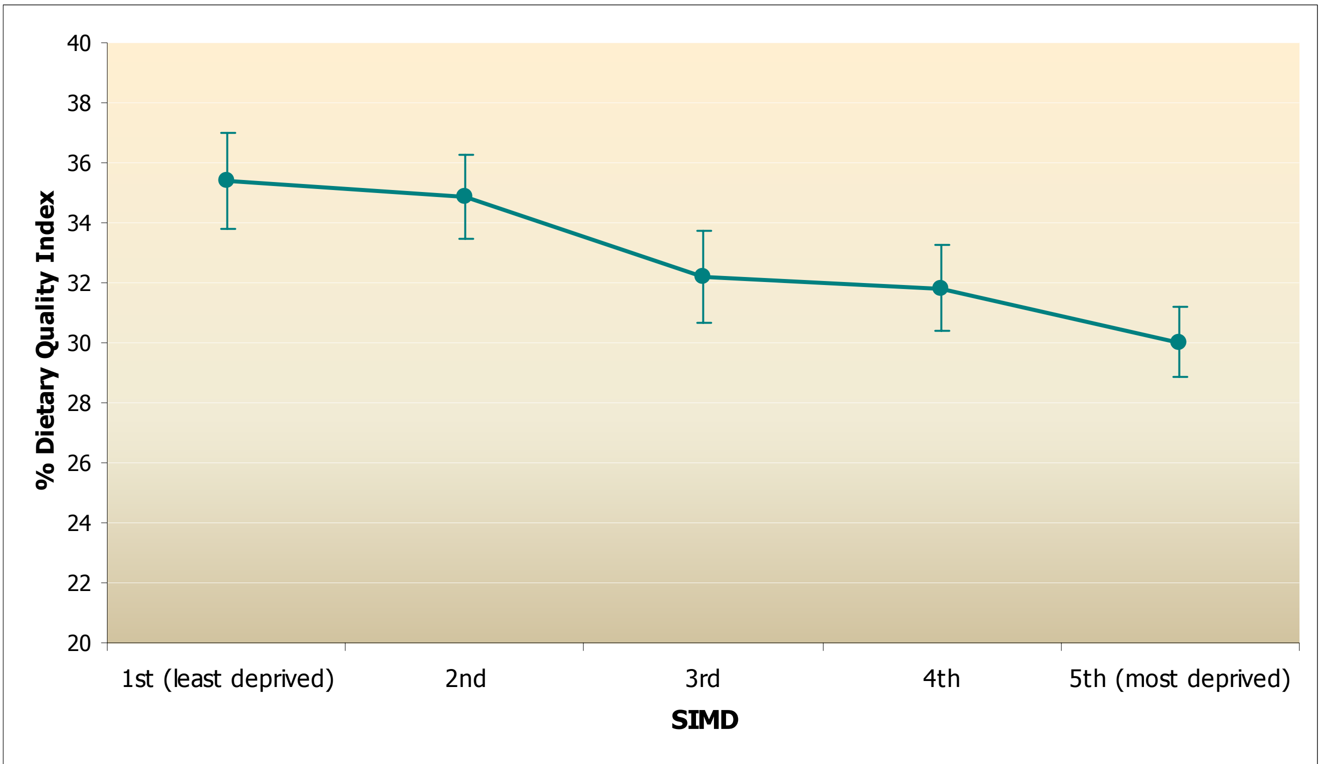
Scottish Index of Multiple Deprivation

There was a linear trend between DQI and SIMD (p<0.0001 for trend). The score in most deprived (1st quintile) of SIMD compared to the most deprived (4th quintile) was 35.4 v 30.0%. There was little difference in DQI between the 1st and 2nd SIMD quintile, then the score dropped to 3rd, 4th and was lowest in the 5th quintile (**Table 26, Figure 28**).

Table 26. DQI in all Scottish households according to SIMD

Dietary Quality Index	**Scottish Index of Multiple Deprivation**						
	1st (least deprived)	2nd	3rd	4th	5th (most deprived)	*p-value overall* *p-value trend**	*R^2 value*
Mean	35.4	34.9	32.2	31.8	30.0	***<0.0001***	***2.3%***
Lower 95% confidence limit	33.8	33.5	30.7	30.4	28.9	***<0.0001****	
Upper 95% confidence limit	37.0	36.3	33.7	33.3	31.2		

Figure 28. DQI in all Scottish households according to SIMD



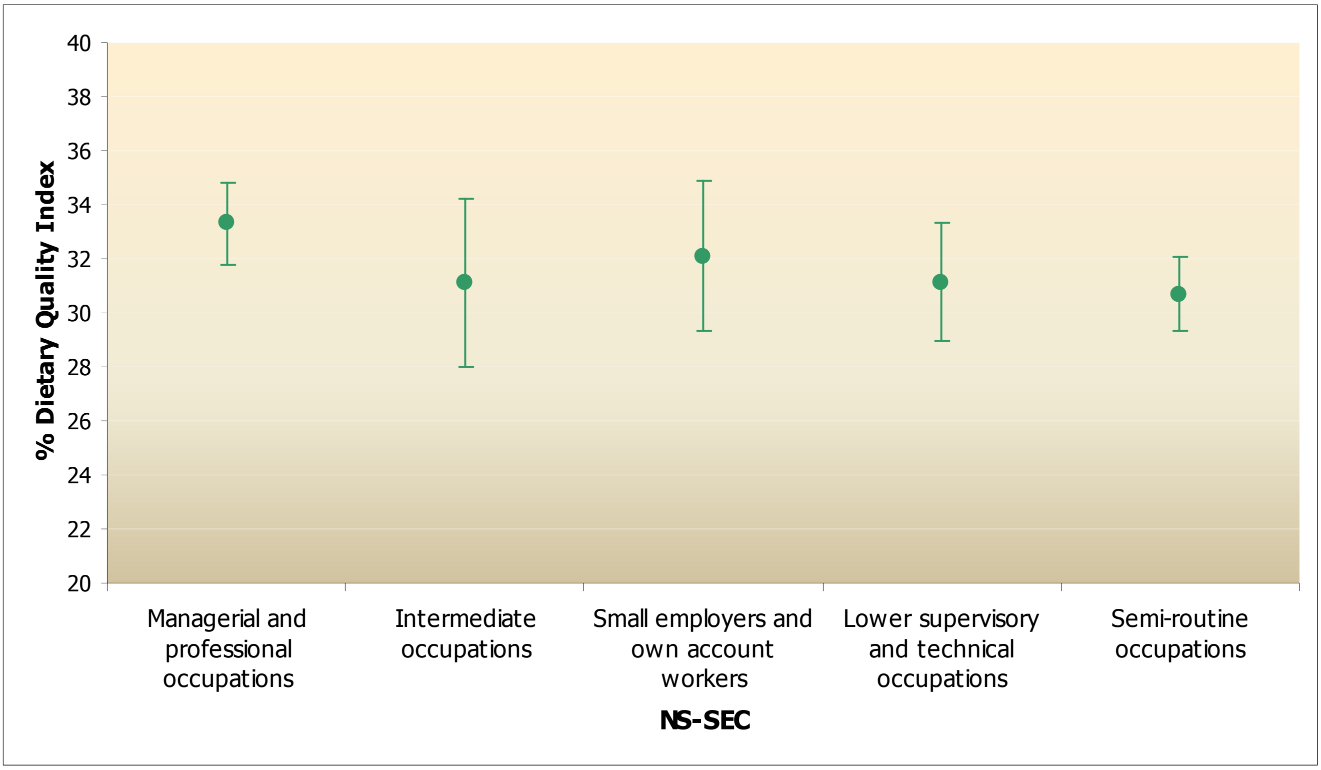
NS-SEC

There was a weak linear trend between DQI and NS-SEC (p for trend <0.01). The score in highest NS-SEC compared to the lowest NS-SEC was 33.3 v 30.7% (**Table 27, Figure 29**).

Table 27. DQI in all Scottish households according to NS-SEC

Dietary Quality Index	NS-SEC						
	Managerial and professional occupations	Intermediate occupations	Small employers and own account workers	Lower supervisory and technical occupations	Semi-routine occupations	*p-value overall p-value trend**	*R^2 value*
Mean	33.3	31.1	32.1	31.1	30.7	***0.11***	***0.9%***
Lower 95% confidence limit	31.8	28.0	29.3	29.0	29.3	***0.01****	
Upper 95% confidence limit	34.8	34.2	34.9	33.3	32.1		

Figure 29. DQI in all Scottish households according to NS-SEC



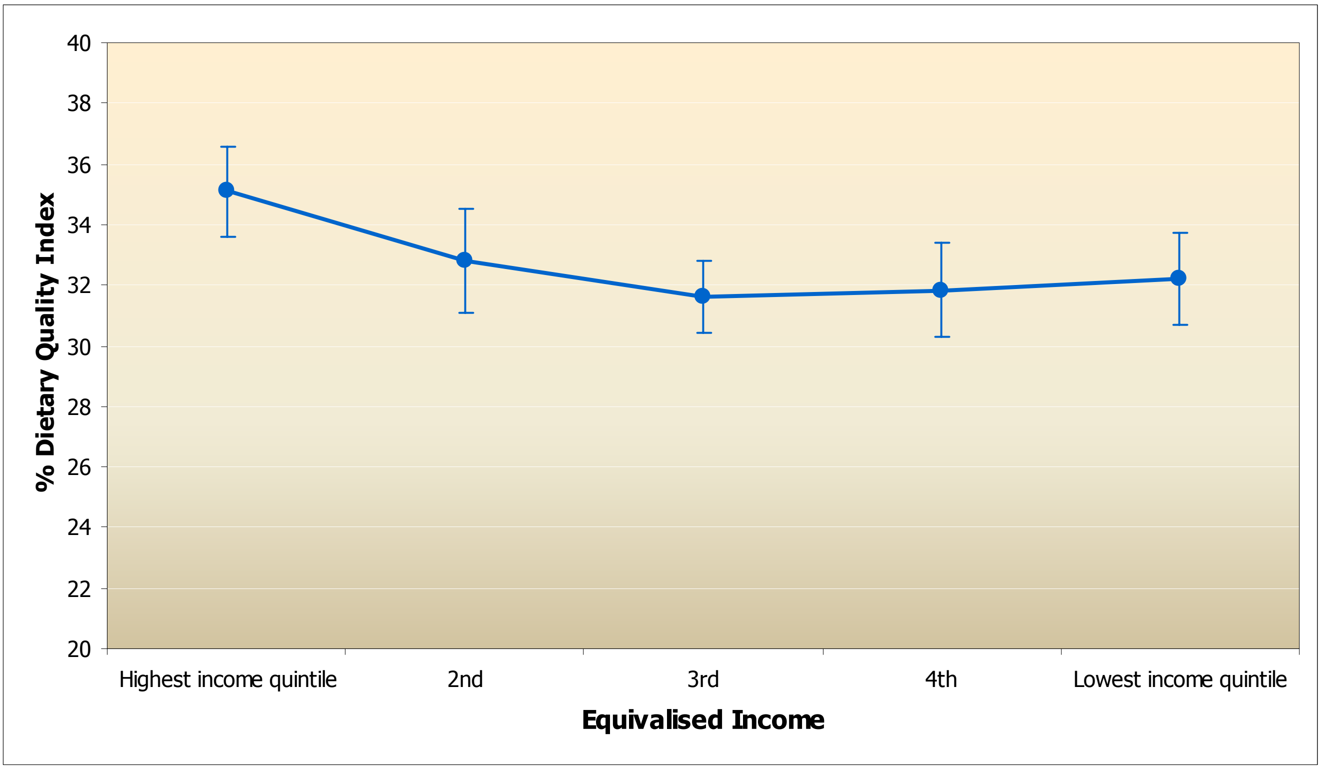
Equivalised Income

There was a linear trend between DQI and income with a plateaus in the last three quintiles (p=0.005 for trend). The score for the household with the highest income compared to the lowest income was 35.1% versus 32.2% (**Table 28, Figure 30)**.

Table 28. DQI in all Scottish households according to Equivalised Income

Dietary Quality Index	**Equivalised Income**						
	Highest income quintile	2nd	3rd	4th	Lowest income quintile	*p-value overall* *p-value trend**	*R^2 value*
Mean	35.1	32.8	31.6	31.8	32.2	***0.002***	***1.0%***
Lower 95% confidence limit	33.6	31.1	30.4	30.3	30.7	***0.005****	
Upper 95% confidence limit	36.6	34.5	32.8	33.4	33.7		

Figure 30. DQI in all Scottish households according to Equivalised Income



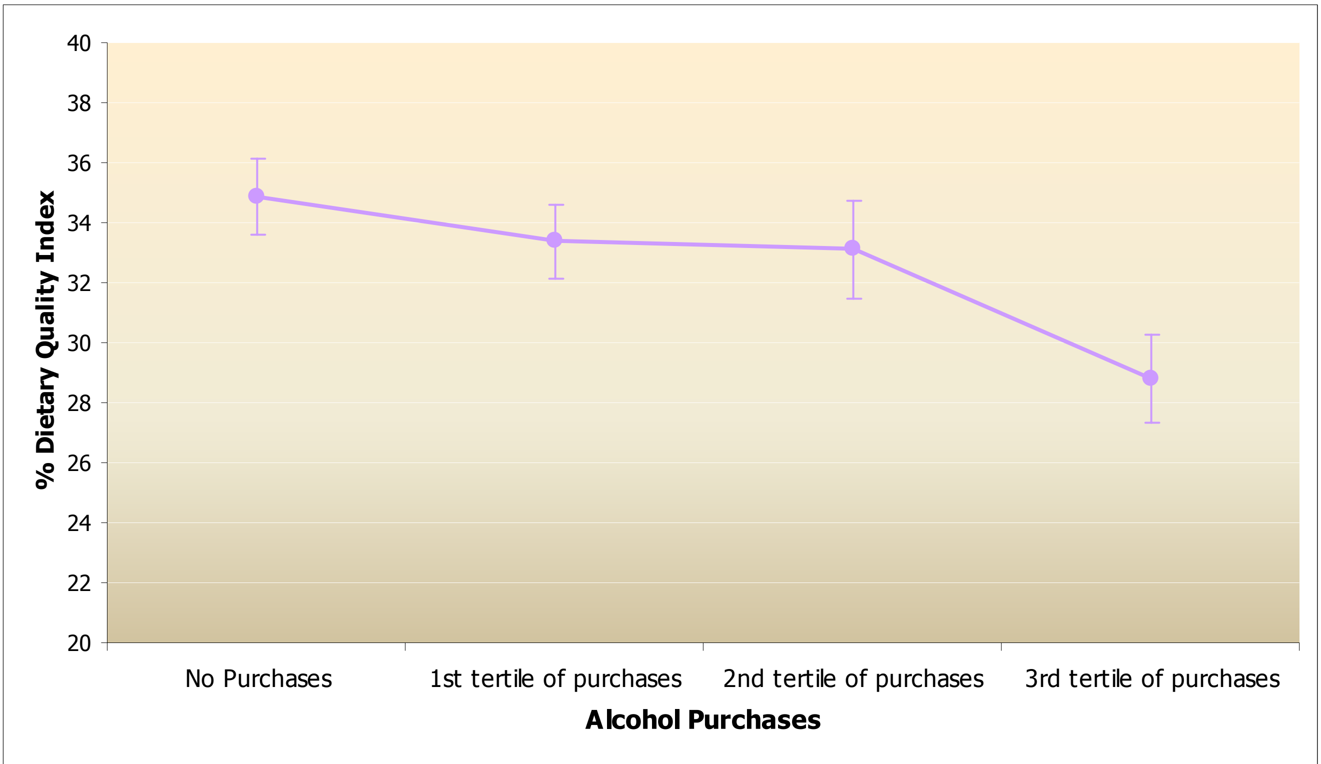
Alcohol Purchases

There was little change in DQI with alcohol purchases up until the 3rd tertile of purchases when the DQI dropped dramatically to 28.8% from 34.9 in the 1st tertile (p<0.0001) (**Table 29, Figure 31**).

Table 29. DQI in all Scottish households according to Alcohol Purchases

Dietary Quality Index	**Alcohol Purchases**					
	No Purchases	1st tertile of purchases	2nd tertile of purchases	3rd tertile of purchases	*p-value overall* *p-value trend**	R^2 *value*
Mean	34.9	33.4	33.1	28.8	***<0.0001***	***3.0%***
Lower 95% confidence limit	33.6	32.1	31.5	27.3	***<0.0001****	
Upper 95% confidence limit	36.1	34.6	34.7	30.3		

Figure 31. DQI in all Scottish households according to Alcohol Purchases



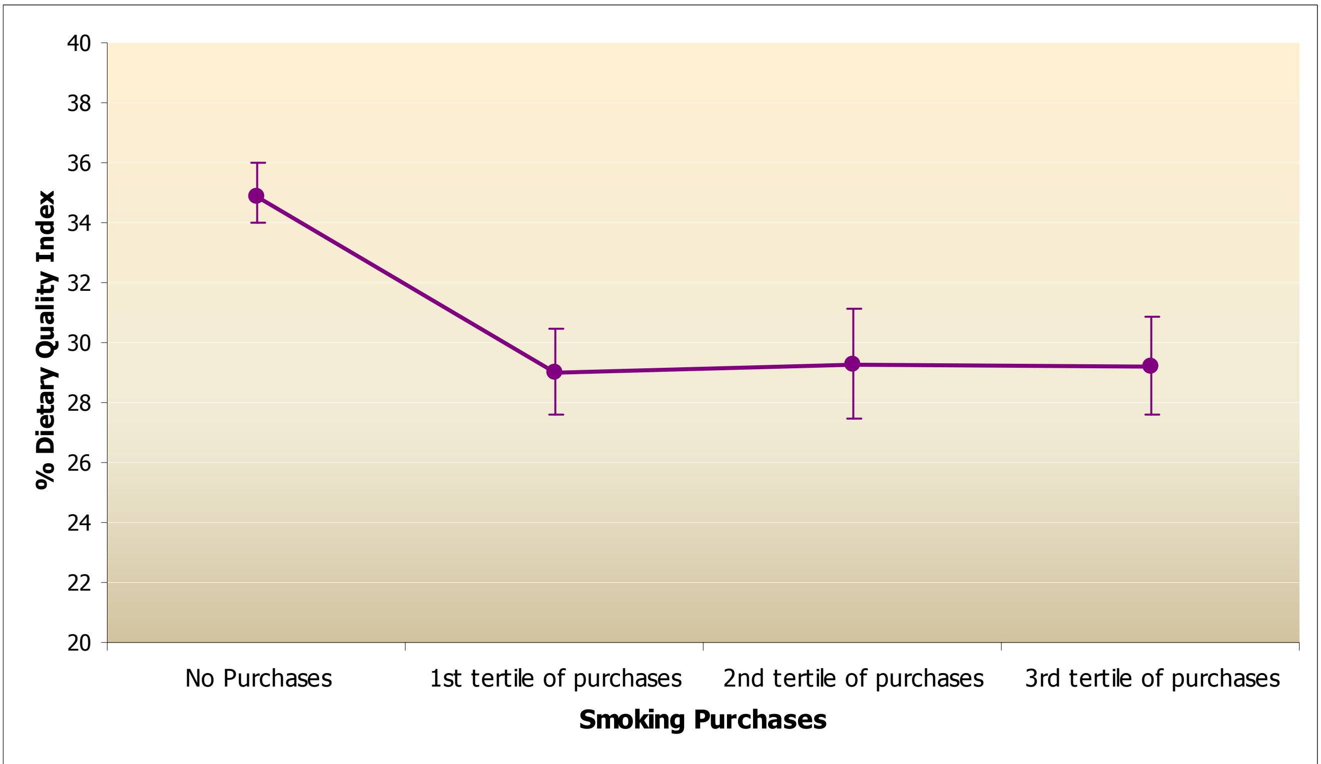
Smoking Purchases

There was a significant drop in DQI with any smoking purchases in the household (p<0.0001). The score for the household with no purchases compared to the highest level of purchases was 34.9% versus 29.2% (**Table 30, Figure 32**).

Table 30. DQI in all Scottish households according to Smoking Purchases

Dietary Quality Index	**Smoking Purchases**					
	No Purchases	1st tertile of purchases	2^{nd} tertile of purchases	3^{rd} tertile of purchases	*p-value overall p-value trend**	*R^2 value*
Mean	34.9	29.0	29.3	29.2	***<0.0001***	***4.7%***
Lower 95% confidence limit	34.0	27.6	27.5	27.6	***<0.0001****	
Upper 95% confidence limit	36.0	30.5	31.1	30.9		

Figure 32. DQI in all Scottish households according to Smoking Purchases



10.7 Correlation coefficients for DQI and Dietary patterns with nutrients

Table 31 shows the correlation coefficients for the association between the DQI and the four dietary patterns from the EFS with saturated fat, non-milk extrinsic sugars, vitamin C and folate. These nutrients were chosen to represent key macronutrients (saturated fat and NMES) from the Scottish Dietary Targets and Vitamin C and folate as a proxy for fruit and vegetables. In interpretation of the findings one must remember that saturated fat, NMES and fruit and vegetables were used to construct the DQI and, therefore, it might be expected that a good correlation coefficient will be found between these nutrients and the DQI.

The correlation coefficients for the DQI and nutrients were in the direction expected with a high correlation between DQI and intake of vitamin C and folate. Conversely, the DQI was negatively correlated with saturated fat and, to a lesser extend, with non-milk extrinsic sugars (NMES).

The healthy with fruit and vegetable dietary patterns were positively correlated with intake of vitamin C and folate and had a weaker negative correlation with saturated fat and NMES. The takeaway/eating out pattern showed weak correlation to the nutrients and these were negative for saturated fat and NMES. This adds more evidence to suggest that this pattern is not simply characterised by poor nutritional quality fast type foods high in fat and NMES. The traditional type pattern contained quite a lot of vegetable foods with high factor loadings which partly explains why it had a higher correlation coefficient for vitamin C and folate than the ‘Takeaway/eating out pattern’ or the ‘Cakes’ pattern.

Table 31. Correlation coefficients for DQI and Dietary Patterns from the EFS with nutrients

Nutrients	Saturated fat	NMES	Vitamin C	Folate
Dietary Quality Index	-0.35	-0.18	0.35	0.47
Dietary Patterns				
Takeaway/Eating out	-0.10	-0.18	0.004	0.05
Healthy with fruit and vegetables	-0.15	-0.11	0.50	0.30
Cakes, pastries, buns, scones, cereal and bread	0.22	0.008	0.05	0.15
Traditional	-0.08	-0.29	0.14	0.28

11.0 Discussion and Summary of Findings

In this report indicators of the quality of the diet have been derived using two different methods, namely principal component analysis (PCA) to generate dietary patterns and the design of a dietary quality index (DQI). The findings from the analysis by PCA dietary patterns and DQI were then used as an indication of the quality of the overall diet for different age, gender (SHS), socio economic groups and lifestyle factors (SHS and EFS). Dietary patterns are multiple dietary components organised as a single exposure or 'type of diet'*.* Studying dietary patterns as an indication of the quality of the overall diet, rather than single nutrients or single food groups, acknowledges foods are eaten together and not in isolation and accounts for the complex interrelations of foods and nutrients in the context of the effect of the 'overall diet'.

In addition, in the SHS scores for individuals (PCA and DQI) were analysed in separate health outcome models while adjusting for SES and lifestyle variables. This was not possible for the EFS as health outcomes are not collected.

11.1 Dietary patterns from the SHS and EFS using PCA analysis

Dietary patterns were derived from the sample population of the SHS for the different age groups (5-10 years, 11-15 years, 25-64 years and >64 years). There were three patterns which emerged from the PCA analysis in each group, but only two in 5-10 years old. In each group a *Healthy* pattern and also an *Energy dense* pattern emerged as one of the key dietary patterns. This *Healthy* pattern did vary between age groups but generally included high factor loadings (i.e. foods that best represented this dietary pattern) for the following list of foods: fresh fruit; potatoes, rice and pasta; vegetables; salad; fruit juice; tuna, oily and white fish; salad; fruit juice; pulses; wholemeal and brown breads. In some age groups (11-15 years, 25-64 years) the *Healthy* type patterns included oily fish and or white fish as a key food and in this case these patterns were given the label *Healthy with fish* **(Table 3).** In the EFS households a healthy with fruit and vegetable pattern also emerged which included: fruit, salad vegetables, yoghurts, other vegetables, fruit and vegetable juice, bread **(Table 18)**.

An *Energy dense/snacking* type pattern emerged in each of the age groups of the SHS and this was the predominate pattern in the children (explained the largest amount of variance) aged 5-10 years and 11-15 years **(Table 3)**. This *Energy dense/snacking* pattern included high factor loadings for the following list of foods: sweets and chocolates; meat products; crisps and savoury snacks; soft drinks; biscuits; ice cream; chips; cheese; cakes, scones, sweet pies and pastries. The highest factor loadings in this pattern were for sweet and chocolates, crisps and savoury snacks, meat products, soft drinks and biscuits, all foods which if eaten in excess contribute to a poor quality diet and are conducive to high weight gain in young people. Females scored higher than males for the *Energy dense/snacking* pattern in the 5-10 year olds but there was not a significant difference in scores for the dietary patterns between 11-15 year old males and females. In the largest adults group (aged 25-64 years) two of the three dietary patterns that emerged were *Energy dense* and males scored more highly for these patterns than females. There was not a pattern directly equivalent to this in the EFS households, although the predominate 1st pattern form the EFS, *Takeaway/eating out* pattern, had high factor loadings for some energy dense foods **(Table 18)**. The SHS eating out food inventory, unlike the EFS does not distinguish where foods are consumed. There is a great variation in the quality of foods and drinks which are available for takeaway/eating out and this was reflected in the high factors loadings for the foods in this patterns which included: chips, processed meats, meat pies and pasties and also potentially higher nutrition quality foods such as white fish dishes, prepared sandwiches and rolls.

In the older adults, >64 years a *Traditional* type pattern emerged which was not evident in any of the younger groups, the key foods in this *Traditional* pattern included red meat, potatoes/rice/pasta white fish, and also breakfast cereals, cheese, oily fish, vegetables, vegetable dishes and alcohol. Males scored higher for this dietary pattern than females. This more traditional type dietary pattern was not identified in the younger generations but a similar pattern emerged from analysis on the EFS households. This was characterised by the following foods: onions, tomato, fresh potato, wine, root vegetable, red meat, green and other vegetables **(Table 18).**

The third pattern from the EFS; *Cakes, Pastries, Buns, Scones Cereals and Bread* scored highly for foods which were mainly carbohydrate sweet baked goods and bread, it also had positive loadings for white fish and green vegetables. This pattern was distinctly negatively scored for processed type snacks and fast food i.e. crisps and savoury snacks, salad dressings, processed meat products eaten out, soft sugary drinks, pizza and pasta **(Table 18).**

The findings reported in this study for the children aged 5-15 years were similar to those reported in other UK children. In the ALSPAC study (Northstone & Emmett, 2005), PCA analysis was used to derive dietary patterns from food frequency questionnaires (57 food types) in children aged 4 years and then again at 7 years of age. The study followed a cohort of children and very similar patterns were obtained at 4 years of age and at 7 years of age. The first pattern to emerge was consistent with a diet of energy dense processed foods (labelled junk-type), the second pattern was best described as a traditional diet based on meat and root vegetables (labelled traditional) and a third pattern seemed to reflect a more healthful diet, consisting of vegetables, rice, pasta, salad and fruit (labelled health conscious).

Togo et al noted there is some degree of consistency and reproducibility in generating dietary patterns by factor analysis and other dietary assessment methods (Togo *et al.*, 2003). In two different studies in UK (Whichelow & Prevost, 1996) and Northern Ireland (Barker *et al.*, 1990) identified dietary patterns in adults with characteristics similar to the patterns in the study reported here. These included a traditional pattern, a convenience pattern, a snack pattern and processed food pattern.

11.2 Dietary patterns according to socio-economic status and lifestyle factors

Socio-economic status

For both the SHS and EFS there was a significant association between socio-economic status (SES) and lifestyle factors and most of the dietary patterns and a summary of the findings is illustrated in **Table 32** and **Table 33.** In the SHS at least two of the dietary patterns within each age group was associated with SES (linear trend) in the direction expected i.e. *Energy dense* and *Energy dense/snacking* patterns associated with lower SES, *Healthy* and/or *Healthy with fish* patterns associated with increased SES. However, in young adults (16-24 years) the *Energy dense/snacking* pattern was not associated with any measure of SES. The third pattern explained less of the variance for dietary patterning in all age groups and in children (11-15 years) the third pattern (*Healthy)* was not significantly associated with SES.

In the largest adults group (25-64 years) the main *Energy dense* pattern was significantly associated with all measures of SES and males scored higher than females for this pattern. In the older adults (>64 years), the *Energy dense/snacking* pattern was only associated with level of education (those with the lowest level of education followed more closely this dietary pattern), but not so influenced by SIMD, income or NS-SEC. In all age groups there was a very clear and consistent association between dietary patterning and household income (equivalised income) such that those in the highest income groups followed more closely *Healthy* and *Healthy with fish* dietary patterns compared to those in the lowest income groups, where the reverse was true. This analysis highlights the potential importance of household income in influencing dietary patterns in both children and adults.

Level of education was an important factor in influencing dietary patterns in adults aged 25-64 years. Those with a degree or professional qualification scored highly for a *Healthy with fish* pattern and low for the *Energy dense* pattern. In the ALSPAC study there was a marked social patterning with diet; the health-conscious pattern was closely associated with increasing levels of maternal education and maternal age. The ‘junk-type’ pattern scored higher where maternal education was low and when the child had siblings (Northstone & Emmett, 2005).

In the EFS the *Healthy with fruit and vegetables* dietary patterns was more clearly associated by socio-economic status than any other pattern. The higher the income, the higher the occupational status, and the lower the deprivation status the higher the scores, suggesting this pattern better distinguishes social patterning of the Scottish diet. This is similar to what we found for healthy dietary patterns in the SHS, i.e. the healthy patterns were strongly and consistently positively associated with the less vulnerable groups according to the different measure of SES.

Conversely, the relationship between the *Takeaway/Eating Out* dietary pattern and measures of socio-economic status was not so clear. Using SIMD, an area based measure of SES, this pattern scored highest in the least deprived group; however, there was little difference between the deprivation categories 3, 4 and 5. In contrast, there was a clearer linear trend with household income such that the higher the household income the higher the score for the *Takeaway/Eating Out* dietary pattern. It is likely this dietary pattern is characterised by foods eaten out of the home and takeaway which are of variable quality and cost. For example, it included meat product based fast foods as well as higher quality dining out meals. Therefore, it is likely that there is considerable social diversity among the households who scored high for this dietary pattern.

Dietary patterns were generated from the Australian National Nutrition Survey of 6680 adults aged 18-64 (Mishra *et al.*, 2002). This Australian national survey has similarities with the SHS, it is a cross sectional survey which collects health and nutrition information from a sample of the population. In this study PCA analysis was used to establish patterns from a food frequency questionnaire with similar categories as used in the SHS. The study went on to assess social factors with the dietary patterns and found distinct dietary patterns in different gender and SES. Several gender and SES differences in food patterns were observed. Men in higher SES chose more 'breakfast cereals' and 'wholemeal bread' and females in higher SES females more frequently ate 'ethnic vegetables' and 'breakfast cereal/muesli'.

Lifestyle factors

In the SHS the relationship between a number of markers of lifestyle (physical activity, screen viewing and smoking) and dietary patterns were assessed. Those individuals who engaged in higher levels of physical activity followed more closely a *Healthy/healthy with fish* pattern compared to those with low levels of physical activity and this was the case across all age groups except 5-10 years where it was not statistically significant. However, 5-10 years olds who engaged in low levels of activity followed more closely an *Energy dense/snacking* pattern. These findings suggest that higher levels of physical activity occur along with *Healthy dietary* patterns.

Screen viewing is a sedentary behaviour which is strongly associated with obesity risk (Reilly *et al.*, 2005). In this study it was defined as average hours per day spent in front of a screen (TV, computer, video games) outside of school, college or working hours. In the children (5-10 years and 11-15 years) the scores for a *Healthy* pattern were highest in those with lowest levels of screen viewing (0-1.5 hours per day). Conversely, in the youngest children (5-10 years) an *Energy dense/snacking* pattern scored higher in children with high levels of screen viewing (3+ hours per day). Similarly, in the adults a *Healthy* pattern was more closely followed in those with low levels of screen viewing (0-2 hours per day) and *Energy dense/snacking* patterns linked with increased screen viewing (4+ hours per day). The link between screen viewing and consumption of energy dense snacking foods has been reported elsewhere and these linked behaviours have been identified as important modifiable risk factors for obesity (Reilly et al 2006).

Adults (25-64 and >64) who did not smoke scored higher for a *Healthy* pattern and a *Traditional* pattern (in >64). Smoking in adults aged 25-64 was positively associated with an *Energy dense* pattern. This was also seen in the EFS where households with the highest smoking purchases scored low for *Healthy* *with fruit and vegetable* pattern. This confirms other research that suggests smokers tend to have poorer quality diets.

High factor scores for *Takeaway/eating out* and *Healthy with fruit and vegetable* and *Traditional* dietary patterns were associated with high alcohol purchases and this may be linked to higher household income.

Table 32. Summary of key findings for dietary patterns from the SHS in each age group and socio-economic and lifestyle factors.

Age 5-10 years		
Dietary pattern 1 Energy Dense/Snacking	**Dietary pattern 2 Healthy with Fish**	
↑ in females ↑ with increasing deprivation ↑ with lower household income ↑ with lower social class ↑ with more screen viewing ↑ with lower physical activity	**↑ in females ↓ with increasing deprivation ↓ with lower household income ↓ with lower social class ↓ with more screen viewing physical activity not significant**	
Age 11-15 years		
Dietary pattern 1 Energy dense/snacking	**Dietary pattern 2 Healthy with Fish**	**Dietary pattern 3 Healthy**
gender non significant ↑ with increasing deprivation ↑ with lower household income ↑ with lower social class screen viewing not significant physical activity not significant	**gender non significant ↓ with increasing deprivation ↓ with lower household income ↓ with lower social class ↓ with more screen viewing ↓ with less physical activity**	**gender non significant deprivation not significant household income not significant social class not significant screen viewing not significant ↓ with less physical activity**
Age 16-24 years		
Dietary pattern 1 Healthy	**Dietary pattern 2 Energy dense/snacking**	**Dietary pattern 3 Healthy**
↓ in females ↓ with increasing deprivation ↓ with lower household income ↓ with lower social class ↓ with more screen viewing ↓ with less physical activity ↓ with more smoking	**↑in males deprivation not significant income not significant social class not significant ↑ with more screen viewing physical activity not significant smoking not significant**	**↓ in males ↓ with increasing deprivation ↓ with lower household income ↓ with lower social class ↓ with more screen viewing ↓ with less physical activity ↓ with more smoking**

Age 25-64 years		
Dietary pattern 1 **Energy Dense**	**Dietary pattern 2** **Healthy with Fish**	**Dietary pattern 3** **Energy Dense/Snacking**
↑ in males	gender not significant	↑ in males
↑ with increasing deprivation	↓ with increasing deprivation	deprivation not significant
↑ with lower household income	↓ with lower household income	↑ with lower household income
↑ with lower social class	↓ with lower social class	↑ with lower social class
↑ with lower education	↓ with lower education	↑ with lower education
↑ with more screen viewing	↓ with more screen viewing	↑ with more screen viewing
↑ with lower physical activity	↓ with lower physical activity	physical activity not significant
↑ with more smoking	↓ with more smoking	↓ with more smoking
Age >64 years		
Dietary pattern 1 **Healthy**	**Dietary pattern 2** **Energy Dense/Snacking**	**Dietary pattern 3** **Traditional**
↓ in males	gender not significant	↓ in females
↓ with increasing deprivation	deprivation not significant	↓ with increasing deprivation
↓ with lower household income	household income not significant	↓ with lower household income
↓ with lower social class	social class not significant	↓ with lower social class
↓ with lower education	↑ with lower education	↓ with lower education
↓ with more screen viewing	screen viewing not significant	↓ with more screen viewing
↓ with less physical activity	physical activity not significant	↓ with less physical activity
↓ with more smoking	smoking not significant	↓ with more smoking
↓ indicates a decreasing factor score and ↑ indicates an increasing factor score, not significant at p<0.05		

↓ indicates a decreasing factor score and ↑ indicates an increasing factor score e.g. in >64 year olds there is an decreasing factors score with increasing deprivation and a linear trend suggesting the those in the least deprived group follow the healthy pattern more closely.

Table 33. Summary of key findings for dietary patterns from the EFS in and socio-economic and lifestyle factors. ↓ indicates a decreasing factor score and ↑ indicates an increasing factor score

Component 1 **Takeaway/Eaten Out**	**Component 2** **Healthy with fruit and vegetables**	**Component 3** **Cakes, pastries, buns, scones, cereals, bread**	**Component 4** **Traditional**
↓ with increasing deprivation ↓ with lower household income social class not significant ↑ with higher alcohol purchases ↑ with smoking purchases	↓ with increasing deprivation ↓ with lower household income ↓ with lower social class ↑ with higher alcohol purchases ↓ with smoking purchases	↓ with increasing deprivation ↑ with lower household income social class not significant ↓ with higher alcohol purchases ↓ with smoking purchases	deprivation not significant income not significant social class not significant ↑ with higher alcohol purchases smoking purchases not significant

11.3 Dietary patterns and health outcomes from the SHS

Health outcome information was not available from the EFS.

There was a strong positive link between healthy dietary patterns and diabetes which might suggest that those who have been diagnosed with diabetes follow this pattern as part of their management. The association between total cholesterol: HDL ratio suggests those that follow an energy dense type pattern may be significantly increasing their risk of having a high ratio. The effect size was considerable after adjusting for socio-economic status and physical activity. A high ratio is an important cardiovascular risk factor.

Dietary patterns in ALSPAC children have been associated with obesity at 7 years of age; the odds ratio (95% CI) for obesity in the children scoring high for the junk type pattern was 1.73 (1.32 to 2.27) in contrast to an odds ratio of 0.70 (0.54 to 0.91) for children scoring high for the health conscious diet (Reilly *et al.*, 2005). In the study reported here we did not find a consistent relationship between obesity and dietary patterns and where there was a significant relationship it ran counter to what we might expect to find. This type of confusing finding (for obesity and diabetes) is not uncommon when exploring diet and health outcomes in cross sectional data and may be partly explained by reverse causation.

A study using the Danish MONICA study (Osler *et al.*, 2001) established distinct patterns using PCA analysis (Prudent diet, Western diet), from a short (28 item) food frequency questionnaire (FFQ). This study also assessed the relationship of the distinct dietary patterns to mortality from cardiovascular disease while controlling for potential confounding factors (smoking, physical activity, alcohol intake, BMI, education). The ‘Prudent diet’ was inversely associated with all cause and cardiovascular disease mortality after controlling for confounding variables. The ‘Western diet’ was not significantly associated with mortality. This study partly supports the assumption that overall dietary patterns, defined by both a dietary index or PCA, are strongly associated with mortality risk, and that the dietary pattern associated with the lowest risk is the one which articulates with the current recommendations for a healthy diet.

Other studies have used short FFQs to derive dietary patterns. Steffen *et al.* (2006) reported associations of dietary patterns with risk of coronary heart disease among 9,318 white and African-American adults enrolled in the Atherosclerosis Risk in Communities (ARIC) cohort. Dietary intake was assessed by FFQ and 32 food groups were entered into the PCA analysis. They also explored the diet through deriving a dietary index score which yielded similar results to the PCA analysis reported here.

11.4 Dietary Quality Index from the SHS and EFS

In this study we developed a dietary quality index from the FFQ used in the SHS and from the food and nutrient data from the EFS. This score which is expressed as a percentage provides an indication of the quality of the diet of the individual (SHS) based on current dietary guidelines. It can therefore be used to compare groups of individuals as we have done by age, gender and socio-economic status (SHS). The score could be used for monitoring purposes, for example: enable local authorities and health board to assess the progress toward dietary targets; to enable government to assess progress in different groups in the population. This would require a power analysis to assess the sample size required at health board level.

Other investigators have used dietary scores based on international or national dietary targets. Examples of these are given by Huijbregts *et al.* (1997) using the World Health Organisation's guidelines for prevention of chronic diseases, Dubois et al. (2000) using the Canadian nutrition recommendations and Wrieden & Moore (1995) using the dietary targets of the original Scottish Diet report (1993).

Michels & Wolk (2002) used a 60 item FFQ to identify food patterns in a group of Swedish women. Dietary patterns were defined as Recommended Food Scores (RFS) and Not Recommended Food Scores (NRFS). Kant *et al.* (2000) used a 62 item FFQ but included some extra foods in the RFS i.e. fruit juice, poultry and potatoes.

11.5 Dietary Quality Index according to socio-economic status and lifestyle factors

In this study there was a consistent and significant relationship between social position and dietary quality index for both the SHS and EFS (summarised in **Table 34**). This was true for the different measures of social position including income, area of residence, occupational status and level of education.

In this study the children (5-10 years, 11-15 years) showed marked differences in dietary quality score between low and high socio-economic status (SES). These findings were consistent with all measures of SES and the differences in scores ranged from 7-10%.

The findings for the dietary quality index were similar to those reported for the dietary patterns, confirming that better quality diets are associated with social circumstances by income, area of residence, occupational status and level of education (**Table 32 and 33**).

Table 34. Summary of the key findings for DQI in each age group according to socio-economic status and lifestyle factors.

Age 5-10 years	Age 11-15 years	Age 16-24 years	Age 25-64 years	Age >64 years
gender not significant	gender not significant	gender not significant	> in females	> in females
			> least deprived	> least deprived
> least deprived	> least deprived	> least deprived	> higher income	> highest income
> higher income	> higher income	> higher income	> high education	> high education
			> higher SES	> higher SES
> higher SES	> higher SES	> higher SES	< more screen	< more screen
< more screen	< more screen	< more screen	> higher activity	> higher activity
activity not significant	> higher activity	> higher activity	< more smoking	< more smoking
		< more smoking		
	> indicates a higher dietary index % and < indicates lower dietary index %,not significant at p<0.05			

> indicates a higher DQI and < indicates lower DQI e.g. in 5-10 year olds there is a higher DQI% with less deprivation with a linear trend suggesting the those in the least deprived group have a better quality diet.

Lifestyle factors were also important factors. Smoking (SHS) and smoking purchases in the household (EFS) were associated with a significantly reduced dietary quality index. Alcohol purchases in the household, in particular the highest level of purchase (3rd tertile), were associated with reduced dietary quality. Table 34 summarises the findings for the DQI (SHS and EFS) according to social and lifestyle factors. To enable some comparison between the DQI from the SHS for individuals and the DQI from the EFS for household in Table 35 we show the DQI findings for the largest adult group age 25-64 together with those for DQI from the EFS.

Table 35. The findings for DQI from the SHS (age 25-64 years) and EFS according socio-economic and lifestyle factors.

SHS Individuals, aged 25-64 years n=5474	EFS Households n=1750
> least deprived	> least deprived
> higher income	> highest income
> high education	NA
> higher SES	> higher SES
< more screen	NA
> higher activity	NA
< more smoking	< higher smoking purchases
	< higher alcohol purchases

> indicates a higher DQI and < indicates lower DQI e.g. a lower DQI% with higher smoking purchases (EFS) or more smoking (SHS) suggesting smokers have poorer quality diet.

11.6 Dietary Quality Index and health outcomes in the SHS

In the study reported here there was a strong positive relationship between diabetes and a high DQI. The effect size was considerable such that adults aged 25-64 with diabetes were 5.6 times more likely to be in the top quintile for DQI score after adjusting for socio-economic status (equivalised income and SIMD) and physical activity. This is a promising finding in that it suggests that individuals diagnosed with diabetes report adherence to a high quality diet as part of their management strategy. A similar effect was found in the older adults, age >64 years. This finding is not unusual for cross section data analysis and illustrates the reverse causation effect. There was no significant relationship between obesity and DQI.

In the same group of adults, aged 25-64 there was a strong relationship between total cholesterol:HDL ratio and DQI such that those in the highest quintile of DQI were at reduced risk of a high ratio with a highly significant odds ratio (AOR 0.56 CI 0.38,0.84) adjusted for socio-economic status (equivalised income and SIMD) and physical activity. There was also a linear trend showing the higher the DQI the lower the risk for a high ratio (p=0.007 for trend). This results articulates well with the findings for a relationship between dietary patterns and total cholesterol:HDL ratio in that it implies that a higher quality diet maybe protective against abnormal lipid levels in this sample. As a cholesterol:HDL high ratio is an important cardiovascular risk factor this finding adds support to strategies which promote improving diet to prevent cardiovascular disease.

In cross-sectional data, as is used in the analysis here, it is not unusual to find inconsistent relationships between diet and health outcomes. In particular, in interpretation of the findings care must be taken to avoid implying causation. The balance between diet contributing to disease outcomes and a disease (or obesity) influencing diet cannot be unravelled from cross sectional data. This is evidenced by the findings we have for the association between dietary patterns and obesity, and diabetes, where reverse causation probably explains the direction of the associations being contrary to what was expected. The relationships are better explored using prospective studies with time ordering of behaviours and health outcomes.

Other researchers have derived diet quality score or equivalents to assess the relationship between diet and other associated health outcomes. In the study by Osler et al. (2005) a Healthy food index was derived in addition to the PCA analysis. The healthy food index was associated with reduced all cause mortality in both men and women but the relations were attenuated after adjustment for smoking, physical activity, educational level, BMI, and alcohol intake.

A recent Italian study (Rossi 2008) uses a Mediterranean Diet Score (MDS) and defines, in a similar way to our study, points by ‘a priori’ on the basis of dietary guidelines. This study found no relationship between BMI and the MDS.

Using household budget data from 10 European countries, including that from the EFS's predecessor the National Food Survey, Lagiou & Trichopoulos (1999) derived a composite score for 'unfavourable' dietary patterns based on dietary risk factors for coronary heart disease, breast and colorectal cancer. They assigned a relevant score and found a significant correlation with mortality from CHD. They have demonstrated that household food data can be used to generate national dietary patterns that can be related to health outcomes.

Lagiou *et al.* (2006) assessed Mediterranean dietary patterns and mortality among young women. Adherence to the Mediterranean diet was assessed by a 10-point score incorporating the characteristics of this diet. Diet was assessed using an 80 item FFQ. A total of 11 food groups were constructed. This study found that the Mediterranean dietary pattern was associated with a reduced mortality even among young persons.

There is good published evidence of the use of diet quality indices or equivalents for assessing the relationship of the composite diet to social, demographic and health variables. The score can be entered into multivariable analysis enabling more complex assessment of relationships between diet and other variables.

11.7 Challenges of the PCA and DQI methodology

PCA is a well validated method which has been used to assess distinct patterns in diets. It can be applied to datasets which have been derived using various dietary assessment methodologies. We have shown in this study PCA applied to two very different datasets: one from limited food frequency inventory questionnaires of individuals (SHS) and the other assessing the whole diet from household food and drink purchases (EFS). The report shows that there were similarities in the findings between the two datasets with a healthy type pattern featuring in both.

Although PCA is a data driven method, there are a number of decisions which have to be made while progressing through the steps to derive the dietary patterns. These are subjective to the extent that the decision made may vary between investigators. Some of the decisions include: the pre-selection of food groups to prepare the dataset; determining the number of components (patterns) from the scree plot to include in the next step of PCA; and setting the factor loading cut-off used to identify the foods which best represent the patterns. In this study we used a factor loading of $\geq$ 0.3 or $\leq$ -0.3 as the cut-off value for listing the foods most closely associated (positively or negatively) with the pattern. We also highlighted foods with factor loading of 0.25 to 0.29 and -0.25 to -0.29. These factor loadings seemed to best represent the data and they have been used by other researchers carrying out PCA analysis to generate dietary patterns (Northstone & Emmett, 2005). Labelling of the food patterns is necessary for ease of interpretation; however, the labels used are subjective and can be controversial.

One of the most important limitations with regard to PCA being used with dietary data is the dietary patterns which emerge explain only a small amount of the variance in the diet. This means there are many more patterns which exist even though they will explain even less of the variance. For example, in this study the total variance explained by the PCA of the EFS, generating four patterns was 11.8% and for the adults (25-64 years) in the SHS it was 18.7%.

Dietary Quality Indices are summary scores of the extent to which the diet (of the individual or household person) meets dietary guidelines. As such, they need to be designed based on evidence and knowledge of diet-disease relationships and definitions may vary between investigators, as might food and nutrients to include/exclude. In addition, some of the components chosen for the DQI are correlated with one another and therefore may not be independent and may in some cases be counted twice. For example, fruit and vegetables are included as a component on their own, but are also included in the fibre component. This is somewhat unavoidable and, taking the example of fruit and vegetables, is partly a factor of the importance of this particular component in overall diet quality.

Further challenge in PCA and DQI analysis is the dependence of the outputs on the quality of the dietary survey data on which they are based. Key to this is when the survey data does not quantify foods and drinks but provides frequencies only, as is the case for the SHS. Consequently, when constructing the DQI from the SHS the cut-off value(s) for scoring a particular food (e.g. slices of bread per day, times per day eating chocolate and sweets) were established from best available evidence and expert opinion. This subjective approach will compound errors from the dietary assessment measurement itself.

The SHS eating habits module is a limited food inventory questionnaire of individuals in Scotland. In contrast the EFS survey includes a detailed 14-day diary of food purchases in households in Scotland. Both samples are representative of the Scottish population but are independent of one another, as are the dietary assessment methods, therefore, we are able to make only limited descriptive comparisons between the dietary patterns and DQI derived from them. What we can see is that the results for demographic and social patterns are similar for the SHS and EFS. The results for the weaker of the two dietary assessment methods (SHS) are as you would expect suggesting it provides a reasonable gauge on the diet of population groups, as we have shown in this analysis. However, the SHS is not a measure of the full diet and therefore application of the DQI for assessing the diet of individuals is not appropriate and likely to result in considerable error.

In devising the DQI from the EFS the food and nutrient components are adjusted for energy, however, the dietary assessment methodology used in the SHS is limited to frequency of intakes and does not provide information on energy intakes. When there is nutrient information as in the EFS the cut-off value used, e.g. saturated fat<11% of energy=10 points, saturated fat≥11% of energy=0 points may need to be set at this to avoid grey areas. This may seem unrewarding, for example, receiving no DQI points if your saturated fat intake is 12% of energy.

The Diet Quality Index can be converted to percentages which makes it easy to understand and to make comparisons between groups e.g. age groups, socio-economic groups.

11.8 The potential for dietary patterns and DQI data to inform food and health improvement policy

Dietary pattern analysis can be used as an alternative to, or in conjunction with, the study of individual food groups or nutrients for epidemiological purposes. The patterns show the types of foods which are most highly correlated with each other in modes of food consumption for individuals (SHS) or food purchasing for households (EFS). Dietary patterns generated by PCA analysis overcome some of the limitations of using one particular food group (e.g. fruit and vegetables only) or nutrient (saturated fat) to evaluate the diet of population groups. In particular, it can compensate for the inter-correlations between food groups and nutrients e.g. the counter balance between fruit and vegetables and processed foods or between dietary sugars and fats.

For example, in the analysis here for adults aged 25-64 we have shown dietary patterns in the Scottish diet which are energy dense but predominate in snacking type foods (sweets, chocolates, sweet pastries) while another energy dense pattern predominates in processed high fat foods which are usually consumed at meal times (e.g. meat products, chips). Conversely, we have shown dietary patterns which may appear healthy for starchy foods but do not load highly for fruit and vegetables (age 16-24 years *Healthy* dietary pattern). These different types of dietary patterns in the population may warrant varying approaches to improving the diet. We can see from our findings which age groups tend to have particular patterns e.g. energy dense snacking is predominate in the 11-15 year olds. Higher household income was clearly associated with a healthy type dietary pattern. At all ages (SHS: 5-10 years, 11-15 years, 16-24 years, 24-65 years, >65 years) the household income was an important factor in the selection of an energy dense or healthy dietary pattern. The relationship was linear from the highest quintile of household incomes in SHS (>£32,000) who scored lowest for the energy dense pattern compared to the lowest income group (<£9,100), who scored highest for this pattern. These findings suggest household income may have a strong influence on dietary patterning in both individuals and households in Scotland. Further analysis is needed to provide more detailed information on actual expenditure on food from the household income, including relative expenditure on particular foods groups. This is likely to relate to alcohol and smoking purchases, as discussed below and therefore multivariate analysis would be most appropriate to help untangle the relationships.

Smoking (both individual behaviour (SHS) and household purchases (EFS)) was associated with a less healthy dietary pattern. Smokers aged 25-64 years scored highly for an energy dense type pattern, and any amount of smoking had a significant effect. Results from the EFS show smoking purchases were associated with low scores for the healthy with fruit dietary pattern. These findings suggest smoking behaviour and purchases may have a strong influence on the quality of the diet for individuals and in Scottish households.

High alcohol purchases were associated with a takeaway/eating out pattern in the household. The households that spent most on alcohol scored highest for this pattern suggesting that the two behaviours (takeaway and eating out dietary pattern, and alcohol purchases) may occur together. Using the dietary quality index, there was little difference in DQI between households with no and low alcohol purchases, however the DQI dropped significantly in households with the highest quintile of alcohol purchases. These findings suggest that alcohol purchases occur along with takeaway/eating out food purchases and when the alcohol purchases are high they reduce the diet quality in the household.

Longer hours of screen viewing were distinctly associated with a low score for healthy dietary patterns across all age groups including the youngest 5-10 years. The diet quality index was significantly lower with high levels of screen viewing. This confirms reports of other investigators who have shown poor diets are associated with high levels of screen viewing and a consequent increased risk of obesity.

These findings provide important insights into inequalities in dietary choices at the population level. They suggest that more work needs to be done on household expenditure on food with regard to nutritional value for money and the balance of purchases of other commodities (e.g. cigarettes, alcohol).

The dietary quality index reported here was theoretically defined based on dietary guidelines, the higher the score (expressed as %) the higher the quality of the diet. As a result it is, compared to dietary patterns, more intuitive providing a relatively simplistic way of assessing the quality of the diet of individuals and households. However, it can only measure the quality of the diet relative to the food groups and/or nutrients used to derive the score. In this way it provides information on progress towards key healthy eating messages e.g. consumption of: fruits and vegetables, fish (oily and white), starchy carbohydrates (bread, cereals), red meats and processed meats, fibre providing foods, fatty and sugary foods.

In contrast to dietary patterns derived by PCA, the DQI does not show the types of foods which are correlated in patterns of consumption. The DQI provides an index for individuals (SHS) and households (EFS) which could (with further analysis) be broken down to component parts to assess where the weakest points are in achieving a healthy diet e.g. in achieving the dietary guideline for oily fish, for fibre foods etc. This would give insight into which particular dietary guideline(s) are most/least well followed by different groups relative to the other guidelines. Household alcohol purchases were associated with a lower DQI suggesting high purchases may have a negative effect on the quality of food in the household.

The DQI scores vary across age groups with the 11-15 years olds scoring lowest for dietary quality, followed by the 5-10 year olds and the oldest age group having the highest DQI. This is somewhat consistent with an energy dense /snacking pattern explaining the greatest amount of variance among the dietary patterns generated by the PCA analysis in children. This emphasises a potentially important generational gap in the quality of the diet. It suggests that older people (>65 years) have a better quality diet than younger. With further analysis it would be possible to explore if the household diet (EFS) is better when an elderly person lives in the household.

In this study the healthy dietary patterns and dietary quality index (EFS) correlated positively with the nutrients folate and vitamin C and negatively with saturated fat. This suggests the patterns are consistent with the nutrient quality of the diet. The healthy dietary patterns (for both food consumption and household food purchases) were consistently positively associated with a higher SES.

Finally, both the dietary patterns and dietary quality index can be entered as a variable into further more complex analysis of the role of diet in the context of the social and physical environment. The results reported here reinforce the suggestion made by other investigators that dietary patterns (scores) or a dietary quality index can be used as an independent covariate in specific epidemiological studies to characterise the diet of population groups and to explore the role of diet-disease relationships. Monitoring the changes in dietary patterns and dietary quality index provides a summary score for the quality of the diet which is not evident from analysis of single food groups or individual nutrient analysis.

Summary of findings

- A dietary quality index was designed based on dietary guidelines for the Scottish population. There were two indices: one designed to be used with the SHS limited food inventory: the second designed to be used with the Expenditure and Food Survey database. Both were expressed as a % giving a score for the quality of the diet of an individual (SHS) or household (EFS). The score could be used for the Scottish population to gauge progress toward Scottish Dietary Targets at national and local level. It is possible to look within the score to determine where points are gained and lost from food groups. This would help to inform food and health improvement policy.
- Dietary patterns were derived using PCA analysis generating distinct patterns in the Scottish Diet at an individual and household level. The patterns illustrate the particular foods which tend to be consumed (SHS) and purchased (EFS) together. They also show a strong association between dietary patterns and socio-economic, and lifestyle factors at both the individual and household level.
- The results also suggested a significant effect of age and gender on dietary patterns and diet quality. Diet quality clearly increased with age; younger age groups were more likely to have a poorer diet and poorer diet has been associated with poor health outcomes in later life.
- Healthy eating patterns were strongly and consistently associated with higher socio-economic status. In particular, low levels deprivation and high household income were positively associated with healthy dietary patterning; there was a significant gap between socio-economic groups. The

results suggest that social position and income is a major predictor in adopting a healthy diet. Expenditure on food in relation to overall household income warrants more detailed study.

- Smoking behaviour (individual and tobacco purchases in the household) has a significantly negative effect on dietary quality. The higher the tobacco purchases the lower the score for a healthy dietary pattern. Tobacco purchases explained 9.4% of the variance in this dietary pattern. In the adults aged 25-64 the dietary quality index was 12% higher in non-smokers compared to smokers (56.5% v 44.2%).

- The highest tertile of alcohol purchases in the household was strongly associated with a diet based on takeaway/eaten out foods. Alcohol purchases explained 13.2% of the variance in this dietary pattern. Also, the households with the highest alcohol purchases had the lowest DQI at 28.8%.

- Individual who have the highest levels of screen viewing (>1.5 hours per day) had the lowest scores for healthy dietary patterns. This confirms findings of other investigators of a relationship between the lifestyle behaviour of screen viewing and the quality of individual's diets.

- Adults aged 24-64 years who scored high for an energy dense/snacking pattern were at higher risk of having a high total cholesterol:HDL ratio. The adjusted odds ratio was 2.13, 95% CI 1.40 and the prevalence of a high ratio in the highest quintile group for *energy dense/snacking pattern* compared to those in the lowest group was 21.9% v 12.4%. This was consistent with the findings for the DQI, where adults 25-64 years in highest DQI quintile were less likely to have a high total cholesterol: HDL ratio (AOR 0.56, 95% CI 0.38, 0.84).

- The overall findings from this report emphasise the relationship between the quality of the diet, socio-economic factors and age and highlights the importance of improving nutritional intakes in both lower income and younger age groups. The results suggest that in order to improve the nutritional intake of all population groups, continued promotion of the balance of foods is required to encourage a healthy diet, in line with the advice provided as part of the Eatwell Plate.

- Our results indicate that the particular groups who may benefit most from initiatives to improve dietary intake include children (who are already the target of nutrition policy interventions, for example, in schools), young people, adult males, smokers and those with high levels of screen viewing particularly those from the lower socio-economic groups.

- The results support the need for the promotion of dietary messages within the context of healthy lifestyle as advocated in the Scottish Government Healthy Eating, Active Living Action Plan document which outlines the Scottish Government's joint action on diet, physical activity and maintaining a healthy weight. Advice should be integrated into current healthy lifestyle messages such as the Take Life On! campaign and could bring about improvements in the wellbeing of the Scottish population.

References:

Barker ME, McClean SI, Thompson KA & Reid NG (1990) Dietary behaviours and sociocultural demographics in Northern Ireland. *Br J Nutr* **64**, 319-329.

Dubois L, Girard M & Bergeron N (2000) The choice of a diet quality indicator to evaluate the nutritional health of populations. *Public Health Nutr* **3**, 357-365.

Hu FB, Rimm EB, Stampfer MJ, Ascherio A, Spiegelman D & Willett WC (2000) Prospective study of major dietary patterns and risk of coronary heart disease in men. *Am J Clin Nutr* **72**, 912-921.

Huijbregts P, Feskens E, Rasanen L, Fidanza F, Nissinen A, Menotti A & Kromhout D (1997) Dietary pattern and 20 year mortality in elderly men in Finland, Italy, and The Netherlands: longitudinal cohort study. *BMJ* **315**, 13-17.

Kant AK (2004) Dietary patterns and health outcomes. *J Am Diet Assoc* **104**, 615-635.

Kant AK & Graubard BI (2005) A comparison of three dietary pattern indexes for predicting biomarkers of diet and disease. *J Am Coll Nutr* **24**, 294-303.

Kant AK, Schatzkin A, Graubard BI & Schairer C (2000) A prospective study of diet quality and mortality in women. *JAMA* **283**, 2109-2115.

Lagiou P & Trichopoulos D (1999) Household budget survey nutritional data in relation to mortality from coronary heart disease, colorectal cancer and female breast cancer in European countries. DAFNE I and II projects of the European Commission. Data Food Networking. *Eur J Clin Nutr* **53**, 328.

Lagiou P, Trichopoulos D, Sandin S, Lagiou A, Mucci L, Wolk A, Weiderpass E & Adami HO (2006) Mediterranean dietary pattern and mortality among young women: a cohort study in Sweden. *Br J Nutr* **96**, 384-392.

Michels KB & Wolk A (2002) A prospective study of variety of healthy foods and mortality in women. *Int J Epidemiol* **31**, 847-854.

Mishra G, Ball K, Arbuckle J & Crawford D (2002) Dietary patterns of Australian adults and their association with socioeconomic status: results from the 1995 National Nutrition Survey. *Eur J Clin Nutr* **56**, 687-693.

Northstone K & Emmett P (2005) Multivariate analysis of diet in children at four and seven years of age and associations with socio-demographic characteristics. *Eur J Clin Nutr* **59**, 751-760.

Osler M, Heitmann BL, Gerdes LU, Jorgensen LM & Schroll M (2001) Dietary patterns and mortality in Danish men and women: a prospective observational study. *Br J Nutr* **85**, 219-225.

Reilly JJ, Armstrong J, Dorosty AR, Emmett PM, Ness A, Rogers I, Steer C & Sherriff A (2005) Early life risk factors for obesity in childhood: cohort study. *BMJ* **330**, 1357.

Schulze MB & Hoffmann K (2006) Methodological approaches to study dietary patterns in relation to risk of coronary heart disease and stroke. *Br J Nutr* **95**, 860-869.

Scottish Executive (2001) Scottish Health Survey 1998. http://www.data-archive.ac.uk/.

Scottish Executive (2003) *Improving Health in Scotland – the Challenge*: Scottish Executive, Edinburgh.

Scottish Executive (2004) *Eating for Health – Meeting the Challenge: Co-ordinated action, improved communication and leadership for Scottish food and health policy 2004, Strategic Framework for Food and Health 2004–2005.*: Scottish Executive, Edinburgh.

Scottish Executive (2005) Scottish Health Survey 2003. http://www.scotland.gov.uk/Publications/2005/11/25145024/50251.

Scottish Executive (2006) *Closing the Opportunity Gap.*: Scottish Executive, Edinburgh.

Scottish Government (2008a) *Equally Well: report of the ministerial task force on health inequalities volume 2*: Scottish Government, Edinburgh.

Scottish Government (2008b) *Healthy Eating, Active Living: An action plan to improve diet, increase physical activity and tackle obesity (2008-2011),* Scottish Government, Edinburgh

Steffen L, Nettleton J, Zhou X & Stevens J (2006) Three methods of deriving dietary patterns and their relation with risk of incident CHD; the ARIC study. *6th International Conference on Dietary Assessment Methods* Copenhagen, Denmark.

The Working Group for Monitoring Scottish Dietary Targets, *Monitoring Scottish Dietary Targets,* Food Standards Agency Scotland/Scottish Executive, 2004

Togo P, Heitmann BL, Sorensen TI & Osler M (2003) Consistency of food intake factors by different dietary assessment methods and population groups. *Br J Nutr* **90**, 667-678.

Togo P, Osler M, Sorensen TI & Heitmann BL (2001) Food intake patterns and body mass index in observational studies. *Int J Obes Relat Metab Disord* **25**, 1741-1751.

Trichopoulou A, Costacou T, Bamia C & Trichopoulos D (2003) Adherence to a Mediterranean diet and survival in a Greek population. *N Engl J Med* **348**, 2599-2608.

Tunstall-Pedoe H & Woodward M (2006) By neglecting deprivation, cardiovascular risk scoring will exacerbate social gradients in disease. *Heart* **92**, 307-310.

van Dam RM (2005) New approaches to the study of dietary patterns. *Br J Nutr* **93**, 573-574.

Waijers PM, Feskens EJ & Ocke MC (2007) A critical review of predefined diet quality scores. *Br J Nutr* **97**, 219-231.

Whichelow MJ & Prevost AT (1996) Dietary patterns and their associations with demographic, lifestyle and health variables in a random sample of British adults. *Br J Nutr* **76**, 17-30

Wrieden WL, Connaghan J, Morrison C & Tunstall-Pedoe H (2004) Secular and socio-economic trends in compliance with dietary targets in the north Glasgow MONICA population surveys 1986-1995: did social gradients widen? *Public Health Nutr* **7**, 835-842.

Wrieden WL & Moore EJ (1995) The dietary habits of 11-12 year-old children in two Tayside secondary schools--comparison with the targets set by the Scottish Diet Report. *Health Bull (Edinb)* **53**, 299-306.

Wrieden W, Barton K, Armstrong J & McNeil G (2006) A review of food consumption and nutrient intakes from national surveys in Scotland: comparison to the Scottish Dietary Targets. *Food Standards Agency Scotland* http://wwwfood.gov.ukmultimedalpdfs/scotdietarytarg.pdf