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Consistent dietary patterns identified from childhood to adulthood: The Cardiovascular Risk in Young Finns Study

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Dietary patterns are useful in nutritional epidemiology, providing a comprehensive alternative to the traditional approach based on single nutrients. The Cardiovascular Risk in Young Finns Study is a prospective cohort study with a 21-year follow-up. At baseline, detailed quantitative information on subjects' food consumption was obtained using a 48 h dietary recall method (*n* 1768, aged 3–18 years). The interviews were repeated after 6 and 21 years (*n* 1200 and *n* 1037, respectively). We conducted a principal component analysis to identify major dietary patterns at each study point. A set of two similar patterns was recognised throughout the study. Pattern 1 was positively correlated with consumption of traditional Finnish foods, such as rye, potatoes, milk, butter, sausages and coffee, and negatively correlated with fruit, berries and dairy products other than milk. Pattern 1 type of diet was more common among male subjects, smokers and those living in rural areas. Pattern 2, predominant among female subjects, non-smokers and in urban areas, was characterised by more health-conscious food choices such as vegetables, legumes and nuts, tea, rye, cheese and other dairy products, and also by consumption of alcoholic beverages. Tracking of the pattern scores was observed, particularly among subjects who were adolescents at baseline. Of those originally belonging to the uppermost quintile of pattern 1 and 2 scores, 41 and 38 % respectively, persisted in the same quintile 21 years later. Our results suggest that food behaviour and concrete food choices are established already in childhood or adolescence and may significantly track into adulthood.

Dietary patterns: Tracking: Finland

Food consumption studies have traditionally focused on investigating the amounts of foods consumed by a group of people and computing the corresponding average consumption and nutrient intakes in selected samples or subsamples. This has also been the predominant means of making comparisons between populations or other groups of people and between time points within a group. While this approach is adequate in some settings, e.g. when examining the difference or change in a given food or nutrient, it has several limitations in others (Jacques & Tucker, 2001; Hu, 2002; Togo *et al.* 2003). This is the case when, for instance, the investigators are interested in people's diet in its entirety as an indicator of differences between populations or time points or as a predictor of their health and disease. People do not eat single nutrients or even foods, but meals consisting of foods and nutrients in different combinations. Moreover, there are numerous synergistic and antagonistic interactions among nutrients in their effects on health and disease (Jacques & Tucker, 2001; Hu, 2002; Newby *et al.* 2003). It is difficult to characterise an individual's diet with only a single or a few food items, or to evaluate the quality of the diet using only a single or a few nutrients. Thus, there is a growing interest in nutritional epidemiology in assessing dietary patterns when investigating food behaviour and diets among different groups of people or the role of nutrition in the risk of chronic diseases, and many findings have been encouraging (see e.g. Slattery *et al.* 1998; Hu *et al.* 2000; Osler *et al.* 2001; Terry *et al.* 2001; Quatromoni *et al.* 2002).

In epidemiology, tracking is defined as the stability of a given variable over a period of time. Dietary tracking values can therefore be considered to illustrate the maintenance of dietary habits, nutrient intakes or food consumption over time. Most earlier studies have shown fair to high tracking in food consumption and nutrient intake when exclusively children have been evaluated over a short time (Singer *et al.* 1995; Wang *et al.* 2002; Zive *et al.* 2002), and weaker values among older subjects or with longer follow-up periods (Welten *et al.* 1997; Cusatis *et al.* 2000; Robson *et al.* 2000; Bertheke Post *et al.* 2001). However, data on dietary tracking are limited, most studies have had relatively short follow-ups and results have been inconclusive.

The subjects of The Cardiovascular Risk in Young Finns Study have been followed for more than 21 years, from childhood into adulthood. Thus, we had a unique opportunity to investigate dietary patterns and their long-term stability among these subjects. It is generally believed that nutritional habits are established in childhood and persist into adulthood, but limited amount of data exist to support this hypothesis. The aims of this study were: (1) to identify and

Abbreviation: FFQ, food frequency questionnaire.
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interpret existing dietary patterns among the study group in 1980, 1986 and 2001; (2) to investigate the associations of dietary patterns with socio-demographic characteristics and nutrient intakes; and (3) to evaluate the stability of food choices on an individual level (i.e. tracking) from childhood into adulthood.

Subjects and methods

The Cardiovascular Risk in Young Finns Study

The Cardiovascular Risk in Young Finns Study is a large multi-centre longitudinal study on cardiovascular disease risk factors and their determinants among children, adolescents and young adults in Finland. Determinations include serum cholesterol and other lipids, blood pressure and anthropometric measurements, and dietary interviews. Data have been collected with questionnaires on diet, smoking, use of alcohol, physical activity and other life-style factors, and on subjects' and their family's socio-demographic situation and history. The ethics committees of the participating centres have approved the study protocol. Details of the project have been described previously (Åkerblom *et al.* 1999; Raitakari *et al.* 2003).

The first cross-sectional study was carried out in 1980, when the participants were 3–18 years of age (*n* 3596, 83 % of those invited), and the same subjects have been followed since. All those who participated in 1980 were invited in 1986 and in 2001 to the follow-up studies.

Subjects

Dietary studies have been an essential part of the project from the beginning. In the first study year in 1980, a random sample of 50 % of the subjects participated in a 48 h dietary recall interview. Reliable dietary information was obtained from 1768 children and adolescents (aged 3–18 years). These subjects were all invited to the first follow-up study in 1986; 1200 (68 %) participated. After 21 years, those who had participated in 1980 and still had a permanent address in Finland (*n* 1748), were invited to the 21-year follow-up field study, which included a dietary interview: 1049 (60 %) participated. Details of the reasons for non-participation have been reported by Raitakari *et al.* (2003). In this 2001 analysis, a further twelve interviewed participants were excluded from the analysis because of obviously unreliable answers, resulting in a sample of 1037 subjects, 466 men and 571 women, 24–39 years of age.

Dietary assessment

In the 48 h recall, dietary interviewers, all trained dietitians, collected information on foods and beverages consumed by the subjects in the 2 d prior to the interview. In 1980 and 1986, 3–12-year-old children were interviewed together with a parent or another accompanying person. As detailed information as possible on the types and amounts of foods and drinks consumed was recorded on the forms by the interviewer. The study protocol in 1980 and 1986 has been described in detail elsewhere (Räsänen *et al.* 1985, 1991). In 2001, we used the National Food Composition Database maintained by the National Public Health Institute (2003). The latest version of the composition database was used to calculate the intakes of energy and nutrients for each participant. Some of the nutrients calculated in 2001 were not available in the food composition databases used in 1980 and 1986.

Identification of dietary patterns

Food groupings of the different food consumption databases were unified to obtain twenty-three standardised food groups (Table 1). Food items were grouped primarily according to their habitual culinary use and only secondarily nutrient composition. Some items (e.g. coffee, tea) were preserved as separate groups because they were considered to represent distinctive food choices. Mean intake (g/d) was used as the input value in the analysis. A principal component factor analysis was then performed separately for each study year to identify the major dietary patterns in the study group. The factors were rotated by an orthogonal transformation to force non-correlation of the factors and to enhance the interpretation. Both the amount of variance (eigenvalue) of each factor and a scree plot analysis were considered as the criteria to decide the number of factors extracted. The two criteria led to similar conclusions and therefore all interpretable factors with eigenvalues > 1 were chosen for further consideration. For each study year, we eventually chose two factors. A third extracted factor was also carefully considered, but was dropped out from further studies in the end because of its inconsistent characterisation. We also tried separate analysis for girls and boys, but due to similar results we decided to conduct the principal component analysis together for both genders.

In addition, in 2001 the subjects were asked to fill in a questionnaire on habitual dietary choices including a short food frequency questionnaire (FFQ) with six response categories. Because of the limited number of foods and food groups included in the FFQ, these data were not used to assess the dietary patterns, but only to evaluate the validity of the dietary patterns, which was

Table 1. Food groups used in the factor analysis

Food group	Foods included in the group
Rye	Rye bread, rye porridge
Wheat	Wheat bread, pasta
Other cereals	Cereals other than rye and wheat, breakfast cereals, biscuits, starch, rice
Potatoes	Potatoes, potato products
Root vegetables	Root vegetables
Legumes and nuts	Peas, beans, other legumes, nuts, seeds, soya products
Other vegetables	Leaf vegetables, onions, cabbages, tomatoes, cucumbers, canned vegetables, mushrooms
Fruit and berries	Fresh fruits, canned fruits, berries, fruit and berry juices
Milk	Milk
Cheese	Cheese
Other dairy products	Cream, sour milk products, yoghurt ice cream
Butter	Butter, butter-oil spreads, lard
Margarines and oil	Soft margarine, low-fat spreads, oil
Pork	Pork
Other meat	Beef, game, poultry, lamb, meat products
Sausages	Sausages, frankfurters
Offal	Liver, kidney, other offal
Fish and shellfish	Fish, shellfish, fish products
Eggs	Eggs
Sugars and confectionery	Sugar, syrup, sweets, chocolate
Coffee	Coffee
Tea	Tea
Alcoholic beverages	Alcoholic beverages

done by calculating the mean consumption (obtained by the 48 h recalls) of relevant food groups in each FFQ category.

Further analyses

Before further analyses, the factor scores computed for each subject at each study point and for both dietary patterns were standardised to ensure normality and energy-adjusted using the residual method of Willett (1998). The subjects were divided into quintiles according to these adjusted scores. The mean values of the selected study characteristics or proportions of the subjects were then calculated in the lowest quintile, three middle quintiles and the highest quintile separately. In addition to the energy adjustment, mean values and proportions were age-standardised. Proportions were standardised by the direct method with six age groups (according to the six age cohorts) and using the age distribution of the total study sample as the standard.

We used the length of parents' education as an indicator of the status of the family in 1980 and 1986. The information on the parent with more years of schooling was included in the analyses. In 2001, we assessed the subject's own years of schooling.

Smoking status was defined as current daily smoking. In 1980 and 1986, subjects less than 15 years old were excluded from the computation of smoking prevalence.

The average daily intakes of selected nutrients were also computed separately in the lowest, middle and highest quintiles of the age- and energy-adjusted dietary pattern scores.

To evaluate dietary tracking, i.e. the stability of food choices over time, we used the aforementioned quintiles, according to the computed energy-adjusted pattern scores, and examined the extent to which the subjects originally in the lowest or highest quintile remained in the same category, i.e. maintained their position relative to other subjects, over 6 (from 1980 to 1986) and 21 (from 1980 to 2001) years. The tracking analyses were conducted separately for those who were children (3–12 years) and for those who were adolescents (15–18 years) at the beginning of the study in 1980. Moreover, Spearman correlation coefficients between factor scores at different study years within the total study population were computed.

All analyses were carried out using version 8.2 for Windows of SAS statistical software (SAS Institute Inc., Cary, NC, USA).

Results

A consistent range in the major dietary patterns across the study years was observed in the factor analysis (Figs. 1–3). The loadings of the food groups for the factors in each study year gave a similar set of two interpretable patterns. These patterns were also the ones with the highest eigenvalues, and together they explained 18, 21 and 17 % of the total variance in food consumption in 1980, 1986 and 2001, respectively. The patterns were labelled as 'pattern 1' and 'pattern 2'. Food group loadings for these patterns for each study year are represented graphically in Figs. 1–3. A positive loading refers to a positive association between the food group and the factor, and a negative loading an inverse association. The foods associated with the factors vary to some extent from year to year, which means that, for example, pattern 1 has a slightly different content in 1980 than in 2001. Pattern 1 was positively loaded with rye, potatoes, milk, butter, sausages and coffee in each study year. Fruit and berries, and other dairy products were negatively correlated with pattern 1 in 1980 and 2001. Pattern 2 was correlated positively with rye (but less than in pattern 1), vegetables, legumes and nuts, tea, cheese and other dairy products at all study points, and also with alcoholic beverages in 2001. Milk was negatively associated with pattern 2.

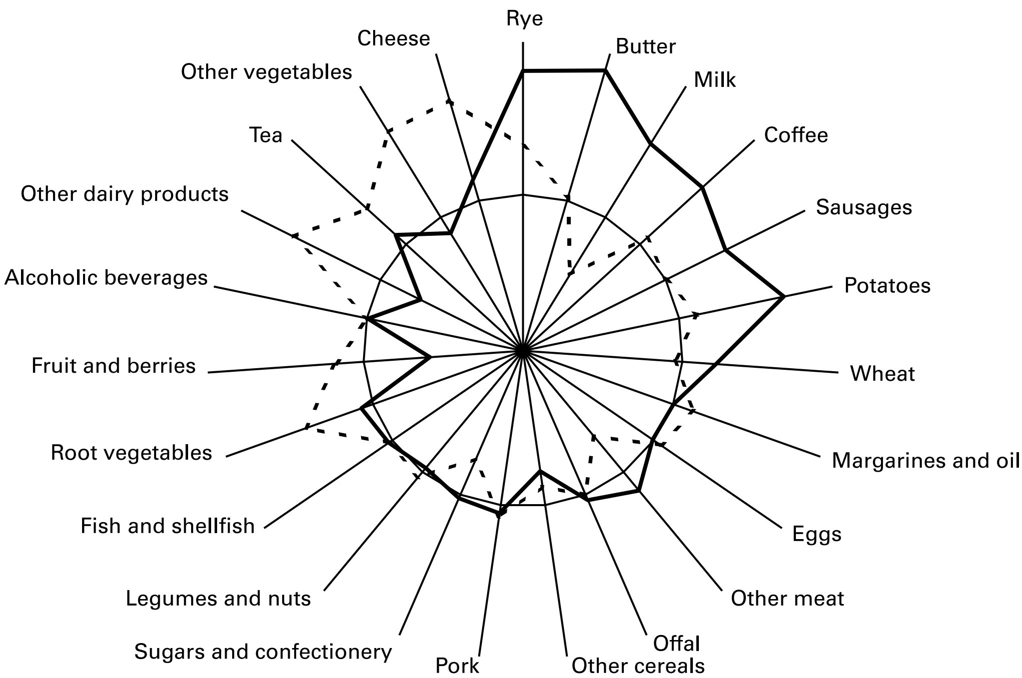

Fig. 1. Dietary patterns identified among subjects in 1980. Each arm of the star in the graphic presentation illustrates the correlation between the patterns (—, pattern 1; –-, pattern 2) and the different food groups, with a negative correlation ($r-1$) at the midpoint and a positive correlation ($r+1$) at the outer edge of the constellation. A correlation of zero is indicated by a circle.

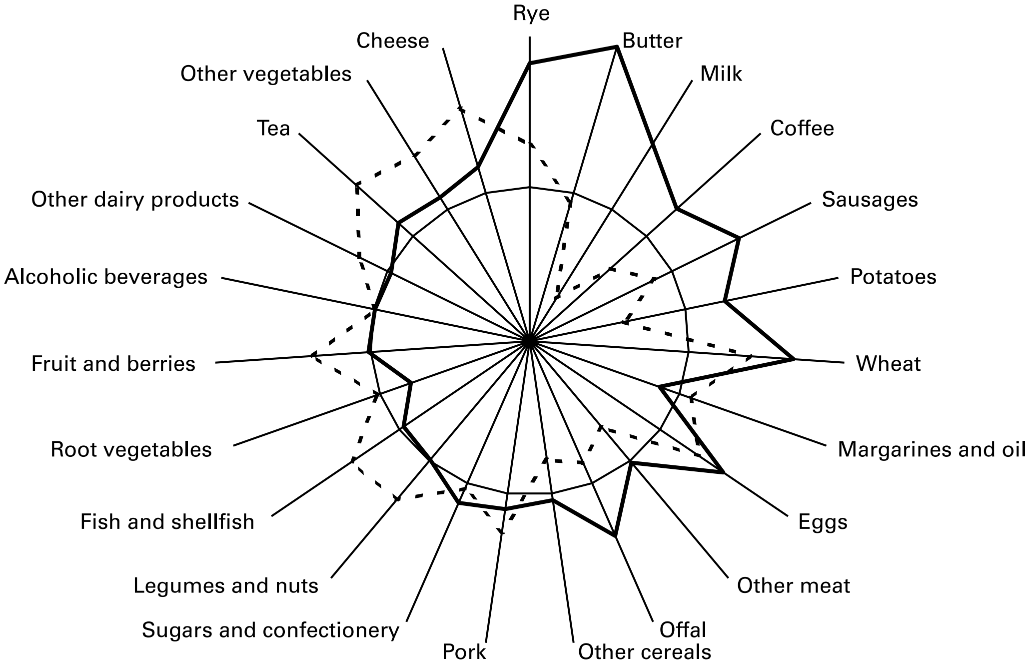

Fig. 2. Dietary patterns identified among subjects in 1986. For details, see Fig. 1.

To evaluate the validity of the assessed dietary patterns, we also computed the mean consumptions of foods and food groups that were the most relevant in the two dietary patterns (i.e. foods or food groups having low or high loadings) according to the response categories of the FFQ. Significantly increasing consumption figures were found from the category 'never' to 'daily' in all food groups (*P* for trend 0·007 for cheese, 0·02 for potatoes, 0·04 for fruit and berries, and $<$0·001 for milk, coffee, tea, vegetables and sausages) except for fish (*P* for trend 0·25) (data not shown).

The mean values or the distribution of subjects' characteristics according to the quintiles of the dietary patterns are shown in Table 2. High pattern 1 scores were more common among men, subjects living in rural areas, smokers and those with lower education (subject's own or parents'). Moreover, among those with high pattern 1 scores, there were fewer users of dietary supplements than among those with low scores. Girls and women, non-smokers, well educated, supplement users and subjects residing in urban areas had on average high scores for pattern 2.

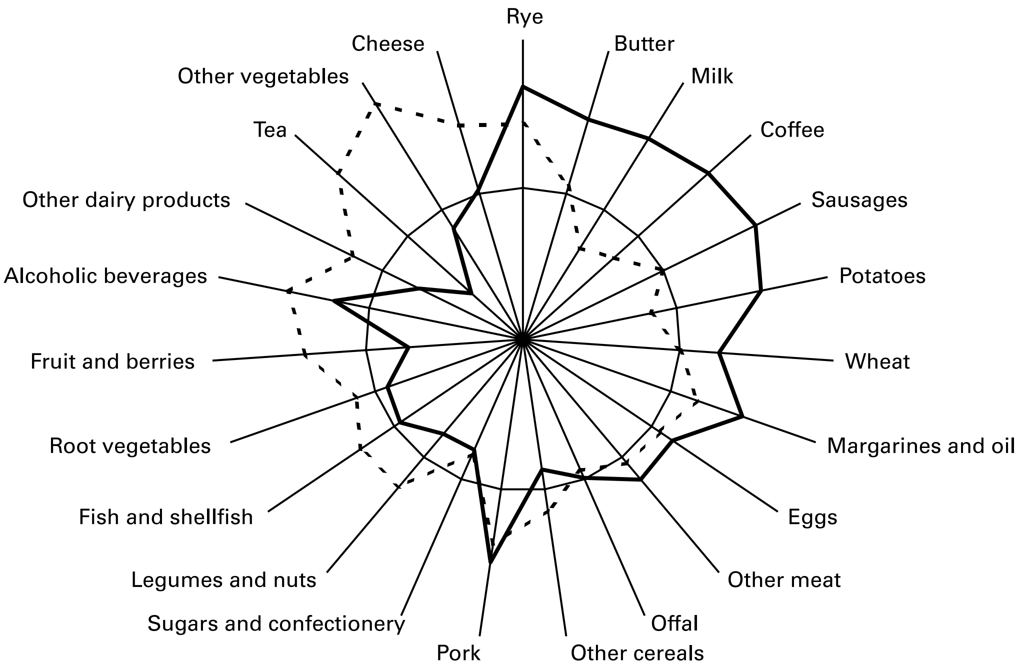

Fig. 3. Dietary patterns identified among subjects in 2001. For details, see Fig. 1.

Table 2. Characteristics of subjects according to quintiles (Q) of energy-adjusted dietary pattern scores*

	Pattern 1							Pattern 2						
	Q1		Q2–Q4		Q5			Q1		Q2–Q4		Q5		
	Mean	SD	Mean	SD	Mean	SD	*P* for trend†	Mean	SD	Mean	SD	Mean	SD	*P* for trend†
1980														
Age (years)	10·0	4·7	9·7	5·0	13·4	3·9	<0·001	10·0	4·4	10·0	5·0	12·4	5·0	<0·001
Gender (% boys)	53		44		59		0·06	59		48		43		0·005
Residential area (% urban)	69		48		27		<0·001	43		47		57		<0·001
Smokers (%)‡	24		23		28		0·002	27		23		22		0·006
Education of parents (years)	12·1	4·0	10·8	3·5	9·1	3·0	<0·001	10·5	3·5	10·7	3·6	11·0	4·0	0·68
1986														
Age (years)	15·3	4·8	15·2	4·9	17·3	4·8	0·01	14·2	4·4	15·3	4·9	18·0	4·7	<0·001
Gender (% boys/men)	49		44		59		0·03	69		43		39		<0·001
Residential area, (% urban)	63		53		49		<0·001	43		54		66		<0·001
Smokers (%)‡	28		32		39		0·004	34		31		23		<0·001
Education of parents (years)	11·9	3·7	11·5	3·6	10·7	3·0	0·008	10·9	3·2	11·6	3·7	12·1	3·6	0·004
2001														
Age (years)	30·9	5·0	32·0	5·2	32·3	4·7	0·06	31·5	5·2	31·8	5·0	32·2	5·1	0·88
Gender (% men)	48		51		57		0·04	58		48		44		<0·001
Residential area (% urban)	74		67		53		<0·001	56		65		75		<0·001
Smokers (%)	15		22		36		<0·001	27		23		18		<0·001
Use of dietary supplements (% users)	45		34		22		<0·001	24		32		48		0·009
Education (years)	15·8	2·9	14·6	2·9	13·6	2·6	<0·001	13·9	2·8	14·7	2·9	15·3	2·8	0·04

* Values are age-standardised (except for age) means with their standard deviations, or proportions.

† For continuous characteristics performed with linear regression analysis; score quintile in the model as a continuous predictor variable. For categorical characteristics performed with Mantel-Haenszel χ^2 test for trend.

‡ Only subjects 15 years or older included.

Several differences were present in nutrient intakes according to pattern scores of subjects (Table 3). Subjects following mainly a pattern 1-type diet had lower intakes of carbohydrates, sucrose and vitamin C, and higher intakes of fat and saturated fatty acids than those with lower pattern 1 scores. High pattern 2 scores indicated lower intakes of saturated fatty acids and sucrose and higher intakes of polyunsaturated and omega-3 fatty acids, fibre, alcohol and vitamin C. Similar associations between dietary patterns and nutrient intakes were found among subjects in 1980 and 1986 (data not shown).

Tracking of food choices

Food choices expressed as dietary pattern scores showed tracking of some extent over the 21-year period. Spearman correlation coefficients between the standardised and energy-adjusted factor scores in 1980 and 2001 were 0·32 for factor 1 and 0·38 for factor 2. When studied more thoroughly, we found stronger tracking among subjects with very low or very high factor scores, and among older subjects. In a secondary analysis we investigated tracking using the quintiles of the pattern scores. The proportion of subjects in the lowest or highest quintile of pattern scores remaining in the same quintile after 6 and 21 years was approximately 1·5 to two times the expected in both patterns if no stability is assumed (Table 4). Tracking was stronger among older subjects (15–18 years at baseline); 30–42 % and 27–41 % of subjects originally belonging to the extreme quintile of the energy-adjusted pattern scores persisted in the same quintile 6 and 21 years later, respectively. The highest stability was found in the uppermost quintile in both patterns.

Discussion

Dietary patterns

Identification of dietary patterns has become an important approach in food consumption studies and nutritional epidemiology (Hu, 2002; Togo *et al.* 2003), complementing the more conventional, single-nutrient 'reductionist' approaches (Jacobs & Steffen, 2003). Some investigators have suggested the reductionist approach to be a simplification to facilitate the understanding of complex diet–disease relationships (Jacobs & Steffen, 2003). The patterns introduced in this paper were constructed using common exploratory factor analysis without any *a priori* assumptions of patterns to be found. These patterns were based on the food consumption information obtained by a 48 h recall method. Short-term methods are suitable for estimating dietary intakes on a group level but fail to take into account intra-individual variability and are thus not appropriate when evaluating the diet of an individual (Willett, 1998). However, when compared with e.g. FFQ, recalls do not rely on the long-term memory of subjects, are unstructured and open-ended, give more detailed information on the foods and amounts consumed and, although not completely unbiased, have less systematic error on a group level (Hoffmann *et al.* 2002). Our project put great emphasis on the implementation of the dietary recalls, and the information obtained was precise and detailed.

Togo *et al.* (2003) compared factor scores based on a FFQ with scores based on a 7 d diet record and found very few differences independent of age, BMI, energy intake and life-style factors. The only differences between the two methods were for foods that were consumed relatively rarely and loaded low on their factors. Recently, McNaughton *et al.* (2005) evaluated the consistency of dietary patterns assessed through short-term dietary recalls and a

Table 3. Energy and nutrient intakes among subjects in 1980 and 2001 according to quintiles (Q) of energy-adjusted (except for energy) dietary pattern scores

	Pattern 1							Pattern 2						
	Q1		Q2–Q4		Q5			Q1		Q2–Q4		Q5		
	Mean	SD	Mean	SD	Mean	SD	*P* for trend*	Mean	SD	Mean	SD	Mean	SD	*P* for trend*
1980														
Energy (MJ)	8·4	2·9	7·8	2·5	10·3	3·4	<0·001	7·1	2·4	7·9	2·3	11·2	3·6	<0·001
Protein (% energy)	14·1	2·7	14·6	2·4	14·3	2·1	0·01	13·7	2·0	14·3	2·3	15·4	2·9	<0·001
Carbohydrate (% energy)	52·4	7·9	50·0	6·1	47·7	5·8	<0·001	50·5	6·7	50·0	6·5	49·6	7·3	0·13
Sucrose (% energy)	12·3	5·6	10·4	5·0	7·3	3·9	<0·001	11·3	6·1	10·2	5·0	9·0	4·5	<0·001
Fat (% energy)	35·3	6·8	37·3	5·1	40·3	5·4	<0·001	37·4	5·6	37·7	5·6	37·0	6·4	0·13
Saturated fat (% energy)	16·3	3·5	19·1	3·2	22·4	3·8	<0·001	19·7	3·9	19·4	3·7	18·2	4·3	<0·001
Monounsaturated fat (% energy)	11·7	2·9	11·9	2·3	12·3	2·2	<0·001	11·5	2·3	12·0	2·4	11·9	2·6	0·02
Polyunsaturated fat (% energy)	5·0	2·1	4·3	1·8	3·6	1·5	<0·001	4·0	1·6	4·2	1·8	4·7	2·2	<0·001
Alcohol (% energy)†	0·1	0·8	0·1	0·8	0·1	0·9	0·56	0·0	0·0	0·0	0·2	0·3	1·8	0·07
Calcium (g)	1·2	0·5	1·1	0·4	1·2	0·5	0·24	1·3	0·5	1·1	0·4	1·2	0·5	0·08
Iron (mg)	15·7	7·1	12·9	6·2	16·7	7·4	0·09	15·3	7·8	13·3	6·0	16·0	7·7	0·11
Vitamin C (mg)	139	77	90	52	76	43	<0·001	78	51	96	57	120	69	<0·001
2001														
Energy (MJ)	7·8	2·7	8·3	2·5	11·7	3·3	0·001	9·6	3·1	8·3	2·8	9·9	3·4	0·24
Protein (% energy)	14·9	3·7	16·3	3·7	17·2	4·1	<0·001	15·0	3·6	16·2	3·6	17·5	4·4	<0·001
Carbohydrate (% energy)	51·2	8·1	46·7	7·5	43·6	6·6	<0·001	49·0	7·1	46·6	7·7	46·1	8·7	0·002
Sucrose (% energy)	14·5	6·1	10·8	5·2	7·5	4·1	<0·001	13·3	6·1	10·7	5·5	9·0	4·6	<0·001
Fat (% energy)	32·3	7·1	34·8	7·3	37·3	6·8	<0·001	34·4	6·7	35·3	7·4	33·8	7·6	0·28
Saturated fat (% energy)	14·0	4·0	14·2	3·7	14·7	3·2	<0·001	14·5	3·6	14·5	3·7	13·4	3·7	0·03
Monounsaturated fat (% energy)	9·7	2·4	10·9	2·7	12·2	2·6	<0·001	10·8	2·4	11·2	2·8	10·5	2·8	0·12
Polyunsaturated fat (% energy)	4·3	1·5	4·9	1·9	5·2	1·7	<0·001	4·5	1·5	4·9	1·8	5·2	2·2	<0·001
Omega-3 fatty acids (g)	2·0	1·0	2·1	1·2	2·6	1·4	0·006	2·1	1·1	2·2	1·3	2·3	1·3	0·01
Alcohol (% energy)	1·5	3·4	2·2	5·0	1·9	4·2	0·76	1·5	3·3	2·0	4·4	2·6	5·8	<0·001
Calcium, (g)	1·3	0·6	1·2	0·5	1·4	0·7	0·17	1·3	0·6	1·3	0·6	1·3	0·6	0·87
Iron (mg)	13·2	7·1	11·8	5·9	13·2	5·5	0·20	12·1	5·6	12·0	6·0	13·8	6·7	0·23
Fibre (g)	20·8	10·4	17·9	7·7	20·3	9·7	0·16	16·0	7·4	18·2	7·9	24·0	10·7	<0·001
Vitamin C (mg)	136	95	103	67	79	58	<0·001	92	77	101	70	129	80	<0·001

* Performed with regression analysis; score quintile in the model as a continuous predictor variable; intakes log-transformed where distributions non-normal.
† Only subjects 15 years or older included.

Table 4. Proportion (%) of subjects remaining in the same extreme quintile at baseline and at follow-up

		Pattern 1*			Pattern 2*		
Age at baseline	Follow-up time from baseline	Q1†	Q5‡	*P*§	Q1†	Q5‡	*P*§
3–12 years	6 years	32	30	0·005	33	27	0·20
	21 years	28	28	0·045	25	29	0·013
15–18 years	6 years	30	39	0·002	34	42	0·07
	21 years	27	41	$<$0·001	29	38	0·041

* Standardised and energy-adjusted pattern scores.
† The lowest quintile.
‡ The highest quintile.
§ Tested with χ^2-test for all quintiles; H_0: distribution at follow-up is independent of the distribution at baseline.

5 d food diary. They concluded that a 48 h recall effectively characterised dietary patterns compared to a diary method among the study population. Likewise, in the present study, foods or food groups that played an important role as markers in the identified dietary patterns were mostly ones consumed daily or several times a week, such as coffee, tea, potatoes, fats, bread, vegetables and fruit. Moreover, the results of our validation study show a significant correlation between information obtained by the 48 h recall and by the FFQ measuring longer-term food choices. Therefore we believe that these patterns reflect the true food behaviour styles existing among children and young adults in Finland. However, neither these nor any similarly obtained dietary patterns in other studies should be used as a method of assessment of nutrient intakes (Hu *et al.* 1999).

Because food grouping, as well as other steps in identifying dietary patterns, is subject to researchers' discretion and other circumstances, this may have an effect on the results. In our study, 'milk' and 'other dairy products' were considered two all-inclusive food groups and were not divided into low-fat and high-fat products. This was because our main objective was to identify patterns reflecting food choices on a behavioural level rather than on the basis of the nutrient intakes. At the beginning of the study, fat contents of the commonly consumed dairy products were much more homogenous than today. Therefore, any division based on the amount of fat in milk and other dairy foods would merely have obscured the identification and interpretation of patterns.

The two dietary patterns identified in this study were substantially different from one another. Pattern 1 had strong positive correlations with foods that are traditional in Finland, such as rye, milk, coffee, potatoes, sausages and butter. We therefore labelled this pattern as the 'traditional pattern'. Pattern 2 had high loadings mostly for completely different foods, including tea, vegetables, fish, cheese and other dairy products. In Finland, most of these have not been traditionally eaten and many represent an alternative to the conventional food items (e.g. tea substituting for coffee, yoghurt substituting for milk). Particularly during the first two study points in the 1980s, high consumption of these foods had to have been a conscious choice of the subjects (or of their parents) because food selection in shops was much smaller (e.g. not all vegetables were available throughout the year) and lunchtime meals offered at school were more traditional than they are today. Also, especially in adulthood, high scores for pattern 2 were observed among non-smokers and nutrient supplement users, both of which can be considered markers of a health-oriented life-style. Because subjects with high scores for pattern 2 appeared to be more health-conscious, we labelled pattern 2 as the 'health-conscious pattern'. However, we must emphasise that all foods positively correlated with pattern 2 cannot be regarded as health-promoting, even if most are in concordance with dietary recommendations (National Nutrition Council, 1999).

Both patterns were clearly identifiable at all study points, i.e. over a 21-year period. The small differences in the loadings do not alter the overall food behaviour styles behind these patterns, but reflect the general change in food variety and culture in Finland during the last decades (e.g. the increased use of margarines and wheat instead of butter and rye). Numerous studies have shown how nutrient intakes have changed significantly in Finland since the 1980s (Puska, 2000; Pietinen *et al.* 2001), even within this particular study sample (Mikkilä *et al.* 2004). In the 1970s, Finns had one of the highest CHID mortality and risk factor levels in the world, which led to several health promotion and nutrition education projects (see e.g. Puska, 2000). These projects have been successful with substantially advantageous effects on public health (Pietinen *et al.* 2001). The extensive nutrition education and official guidelines were particularly aimed at health professionals and institutional kitchens. The results of this study suggest that when the nutrient composition of industrially or institutionally prepared or produced foods was significantly changed and a wider selection of healthier versions of familiar foods became available in shops, individuals were not forced to change their dietary habits in the respect of food items. For instance, it was possible to continue consuming plenty of dairy products and meat and at the same time decrease the intake of saturated fatty acids by choosing low-fat dairy products and leaner meat. In our data, the most reported dishes in 2001 were to a great extent similar to the ones reported in 1980, such as minced meat sauce, macaroni meat casserole, pea soup and sausage soup. Therefore, despite the unchanged food patterns, the aforementioned changes in addition to wilful individual choices have led to great differences in nutrient intakes in Finland between the 1980s and today.

Pattern associations

Some of the characteristics of our subjects were different according to the pattern scores obtained. The greatest differences in the 'traditional pattern' were found in adulthood; men and subjects living in rural areas had higher scores than women and urban participants. Fagerli & Wandel (1999) see women as innovators and mediators of dietary changes in society, which may partly explain the tendency of women to eat less traditional foods than men. Moreover, some foods that have a positive correlation with the 'health-conscious pattern', such as vegetables and fruit, are in Western food culture considered to be feminine (O'Doherty Jensen & Holm, 1999) and may be avoided by some men, especially in the lower educational groups (Roos *et al.* 1998). In addition, high 'traditional pattern' scores and low 'health-conscious pattern' scores were associated with smoking. We have earlier shown a clear clustering of cardiovascular risk habits among these same subjects (Raitakari *et al.* 1995). Prättälä *et al.* (1994) concluded that an accumulation of unhealthy behavioural traits is pronounced among Finnish men and that male smokers, in particular, are consistent in their unhealthy behaviour. The diet of Finnish women has previously been found to better adhere to guidelines than that of men (Roos *et al.* 1998), and this has also been demonstrated in The Cardiovascular Risk in Young Finns Study sample (Mikkilä *et al.* 2004).

The changes in nutrient composition of foods can also be seen in the mean intakes of nutrients in pattern score quintiles. Those who had high scores for 'traditional pattern' in 1980 had significantly higher intakes of saturated fatty acids than less traditional eaters, but by 2001, the difference had diminished, although it had not completely disappeared. In addition, the shift in the fat composition of foods has inverted the association between polyunsaturated fatty acids and the 'traditional pattern' from a negative one into a positive one. While high scores in the 'health-conscious pattern' may reflect a general tendency towards a healthy life-style, the differences in nutrient intakes between score quintiles were less significant. Subjects in the uppermost quintile of pattern 2 had throughout the study significantly higher intakes of vitamin C and fibre, and in 2001, a lower intake of sucrose, but less pronounced differences were present in total fat and different fatty acids. Thus, health-orientated food choices do not necessarily result in better nutrient intakes.

Tracking

Despite considerable within-subject variation in daily food consumption, which presumably diluted the tracking analysis to some degree, we observed clear tracking in dietary pattern scores among subjects over the 21-year period. Previous studies have reported substantial tracking in dietary intake patterns from childhood into adolescence (Wang *et al.* 2002) and in food choices from adolescence into early adulthood (Kelder *et al.* 1994; Lien *et al.* 2001). Hu *et al.* (1999) investigated the reproducibility of the two found dietary patterns obtained 1 year apart by using FFQ among adult men, and reported pattern score correlation coefficients of 0·7 and 0·67. Our study shows substantially lower correlation between factor scores in 1980 and 2001. However, given the fact that our study period was as long as 21 years, that the subjects grew from children to adults during that time, and that we used a short-term measurement of food consumption, we think our results give some evidence of tracking. It must be kept in mind that the patterns, although labelled 'traditional' and 'health-conscious' throughout the study period, did not stay identical from one study point to another. Therefore, we cannot make conclusions on the reproducibility of the dietary pattern analysis but only on the stability of food behaviour suggested by this study between adolescence and adulthood, and especially among those whose diets were clearly traditional or health-conscious. Within this same study population, we observed significant tracking of another life-style factor, physical activity and inactivity, occurring from adolescence to young adulthood (Raitakari *et al.* 1994). Likewise here, tracking was stronger among subjects who were adolescents at baseline than among those who were younger children. Dietary studies extending from childhood into adulthood are scarce, but Bertheke Post *et al.* (2001) did report only fair tracking in nutrient intakes from the age of 13 to 33 years. However, dietary patterns reflect general food behaviour better than do the intakes of single nutrients and may therefore be more stabile. Based on our findings and those of previous studies (Von Post-Skagegard *et al.* 2002), adolescence is the time when considerable changes in food behaviour are most likely to occur. This may be due to both physiological changes and the growing importance of social environment (Wang *et al.* 2002). Our results suggest that food behaviour and concrete food choices are established early in life and show long-term stability. Therefore, nutritional education should be targeted at children and adolescents in particular, and could thus have a potential role in the prevention of many diet-related diseases.

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