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FAMILY-BASED DIETARY INTERVENTION IN THE STRIP STUDY

- INFLUENCES ON DIET AND DIET-RELATED ATTITUDES

by

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To my late Father Walter

ABSTRACT

Sanna Talvia

Family-based dietary intervention in the STRIP study – influences on diet and diet-related attitudes

The Department of Pediatrics and The Research Centre of Applied and Preventive Cardiovascular Medicine, University of Turku, Turku, Finland. Annales Universitatis Turkuensis, Medica-Odontologica, Turku, Finland, 2013.

The focus of this dissertation was to investigate the effects of family-based dietary intervention during childhood and adolescence. The participants comprised of children and parents who participated in a longitudinal, randomised atherosclerosis prevention trial (STRIP study). The intervention families (n=540) took part in a dietary intervention since the child's age of 8- months. The control group (n=522) did not receive any tailored dietary intervention. The main focus of the intervention was to improve the quality of dietary fat. The diet of children and parents was evaluated by daily food records and diet-related attitudes by a questionnaire.

The dietary intervention influenced, favourably, the dietary fat quality in children and parents. Fat quality improved mainly by the decrease of saturated fat intake. Some minor effects of the intervention were also observed in children's fruit and vegetable (F&V) consumption although the F&V consumption was very low. The intervention increased parental interest in healthy eating, but there was no difference in interest in natural products or in attitudes towards hedonic eating attitudes between the intervention and control parents. Parents' interest in healthy eating associated with parents' and children's high fruit and vegetable consumption but not with their fat quality ratio. On the other hand, dietary fat quality improved at every level of interest in healthy eating.

It seems that the main target of the intervention, the dietary fat quality of the children, was promoted effectively. In the future, more emphasis should be given on increasing unsaturated fat intake and on elevating F&V consumption in children. Children's diet, especially F&V consumption, associated with diet-related attitudes of the parents. Therefore, co-operation with parents and family-based premises for working should be capitalized upon when promoting healthy eating in children and adolescents.

Key Words: children, adolescents, dietary intervention, health promotion, nutrition education, diet, eating-related attitudes

TIIVISTELMÄ

Sanna Talvia

Lapsiperheille suunnattu ravitsemusinterventio STRIP –tutkimuksessa – Vaikutukset ruokavalioon ja ruokaan liittyviin asenteisiin

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Tämän tutkimuksen tarkoituksena oli tutkia lapsiperheille suunnatun ravitsemusintervention vaikutuksia. Tutkittavat olivat pitkäkestoiseen, satunnaistettuun STRIP -tutkimukseen osallistuneiden perheiden lapsia ja vanhempia. Interventioon osallistuneet lapset (n=540) olivat vanhempineen mukana erityisesti ruokavalion rasvan laadun parantamiseen tähdänneessä ravitsemusinterventiossa lapsen 8 kuukauden iästä lähtien. Vertailuryhmän lapset (n=522) perheineen eivät saaneet henkilökohtaista ravitsemusohjausta. Lasten ja vanhempien ruokavaliota tutkittiin ruokapäiväkirjojen avulla. Syömiseen liittyviä asenteita tutkittiin kyselylomakkeen avulla.

Ravitsemusinterventio vaikutti suotuisasti interventioperheiden ruokavalion rasvan laatuun. Rasvan laatu pehmeni erityisesti tyydyttyneen rasvan käyttöä vähentämällä. Interventio vaikutti myös jossain määrin lasten kasvisten kulutukseen, tosin yleisesti ottaen kasvisten kulutus todettiin vähäiseksi. Interventioon osallistuminen lisäsi vanhempien kiinnostusta terveellistä syömistä kohtaan, mutta ei heidän kiinnostustaan luonnonmukaisia elintarvikkeita tai mielihyvää tuottavaa syömistä kohtaan. Vanhempien kiinnostus terveellistä syömistä kohtaan oli yhteydessä vanhempien ja lasten runsaampaan kasvisten käyttöön mutta ei parempaan rasvan laatua kuvaavaan suhteeseen.

Tulokset osoittavat, että intervention pääkohteeseen, ruokavalion rasvan laatuun, kyettiin vaikuttamaan suotuisasti. Ravitsemuskasvatuksessa tulee jatkossa panostaa enemmän tyydyttymätöntä rasvaa sisältävien ruokien ja kasvisten kulutuksen lisäämiseen. Lasten ruokavalio, erityisesti kasvisten käyttö, oli yhteydessä vanhempien ruokaan liittyviin asenteisiin. Terveellisen syömisen edistäminen lapsilla edellyttääkin perhelähtöisyyttä sekä yhteistyötä vanhempien kanssa.

Avainsanat: lapset, nuoret, ravitsemusinterventio, terveyden edistäminen, ravitsemuskasvatus, ruokavalio, ruoka-asenteet

CONTENTS

ABBREVIATIONS

AHA	American Heart Association
ANOVA	analysis of variance
CCT	controlled clinical trial
CHD	coronary heart disease
CI	confidence interval
CVD	cardiovascular diseases
DIPP	The Type 1 Diabetes Prediction and Prevention study
E%	percentage of total energy intake
F&V	fruit and vegetables
GHI	General Health Interest
HFQR	constantly high fat quality ratio
HFVC	constantly high fruit and vegetable consumption
HTAS	Health and Taste Attitude Scales
LDL	low density lipoprotein
LFQR	constantly low fat quality ratio
LFVC	constantly low fruit and vegetable consumption
LS-means	least square means
MUFA	monounsaturated fatty acids
NNR	Nordic Nutrition Recommendations
(P+M)/S	fat quality ratio, PUFA+MUFA)/SFA
PUFA	polyunsaturated fatty acids
RCT	randomized controlled trial
RM ANOVA	repeated measures analysis of variance

SFA	saturated fatty acid
SD	standard deviation
STRIP	Special Turku coronary Risk factor Intervention Project for children
U:S	ratio of unsaturated to saturated fat
WHO	World Health Organization

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following original publications, which are referred to in the text by their Roman numerals (Study I-IV). Some previously unpublished data are also presented.

I Talvia S, Lagström H, Räsänen M, Salminen M, Räsänen L, Salo P, Viikari J, Rönnemaa T, Jokinen E, Vahlberg T, Simell O. Calorie (Energy) and Nutrient Intakes up to the Age of 10 Years in the Special Turku Coronary Risk Factor Intervention Project. Arch Pediatr Adolesc Med 2004;158:41-47.

II Talvia S. Räsänen L, Lagström H, Pahkala K, Viikari J, Rönnemaa T, Arffman M and Simell O. Longitudinal trends in consumption of vegetables and fruit in Finnish children in an atherosclerosis prevention study (STRIP). Eur J Clin Nutr 2006; 60:172-180.

III Talvia S, Anglé S, Lagström H, Pahkala K, Salo P, Saarinen M, Viikari J, Simell O. Dietary longitudinal intervention and diet in childhood and adolescence. The STRIP Study. Submitted

IV Talvia S, Räsänen L, Lagström H, Anglé S, Hakanen M, Aromaa M, Sillanmäki L, Saarinen M, Simell O. Parental eating attitudes and indicators of healthy eating in a longitudinal randomised dietary intervention trial (The Strip Study). Pub Health Nutr 2011;14,2065-2073.

1 INTRODUCTION

Cardiovascular diseases (CVD), combined with type 2 diabetes mellitus and obesity, are a global health burden producing enormous losses of life and disability-adjusted life-years in both developed and developing nations. Most of the burden occurs at unnecessarily young ages. A causal factor to this burden is a suboptimal lifestyle, which includes smoking, minimal physical activity and poor diet quality, and is therefore at least partly preventable (Mozaffarian and Capewell 2011). Main aspects of a cardioprotective diet include dietary fat intake and quality, fruit and vegetable consumption and dietary fibre and salt intake (WHO 2003).

Primary prevention of diet-related diseases should start early in life because of possible influences on and tracking of the eating habits until adulthood. Findings from a population-based Finnish cohort of the Cardiovascular Risk in Young Finns study show that exposure to cardiovascular risk factors in childhood is associated with increased progression of atherosclerosis over 20 years later in adulthood (Aatola et al 2010, Juonala 2010). Of the individual dietary variables, especially fruit and vegetable consumption in childhood, is associated with better cardiovascular health in early adulthood. Moreover, a long-term adherence to a traditional eating pattern (characterised by high consumption of rye, potatoes, butter, sausages, milk and coffee) with a low adherence to a health-conscious dietary pattern (characterised by high consumption of vegetables, legumes and nuts, tea, rye, cheese and other dairy products, and alcoholic beverages) is positively correlated with cardiovascular risk in adulthood (Mikkilä 2007, Mikkilä et al 2009). There is also some evidence from the Cardiovascular Risk in Young Finns study that eating behaviour and food choices are established early in life and show some long-term stability (Mikkilä et al 2005) and that childhood diet is a significant determinant of the cardiovascular quality of the adult diet (Mikkilä et al 2004).

The eating behaviour of children and adolescents is a function of multiple levels of influence. One of the most influential determinants of a children's diet is their home environment. In a recent systematic review de Vet and co-workers (2011) conclude that interpersonal family factors (for example, family cohesion, modelling by family members and parental monitoring) played a pronounced role in the dietary behaviours of children and adolescents (de Vet et al 2011). Further, relationships among a child's dietary behaviour and parental feeding style and feeding practices (Blissett 2011) and home availability, family rules and parental encouragement (Pearson et al 2008) exist. The parents' diet-related attitudes affect all of the above-mentioned factors. Therefore, not only a child, but the whole family should be on the focus of nutrition interventions during childhood (Hill 2002, Scaglioni 2008, Daniels et al 2011).

The prospective Special Turku Coronary Risk Factor Intervention Project for Children (the STRIP study) offers a unique possibility to study prospectively the diet during childhood and adolescence. In a controlled and randomised study, intervention

families took part in dietary education and counselling beginning at the child's age of 8 months. The main target of the intervention was to influence the development of cardiovascular risk factors and especially the quality of dietary fat already in childhood. The focus of this dissertation is to analyse the influence of the STRIP dietary intervention on fat intake and fruit and vegetable consumption of the children from the age of one year to adolescence. Furthermore, the effects of the intervention on parental diet-related attitudes are observed, as well as associations between parental interest in healthy eating and family eating habits.

2 REVIEW OF THE LITERATURE

2.1 Dietary recommendations for promoting cardiovascular health

Dietary recommendations are guidelines for the nutritional composition of a diet which provides a basis for good health and contributes to a reduction of risk for diet-associated diseases. They are based on current scientific knowledge, and an overall assessment of available evidence. Recommendations set dietary reference values for the intake of and balance between individual nutrients and consumption of food groups for use in planning diets for various population groups. The recommendations can also be used in planning and evaluation of nutrition programmes, interventions, teaching and other initiatives.

The Nordic countries collaborated for several decades in setting general guidelines for dietary composition and recommended intakes of nutrients. Already in 1968, a joint official statement on "Medical aspects of the diet in the Nordic countries" was published (Nordic Nutrition Recommendations 2004). The first official Nordic Nutrition Recommendations were published in 1980 and subsequent editions in 1989, 1996 and 2004. The newest version of the Nordic Nutrition recommendation (2012) is currently under review. The Finnish Nutrition Recommendations (2005) are based on the Nordic Nutrition Recommendations. Only some national adjustments have been done in order to make the recommendation fit with the Finnish food culture and traditions.

Besides general dietary recommendations, also recommendations for prevention of specific diseases exist. The WHO provides general dietary recommendations on prevention of chronic diseases and especially on prevention of CVD as a joint expert consultation (WHO 2003, WHO 2008). Moreover, national heart associations have their own dietary recommendations for prevention of CVD.

Two aspects of dietary recommendations with significance for the present study will be presented in detail: recommendations for fat intake and recommendations for fruit and vegetable consumption, both of which are considered important with regard to the prevention of cardiovascular diseases.

2.1.1 Quantity and quality of fat

Dietary fat intake has a central part in previous dietary recommendations. Fat intake is strongly associated with the risk of cardiovascular diseases through effects on blood lipids, thrombosis, blood pressure, arterial (endothelial) function, arrythmogenesis and inflammation (WHO 2003).

The first nutrition recommendation of heart associations was given by the American Heart Association (AHA) in 1957 (Page et al 1957). In that recommendation, reduced fat intake is recommended to reduce CVD risk. At the beginning of 1980s, a fat

reduction diet was recommended also for children over two years of age (Weidman et al 1983). Since then, a shift of emphasis has been put for the fat quality. The recent recommendation of the AHA emphasise that individuals should aim to improve their whole or overall diet instead of focusing on a single nutrient or food (Lichtenstein et al 2006). Recommendations for saturated and trans-fatty acids are still given, however. The AHA recommends intakes of <7 E% of saturated fat and <1 E% of *trans* fat.

In 2003, a joint WHO/FAO expert consultation group gave global goals for population nutrient intakes for preventing diet-related chronic diseases (WHO 2003). Among the goals are recommendations for fat intake: the goal for total fat intake is 15-30 E%, for saturated fat <10 E%, for *trans* fatty acids <1 E% and for polyunsaturated fatty acids 6-10 E%. The determination of intake of monounsaturated fat is calculated by difference, *i.e.* Total fat intake (E%) – SFA (E%) – PUFA (E%) – *trans* fatty acids (E%). In the specific recommendation for prevention of CVD, the importance of dietary fat intake and fat quality components on CVD risk is further emphasised. In 2008, a new joint WHO/FAO expert consultation recommendation specifically for fat intake was made. The recommendations for saturate, monounsaturated and *trans* fatty acids are equal to the 2003 recommendations, but the goals for total fat intake changed to 15-35 E% in adults and 25-23 E% in children up to the age of two years and the goal for polyunsaturated fatty acids to 6-11 E % in adults and to 11 E% in children (WHO 2008). It is also recommended that SFA should be replaced with PUFA in the diet.

The European Heart Network, an alliance of European heart foundations and organizations, have intermediate and long-term goals for fat intake (The European Heart Network 2011). The intermediate goals for total, saturated, *trans*, polyunsaturated and monounsaturated fats are <30 E%, <10 E%, <1 E%, 6-11 E%, and 8-13 E% and the long-term goals 20-25 E%, <7 E%, <0.5 E%, 5-8 E% and 7.5-9.5 E%, respectively. The Finnish Heart Association (2010) recommends 25-35 E% total fat intake of which at least 2/3 should be unsaturated fat. The specific recommendation for saturated fat intake is <7-10 E% and for polyunsaturated fat intake 6-11 E%.

The previous and present Nordic Nutrition Recommendations emphasize a reduction in total fat intake to less than 30 or 35 E%, especially by decreasing saturated and trans-fatty acids in adults and children from 2 years of age (Table 1). Since 1996, the upper limit for saturated and *trans* fatty acids has been 10 E%. The reduction of saturated and *trans* fatty acids has been justified by the effects of these fats on serum LDL-cholesterol levels and on the risk of coronary heart disease.

According to the draft proposal of the latest Nordic recommendation (NNR 2012), more emphasis has been put on the role of dietary patterns and food groups contributing to the prevention of the major diet-related chronic diseases. However, also intake ranges for various macronutrients are still included in the recommendation. The upper limit of 10 E% for saturated and *trans*-fatty acids is suggested to remain. It is also recommended that saturated and *trans*-fatty acids should contribute no more than one third of the total

fatty acids. Furthermore, monounsaturated fat intake is recommended to be between 10-20 E% (in previous NNRs 10-15 E%) and polyunsaturated fat intake between 5-10 E% (same as in the previous recommendations). No upper range for total fat intake is given, although intake below 25 E% and above 35 E% is not advocated (NNR 2012).

Table 1. Nordic Nutrition recommendations (NNR) for fat intake

Recommended intake for	NNR 1989	NNR 1998	NNR 2004	NNR 2012 (a draft)
total fat E%	<30	<30	25-35	-*
saturated fat + trans-fatty acids E%	-	approx 10	approx. 10	<10
monounsaturated fatty acids E%	-	10-15	10-15	10-20
polyunsaturated fatty acids E%	7 (P:S ratio 0,5)	5-10	5-10	5-10

*No specific recommendation for total fat is given. However, it is stated that there are no specific reasons or advantages to increase total fat intake above 30-35 E%. Further, a reduction of fat intake below 25E% is not advocated.

On the food consumption level, saturated and *trans* fat intake should be lowered by choosing lean meats and fat-free (skim), 1%-fat, and low-fat dairy products (Lichtenstein 2006, Finnish Heart Association 2010, NNR 2012). Unsaturated fat intake should be increased by consuming more fish and other seafood, vegetable oils and spreads, as well as nuts and seeds (Lichtenstein et al 2006, Finnish Heart Association 2010, NNR 2012).

In conclusion, although the emphasis in nutrition recommendations is increasingly on the level of food consumption and dietary patterns, specific recommendations for fat intake are still included. Reduced intake of saturated and *trans*-fatty acids is widely recommended, as well as replacement of them with unsaturated, especially polyunsaturated fatty acids.

2.1.2 Fruit and vegetable consumption

Fruits and vegetables contribute to cardiovascular health through the variety of phytochemicals, micronutrients and fiber that they contain (WHO 2003). With the high consumption of fruits and vegetables, it is possible to produce substantial improvements in several risk factors of CVD, including blood pressure, lipid levels, inflammatory biomarker levels, endothelial function and weight control (Mozzaffarian et al 2011).

Virtually all dietary recommendations introduce high consumption of fruit and vegetables. The World Health Organisation's (WHO's) population goal for fruit and vegetable consumption for prevention of chronic diseases is ≥ 400g per day (WHO 2003). A specific goal for promotion of cardiovascular health is 400-500g g per day (WHO 2003).

Also, the American Heart Association (AHA) has recommended a high and varied consumption of fruit and vegetables (Lichtenstein et al 2006). More specifically, the AHA recommends ≥4.5 cups of fruits and vegetables daily for adults (for a 2000 kcal diet) as part of an ideal cardiovascular diet (Lloyd-Jones 2010). For children, the recommended amount increases with age (Gidding et al 2005). For 1 year olds, the daily recommendation is 1 cup of fruits and 1 cup of vegetables and for 9-13 year olds, 1.5 cups of fruits and 2-2.5 cups of vegetables is recommended.

National food-based dietary guidelines for F&V consumption in European countries are usually been stricter than the WHO population goal (Yngve et al 2005). There are some differences among countries about fruit juice consumption or potato consumption to be included in the recommended F&V consumption or not. Some countries have recommended the same amounts for children and adults, while others have somewhat different recommendations for children at different ages. The European Heart Network (2011) has set the intermediate population goal for fruit and vegetable consumption for >400g per day and a longer-term goal for >600g per day.

In the Nordic recommendations, no specific recommendations for fruit and vegetable consumption is given, but a high and varied consumption of fruit and vegetables is mentioned to the desirable. In the Finnish nutrition recommendations, a daily consumption of 400g fruit and vegetables (potatoes excluded) and at least 5 servings per day are recommended (National Nutrition Council 2005). In preschool-aged children a recommendation of 5 servings per day is also given, but with serving size smaller than for adults (Hasunen et al 2005). The Finnish Heart Association (2010) recommends ≥ 500g of fruit and vegetables daily (excluding potatoes and including ≤ 1 glass of fruit juice).

In conclusion, there is a clear global consensus of recommending high intake of fruits and vegetables. The absolute recommendations vary somewhat between countries, but in general the recommendation is least 400g or more daily. In some counties the absolute amount is smaller for children than in adults.

2.2 Diet in childhood

Analysis of the diets of children around Europe has one common problem: a national survey of children's and adolescent's diet is either lacking or quite out of date in many countries (Lambert et al 2004). This is also true in Finland: no system of regular national surveys of Finnish children's and adolescents' diets exists. Comparisons among existing studies should be done with caution, because of different methods used for dietary data collection and analysis and different set of food composition data which vary in definitions, analytical methods, units and modes of expression.

In Finland, the most comprehensive observations of Finnish children's diet function as a part of studies with emphasis on chronic diseases, for example, the Multicentre Study on atherosclerosis Precursors in Finnish Children (later known as Cardiovascular Risk in Young Finns study) or The Type 1 Diabetes Prediction and Prevention study (DIPP). In the Multicentre Study on atherosclerosis Precursors in Finnish Children, the diet of 1768 children aged 3, 6, 9, 12, 15 and 18 years was studied by 48 hour recalls in 1980 (Räsänen et al 1985). In the DIPP study, the diet of Finnish 1 to 6-year-old children was observed by food records between the years 2003 and 2005 (Kyttälä et al 2010).

2.2.1 Fat intake

A recent global review of children's and adolescents' fat intake has observed results from dietary studies published between 1995 and 2009 (Harika et al 2011). The mean daily intake of total fat ranged mostly between 30 and 35 E% and saturated fat between 11 and 15 E%. In twenty-eight of the thirty countries included, the children and adolescents have had mean SFA intakes above 10 E%. In all countries, less than 50% of children and adolescents have had SFA intake lower than 10 E%, except for Japan and South Africa. Mean daily PUFA intakes have ranged from 3.5 E% to 9.7 E% in children and from 3.6 E% to 11.2 E% in adolescents. In twenty-one of the thirty countries, the mean PUFA intake was lower than 6 E%.

Another review of dietary intakes among European children and adolescents has collected nutrient intake data published between 1987 and 2002 (Lambert et al 2004). The lowest fat intakes (close to 30 E%) were recorded in the Norwegian and Swedish surveys and highest (more than 40 E%) in Mediterranean countries, particularly Spain and Greece, and in some surveys from the UK. Consumption of saturated fatty acids was highest in Belgium and France (about 17 E%), and Finland (20 E%). Southern Mediterranean countries (Greece, Spain and Italy) have reported intakes of 12–13 % and lowest SFA intakes have been in Yugoslavia (10 E%) and Poland (10–11 E%). The Southern European countries have reported highest MUFA consumption: in Spain, it has been 16–17 E% and in Greece up to 18 E%. For the other countries, 11–13 E% seemed to be the most common range of consumption. Low intakes of MUFA exist in Denmark, Norway and Sweden, and also in Hungary, where the intake of MUFA was 10 E% of energy. In most countries, intakes of PUFA have ranged from 4 to 6 E%. To conclude, high-fat diets in Mediterranean countries associate with high intakes of both SFA and MUFA, while high-fat diets in Central and Eastern and Northern Europe showed quite high levels of SFA with relatively lower levels of both MUFA and PUFA.

According to the Multicentre Study on atherosclerosis Precursors in Finnish Children the total fat intake of Finnish children and adolescents was about 36-38 E% in 1980, *i.e.* some thirty years ago (Räsänen et al 1985). Polyunsaturated fat intake is low compared to the intake of saturated fat, studied by measuring the ratio of polyunsaturated and saturated fatty acids (P/S). The ratio was on average 0.24 and higher in urban than rural

children (0.27 vs. 0.21) and in Western than in Eastern Finland (0.26 vs. 0.22). About 20 years later, the total fat intake of the preschool-aged Finnish DIPP children was remarkably lower, about 31 E% (Kyttälä et al 2010) The saturated fat intake of the DIPP children was 13.7 E%, monounsaturated fat intake 10.6-10.7 E% and polyunsaturated fat intake 4.0-4.2 E%.

In conclusion, children's saturated fat intake is higher than recommended and unsaturated fat intake is lower than recommended, both globally and in Finland, during the past decades.

2.2.2 Fruit and vegetable consumption

In the PRO CHILDREN project, the fruit and vegetable consumption among European 11-year-old children was investigated by 24-hour recall questionnaires in 2003 (Yngve 2005). The mean daily fruit and vegetable consumption was 227g, of which fruit intake 141g and vegetable intake 86g. The intakes are highly diverse in different countries: both fruit and vegetable consumptions have been low in Iceland (90g and 54g, respectively). The highest fruit consumption is in Austria (171g) and Denmark (157g) and the highest vegetable consumption in Portugal (111g) and Sweden (109g). In general, boys have consumed less fruit and vegetables than girls.

In a large sample (n=7285) of 7-year-old English children of the Avon Longitudinal Study of parents and children (ALSPAC), the median daily fruit and vegetable consumption has been 201g, fruit consumption 127g and vegetable consumption 71g, observed by food record data in 1999-2000 (Jones 2010). The total consumption has been somewhat higher in girls (209g) than in boys (194g). In Czech children (n=602) of the national dietary survey, the average daily fruit and vegetable consumption studied by 24 hour recalls has been 209g in children aged 4-6 years, 230g in children aged 7-10 years and 284/261g in boys/girls aged 11-14 years, respectively.

Among the participants of the Multicentre Study on atherosclerosis Precursors in Finnish Children, the consumption of most foods increases with increasing age (Räsänen et al 1985). However, the consumption of fruit and berries is an exception: the two youngest age groups (3 and 6 years old children) have consumed more fruits and berries than the older age groups (15 and 18 years old children). Consumption has been about 239-251g at the age of 3 and 6 years and about 187-215g at the age of 15 and 18 years. In preschool-aged Finnish children of the DIPP study, the consumption of fruits and berries, analysed by food records, has been about 100-110 g per day, and the consumption of vegetables about 50g per day (Kyttälä et al 2010). At the age of six years, the energy-adjusted consumption of fruits and berries is higher in girls than in boys.

In conclusion, the fruit and vegetable consumption of European children and adolescents is lower than recommended. In general, the consumption is higher in girls than in boys and the consumption of fruits is higher than the consumption of vegetables.

2.3 Role of diet-related attitudes in dietary choices

Nutrition education is often viewed as the process of translating the findings of nutrition science to various audiences. Thus, nutrition educators believe that their task is to provide the public with information to eat well. According to a recent review of intervention studies aimed at improving children's weight-related nutrition and physical activity patterns, the most commonly used behavioural change techniques have been providing instructions and providing general information (Golley at al 2011). However, providing information is not enough when providing effective nutrition education. In a recent review, information and advice to adults appeared not to be particularly effective in terms of reducing the risk of clinical cardiovascular events, especially in adults at relatively low risk of cardiovascular disease (Ebrahim et al 2011). In the STRIP study, the nutritional knowledge of both the intervention parents and children have increased during the dietary intervention but the nutrition knowledge of the parents has correlated poorly with their nutrient intakes (Räsänen et al 2003, Räsänen et al 2004). This indicates that other factors, besides knowledge, influence parental dietary decisions (Räsänen et al 2003).

Simple proving information is not enough when trying to influence diet and eating because people's food choices and nutrition-related practices are determined by many factors (Contento 2011). Besides biologically predispositions, such as liking of sweet taste and rejecting sour and bitter tastes, physical, social, economic and cultural environment influence the foods that are available, accessible and desirable. People acquire and develop perceptions, expectations and feelings about food. These psycho-social factors like beliefs, emotions, values, personal meanings and attitudes are all powerful determinants of food choice and dietary behaviour.

Attitude is one of the psycho-social concepts present in many theories explaining health behaviours like eating. Attitudes, in some way, guide, influence, direct, shape, or predict actual behaviour (Kraus 1995). In general, attitudes are defined as favourable or unfavourable judgments about a given object, person or behaviour. Attitudes have both a cognitive/evaluative component (*e.g.* how healthy would it be to eat fruit and vegetables) and an affective component (*e.g.* how a person would feel about eating fruit and vegetables) (Contento 2011, 75).

Traditionally, attitudes towards food and eating are assessed by means of direct, self-report verbal methods like questionnaires or interviews. In these studies, attitudes are operationalised in diverse ways and attitude statements are based on different theories or data sources. The dietary focus of the attitudes has varied as well. The Health and Taste Attitude Scales (HTAS) is one example of diet-related attitude questionnaires. In the HTAS, the attitude statements are derived selectively from previous literature and an empirical interview study (Roininen et al 2000). Further, HTAS distinguish two main categories of diet-related attitudes: attitudes that reflect interest in healthy eating and attitudes towards hedonic eating.

2.3.1 Interest in healthy eating and dietary intake

In general, attitudes towards healthy eating differ between women and men: usually women have a more positive attitude towards healthy eating (Barker et al 1995, Roininen et al 1999, Roininen and Tuorila 1999, Girois et al 2001, Roininen et al 2001, Hearty 2007). Interest in healthy eating increases with age and higher education (Kearney et al 1998, Hearthy et al 2007, Vereecken and Maes 2010).

There are few studies about the associations between attitudes towards healthy eating and dietary intake. The comparability of the studies is hampered by different operationalisations of the diet-related attitudes and different methods used for collecting dietary data. In the above mentioned Irish study (Hearthy 2007), a positive attitude toward healthy eating is operationalised as "a conscious effort to try to eat a healthy diet." The attitude was associated with food intake data collected by using a 7-day dietary record. The percentage of the population who complied with dietary guidelines for carbohydrate, total fat, saturated fat, dietary fibre and fruit and vegetable consumption was higher among those people with a positive attitude towards healthy eating. An increased intake of breakfast cereals, vegetables, fruit and poultry were associated with decreased odds ratio for negative attitudes towards healthy eating, while an increased intake of high-calorie beverages was associated with an increased odds ratio.

In a Danish study, based on a random population sample, frequent intentions to eat healthily have a strong association with dietary habits (Biltoft-Jensen et al 2008). When planning dinner, compliers with dietary recommendations differed from non-compliers as their meal focus was health-oriented, *i.e.* "low in fat" and "lots of vegetables," whereas non-compliers were more focused on the fact that "the food tastes good" and "the family likes the meal." In another recent study among young Finnish men, general interest in healthy eating studied by the HTAS attitude questionnaire correlates negatively with the eating of unhealthy sweet and fatty foods (Jallinoja et al 2011).

Within a family-context, associations between parental attitudes towards healthy eating and the diet of their children is an object of interest. So far, these parent-child associations are unclear. In a rather small English study, the mothers' concern for disease prevention in choosing the child's diet has correlated positively with 9-11-year-old children's fruit and vegetable intake (Gibson et al 1998). In Flemish preschoolers, an association between a mother's positive attitude towards healthy eating and a children's healthy eating score exists (Vereecken and Maes 2010). Further, there was a negative association between the same maternal attitude and an "excess eating index" of the child, indicating a high intake of sweet and savoury snacks, sweetened beverages, sugar products and french fries.

2.4 Family-based nutrition interventions in childhood and adolescence

There is considerable variability in the dietary intervention studies aimed at improving healthy eating in childhood and adolescents. The studies differ with respect to study

design, setting, participants, intervention content and duration and dietary targets (Figure 1). Primary study objectives improve diet quality alone or in combination with increased physical activity and/or decreased sedentary behaviour. Also prevention of obesity, cardiovascular diseases or diabetes has been set as primary objectives in some studies. Dietary targets of the interventions vary, including, for example, increased fruit and vegetable consumption, decreased fat and sugar intake or increased consumption of whole grains. Because of the heterogeneity of intervention studies, no meta-analysis to estimate pooled effects of dietary interventions exists, i.e. only narrative systematic reviews have been published so far.

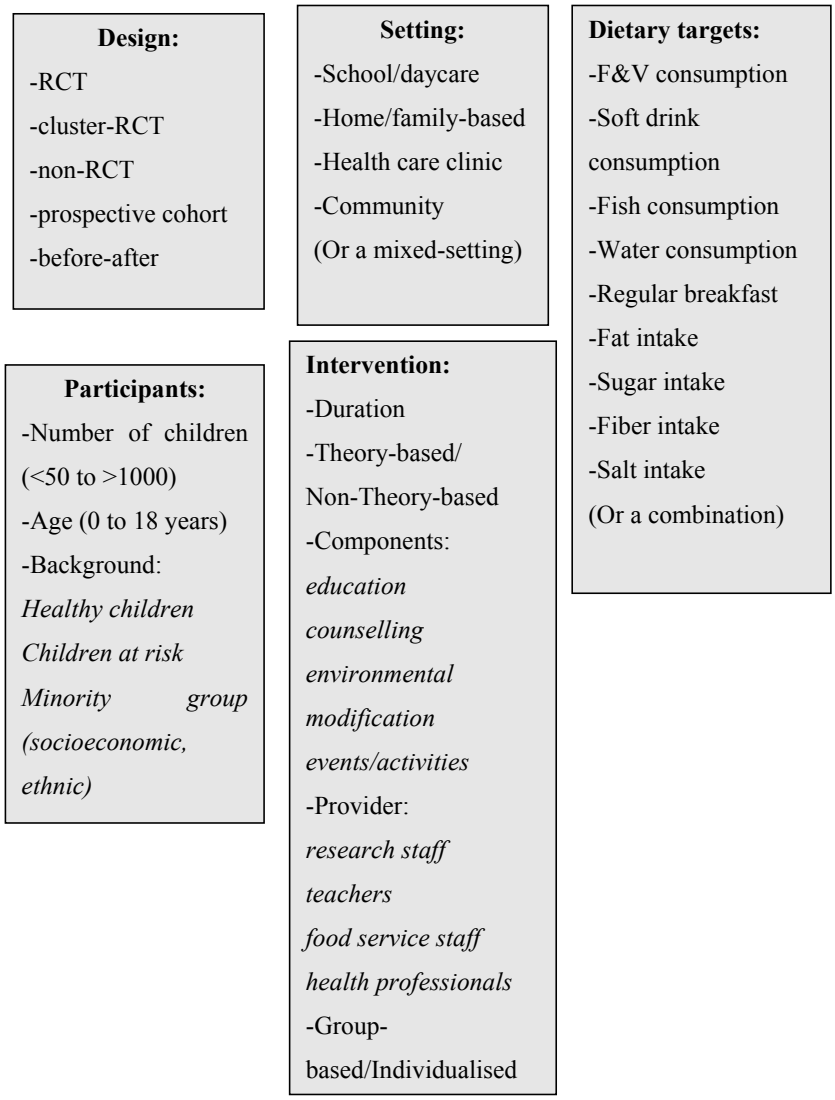

Figure 1. Examples of characteristics causing heterogenity in dietary intervention studies in children and adolescents.

Dietary interventions in childhood and adolescence occur mainly at preschool/ childcare settings (*e.g.* Hesketh and Campbell 2010) or school settings (*e.g.* Blanchette and Brug 2005, Van Cauwenberghe et al 2010, Roseman et al 2011, Waters et al 2011). Some of those studies have also had a parent and family component within the intervention (Blanchette and Brug 2005, Golley et al 2011, Hesketh and Campbell 2010, Roseman et al 2011). In a few interventions with parental involvement home, outpatient clinic or community settings are the main setting (Hingle et al 2010, Golley et al 2011).

In general, a common feature in the interventions was to improve children's dietary intake for a short duration. In the review by Golley et al (2011), most of the family-targeted interventions had the duration of 6-months or less. Furthermore, most of the studies focused on school-aged children (6 to 12 years of age) and there is a research gap of interventions for children aged 0-5 years and adolescents (Waters et al 2011).

In the following, two categories of interventions published since 1990 are presented in detail: First, the family-based interventions with home- or outpatient clinic as the main setting and fat intake and/or fruit and vegetable consumption as dietary goals/ indicators of eating (Table 2); and second, interventions mainly aimed at decreasing the risk of cardiovascular diseases (Table 3). In conclusion, most of the interventions had a short duration (less than one year). The longest duration, three years, was in the family-based DISC study for children with elevated LDL-cholesterol level (Lauer et al 2000) and in the school-based CATCH study (Lytle at al 1996), both aiming at reducing the risk for CVD.

Most interventions positively affect the total fat intake (Lytle et al 1996, Tershakov et al 1998, De Bourdeaudhuij and Brug 2000, Lauer et al 2000, Paineau et al 2008,Curtis et al 2012) but not in all (De Bourdeaudhuij et al 2002, Harvey-Berino and Rourge 2003, Patrick et al 2006). In the studies with a longer duration, the mean total fat intake decreased from 33.4 E% to 28.6 E% in the DISC study (with a significant decrease in SFA, MUFA and PUFA intake) and from 32.7 E% to 30.3 E% in the CATCH study (with significant decrease in SFA and MUFA intake). The mean change in fruit and vegetable consumption, when observed, was less than one portion (Epstein et al 2001, Haire-Joshu et al 2008). Different intervention effects occur between boys and girls (Patrick et al 2006) and between overweight and normal weight participants (Haire-Joshu et al 2008).

The results of the present study are based on the STRIP study, a randomised trial since infancy (Lagström 1997). Previously, tailored, family-based intervention decreases total fat and SFA intake in children up to the age of four years (Lagström et al 1997)

Table 2. Family-based interventions with home or outpatient clinic as the main setting.

Study Country	Design	Setting	Participants	Intervention	Dietary goals	Results in children
Epstein et al 2001 USA	CCT	Outpatient clinic	Families with at least one obese parent and a non-obese child (6-11 years) n=27 families	Targeted at parental weight-loss Included individual counselling and group meetings Duration: 6 months and 6 months follow-up Two different interventions (I1 and I2)	I1: Increased fruit and vegetable intake I2: decreased intake of high-fat and high-sugar foods	Change in F&V consumption (portions): I1: +0.72±1.11 I2:-0.55±1.31 Between group difference: p <0.025 Intervention 1 more effective in increasing F&V consumption Change in high-fat/high-sugar food consumption (portions): I1: -4.50±7.97 I2: -8.50±7.58 between group difference p = NS time effect <0.001 Both intervention 1 and 2 decreased the consumption of high fat and high sugar foods.
Haire-Joshu et al 2008 H5-KIDS/ Parents as teachers USA	RCT	Home	Participants taking part in "Parents as teachers" parent education program n=1306 parents and their children (age 1-6 years)	Computer tailored newsletters, home visits, written materials (e.g.. a storybook) Duration 6-11 months.	Increase F&V consumption by improving parents ability to shape the F&V consumption of their children	F&V (servings): Intake increased in normal weight (+0.35, p=0.02) but not in overweight (-0.10, p=0.48) children. Parents change in F&V intake was a significant predictor of child's change in F&V intake
Patrick et al 2006 PACE+ USA	RCT	Primary care with follow up at home (including mail and telephone counselling)	n=878 children (age 11-15 years)	Office-based computer-assisted diet and physical activity assessment and stage-based goal setting and counselling, Monthly mail and telephone counselling (duration 12 months)	Increase F&V consumption Increase fiber intake Decrease total fat intake.	Change in F&V consumption (portions): I girls: 3.5(1.5) →4.2 (1.8) C girls 3.5(3.9) →3.9(1.7) p=0.07 I boys: 3.5(1.6) →4.2(1.7) C boys: 3.7(1.6) →4.4(1.6) p=0.49 →The intervention increased F&V consumption in the intervention girls compared to the control girls. Total fat intake (E%): I girls: 32.6(31.4) →31.4 (7.0) C girls 33.3(7.2) →31.7(6.6) p=0.86 I boys: 32.6(5.7) →31.2(6.3) C boys: 32.3(6.2) →31.6(5.9) p=0.31 →No intervention effect on fat intake. After the intervention, more girls in the intervention group compared with the control group met the guideline (<10 E%) for saturated fat: I: 23% →41% C: 19% →31% RR 1.33; 95% CI (1.01–1.68)

Study Country	Design	Setting	Participants	Intervention	Dietary goals	Results in children
Paineau et al 2008 ELPAS study France	RCT	Home	n=1013; Parents and their children (mean age=7.7 years)	"Dietary couching": Phone counselling and internet-based monitoring, (also some events and lessons at schools) Duration: 8 months	I1: Reduced fat (SFA) intake and increased complex carbohydrate intake I2:Reduced fat (SFA) and sugar intake and increased complex carbohydrate intake	Mean change in fat intake (E%): I1: -3.3(-4.0 to -2.6) E% I2: -2.3 (-3.0 to -1.5)E% C: -0.6 (-1.2 to -0.1)E% p<0.01 between I1 and C and I2 and C. →Both interventions decreased fat intake compared to the control group. fat intake (E%) at baseline: I1: 35.7 (5.2) I2: 34.9 (6.0) C: 35.1 (5.5)
Wardle et al 2003 USA	RCT	Home	n=143; Children (aged 34-82 months) with a principal caregiver	I1: exposure-based intervention, carried out by parents at home I2: information only C:contol	To increase children's liking for a previously disliked vegetable	Greater increase in liking ranking and observed consumption of the target vegetable in the exposure group
Harvey-Berino and Rourge 2003 OPPS (part of PS study) USA and Canada	CCT	Home	n=43; Overweight mothers and their child (aged 9 months – 3 years)	Obesity prevention intervention as a part of parenting support (PS) intervention delivered by peer educators I1: OPPS (obesity prevention and parenting support) intervention I2: PS (parenting support) intervention Duration: 16 weeks	Development of eating behaviours in children by improving parenting skills	Change in total fat intake (E%): I1: 34.9(±6.4) →34.0(±7.2) I2 35.8(±8.7) →32.7(±5.2) Change between groups p=NS →The change in fat intake not significant between the intervention groups.
De Bourdeaudhuij and Brug 2000 Belgium	CCT	Home	n=35; Family quartets including two parents and two adolescents (aged 12-18 years)	Mailed nutrition education letters I1:Letters included tailored messages to the family to reduce fat intake, including personal feedback on fat intake measured earlier. I2: letters included general nutrition education. Duration: 6 weeks	Reduced fat intake	Tailored intervention was more effective than the non-tailored intervention in reducing total and saturated fat intake only for mothers. Total fat intake (E%) at baseline and post-intervention for the adolescents: I1: 41.0 →39.3 I2: 39.4 →38.1 Significant (p<0.05) reduction for both groups SFA intake (E%) at baseline and post-intervention for the adolescents: I1: 15.5 →14.1 I2: 14.1 →13.9 Significant (p<0.05) reduction for both groups Among the adolescents both the tailored and non-tailored interventions decreased total fat SFA intake.

Study Country	Design	Setting	Participants	Intervention	Dietary goals	Results in children
De Bourdeaudhuij et al 2002	CCT	Home	n=180; Adolescents (aged 15-18 years) and parents	Individually tailored nutrition education letter sent to: I1: two family members simultaneously; family-based intervention I2: one family member only (one adult or one child); individual-based intervention Durations: 6 weeks	To reduce fat intake	No reduction in fat intake (E%) among I1 or I2 and no differences in post intervention fat intake between the two interventions. However, there was a significant reduction in fat intake among respondents with high fat intake (>35 E%) at baseline.
Curtis et al 2012 FFHP study UK	CCT	Home	n=169 families with at least one child under the age of 16 years. n=589 individual's average age for children was 8-9 years.	I1: Education only (a fayre) I2:cook and eat sessions only I3:education + cook and eat + personalised goal setting in face-to-face meetings Duration: 3 months	To increase intake of low-fat starchy foods and to reduce fat intake	Results given to all family members together, not to children separately. Change in total fat intake (E%) I1: 37.1 →35.9 I2: 36.7 →35.4 I3: 37.0 →34.1 Intake decreased in all groups ($p<0.05$). There was a significant difference between I1 and I3 in post-intervention intake ($p=0.02$) →The multicomponent intervention was more effective than a single component intervention to decrease total fat intake in family members.

CCT - clinical comparison trial / **RCT** - randomised controlled trial / **I** – Intervention / **C** – Control / **NS** - non significant

Table 3. Dietary interventions in childhood and adolescence targeted at reduction of risk for CVD

Study Country	Design	Setting	Participants (number, children's age at baseline)	Intervention	Dietary goals	Results in children
Tershakov et al 1998 CHP study USA	CCT	Family	Hypercholesterolemic children, aged 4 to 10 years n=342; mean age was 6 years	Two educational approaches and a control group I1: Parent-child autotutorial program (taking-book lessons, paper-pencil activities) I2: A counselling session with a registered dietician Duration: 3 months	Heart smart nutrition: Fat intake	Both intervention groups decreased their total and SFA intake (E%) significantly more than the control group ($p<0.05$); change 1.5-2.5 E%. Total and SFA intake low at baseline: 29-30 E%; 11-12 E%.
Lauer et al 2000 DISC USA	RCT	Family	Children with elevated LDL cholesterol, age 8-10 years n=663 (children with extreme LDL cholesterol concentration or with a premature CVD in a parent excluded)	Individual and group visit, telephone contacts between visits Control: Usual care Duration: 3 years	Total fat <28 E% SFA <8 E% PUFA <9 E%	Change in total fat intake E%: I: 33.4(±5.5) → 28.6(±5.8) C: 34.0(±4.9) → 33.0(±4.7) Difference between groups $p<0.001$ →The intervention decreased total fat intake. Change in SFA intake E%: I: 12.5(±2.7) → 10.2(±2.6) C: 12.7(±2.5) → 12.3(±2.2) Difference between groups $p<0.001$ →The intervention decreased SFA intake Change in MUFA intake E%: I: 12.5(±2.4) → 10.7(±2.5) C: 12.7(±2.2) → 12.3(±2.1) Difference between groups $p<0.001$ →The intervention decreased MUFA intake Change in PUFA intake E%: I: 5.7(±1.5) → 5.5(±1.9) C: 6.0(±1.6) → 5.9(±1.8) Difference between groups $p=0.03$ →The intervention decreased PUFA intake.
Salminen et al 2005 Finland	Controlled Clinical Trial	Home	Children (aged 6 to 17 years) with a familial history of CVD n=1055	Counselling sessions at home and at school; Parents accompanied the youngest children Duration: 2 years	Use of fat products, type of milk, salt and fibre intake	Favourable changes in the use of fat products and type of milk used in the intervention group. Nutrient intake or absolute food consumption not measured.

Study Country	**Design**	**Setting**	**Participants** (number, children's age at baseline)	**Intervention**	**Dietary goals**	**Results in children**
Lytle et al 1996 CATCH USA	RCT (school-based ran-domisa-tion)	School	n=1182 children Age: 8-9 years	Classroom activities Changes in school food service Family intervention Duration: 3 years	Total fat intake < 31.5 E% SFA≤10 E% Sodium intake ≤3g	Change in total fat intake E%: I: 32.7(±7.4) → 30.3(±6.8) C: 32.6(±6.6) → 32.2(±7.1) Difference between groups p<0.005 →The intervention decreased total fat intake. Change in SFA intake E%: I: 12.8(±3.6) → 11.4(±3.5) C: 12.7(±2.5) → 12.3(±2.2) Difference between groups p<0.005 →The intervention decreased SFA intake. Change in MUFA intake E%: I: 11.9(±3.1) → 11.1(±3.0) C: 11.9(±2.9) → 11.6(±3.0) Difference between groups p>0.05. →The intervention decreased MUFA intake. Change in PUFA intake E%: I: 5.7(±2-5) → 5.6(±2.3) C: 5.9(±2.3) → 6.1(±2.7) Difference between groups p>0.20 →The intervention had no effect on PUFA intake.
Williams et al 2002 Healthy-Start USA	Con-trolled Clinical Trial	Pre-School	n=1296; Aged 2-5 years	Food service interven-tion Duration: 2 years	Total fat intake ≤ 30 E% SFA intake ≤ 10 E%	Change in total fat intake E%: I: 30.9(6.8) → 30.2(6.9) C: 31.0(6.8) → 31.1(6.4) P=? (not found). →The intervention decreased total fat intake? Change in SFA intake E%: I: 12.0(3.7) →10.9(3.1) C: 12.4(3.2) →12.4(3.5) P=? (not found) →The intervention decreased SFA intake?

Study Country	Design	Setting	Participants (number, children's age at baseline)	Intervention	Dietary goals	Results in children
Lagström et al 1997 STRIP Finland	RCT	Family	n=1052; Children, aged 7 months at baseline Duration: Results analysed here until the age of four years (intervention continued)	Tailored counselling to the parents since infancy	Major target: dietary fat quality Minot targets (for example):F&V consumption, fibre intake, balanced diet	Total fat intake E% (at 4 years): 1:31.2 (4.8) C: 33.1(4.7) p<0.001 →The intervention decreased total fat intake. SFA intake E% (at 4 years): I:12.1(2.5) C: 14.6(2.8) p<0.001 →The intervention decreased SFA intake. MUFA intake E% (at 4 years): I: 10.7(2.0) C:10.7(1.8) p=0.78 →The intervention had no effect on MUFA intake. PUFA intake E% (at 4 years): I: 5.3 (1.2) C:4.6 (1.2) p<0.001 →The intervention increased PUFA intake.

CCT - clinical comparison trial / **RCT** - randomised controlled trial / **I** – Intervention / **C** – Control / **NS** - non significant

2.5 Summary of the literature review

Both the general dietary recommendations and the clinical recommendations for preventing CVD emphasise reduced intake of saturated and *trans*-fatty acids and their replacement with unsaturated, especially polyunsaturated fatty acids. There is also a clear global consensus of recommending high intake of fruits and vegetables for promoting health.

In many counties, national surveys of children's and adolescent's diets are lacking. Also Finnish dietary studies among children are scarce. Previous studies show that children's saturated fat intake is higher than recommended and unsaturated fat intake and fruit and vegetable consumption lower than recommended both globally and in Finland.

Dietary behaviour is influenced by many psycho-social factors such as attitudes. Self-reported, diet-related attitudes seem to reflect dietary choices. Associations between parental diet-related attitudes and dietary choices in families with children have not been widely studied.

There is considerable variability in dietary intervention studies aiming to improve healthy eating in childhood and adolescence. These are implemented at school or childcare settings, they have had a fairly short duration and most of the studies focus on school-aged children. There is a lack of long-term, family-based dietary interventions starting in early childhood.

The Finnish STRIP study shows that the infancy-onset, family-based dietary intervention affects children's fat quality favourably until the age of four years. Parental nutritional knowledge has grown during the dietary intervention but it has correlated poorly with parents' nutrient intakes, indicating that other factors than knowledge have influenced parental dietary decisions.

The present studies analyse the influence of the STRIP dietary intervention on fat intake and fruit and vegetable consumption among the children until the age of eighteen years. Also, the effects of the intervention on parental diet-related attitudes are observed, as well as associations between parental interest in healthy eating and eating habits in parents and children.

3 AIMS OF THE STUDY

The STRIP study is the first family-based, long-term, infancy-onset dietary intervention study in children and adolescence. The main focus of the cardioprotective STRIP intervention is to determine the fat quality of the diet since infancy. A minor target was to increase the consumption of fruits and vegetables.

The main aim of this study was to investigate the longitudinal effects of the dietary intervention on the families covering the effects on children's diet from early childhood throughout adolescence, as well as effects on the diet and diet-related attitudes of the parents of the STRIP study.

The specific aims were to study the influences of the dietary intervention:

1. On dietary fat intake and fat quality in children (Study I, Study III).
2. On fruit and vegetable consumption in children (Study II, Study III).
3. On diet-related attitudes in parents (Study IV).
4. On diets of parents and their children with different levels of parental interest in healthy eating (Study IV, unpublished data).

4 PARTICIPANTS AND METHODS

4.1 The study setting and design

The STRIP study is a prospective, randomised coronary heart disease risk factor intervention trial. The aim of the study was to reduce exposure of the intervention children to the established CVD risk factors.

The families were recruited to the study by nurses at well-baby clinics in the city of Turku, Finland, at the infants' routine 5-month visit between March 1990 and June 1992 (Figure 2). Of the 1880, 5-month-old infants, 1105 infants with their families were interested to visit the study centre (Research Centre of Applied and Preventive Cardiovascular Medicine, CAPC). Finally, at the study centre the participating 1062 infants (8 twin pairs) with their parents were randomly allocated into an intervention group (n=540) or a control group (n=522) at the 7-month visit. The mother's mean age (SD) at the randomisation was 30 (±5) among the intervention families and the control families. The father's mean age (SD) at the randomisation was 33 (±6) years among the intervention families and 32 (±6) years among the control families.

After the randomisation, the intervention families received regular, individualised dietary and lifestyle intervention aimed at reducting established CVD risk factors. They visited the study centre at 1- to 3-month intervals until the child was 2 years old and biannually thereafter. The control families, which received no specific preventive intervention (*i.e.* they received only standard care at regular visits at well baby clinics) were seen biannually until the child was 7 years old and once a year thereafter. At each visit, the intervention and control families met a nutritionist, a physician and/or a nurse. During the study visits, data on food consumption, other lifestyle habits and anthropometric and laboratory data were collected.

The main aim of the intervention was to influence the dietary fat quality: to reduce the saturated fat intake and to increase mono- and polyunsaturated fat intakes. Counselling on primary prevention of smoking was initiated when the intervention children were nine years old. A physically active lifestyle was also encouraged, but physical activity *per se* has not been a formal, continuous component of the intervention.

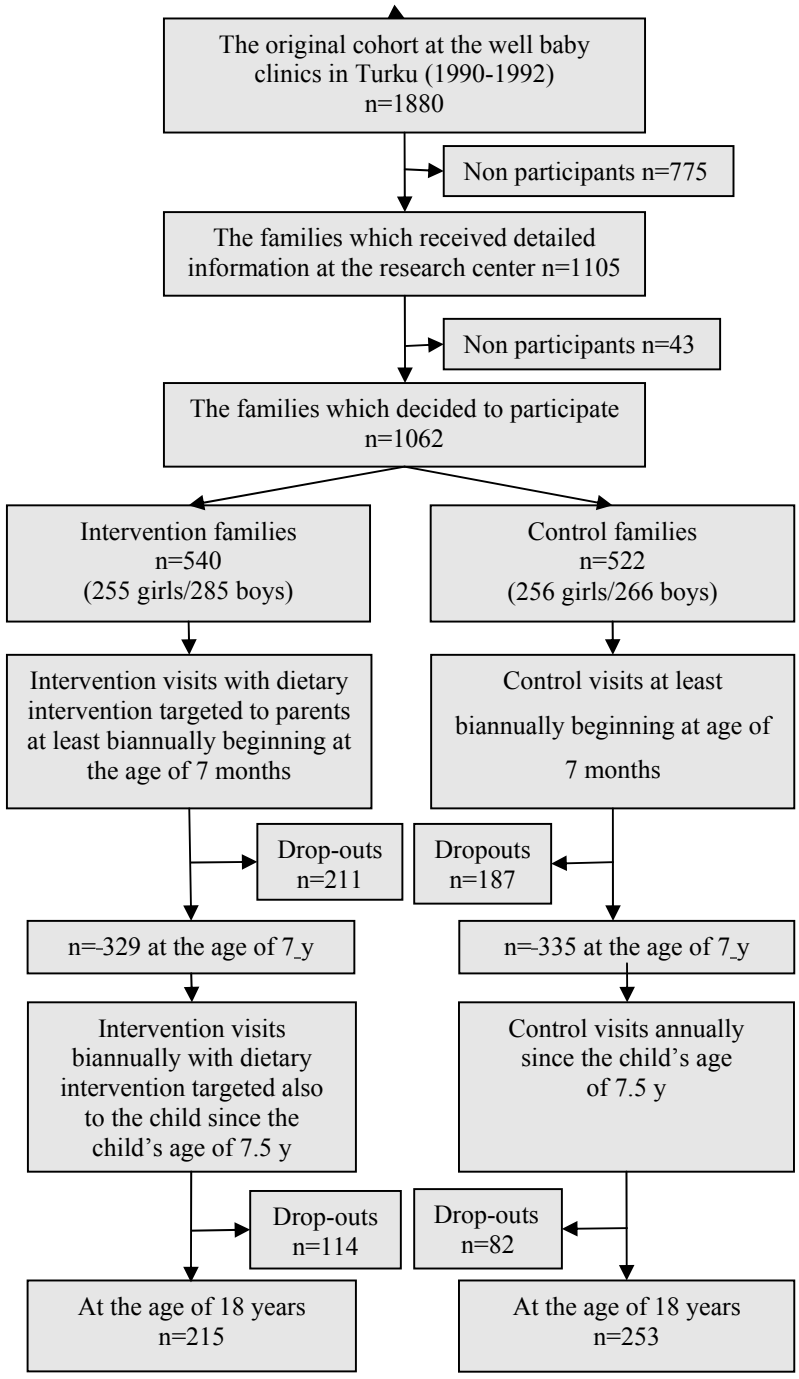

Figure 2. Flow chart of the study design.

4.2 Participants and data

The number of child and parent participants at different ages of children by main variables is presented in Table 4.

Table 4. Age of children and number of participants studied by main variables

Main variables	Age of children (years)	Number of participants	Sub study
Fat quality in children	4-10	481-752*	Study I
	2-18	358	Study III
	11	335	unpublished data
Fruit and vegetable consumption in children	1-10	481-953*	Study II
	2-18	358	Study III
	11	358	unpublished data
Parental fat quality	11	491	Study IV
Parental fruit and vegetable consumption	11	491	Study IV
Parental diet-related attitudes	11	610	Study IV

*Depending on the age point

In **Study I,** the fat intake of the children was examined when they grew from 4 to 10 years of age and in **Study II,** fruit and vegetable consumption of the children was studied while they grew from 1-year-old (13 months) to 10-year-olds. The number of the intervention children was 492, 371 and 228 at the ages of one, four and ten years, respectively and the number of the control children was 461, 381 and 253 at the ages of one, four and ten years, respectively. In **Study III,** the longitudinal dietary intake was evaluated in 151 intervention children (74 girls, 78 boys) and 207 control children (104 girls, 103 boys) with ≥ 50% of food records within each of the four age intervals studied (2-6 y, 7-11 y, 12-16 y, 17-18 y).

In **Study IV,** diet-related attitudes of parents were studied at the child's age of 11 years. Questionnaires were sent to the mothers (n=602) and the fathers (n=599) of those families who visited the study centre. Only those parents who had taken part in the study from the beginning were included in the analysis (*i.e.* new step parents were excluded). Questionnaires were received from 369 mothers (=61.3% of the questionnaires sent), and 241 fathers (=48.7% of the questionnaires sent). For the analysis of the associations between attitudes and diet, we included only parents with a completed food record (135 intervention mothers, 93 intervention fathers, 151 control mothers and 112 control fathers) and their children with a completed food record (155 intervention children and 180 control children).

4.3 Dietary intervention

The purpose of the STRIP dietary intervention was to gradually increase parents' and later also children's knowledge and skills of cardioprotective eating, and to support the belief

that children's dietary habits can be modified and that favourable changes in diet will improve health. Parents were encouraged to purchase and eat healthy food themselves and to enlarge the repertoire of healthy foods offered to the child and family. The dietary targets were based on the Nordic Nutrition Recommendations. The main dietary aims were to reduce saturated fat intake and to increase the unsaturated to saturated fat ratio. The optimal diet was defined to contain energy without any restrictions, fat 30 E% (30-35 E% between 13 months and 2 years) and saturated fat $\leq$ 10 E% with an unsaturated to saturated fat ratio (U:S) of 2:1.

The biannual dietary intervention session with a nutritionist consisted of *nutrition education* with an age-specific dietary topic (*e.g.* saturated and unsaturated fat, visible and invisible fats, role of fruit and vegetables and whole grain products in healthy eating, regular eating) and tailored *dietary counselling* dealing with the child's and family's dietary choices and intake. The family received both oral and written tailored feedback about the child's nutrient intake. The feedback included comparisons of the child's diet with the dietary goals of the study, and with the Nordic dietary recommendations. Moreover, practical suggestions were given on how to further improve the quality of the child's diet. The tools used for monitoring dietary intake and food choices are presented in detail in Table 5.

The total time of an intervention session for each family was approximately 30 minutes. Depending on the family's circumstances, interests and time restrictions, one or both parents participated in the session. In the beginning of the study, only the parents took actively part in the intervention, but after the child turned seven years old a separate educational session was organized for the child. The parents were carefully informed about the tasks the child had performed during the separate educational session. The sessions are described in more detail up to the child's age of seven years in Table 6 and between 7.5 and 18 years in Table 7.

Written material and brochures concerning the specific topic of each intervention session were given to the families during the session. Between the ages of seven and fifteen years of age, letters with paper-pencil, cut-glue and food preparation tasks were sent home between the two annual visits. Letters included a separate information sheet for parents, in which the nutritional background information of the tasks was given in simple terms. The parents were also encouraged to discuss food choice and preparation issues with their child.

The control families did not routinely receive any detailed intervention focused on risk factors of atherosclerosis, especially dietary fat intake. During the study, they filled in a four-day food record of the child before each study visit biannually until the child's age of seven years and once a year thereafter. Families received a short general feedback letter of the child's dietary intake focusing on issues other than dietary fat (*e.g.* energy, sucrose, vitamin and mineral intakes) to motivate them to keep the food diary and to take part into the study. No brochures or other material with related to the intervention topics were given to the families during the visits.

Table 5. Monitoring of dietary intake and food choice behaviour in the counselling.

Age	Short structured interview: eating pattern/ Food consumption of the child	Short structured interview: basic food habits of the family	Food record of the child with feedback	Food frequency questionnaire	Dietary recall[1]or food record[2] of the parents
7 mo	X	X			X[1]
8 mo		X	X		
10 mo	X	X			
13 mo		X	X		X[1]
15 mo	X	X	X		
18 mo		X	X		
21 mo	X	X			
2 y		X	X		X[1]
2.5 y		X	X	X*	
3 y		X	X		X[1]
3.5 y		X			
4 y		X	X		X[1]
4.5 y		X	X		
5 y		X	X		X[1]
5.5 y		X	X		
6 y		X	X		
6.5 y		X	X		
7 y		X	X		X[1]
7.5y		X	X		
8 y		X	X		
8.5 y		X	X		
9 y		X	X		X[2]
9.5 y		X	X		
10 y		X	X		
10.5 y		X	X		
11 y		X	X		X[2]
11.5 y		X	X		
12 y		X	X		
12.5 y		X	X		
13 y		X	X		X[2]
13.5 y		X	X		
14 y		X	X		
14.5 y		X	X		
15 y		X	X		X[2]
15.5 y		X	X		
16 y			X	X	
16.5 y			X	X	
17 y			X	X	X[2]
17.5 y			X	X	
18 y			X	X	

*Food frequency questionnaire about the sources of saturated fat

Table 6. Main themes of the nutrition intervention between the ages of 7 months and 7 years, when the intervention was focused mainly on parents.

Age	Main themes
7 mo	Introduction of the major goals of the nutrition intervention Differences between different types of fat
8 mo	Fat quality, margarine and vegetable oil in cooking, fatty acid composition of different margarines
10 mo	Skim milk and extra vegetable fat, low-fat sour milk products
13 mo	Quality of fat, skim milk and extra vegetable fat, visible and invisible fat
15 mo	Balanced diet, regular meals High-saturated fat and high-cholesterol food items
18 mo	Importance of fat in the diet, quantity of skim milk and extra vegetable fat, Cereals and dietary fibre
21 mo	Unsaturated fat Cereals
2 y	Salt and health
2.5 y	Dietary sources of saturated fat (e. g. cheese, meat)
3 y	Visible and invisible fat, quantity of fat in the child's diet
3.5 y	Sources of saturated fat in child's diet, oil in cooking Sucrose, snacks & dental health
4 y	Invisible fat in diet
4.5	Eating pattern Food, eating and dental health
5 y	Salt and health, reduce the amount of salt in diet
5.5 y	Review: dietary fat, sources of saturated fat in child's diet, use of oil in cooking and salad dressings
6 y	Dietary habits of parents, parents as role models for their children Quality of fat, fruit and vegetables, salt intake
6.5 y	Quality and quantity of dietary fat Food choices at school (skim milk, margarine)
7 y	Child's food choices outside the home/at school Carbohydrates in diet, sources of carbohydrates

Table 7. Main themes/goals and methods of the nutrition intervention between the ages of 7.5 and 18 years, when the educational part of the intervention was targeted mainly to children.

Age (Years)	**Main themes/goals**	**Practical methods used**
7.5	Fat, visible fat, invisible fat, heart healthy fat	Food models (The child explained which foods contain fat) Educative pictures of dietary fat *Homework*: to choose 5 non-fat and 5 fatty foods from the home kitchen; colouring task about invisible fat *Letter 1:* A paper-pencil task: Animal fat and vegetable fat *Recipe letter:* milk shake/quark
8	Reducing the use of salt	Salt exhibition: Salt content of different foodstuffs Paper pencil task: foods with different amounts of salt were compared *Homework:* To examine and compare dairy products at home *Letter 1:*A paper-pencil task: low-fat and low-salt products *Recipe letter:* Salads and salad dressings; how to recognize low-salt products at supermarket *Salt letters:* two information sheets about salt intake
8.5	Dietary fat quality	Picture identification task: the child chose a low-fat option from different foods A task with wooden balls: the child gave red and green wooden balls (i.e. saturated and unsaturated fat) to different foods depending on their fat quality. *Homework:* Colouring task related to the task of wooden balls *Letter 1:* Paper-pencil task about heart-healthy foods and food labelling *Recipe letter*: Berry pie and oat bread *Salt letters*: Recipes with non-salt spices
9	To measure child's nutrition knowledge	Picture identification test: issues addressed in the test were the amount of salt and the fat in foods and the heart healthiness of foods *Letter:* Crosswords about nutrition *Recipe letter :* Vegetables with a dipp sauce
9.5	Increasing the consumption of fruit and vegetables Use of vegetable oil-based salad dressings	Picture identification: different fruit and vegetables All fruit and vegetables eaten on previous day were counted *Homework:* To cut and clue or draw pictures of all fruit and vegetables eaten during one day *Recipe letter:* Fruit and berry desserts
10	Use of cereal products, intake of fibre, the importance of bread in everyday diet Margarine on bread	Identification of cereal grains A picture presentation of the functions of dietary fibre in the human body *Homework:* To count the amount of bread eaten during one day *Letter:* To make a sandwich *Recipe letter:* Porridges

Age (Years)	Main themes/goals	Practical methods used
10.5	Dietary fibre intake Sources and functions of fibre	The child selected items from food models based on their fibre content *Homework:* True or false claims about dietary fibre *Recipe letter:* Pancake and yoghurt with oats
11	Food pyramid and the food plate model as models for healthy eating Balanced diet	The child explored different models for healthy eating *Homework*: To draw one of the favourite meals using a food plate model *Recipe letter*: A pasta dish, salad, salad dressing and a fruit dessert
11.5	Quality of fat, unsaturated and saturated fat	The child compared two photos of meals (one of them a heart healthy meal with better fat quality) *Recipe letter*: Pizza, salad and salad dressing
12	Visible fat and invisible fat Reasons for choosing unsaturated fat Essential fatty acids, fat-soluble vitamins	A Computer game about fat ("Fättilän kylä"/"Village of Fatties") Self-evaluation of family's food habits *Recipe letter:* Scones and buns, self-made spreads
12.5	Basic principles of healthy eating Food pyramid (balanced diet) Different food groups	Rainbow model (resembles food pyramid): The child found places for different food groups in the model *Recipe letter:* Different snacks: pizza bread, rye hamburger, yoghurt with fruits
13	Motivate the child to fill the food record independently Use of the new food portion booklet	A story of Saku's day: the child filled the Saku's food record according to the story and food models *Letter:* Web pages about nutrition and healthy eating
13.5	Healthy eating The HEART SYMBOL (a product marked with this symbol is a better choice among the product group regarding fat, sodium and fibre content)	A nutrition quiz with multiple choice questions about healthy eating; answers were discussed with the child Features of different products with the HEART SYMBOL were discussed *Recipe letter:* A healthy breakfast, porridge; a sachet of an instant porridge included
14	Eating pattern Flexibility and individuality in eating	A picture of meals and snacks of a typical day *Letter:* The importance of free School lunch: pictures of different school meals, brochure about fruit and vegetables (including a tool to count fruit and vegetable consumption)
14.5	Evaluation of the personal and family's eating habits Nutritional and other life style factors influencing health	Self evaluation of the diet: The child gave a grade for personal/family eating habits and discussed the reasons for giving that grade. Further, the child evaluated whether he/she was satisfied with the grade and the features he/she is satisfied/unsatisfied with. Finally, the child set a personal dietary goal for the future. General discussion about life style habits which influence health. *Letter:* To remind about the goal set on the previous visit.

Age (Years)	Main themes/goals	Practical methods used
15	Motivating the child to continue in the study A short review of the topics of the previous counselling sessions.	A table about previous dietary intervention topics was shown to the child The progress of personal blood cholesterol and dietary intake values discussed with the child and the family. *Letter:* Dietary recommendations
15.5	Portion sizes Low nutrient density foods	Pictures of different portion sizes Pictures to visualize the concept of nutrient density The appropriate use of foods with low nutrient density was discussed with the child A cook book of Finnish Horticultural Products Society given to the child
16	Fat quality Taste preferences: Healthy food can also be tasty	The child did a test about the quality of dietary fat. The results were discussed and future goals evaluated with the nutritionist. A bottle of rapeseed oil given to the family with recipes for salad dressings and marinades
16.5	Fruit and vegetable consumption Reasons and practical ways to increase fruit and vegetables consumption	Pictures and 500 g of real fruits and vegetables presented to the child to demonstrate the amount of recommended intake and to activate discussion. Baby carrots, fruit and vegetable drinks and dried fruits provided to children.
17	Convenience food, ready meals: diversity of options, differences in the nutritional profile, complementation of ready meals with salad, bread, margarine and milk.	Power point presentation and discussion.
17.5	Eating patterns Hunger versus desire to eat	Power point presentation and discussion
18	Cereal products Dietary fibre intake	Pictures on how to increase fibre intake in practise. Reasons why to choose whole grain products discussed with the child.

4.4 Measures

4.4.1 Dietary assessments

Data on food consumption of the children were obtained close to each study visit by using food records on four consecutive days including at least one weekend day. In the present study, the food consumption data of each child was calculated by using one, four-day food record annually (filled in close to the child's annual birthday). Parents' food consumption data were obtained by using one day food records close to the child's birthday.

In the beginning of the study, the parents were given written instructions on how to record food consumption with exact descriptions of the amounts of all foods and drinks. A new diary form was sent to the families three to four weeks before each follow-up-visit. It included instructions and drawings, which helped the record-keeping and the estimation of the food amounts. From the age of 13 years, a special food picture booklet was used. The amounts were mainly estimated using household measures (spoons, cups, glasses). The parents, other caregivers and later the child him/herself also recorded the type, brand and preparation method of all foods used. Special information meetings about the STRIP project and on how to keep food records were arranged to kindergarten and school personnel.

Food records were analysed with the Micro Nutrica® program by the same experienced dietary technician. The program was developed at the Research Centre of the Social Insurance Institution (Turku, Finland), and it was based on their Food and Nutrient Database. The data bank of the program is flexible and permits continuous updating. During the study, the data of foods, recipes and nutrient compositions was regularly updated.

Dietary outcomes are presented in the Table 8**.** When studying the fruit and vegetable consumption, all the fresh, dried, canned and cooked vegetables including root vegetables and fruits including berries were included to the analyses. Fruit juices as well as legumes were excluded from the analyses. Potatoes were analysed separately, because in the Finnish food culture potato is an energy-yielding food item comparable to rice or pasta, not to other root vegetables.

Participants with constantly high fat quality ratio (HFQR) and low fat quality ratio (LFQR) as well as constantly high fruit and vegetable consumption (HFVC) and low fruit and vegetable consumption (LFVC) were determined in two steps: first within the separate age intervals then during the whole time range. The participant was first defined as a subject with high fruit and vegetable consumption or fat quality ratio *in an interval* if at least 50% of the age point measurements were in the highest tertile and not in the lowest tertile. Second, the participants with *constantly* high fruit and vegetable consumption or fat quality ratio were defined as having at least >50% of the intervals

high consumption or fat quality ratio and never low consumption or ratio. Participants with constantly low consumption or ratio were determined likewise.

Table 8. Outcomes and measurement points of dietary assessments measured by food records in children and parents

Outcomes		Measurement point (Child's age) & Study
In children	Total intake E%	4-10 years (Study I)
	SFA E%	4-10 years (Study I) 2-18 years (Study III) 11 years (Unpublished data)
	MUFA E%	4-10 years (Study I) 2-18 years (Study III)
	PUFA E%	4-10 years (Study I) 2-18 years (Study III)
	Fat quality ratio ((PUFA+MUFA)/SFA)	4-10 years (Study I) 2-18 years (Study III) 11 years (Unpublished data)
	Constantly high fat quality ratio (HFQR) Constantly low fat quality ratio(LFQR) (more details in the text)	2-18 years (Study III)
	Fruit and vegetable consumption in grams (potatoes excluded)	1-10 years (Study I) 2-10 years (Study III) 11 years (unpublished data)
	Consumption of potatoes in grams	1-10 years (Study II)
	Vegetable consumption in grams (potatoes excluded)	1-10 years (Study II)
	Fruit and berry consumption in grams	1-10 years (Study II)
	Constantly high F&V consumption(HFQR) (more details in the text) Constantly low F&V consumption (LFQR) (more details in the text)	11 years (Unpublished data)
In adults	SFA E%	11 years (Study IV)
	Fat quality ratio ((PUFA+MUFA)/SFA)	11 years (Study IV)
	Fruit and vegetable consumption in grams (potatoes excluded)	11 years (Study IV)

4.4.2 Evaluation of diet-related attitudes

In **Study IV,** the eating attitudes of the parents were measured by using the Health and Taste Attitude Scales (HTAS), an attitude measurement tool developed in Finland (Roininen at al 1999). The original scale questionnaire consisted of 20 health- and 18 taste-related statements which were scored on seven-point Likert scales with the categories ranging from "disagree strongly" (number 1) to "agree strongly" (number 7). The original scales consisted of six subscales: *General health interest*, *Light product interest*, *Natural product interest*, *Craving for sweet foods*, *Using food as a reward* and *Pleasure*. Each subscale was composed of an equal number of positively and negatively worded statements in order to minimize the respondents' tendency to agree with the items.

In the present study, the attitude item evaluation using factor loadings resulted in the retention of 18 health related items loading on three factors *General health interest*,

Light product interest and *Natural product interest* (the Cronbach's alphas for subscales 0.88, 0.81 and 0.72, respectively) and 16 hedonic items loading on four factors *Craving for sweet foods*, *Understanding other people's craving*, *Using food as a reward* and *Pleasure (*the Cronbach's alphas for subscales 0.75, 0.89, 0.81 and 0.67, respectively). The variance explained by each subscale ranged between 2.7 – 15.1%.

4.5 Statistical analyses

The statistical analyses were performed using SAS statistical software, release 8.2 (Study I&II), release 9.2 (Study III) and release 9.1.3 (Study IV) (SAS Institute Inc, Cary, NC, USA). P-values <.05 were considered statistically significant. In linear models, variables with a skewed distribution were log-transformed for the analyses.

When analyzing the effect of the intervention on fat intakes in children aged from 4 to 10 years in **Study I**, general linear models for longitudinal data were used (repeated measurements ANOVA). In the full model, age (continuous variable), STRIP group, interaction between age and group (age x group), quadratic term for age (age x age), and interaction between quadratic term for age and group (age x age x group) were included. If there was significant interaction between age and group or between the quadratic term for age and group, then differences between groups at the ages of 4, 7, and 10 years were calculated with contrasts from the full model. Otherwise, the difference between groups was estimated from the model without these interactions.

In **Study II**, the effects of the intervention on fruit and vegetable consumption in children aged from 1 to 10 years were analysed using general linear models for longitudinal data (repeated measurements ANOVA). In the full model, age, STRIP group and gender as well as interaction between age and group (age x group), age and gender (age x gender), group and gender (group x gender) and age and group and gender (age x group x gender) were included. If there were significant interactions with gender, genders were analysed separately. If there was still an interaction of age and group, differences were calculated separately at different age points. Otherwise, the differences between groups or genders were estimated from the model without these interactions.

In **Study III,** the means of dietary intakes within the age intervals (2-6 y, 7-11 y, 12-16 y, 17-18 y) between participants with constantly high fat quality ratio (HFQR) and low fat quality ratio (LFQR) as well as constantly high fruit and vegetable consumption (HFVC) and low fruit and vegetable consumption (LFVC) were compared with RM ANOVA models including also age intervals and gender as confounders. When comparing high and low fruit and vegetable consumption groups, the STRIP group was also included as a confounder.

When analysing parental answers to the HTAS eating attitude questionnaire in **Study IV,** the answers to the negative attitude statements were first reversed so that final high

values indicated a positive attitude toward the phenomenon studied. Then health and hedonic items were analysed separately with Maximum Likelihood factor analysis with Promax rotation. Items not clearly loading on a single factor and items with factor loadings smaller than 0.4 were excluded from further analysis. Factors with eigenvalues (*i.e.* the amount of variance explained by each factor) >1 were chosen for further consideration. Internal consistency of each factor was analysed with Cronbach's alpha statistics. To measure the associations between different subscales, a Spearman correlation was used. Scores for factors *General health interest, Light product interest* and *Pleasure* were squared for linear model analyses due to negatively skewed distributions.

Differences in eating attitude mean scores by STRIP group and gender were analysed using ANOVA.

For further analyses of the association of *General health interest* and dietary indicators of healthy eating, the respondents were first divided into three groups (low, medium, high) depending on their mean subscale values of *General health interest* using 33rd and 66th percentile points as cut off values. These analyses were done with ANOVA. All ANOVA analyses were done with full models including gender and STRIP group as covariates. Non-significant terms were excluded from the models with backward selection with an exclusion criteria $p>0.1$ for main effects and $p>0.05$ for interactions. Tukey-Kramer adjustment was used in the post hoc analyses.

4.6 Ethics

In the beginning of the STRIP study an informed consent was obtained from the parents and later from the children at the age of fifteen years. No financial incentives were given to the families. The STRIP study was approved by the Ethics Committee of the Turku University and Turku University Hospital (13/9.11.1989). The protocol of the STRIP study is consistent with the principles of the Declaration of Helsinki and is registered at http://www.clinicaltrials.gov (identifier NCT00223600).

5 RESULTS

5.1 Effects of the intervention on fat intake in children

The energy-adjusted intakes of the energy-yielding nutrients remained rather constant between the ages of five and ten years. The total fat intake of the intervention children was constantly around 30% of the energy, while that of the control children was constantly 2 to 3 energy percentage units higher ($P<0.001$). The low fat intake of the intervention children was compensated for by increases in carbohydrate and protein intake; the carbohydrate intake was about 1 to 2 energy percentage units higher ($P<0.001$) and the protein intake was 0.5 energy percentage units higher ($P=0.005$ and $P<0.001$ for girls and boys, respectively) in the intervention children than in the control children. The control boys had a slightly higher sucrose intake than the intervention boys ($P=0.002$), but in girls, the intake did not differ between the intervention and control groups ($P=0.61$).

Between the ages of four and ten years, the intervention children received 2 to 3 energy percentage units less saturated fats ($P<0.001$) than the control children, the intake being about 11-12 E% in the intervention children and about 14 E% in the control children. In children undergoing the intervention, the polyunsaturated fat was about 5-6 E% and in the control children about 5 E%, the difference (0.5 to 1.0 energy percentage units) being significant ($P<0.001$). The energy-adjusted intake of monounsaturated fatty acids did not differ between the groups, being about 10-11 E% in both groups. The intervention children had a more favourable fat quality ratio than the control children ($P<.001$). In children undergoing the intervention, the ratio increased from 1.36/1.38 at the age of four years to 1.53/1.56 at the age of ten years (girls/boys, respectively). Among the control children, the ratio increased from1.10/1.08 to 1.16/1.25 (girls/boys, respectively).

When analysed between the ages of two and eighteen years, of the intervention children (n=151), 48.7% had a constantly high fat quality ratio (HFQR) and 2.6% a constantly low fat quality ratio (LFQR). Of the control children (n=207), 4.4% had a constantly HFQR, and 43.0% a constantly LFQR ($P<0.001$). The number of intervention children and control children was 74 and 9 among the children with HFQR, and 4 and 89 among the children with LFQR, respectively.

The fat quality ratio of the children with HFQR and LFQR was between 1.48-1.69 and between 1.02-1.18, respectively (Table 9). The children with HFQR had a lower total and saturated fat intake than the children with LFQR ($P<0.001$) (Figure 3). There was no difference in the monounsaturated fatty acid intake ($P=0.71$) but the intake of polyunsaturated fatty acids was higher among the children with HFQR ($P<0.001$) (Figure 3). In the children with HFQR, there was a higher intake of fibre from cereal products

and slightly higher consumption of fish and fish products (P=0.049) than in the children with LFQR (Table 9). The soft drink, juice or meat and meat product consumption did not differ between the children with different fat quality ratios.

The consumption of dairy and fat products was analysed in detail among children with LFQR and HFQR (Table 10). The consumption of skim milk, low-fat sour milk products, low-fat and vegetable oil-based cheese as well as vegetable oil and margarines was more common among children with HFQR, analysed by percentage of total product group consumption. There was no difference in total consumption of milk (P=0.56) or sour milk products (P=0.91) between children with LFQR and HFQR. The children with HFQR consumed somewhat less cheese (difference of LS-means 4.0, P=0.007)) and more fat products (difference of LS-means 4.0, P<0.001) than the children with LFQR. The children with HFQR consumed more margarine (difference of LS-means 9.4, P<0.001) and oil and oil-based salad dressings (difference of LS-means 3.9; P<0.001) and less butter and butter-oil mixtures (difference of LS-means -1.5, P<0.001) than children with LFQR.

Table 9. Mean (SD) nutrient intakes and food consumption in children with constantly low fat quality ratio (LFQR) and high fat quality ratio (HFQR).

	2-6 years		**7-11 years**		**12-16 years**		**17-18 years**		*P* for difference between the dietary groups
	LFQR	**HFQR**	**LFQR**	**HFQR**	**LFQR**	**HFQR**	**LFQR**	**HFQR**	
Fat quality ratio (P+M)/S	1.02 (0.13)	1.48 (0.24)	1.14 (0.13)	1.63 (0.22)	1.18 (0.15)	1.64 (0.21)	1.18 (0.15)	1.69 (0.21)	<0.001
Vegetables (g)	61.2 (24.8)	74.9 (30.8)	78.8 (35.9)	99.7 (39.5)	96.4 (42.3)	126.0 (56.6)	110.8 (53.2)	148.2 (116.3)	<0.001
Fruit and berries (g)	94.6 (32.9)	119.0 (43.3)	96.6 (43.8)	116.5 (59.1)	95.7 (57.0)	112.8 (60.7)	102.9 (89.1)	116.3 (100.6)	<0.001
Fibre intake from grain products (g)	5.2 (1.4)	5.9 (1.5)	7.1 (2.1)	8.3 (2.5)	8.9 (3.0)	10.3 (3.2)	9.4 (4.0)	11.1 (4.5)	<0.001
Juice beverages (100% juices excluded) (g)	129.5 (73.8)	126.1 (64.9)	148.1 (80.2)	143.3 (80.6)	183.8 (133.4)	187.9 (169.4)	178.3 (166.9)	165.1 (166.7)	0.51
Soft drinks (g)	70.8 (47.5)	71.4 (46.2)	125.2 (62.6)	107.9 (54.4)	181.2 (112.0)	153.2 (77.3)	199.3 (133.4)	201.6 (189.4)	0.31
Meat & processed meat products (g)	80.7 (26.30)	78.8 (22.37)	107.9 (28.3)	106.4 (29.2)	140.0 (53.6)	142.7 (42.9)	163.3 (73.8)	168.3 (76.7)	0.77
Fish and fish products (g)	14.9 (7.0)	16.5 (8.8)	19.3 (10.6)	22.2 (12.0)	28.4 (12.6)	33.3 (20.1)	35.0 (21.7)	36.2 (28.7)	0.049

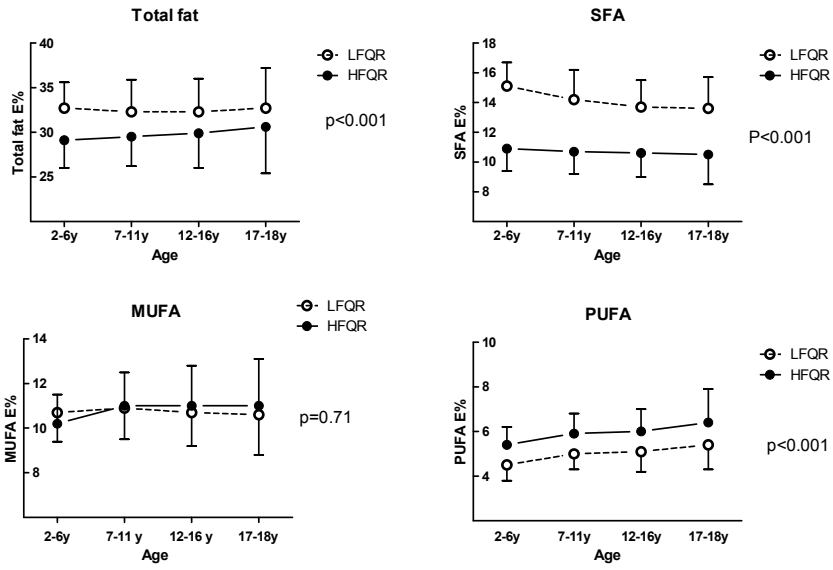

Figure 3. Total fat, saturated fat (SFA), monounsaturated fat (MUFA) and polyunsaturated fat (PUFA) intake (as E%) in children with constantly low fat quality ratio (LFQR) (white circle) and high fat quality ratio (HFQR)(black circle).

Table 10. Mean (SD) consumption of dairy and fat products in children with constantly low fat quality ratio (LFQR) and high fat quality ratio (HFQR).

	2-6 years		7-11 years		12-16 years		17-18 years		
	LFQR	**HFQR**	**LFQR**	**HFQR**	**LFQR**	**HFQR**	**LFQR**	**HFQR**	P
Skim milk %[#]	10.4 (18.5)	66.5 (27.5)	30.6 (32.6)	86.3 (12.2)	38.3 (37.1)	86.6 (14.8)	48.5 (40.4)	87.0 (20.8)	<0.001 *
Milk, total (g)	467.2 (134.7)	494.1 (120.9)	553.3 (175.8)	552.6 (170.8)	556.6 (214.7)	575.3 (222.5)	531.5 (284.2)	538.9 (297.9)	0.56
Low-fat sour milk products %[#]	15.8 (20.0)	55.7 (29.3)	29.3 (30.6)	66.5 (34.9)	31.6 (35.0)	58.4 (35.8)	26.6 (36.4)	45.1 (38.7)	<0.001
Sour milk products, total (g)	97.1 (49.0)	107.1 (65.9)	99.3 (67.6)	124.3 (69.8)	98.8 (58.3)	120.5 (68.4)	120.6 (110.2)	130.9 (115.0)	0.91
Low/vegetable fat cheese %[#]	26.8 (27.4)	39.0 (30.8)	23.5 (23.3)	46.3 (30.8)	29.7 (23.2)	49.3 (27.0)	34.7 (31.3)	53.9 (32.3)	<0.001
Cheese, total (g)	13.9 (7.8)	13.1 (9.3)	23.4 (14.4)	19.5 (11.1)	35.0 (17.6)	29.4 (17.1)	41.2 (26.8)	34.3 (23.0)	0.007
Margarine + oil %[#]	40.1 (19.0)	71.1 (10.6)	49.1 (18.7)	76.1 (9.1)	49.1 (18.9)	75.3 (10.8)	47.8 (22.1)	77.6 (15.9	<0.001
Fat products, total (g)	18.5 (6.2)	20.8 (4.5)	25.9 (8.1)	28.8 (6.7)	29.0 (11.0)	33.5 (10.3)	28.6 (13.3)	32.8 (12.1)	<0.001
Margarine (g)	8.4 (6.0)	15.9 (7.5)	13.4 (8.0)	22.6 (8.1)	13.2 (9.4)	24.4 (10.9)	12.0 (10.2)	19.7 (13.5)	<0.001
Butter, butter-oil mixtures (g)	6.5 (4.7)	2.3 (1.7)	7.8 (6.4)	2.3 (1.3)	9.4 (8.2)	3.2 (3.4)	11.2 (10.3)	4.7 (6.7)	<0.001
Oil, oil-based salad dressings (g)	2.3 (2.7)	3.5 (2.2)	4.3 (2.4)	5.5 (3.4)	6.1 (3.3)	7.4 (4.9)	7.2 (5.1)	9.5 (5.9)	<0.001

* P<0.001 for each age interval; analysed separately for each age interval because of interaction (age interval x group)
[#]A child was included to the %-analyses, if his/her mean consumption of fat products was >10g/day, milk consumption >200g/day, consumption of sour milk products >50g/day and cheese consumption >10g/day. The '%' refers to the percentage of the consumption of a subgroup of the total consumption. For example, percentage of skim milk consumption of the total milk consumption.

5.2 Effects of the intervention on fruit and vegetable consumption in children

Between the ages of one and ten years, the absolute daily potato consumption ranged between 70 and 100 grams, the absolute vegetable consumption between 40 and 120 grams and the absolute fruit consumption between 75 and 120 grams, depending on age, sex and STRIP group (Figure 4**)**. Only the vegetable consumption clearly increased with age. There was no difference between intervention and control children in the potato consumption (mean difference 0.2g/day; CI –2.5 to 2.9; *P*=0.89) but the intervention children consumed more vegetables than the control children (estimated difference 2.4 g/day; CI 1.2 to 3.5; *P*<.001).When the genders were analysed separately, the intervention effect was present among boys (mean difference 3.2 g/day; CI 1.5 to 4.9; *P*<.001), but not among girls (mean difference 1.5 g/day; CI –0.2 to 3.1; *P*=0.08). Because of interactions, the fruit consumption was analysed separately by genders. The intervention and the control girls did not show a difference in consumption (mean difference was 2.7 g/day; CI –2.0 to 7.3; *P*=0.26). In contrast, among boys, the fruit consumption was higher in the intervention boys than in the control boys (mean difference 10.1 g/day; CI 5.3 to 14.9; *P*<.001).

When analysed between the ages of two and eighteen years, 31.6% of the intervention children had a constantly high fruit and vegetable consumption (HFVC) and 13.8% a constantly low fruit and vegetable consumption (LFVC). Of the control children, 19.3% had a constant HFVC and 32.9% a constant LFVC. Number of intervention children and control children was 48, and 40 among the children with HFVC and 31 and 68 among the children with LFVC and, respectively.

The children with LFVC consumed remarkably less both vegetables and fruit and berries than the children with HFVC (*P*<0.001) **(**Table 11**)**. The fruit and berry consumption of the children with constantly low consumption even decreased with increasing age. The fat quality ratio of the children with HFVC and LFVC was between 1.30-1.47 and between 1.16-1.39, respectively (Table 11). The children with HFVC had a higher fat quality ratio, fibre intake from cereal products and consumption of fish and fish products and lower consumption of soft drinks than the children with LFVC (*P*<0.001), but there was no difference in meat and meat product consumption (*P*=0.064) or juice consumption (*P*=0.19) (Table 11).

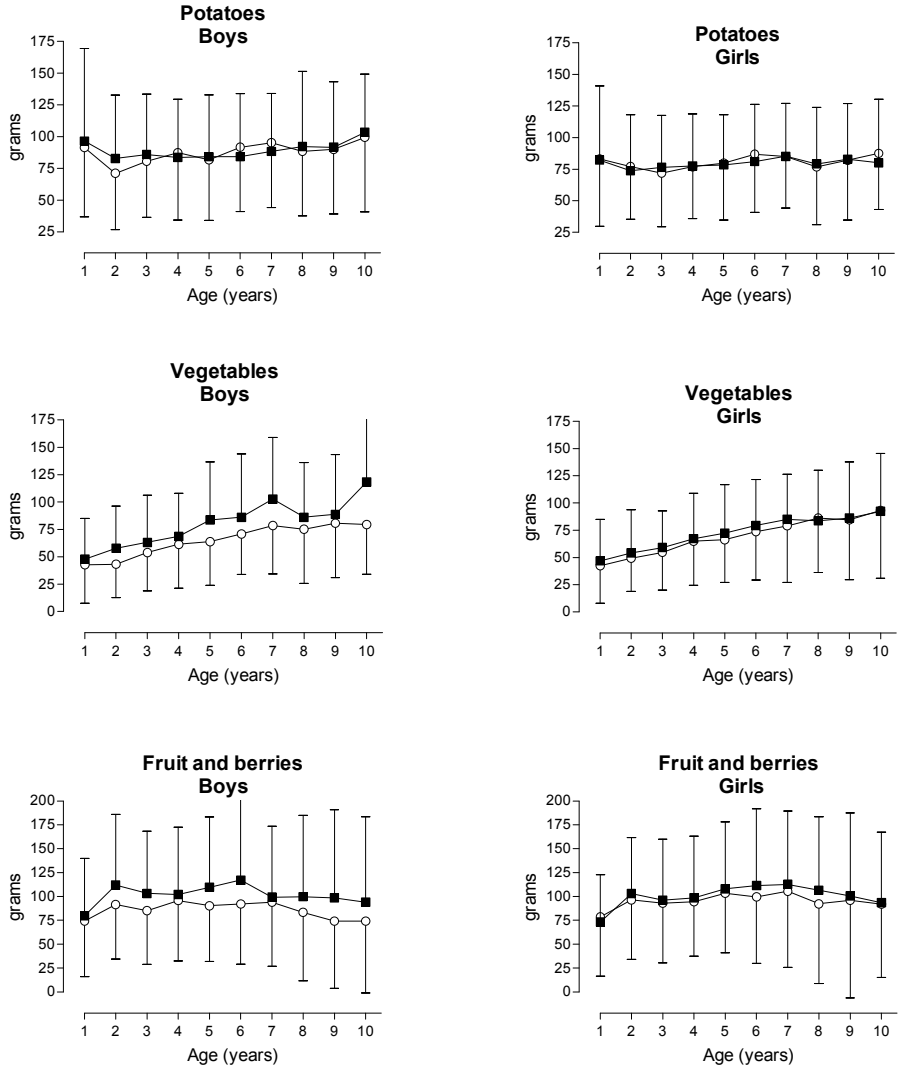

Figure 4. Absolute consumption of potatoes, vegetables and fruit and berries among the intervention children (black square) and the control children (white circle) between the ages of one and ten years of age.

Table 11. Mean (SD) nutrient intakes and food consumption in children with constantly low fruit and vegetable consumption (LFVC) and high fruit and vegetable consumption (HFVC).

	2-6 years		7-11 years		12-16 years		17-18 years		*P* for difference between the dietary groups
	LFVC	HFVC	LFVC	HFVC	LFVC	HFVC	LFVC	HFVC	
Fat quality ratio (P+M)/S	1.16 (0.28)	1.30 (0.25)	1.27 (0.22)	1.42 (0.26)	1.30 (0.20)	1.44 (0.23)	1.39 (0.30)	1.47 (0.28)	<.0.001
Vegetables (g)	43.1 (19.3)	85.9 (33.9)	52.9 (20.0)	119.4 (48.4)	65.8 (24.9)	155.1 (60.5)	76.1 (33.1)	189.6 (92.0)	<0.001
Fruit and berries (g)	61.2 (30.6)	124.6 (46.5)	46.5 (27.7)	133.2 (56.3)	35.9 (25.8)	145.3 (67.6)	34.1 (37.0)	153.1 (113.2)	<0.001
Fibre intake from grain products (g)	5.0 (1.4)	5.9 (1.6)	6.7 (1.7)	8.0 (2.4)	8.0 (2.7)	10.4 (3.3)	8.3 (3.6)	11.2 (4.9)	†
Juice beverages (g)	138.5 (77.2)	123.6 (66.1)	157.1 (101.0)	145.9 (82.3)	159.5 (100.1)	193.3 (172.7)	207.6 (171.2)	183.8 (159.6)	0.19*
Soft drinks (g)	80.0 (51.4)	60.5 (40.3)	137.1 (78.8)	115.9 (77.4)	203.8 (120.9)	165.6 (110.7)	243.9 (190.0)	199.6 (144.1)	<0.001
Meat & processed meat products (g)	77.0 (21.2)	84.5 (22.5)	105.0 (26.0)	114.2 (36.5)	132.5 (43.0)	148.0 (50.8)	163.7 (73.5)	176.0 (72.7)	0.064
Fish and fish products (g)	14.0 (7.2)	17.0 (8.2)	19.5 (10.6)	22.7 (10.0)	22.9 (11.1)	35.2 (19.8)	29.9 (20.9)	41.3 (27.1)	<0.001

*Despite a significant age interval x study group interaction, none of the pairwise post hoc analyses between groups were significant. Therefore, the given P-value is from the main effects model without the interaction.
interaction between age interval and group difference were analysed within each age interval. However, there were no differences within each age interval between the groups. Therefore the given P-value is from the main model without the age interval x group interaction.
† Because of an interaction between age interval and group differences were analysed within each age interval. There was a significant difference at the age interval between 7-11 years (P=0.033), 12-16 years (p<0.001) and 17-18 years (p<0.001).

5.3 Parental diet-related attitudes

Subscale *General health interest* correlated moderately with subscales *Natural product interest (r=0.44), Light product interest* (r=0.33) and *Pleasure (r=0.29).* There was a clear correlation (r=0.54) between subscales of craving, *Understanding other people' craving* and *Personal craving for sweet food. Using food as a reward* correlated moderately with *Personal craving* (r=0.42) and *Understanding other people' craving* (r=0.35). All other correlations between the subscales were <0.14.

5.3.1 Associations of diet-related attitudes with intervention and gender

The intervention parents were more interested in healthy eating than the control parents. In *General health interest* subscale the intervention mothers rated higher than the control mothers and the intervention fathers higher than the control fathers (Figure 5). In *Light product interest,* the intervention fathers rated higher than the control fathers but there was no difference between the mothers of the intervention and control groups (Figure 5).

There were no differences between the intervention and control parents either in *Natural product interest* (Figure 5) or in any of the hedonic subscales (Figure 6).

An apparent gender effect was seen both in health-related and hedonic subscales. Mothers scored higher than fathers in *General health interest*, in *Natural product interest* and in all of the hedonic subscales. In *Light product interest* only the control mothers rated higher than the control fathers.

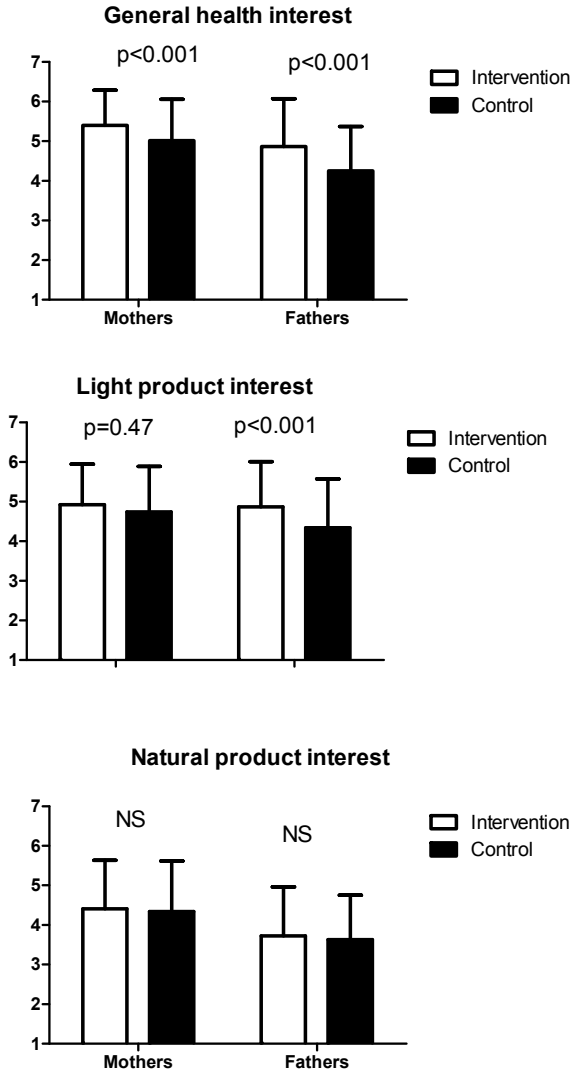

Figure 5. Mean scores (SD) on health-related attitude subscales in the intervention and control parents. NS indicates non-significant difference.

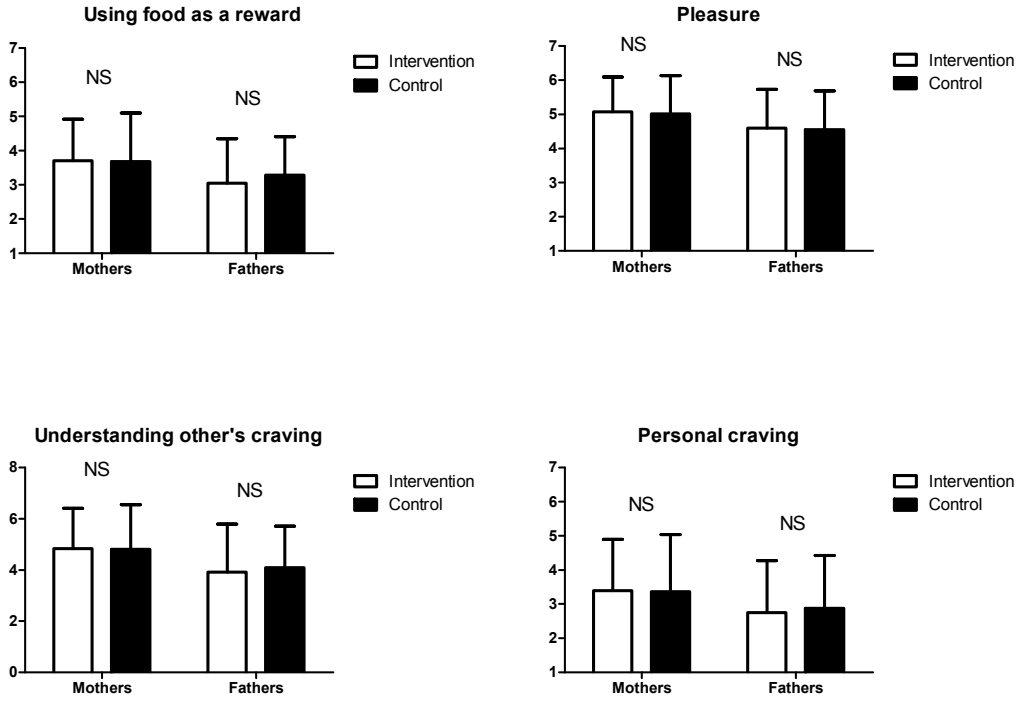

Figure 6. Mean scores (SD) on subscales measuring hedonic aspects of eating in the intervention and control parents. NS refers to the non-significant difference between the intervention and the control parents.

5.3.2 Associations between General health interest and diet

Associations between parental interest in healthy eating (*General health interest)*, STRIP intervention and dietary indicators of healthy eating in parents are presented in Table 12 and in children in Table 13 and Table 14. In parents, high level of *General health interest* associated with lower energy adjusted saturated fat intake and higher fruit and vegetable consumption. However, intervention parents had a lower saturated fat intake and a higher fat quality ratio than the control parents regardless of the level of *General health interest*.

In children, a high level of mothers' *General health interest* associated with higher fruit and vegetable consumption and saturated fat intake and high level of fathers' *General health interest* with higher fruit and vegetable consumption. As with parents, the intervention children had a lower saturated fat intake and higher fat quality ratio than the control children regardless of the level of *General health interest* in parents.

Table 12. Influence of Parental interest in healthy eating (GHI) and nutrition intervention on dietary indicators of healthy eating in the intervention and control parents (n=491) of the STRIP study measured by ANOVA with the Tukey-Kramer adjustment.

Dietary indicator of healthy eating	General health interest (GHI)						P for Interaction (GHI x Intervention)	P for GHI	P for Intervention
	Low (n=173, 78 intervention parents)		Medium (n=148, 99 intervention parents)		High (n=170, 125 intervention parents)				
	Mean	SD	Mean	SD	Mean	SD			
Saturated fat intake E%									
All	14.6	4.3	13.3	4.5	12.4	4.3	NS	0.003	<0.001
Intervention parents	14.3	4.3	12.6	4.3	11.5	4.0			
Control parents	14.7	4.3	14.0	4.6	13.9	4.4			
Fat quality ratio									
All	1.42	4.6	1.50	0.62	1.56	0.65	NS	NS	<0.001
Intervention parents	1.56	4.6	1.67	0.66	1.69	0.69			
Control parents	1.36	4.5	1.33	0.53	1.38	0.54			
Fruit and vegetable consumption (g)									
All	233.9	183.0	269.4	182.0	330.7	212.0	NS	<0.001	NS
Intervention parents	253.5	205.6	276.3	198.0	328.2	212.4			
Control parents	225.8	173.0	262.3	165.0	334.4	213.1			

Table 13. Influence of father's interest in healthy eating (GHI) and nutrition intervention on dietary indicators of healthy eating in the intervention and control children (n =256) of the STRIP study measured by ANOVA with the Tukey-Kramer adjustment.

Dietary indicator of healthy eating	General health interest (GHI)								
	Low (n=124, 46 intervention children)		Medium (n=78,41 intervention children)		High (n=54, 36 intervention children)		P for Interaction (GHI x Intervention)	P for GHI	P for Intervention
	Mean	SD	Mean	SD	Mean	SD			
Saturated fat intake E%									
All	12.8	2.7	11.8	2.8	12.0	2.7	NS	0.11	<0.001
Intervention children	12.1	2.4	10.7	2.9	11.5	2.4			
Control children	13.2	2.7	13.0	2.2	12.8	3.1			
Fat quality ratio									
All	1.35	0.29	1.49	0.43	1.45	0.31	NS	0.13	<0.001
Intervention children	1.54	0.24	1.69	0.44	1.50	0.32			
Control children	1.24	0.27	1.26	0.27	1.34	0.26			
Fruit and vegetable consumption (g)									
All	167.0	121.0	185.9	92.5	222.0	116.5	NS	0.02	0.81
Intervention children	167.4	105.3	178.6	76.0	235.5	124.2			
Control children	166.8	130.0	194.0	108.5	195.1	97.1			

Table 14. Influence of mother's interest in healthy eating (GHI) and nutrition intervention on dietary indicators of healthy eating in the intervention and control children (n=320) of the STRIP study measured by ANOVA with the Tukey-Kramer adjustment.

Dietary indicator of healthy eating	General health interest (GHI)						P for Interaction (GHI x Intervention)	P for GHI	P for Intervention
	Low (n=83, 21 intervention children)		Medium (n=100, 47 intervention children)		High (n=137, 77 intervention children)				
	Mean	SD	Mean	SD	Mean	SD			
Saturated fat intake E%									
All	13.1	2.8	12.7	3.0	11.7	2.4	NS	0.02	<0.001
Intervention children	11.7	2.9	11.5	3.0	11.1	2.4			
Control children	13.6	2.7	13.8	2.7	12.5	2.3			
Fat quality ratio									
All	1.32	0.31	1.41	0.37	1.46	0.35	NS	0.68	<0.001
Intervention children	1.49	0.32	1.62	0.35	1.60	0.36			
Control children	1.26	0.28	1.23	0.28	1.27	0.24			
Fruit and vegetable consumption (g)									
All	166.1	126.3	177.1	99.2	201.7	106.3	NS	0.07	0.62
Intervention children	153.2	114.6	194.9	100.0	200.4	97.5			
Control children	170.4	130.6	161.3	96.7	203.4	117.5			

6 DISCUSSION

This dissertation aimed at studying the effects of the STRIP dietary intervention on fat intake, fruit and vegetable consumption and parental diet-related attitudes in the families during childhood and adolescence. Table 15 presents an overview of the main results of the substudies. The intervention had a favourable long-term effect on the dietary fat quality of children mainly because of a decrease in the intake of saturated fat. The effect on the consumption of fruit and vegetables was weaker. Next, the results, methods and data will be discussed in detail. Moreover, implications for dietary interventions in research and practise are evaluated.

Table 15. An overview of the results of the present dissertation.

Substudy	What was known before the study?	What this study adds?
I	The dietary STRIP intervention, mainly targeted at improving fat quality in children, reduced SFA intake in the intervention children until the age of four years.	The intervention continued to influence children's fat quality ratio favourably by decreasing SFA intake until the age of ten years. However, increasing unsaturated fat intake seemed to be more challenging.
II	Fruit and vegetable consumption has generally been lower than recommended in children and adolescents. The F&V consumption has been a minor target of the intervention but there were no studies of the F&V consumption of the STRIP children.	Only a slight intervention effect was observed on the F&V consumption among boys between the age of one and ten years of age. In general, the consumption of F&V was low and consumption of fruit and berries decreased with increasing age.
III	The dietary effects of the STRIP intervention were earlier observed only on group level at different age points. There were no findings based on longitudinal data of individuals.	Data of children with constantly high and low fat quality ratio (HFQR and LFQR) and with constantly high and low F&V consumption (HFVC and LFVC) between the ages of 2 and 18 years were observed. Children with HFQR were mainly intervention children. They had improved their fat quality ratio mainly by decreasing SFA intake and slightly by increasing PUFA intake. On food consumption level, the children with HFQR had increased consumption of low fat dairy and soft margarines. Further, there were somewhat more intervention children in children with HFVC and more control children in children with LFVC.
IV +unpublished data	Intervention increased nutrition knowledge in STRIP parents and children but knowledge correlated poorly with their nutrient intakes, indicating that other factors than knowledge explained dietary decisions.	After about ten years of intervention, the intervention parents had a higher interest in healthy eating than the control parents but there was no difference in attitudes toward natural products or hedonic eating. Parental interest in healthy eating associated with increased consumption of fruit and vegetables and decreased SFA intake in parents and children. The intervention, on the other hand, improved dietary fat quality on every level of parental interest in healthy eating.

6.1 Discussion of the main findings

6.1.1 Decreasing saturated fat intake is easier than increasing unsaturated fat intake

This study shows that individualised infancy-onset dietary intervention had favourable effects on fat intake among the intervention children. Changes in fat intake observed earlier, during the first 4 years of life (Lagström et al 1997), persisted between the ages of 4 and 10 years. The total fat intake of the intervention children was constantly around 30% of the energy, while that of the control children was constantly 2 to 3 energy percentage units higher. The SFA intake was about 11-12 E% in the intervention children and about 14 E% in the control children. When studied until the age of eighteen years about the same differences have remained between the intervention and control children in fat intakes after the age of ten years (Niinikoski et al 2007, Niinikoski et al 2012).

The considerable variability of the dietary intervention studies aimed at improving healthy eating in childhood and adolescence make the comparisons between studies difficult. The studies have differed *with respect to study design, setting, characteristics of participants, intervention content and duration and dietary targets. T*he results found among the healthy STRIP children are consistent with those of the randomised, controlled Dietary Intervention Study in Children (DISC), which has tested the efficacy of a family-based, dietary intervention in American children with an elevated serum low-density lipoprotein cholesterol level between the ages of 8 and 10 years (Lauer et al 2000). In the DISC, the intervention children's total fat intake has reduced from *33.4 E% to 28.6 E% and* SFA intake from 12.5 E% to 10.2 E% during the three year intervention. The post-intervention difference between the intervention and control children has been -4.1 energy percentage points for total fat and -2.1 energy percentage points for SFA intake.

The main aim of the intervention, the constantly high fat quality ratio, was reached mainly by the intervention children and by reducing saturated fat intake. The saturated fat intake remained constantly below 11 E% among the children with high fat quality ratio. Among the children with a constantly low fat quality ratio, the saturated fat intake was about 15 E% in the beginning of the study and decreased gradually to 13.5 E% during the study. When comparing these data with earlier data about Finnish children and adolescents (Räsänen et al 1985, Ylönen et al 1996), it can be observed that fat intake has decreased markedly in recent decades. In Finnish adult population the saturated fat intake has also decreased: in the Findiet study the saturated fat intake was about 15 E% in the early 1990s and 12-13 E% in 2007 (Valsta et al 2010).

Although the reduction of SFA intake has a central position in dietary recommendations for decades, recent findings in nutrition research have questioned the independent role of saturated fatty acids in increasing the risk of cardiovascular disease (Skeaff and Miller 2009, Mente et al 2009, Siri-Tarino et al 2010). Instead, it has been proposed that health effects of reducing saturated fat vary depending on the replacement nutrient (Astrup et

al 2011, Hooper et al 2011, Mozaffarian et al 2010). In the above mentioned DISC study, not only SFA but also the MUFA and PUFA intakes have slightly decreased among the intervention children. This did not happen among the STRIP intervention children. The intake of PUFA was higher among the intervention children than among the control children and among the children with constantly high fat quality ratio than among the children with constantly low fat quality ratio. However, the energy-adjusted intakes of monounsaturated and polyunsaturated fats only poorly reached the target of 10% to 15% and 5% to 10% of energy, respectively, recommended in the Nordic Nutrition Recommendations (1996, 2004). Further, the intervention failed to reach the 2:1 goal for unsaturated to saturated fat. To conclude, the results of the present study indicate that the target for reducing saturated fat intake was better reached than the target for replacing it with unsaturated fat.

When comparing the food consumption of the children, we observed that the children with a high fat quality ratio had consumed more skim milk, low fat sour milk products and low fat cheese than the children with low fat quality ratio. However, during such a long intervention trial like the STRIP study, some dietary changes occur also in the society in general. As an example, the consumption of skim milk and low-fat dairy has become more popular in Finland from the 1990s (Männistö et al 2010). This progress can be seen in the food choices of the children with constantly low fat quality ratio, consisting mainly of control children. The children with constantly high fat quality ratio had also higher consumption of dietary fat products with unsaturated fatty acids, especially consumption of margarines. However, only a minor difference was observed in oil and oil-based salad dressing consumption between the children with different fat quality ratios.

6.1.2 Fruit and vegetable consumption in children: minor target, minor effects

Compared to influencing dietary fat quality, increasing fruit and vegetable consumption was only a minor target of the STRIP intervention. When observing the constant fruit and vegetable consumption between the ages of two and 18 years, there were more intervention children among the children with high fruit and vegetable consumption and more control children among children with low fruit and vegetable consumption. On group level, the intervention had also a minor effect on fruit and vegetable consumption among boys between the ages of one and ten years of age. Although the differences in consumption were statistically significant, with respect to practice they were very small (from 3 to 10 grams). The mean change was also less than in some other family-based interventions which specifically aimed at and succeeded in increasing children's fruit and vegetable consumption (Epstein et al 2001, Haire-Joshu et al 2008).

In general, the preschool and school-aged children in the STRIP study consumed relatively small amounts of fruit and vegetables. Even the consumption by children with constantly HFVC was below 400 grams at the age of 18 years. Of note, the constantly high consumption referred to relative consumption compared to the others, not to absolute

consumption. In several other studies, the fruit and vegetable consumption of children and adolescents has not met the recommendations (*e.g.* Yngve et al 2005, Guenther et al 2006, Jones et al 2010, Jakubikova et al 2011). In preschool-aged Finnish children of the DIPP study, the consumption of fruits and berries, analysed by food records, has been about 100-110 g per day and the consumption of vegetables about 50 g per day (Kyttälä et al 2010). Compared to those results, the consumption of fruits and berries was equal and consumption of vegetables somewhat higher in the preschool-aged STRIP children.

The absolute consumption of fruit and berries of the STRIP children did not increase with age and food consumption. Evidence from earlier research indicates that children prefer fruits to vegetables and that, correspondingly, intake of fruit is easier to increase than intake of vegetables (Blanchette and Brug 2005). In a systematic review of qualitative studies children's preference for fruit over vegetables have appeared to be related to the sensory attributes of fruit and vegetables and to the way vegetables are prepared (Krolner et al 2011). These mainly American children have also been observed to perceive dinner as the only appropriate time and family/home as the only appropriate setting for eating vegetables, whereas fruit could be eaten everywhere at all times of the day. In the Finnish food culture, eating vegetables may be more flexible.

6.1.3 Intervention effects diet via diet-related attitudes

At the children's age of 11 years, *i.e.* after ten years of intervention, the intervention parents were more interested in healthy eating than the control parents. No differences in interest in natural products or in hedonic eating attitudes were observed between the intervention and control parents. In the beginning of the study, the families were randomly allocated to the intervention and control groups and parents' general eating attitudes, dietary variables indicating healthy eating or BMI did not differ between the groups (Lagström 1999, Saarilehto 2001). Furthermore, there have been no differences in the socioeconomic status between the intervention and the control families. Therefore, the results indicate that the intervention increased positive attitudes towards healthy eating among the intervention parents. The control parents also received general dietary information of their child's diet and they knew they were participating in a heart disease prevention trial. Food records of the child and parents induced self-monitoring of the diet also among the control families. It may, thus, be speculated that this might influence the control parents' answers and diminish the difference noticed between the intervention and control parents' health-related attitudes. On the other hand, *the General health interest* of the control parents was on the same level than in the earlier studies examining Finnish adult population's attitudes by the HTAS questionnaire (mean values 4.5-4.7) (Roininen et al 1999, Roininen and Tuorila 1999).

The STRIP parents' *General health interest* associated with dietary indicators of healthy eating, *i.e.* low intake of saturated fat and high consumption of fruit and vegetables both in parents themselves and in their child. This is in accordance with Irish and Danish studies (Hearty et al 2007, Biltoft-Jensen et al 2008), which have demonstrated a link

between attitudes towards healthy eating and dietary behaviour as measured by a food record. In those studies, individuals who have reported conscious efforts to eat a healthy diet or have had frequent intentions to eat healthily have had a better dietary profile and are more likely to comply with dietary guidelines than those with negative attitudes. Attitudes may guide and predict behaviour (Kraus 1995). However, it may also be visa versa: we first change our eating habits for some reason (*e.g.* after receiving dietary education and counselling in an intervention) and second, after the positive experiences, our attitudes will change.

In the present study, the dietary fat quality ratio of the parents and children associated only with the intervention, not with the interest in healthy eating. Further, saturated fat intake was lower among the intervention parents than among the control parents and among the intervention children than among the control children on every level of parental interest in healthy eating. This indicates that a regular but fairly low impact intervention managed to influence the main target, the quality of dietary fat, also among those families with less interest in healthy eating.

A gender difference in dietary attitudes is well documented (Barker et al 1995, Roininen et al 1999, Roininen and Tuorila 1999, Roininen et al 2001, Hearty 2007). Also, in the present study, mothers scored higher than fathers both in health related and hedonic subscales. Interestingly, the intervention fathers' attitudes towards healthy eating were close to those of the control mothers; the dietary intervention seemed to compensate the influence of gender in dietary attitudes. In general, the women's health interest and at the same time a positive attitude toward hedonic aspects of eating may put women to face more ambivalent and difficult food choice situations than men.

In general, parents' *General health interest* correlated positively with seeking *Pleasure* in eating, which indicates that people who are interested in healthy eating are also more interested in the sensory and pleasure giving qualities of food. Jallinoja and colleagues have recently studied the argumentation around pleasure from food among Finnish adult participants of a health promoting intervention (Jallinoja et al 2010). They concluded that due to a discrepancy between pleasure seeking and health enhancement, pleasure was constructed not simply as a spontaneous experience but often as a planned and disciplined event. According to Jallinoja and colleagues, people use different strategies when they negotiate between food-related pleasures and their overall will to live a healthy life.

In a Danish study, adult compliers with dietary recommendations have differed from non-compliers as their food/meal focus has been health-oriented, *i.e.* "low in fat" and "lots of vegetables", whereas non-compliers have been more focused on the fact that "the food tastes good" and "the family likes the meal" (Biltoft-Jensen et al 2008). Both compliers and non-compliers have prioritized "home cooked" meals. This indicates that home economics classes at school could be one practical venue to illustrate that pleasure and healthiness of meals do not have to be in conflict. In general, it is essential that all the interventions aiming

at promotion of healthy eating behaviour also give a central position for taste preferences and the pleasure of eating (Eertmans et al 2001, Jallinoja et al 2010).

6.2 Participants and methods

6.2.1 Participants

The STRIP study offers a unique possibility to assess, prospectively, the effects of dietary intervention during childhood and adolescence in a randomised, controlled design. The number of participants has been high and the recruitment by nurses at well-baby clinics made it possible to reach widely families with babies. The study design creates also some possible limitations. The families of the STRIP study volunteered to participate in the study and they may have had a more positive attitude towards healthy eating than the Finnish people on average. Furthermore, some unintentional intervention has occurred also among the control families. Filling in food records and receiving general feedback on diet has brought about self-monitoring of the eating habits also among the control families, although no specific education or counselling aimed at improving cardiovascular health was present. Control families were also informed about the results of anthropometric and biochemical measurements, such as blood pressure and serum lipid and lipoprotein values.

A long duration of the study has also caused drop-outs. The attrition has been studied by comparing regularly characteristics of children still participating in the STRIP study and to those lost to follow-up. No major differences existed in weight, body mass index (BMI), serum lipoproteins or dietary data (Hakanen et al 2006, Raitakari et al 2005, Rask-Nissilä et al 2000), especially dietary fat intake (Study I) or fruit and vegetable consumption (Study II). A somewhat higher percentage of intervention children than control children have dropped out the study until the age of 15 years (Saarinen 2008). In a detailed analysis the variables targeted in the intervention (like SFA intake) have not been observed to be the reason for drop-out. The resistance to give blood samples (indicated by missing blood sample values in the data) is the most important single reason for drop-outs. Further, the difference in drop-out rates between the intervention and control children has emerged at the age of seven years, the time point when the study visits of the control children have decreased, mitigating the efforts needed and resulting in less stress in families.

6.2.2 Analysing diet

In the STRIP study, a unique data of the children's dietary intake was collected by using annual food records. Although food records are considered as a golden standard when measuring dietary intake, it should be noted that they too have some limitations as a data collecting method. Misreporting of dietary intake is a common concern in dietary studies

(Burrows et al 2010), although there is some evidence that there may not necessarily be systematic misreporting related to macronutrients or unhealthy foods (Hirvonen et al 1997, Lillegaard and Andersen 2005). Moreover, inaccurate food and nutrient data of the programs used in analyzing the nutrient intake and food consumption may cause problems.

In the STRIP study, diligence and accuracy minimise the errors caused by misreporting or invalid databases. Families were carefully and repeatedly instructed in keeping food records. Written instructions with drawings and later a special food picture booklet were sent to families to help the recording. The day-care and school personnel were asked to collaborate with the study by helping with food records and by giving information about nutrient composition on catering menus and services to the study personnel. When the children grew up they were repeatedly motivated to keep the records themselves. The records were reviewed by a nutritionist for completeness and accuracy at each study visit. Food records were analysed by the same experienced dietary technician throughout the study and the data base of the Micro Nutrica® program was updated regularly.

In children, we used four-day food records, including one weekend day, to analyse nutrient intake and food consumption. In adults, only one-day food records were available, which may not represent habitual consumption on individual level. Therefore, we used parental dietary data to indicate eating behaviour on a group level only. The participating parents had also a long history of filling food records of their child, which improved their skills to record their own food consumption.

6.2.3 Evaluating diet-related attitudes

In general, the HTAS questionnaire used for measurement of parental attitudes seemed to be a feasible tool for measuring diet-related attitudes in adults. The values of Cronbach's alpha indicated moderate to high reliability of the questionnaire and they corresponded to those obtained earlier when using HTAS in Finnish population (Roininen et al 1999, Roininen et al 2001). However, the number of attitude items in the subscales of *Natural product interest* as well as *Pleasure* was reduced in this study. These subscales also had the lowest reliabilities. Furthermore, the original subscale *Craving for sweet foods* was divided into two new subscales.

One of the challenges of attitude research is the diversity in operationalisation of diet-related attitudes. In some studies attitude variables seem to measure, at least to some extent, also behavioural beliefs (*e.g.* Vereecken and Maes 2010), intentions to behave (*e.g.* Hearthy et al 2007) or values (*e.g.* Biltoft-Jensen et al 2008). There is also possibility for different interpretations of the statements in the HTAS questionnaire used in the present study. The subscale of *Using food as a reward* included statements like *"I reward myself by buying something really tasty"* or *"I indulge myself by buying something really delicious"* which can also be seen as indicators of eating behaviour, not as an attitude towards the behaviour. The statements *"I avoid rewarding myself with food."* and *"I try to avoid eating delicious food when I am feeling down."* are used

as indicators of negative attitude towards using food as a reward, although they may include a conflicting attitude (for instance: "I would like to reward myself but I try to avoid it because I am overweight").

Self-reported explicit measures of attitudes are criticized for being highly susceptible to social desirability that often reduces their validity. Instead, the use of implicit measures, for instance, an affective priming paradigm can measure eating-related attitudes (Czyzewska and Reiko Graham 1998, Lamote et al 2004, Verhults et al 2006). In a large scale intervention study like the STRIP study, the use of implicit or more objective methods is usually not possible due to cost- effects and time-restrictions.

6.3 Implications for dietary interventions in research and practise

In nutrition education, more emphasis should be put on individual foods in the context of a healthy dietary pattern instead of single nutrients (Lloyd et al 2010, Micha and Mozaffarian 2010, Astrup et al 2011, Mozaffarian et al 2011). Although the main targets of the STRIP dietary intervention were formulated in the terms of nutrients, during the dietary intervention the nutrient goals were also translated into terms of food choice and a whole diet approach was included with a balanced diet as a goal. The main idea was not to remove food stuffs from the diet but to replace them with healthier options. The increased consumption of some foods like vegetable oil, vegetable oil-based salad dressings and fruit and vegetables was also encouraged. The results of the present study indicate that the highest input (time, repetition, tailored information) put on the main target of the dietary intervention, dietary fat quality, influenced the dietary choices in the intervention families more than minor input targets, like increase in fruit and vegetable consumption. Further, it seems that *changing* a food product to another option (*e.g.* fatty dairy to low-fat dairy, butter to margarine) is easier to accomplish than *adding* something new (like fruit and vegetables, oil based salad dressing) to the diet.

In the 1980s and early 1990s, the time when the STRIP study started, influencing nutrition knowledge of children and parents was identified as a key target to improve dietary behaviour (Shepherd 2007). Also, in the STRIP study, improving nutrition knowledge by providing information and *via* educational activities was clearly one of the main goals of the intervention. It seems, however, that although people often know basic principles of healthy eating they do not follow these principles. In the STRIP families, the dietary intervention has increased nutrition knowledge both among the parents and children (Räsänen et al 2003, Räsänen et al 2004) but the nutrition knowledge, at least the fairly *theoretical* knowledge studied, has correlated poorly with nutrient intakes, indicating that other factors than knowledge influence dietary decisions (Räsänen et al 2003). The present study shows that diet-related attitudes like interest in healthy eating can be used for explaining the dietary choices. The intervention increased parental interest in healthy eating and the interest further associated with the dietary indicators of healthy eating. On

the other hand, the intervention influenced the main dietary target, the fat quality, even among the parents and children with lowest level of parental interest in healthy eating. It is possible that the *quality* of the nutrient knowledge has a role to play in this: it may be that a fairly *practical* knowledge accompanied with simple tips for shopping, food preparation and cooking given by the nutritionist changed the parents' and children's food choice behaviour also without specific interest in healthy eating. Obviously nutrition knowledge, in some form, is a prerequisite for intentional healthful eating.

Restructuring the home environment and prompting self-monitoring are commonly used behaviour change techniques in effective dietary interventions (Michie et al 2009, Golley et al 2011). In the STRIP study, parents were suggested to make healthier foods available and accessible at home, *i.e*. to restructure their home environment. Food records were regularly used to collect dietary data of the children and occasionally of the parents but they also induced self-monitoring of eating habits in the family. Also specific goal setting is considered as a useful behavioural change technique in dietary interventions (Artinian et al 2010, Golley at al 2011). During the STRIP intervention individual dietary goals were mainly suggested by the nutritionist, although they were always tailored according to the child's food record and food choice data of the family. There were also some intervention sessions were the child and the family specifically evaluated their own diet and eating behaviour and invented personal goals for the future. More effective activation of the families to invent their own dietary goals may have resulted in better results through higher inner motivation to reach the goals (Ryan et al 2000).

The STRIP intervention can be viewed as a preventive or health promoting intervention. Subjects of the study consisted of families with healthy kids without any known risk factors of CVD. The challenge of such an intervention may be the lack of motivation for changing dietary behaviour: there are no health problems which hamper everyday life and which should be solved. On the other hand, the health and well being of the child is usually a very important value for the parents. This can be a motivating factor even without any health problems. In case of lacking motivation to changing behaviour or ambivalence of change, methods of Motivational Interviewing is used in adults to enhance adherence to behavioural interventions, including dietary interventions (Artinian et al 2010). They may be effective also in families with children and worth testing in future studies.

In the STRIP study, no thorough theory-based analysis of determinants of specific dietary behaviours was done in the beginning of the study when originally planning the dietary intervention. Using a theory-based model could help to plan even more effective health interventions (Contento 2011). An important part of selecting a theory or a model is to articulate the educational philosophy underlying the intervention. The step of translating theory into practice, *i.e.* the operationalisation of the theory to behavioural techniques used, is another crucial part of the planning process (Golley et al 2011). As an example, Contento (2011, 146-149) has suggested a stepwise procedure for designing theory-based nutrition education. The procedure includes steps like analysing

needs and identifying behaviours, identifying mediators of targeted behaviour, selecting theory or model to guide education, stating objectives for mediators, designing theory-based strategies and practical activities to address mediators and planning theory-based evaluation. In the future, more research is needed to gain insight into the strategies that are effective in changing relevant mediators. A rapidly developing field of mediation analysis can be used to evaluate whether an intervention works via the hypothesised working mechanisms or not (Van Stralen et al 2011).

The STRIP intervention focused only on family-level influences, not on peers, day care, schools or community, which are all important factors influencing dietary habits of children and adolescents. The effectiveness of nutrition education can be increased if it attends to the multiple levels of influencing factors: individual level, interpersonal level, organizational and community setting levels and policy level (Contento 2011, 121-122). As an example, it seems that achieving and sustaining fruit and vegetable consumption at recommended levels cannot be achieved through behaviour-based interventions alone (Thomson and Ravia 2011). Other approaches like social marketing, creating healthful food environments at schools and involvement of community, religious and voluntary organisations should be combined to ensure better results.

The general principles of the nutrition intervention used in this study could be used in many different cultural settings, assuming that the facilities for repeated meetings with the families are possible. However, many economic and cultural differences have to be considered when a practical intervention is being adopted locally. In Finland, an integration of educational and counselling elements of the STRIP study can be implemented in health care, day-care and school settings. Public health nurses in well baby clinics and school health care can be responsible for the dietary counselling and teachers in day care and schools for nutrition education, for example, during classes of health education and home economics or *via* school lunch practices. Co-work of these institutions and professionals working at them is crucial in creating effective health education practises. A recent Nordic study observing adolescents' suggestions for improving healthy eating at school concluded that an important future challenge is trying to involve school health care personnel and aligning classroom activities more coherently with adolescents' eating patterns during the school day (Kainulainen et al 2012).

Furthermore, a comprehensive planning of nutrition education from preschool-age to adolescence is needed instead of sporadic approaches. Organizational and policy levels as well as community settings should also be considered: how to implement healthful changes in general food and eating environments and enable healthy eating? As the results of this study show, there is a link between parental attitudes and the diet of their children. Parents are food providers as well as role models for their children, especially at younger ages. Also, adolescents themselves seem to perceive parents as most important factors influencing their everyday eating, even at school (Kainulainen et al 2012). Therefore also co-operation with parents and a family-based premise for working should be capitalized upon when promoting healthy eating in children and adolescents.

7 CONCLUSIONS

The dietary intervention of the STRIP study influenced favourably the main target, dietary fat quality among the intervention children and parents. Fat quality changed mainly by the decrease of saturated fat intake. In the future, nutrition educators should give more emphasis on increasing unsaturated fat intake, *e.g.* by consuming more vegetable oils, fish and nuts.

Consumption of fruit and vegetables was very low during childhood and adolescence and the intervention had only a minor effect on it. Because fruit and vegetable consumption is associated with a number of health outcomes, more input in increasing F&V consumption in children is needed.

The HTAS questionnaire turned out to be a useful tool for observing diet-related attitudes, especially general interest in healthy eating among parents. The intervention concentrating on healthy eating increased the parents' interest in healthy eating but there were no differences in interest in natural products or in hedonic diet-related attitudes between the intervention and control parents. The interest in healthy eating appeared to explain dietary choices in the families. On the other hand, the intervention had a favourable influence on dietary fat quality also among those families with the lowest parental interest in healthy eating.

In the future, a theory-based development of dietary interventions would improve the efficacy of interventions as well as the comparability between studies. When promoting healthy eating in children and adolescents, parental involvement, the integration of educational and counselling aspects and co-operation among professionals in health care, day-care, schools and organizations is crucial.

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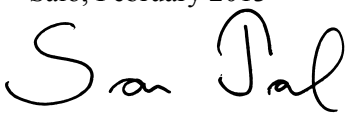

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