FOOD, FAT, FAMILY AND FRIENDS:

STUDIES ON THE IMPACT OF THE SOCIAL ENVIRONMENT ON DIETARY INTAKE

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the social environment on dietary intake

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Food, fat, family and friends:
studies on the impact of the social environment on dietary intake

Wageningen, 31 mei 1996

Gerda I.J. Feunekes

1. De vetinneming van ouders en kinderen in Nederland vertoont een positieve samenhang, die niet duidelijk afneemt met de leeftijd van de kinderen.
   Dit proefschrift

2. Zowel bij vijftienjarigen als bij hun ouders, hebben vrienden weinig invloed op de vetconsumptie.
   Dit proefschrift

3. De subjectieve norm, de ervaren druk van de omgeving, beïnvloedt de vetinneming van vijftienjarigen niet rechtstreeks, maar via de attituden.
   Dit proefschrift

4. Een gevalideerde voedselconsumptiemethode is geen synoniem voor een valide voedselconsumptiemethode.

5. De effectiviteit van voorlichtingsactiviteiten die tot doel hebben de vetconsumptie te verlagen, wordt nadelig beïnvloed door het feit dat de meeste Nederlanders ten onrechte denken dat hun vetconsumptie geen verandering behoeft.
   (*Brug J & Kok GJ, Voeding 1995; 12:11-14*)

6. De nieuwe generatie zuiveldranken, waarvan men beweert "dat het nu wel heel verleidelijk wordt om iets aan je cholesterol te doen", maken het wel heel verleidelijk om verder niets aan je cholesterol te doen.

7. De recente verruiming van de "sensible drinking limits" door het Britse Ministerie van Gezondheid, naar 3 à 4 alcoholische consumpties per dag voor mannen en 2 à 3 voor vrouwen, verdient geen navolging in andere landen.

8. Er sterven meer mannen mét dan aan prostaatkanker.
(*Johansson JE, et al., JAMA 1992; 267: 2191-2196, Lu-Yao GL & Greenberg ER, Lancet 1994: 343: 251-254*)

9. Teneinde een bericht zo snel mogelijk onder zoveel mogelijk mensen te verspreiden, verdient het aanbeveling om het te voorzien van het opschrift "strictly confidential".

10. De vluchtigheid van electronische post leidt ertoe dat in dit medium de schrijftaal veel overeenkomst vertoont met spreektaal.

ABSTRACT

Food, fat, family and friends: studies on the impact of the social environment on dietary intake

PhD thesis by Gerda I.J. Feunekes, Department of Human Nutrition, Wageningen Agricultural University, The Netherlands. May 31, 1996.

The impact of the social environment on food and fat intake was investigated in several samples including family members, close friends, and meal time companions in the Netherlands. Firstly, a food frequency questionnaire to assess the intake of fat, fatty acids and cholesterol was developed. Biomarker-based validity (n = 99), relative validity against a dietary history (n = 191), and reproducibility (n = 93) were satisfactory for adults.

Up to 40% of the variance in fat intake, expressed as % of energy intake, could be explained by influences from the social environment. This maximum value was derived from resemblances in fat intake within social networks, including nuclear family members and friends. Associations in fat intake in 1077 nuclear families, based on two-day diet records, ranged between 0.50 and 0.60 between spouses and between siblings, and around 0.40 between parents and children. Resemblance in fat intake was high for food consumed at home and weak for food consumed elsewhere. In another study, fat intake in the last four weeks was assessed with the food frequency questionnaire in 361 social networks, consisting of at most six subjects: a 15 year old adolescent; father; mother; and their best friends. Fat intake was significantly related between nuclear family members ($r = 0.18$ to $r = 0.30$), but not between best friends.

Specific influences from the social environment were quantified: the subjective norm; modelling; and social facilitation. The subjective norm, reflecting the perceived pressure from the social environment, explained 1% of the variance in fat intake of adolescents (n = 122). The subjective norm appeared to influence fat intake in this group by modifying attitudes towards fat intake. Modelling behaviour explained 6% of the variance in fat intake of adolescents. Mothers were more influential than fathers and best friends. Social facilitation of dietary intake explained up to 5% of the variance in energy intake in young adults (n = 50): spontaneous meal size increased when more others were present, due to an increased meal duration. Focus group and family interviews (n = 14) showed that social influences are embedded in family food rules and interact with other determinants of food intake.

In conclusion, social influences have considerable effects on dietary intake. Members of nuclear families are more powerful in affecting each others fat intake than best friends. Future research should focus on changes in dietary intake in relation with changes in social environment.

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1

General introduction

This thesis aims to quantify and characterise influences from people in the social environment on dietary intake. The main focus is on social influences on fat intake.

FAT INTAKE

Fat intake in the Netherlands

In the Netherlands, coronary heart diseases are the most important cause of death[1]. A diet high in saturated fat is a risk factor for the development of coronary heart disease, through its influence on serum cholesterol [2-4]. Annual national campaigns to reduce fat intake have been carried out from 1991 onwards [5,6], and fat intake reduction has also been an important aim in regional nutrition education projects[7].

The average fat intake in the Netherlands has decreased a little between 1987/1988 and 1992 [8], but most people still have a fat intake above the recommended levels. In the Dutch National Food Consumption Survey of 1992 six out of ten subjects had a fat intake above 35% of energy intake, and even nine out of ten subjects had a saturated fat intake above 10% of energy intake (KFAM Hulshof, personal communication). Important sources of fat in the Dutch diet are the food groups "fats, oils and sauces" (28%), "meat, meat products, and poultry" (19%), "milk and milk products" (9%), "cheese" (9%), and nuts and savory snacks (9%) [8].

Assessment of fat intake

In the Netherlands, there was a need for a relatively quick and valid estimate of the habitual fat intake. This method should be a standardized alternative for time consuming dietary assessment methods such as dietary histories, and multiple diet record or recalls. Therefore, a food frequency questionnaire to assess the habitual intake of fat, fatty acids, cholesterol, and energy was developed.

The performance of this newly developed food frequency questionnaire needed to be carefully evaluated for use in men and women of a wide range of ages. Relative validity against a more elaborate method, the dietary history, was

assessed in adults (**Chapter 2**), elderly [9], and adolescents [10]. In these validity studies, the food frequency questionnaire was evaluated on its ability to rank individuals according to intake, and to estimate the level of fat intake. A gold standard method to assess dietary intake of free-living subjects is not available, therefore the validation study was strengthened by including two biological markers of fatty acid intake. Biomarker-based validity of the intake was assessed simultaneously with the relative validity in adults (**Chapter 2**). Reproducibility refers to the variability of a measurement on the same subject, under the same condition, and is important to assess in order to distinguish real changes from random error[11]. The reproducibility of the questionnaire was assessed in adults (**Chapter 3**).

Determinants of fat intake

To be able to induce changes in fat intake in a population, more knowledge on the determinants of fat intake is needed. People do not consume fat, they consume foods, so the main point is to identify the determinants of consumption of foods that contribute to fat in the diet. Food choice is a process that is influenced by a range of factors, which cannot all be investigated simultaneously. The two main factors influencing food choice are physiological effects such as hunger and thirst, and psychological factors such as attitudes and beliefs towards foods [12]. The most important of socio-psychological determinants of fat intake have been found to be attitudes, especially preferences, beliefs, and habits [13]. Short-term rewards such as taste of the food appeared to be in general more important than rewards on longer term such as figure and heart disease [14].
Eating is often a social phenomenon, and social influence on food and consequently fat intake is regarded to be an important determinant [13,15-17], but quantification of this phenomenon has been scarce. To what extent social influences are important determinants of fat intake needed further investigation.

SOCIAL INFLUENCES ON FOOD INTAKE

So far, influences from the social environment on food intake have been studied in several ways.

The *subjective norm*, derived from the Theory of Reasoned Action [18], is often used in surveys to assess social influences [13]. It assesses the perceived pressure of significant others on the intention to perform a specific behaviour [18]. A review by Stafleu et al. showed that the impact of the subjective norm on fat intake is in general small compared to the influence of attitudes [13].

The social environment provides models for behaviour. Observed behaviour that is considered rewarding is likely to be imitated [16,19]. Assessments of the impact of *modelling* behaviour have been made for fat related intakes, e.g. by asking the subject about the eating behaviour of significant others [20-22]. Modelling appears to be more powerful than the subjective norm.

Family resemblance in intake have been assessed in nuclear families with a range of dietary assessments techniques. Significant associations in fat intake have been found between spouses, between siblings and between parents and children [23-29]. The influence of the age of the children on the resemblance with parents and siblings is not clear. Only a few studies have been investigating the resemblance that remains when children have left the parental home [30,31].

Support from family and peers in dietary change. Significant others may affect changes in health behaviour. Development and change in food habits occurs for an important part within the nuclear family, which makes the family unit an interesting target for nutrition education [32,33]. Support from the social environment has been shown to be helpful when fat intake had to be reduced [34]. Family involvement in trials aiming to reduce fat intake achieved a greater degree of dietary change than those who did not have family involvement [35]. Husbands of women who adopted low-fat diets reduced their fat intake, most likely through simply accepting lower-fat foods being served at home [36].

Social influences on food intake are also important during eating occasions. Studies on *social facilitation* have shown that the number of people eating with a subject has a positive effect on the amount eaten [37-39].

Definition of social influences on food intake

Social or interpersonal influences on food intake are the influences that one or more subjects have on the eating behaviour of others, either direct or indirect, either conscious or subconscious.

Aim of studies: impact of social influences on fat intake

The aim of our studies was to quantify influences of the social environment on food intake, and especially, on fat intake. Knowledge of the impact of the social environment on fat intake enables nutrition education programmes to improve targeting of their inventions. Further, the spin-off of dietary changes in one subject on the eating habits of his/her social environment is of interest. In the studies described in this thesis the focus is on nutrition behaviour, especially on fat intake.

Difficulties in the quantification of social influences

There are several difficulties in quantifying influences from the social environment on food intake:

(i) Several types of influence. The influences which people have on the eating behaviour of others are not limited to one type, but include a range of influences. For instance: modelling of eating behaviour of others; persuasion to consume or avoid eating certain foods; changing the availability of foods for others; and attempting to change someone's eating attitudes.

(ii) Not extractable. Social influences are embedded in everyday eating behaviour, in family food rules, and in the eating culture as a whole. Extraction of social influences in an experimental situation to get information on the impact of these influences in real life is therefore almost impossible.

(iii) Time frame. The time frame is not equal for the different types of social influences. Influences may be exerted during the eating or drinking occasion, such as persuasion, encouragement, and social facilitation of food intake. Else, they may be spread over a prolonged period, such as the effect of cohabitation.

(iv) Awareness. Individuals are not necessarily aware of the social influences that are exerted on their eating behaviour. In case they are aware of this, they might not be willing to admit that their behaviour is influenced by others. This makes it difficult to assess social influences by simply asking to rate the perceived influences of others.

APPROACH TO QUANTIFY SOCIAL INFLUENCES ON FOOD INTAKE: ASSESSMENT OF LONG- AND SHORT-TERM INFLUENCES

The studies described in this thesis investigated long-term and short-term influences of the social environment.

Long-term effects of social environment on food intake

We expected that when social influences play an important role in food choice, a resemblance in food intake within social networks would emerge. The nuclear family plays an important role in the development of food patterns [31,32,40,41], and friends have been found to be influential only in some life stages [31,41]. Weak to moderate associations in intakes have been found within families [23,26,29,42], and small associations for preferences have also been reported [43]. Modelling is suggested to be the most important mechanism for parental influences [31]. Parental influences appear to persist, at least for a few years, when children have left the parental home [30,31].

Firstly, more knowledge on resemblance in fat intake within Dutch families was needed, because the currently available data on family resemblance in food intake all came from North-America. Data from the Dutch National Food Consumption Survey 1987/1988 were used to assess the association of fat intake within nuclear families. This data set contained two-day food records of each individual from over 1000 nuclear families, with children in a wide range of ages. These analyses were repeated with data of the Dutch National Food Consumption Survey of 1992, to examine whether the results were similar (**Chapter 4**).

Secondly, a study was designed which did not only include nuclear family members, but also the best friend of child, mother and father. Further, habitual fat intake was assessed in this study, instead of two-day records which were used in the Dutch National Food Consumption Survey. Within this network the resemblance in habitual fat intake between family members and peers could be studied (**Chapter 5**).

In addition, social influences on the fat intake of adolescents were predicted by concepts from two commonly used socio-psychological theories: the Theory of Reasoned Action [18] and the Social Cognitive Theory [16] (**Chapter 6**).

Short-term social influences on food intake

(i) Qualitative research on social influences on fat intake. Although quantification of social influences was the main goal of the studies described in this thesis, we acknowledged that there was a need to know more about *how* people influenced each other. Focus group discussions aiming to gain further insight in the social influences on fat intake and family rules about food, were carried out in a sub sample of the network study, in order to improve our interpretation of the quantitative data (**Chapter 5**).

(ii) Social facilitation of food intake. The influence of social facilitation, defined as the enhancement of a certain behaviour due the sheer presence of others [44], had not been investigated outside the United States. De Castro et al. reported a positive association between the number of others present and the amount eaten for main meals and for snacks, on weekdays as well as weekend days, for meals eaten at home or elsewhere [37,45-47]. We investigated the impact of social facilitation on food intake in a Dutch sample, and tried to detect possible mediators of this phenomenon. For example, at meals eaten with others, there might be relatively more food available, subjects might have larger feelings of hunger, or the atmosphere might be more sociable (**Chapter 7**).

OUTLINE OF THE THESIS

This thesis describes first the development and evaluation of the performance of a food frequency questionnaire to assess the intake of fats, fatty acids, cholesterol, and energy in the Netherlands. In **Chapter 2** the focus is on the validity of the food frequency questionnaire, and in **Chapter 3** the reproducibility of the method is presented.

Quantification of influences from the social environment on habitual fat intake within social networks, including nuclear family members and friends, was carried out in several studies. In **Chapter 4** the resemblance in fat intake within nuclear families was assessed within two large samples, representative for the Dutch population in 1987/1988, and 1992. Fat intake was differentiated into fat intake at home and outside of the home. **Chapters 5** and **6** describe a study of influences

within social networks, consisting of nuclear family members and friends. Resemblance in fat intake was assessed by quantitative methods, and these results were interpreted using qualitative methods (**Chapter 5**). **Chapter 6** presents an evaluation of the social influences on the fat intake of adolescents, using the Theory of Reasoned Action and the Social Cognitive Theory. In **Chapter 7** the influence of the sheer presence of others during eating occasions is investigated. Finally, in **Chapter 8** the main findings are presented and methodological issues, implications for nutrition education and possibilities for future research are discussed.

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Relative and biomarker-based validity of a food frequency questionnaire estimating the intake of fats and cholesterol

Feunekes GIJ, van Staveren WA, de Vries JHM, Burema J, Hautvast JGAJ.
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ABSTRACT

The relative validity of a 104-item food frequency method to assess the intake of fats and cholesterol was tested against the dietary history of 191 men and women. Pearson correlation coefficients ranged from 0.38 for linoleic acid (% of energy) to 0.83 for energy intake, with 0.78 and 0.75 for the intake of total fat and saturated fatty acids, respectively. Mean intakes were overestimated by the food frequency questionnaire relative to the dietary history by 5% for energy and monounsaturated fatty acids (% of energy intake) and up to 30% for linoleic acid intake. Linoleic acid concentrations in erythrocytes and adipose tissue were used as biomarkers of intake. The correlation of the linoleic acid intake according to the food frequency questionnaire for linoleic acid in erythrocytes and adipose tissue was 0.44 and 0.28, respectively, and the dietary history gave similar values. The food frequency questionnaire gives results similar to those from the dietary history and is thus considered appropriate for classifying subjects according to their fat intake.

INTRODUCTION

In the Netherlands a consensus on the treatment of hypercholesterolemia was reached in 1987. Priority was given to the achievement of dietary changes without drug treatment for subjects with serum cholesterol levels below 8 mmol/L [1]. Therefore, a tool to estimate individual intakes was needed. A short semiquantitative food frequency questionnaire aimed at assessing the intake of fat, fatty acids, cholesterol and energy was developed.

The purpose of this study was to assess the validity of the questionnaire against a more elaborate dietary intake method, the dietary history. The validity as determined in this study is not considered to be absolute as no gold standard for estimating true usual food intake of free-living subjects is available [2,3]. Biological markers were used also to compare the results of the food frequency questionnaire also with an independent measure of fat intake. The linoleic acid content of subcutaneous adipose tissue reflects the linoleic acid content of the diet of the past 2 to 3 years [4,5] and the linoleic acid content of erythrocytes may be a marker of the linoleic acid in the diet of the past 6 to 8 weeks [6,7].

METHODS

The semiquantitative food frequency questionnaire

The questionnaire was developed with data from the Dutch National Food Consumption Survey 1987-1988 [8]. The part of this data set used contains food consumption data assessed by a two-day record method in 1807 subjects aged 30 to 50 years, a representative sample of the population of the Netherlands. First, all foods were selected that contributed more than 0.5% to the group mean intake of at least one of the following nutrients: total fat, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids, and cholesterol. This resulted in a list of 74 products, which together accounted for 77 to 83% of the intake of the nutrients mentioned. This basic list was extended with products important for reasons other than their contribution to the intake of fats and cholesterol for the group. To identify foods important for explaining the variance

of intake between persons, a stepwise multiple regression analysis as described by Byers et al. [9] was performed with all products contributing at least 0.1% to the mean intake of fat, fatty acids or cholesterol. Separate analyses were performed with the intake of total fat, saturated fatty acids, monounsaturated fatty acids, polyunsaturated fatty acids and cholesterol, each acting as the dependent variable. The square of the correlation between the total intake of a nutrient and the intake of this nutrient from a specific food item was below 0.01 for all items not yet on the basic list and no foods were added after this analyses. Low-fat products that would give valuable information on dietary patterns were added. Questions on vegetable and fruit intakes were added for the face validity of the questionnaire on food intake. When the questionnaire was extended with nine food items it appeared to account for over 90% of energy intake on a group level. This extension was made to be able to estimate fat intake relative to energy intake.

The final questionnaire consisted of 104 items and was structured according to a meal pattern. **Appendix 1** shows the different food groups and the number of items per group. The questionnaire theoretically accounted for 92% of the energy intake; 97% of the intakes of total fat, saturated fat, monounsaturated fat, and polyunsaturated fat; and 98% of cholesterol intake in Dutch men and women aged 30 to 50 years. Frequency of consumption of an item was to be recorded per day, per week, or per month. The reference period was to be the past four weeks. The questionnaire was semiquantitative. Subjects were asked to express their regular portion size relative to the standard portion size. Half portions were possible. For many items a choice between several common serving sizes could be made. Portion sizes were derived from a Dutch table of regular portion sizes and household units and a basic Dutch cookbook [10,11].

Before the start of the validation study, the feasibility of the questionnaire was tested with a small group of dieticians (n = 7).

Validation study

Population

Addresses for all men and women aged 30 to 50 years and born on the first day of a month were taken from the municipal register of Veenendaal, a town with about 50,000 inhabitants in the centre of the Netherlands. Local newspapers

published announcements of the study. All subjects received a letter and were contacted subsequently either by telephone or by a home visit. Participants had to be Dutch speaking. The response rate was 55% (n = 199); the response rate calculated for the population contacted and eligible was 61%. Eight subjects did not complete the study, and results will be presented for 191 subjects.

Procedure

The subjects were asked to participate in a study in which a newly developed questionnaire to estimate food intake was tested. Participants were visited two times at home: once for a short interview to assess food intake with the food frequency questionnaire and once for an elaborate assessment of food intake with the dietary history. The dietary intake of polyunsaturated fatty acids and cholesterol is influenced by relatively few products, which are eaten irregularly, so that day-to-day variability (within-person variability) is large compared with the between-person variability. This means that a relatively long reference period was needed to classify subjects correctly [12]. From dietary records it is known that three to four weeks are required [12-14], so the past month was chosen as the reference period for both dietary assessment methods. Common festivities such as birthday visits and parties were considered to be part of the habitual food pattern. The comparison of the methods took place in a crossover design. The washout period between the interviews was planned to be 8 weeks.

The food frequency questionnaire had to be answered by the respondent alone, checking types or brands of products eaten or asking others for this information was not allowed in this interview. At the dietary history interview the presence of the person who prepared main meals was requested for participants who seldom or never cooked, to provide information about the ingredients and preparation of the meals. The length of the interviews was recorded to the nearest 5 minutes. The field work period ran from the end of January until the end of June 1991.

A pilot study in which all questionnaires were tested was carried out in a group of 19 men and women two months before the main study. The interviews were conducted by two registered dieticians, two student dieticians who were near graduation and a nutritionist. The team was trained in both methods of food intake assessment. The two interviews as well as the accompanying coding of the

questionnaires for a subject were all carried out by the same interviewer. Every week the field work was evaluated and coding problems were solved. Regularly during the study period a dietary history or a short questionnaire of a randomly selected subject was coded by all interviewers to maintain standardised coding. The assessment of food consumption was followed by the general questionnaire. Anthropometric measurements took place in the last visit. In this visit the participants were asked to have blood and a microbiopsy of adipose tissue taken as an independent marker of short- and long-term fat intake. The protocol was approved by the Medical Ethical Committee of Wageningen Agricultural University.

Dietary history

The dietary history was carried out as described and validated earlier by van Staveren [15,16]. The last four weeks were taken as the reference period, as for the food frequency questionnaire. Distinction was made between weekdays and weekend days. Additions to meals were checked for every eating occasion. A checklist of 43 items was gone through to pick up items not yet recalled.

Portion sizes for cooked meals were estimated by asking the amounts for the whole family and the part the respondent ate from this. The amount of butter or margarine spread on a slice of bread, cheese on bread, fat and water used for making gravy, and the volume of both the gravy spoon and the milk mug were measured to the nearest gram with a weekly calibrated Sartorius scale (model 1020; Sartorius, Göttingen, Germany). Other portion sizes were estimated using common household units.

Biological markers of fat intake

Blood samples from 99 subjects were taken for the assessment of the fatty acid composition of erythrocyte membranes. A microbiopsy of adipose tissue was taken also from 55 of these subjects. Participants received written information and gave written informed consent. A medical questionnaire was filled out by the participants and screened by a physician. The samples were taken in the afternoon and early evening on 5 separate days at a health centre in Veenendaal. No restrictions on food intake were made. Samples were taken as soon as possible after the last interview, varying between 6 and 93 days, with a mean (± SD) of 33 ± 20 days.

Sampling, storage, and determination of the fatty acid composition of erythrocyte membranes were carried out as described by Glatz [6]. The analyses were carried out on a Chrompack-Packard gas chromatograph, model 438 AS with automatic sampler model 910/911 and a CP-WAX-58-CB capillary column (Chrompack, Bergen op Zoom, the Netherlands). Hydrogen was used as the carrier gas with a split vent of 32 mL/min. The oven temperature was programmed to increase from 140 °C to 170 °C with 5 °C/min, from 170 °C to 213 °C with 1.75 °C/min, from 213 °C to 240 °C with 40 °C/min, and the program ended with 13.8 minutes on 240 °C. The injector temperature was 275 °C and the detector temperature was 265 °C. A control sample, consisting of a mixture of blood samples taken from volunteers, was analyzed in every run. For the different fatty acids in the erythrocyte membranes the coefficient of variation within and between runs ranged from 0.24% to 11.22% and from 0.0% to 8.27%, respectively, with the maximum values for C20:5(n-3). For linoleic acid the within and between run variation were 1.23% and 1.16%, respectively.

Microbiopsies of subcutaneous adipose tissue were taken from the buttocks with a 1.5 mm needle, stored at -20 °C, and analyzed as described by Beynen and Katan [17]. The same apparatus described in the analysis of the erythrocyte membranes was used. The oven temperature was programmed to increase from 140 °C to 170 °C with 5 °C/min, from 170 °C to 225 °C with 7.5 °C/min, from 225 °C to 240 °C with 40 °C/min, and the program ended with 5 min on 240 °C. The injector temperature was 275 °C and the detector temperature was 250 °C. Analyses of a control sample of human adipose tissue revealed that the coefficient of variation within and between runs ranged from 0.1% to 1.3% and from 0.0% to 1.2% for the different fatty acids, respectively, with the maximum values for C18:3(n-3). For linoleic acid the within and between run variation was 0.4% and 0.0%, respectively.

All samples were analyzed within 5 months. Washed erythrocytes stored at - 80 °C are stable for 6 months [6] and samples of adipose tissue stored at -20 °C for 1.5 year [17]. The amount of a fatty acid is expressed as percentage by weight (g/100 g) of fatty acid methyl esters.

Lifestyle questionnaire

The frequency of meal preparation by the respondent, shopping for meal

ingredients, eating out for lunch or dinner, and eating take-away foods was recorded. Household size, defined as the number of people with whom main meals were shared, was recorded as was education level. At both interviews adherence to a special diet and change of body weight in the month preceding the interview was recorded. After the second interview subjects were asked if there had been any changes in their diet after the first interview with regard to fat content of milk, yoghurt, and cheese; type of butter or margarine used on bread; and type of cooking fat. Other reported changes in the subjects' food consumption after the first dietary assessment were recorded.

Anthropometry

Body weight without shoes and jackets was assessed on a SECA scale (Laméris Instruments, Utrecht, the Netherlands) to the nearest 0.5 kg. Height was reported by the subject (in cm).

Data treatment

Nutrient and statistical analyses were performed by using the SAS statistical analyses package (SAS Institute Inc, Cary, NC). Nutrient intake was calculated with the extended version of the Dutch nutrient data base 1986, which was also used in the Dutch National Food Consumption Survey [18]. For the items on the food frequency questionnaire containing more than one food product, the nutrient content was calculated as the weighted consumption of the separate foods in the Dutch National Food Consumption Survey.

Statistical analyses

To assess the validity of the food frequency questionnaire, several analyses were carried out. First, differences in intake between dietary history and food frequency questionnaire were computed. Student's t-test for paired observations was used to test these differences ($\alpha = 0.05$). The effect of the sequence of the dietary assessment methods was evaluated by comparing the difference in intake between the methods for the interview sequence dietary history-food frequency questionnaire and food frequency questionnaire-dietary history. The difference between the methods was calculated as the intake assessed with the food frequency questionnaire minus the intake assessed with the dietary history.

Pearson's product-moment correlation coefficient was used to evaluate the linear association between the results of the food frequency questionnaire and the dietary history method. A description of the agreement of the food frequency questionnaire and the dietary history was given by classifying intake values obtained by both methods into five categories. Cutoff points were determined on the basis of the quintiles of the intake assessed with the dietary history, because systematic differences between the methods should be taken into account.

Associations between the fatty acid composition of the diet as estimated by the food frequency questionnaire and the fatty acid composition of subcutaneous fat and erythrocytes, respectively, were evaluated by Pearson's product-moment correlation coefficients. In this analysis the dietary fatty acid intake was expressed as percentage of the total fat intake (g/100 g), because fatty acids in the tissues were expressed also as percentage of the total fat fraction.

RESULTS

Population

The study population consisted of 96 women and 95 men with a mean (± SD) age of 39.9 ± 5.7 years. Body weight was 69.5 ± 11.8 kg for women and 82.0 ± 11.5 kg for men, and body mass index (in kg/m^2) was 25.2 ± 4.5 for women and 25.4 ± 3.3 for men. Reported changes in body weight in the month preceding the first and second interviews were 0.0 ± 1.4 kg (ranging from -5.5 to +5 kg) and -0.1 ± 1.5 kg (ranging from -5 to +4.5 kg), respectively. Household size ranged from one to eight, with a mean of 3.6 subjects per household. Of the 191 subjects 75% were employed, with 10% of them in shiftwork. A low education status, not more than primary school, characterised 28% of the population, whereas 23% had at least higher vocational education or a university degree.

Food preparation and diet

Most of the subjects (70%) prepared main meals at least once a week, whereas 22% never did. Meal ingredients were bought at least once a week by 79% of the subjects, whereas 10% never shopped. Eating out or eating take-away food occurred less than once a week for 72% of the participants whereas only 7%

Table 1. Comparison of the intake of energy, fats and cholesterol per day measured with the food frequency questionnaire (FFQ) and the dietary history (DH) and the effect of the sequence of the dietary assessment methods

Food component	FFQ	DH	Overestimation by FFQ[a] (%)	Difference sequence FFQ,DH[b] (n=102)	Difference sequence DH,FFQ[b] (n=89)	Correlation coefficient[c]		
						All (n=191)	Women (n=96)	Men (n=95)
Energy (MJ)	10.02 ± 3.25[d]	9.69 ± 2.98	5	0.85 ± 1.74[f]	-0.25 ± 1.78	0.83	0.76	0.77
Fatty acids (g)								
Total	111.8 ± 45.3	100.9 ± 35.9	13	18.3 ± 28.0[f]	2.4 ± 26.7	0.78	0.74	0.71
Saturated	43.5 ± 17.0	39.8 ± 14.4	12	6.8 ± 11.4[f]	0.1 ± 10.1	0.75	0.74	0.68
Monounsaturated	40.3 ± 16.9	37.1 ± 14.2	11	6.2 ± 10.5[f]	-0.2 ± 10.0	0.78	0.75	0.71
Polyunsaturated	21.4 ± 11.6	17.9 ± 7.7	24	4.1 ± 8.7	2.7 ± 9.7	0.61	0.58	0.53
Linoleic acid	18.6 ± 10.8	15.2 ± 7.0	30	4.0 ± 8.2	2.7 ± 9.7	0.56	0.53	0.48
Cholesterol (mg)	303 ± 115	297 ± 105	6	24 ± 94[g]	-14 ± 87	0.65	0.57	0.61
Fatty acids (En%)[e]								
Total	41.3 ± 6.3	39.0 ± 5.7	7	3.1 ± 5.3[h]	1.6 ± 4.6	0.65	0.70	0.60
Saturated	16.1 ± 2.8	15.4 ± 2.6	6	1.1 ± 2.5[h]	0.3 ± 1.9	0.66	0.67	0.68
Monounsaturated	14.9 ± 2.8	14.3 ± 2.5	5	0.9 ± 2.1[h]	0.2 ± 2.1	0.69	0.73	0.65
Polyunsaturated	7.8 ± 2.5	6.9 ± 2.0	18	0.8 ± 2.7	1.0 ± 2.3	0.41	0.44	0.38
Linoleic acid	6.8 ± 2.5	5.9 ± 1.9	23	0.9 ± 2.6	1.0 ± 2.4	0.38	0.42	0.35

[a] Overestimation (%): FFQ-DH/DH * 100, then averaged over subjects.

[b] Calculated as FFQ minus DH.

[c] Pearson's product-moment correlation coefficient.

[d] Mean ± SD. [e] En%, percent of energy intake.

[fgh] Significantly different from sequence DH,FFQ: [d] $p<0.0001$, [e] $p<0.02$, [f] $p<0.05$.

did this more often than once a week. Eating lunch at home or a home-packed lunch at work was reported by 81%, whereas 11% lunched more than once a week outside of the home. Two subjects were vegetarian. Seven percent followed a therapeutic diet the month preceding an interview, mostly weight reducing or cholesterol lowering diets. When asked for changes in type of food used after the first interview, 3% reported change in type of milk or yoghurt, 5% for type of cheese, 8% for type of butter or margarine used as spread, 8% for type of cooking fat, 7% for type of meat and meat products, and 17% reported other changes which were mostly changes in the amount of foods consumed. Altogether, 60 subjects (31%) reported one or more of the mentioned changes in their food pattern.

Comparison of the dietary methods

The food frequency interview took on average 25 minutes (ranging from 15 to 55 minutes), whereas it took 90 minutes (ranging from 40 to 180 minutes) to administer the dietary history. The period between the interviews was 63 ± 11 days. Mean daily intakes of fat, fatty acids and cholesterol for both methods are presented in **Table 1**. Energy and nutrient intakes were overestimated by the food frequency questionnaire as compared with the dietary history. For most of the dietary components the mean individual differences between the assessment methods were within 15% of the results of the reference method. An exception is linoleic acid, which was overestimated by 30% when expressed in grams and by 23% when expressed relative to energy. Pearson's correlation coefficients of intake determined by the food frequency questionnaire and the dietary history range from 0.38 for percent of energy from linoleic acid to 0.83 for energy intake. There were no substantial gender differences in correlation coefficients. Sex-specific correlations of absolute levels of intake tended to be slightly lower than values for men and women together because of smaller between-subject variation in the subgroups. Correlation coefficients between intakes assessed with the two food consumption assessment methods that were adjusted for age hardly differed from unadjusted coefficients (data not shown). Excluding the 60 subjects who reported having changed their diets between the interviews did not significantly alter the correlations; only coefficients for polyunsaturated fatty acids tended to be slightly higher in the group that did not report dietary changes.

Table 2. Results of the food frequency questionnaire classified into five categories compared with the results obtained with the dietary history[a]

Food component	Same category	Same or adjacent category	Grossly misclassified[b]
Energy (kJ)	73 (38.2%)	156 (81.7%)	1 (0.5%)
Fatty acids (g)			
Total	72 (37.7%)	131 (68.6%)	3 (1.6%)
Saturated	85 (44.5%)	154 (80.6%)	1 (0.5%)
Monounsaturated	88 (46.1%)	161 (84.3%)	1 (0.5%)
Polyunsaturated	79 (41.4%)	120 (62.8%)	5 (2.6%)
Fatty acids (En%)[c]			
Total	72 (37.7%)	131 (68.6%)	4 (2.1%)
Saturated	65 (34.0%)	137 (71.7%)	0 (0.0%)
Monounsaturated	74 (38.7%)	138 (72.3%)	2 (1.0%)
Polyunsaturated	62 (32.5%)	120 (62.8%)	5 (2.6%)
Cholesterol (mg)	67 (35.1%)	148 (77.5%)	0 (0.0%)

[a] n = 191. Number of subjects; percent of subjects in parentheses.

[b] Classified from one extreme category to the other extreme category.

[c] En%, percent of energy intake.

The sequence of the methods appears to have influenced the results. For those subjects (n = 89) having the dietary history interview first, the intake assessed by the food frequency questionnaire was overestimated considerably less relative to the dietary history than for the remainder of the study population (n = 102). The percentage of energy intake from total and saturated fat was overestimated by the food frequency questionnaire relative to the dietary history to a greater extent in men than in women (3.3 En% vs. 1.5 En%, $p < 0.02$ for total fat and 1.2 En% versus 0.3 En%, $p < 0.01$ for saturated fat). Pearson correlation coefficients were similar for both interview sequences. The differences in intake between the food frequency questionnaire and the dietary history were similar for subjects preparing meals at least once a week (n = 134) and the others (n = 57), and also for subjects who reported one or more changes in their food pattern compared with the first interview (n = 60) and those who did not (n = 131).

Table 3. Pearson's correlation coefficients between fatty acid composition of the diet assessed by the food frequency questionnaire and dietary history and the fatty acid composition of the *erythrocyte membranes* in Dutch men and women (n = 99), and for the food frequency questionnaire separately for those with stable and unstable body weights[a]

	Food frequency questionnaire			
Fatty acids in erythrocyte membranes[a]	(n = 99)	Stable body weight (n = 56)	Unstable body weight (n = 43)	Dietary history (n = 99)
Linoleic acid	0.44 [0.26,0.59][b]	0.45	0.43	0.41 [0.23,0.56]
M:Linoleic acid	0.41 [0.23,0.56]	0.42	0.42	0.44 [0.26,0.59]
Linoleic acid:S	0.40 [0.22,0.55]	0.45	0.35	0.37 [0.19,0.53]
P	0.33 [0.14,0.49]	0.43	0.22[c]	0.38 [0.20,0.54]
M:P	0.37 [0.19,0.53]	0.38	0.40	0.38 [0.20,0.54]
P:S	0.22 [0.02,0.40]	0.40	- 0.03[c]	0.23 [0.03,0.41]

[a] M, monounsaturated fatty acids; S, saturated fatty acids; P, polyunsaturated fatty acids.

[b] 95% confidence interval in brackets.

[c] Not significantly different from zero, $p > 0.05$.

Classification of individuals by the food frequency questionnaire in the same or an adjacent category as by the dietary history ranged from 62.8% of the subjects for polyunsaturated fatty acids (either in grams or as percentage of energy intake) to 84.3% for the intake of monounsaturated fatty acids (**Table 2**). Only a few subjects were grossly misclassified (classified from one extreme category to the other extreme category), the highest proportion being 2.6% for polyunsaturated fatty acids (either in grams or as percentage of energy intake).

Biological markers

Table 3 and **Table 4** show that the correlations between the intake assessed by the dietary assessment methods and the fatty acid composition of erythrocyte membranes and subcutaneous adipose tissue, respectively, are similar for the food

Table 4. Pearson's correlation coefficients between fatty acid composition of the diet assessed by the food frequency questionnaire and dietary history and the fatty acid composition of *adipose tissue* in 55 Dutch men and women, and for the food frequency questionnaire separately for those with stable and unstable body weights

	Food frequency questionnaire			
Fatty acid in adipose tissue[a]	(n=55)	Stable body weight (n=29)	Unstable body weight[b] (n=26)	Dietary history (n=55)
Linoleic acid	0.28 [0.02,0.51][c]	0.57	0.04	0.34 [0.08,0.56]
M:linoleic acid	0.25 [-0.02,0.48]	0.52	- 0.08	0.44 [0.20,0.63]
Linoleic acid:S	0.33 [0.07,0.55]	0.53	0.19	0.30 [0.04,0.52]
P	0.24 [-0.03,0.48]	0.52	0.09	0.29 [0.02,0.51]
M:P	0.24 [-0.03,0.48]	0.46	0.02	0.34 [0.08,0.56]
P:S	0.32 [0.06,0.54]	0.51	0.22	0.28 [0.02,0.51]

[a] M, monounsaturated fatty acids; S, saturated fatty acids; P, polyunsaturated fatty acids.

[b] None of the correlations with unstable body weight were significantly different from zero, $p>0.05$.

[c] 95% confidence interval in brackets.

frequency questionnaire and the dietary history. The correlation between fatty acid intake and the fatty acid composition of adipose tissue is apparently decreased for the group with unstable body weight. Subjects were considered to have a stable body weight when in both interviews the reported weight change of the preceding month was less than 1.5 kg. This decrease was not apparent in erythrocytes. Excluding the subjects that reported changes in their diet between the interviews did not significantly influence the correlations between the intake assessed by the dietary assessment methods and the fatty acid composition of the biomarkers. However, for the dietary history the correlation of the fatty acid intake and the fatty acid composition of the adipose tissue was at least 0.1 higher in subjects reporting dietary changes (16 of 55), but the numbers of the remaining groups are too small to draw any conclusions. The correlation between linoleic acid in erythrocyte membranes and adipose tissue is 0.34, with the 95% confidence interval ranging from 0.08 to 0.56.

Table 5. Fatty acid composition of diet as estimated by the food frequency questionnaire (FFQ) and the dietary history (DH), and of erythrocyte membranes and subcutaneous adipose tissue in Dutch men and women aged 30 to 50 years[a]

Fatty acid variable (% of total fat)[b]	FFQ	DH	Erythrocyte membranes	Adipose tissue (n=55)
Linoleic acid	16.40 ± 5.16	15.17 ± 4.38	9.27 ± 1.11	14.20 ± 2.44
M:linoleic acid	2.47 ± 0.93	2.89 ± 1.17	1.87 ± 0.29	3.93 ± 0.80
Linoleic acid:S	0.44 ± 0.18	0.40 ± 0.15	0.21 ± 0.03	0.56 ± 0.11
P	18.81 ± 5.00	17.94 ± 4.63	32.21 ± 11.15[c]	15.50 ± 2.55[d]
M:P	2.08 ± 0.64	2.23 ± 0.76	0.53 ± 0.05	3.58 ± 0.69
P:S	0.50 ± 0.18	0.47 ± 0.17	0.72 ± 0.04	0.61 ± 0.12

[a] Mean ± SD; n=99 except where otherwise noted. [b] M, monounsaturated; S, saturated; and P, polyunsaturated fatty acids. [c] C20:4(n-6) = 12.01 ± 0.80, C22:4(n-6) = 2.54 ± 0.41. [d] C18:3(n-6) = 0.11 ± 0.05, C20:3(n-6) = 0.26 ± 0.14, other metabolites of linoleic acid were below the detection limit.

Table 6. Pearson's correlation coefficients between the fatty acid composition of erythrocyte membranes and the fatty acid composition of the diet as assessed by the food frequency questionnaire (FFQ) and by the dietary history (DH) in 99 Dutch men and women, for both test sequences[a]

Fatty acid in erythrocyte membranes[b]	Sequence FFQ,DH (n=49)		Sequence DH,FFQ (n=50)	
	FFQ	DH	FFQ	DH
Linoleic acid	0.15 [-0.13 to 0.42][c]	0.39 [0.12 to 0.60]	0.60 [0.39 to 0.75]	0.41 [0.15 to 0.62]
M:linoleic acid	0.26 [-0.02 to 0.50]	0.53 [0.29 to 0.71]	0.48 [0.24 to 0.67]	0.39 [0.13 to 0.60]
Linoleic acid:S	0.05 [-0.24 to 0.33]	0.31 [0.03 to 0.54]	0.60 [0.39 to 0.75]	0.40 [0.14 to 0.61]
P	0.11 [-0.18 to 0.38]	0.19 [-0.10 to 0.45]	0.46 [0.21 to 0.65]	0.48 [0.24 to 0.67]
M:P	0.27 [-0.01 to 0.51]	0.35 [0.08 to 0.57]	0.45 [0.20 to 0.65]	0.43 [0.17 to 0.63]
P:S	-0.04 [-0.32 to 0.24]	0.04 [-0.28 to 0.55]	0.37 [0.10 to 0.59]	0.36 [0.09 to 0.58]

[a] Intake of fatty acids with diet expressed as percentage of fat intake, fatty acids in erythrocytes are expressed as percentage of fatty acids methyl esters.

[b] M, monounsaturated; S, saturated; and P, polyunsaturated fatty acids. [c] 95% confidence interval in brackets.

Table 5 shows the fatty acid composition of the diet assessed by the two methods and the fatty acid composition of the two body tissues. The low linoleic acid and high total polyunsaturated fatty acid concentration in erythrocytes compared with the diet and the adipose tissue is as expected[6]. The values of the separate fatty acid concentrations show that in adipose tissue the concentrations of more desaturated and longer-chain fatty acids metabolised from linoleic acid are very low or below the detection limit. In erythrocyte membranes, however, the concentrations of these metabolites are high.

The correlation of the linoleic acid in erythrocytes with the intake assessed by the food frequency questionnaire seems to be generally higher in the group where the dietary history was carried out before the food frequency questionnaire (**Table 6**). In adipose tissue no such effect was found, but the numbers were small (n = 27 food frequency questionnaire first, n = 28 dietary history first) and only a few correlation coefficients reached statistical significance (data not shown).

DISCUSSION

Comparison of the results of this validation study on a questionnaire about fat intake with other validation studies is difficult, because studies differ in design, respondent characteristics, reference method, and the questionnaire itself[19]. In this study we assessed the validity of a newly developed questionnaire on fat intake against an often used and validated dietary assessment method as well as against the fatty acid composition of body tissues.

The dietary history is considered a valid method to classify individuals into categories with respect to intake over a prolonged period of time[16,20]. The food frequency method focuses on the consumption of specific food items. As such, it has its limitations.

The capacity of the food frequency questionnaire to assess the relative magnitude of the intake of individuals is very acceptable when compared to another study using a dietary history[21] and also with validation studies in which a food frequency questionnaire is compared with dietary records[22-24]. However, the comparison of the results of this study with validation studies using dietary records is not fully appropriate as both the food frequency questionnaire as well as the

dietary history method rely on the memories of the respondents and on their ability to estimate amounts [25]. This may introduce similar errors leading to inflated correlations [26].

The estimated intakes of fat, fatty acids and cholesterol assessed by the newly developed food frequency questionnaire on fat intake are higher than those found by using a dietary history, but the mean difference in the intakes between the methods is not very large. Energy intake as assessed by the food frequency questionnaire results in amounts fairly equal to the energy requirements for this group. Energy requirements based on body weight are predicted to be 10.13 MJ for this population, so the energy intake assessed by the food frequency questionnaire (10.02 MJ) and by the dietary history (9.69 MJ) is as expected [27]. It is of great practical importance that the time required for administering the food frequency questionnaire (25 minutes) is much shorter than for the dietary history (90 minutes), which results undoubtedly a preference for the newly developed food frequency questionnaire.

Not only did we observe a bias in the results of the food frequency questionnaire, but because of the crossover design we were also able to pick up a differential bias for the two interview sequences. In the group where the dietary history interview took place first the intake measured with the food frequency questionnaire was more similar to the results of the dietary history than in the group that started with the food frequency questionnaire. This complicates the evaluation of the food frequency questionnaire's capacity to assess absolute intakes. The differential bias may have various causes. When caused by a learning or a test effect, it means that results with the food frequency questionnaire may be improved by additional information beforehand. Enhanced consciousness and/or ability to recall consumption in the second interview may have been caused by the assessment of food intake two months earlier. A time-effect is also possible, as halfway through the fieldwork period a national campaign to reduce fat intake was carried out. Because the groups were randomly assigned to treatments, these effects were not expected to invalidate the results, because they were supposed to occur in the same way in either of the sequence groups. It may be that the group with the food frequency questionnaire interview as the last assessment was influenced more by one of the mentioned possible effects.

The biomarker data do not fully provide supporting evidence. There seems to

be a stronger association between the results of the food frequency questionnaire and the fatty acid composition of erythrocytes when the dietary history was carried out before the food frequency questionnaire. However, such a trend is not apparent in the association between fat intake according to the food frequency questionnaire and the fatty acid composition of adipose tissue, but the numbers of subjects here are too small to draw conclusions. It is important that there is no difference in the correlation between intake assessed with the food frequency questionnaire and the dietary history for the two sequences, so the order of subjects according to intake is assessed as well by the newly developed food frequency questionnaire as by the dietary history.

Biomarkers of fat intake have not been used often in studies of the validity of food assessment questionnaires. Linoleic acid is considered to be the best marker of fatty acid intake, because it can not be synthesised in humans. However, the percentage of the essential linoleic acid can be diluted in tissues because of the own synthesis of fatty acids.

The fatty acids in adipose tissue have been used as a biomarker of fatty acid intake several times [28-32]. Plakké et al. [28] reported a 0.54 correlation with dietary intake assessed with 2-day records in 321 Dutch men and women: among them were 159 Seventh-day Adventists. The correlation between dietary linoleic acid intake from a 7-day record and adipose linoleic acid was 0.57 in middle-aged men in Scotland and 0.37 in middle-aged men in South-Africa [29,31]. Hunter et al. studied the relationship between dietary and polyunsaturated fatty acids in fat aspirates from 118 Boston-area men and found a correlation of 0.49 when dietary intake was calculated from two 7-day records and 0.50 when diet was assessed by a 131-item food frequency questionnaire [32]. In a group of females, van Staveren et al. [30] found a relatively high correlation of 0.70 between the linoleic acid concentration in adipose tissue and the mean linoleic acid intake of nineteen 24-h recalls over a period of 2.5 years. For those women having a relatively stable body weight, the association was as high 0.82. In the latter study the biopsies were taken 3 months after the last recall, which means that the reference time of the biomarker matched very well with that of the food consumption data. The relatively weak associations we found between the fatty acid composition of the adipose tissue and the dietary intake may be due in the first place to the fact that fat intake of the past month was related to a biomarker of fat intake covering the

last 2 to 3 years. Secondly, the instability of body weight during the past months in half of the group may be related to instability of body weight during the last few years and thus influence the fatty acid composition of the adipose tissue. Dayton et al. [33,34] and van Staveren et al. [30] reported also an influence of changes in body weight on the association between intake of fatty acids and the fatty acids in adipose tissue. Other factors involved might be the small range of the values of the biomarker and unknown errors in the recall of food intake.

Until now, no comparable studies using erythrocyte membranes as a biological marker in validation studies of dietary intake have been published. We found that the correlation between fatty acids in erythrocytes and intake as assessed by the dietary history is similar to the correlation with intake as assessed by the food frequency questionnaire (**Table 3**). This finding strongly supports the validity of the newly developed food frequency questionnaire.

The reference period of one month used for the two dietary assessment methods does not exactly reflect the reference period of the chosen biomarkers, because the fatty acid composition in adipose tissue, and in erythrocyte membranes, reflects intakes of the preceding 2 to 3 years and 6 to 8 weeks, respectively [4-7]. We believe that in this study, where a marker reflecting intake of the past one or two months was needed, the fatty acid composition of the erythrocyte membranes is a better marker of the fatty acid intake than the fatty acid composition of adipose tissue. The correlations with intake for the fatty acid composition of erythrocyte membranes tend to be higher than those for the fatty acid composition of adipose tissue and are not dependent on stability of body weight.

We regard the use of the food frequency questionnaire by dieticians suitable to form the basis for dietary advice and to check dietary compliance.

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Appendix 1

Food group	Number of items per group	Subgroups (number of items per subgroup)
Bread	8	
Butter, margarine	1[a]	
Sandwich fillings	13	Hard cheese [1], Soft cheese [2], Liver [1], Liver sausage and paté [1], Other meat products [1][b], Other fillings: savory [3], sweet [4].
Cheese as snack	1[b]	
Meat products as snack	1	
Eggs	1	
Milk	1[b]	
Milk or creamer in coffee	8	
Sugar	1	
Soup	1	
Chinese food	1	
Pizza	1	
Complex carbohydrate foods	3	Beans [1], Pasta and rice [1], Potatoes [1].
Vegetables	1	
Additions to foods	3	Cheese [1], Cream [1], Cream sauce [1].
Fish	4	Raw herring [1], Fried fish [2], Other fish[b] [1].
Meat	9	Ground meat [2], Chicken [2], Sausages [2], Liver [1], Bacon [1], Other meats[b] [1].
Gravy	1[a]	
Added fats and oils	5[a]	Fried breaded products, Fried potatoes, Mashed potatoes, Cooked vegetables, Other fried products.
Yoghurt	1[b]	
Custard and puddings	1[b]	
Ice-cream	1	
Muesli	1	
Fruits	1	
Cookies, cakes and pastry	7	
Whipped cream	1	
Chocolate and candy bars	3	Chocolate bars [1], Bonbons [1], Candy bars [1].
Miscellaneous snack foods	9	
Crisps and nuts	2	Crisps [1], Nuts [1].
Mayonnaise and salad dressings	5	
Non-alcoholic and alcoholic drinks	6	

[a] For all added fat and oils a choice from 13 types could be made.

[b] A choice from 3 fat-levels could be made.

3

Reproducibility of a semiquantitative food frequency questionnaire to assess the intake of fats and cholesterol in the Netherlands

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ABSTRACT

The reproducibility of a 104-item semiquantitative food frequency questionnaire to estimate the intake of energy, fat, fatty acids and cholesterol was assessed in a group of 93 men and women in the Netherlands. The questionnaire was administered by trained interviewers. Subjects were asked to recall the consumption of 104 items during the past month. A second interview was conducted 8 weeks later. The mean difference in nutrient intake between the two assessments was very small, with a maximum of 5% for cholesterol intake, but the variance of individual differences was considerable. Pearson correlation coefficients between two assessments 8 weeks apart ranged from 0.71 for polyunsaturated fatty acids intake (when expressed as % of energy intake) up to 0.91 for energy intake. The reproducibility was found to be similar in males and females. Reproducibility was assessed for separate food items as well as for 20 food groups. Items that were consumed frequently had a high reproducibility, whereas items that were consumed infrequently had a poor reproducibility. This food frequency questionnaire is considered to be a suitable tool to estimate and monitor the intake of fat, fatty acids and cholesterol in the Netherlands.

INTRODUCTION

In the Netherlands, as in most affluent societies, the diet is rich in saturated fat. According to the National Food Consumption Survey in 1987/1988 the mean intake of fat was 40% of energy intake, with 16% of energy intake contributed by saturated fat [1]. With respect to the Dutch dietary guidelines: in 1987/1988 only 20% of the men and 13% of the women had a total fat intake below 35% of the daily energy intake, and only 3% had diets with at most 10% of energy intake contributed by saturated fat [2,3]. National and regional campaigns to reduce (saturated) fat intake have been undertaken. According to the most recent Dutch Food Consumption Survey in 1992 the mean fat intake of the population is decreased to 37% of energy intake, still above recommendations [4].

A 104-item semiquantitative food frequency questionnaire to estimate the current intake of fats, fatty acids and cholesterol was developed and validated against the dietary history method and two biomarkers of fatty acid intake [5]. This questionnaire is regarded to be a tool for dieticians to monitor dietary intake in hypercholesterolemic patients, and for the measurement of the intake of fat, fatty acids and cholesterol in epidemiological and intervention studies.

In the current study we investigated the reproducibility of the questionnaire. Reproducibility refers to the variability of a measurement on the same subject, under the same condition [6]. It is important to assess the reproducibility of a questionnaire. In the first place, a method with poor reproducibility can not be expected to produce valid estimates of dietary intakes of individual subjects. Secondly, knowledge of the variance of the method enables investigators to calculate the extent of the dietary change between two administrations of the questionnaire that can be detected with sufficient power. Furthermore, from the results of a reproducibility study it is possible to estimate the gain in precision that would result from an extra administration [7] or a larger sample size. In this study two administrations of the food frequency questionnaire were conducted 8 weeks apart. The length of this wash-out period was selected to meet two goals with opposite requirements: the period between the assessments has to be long enough to fade out the memory of the first interview, and at the same time as short as possible to reduce the effect of any changes in dietary habits.

METHODS

Subjects

A random sample of 250 men and women between 30 and 50 years of age was obtained from the municipal register of Amersfoort, a town with about 100,000 inhabitants in the centre of the Netherlands. A letter was sent to all subjects. An appointment for an interview was made by means of a telephone call or by means of a home-visit, in the case of their telephone number being inaccessible. Three attempts were undertaken to contact a subject. We were able to contact 167 of the 250 subjects, who had to be Dutch speaking to participate. Exactly 100 subjects (40% of the total sample) were enrolled in the study. Seven subjects did not complete the study, and results will be presented for 93 subjects.

Procedure

The 104-item semiquantitative food frequency questionnaire as described elsewhere [5] was conducted twice in an interview. The food items in this questionnaire which assesses the intake of fats and cholesterol were derived from the Dutch Food Consumption Survey 1987-1988. The questionnaire covered over 90% of the intake of energy, fats and cholesterol in Dutch men and women aged 30-50 years. Consumption frequencies were recorded per day, per week or per month, with a reference period of the past four weeks. No seasonal variation in the intake of the nutrients of interest was expected, and the past month rather than the 'usual intake' or the intake of the past year was taken as a reference, because subjects can report more accurately over the past month [8]. If the past month was atypical due to events such as illness or vacation, the month before the most recent one was taken as the reference period. Portion sizes were estimated relative to standard portion sizes.

The interviews were conducted by two dieticians (FG and JdV), who were trained in conducting the food frequency interview. The interviews took place at the respondents' homes. Checking types or brands of products eaten or asking others for this information was not allowed. Each subject was interviewed on both occasions by the same dietician. The duration of the food frequency interview,

assessed to the nearest 5 minutes, was on average 25 minutes and ranged from 15 to 40 minutes.

A wash-out period of 8 weeks was successfully achieved between the interviews, resulting in a mean period of 55 days (SD 5). A general questionnaire was conducted at the first interview. The frequency of preparing cooked meals, eating out for dinner, shopping for meal ingredients, and adherence to a therapeutic diet or special food pattern were recorded. Height, body weight and the highest educational level were recorded.

The field work was carried out in the autumn of 1991.

Data treatment

Conversion into nutrients

Nutrient intake was calculated with the extended version of the Dutch nutrient data base 1986 [9]. Total fat is not equalled by the sum of saturated, monounsaturated and polyunsaturated fatty acids in the Dutch nutrient data base, because of rounding of figures and a small amount of unidentifiable fatty acids. For the items on the food frequency questionnaire containing more than one food product, the nutrient content was calculated as the weighted consumption of the separate foods in the Dutch Food Consumption Survey [1].

Statistical analyses

Differences in intake between first and second measurement, and the variation of the differences (SD_{diff}) have been calculated. To examine a possible time effect paired t-tests ($\alpha = 0.05$) were performed on the differences between the first and second estimate of dietary intake. To describe the agreement between the results of both questionnaires a classification according to tertiles was made. Cutoff points were 1st and 2nd tertile of the distribution of intake. The association between the intakes of the first and second measurement was assessed by calculating Pearson correlation coefficients for the intake of energy, fats and cholesterol, respectively. Spearman rank correlation coefficients were calculated for all food items and for 20 food groups, because consumption frequencies of foods and food groups do not have a normal distribution. All statistical analyses were performed using the SAS program version 6.06 (SAS Institute Inc, Cary, NC).

RESULTS

Population

The study population consisted of 93 subjects, 50 women and 43 men, with a mean age of 40 (SD 6) years. For a small percentage (4%), primary school was the highest level of education, whereas 33% had a higher education level consisting of at least a higher vocational education or a university degree.

Food pattern and preparation

Seven subjects reported being on a low-calorie diet, and two subjects reported following a diet low in fat and cholesterol. Eating out for dinner or eating take-away food occurred less than once a week for 42% of the population. Main (cooked) meals were prepared by 78% of the subjects at least once a week, and 79% shopped at least once a week for meal ingredients.

Table 1. Reproducibility of the food frequency questionnaire in 93 Dutch subjects, 43 men and 50 women. Intake of energy, fats and cholesterol (mean ± SD) on two occasions 8 weeks apart, and differences between the two interviews

Food component	Interview 1	Interview 2	Difference[a]
Energy (kJ)	10895 ± 3785	10430 ± 3850	- 465 ± 1597 (-4%)[b]
Total fat (g)	114.6 ± 50.2	112.1 ± 50.0	- 2.5 ± 25.9 (-2%)
Saturated fat (g)	45.0 ± 18.9	43.7 ± 18.6	- 1.4 ± 9.7 (-3%)
Monounsaturated fat (g)	40.5 ± 18.1	40.4 ± 18.3	- 0.2 ± 9.1 (0%)
Polyunsaturated fat (g)	22.4 ± 12.8	21.4 ± 12.7	- 1.0 ± 8.4 (-4%)
Total fat (En%)[c]	39.0 ± 6.7	39.9 ± 7.2	0.9 ± 4.8 (2%)
Saturated fat (En%)	15.4 ± 3.1	15.7 ± 3.3	0.3 ± 2.1 (2%)
Monounsaturated fat (En%)	13.8 ± 2.7	14.4 ± 3.0	0.6 ± 1.9 (4%)[b]
Polyunsaturated fat (En%)	7.5 ± 2.4	7.4 ± 2.4	- 0.0 ± 1.8 (0%)
Cholesterol (mg)	305 ± 124	289 ± 119	16 ± 69 (-5%)[d]

[a] Second minus first estimate, with difference as percentage of the first estimate in parentheses.

[b] Paired t-test, $p < 0.01$.

[c] En%, percent of energy intake.

[d] Paired t-test, $p < 0.05$.

Table 2. Classification in tertiles (% of the population) according to estimated intakes of energy, fat, fatty acids and cholesterol with a food frequency questionnaire on two occasions 8 weeks apart (n = 93)

Food component	Same tertile	Adjacent tertile	Opposite tertile
Energy (kJ)	73.1	25.8	1.1
Total fat (g)	71.0	28.0	1.1
Saturated fat (g)	74.2	23.7	2.2
Monounsaturated fat (g)	69.9	28.0	2.2
Polyunsaturated fat (g)	66.7	32.3	1.1
Total fat (En%)[a]	69.9	25.8	4.3
Saturated fat (En%)	66.7	30.1	3.2
Monounsaturated fat (En%)	61.3	36.6	2.2
Polyunsaturated fat (En%)	63.4	34.2	2.2
Cholesterol (mg)	65.6	30.1	4.3

[a] En%, percent of energy intake.

Anthropometry

Mean weight, height and body mass index were 79.0 (SD 9.2) kg, 1.79 (SD 0.07) m and 24.7 (SD 2.6) kg/m^2 for men and 66.8 (SD 10.9) kg, 1.68 (SD 0.06) m and 23.6 (SD 3.5) kg/m^2 for women, respectively.

Reproducibility

Mean intakes between the successive assessments of dietary intake differed significantly for energy, monounsaturated fatty acids (% of energy intake) and cholesterol (paired t-test, $p < 0.05$), but the differences are rather small (**Table 1**). The largest difference was for cholesterol; the mean intake of the second interview was 5% below the intake reported at the first interview. The differences in the intake of energy and nutrients between the successive assessments were similar for males and females (data not shown). Subjects preparing a cooked meal at least once a week had similar small differences between the first and second assessment of dietary intake as the subjects who seldom or never prepared main meals. However, the group of subjects preparing dinner less than once a week

Table 3. Pearson correlation coefficients between the intake of energy and nutrients of the first and second measurement for all subjects (n = 93), and for men and women separately

Food component	All (n = 93)	Men (n = 43)	Women (n = 50)
Energy (kJ)	0.91 [0.87,0.94][a]	0.91	0.85
Total fat (g)	0.87 [0.81,0.91]	0.84	0.87
Saturated fat (g)	0.87 [0.81,0.91]	0.84	0.89
Monounsaturated fat (g)	0.88 [0.82,0.92]	0.86	0.87
Polyunsaturated fat (g)	0.78 [0.69,0.85]	0.78	0.73
Total fat (En%)[b]	0.77 [0.67,0.84]	0.67	0.85
Saturated fat (En%)	0.78 [0.69,0.85]	0.74	0.81
Monounsaturated fat (En%)	0.78 [0.69,0.85]	0.73	0.82
Polyunsaturated fat (En%)	0.71 [0.59,0.81]	0.67	0.76
Cholesterol (mg)	0.84 [0.77,0.89]	0.81	0.85

[a] 95% confidence interval.

[b] En%, percent of energy intake.

consisted of only 20 subjects (data not shown). Although the mean differences in intake between the successive assessments were small, the variance associated with the estimation of individual intakes was considerable as shown by the standard deviations of the test-retest differences of the estimated intake.

Classification of the intakes into tertiles (**Table 2**) illustrates the agreement between the first and second measurement. For all nutrients, about two thirds of the group were classified into the same tertile on both assessments whereas only 4% of the subjects were grossly misclassified, i.e. moved from one extreme tertile to the other.

Pearson correlation coefficients between the intakes on the two occasions ranged between 0.71 for polyunsaturated fatty acids (% of energy intake) and 0.91 for energy (**Table 3**). Sex-specific correlations showed that the test-retest correlations of fat intake expressed as a percentage of energy intake tended to be slightly higher in women than in men. However, the 95% confidence intervals of the coefficients were wide and overlapping (confidence intervals not shown for the sexes separately). Test-retest correlation coefficients of subjects preparing regularly

Table 4. Total fat intake from 20 food groups, difference between two assessments and correlation between the total fat intake on the two occasions (n = 93)

Food group	Intake[a] (g/day)	Difference[b] (g/day)	r_s[c]
Bread	4.8 ± 2.6	-0.2 ± 2.2	0.64 [0.50,0.75]
Cheese	15.3 ± 11.4	-2.1 ± 8.3 [d]	0.69 [0.57,0.79]
Oils and fats	30.9 ± 23.6	0.2 ± 14.8	0.83 [0.75,0.89]
Meat products	5.6 ± 6.5	0.8 ± 6.3	0.69 [0.57,0.79]
Savory spreads	2.4 ± 4.8	-0.1 ± 4.6	0.64 [0.50,0.75]
Sweet spreads	1.0 ± 1.7	0.1 ± 1.7	0.84 [0.77,0.89]
Egg	1.4 ± 1.0	0.0 ± 0.8	0.65 [0.52,0.75]
Milk, yoghurt, custard	10.1 ± 8.6	-1.4 ± 4.8[e]	0.80 [0.71,0.86]
Chinese and pizza	2.5 ± 2.4	-0.4 ± 2.5	0.56 [0.40,0.69]
Potatoes, rice, etc.	0.7 ± 0.6	-0.1 ± 0.4	0.76 [0.66,0.83]
Vegetables and fruits	0.0 ± 0.0	0.0 ± 0.0	--
Fish	1.3 ± 1.5	-0.1 ± 1.2	0.68 [0.55,0.78]
Meat	10.8 ± 6.3	2.3 ± 6.5[e]	0.67 [0.54,0.77]
Cookies and cakes	6.8 ± 6.2	0.1 ± 4.3	0.76 [0.66,0.83]
Chocolate snacks	1.8 ± 2.7	-0.1 ± 2.0	0.67 [0.54,0.77]
Savory snacks	13.0 ± 9.4	-0.7 ± 6.0	0.79 [0.70,0.86]
Sauces, hot and cold	5.0 ± 4.7	-1.0 ± 4.0[d]	0.56 [0.40,0.69]
Advocaat	0.0 ± 0.0	0.0 ± 0.0	0.45 [0.27,0.60]
Other drinks	0.0 ± 0.0	0.0 ± 0.0	--
Other products	1.2 ± 1.3	0.2 ± 1.4	0.70 [0.58,0.79]
Total	114.6 ± 50.2	-2.5 ± 25.9	0.84 [0.77,0.89]

[a] Intake at first interview, mean ± SD.

[b] Intake of second estimate minus first estimate, mean ± SD.

[c] Spearman correlation coefficient with 95% confidence interval.

[d] Significantly different from zero, $p<0.02$.

[e] Significantly different from zero, $p<0.01$.

a cooked meal, i.e. at least once a week, were similar to those of subjects who seldom or never prepared a cooked meal (data not shown).

Reproducibility on the level of foods was different for foods consumed often, a mean consumption frequency of at least once a day, and the foods with the lowest consumption frequencies on aggregate level. The reproducibility was high

for the daily consumed items such as bread, butter/margarine on bread, cheese, fruit, and cookies, which had Spearman correlation coefficients ranging from 0.64 to 0.92. Rarely eaten foods such as liver, fatty fish, Chinese egg-roll, and advocaat (a drink of egg yolk and brandy), had lower test-retest correlation coefficients ranging from 0.19 to 0.58.

The analyses for food groups revealed that there were small positive and negative differences in almost all contributing food groups between the first and the second interview. Data are shown for total fat intake (**Table 4**), but results were similar for energy, saturated, monounsaturated and polyunsaturated fatty acids, and cholesterol. The differences in intake from the food groups cheese; milk, yoghurt and custard; meat; and sauces were significantly different from zero ($p < 0.05$) for both total fat intake and saturated fat intake.

DISCUSSION

In this study we assessed the reproducibility of the questionnaire which was validated earlier in adults [5] and elderly subjects [10]. When fat intake is being followed in time by multiple assessments, e.g. before and after dietary advice or in an intervention study, the reproducibility of a method is of utmost importance. The comparison with other studies is difficult because studies differ in many aspects, e.g. the questionnaire itself, self-administered or interview, population characteristics, reference period, and wash-out period. The test-retest correlations between the two assessments of the intake of fat, fatty acids and cholesterol with the food frequency questionnaire are high compared to most other studies carried out in the Netherlands and abroad [11-16]. The most important reason is considered to be the length of the wash-out period between the interviews; the period of 8 weeks in our study is shorter than in most other studies. However, a period between two measurements of more than 8 weeks is not regarded as beneficial for a reproducibility study as systematic changes in food intake may occur [7]. A study by Pietinen [17] showed correlations comparable to ours with a 44-item questionnaire administered three times within 6 months. The fact that the questionnaire was conducted in an interview may have contributed to the high reproducibility. Mistakes like skipping questions or writing frequencies in the wrong column were

reduced to a minimum because the interviewer recorded the frequencies.
It is very important that the reproducibility was similar in males and females. A test for a possible difference between those with a greater versus a lesser involvement in food purchasing and preparation would have had low statistical power because most of the subjects, both males and females, regularly prepared meals and also regularly shopped for meal ingredients.

As known from other studies, a food frequency questionnaire which permits a small variability in answers may have a reproducibility that is higher than a questionnaire with a large variability of answers [7,17,18]. The questionnaire used in this study did not ask for frequency categories. As subjects were requested to indicate the exact number of times that an item was eaten per day, week, or month, a variety of answers was possible. Moreover, the choice between several comparable products with a different fat content and the estimation of portion size relative to the standard portion size also introduced variance.

Our study population in Amersfoort was relatively highly educated; only 4% had a low education level consisting of primary school or less, while one third of the group had a higher vocational education or a university degree. For comparison, in the general population of the Netherlands, 15% of the men and 18% of the women had only a primary school education in 1985 [19]. The reproducibility of this questionnaire could be somewhat lower in the general population.

There were small differences between the intake of the first and second interview, with three of them statistically different. These differences appeared in both directions and in several food groups, and they eventually added up to a lower intake in the second assessment of 465 kJ (4%) and 2.5 (2%) gram fat per day. As a consequence, the percent of energy contributed by fat was 0.9 higher in the second assessment which is a 2% difference with the first assessment. We think that this difference is rather small and that it will hardly affect the reliability of the questionnaire.

On the individual level large differences between two assessments existed, but they might be easy to explain. For example, the large standard deviation of the difference between the two assessments in the groups 'oils and fats', 14.8 g/day (SD), may be due to a lack of knowledge of the subjects concerning the products they ate in the first interview, followed by a higher awareness and more accurate knowledge in the second interview. Some subjects used low-fat margarine without

knowing, supposing they ate margarine. Also some subjects consumed a high-fat or a low-fat gravy without knowing, and a medium-fat gravy was coded instead. When the questionnaire is used by a dietician to follow the fat intake of a client it is advised to make corrections for false or incomplete answers of the first assessment after receiving additional information in the second assessment of intake.

When fat intake data is used on aggregate level, e.g. in epidemiological studies, it is not feasible to carry out corrections. However, considering the high association between consecutive assessments, corrections are not regarded worthwhile in this case. With the observed variance a difference between two assessments of 2% of daily energy from total fat can be detected with a power of 0.84 in a group of 50 subjects. For most interventions this will be regarded as sufficient.

For specific food items there was a considerable variation in reproducibility. The foods used daily were more reproducible than foods eaten infrequently. The higher reproducibility for foods consumed with a relatively high frequency is supported by Feskanich [20]. In studies which presented reproducibility data on the level of foods, seasonal products have been shown to have poor reproducibility [17,21]. As our assessments were within one season, i.e. the autumn, such an effect was not visible here. On the level of food groups no substantial differences in reproducibility of the nutrient intakes were seen. This suggests that the variance associated with the method is evenly distributed over all food groups.

We regard this food frequency questionnaire as a suitable tool for assessing and monitoring fat intake in the Netherlands, both on an individual level and on an aggregate level.

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4

Family resemblance in fat intake in the Netherlands

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(submitted for publication)

ABSTRACT

Family resemblance in fat intake was assessed in a representative sample of Dutch families. Households (n = 1077) with children between 1 and 30 years old were selected from the data set of the Dutch National Food Consumption Survey 1992. Pearson correlation coefficients for fat and fatty acid intakes (En%) derived from two-day diet records, ranged from r = 0.51 to r = 0.61 between parents, and from r = 0.52 to r = 0.72 between siblings. The mean associations in fat and fatty acid intake (En%) between mothers or fathers and children ranged from r = 0.37 to r = 0.50, and they were surprisingly similar for children from 1 to 3 years of age up to children above 21 years of age. Associations were consistently high for foods eaten at home, and weak for foods eaten outside of the home. Similar within-family associations were found in a set of 1052 households of the Dutch National Food Consumption Survey of 1987. Reported adherence to a therapeutic diet by one of the parents did not erase within-family intake correlations, suggesting that family resemblance is a dynamic phenomenon. Thus, the results show consistently that Dutch parents and children living together resemble each other in short term intake of fats and fatty acids.

INTRODUCTION

Atherogenesis is a process that starts early in life, and coronary heart disease risk factors of young people may persist into adulthood [1-3]. Prevention of coronary heart disease should therefore start early in life [4,5]. Aggregation of fat intake within nuclear families who live together has been reported for husband and wife pairs [6-11] and for parents and children [9-11].

Associations in dietary fat intake within nuclear families are expected to be due to a combination of factors. In the first place, the cohabitional effect: family members living in the same household have access to about the same foods [12]. Further, family members may influence each other by means of their attitudes and norms regarding fat intake, and they may act as a model for each others eating behaviour. Influences within families are multidirectional. For example, children may imitate eating behaviour of parents and siblings, but they may also influence which foods are purchased or prepared. Shared food preferences may cause some resemblance in intake. In a meta-analysis of seven studies weak resemblances in food preferences ($r = 0.19$) have been found between parents and children [13]. Also, genetic factors may influence the energy and nutrient intake [14-16].

Whether family resemblance in dietary intake changes with increasing age of children has not been subject to study yet. In the current study the association of intakes of fat, fatty acids, cholesterol and energy was assessed within a large representative sample of Dutch nuclear families with children from 1 to 30 years of age. The data of the 1992 Dutch National Food Consumption Survey were used. The analyses were repeated on comparable data of the Dutch National Food Consumption Survey of 1987.

We hypothesised that there was at least a moderate association in intakes of fats and cholesterol within these families. The association between intakes of parents and children was expected to decline with increasing age of the children, because the children acquire more influence on their own diet and influences of peers may increase [11,17,18].

METHODS

Sample

Data from the Dutch National Food Consumption Surveys (=DNFCS) of 1987 and 1992 [19-21], were used to assess the resemblance in dietary intake within families. The households in these surveys were derived from an existing panel, which consisted of a stratified probability sample of non-institutionalised households in the Netherlands [19,21]. There were 2203 households in the survey of 1987, 2475 households in the survey of 1992, and 453 of the households participated in both surveys. Households with at least one parent and one child were selected. "Children" above the age of 30 were removed from the dataset; their parents were also removed when there were no younger children in the household. No information about a biological relationship between members of the households was available. The samples did not contain same-sex couples of caretakers with children.

In the DNFCS of 1987 adult children above 18 years of age could not be distinguished from non-family members living in the same household. Parents and children within these specific households were identified by an inspection of the composition of the family with respect to age and sex. Three families were removed as it was unclear from their ages who should be labelled as father, mother and child; these families might have been three generational households.

In the DNFCS of 1992 subjects were labelled as: "breadwinner" which is the person (male/female) responsible for the main income; "housekeeper" (male/female) which is the person principally responsible for domestic affairs and can be the same person as the "breadwinner"; child up to 18 years old; adult family member; non-family member. The position of the subject within the family could therefore be established more reliably than in the sample of 1987. Non-family members such as boarders (n=6), and older family members such as grandparents (n=7) that were part of the household were removed from the data set.

From the DNFCS of 1987 finally 1052 families with 1998 children were selected, with 70 single parent families among them. For the 1992 survey these figures were 1077 families and 2012 children, among which 136 single parent families. This sample included 1069 mothers, 949 fathers, 1006 girls, and 1006 boys. The subjects within these two generation families will be referred to as

mothers, fathers, daughters, and sons, respectively.

Dietary assessment method

Food consumption was assessed by a two-day dietary record both in the survey of 1987 and 1992. The "housekeeper" recorded all the foods that were eaten at home by the members of the household in a household diary. This person recorded also for each meal the quantities served to the persons attending. In addition to this household diary, each household member kept a diary of food eaten outside of the home. Parents completed the diaries of children below the age of 13 years. Common household measures and foods regularly used were weighed [19]. Conversion of food intake data into nutrient intake was carried out with computerised versions of the Dutch nutrient data base 1986/1987 and the Dutch nutrient data base 1993, for the surveys of 1987 and 1992 respectively [22,23].

Characteristics of subjects

Body Mass Index (kg/m^2) was calculated from reported height and body weight. Subjects reported also whether they were following a therapeutic diet, either on prescription or on their own initiative.

Statistical analyses

The data of the surveys of 1987 and 1992 were analysed separately. Children were divided in sex-specific groups of three consecutive years of age, according to the age groups referred to in the Dutch dietary guidelines [24]. Pearson correlation coefficients between the intakes of mothers and sons, mothers and daughters, fathers and sons, and fathers and daughters were calculated separately for all age-groups. Correlations per age-group were on average based on 120 pairs, with a minimum of 32 pairs for fathers and their 21 to 30 year old daughters, and a maximum of 201 for mothers and their 1 to 3 year old daughters. Twenty-one percent of the fathers and 30% of the mothers had more than one son and/or more than one daughter living with them. The data of these parents were used more than once for the calculation of a correlation coefficient in order to use the data of all children.

The association between intakes of siblings was assessed by means of the intraclass correlation coefficient, which compares within- and between-family

variances [25]. The SAS-procedure PROC VARCOMP was used to assess the within- and between-family variances in intakes (SAS Institute Inc, Cary, NC). Children without brothers and/or sisters were included in these analyses to contribute to the estimation of the between-family variance in intakes.

Correlations were calculated between pairs of randomly paired, non-related pairs of "spouses", "parent-child", and "siblings" to confirm the results between related pairs.

Intakes and within-family correlations were calculated separately for foods eaten at home and foods eaten elsewhere. Data of subjects who consumed everything at home during the recording days were excluded from the latter analyses as they would make the intake distribution bimodal.

It was not possible to study the stability of the resemblances over time by using longitudinal data of families participating both in the 1987 and 1992 surveys due to insufficient numbers per age-group. To acquire some data on dynamics in family resemblance in fat intakes, we selected families in which one of the parents reported to follow a therapeutic diet, which would presumably have put pressure on the family resemblance in intake. Families with two dieting parents (n = 20), and single-parents families were excluded to make a comparison between the effect of a dieting father (n = 58) and a dieting mother (n = 93) on family resemblance in fat intake. Differences in intake between dieters and non-dieters were tested with a paired t-test, $\alpha = 0.05$.

Pregnant women (n = 39) were initially excluded from analyses using body weight or energy intake, but the results were similar and are therefore presented for the whole group. The associations in intakes within the Dutch families were similar for the 1987 and 1992 survey, therefore we decided to present only the results of the most recent survey.

All statistical analyses were performed using the SAS program version 6.09 (SAS Institute Inc, Cary, NC).

RESULTS

Sample

The 1992 sample contained 1077 nuclear families who lived together. The sample

Table 1. Intake of energy, fats and cholesterol of parents and children in the Netherlands in 1992[a]

	PARENTS		CHILDREN							
	Mothers (n=1069)	Fathers (n=949)	1-3 y (n=350)	4-6 y (n=329)	7-9 y (n=254)	10-12 y (n=255)	13-15 y (n=252)	16-18 y (n=249)	19-21 y (n=207)	> 21 y (n=116)
Energy (MJ)	8.3 (2.4)	11.2 (2.9)	5.4 (1.4)	6.9 (1.7)	8.0 (1.9)	9.0 (2.1)	9.8 (2.6)	10.2 (3.1)	10.3 (3.2)	10.8 (3.1)
Total fat (g)	86 (32)	113 (37)	47 (19)	64 (23)	76 (24)	89 (28)	97 (33)	101 (39)	102 (39)	106 (37)
SF (g)[b]	33 (13)	43 (15)	18 (8)	24 (9)	28 (9)	34 (11)	36 (12)	38 (15)	38 (15)	40 (15)
MUFA (g)[c]	33 (13)	42 (15)	17 (8)	23 (10)	28 (11)	33 (12)	37 (15)	38 (16)	38 (15)	39 (15)
PUFA (g)[d]	16 (8)	21 (9)	8 (5)	11 (6)	14 (6)	16 (7)	18 (8)	18 (9)	19 (10)	20 (9)
Cholesterol (mg)	235 (101)	304 (125)	124 (62)	154 (73)	174 (73)	212 (82)	220 (92)	240 (105)	252 (112)	277 (118)
Total fat (En%)[e]	38.3 (7.0)	37.7 (6.4)	31.7 (7.3)	33.8 (6.2)	35.2 (5.4)	36.6 (6.0)	36.7 (6.5)	36.8 (6.4)	36.8 (6.9)	36.7 (6.6)
SF (En%)	14.7 (3.2)	14.3 (3.1)	12.4 (3.2)	13.0 (2.8)	13.2 (2.6)	13.9 (2.6)	13.6 (2.8)	13.9 (3.0)	13.8 (3.1)	13.8 (3.2)
MUFA (En%)	14.4 (3.3)	14.0 (3.0)	11.1 (3.2)	12.2 (3.0)	12.9 (2.7)	13.6 (3.1)	14.0 (3.2)	13.8 (3.0)	13.7 (3.2)	13.6 (2.9)
PUFA (En%)	6.9 (2.4)	7.1 (2.3)	5.5 (2.2)	6.0 (2.1)	6.5 (2.2)	6.6 (2.2)	6.8 (2.2)	6.6 (2.3)	6.9 (2.3)	7.0 (2.4)
Cholesterol (mg/MJ)	29 (11)	27 (10)	23 (9)	22 (9)	22 (8)	24 (8)	23 (8)	24 (9)	25 (9)	26 (8)

[a] Mean (SD).

[b] SF, saturated fat.

[c] MUFA, monounsaturated fat.

[d] PUFA, polyunsaturated fat.

[e] En%, percent of energy intake.

included 1069 mothers, 949 fathers and 2012 children. Families with two children were most common, in total 488 families. Further, the sample included 395 families with one child, 151 families with three children, 30 families with four children, 10 families with five children, and 3 families with six children. The children included were all between 1 and 30 years of age, with only 6% of them older than 21 years. The parents ranged in age from 22 up to 71 years. Mothers were on average 39 years (SD 9), and fathers were on average 41 years (SD 9) old. Mean Body Mass Index was 24.4 (SD 3.9) kg/m^2 for mothers; 25.0 (SD 3.0) kg/m^2 for fathers; 17.8 (SD 3.6) kg/m^2 for daughters; and 18.3 (SD 3.5) kg/m^2 for sons.

Energy and nutrient intake

The mean daily intakes of energy, fat, fatty acids and cholesterol of parents and their children in 1992 are shown in **Table 1**. The mean fat intake in 1992 was lower than in 1987 [21], but this difference was similar for fathers, mothers, sons and daughters. Total fat intake in 1992 was 32 percent of energy intake (En%) for 1 to 3 year old children, and increased gradually with age to 37 En% for children above 21 years of age, which is comparable to the intake level of the adults (38 En%). The difference in fat intake between the group of 1 to 3 year children and the children over 21 years of age comprised of 1.4 En% saturated fatty acids, 2.5 En% monounsaturated fatty acids, and 1.5 En% polyunsaturated fatty acids.

On average, most foods were consumed at home. Twenty-one percent of the mothers, 10% of the fathers, and 5% of young children up to 9% of children above 18 years of age consumed all food and drinks at home during the recording days. The daily amount of energy consumed out of the home, excluding subjects who consumed all foods at home, was 1.4 MJ (SD 1.6) for mothers, 3.7 MJ (SD 2.5) for fathers, and for the children from 0.8 MJ (SD 0.9) at age 1 to 3, gradually increasing with age to 4.9 MJ (SD 2.8) above the age of 21. The relative amount of fat (En%) of the foods consumed out of the home for children of all age groups was 18.6 (SD 16.1) at age 1 to 3, gradually increasing until it stabilised around 32.4 (SD 14.0) at age 16 to 18.

Associations in energy intake and body composition within families

Energy intakes were significantly correlated between parents and children ($r = 0.09$

Table 2. Associations in body composition, energy intake, and fat and cholesterol intake within families in the Netherlands in 1992

	Mothers & fathers[a] (n=941)	Mothers & sons[a] (n=1003)	Mothers & daughters[a] (n=998)	Fathers & sons[a] (n=914)	Fathers & daughters[a] (n=900)	Siblings[b] (n=1541)[c]	Brothers[b] (n=431)[d]	Sisters[b] (n=467)[e]
Body Mass Index (kg/m^2)	0.18 (n=940)	0.28 (n=994)	0.23 (n=989)	0.28 (n=905)	0.28 (n=889)	0.64 (n=1528)	0.61 (n=422)	0.70 (n=457)
Energy (MJ)	0.47	0.09	0.24	0.19	0.24	0.55	0.52	0.63
Energy (MJ/kg body weight)	0.37	0.32	0.35	0.23	0.26	0.65	0.65	0.71
Total fat (g)	0.58	0.20	0.33	0.28	0.35	0.61	0.62	0.67
Saturated (g)	0.57	0.25	0.38	0.36	0.38	0.62	0.65	0.67
Monounsaturated (g)	0.61	0.23	0.33	0.29	0.35	0.64	0.62	0.70
Polyunsaturated (g)	0.59	0.30	0.36	0.34	0.37	0.61	0.64	0.66
Cholesterol (mg)	0.55	0.35	0.45	0.38	0.40	0.61	0.60	0.63
Total fat (En%)[f]	0.54	0.37	0.44	0.40	0.39	0.65	0.67	0.69
Saturated (En%)	0.54	0.43	0.45	0.43	0.37	0.63	0.70	0.66
Monounsaturated (En%)	0.58	0.38	0.45	0.38	0.42	0.65	0.64	0.70
Polyunsaturated (En%)	0.61	0.50	0.50	0.50	0.48	0.69	0.71	0.72
Cholesterol (mg/MJ)	0.51	0.47	0.55	0.41	0.46	0.58	0.52	0.64

[a] Pearson correlation coefficients, all significantly different from 0 ($p<0.05$).

[b] Intraclass correlation coefficients, all significantly different from 0 ($p<0.05$).

[c] n=1617 children, from families with two children (n=976), three children (n=453), four children (n=120), five children (n=50), six children (n=18).

[d] n=468 sons, from families with two sons (n=344), three sons (n=108), and four sons (n=16).

[e] n=467 daughters, from families with two daughters (n=356), three daughters (n=102), four daughters (n=4), and five daughters (n=5).

[f] En%, percent of energy intake.

to r = 0.24), between spouses (r = 0.47) and between siblings (r = 0.52 to r = 0.71). Associations generally increased when energy intake is expressed per unit of body weight. Body composition also showed resemblance within families: from a correlation of 0.18 for Body Mass Index between spouses to more than 0.60 for siblings (**Table 2**).

Associations in fat intakes within families

Associations between fat intakes of family members are presented in **Table 2.** The correlation coefficients between the parental intakes for fats and cholesterol (En%) were between 0.51 and 0.61 with the 95% confidence intervals (= 95% CI) around these correlations ranging from 0.46 to 0.65. The mean associations between the intakes of parents and children ranged between 0.37 and 0.55 (95% CI 0.31, 0.59) (**Table 2**). All associations between the intakes of parents and children were between 0.30 and 0.60 and differed significantly from zero ($p < 0.05$), and no change in the magnitude of the associations was seen with increasing age of the children (data not shown). For siblings, the association for the intakes of fats and cholesterol, relative to energy intake, ranged between 0.52 and 0.72 (95% CI 0.38, 0.80). Gender of parents or children did not influence the associations.

Association between pseudo family members

The correlations in intake between fathers and randomly selected mothers, between children and pseudo parents, and between unrelated "siblings", were around zero with only few significantly different from zero that were expected due to chance (data not shown).

Associations in intakes of foods consumed at home versus elsewhere

Figure 1 shows the associations of fat intake (En%) within the families, separately for foods consumed at home and foods consumed elsewhere. Associations for energy and other nutrients showed a similar trend. Associations for foods consumed at home were significantly higher than the associations for foods consumed elsewhere. Especially between spouses, and between fathers and children, the associations for foods eaten at home were higher than the associations for foods eaten away from home.

In **Figure 2** the parent-child associations are presented for foods consumed at home and elsewhere, by age group of the children. The associations for foods consumed at home are moderate to strong and do not change very much with

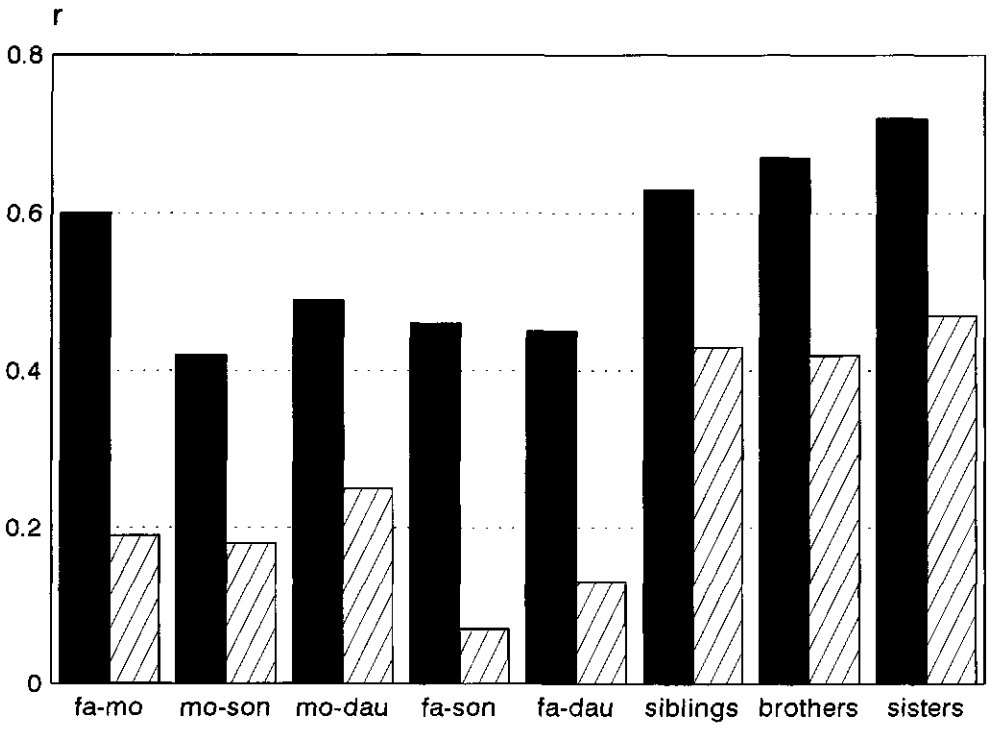

Figure 1. Pearson correlation coefficients for total fat intake (en%) within the nuclear family in the Netherlands in 1992, for foods consumed at home (black bars) and foods consumed elsewhere (striped bars). Fa = father, mo = mother, dau = daughter.

increasing age of the children. For foods consumed elsewhere, the associations were lower and unstable with increasing age of children. The resemblance in fat content of all foods eaten away from home for fathers and children was absent or weak. For mothers and children, the association in fat intake (En%) was significant for children up to around 12 years of age.

Influence of following therapeutic diets on associations

Ten percent of the mothers, six percent of fathers, five percent of the sons and five percent of the daughters followed a therapeutic diet. Most diets were weight-reducing or cholesterol lowering diets. The diets were prescribed by a practitioner for 72% of the fathers, 45% of the mothers, 68% of the sons, and 56% of the daughters. Children following a therapeutic diet had in one third of the cases a

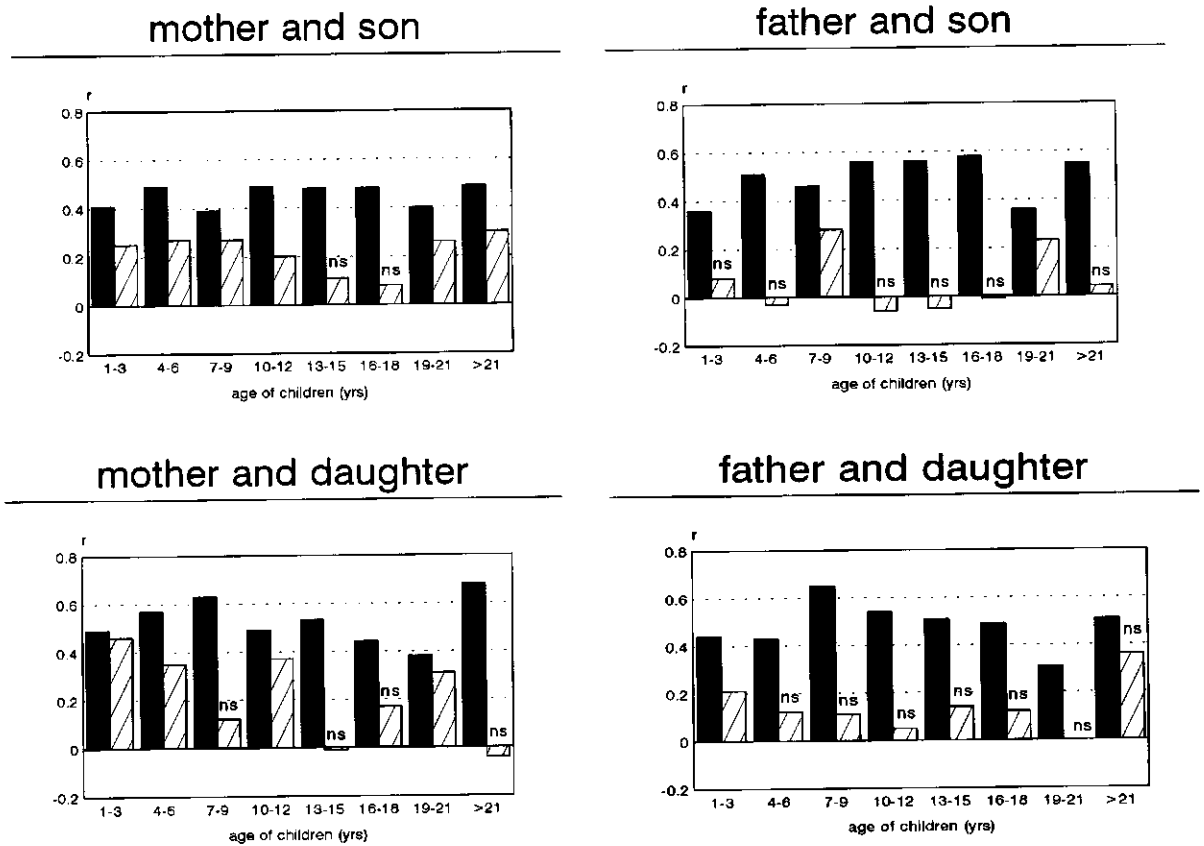

Figure 2. Pearson correlation coefficients for total fat intake (en%) between parents and their 1 to 30 year old children in the Netherlands in 1992, separately for foods consumed at home (black bars) and foods consumed elsewhere (striped bars).
All associations are significantly different from zero, except when ns (=not significant) is added.

dieting father and in one third of the cases a dieting mother. Dieting fathers consumed on average 9.6 MJ (SD 2.8) and dieting mothers 6.7 MJ (SD 2.1) which is for both significantly less than their non-dieting counterparts ($t = 4.6$ for mothers and $t = 7.9$ for fathers, $p < 0.001$). With respect to the composition of the diets, the average fat intake of dieting fathers was 37.5 En% and similar to the fat intake of other fathers ($t = 0.2$, $p > 0.05$), while dieting mothers consumed with 35.7 En% less fat than non-dieting mothers ($t = 3.5$, $p < 0.001$). Moderate associations in intakes between parents and children still existed for families with a dieting mother ($n = 93$) or father ($n = 58$) (**Table 3**). When the mother followed a therapeutic diet ($n = 93$), within-family associations in fat intake tended to be lower than average. In families where the father ($n = 58$) was dieting, the associations did not change much. Father-daughter associations in fat intake in families of which one parent followed a dietary treatment were often not significant, no matter which parent followed the dietary treatment.

DISCUSSION

We found moderate to high associations in the intake of fat, fatty acids, and cholesterol in a representative sample of Dutch nuclear families in 1992 and in a comparable sample from 1987. Fat intake was more strongly associated within generations, i.e. between parents and between siblings, than between generations, i.e. between parents and children. The association in intake between parents and children was surprisingly similar for children of all ages. The resemblance in intakes within the nuclear families was strong for foods eaten at home, and was consistently lower for foods eaten elsewhere. The finding that intakes of unrelated subjects were not associated supported the validity of the resemblances found within families.

Associations in fat intake between parents and children as reported here were similar to some studies [6,8-10] and high relative to other studies [7,11,26]. Reported associations in fat intakes between husband and wives ranged between 0.38 en 0.58 in spouse pairs from North-America and the United Kingdom [6-10]. Parent-child associations in fat intake within families living together have only been reported from studies in North-America. The highest associations were found for Framingham mothers and their 3 to 5 year old daughters, $r = 0.35$ to $r = 0.56$ for the different fatty acids [9]. Stafleu et al. [27] reported that resemblance in fat intake persist to some extent when parents and children do not live together any more;

Table 3. Associations[a] in intakes within the nuclear family for families where the mother or the father has reported to follow a therapeutic diet

	MOTHER WITH DIET					FATHER WITH DIET				
	Mothers & fathers (n=93)	Mothers & sons (n=100)	Mothers & daughters (n=78)	Fathers & sons (n=100)	Fathers & daughters (n=78)	Mothers & fathers (n=58)	Mothers & sons (n=55)	Mothers & daughters (n=53)	Fathers & sons (n=55)	Fathers & daughters (n=53)
Energy (MJ)	0.24	0.03[b]	0.34	0.10[b]	0.09[b]	0.59	-0.08[b]	0.31	-0.04[b]	0.29
Energy (MJ/kg body weight)	0.05[b]	0.19[b]	-0.02[b]	0.21	0.14[b]	0.42	0.50	0.36	0.30	0.41
Total fat (En%)	0.35	0.36	0.30	0.29	0.18[b]	0.53	0.67	0.51	0.38	0.30
Saturated (En%)[c]	0.40	0.44	0.48	0.31	0.22[b]	0.52	0.72	0.37	0.49	0.16[b]
Monounsaturated (En%)	0.40	0.37	0.23	0.36	0.22[b]	0.61	0.66	0.37	0.33	0.24[b]
Polyunsaturated (En%)	0.41	0.45	0.28	0.54	0.18[b]	0.54	0.53	0.57	0.48	0.43
Cholesterol (mg/MJ)	0.24	0.45	0.40	0.40	0.37	0.36	0.57	0.57	0.24[b]	0.23[b]

[a] Pearson correlation coefficients, significantly different from 0 ($p<0.05$) unless otherwise stated.
[b] not significant ($p>0.05$).
[c] En%, percent of energy intake.

significant associations were found between mothers and their 25 year old daughters, but not between the mothers and their mothers who were around age 75. Associations in intakes between siblings have been presented in one study, from Quebec; the intraclass correlation for fat intake (En%) between siblings was $r = 0.36$ [10].

The limitation of the associations as reported here is that they represent a resemblance in relatively short term (two-day) intake of fats and cholesterol. These within-family associations based on two-day fat intakes might be different from the associations in habitual fat intake. However, the similarity of the associations found in the surveys of 1992 and 1987 suggests that the day to day variation of energy and fat intake is probably not so large that associations are affected dramatically. Food habits on a recording day may be different than on a usual day due to perceived social desirable habits, such as eating together with the family, and dividing foods in equal parts among the household members. The resemblance in intakes might have been affected by the procedure that the person who kept the household diary recorded what all subjects consumed in the house, and the parents recorded everything for children under the age of 13 years. On one hand, reliability of the data will increase because differences in recording type and amounts of food by the individual family members are avoided. On the other hand the similarity of the food intake might be overestimated by this procedure. Foods eaten out of the home for children under 13 years of age without their parents knowing this (e.g. with friends or at school), foods supposed to be eaten by the children out of the home but not consumed (e.g. home-packed lunch), and foods eaten at home by one subject without other family members present may have been overlooked sometimes.

The differences in the magnitude of the associations may be partly due to the use of different dietary assessment methods. Lee and Kolonel used a dietary history [6]; others used multiple diet records [7-10]; diet records and recall methods [11]; or a 24h-recall [26]. In two of these studies, dietary intake was assessed at a different moment for parents and for children [9,26]. The differences in reference period of the dietary assessment methods might have affected associations, especially for nutrients that have a high day to day intake variability such as polyunsaturated fatty acids and cholesterol. Dietary intake was not always reported by the subjects themselves, which might have introduced a bias [28]. The

Framingham parents recorded the intake of their young children [9] which is supposed to have mainly a positive effect on the validity of the data as those children were not able to record intakes themselves yet. In almost half of the cases of Lee & Kolonel's husband-wife study [6] one of the spouses answered questions for both of them, which could have increased the observed resemblance in fat intake.

Our study did not show a gender effect in the over-all correlations: correlations were similar for pairs of mothers and daughters, fathers and daughters, mothers and sons, and fathers and sons. Oliveria et al. found a higher association between Framingham mothers and their 3 to 5 year old children than between the fathers and their children: associations in intakes were often not significantly different from zero for fathers and children [9]. Patterson et al. reported higher mother-child associations in Mexican-American families, but not in Anglo-American families [11]. For foods consumed out of the house, however, we did find higher associations for mothers and young children compared to fathers and children. Mothers might accompany their children more often outside of the home than fathers do.

Cross-sectional data as used here can not provide information on the dynamics of the relationship with increasing age of the children. However, in both the 1992 and the 1987 study no decline in parent-child intake association was found with increasing age of the children. The fairly stable parent-child resemblance in fat intake for children of all ages has been shown to be mostly due to the similarity in consumption at home. Children are expected to have more freedom in what they eat when they grow older, either inside or outside of the home, which would result in lower parent-child associations in intake. This effect may have been faded out by an increased amount of "adult foods" and/or a decreased amount of "children foods" in the diet of the children, which would be expected to increase the association. This is supported by the increased fat content of the diet of the children with increased age in the direction of the intake level of the adults (**Table 1**). In the Princeton School District Study associations in intake between parents and their oldest child was also similar to that of parents and other child(ren) [26]. Patterson et al. however reported lower associations between parents and 13 year old children compared to parents and 11 year old children in both Mexican-American and Anglo-American families [11].

In the current study, the stability of the resemblance in fat intake between parents when one of them reported to be on a therapeutic diet, suggests that changes in intakes of family members living together are related as well. The finding that the association between the fat intake of father and daughter almost disappears when one of the parents is dieting suggests that father and daughter do not have the strongest influence within families. Dynamics of the influences on dietary intake within households are reflected in a study of Shattuck et al. in which a dietary intervention aimed at women affected the fat intake of their husbands as well [29]. The transfer of eating habits is most likely to be multidirectional, and more research is needed on the influence of a change in dietary habits of one family member on the intake of other family members.

With respect to the resemblance in intake between spouses, partner selection and convergence of habits over the years are both important [30]. Qualitative research in the field of the transfer of nutritional habits is considered important to reveal norms and patterns of influences within families.

Considering the important role the family plays in the development of food behaviour [31,32], and the resemblance found in fat intakes, the family is a suitable target for public health interventions attempting to lower fat intakes, thus decreasing the risk for coronary heart disease.

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5

Food choice and fat intake of adolescents and adults: associations of intakes within social networks

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ABSTRACT

Influences of the social environment are important in determining eating behaviour. Family influences have been demonstrated by resemblances in intakes within families, but research on resemblance in intake between friends is lacking. We investigated the resemblance in fat and food intake within social networks which included family members and peers. Fat consumption was assessed with a food frequency questionnaire in 361 social networks consisting of: fifteen year old adolescents (n = 347); their mothers (n = 309); their fathers (n = 270); their friends (n = 240); 79 friends of mothers; and 29 friends of fathers. Ten family interviews and four focus group interviews were carried out in a subsample to interpret the quantitative work. Within the nuclear family, the intake of 76 to 94% of the foods were significantly associated, which resulted in moderate Pearson correlations for fat and fatty acid intake (% of energy intake) between parents (0.30-0.34), between mother and child (0.19-0.38), and between father and child (0.16-0.26). No significant correlations for fat intake were found between friends, but the consumption of specific foods was related. In conclusion, we found clear resemblance in habitual fat and food intake between parents and their adolescent children and between spouses. Friends do not seem to have a lot of influence on the fat intake of adolescents and adults.

INTRODUCTION

Social influences on food intake refer to influences that one or more subjects have on the eating behaviour of others, either direct or indirect, either conscious or subconscious. Even when eating alone, food choice is influenced by social factors because attitudes and habits develop through the interaction with other people. Although the impact of social influences is regarded as large [1-4], research quantifying this phenomenon is scarce. In our opinion, there are three main causes that complicate the quantification of social influences on food intake.

(i) The influences which people have on the eating behaviour of others are not limited to one type, but include a range of influences. For instance: modelling of eating behaviour of others; persuasion to consume or avoid eating certain foods; changing the availability of foods for others; and attempting to change someones eating attitudes. These social influences are embedded in everyday eating behaviour, in family food rules, and in the eating culture as a whole. Extraction of social influences in an experimental situation to get information on the impact of social influences in real life is therefore virtually impossible.

(ii) Social influences play a role in different time frames. Influences may be exerted during the eating or drinking occasion, such as persuasion, encouragement, and social facilitation of food intake. Else, they may be spread over a prolonged period, such as the effect of cohabitation.

(iii) People are not necessarily aware of social influences that are exerted on their eating behaviour. In case they are aware of this, they might not be eager to admit that their behaviour is influenced by others. This makes it difficult to assess social influences by simply asking to rate the perceived influences of others.

In this study we focused on the influences of the direct social environment, i.e. family members and friends. We expected that if social influences play an important role in food choice, a resemblance in food intake within social networks would be present. Food intake, and from that energy and fat intake, were assessed in this study for several subjects that were connected on the basis of family and friendship ties. Within this network the resemblance between family members and peers could be studied. A qualitative study was carried out in a subsample to improve the interpretation of the results of the quantitative study.

We hypothesized a moderate to large resemblance in intakes within the

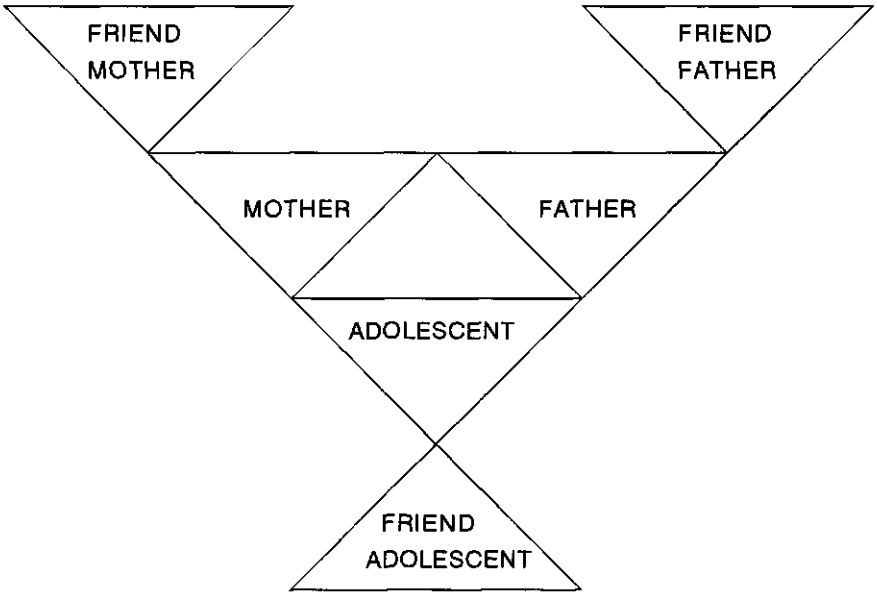

Figure 1. The social network studied: 15 year old adolescents; their mothers; their fathers; their best friends; their mothers' best friend; their fathers' best friend

families, and a smaller resemblance for friends. The magnitude of the correlations was expected to be larger when subjects ate more meals together [5].

METHODS

Sample

The social networks consisted of up to six subjects: an adolescent child and his/her parents, and for all of them their best friend (**Figure 1**). The centre of the network was the father-mother-adolescent triad. Each subject of this triad has three ties with others: two ties with other members of their nuclear family, and one with their best friend. In this paper we will refer to the parents as "fathers" and

"mothers", to their 15 year old children as "adolescents", and to their respective best friends as "friends of fathers", "friends of mothers" and "friends of adolescents".

Recruitment networks

The sample consisted of networks including (a) parent(s), their 15-year old son or daughter, and the best friend of this son or daughter. Recruitment of social networks started with the recruitment of the adolescents. Students in the third grade of secondary schools, who were in the 11th year of their education and about 15 years of age, were informed about the study in their classrooms. They were asked to participate together with the parent(s) with whom they were living and their best friend. The parents were not necessarily the biological parents. The best friend was defined as "someone you know very well, of about your own age, with whom you meet regularly". Friends were not supposed to be family members (sister, cousin, etc), or people living in the same household. Subjects were allowed to participate in one network only. Non-responders were asked to report sex, height and body weight and the reason(s) for not participating.

Fathers and mothers were asked individually to provide name and address of their best friend who received then also a questionnaire.

Recruitment started at five schools in the Netherlands, in the villages Leek, Nieuwegein, and Zevenaar and in the towns Hoorn and Zwolle. Sites were selected on the basis of the presence of a secondary school with the three most common (low, intermediate, and high) educational levels [6], a broad geographical distribution within the Netherlands, and a range in degree of urbanisation [7]. Twelve schools were approached and 5 agreed to participate. Recruitment was balanced for gender, and educational level.

In an pilot study (unpublished) this recruitment method appeared feasible to recruit social networks around 18 year old students of higher vocational schools.

Quantitative network study

General questionnaire

Age, sex, height, weight and dietary restrictions were asked. Educational level was assessed for the parents and their adult friends, and current school type for the

adolescents and their friends. Frequency of preparing main meals, and frequency of shopping for food were recorded.

Network ties

Several questions concerning the relationship with their best friend were filled out by the adolescent and his/her parent(s). The origin of the friendship was asked, e.g. classmate, member of same (sporting) club, living in same neighbourhood. The duration of the friendship was estimated as less than one year, one to five years, or more than five years. Meeting and telephone contact with the best friends in the past four weeks were recorded in four categories: more or less every day; once or twice a week; less than once a week; never. The frequency of sharing main meals and snacks together with network members was asked. The frequency of talking about foods with other network members was scored at one of 4 categories: often; sometimes; seldom; never.

Adolescents reported the composition of their household, with respect to age and sex of the subjects they lived with. Fathers and mothers were asked whether they were the biological parents of their adolescent child. To assess the amount of influence the adolescents had on their food intake, the money spent on foods and drinks outside the home by the adolescents was asked. In addition the perceived influence of adolescents on the food purchases and preparation by their parents were asked and scored on two 7 point scales: "My parents take into account what I would like to eat or drink when they buy food (or: when preparing a meal)". The scales were anchored "very certain" (score = 1) and "certainly not" (score = 7). Scores below 4 meant that the adolescent perceived he/she could influence purchases and/or preparation.

Dietary assessment method

A self administered food frequency questionnaire which measured the intake of energy, total fat, saturated fat, monounsaturated fat, and polyunsaturated fat, and cholesterol in the past four weeks, was filled out by all network members. The foods on the questionnaire were derived from the Dutch National Food Consumption Survey 1987/1988 [8]. Validity of the food frequency questionnaire (interviewer administered) to rank individuals according to fat intake (En%, % of energy intake) relative to the dietary history, was moderate to high for elderly

above 65 years of age, r=0.72 (n=51) [9], and for 30 to 50 year old adults, r=0.65 (n=191) [10], and moderate for adolescents, r=0.29 (n=77) [11]. The associations of linoleic acid in body tissues and linoleic acid intake were comparable for the food frequency questionnaire and the dietary history in the group of adults [10]. Test-retest correlations for fat intake (En%) were 0.77 when administered 8 weeks apart [12], and 0.64 when adminsitered 13 weeks apart [13].

Procedure

Questionnaires were distributed to the students in the classrooms and mailed to all other network members individually. When the questionnaire was not returned within two weeks, subjects received a reminder telephone call. Subjects were also contacted when they filled out the questionnaire incorrect or incomplete. Adolescents and persons who seldom or never prepared meals were instructed to check details about meal preparation with the person(s) in the household that was responsible for preparing meals. All participants received their personal nutrient intake values.

Statistical analyses

Pearson correlation coefficients between nutrient intakes of network members were calculated. Spearman correlation coefficients between the food intakes of network members were calculated, because intake on food level was not normally distributed. The level of significance was set at 0.05. Non-consumers were included in the analyses, as resemblance in foods that were not eaten was considered of interest. Correlations were calculated also for randomly selected subjects, to confirm any resemblance between related subjects.

Qualitative network study

Family and focus group interviews

To interpret the results of the quantitative study, a qualitative study was carried out in Zevenaar, in a subsample (n=63) of the main study. A series of 10 family interviews was conducted, with 3 to 5 subjects participating per family. In addition, four focus group interviews were conducted with a group of adolescent boys (n=6), a group of adolescent girls (n=7), a group of mothers (n=5) and a

group of fathers (n = 5). Family interviews were carried out to get a discussion between family members about their own food choice, that of their family members, and their personal interpretation of the family food rules. The focus groups for boys, girls, mothers, and fathers were held to elicit information that subjects probably would not tell in the family environment. All family interviews were conducted at the homes of the participants. The focus group interviews took place in a supermarket canteen, which was regarded a neutral place related to food.

The interviews were carried out according to the focus group procedure described by Krueger [14]. Interviews were conducted by a moderator and an assistant (assistant 1). All interviews were taped. Assistant 1 wrote down the headlines of the discussions, to support the transcription of the tapes later on. In the interviews, a typical day was chronologically discussed with respect to eating and drinking. Participants discussed: (i) why they ate what they ate; (ii) family rules regarding eating behaviour. Additional questions were asked on food preparation and shopping for foods. Subjects were often triggered to talk about social influences: whether eating alone or with others would make a difference, what friends and colleagues eat, etcetera. The same questioning route was used for the family interviews and for the focus group interviews. Two pilot interviews were carried out, one with a family and one with a group of adolescents. Procedures and questions were adjusted afterwards. The pilot group of adolescents fell apart in a group of boys and a group of girls who were not eager to talk with each other, therefore it was decided to have separate groups of boys and girls. The pilot interviews were not used for analyses.

Analyses

All interviews were fully transcribed by the moderator. The transcripts were checked by an assistant (assistant 2), who listened to the tapes. Key words were ascribed to statements or to a set of connected statements by both the moderator and assistant 2. Assistant 1 compared the two transcripts and prepared the final transcript with a consensus coding. Statements were coded according to who it said (boy, girl, father, mother), with respect to which meal moment (breakfast, morning snack, lunch, etc.), motivation to eat something (e.g. taste, price, health), specific limitations or rules, what other persons eat but they would never eat,

eating alone or with others, getting influenced by other people, differences between week and weekend days, change in eating patterns over time. Kwalitan software was used to select statements by (combinations of) key words [15].

RESULTS

Quantitative network study

Response

Sixty-six percent of the adolescents who were approached in their school classes agreed to participate in the study together with their parents and their best friend. Non-responders were not interested (64%), did not want to involve their parents or friends (45%), participated already as best friend in another network (14%), and/or mentioned other reasons (12%). Responders were more often female and more often from the highest of the three educational levels, whereas their Body Mass Index and age were comparable with non-responders (**Table 1**). The questionnaire was filled out properly and returned by 68% of the adolescents, 62% of the mothers, 57% of the fathers, 53% of the friends of the adolescents, 89% of the friends of the mothers, and 74% of the friends of the fathers.

The study sample comprised of 347 adolescents, 270 fathers, 309 mothers, 240 friends of the adolescents, 79 friends of mothers, and 29 friends of fathers. Together they formed 361 networks of at least two subjects, and 169 networks consisted of at least an adolescent, a father, a mother, and the best friend of the adolescent. Incomplete networks were included in the analyses, because correlations were calculated per pair of subjects.

Network characteristics

Characteristics of the participants are shown in **Table 1**. Most adolescents lived with both parents (95%) and with one or two siblings, on average 1.4 (SD 0.8). Eighty-one percent of the fathers and 79% of the mothers reported to be the biological parent of their adolescent child. Most fathers were employed (94%), others were occupational disabled or unemployed (5%), and less than 1% (n = 1) did the housekeeping. About half (57%) of the mothers was employed, 35% did

Table 1. Characteristics[a] of parents, adolescent children, and their friends

	Parents		Adolescent children		Friends		
	Mothers (n = 309)	Fathers (n = 270)	Girls (n = 201)	Boys (n = 146)	Friends of mothers (n = 79)[b]	Friends of fathers (n = 29)[c]	Friends of adolescents (n = 240)[d]
Age (years)	42 ± 4	44 ± 5	15 ± 1	15 ± 1	42 ± 7	40 ± 10	15 ± 1
Height (m)	1.69 ± 0.06 (n = 307)	1.80 ± 0.07 (n = 269)	1.69 ± 0.06 (n = 196)	1.76 ± 0.09 (n = 139)	1.69 ± 0.06 (n = 77)	1.75 ± 0.08	1.72 ± 0.08 (n = 226)
Weight (kg)	66 ± 9 (n = 307)	81 ± 11	55 ± 7 (n = 194)	60 ± 10 (n = 142)	68 ± 11	73 ± 12	58 ± 10 (n = 228)
Body Mass Index (kg/m^2)	23.3 ± 2.9 (n = 306)	24.8 ± 2.7 (n = 269)	19.3 ± 2.0 (n = 192)	19.3 ± 2.1 (n = 138)	24.0 ± 3.5 (n = 77)	23.7 ± 3.5	19.5 ± 2.2 (n = 221)
Educational level[e] (%)							
low	54	34	30	32	46	39	35
intermediate	23	32	26	27	31	25	25
high	20	33	44	42	18	32	32
Meal preparation[f]	22.3 ± 8.8	4.6 ± 9.2	2.4 ± 8.0	1.9 ± 8.5	25.5 ± 12.9	16.4 ± 11.6	2.1 ± 9.3
Food purchasing (%)							
always	67	10	0	2	-	-	-
mostly	25	13	7	5			
now and then	7	55	77	69			
never	1	23	16	25			
Dietary restrictions (%)							
none	84	93	92	90	76	76	92
low-fat and/or low cholesterol diet	3	4	2	3	4	14	3
weight loss diet	9	2	3	2	14	3	1
vegetarian	1	2	3	3	1	3	2
other	3	0	1	2	5	3	2

[a] Mean ± SD.

[b] 3 males and 76 females, [c] 15 males and 14 females, [d] 94 males and 146 females.

[e] For adults: low = primary school, lower level of secondary school, lower vocational training; intermediate = higher level of secondary school, intermediate vocational training; high = higher vocational training, university degree. For adolescents: current secondary school level.

[f] Frequency of preparing cooked meal in past four weeks.

Table 2a. Social network ties: frequency of sharing meals with specific others according to mothers and fathers

	Mothers	Fathers
Eating with spouse[a,b]		
• breakfast	13.9 ± 11.3 (n=253)	13.8 ± 10.8 (n=251)
• lunch	11.4 ± 9.4 (n=253)	11.0 ± 9.1 (n=250)
• dinner	24.4 ± 5.8 (n=253)	24.5 ± 5.1 (n=251)
• snack	24.9 ± 17.6 (n=250)	25.5 ± 19.4 (n=243)
Eating with child[a,b]		
• breakfast	16.6 ± 11.1 (n=295)	12.0 ± 10.4 (n=254)
• lunch	8.6 ± 6.9 (n=295)	7.0 ± 6.4 (n=254)
• dinner	24.6 ± 4.7 (n=295)	22.8 ± 5.6 (n=254)
• snack	24.4 ± 13.8 (n=293)	16.5 ± 12.3 (n=246)
Eating with best friend[a,b]		
• breakfast	0.1 ± 0.9 (n=78)	0.0 ± 0.0 (n=28)
• lunch	0.3 ± 1.2 (n=78)	1.4 ± 4.4 (n=28)
• dinner	0.3 ± 1.0 (n=78)	0.4 ± 1.0 (n=28)
• snack	3.2 ± 4.0 (n=78)	6.4 ± 9.3 (n=28)

Table 2b. Social network ties: frequency of sharing meals with specific others, according to adolescents

	Girls	Boys
Eating with mother[a,b]		
• breakfast	14.9 ± 12.2 (n=171)	14.5 ± 11.8 (n=124)
• lunch	6.7 ± 8.0 (n=171)	7.7 ± 9.4 (n=124)
• dinner	25.5 ± 4.4 (n=172)	24.8 ± 5.5 (n=123)
• snack	24.4 ± 16.9 (n=169)	21.0 ± 14.9 (n=123)
Eating with father[a,b]		
• breakfast	11.1 ± 11.3 (n=145)	11.2 ± 11.0 (n=112)
• lunch	5.7 ± 7.2 (n=144)	6.0 ± 8.0 (n=111)
• dinner	23.7 ± 5.2 (n=145)	23.2 ± 6.8 (n=112)
• snack	18.0 ± 14.9 (n=143)	16.5 ± 13.7 (n=109)
Eating with best friend[a,b]		
• breakfast	0.5 ± 1.1 (n=152)	0.5 ± 3.1 (n=88)
• lunch	4.6 ± 8.1 (n=152)	5.0 ± 8.4 (n=87)
• dinner	0.7 ± 1.3 (n=152)	0.8 ± 3.2 (n=88)
• snack	8.8 ± 11.2 (n=150)	5.9 ± 7.4 (n=87)

[a] Mean ± SD, [b] Frequency in past four weeks.

Table 2c. Social network ties: contact frequency between friends, and frequency of talking about food at home and with best friend

	Parents		Adolescents	
	Mother (n=309)	Fathers (n=270)	Girls (n=201)	Boys (n=146)
Meet best friend (%)[a]				
• (almost) every day	12	21	56	66
• 1 or 2 times a week	43	39	37	26
• less than once a week	33	25	6	8
• not in past 4 weeks	24	14	2	0
Speak to best friend on telephone (%)[a]				
• (almost) every day	4	11	14	3
• 1 or 2 times a week	21	11	28	25
• less than once a week	51	29	32	30
• not in past 4 weeks	15	50	26	42
Talk about food at home (%)				
• often	46	48	23	22
• sometimes	48	44	59	56
• seldom	6	8	17	22
• never	0	0	1	1
Talk about food with best friend (%)[a]				
• often	8	7	7	3
• sometimes	60	46	38	16
• seldom	22	25	37	50
• never	10	21	18	31

[a] n=78 for mothers and friends, n=28 for fathers and friends, n=152 for girls and friends, n=88 for boys and friends.

the housekeeping, 6% worked as a volunteer, and 2% was occupational disabled or unemployed.

Adolescents spent an average of 5.1 (SD 4.9) Dutch guilders per week on foods and drinks outside the home, ranging from zero to 40 guilders. Seventy-five percent of the adolescents reported that they influenced their parents' food purchases, and 65% thought they influenced the preparation of foods.

Friends were on average comparable in age, body mass index, and educational level. Parents' friend had on average more often dietary restrictions than the

parents themselves.

Table 2a and 2b give more details on how often the father, the mother, and the adolescent ate together with the three members of their personal network. Frequencies of eating together reported by different network members were consistent. Dinner appeared to be a meal that was mostly eaten with the family, and lunch was eaten least often with other nuclear family members. Adolescents did eat lunch and snacks together with their friend sometimes, but only breakfast or dinner. Parents rarely ate main meals together with their b but they did eat or drink regularly with their friend in between meals.

About half of the parents (47%) reported to talk often about food whereas most adolescents (58%) reported that they sometimes did. Ta friends about food occurred less often than talking about food at home (

The adolescents knew their friends from their current school (43%), f primary school (32%), from living in the same neighbourhood (29%) (sports)club (29%), as boyfriend or girlfriend (3%), from a job (2%), or soi else (1%). The duration of the friendship of the adolescents was for 90% o subjects more than one year, and for 45% even more than 5 years. Adolescents and mothers had mostly a same-sex friend participating (92 to 96%), whereas fathers had as often a male friend as a female friend (52% males). Most parents, 66% of mothers and 69% of fathers described their friend as "their best friend, bosom friend" or "just a good friend". The friend was a colleague of 13% of the mothers and 31% of the fathers (13%/31%), a neighbour (18%/3%), or a sister-in-law (5%/7%). Most mothers (90%) and fathers (74%) knew their friends for more than 1 year, and 45% of mothers and 56% of the fathers knew their friends for more than 5 years. In 17 families both the father and the mother had a friend participating in the study.

Resemblance in intake of foods

Significant associations were found for almost all food items of the food frequency questionnaire between husbands and wives (94% of the items), between mothers and children (87%), and between fathers and children (76%). For the adolescents and their friends, 19% of the foods of the food frequency questionnaire were significantly associated. For mothers and their friends this was 11% and for fathers and their friends 8%, just above the 5% level which would be expected significant due to chance. **Table 3** shows specific foods that had the highest association in intake between husband-wife pairs, between parent and child, and between friends. Within the nuclear family, the highest associations

Table 3. Associations in food intake within social networks: foods with the highest intake resemblance between parents, between parents and 15 year old children, and between friends

Within family						Between friends					
Mother & father (n = 253)	r[a]	Mother & child (n = 296)	r	Father & child (n = 257)	r	Father & friend (n = 29)	r	Mother & friend (n = 79)	r	Child & friend (n = 240)	r
minced meat -pork & beef mixture-	0.73	butter/margarine added to cooked vegetables	0.56	bacon (dinner)	0.50	whitener (in coffee)	0.61	condensed milk, high P/S ratio (in coffee)	0.56	bread	0.29
fish -type unknown-	0.70	bacon (dinner)	0.53	milk, full fat (in coffee)	0.49	light beer	0.56	pizza	0.40	spirits	0.25
milk, full fat (in coffee)	0.70	pizza	0.52	fish fingers	0.47	bacon (dinner)	0.55	cake	0.38	condensed milk, semi-skimmed (in coffee)	0.24
bacon (dinner)	0.69	soup	0.51	minced meat -pork & beef mixture-	0.47	salads with mayonnaise dressing (on toast)	0.52	shawarma	0.37	croquettes	0.21
pizza	0.65	minced meat -pork & beef mixture-	0.50	pizza	0.46	custard -type unknown-	0.51	croquettes	0.37	low-fat cheese	0.20
condensed milk, high P/S ratio, full fat (in coffee)	0.62	fish fingers	0.49	yogurt, full fat	0.46	chicken with skin	0.45	fish -average fat-	0.34	fried sausage	0.20
fish fingers	0.61	cheese (dinner)	0.48	soup	0.44	chocolate & hazelnut spread	0.43	meat products -type unknown-	0.30	French fries	0.18
French fries (dinner)	0.59	French fries (dinner)	0.47	butter/margarine added to cooked vegetables	0.44	hamburger (snack)	0.37	eggs	0.28	beer	0.18
fried potatoes	0.59	fried sausage (dinner)	0.47	milk, full fat	0.44	low-fat cookies	0.37	salads with mayonnaise dressing (on toast)	0.27	shawarma	0.18
butter/margarine added to cooked vegetables	0.59	stir fried vegetables	0.46	coconut spread	0.43			cheese (dinner)	0.27	minced meat -beef-	0.18
chicken without skin	0.57	fried potatoes	0.46	chicken with skin	0.42			chicken without skin	0.26	whitener (in coffee)	0.17
minced meat -beef-	0.57	oil & vinegar dressing	0.45	muesli	0.41			meat products -fat- (as snack)	0.25		
rice, grains, pasta	0.57	fried fish	0.44					bread	0.23		
croissants	0.57	muesli	0.43								

[a] Spearman correlation coefficients ($p < 0.05$).

Table 4. Mean intakes[a] of energy, fats and cholesterol

	Women (n = 399)	Men (n = 288)	Girls (n = 347)	Boys (n = 240)
Energy				
(MJ)	9.21 ± 2.43	11.94 ± 3.41	11.14 ± 3.37	15.26 ± 4.98
(kJ/kg body weight)	140 ± 43	150 ± 42	198 ± 83	252 ± 99
Fatty acids (En%)				
Total	39.5 ± 7.0	41.5 ± 6.3	41.0 ± 6.5	42.4 ± 6.4
Saturated	15.2 ± 2.9	15.6 ± 2.6	15.7 ± 2.4	16.0 ± 2.5
Monounsaturated	14.3 ± 3.0	15.0 ± 3.1	14.7 ± 2.8	15.2 ± 2.8
Polyunsaturated	7.7 ± 2.3	8.3 ± 2.6	8.2 ± 2.6	8.8 ± 2.7
Cholesterol (mg/MJ)	28 ± 7	27 ± 8	23 ± 5	22 ± 6

[a] Mean ± SD.

were found for foods eaten with the main meals. Associations on food level were similar for father-son and father-daughter pairs. For friends, the type of milk or whitener in coffee, alcoholic drinks, and several snack foods were significantly associated.

Resemblance in fat intake

The intakes of energy, fats and cholesterol of the participants are shown in **Table 4**. Gender and age had an important effect: fat intake of males (n = 528) was 1.7 En% higher than that of females (n = 746) ($F(1,1270) = 20.43$, $p < 0.001$), adolescents had a 0.8 En% higher intake than adults ($F(1,1270) = 10.16$, $p < 0.01$), and there was no interaction between age-group and sex ($F(1,1270) = 0.53$, $p > 0.05$). The fat intake of the adolescents was similar for the three educational levels ($F(1,345) = 1.97$, $p > 0.05$). Associations in energy and nutrient intakes are shown in **Table 5**. Within the nuclear family, fat and fatty acid intakes were in general significantly positively associated. Between parents the associations in intakes of fat and fatty acids, relative to energy (En%), ranged between 0.30 and 0.34. Significant mother-child associations in fat intakes (En%) ranging from 0.19 to 0.41 were found for boys and girls. Father-son associations in fat intakes (En%) ranged between 0.25 and 0.36, whereas father-daughter

Table 5. Associations[a] for energy intake, fat intake and body composition between members of a social network

	Within family			Between friends		
	Mother & father (n=253)	Mother & child (n=296)	Father & child (n=257)	Mother & friend (n=79)	Father & friend (n=29)	Child & friend (n=240)
Energy (MJ)	0.23	0.19	0.13	0.20 ns	0.31 ns	0.28
Energy (MJ/kg body weight)	0.24 (n=252)	0.22 (n=285)	0.10 ns (n=246)	0.14 ns	0.09 ns	0.18 (n=222)
Body Mass Index (kg/m^2)	0.27 (n=250)	0.10 ns (n=279)	0.16 (n=241)	0.17 ns (n=77)	0.23 ns	0.10 ns (n=213)
Total fat (En%)	0.30	0.19	0.18	0.04 ns	-0.02 ns	0.04 ns
Saturated (En%)	0.34	0.23	0.24	0.05 ns	0.15 ns	0.01 ns
Monounsaturated (En%)	0.34	0.20	0.26	0.14 ns	0.12 ns	0.05 ns
Polyunsaturated (En%)	0.34	0.38	0.16	-0.05 ns	0.27 ns	-0.04 ns
Cholesterol (mg/MJ)	0.44	0.00 ns	0.22	0.17 ns	0.27 ns	0.04 ns

[a] Pearson correlation coefficients ($p<0.05$), ns = not significantly different from zero.

associations ranged between 0.09 and 0.21 and were in general not significant. Fat intakes (En%) between friends were not significantly associated, neither for the adolescent nor for the adults. Fat intakes for unrelated subjects were around zero and only as often significant as would be expected due to chance.

Frequency of interaction

The frequency of sharing meals together did not clearly influence the association in intakes between network members (**Table 6**). The variation in the frequency of "talking about food" was too small (**Table 2c**) to pick up possible differences in resemblances in intakes between friends and within the family.

Qualitative network study

A total of 15 mothers, 14 fathers, 19 boys and 15 girls participated. The total number of (series of) statements coded was 1778: 670 of these statements were made by mothers, 379 by fathers, 432 by boys, and 297 by girls. The mother played in most families the most important role in food buying and preparation. **Table 7** contains characteristic statements that refer to influences of the social environment on food intake. The statements are divided in the categories: direct social influences; modelling; and social facilitation. Some of these social influences appeared to be connected with other determinants of food intake: time constraints; finances; hunger; and food availability.

Resemblance in intakes within families depends partly on food rules within the family. **Table 8** gives an overview of the family rules that emerged during the discussions, classified according to the issue of the food rule. The amount that should be eaten of specific types of foods covers a large part of the rules. Other rules dealt with where, when, or with whom to eat; preparation; appropriateness for the occasion; and general eating rules. Family food rules are illustrated by the statements made in the discussions about "What I would never eat". Rules appeared to be dynamic, and had gradually loosened when children got older. The adolescents were considered almost old and wise enough to decide themselves what they should eat.

Table 6. Association in intake of energy and fat for friends and family members, according to the frequency of eating together[a]

Pairs of network members	Frequency of eating together (in past four weeks)				
Mothers and fathers	< 51 times (n=49)	52-64 times (n=45)	65-82 times (n=56)	83-96 times (n=48)	> 96 times (n=53)
Energy	0.39	-0.15 ns[b]	0.14 ns	0.34	0.39
Fat (g)	0.36	-0.30	0.34	0.47	0.42
Fat (En%)	0.27 ns	-0.11 ns	0.41	0.64	0.42
Mothers and children	< 47 times (n=60)	47-60 times (n=59)	61-78 times (n=57)	78-93 times (n=58)	> 93 times (n=61)
Energy	0.16 ns	0.40	0.08 ns	0.18 ns	0.14 ns
Fat (g)	0.00 ns	0.26	0.19 ns	0.14 ns	0.16 ns
Fat (En%)	-0.05 ns	0.30	0.34	0.29	0.11 ns
Fathers and children	< 36 times (n=49)	36-49 times (n=53)	50-61 times (n=54)	62-79 times (n=49)	> 79 times (n=52)
Energy	0.23 ns	0.25 ns	0.11 ns	0.10 ns	-0.02 ns
Fat (g)	0.32	0.21 ns	0.11 ns	0.19 ns	0.09 ns
Fat (En%)	0.19 ns	0.08 ns	0.04 ns	0.25 ns	0.34
Adolescents and friends	not (n=51)	1-4 times (n=47)	5-13 times (n=46)	13-25 times (n=45)	> 25 times (n=45)
Energy	0.39	0.25 ns	0.35	0.31	0.07 ns
Fat (g)	0.35	0.21 ns	0.17 ns	0.26 ns	0.02 ns
Fat (En%)	0.13 ns	0.07 ns	0.00 ns	0.04 ns	0.05 ns
Mothers and friends	not (n=24)		1-3 times (n=26)		> 4 times (n=28)
Energy	-0.07 ns		0.17 ns		0.40
Fat (g)	-0.15 ns		0.32 ns		0.33 ns
Fat (En%)	-0.30 ns		0.24 ns		0.10 ns

[a] Frequency of eating together = total number of breakfasts, lunches, dinners, and snacks, that are eaten together.

[b] ns = not significant.

Table 7. Social influences on food choice: a selection of statements made by parents and adolescents

Category	Statements of parents	Statements of adolescents
Direct social influences: pressure, persuasion, competition, demanding	the children have to drink orange juice with breakfast; I make something different for anyone who does not like it; I prepare food that they all like; I always have to remind my wife that we should eat pasta a few times a week; I don't mind what she cooks, as long as there is soup; one of the children eats all the sweets so the others have to hurry to get something as well; my son does not eat fruit when he does not have to; children do not mind what they eat, they never do a suggestion about what to make for dinner; my children sometimes make remarks about my belly; it makes a change when children ask for something; the children sometimes make a game of who can eat most chips; my wife sees to it that I do not put butter on my bread;	I have to ask when I want something; I can influence purchases when I join my mother shopping; when my parents aren't looking I throw away the milk that I am supposed to drink; when I ask for something for dinner my mother sometimes prepares it, but if my father asks for something she always prepares it; we have to drink milk; I would eat more cookies if no one saw it; mother buys what we ask; I did not like it, but my mother made me eat it to be polite; my parents say that I should put savory spreads on my bread more often; my parents don't care whether I eat breakfast, when I am hungry later on it is my problem; I do not eat sweet sandwich filling when my father (dentist) is at home;
Modelling behaviour of others	I inherited a sensitiveness for rheumatic pains from my mother, so like her I avoid coffee and pork; we don't drink, so I think that's why the children do not drink either; my mother did not use a lot of fat for cooking and I adopted that way of cooking; when my youngest son is with his older brother at a party he drinks alcohol like his brother;	self-sliced bread looks stupid, others probably think it's French loaf; my parents do not eat breakfast either; when friends don't buy something at school I don't; I take sweet sandwich filling, because dad also eats it; some people in my family drink a lot and I do not want to become like them; I never drink tea at home, but I do drink tea with my friend and his mother; I drink the regular type of beer, everyone does; I eat low-fat margarine like my mother;

Category	Statements of parents	Statements of adolescents
Social facilitation: about eating alone or with others	I don't like to eat alone; it is good to eat with the whole family; we eat fish when my husband is away; father is the only one who eats chocolate in the evening; I try to eat slower when I eat with my wife; he asked all of us what we would like to have and got it from the snack-bar; I never eat a cookie with my coffee and I do not care if others do;	I don't like to eat alone so I watch television while eating; without my friends I would not buy anything at school; when dad is at home with dinner we have to stay at the table until everyone is finished; we buy sweets at school by turn; we are always with a group during the breaks; I don't care what the others do, when I am hungry and buy something they will wait for me; I always empty the biscuit-box when my parents are away and I have to baby-sit;
Time constraints & social influences	we eat luxury food and elaborate meals only at weekends, when everyone has time to enjoy it; I prepare the meal beforehand when we have guests;	I have no time to pack a lunch in the morning, I'd rather sleep than get up early for that; I do not often have time to help mum with cooking, because I have to do my homework; I eat quickly because I have to leave soon for sports; only when I have time I wait for the others at breakfast;
Finances & social influences	give children sweets, because it's cheaper than when they buy it at school; hard workers deserve good food, so I do not look at the costs; children always ask for the expensive things;	I do get some sweets at home, but if I want more I have to buy it myself;
Hunger & social influences	children are too hungry to wait for dinner until father comes home; when I have guests I give them something with their coffee, but don't take it myself, unless I am very hungry;	I am not hungry in the morning, but I eat breakfast because I have to and because I need the energy later on at school;
Food availability & social influences	father finishes the meat products that have to be finished; when there are no more chips/sweets/etc they have to wait till the end of the week when shopping is done; they do not sell that type of margarine in the supermarket where my daughter works;	eat what is opened; we get something else when we do not like it; when they sell croquettes at school, I buy some; there are more cookies at home when my mother is dieting, because then she is hungry when she buys food; I would eat more nice and tasty things if I lived on my own;

Table 8 - continued -

Topics of family food rules	Statements of parents	Statements of adolescents
Preparation of meals	Fathers: my wife cooks dinner, I have other tasks; my wife makes sandwiches for me and the children; I only prepare dinner when my wife is ill; Mothers: children can choose what they want to eat on their birthday; always fresh vegetables; everyone makes his/her own sandwiches;	dad cooks when my mother has to work; I have to prepare dinner once a month; a lot of my friends do not have to make their own sandwiches;
About family rules		
Unfamiliar or inappropriate: "What others eat but I/we would not"	what people in other cultures eat; fruit on bread; cheese with jam on bread; often eat "fancy meals" such as pasta and pizza, instead of a normal (potatoes/vegetables/meat) dinner; eating "fancy meals" on a week day; drinking coke with a meal; eating a lot of snack food; drinking a lot of alcohol; we never have canned vegetables; we don't eat horse meat;	snails; caviar; cows eyes; mussels; shrimps; elaborate meals which take a lot of preparation time; eating late at night; eating a little of the main course and a lot of dessert; I saw a guy on television who ate French fries for breakfast; these German friends served us pasta with whipped cream; my uncle and his family drink beer with their dinner, even the children do, but they do get light beer; at a barbecue at my friends home, there is only one type of meat;
Change in food rules over time	when the children were young the rules were much stricter, they have their own responsibility for what they eat now; full fat milk was supposed to be good for young children; my youngest son still has to ask when he wants something; if they did not have to eat everything when they were younger they would not have liked anything now;	we had to finish everything on our plate, now we do that anyway; I think they listen more to what we want, they take us more seriously, because when we were younger we always said that we wanted French fries for dinner;

[a] "Unrestricted" foods were also restricted, but the threshold was higher.

DISCUSSION

In this study we quantified the impact of social influences on eating behaviour within social networks, by means of assessing resemblance in food and fat intake of members of nuclear families and their best friends. The consumption frequency of most foods were significantly associated between spouses and between parents and their children, which resulted in moderate to weak associations on the level of energy and fat intakes within nuclear families. Between mothers and best friends, fathers and best friends, and adolescents and best friends, resemblance in intake existed for some foods, but no significant associations in energy and fat intakes were found. The family and focus group interviews showed that there is a range of influences of the social environment that are partly embedded in rules, such as the family food rules, which regulate when, what, where, and with whom to eat. This qualitative part of the study illustrated also the multidirectional influences in eating behaviour within social networks.

Family resemblance in intake

Family resemblance in energy and fat intakes as reported here is comparable to those of other studies which took place in Western countries using a range of dietary assessment techniques [5,16-22]. Within most studies the resemblance was highest between spouses, and somewhat lower between parents and children. With respect to the Netherlands, we reported correlations between 0.35 and 0.60 between nuclear family members who participated in the Dutch National Food Consumption Survey [5]. Stafleu et al. [23] showed persistence of family resemblance between Dutch women and their 25 year old daughters who lived separately who met often.

Resemblance in intake between friends

Peers are considered important sources of influence on adolescents eating behaviour [24-29]. However, intakes of best friends in this sample in the Netherlands were found to be associated for only a few foods. That the foods were mainly snack foods, agrees with the finding that adolescents associated "junk" foods more with friends than with the home environment [30]. Friends or classmates in general might influence food choice more than just the friend that was chosen to

participate in the network. In the qualitative study, the adolescents mostly spoke in general terms about their friends, or the kids at school.

The resemblance between parents and their friends and between adolescent and their friends was found only for some specific foods. Food habits appear to be more associated within the nuclear family, than between friends. This agrees with the finding that most meals and snacks are eaten together with members of the nuclear family. Having dinner with friends appeared an exceptional thing for most participants, very good friends come for dinner with Christmas or during the holidays. Adolescents regularly ate together lunch and snacks with their friends, but these were often brought from home. Parents did regularly drink coffee with their friends, at home and at their work. Also, lunches and snacks between meals were eaten together sometimes. Apart from the low frequency of eating or drinking together, food also was more an issue of conversation in the family, and not so much between friends.

The variance in the intakes was not expected to be a limitation for the magnitude of the correlation.

Association in intakes to assess influence

Correlation coefficients were used to assess association between intakes of social network members. However, a non-significant association does not exclude the existence of social influences on food intake within the social network. Not all influences will result in an association in intake, and it is possible that a balance is achieved between enhancing and opposing effects. For the adolescents, opposing against parents might lead to an absence in resemblance or even a negative correlation between parental and adolescent intakes. A girl said: "I do finish my plate but when my mother would say that I have to, I would not do it any more", which is a statement that suits in a period often conceptualized as a period in which the young people try to break away from the influence of the parents [31,32]. Subgroups in the population may be more or less than average susceptible to influences of their friends [29].

Interaction between network members

Resemblance is expected to be connected with the frequency and context of interaction within the network, and the context of the network interactions [33].

Foods eaten at home were associated between nuclear family members in the Dutch National Food Consumption Survey, whereas foods eaten elsewhere were not [5]. The finding that the frequency of sharing meals more often did not lead to a higher resemblance in the current study might be explained partly by the finding that all family members shared meals relatively often, even in the lowest frequency quintile, so that the variation might not be large enough. Also, adolescent friends mostly shared snacks and lunches at school, but these appeared to be generally home-packed lunches and snacks. Now and then the adolescents bought something extra at school. Most adolescents did not go out regularly.

Future research

More knowledge about food behaviour in the context of social networks will help us to improve our understanding of why people eat what they eat, and give ideas to intervene for nutritional educators [34,35]. Further studies of the mechanism of social influences on food intake are needed: who influences who, in which way, in which (sub)culture. Instead of cross-sectional data, the impact of social influences on food intake might be studied prospective: with observational work or carefully conducted experiments, which are very difficult to carry out. A "natural" experiment, in which a change in behaviour occurs spontaneously, is preferred as it gives the possibility to study social influences as they occur in real life. Determinants of change, and the influence of specific persons can be deducted from these types of studies.

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6

Fat intake of adolescents: quantification of influences from the social environment

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ABSTRACT

Concepts from the Theory of Reasoned Action and the Social Cognitive Theory assessing influences of the social environment were evaluated as determinants of fat intake of adolescents. The sample consisted of 122 social networks each consisting of a 15 year old adolescent, his/her father, mother, and best friend. Fat intake of all network members was assessed by a food frequency questionnaire, and subjects rated their perceived fat intake. Influences from the social environment were quantified by the subjective norm (Theory of Reasoned Action), and by modelling behaviour of significant others (Social Cognitive Theory), using path analysis. With both theories influence of the social environment was small: the subjective norm explained 1%, and fat intake of others up to 6% of variance in fat intake. Results were similar for boys and girls. The subjective norm did not directly influence fat intake of adolescents, but adversely affected attitudes towards fat (path coefficient = -0.25), suggesting that adolescents either oppose against pressure from their environment or that they perceive pressure only when they consume a high fat diet. With respect to modelling, mother's fat consumption significantly explained fat intake of adolescents (path coefficient = 0.25), but fat intake of father and best friend did not. Quantifying social influences of actual fat intake and perceived fat intake gave different results. In conclusion, social influences on fat intake according to these theories were small in this group. Mothers had more influence on adolescents' fat intake than fathers and friends.

INTRODUCTION

Social influence is supposed to be an important determinant of food intake. Social influences on food intake were defined as all influences that one or more subjects have on eating behaviour of others, either direct or indirect, conscious or subconscious.

We studied to which extent the eating behaviour of adolescents was influenced by specific individuals in their social environment. Fifteen year old boys and girls were the objects of study, because they are in a phase of life in which eating habits are established. Family members play an important role [1-3], but influences of peers on eating habits are expected also [3,4]. Therefore, we studied behaviour of adolescents within the context of their social environment, in small social networks including their parents and best friend. The importance of dietary fat in the development of coronary heart disease [5,6] led us to focus on fat consumption. Qualitative work on this sample revealed a range of social influences on food intake between parents and children, which were partly embedded in family rules [7]. Fat intakes of adolescents were significantly associated with those of their parents, but not with those of best friends [7].

In this article, more knowledge was gained on the nature and direction of the influences within these networks. For example, the correlation between the fat intake of parent and child was similar for father and mothers [7], but this does not necessarily mean that influences of fathers and mothers on the fat intake of their adolescent children are similar. Path analysis enables to quantify concurrently the influences of father, mother, and best friend, on fat intake of adolescents. Two theories which include an assessment of social influences were used to evaluate social influences on fat intake: the Theory of Reasoned Action from Fishbein and Ajzen [8] and Bandura's Social Cognitive Theory [9].

The Theory of Reasoned Action predicts behavioral intention from a person's attitude towards the behaviour, and from the subjective norm. Behaviourial intention strongly predicts behaviour [8]. The subjective norm of Fishbein and Ajzen's Theory of Reasoned Action has been used often to measure influences from the social environment on fat intake [10]. The *subjective norm* reflects the pressure from the social environment to perform a certain behaviour [8]. However, this concept has several drawbacks. It is not clear whether the subjective norm really assesses

influences from the social environment. The subjective norm represents rather the subject's reported awareness of social influences than the influences really exerted by the social environment [10]. In a pilot study with 18 year old students and their parents, participants complained about the questions on the subjective norm and normative beliefs: e.g. "I don't care what others want me to eat" or "People in my social environment do not bother what I eat". Such complaints were also reported in a study among adults in the Netherlands [11,12]. This suggest that the subjective norm assessment regarding food consumption is more likely to assess perceived (in)dependence than perceived pressure from the social environment. Furthermore, it can be seriously doubted whether the subject's answers on questions about the subjective norm are independent from those on attitudinal questions [10]. Currently, extended versions of the Theory of Reasoned Action such as Theory of Planned Behaviour are used often to predict nutritional behaviour. To test the impact of social influence components on fat intake, we confined to the basic model (**Figure 1**).

Social influences on food intake can also be quantified by the concept of *modelling* [9]. The social environment provides models for behaviour. Actions of other persons, and reinforcements that these persons receive are observed. Observed behaviour that is considered rewarding, is likely to be imitated [9,13]. Modelling is believed to be the strongest socialization technique in developing healthy life styles [4]. The concept of modelling is a component of the Social Cognitive Theory, which is formed by a triad of factors that operate as interacting determinants: a subject's cognitions and other personal factors, environmental events, and behaviour [9]. With fat consumption, modelling might take place both at the level of foods, and at the aggregate level of eating a high-fat (unhealthy) or low-fat (healthy) diet.

In 1987/1988, eight out of ten people in the Netherlands had a fat intake above the recommended 30 to 35 percent of energy intake [14]. Fat intake has decreased a little since then [15], but still 63 percent of the people consumed too much fat in 1992 (KFAM Hulshof, personal communication). However, most people do not seem to be aware that their own fat consumption is too high [16], and self reports of fat intake have been shown to correlate poorly with actual fat intakes [16,17]. Brug et al. observed that explained variance doubled when subjective or perceived fat intake was the outcome variable in their ASE-model, compared with the actual fat intake assessed by a short food frequency questionnaire [17]. This

suggests that psychosocial determinants of fat intake are stronger predictors of perceived fat intake than of actual fat intake.

Therefore, the objective of this study was to quantify influences of father, mother, and best friend on fat intake of adolescents, by testing models derived from the Theory of Reasoned Action [8] and models derived from the Social Cognitive Theory [9]. The influences of the social environment on *actual* fat intake and on *perceived* fat intake of adolescents were evaluated using path analysis. Fat intake is not one action, but the result of a series of behaviourial actions. Therefore, we carried out additional analyses to predict intake of specific foods.

METHODS

Sample & recruitment networks

The sample consisted of networks including (a) parent(s), their 15-year old son or daughter, and the best friend of this son or daughter. Recruitment of social networks started with the recruitment of adolescent children. Students in the third grade of secondary schools, who were in their 11th year of education and about 15 years of age, were informed about the study in their classrooms. The students were asked to participate together with the parent(s) with whom they were living and their best friend. Parents were not necessarily the biological parents. The best friend was defined as "someone you know very well, of about your own age, with whom you meet regularly". Friends were not supposed to be family members or people living in the same household. Subjects were allowed to participate in one network only. Non-responders were asked to report sex, height and body weight and reason(s) for not participating. Best friends of parents were also involved in this study, but data were not used in analyses presented here. In this paper we will refer to the parents/caretakers as "fathers" and "mothers", to their 15 year old children as "adolescents", and to friends as "friends of adolescents".

Recruitment started at five schools in three villages and two towns in the Netherlands. Twelve schools were approached and five agreed to participate. Selection of sites was based on presence of a secondary school with the three most common (low, intermediate, and high) educational levels [18], a broad

geographical distribution, and a range in urbanisation degree [19]. Recruitment was balanced for gender and educational level.

Procedure

Questionnaires were distributed to the adolescents in their classrooms and mailed to parents and friends. When the questionnaire was not returned within two weeks, subjects received a reminder telephone call. Subjects were also contacted when they filled out the questionnaire incorrectly or incomplete. Those who seldom or never prepared meals were instructed to check details about meal preparation with the person(s) responsible for preparing meals. All subjects received their personal nutrient intake values.

Response

Sixty-six percent of the adolescents who were approached in their school classes agreed to participate in the study together with their parents and their best friend. Non-responders reported to be not interested (64%), did not want to involve their parents or friends (45%), participated already as best friend in another network (14%), and/or mentioned other reasons (12%). Responders were more often female and more often from the highest of three educational levels, whereas their Body Mass Index and age were comparable with non-responders [7]. A questionnaire was filled out properly and returned by 68% of the adolescents who agreed to participate, 62% of the mothers, 57% of the fathers, and 53% of the friends. The full study sample comprised of 347 adolescents, 270 fathers, 309 mothers, and 240 friends of adolescents. There were 169 complete networks consisting of an adolescent, father, mother, and best friend. In this paper, two theories were compared in a sub sample of 122 networks, consisting of all subjects without any missing values for variables used to evaluate the models.

Questionnaire

A self-administered questionnaire was used, which included general questions, a food frequency questionnaire, and questions on socio-psychological concepts.

General questionnaire

Age, sex, height, and weight were asked. Educational level was assessed for

parents, and current school type for adolescents and their friends. The origin of friendship was recorded, e.g. classmate, member of same (sporting) club, living in same neighbourhood.

Food and fat intake

Actual fat intake (En%), perceived fat intake, and consumption of specific foods were used as outcome variables in the path analyses. Only current behaviour was assessed, no behaviourial intentions. Testing on the level of food items was carried out to check whether results would differ from results for fat consumption, which is not an action on itself, but the result of a series of eating actions. Fruit was chosen as non-fat food item, and amount of butter/margarine as high-fat item. For the Social Cognitive Theory we had the possibility to use reported frequencies from all network members for 104 foods: 16 foods were selected to yield a range in fat content from zero to 83%.

For each network member, fat intake was assessed by a self administered food frequency questionnaire which asks for the intake of 104 foods in the past four weeks. This fat intake, derived from reported consumption frequencies of individual foods, is referred to as "actual" fat intake. Validity of the food frequency questionnaire to rank individuals according to fat intake (En%) relative to the dietary history, was moderate to high for elderly above 65 years of age, $r = 0.72$ ($n = 51$) [20] and for 30 to 50 year old adults, $r = 0.65$ ($n = 191$) [21], and moderate for adolescents, $r = 0.29$ ($n = 77$) [22]. The associations of linoleic acid in body tissues and linoleic acid intake were comparable for food frequency questionnaire and dietary history in a group of adults [21]. Estimates of energy, fat, fatty acids and cholesterol were reproducible: test-retest correlations for fat intake (En%) of adults were 0.77 when administered 8 weeks apart [23], and 0.64 when administered 13 weeks apart [24]. The questionnaire was interview administered in these methodological studies, which is expected to prevent some errors compared with self-administration.

Perceived or subjective fat intake was scored by all network members, on a 7 point scale. The question "I think the fat content of my diet is .." was anchored with "very low" (score = 1) and "very high" (score = 7). Fathers, mothers and adolescents estimated on a similar scale each other's fat intake, and adolescents also estimated the fat intake of their best friend.

For intake of specific foods, reported frequencies were derived from the food frequency questionnaire. Perceived intake of butter or margarine on bread, and fruit by other network members was asked separately.

Theory of Reasoned Action

This theory was evaluated for actual fat intake, perceived fat intake, butter/margarine intake, and fruit intake.

Attitudes towards low- and high-fat foods were assessed by a Fishbein-Ajzen based scale which was developed by Stafleu et al. [24]. Test-retest correlation of the attitude scale was 0.92 (n = 25) and Cronbach's α of the attitude scale was 0.67. The Pearson correlation coefficient between the attitude score and fat intake (en%) was 0.40 (n = 33) [24]. The scale reflects the choice between full fat foods and their low-fat alternatives and is constructed from liking and good/bad attitudes towards five high-fat foods (full fat milk, margarine, full fat yoghurt, saveloy, minced meat) and their low-fat alternatives (semi-skimmed milk, low-fat margarine, skimmed yoghurt, smoked beef, chopped steak). The liking attitude "I like eating product X" was anchored "fully agree" (score = 7) to "fully disagree" (score = 1). The good-bad attitude question "Eating product X is:" was anchored "very good" (score = 7) to "very bad" (score = 1). Sum scores were calculated for five high-fat and five low-fat foods separately. The attitude score was calculated by subtracting the summed score of attitudes towards low-fat foods from the summed attitude score of high-fat foods.

The scale was slightly modified compared with the original from Stafleu et al., using their suggestions [24]. Pork meat is not necessarily high in fat, and beef is not necessarily low in fat, so we substituted these items by more specific meat types: minced meat as high-fat meat, and chopped steak as low-fat alternative. Saveloy was taken as high-fat meat product instead of liver sausage, as its use was considered more similar to that of the low-fat alternative smoked beef. A 7 point scale was used instead of a 5 point scale to increase the range of answers. Cronbach's α of this slightly revised attitude scale was 0.68. The attitude score has a range from -60 to +60: a high score on the attitude scale reflect a positive attitude towards high-fat foods and a negative attitude towards low-fat alternatives, whereas a low score reflects a negative attitude towards the high-fat foods and a positive attitude towards the low-fat alternatives.

The subjective norm was assessed for fat consumption with the question

"People who are important to me think that I should eat a low-fat diet" on a 7 point scale (-3 to 3) anchored "very sure" and "surely not". Normative beliefs were assessed by the question "I suppose that my father (mother, best friend) thinks that I should eat a low-fat diet".

Motivation to comply with father, mother, or friend, was assessed on a 7 point scale "In general I want to eat what my father (mother, friend) thinks I should eat" and scored from 1 to 7. Normative beliefs x motivation to comply for the adolescents was calculated from questions referring to their father, mother and best friend.

For foods, attitudes, subjective norm, and normative beliefs towards fruit consumption and thickness of spread on bread (butter/margarine) were assessed by similar scales as used for fat.

Social Cognitive Theory

Modelling refers to imitating perceived behaviour of others, which can be different from what others actual consume. Also, adolescents may have incorrect assumptions concerning their food and fat intake. Consequently, models explaining actual behaviour and perceived behaviour, by actual and perceived behaviour of others, were compared. Separate analyses were performed for foods.

Path analyses

Statistics

Pearson correlation coefficients between intakes, and between determinants of intake within networks were calculated with SAS version 6 (SAS Institute Inc, Cary, NC). LISREL VII causal modelling [25] within SPSSX was used (SPSS Inc, Chicago, IL) to evaluate the processes of influence within the social network.

Only data of adolescents who had both parents, and a best friend participating in the study were used, so that the number of subjects was identical for all models. Subjects with missing values for one of the variables were excluded for the same reason. T-values were used to decide which path could be removed; t-values below 1.96 were considered not significantly different from zero. Path coefficients were estimated with the maximum likelihood method. A χ^2/df ratio smaller than 1.00, and an adjusted goodness of fit above 0.95 was considered to indicate a good fit

Table 1. Models tested to explain fat intake of adolescents

Model	Theoretical framework	Dependent variable	Independent variables	Results in
1	Theory of Reasoned Action	actual[a] fat intake	▸ subjective norm ▸ normative beliefs x motivation to comply ▸ attitudes	Fig. 4a
2	Theory of Reasoned Action	perceived[b] fat intake	▸ subjective norm ▸ normative beliefs x motivation to comply ▸ attitudes	Fig. 4b
3	Social Cognitive Theory	actual fat intake	▸ mother's actual fat intake ▸ father's actual fat intake ▸ best friend's actual fat intake	Fig. 5a
4	Social Cognitive Theory	actual fat intake	▸ mother's fat intake, perceived by adolescent ▸ father's fat intake, perceived by adolescent ▸ best friend's fat intake, perceived by adolescent	Fig. 5b
5	Social Cognitive Theory	perceived fat intake	▸ mother's fat intake, perceived by adolescent ▸ father's fat intake, perceived by adolescent ▸ best friend's fat intake, perceived by adolescent	Fig. 5c
6	Social Cognitive Theory	perceived fat intake	▸ mother's actual fat intake ▸ father's actual fat intake ▸ best friend's actual fat intake	Fig. 5d

[a] Actual fat intake = fat intake as % of energy intake, calculated from food frequency questionnaire.
[b] Perceived fat intake = estimation fat intake on 7 point scale.

of the model [26]. The models were both tested for the whole group, and for boys and girls separately.

Models evaluated with path analyses

Quantification of the subjective norm component from Fishbein and Ajzen's Theory of Reasoned Action [8], and of behaviourial modelling processes as described in the Social Cognitive Theory [9] were performed. All models that have been tested are described in **Table 1**.

Figure 1 presents the Theory of Reasoned Action, which does not assume interactions between attitudinal and subjective norm components. This assumption has been challenged [27-29]. To be able to explore direct effects of subjective norm,

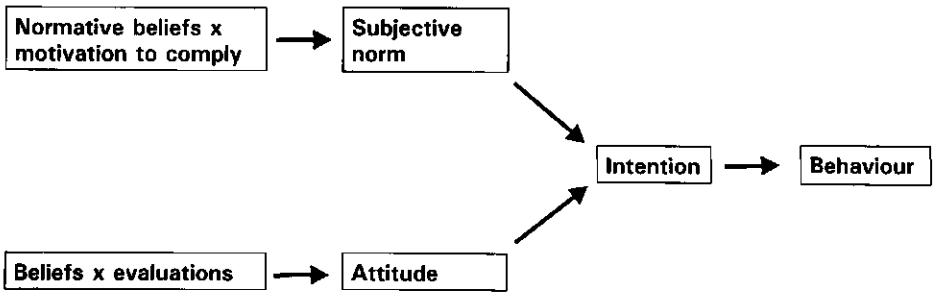

Figure 1. Representation of the components of the Theory of Reasoned Action (Ajzen & Fishbein, 1980)

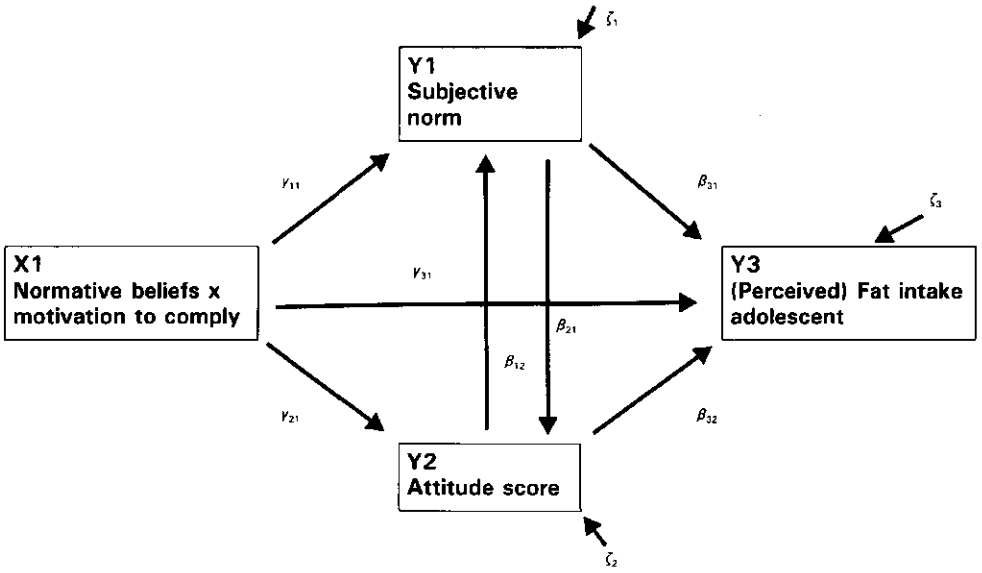

Figure 2. Structural model used to predict *actual fat consumption and perceived fat consumption* of adolescents with the Theory of Reasoned Action

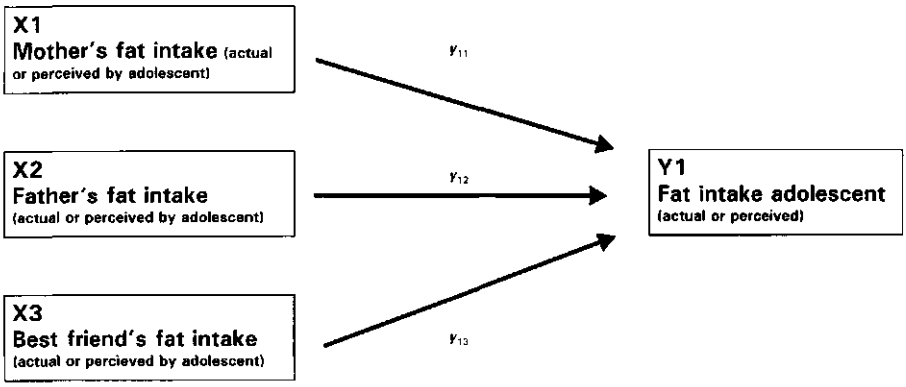

Figure 3. Structural model used to predict *fat consumption (actual or perceived)* of adolescents from fat intakes of other social network members (actual or as perceived by the adolescent), using the Social Cognitive Theory

and possible attitude-mediating effects of subjective norm on fat intake, the Theory of Reasoned Action was modified into the structural model shown in **Figure 2**. A possible interaction between subjective norm and attitudes was evaluated by estimating the path from attitudes to subjective norm and the inverse path between these variables. This model has been tested with "actual fat intake of adolescents" (model 1), and "perceived fat intake of adolescents" (model 2). In addition, this model was tested for "fruit consumption of adolescents" and "amount of butter/margarine used on bread by adolescents". Testing on the level of food items was carried out to check whether results would differ from the results for fat consumption, which is not an action on itself, but the result of a series of eating actions. Fruit was chosen as non-fat food item, and amount of butter/margarine as high-fat item.

Figure 3 is the basic specification of the model according to the Social Cognitive Theory, to quantify the impact of modelling of the behaviour of important others with respect to fat intake. We tested four varieties of this basic model. Actual fat intake of the adolescent was predicted by actual fat intake of successively mother, father, and best friend (model 3). Then, actual fat intake was

Table 2. Characteristics[a] of adolescents, their parents, and their best friends (n = 122 networks)

	PARENTS		ADOLESCENT CHILDREN		BEST FRIENDS OF ADOLESCENTS
	Mothers (n = 122)	Fathers (n = 122)	Girls (n = 77)	Boys (n = 45)	(n = 122)[b]
Age (y)	42 ± 4	44 ± 5	15 ± 1	15 ± 1	15 ± 1
Body Mass Index (kg/m^2)	23.2 ± 2.9 (n = 121)	24.3 ± 2.4 (n = 121)	19.5 ± 2.3 (n = 72)	19.3 ± 1.7 (n = 44)	19.5 ± 2.1 (n = 111)
Educational level[c] (%)					
low	50	36	29	24	32
intermediate	25	34	26	27	28
high	24	29	46	49	34
Energy intake (MJ)	9.4 ± 2.5	12.1 ± 3.2	11.4 ± 3.3	15.8 ± 4.9	12.7 ± 4.4
Fat intake (% of energy intake)	39.6 ± 7.1	41.6 ± 5.8	40.7 ± 6.1	42.6 ± 5.7	41.6 ± 6.8
Meal preparation (frequency/4 w)	22 ± 7	5 ± 7	2 ± 4	1 ± 2	2 ± 9
Food purchasing (%)					
always	65	9	0	4	-
mostly	26	13	4	4	
now and then	6	55	83	73	
never	3	23	13	18	
Dietary restrictions (%)					
none	82	95	90	91	92
low-fat and/or					
low cholesterol diet	3	3	3	0	3
weight loss diet	9	0	4	4	1
vegetarian	2	2	4	2	2
other	3	0	0	2	3

[a] Mean ± SD. [b] 49 males and 73 females. [c] For adults: low = primary school, lower level of secondary school, lower vocational training; intermediate = higher level of secondary school, intermediate vocational training; high = higher vocational training, university degree. For adolescents: current secondary school level.

predicted by fat intakes of mother, father, and friend *as perceived by the adolescent* (model 4). The same two models were also used to explain the amount of fat the adolescent perceived to consume, instead of actual fat intake (model 5 and 6).

RESULTS

Network characteristics

Characteristics of the participants are shown in **Table 2.** Characteristics of the subsample of 122 networks were similar to characteristics of the full study sample. The adolescents knew their friends from school (75%), from living in the same neighbourhood (29%), a sports club (29%), or else (6%). Most adolescents (92%) had a best friend of their own gender.

Associations between fat intake and determinants of fat intake

Table 3 shows within subject associations between reported fat intake which was assessed by the food frequency questionnaire, perceived fat intake, attitudes towards fat, and subjective norm towards fat. Attitudes were significantly associated with fat intake, but subjective norm was not. Perceived fat was significantly but not strongly associated with actual fat intake, derived from the food frequency questionnaire. Correlation matrices were comparable for girls (n = 77) and boys (n = 45).

Table 4 shows associations between network members for fat intake, perceived fat intake, subjective norm, and attitude towards fat consumption. In general, associations were highest between fathers and mothers, and decreased in the direction adolescent and parent, and were never significant for adolescent and best friend. Associations were different for actual and perceived fat intake. Attitudes towards fat were significantly related within the nuclear family, but not between friends.

Models derived from the Theory of Reasoned Action

The results of the structural models to predict fat intake with the Theory of Reasoned Action are shown in **Figures 4a** and **4b. Table 5** shows that these models had a good fit. Both the actual fat intake and the perceived fat intake of

Table 3. Associations between fat intake, perceived fat intake (PFAT), subjective norm (SN) and attitudes (ATT) towards fat intake for all adolescents (n = 122), and by gender

	All (n = 122)				Girls (n = 77)				Boys (n = 45)			
	PFAT[a]	NBxMC[b]	SN[c]	ATT[d]	PFAT	NBxMC	SN	ATT	PFAT	NBxMC	SN	ATT
Fat intake[e]	0.29[f]	-0.02	-0.08	0.39[f]	0.25[f]	0.04	-0.04	0.41[f]	0.35[f]	-0.18	-0.27	0.30[f]
Perceived fat intake (PFAT)[a]		-0.19[f]	-0.25[f]	0.24[f]		-0.14	-0.21[f]	0.25[f]		-0.31[f]	-0.36[f]	0.23
Normative beliefs x motivation to comply (NBxMC)[b]			0.70[f]	-0.20[f]			0.71[f]	-0.30[f]			0.67[f]	-0.06
Subjective Norm (SN)[c]				-0.25[f]				-0.32[f]				-0.27

[a] Self-scored fat intake on scale from 1-7.

[b] Normative beliefs (NB) x motivation to comply (MC). Scale from -42 to +42.

[c] SN = Subjective norm, assessed on scale -3 to +3.

[d] Attitude score = Σ (liking + good high-fat foods) - Σ (liking + good low-fat foods). Scale -60 to +60.

[e] % of energy intake, assessed with food frequency questionnaire.

[f] significantly different from 0 ($p < 0.05$).

Table 4. Associations within social networks (n = 122): Pearson correlation coefficients between actual fat intake, perceived fat intake, subjective norm, and attitude towards fat intake

	Mother & father	Adolescent & mother	Adolescent & father	Adolescent & best friend
Fat intake (En%)[a]	0.29	0.25	0.18 ns	0.04 ns
Perceived fat intake[b]	0.16 ns[c]	0.04 ns	0.22	-0.06 ns
Subjective norm	0.20	0.11 ns	0.12 ns	-[d]
Attitude[e]	0.43	0.29	0.27	0.14 ns

[a] En% = percentage of energy intake.

[b] Self-scored fat intake on scale from 1-7.

[c] ns = not significantly different from 0 ($p > 0.05$).

[d] Subjective norm was not assessed for friends.

[e] Attitude score = Σ (liking + good high-fat foods) - Σ (liking + good low-fat foods).

adolescents were significantly predicted by their attitudes towards fat, explaining 15 and 4% of variance in intake, respectively. Subjective norm appeared to influence both actual fat intake and perceived fat intake by mediating attitudes. The subjective norm had an impact of -0.10 (= -0.25 x 0.39) on actual fat intake, thus explaining 1% of adolescent's fat intake. However, subjective norm was a stronger predictor of perceived fat intake: a total impact of -0.25, consisting of a direct effect of -0.20 and an indirect effect of -0.05 (= -0.25 x 0.20), which means the subjective norm explained 6% of the perceived fat intake. Normative beliefs x motivation to comply and subjective norm were strongly associated (0.70).

At the level of single food items, models predicting fruit and butter/margarine consumption did not show an identical pattern as models predicting fat intake, but attitude-modifying effects of subjective norm were supported. Fruit consumption was significantly predicted by attitudes, with a path coefficient of 0.29, and by subjective norm (path coefficient = 0.18). The amount of butter/margarine on bread was significantly predicted by attitudes, with a path coefficient of 0.64. The subjective norm did not directly influence intake, however, both the subjective norm and the normative beliefs x motivation to comply had a positive impact on

Table 5. Results of models tested to explain fat intake of adolescents (n = 122)

Model	Theoretical framework	Initial model		Best fitting model[a]		Figure	Explained variance	χ^2 (df)	p	Adjusted goodness of fit	Maximum modification index
1	Theory of Reasoned Action	γ_{11} = 0.69 γ_{21} = -0.08 γ_{31} = 0.10	β_{12} = -0.02 β_{21} = -0.18 β_{31} = -0.05 β_{32} = 0.40	γ_{11} = 0.70	β_{21} = -0.25 β_{32} = 0.39	4a	15%	0.97 (3)	0.81	0.987	0.59 for γ_{31}
2	Theory of Reasoned Action	γ_{11} = 0.69 γ_{21} = -0.08 γ_{31} = -0.02	β_{12} = -0.02 β_{21} = -0.18 β_{31} = -0.18 β_{32} = 0.20	γ_{11} = 0.70	β_{21} = -0.25 β_{31} = -0.20 β_{32} = 0.20	4b	8%	0.22 (2)	0.90	0.995	0.19 for γ_{21}
3	Social Cognitive Theory	γ_{11} = 0.22 γ_{12} = 0.11 γ_{13} = 0.07		γ_{11} = 0.25		5a	6%	2.10 (2)	0.35	0.957	1.54 for γ_{12}
4	Social Cognitive Theory	γ_{11} = -0.02 γ_{12} = 0.03 γ_{13} = 0.03		-		5b	0%	0.23 (3)	0.97	0.997	0.16 for γ_{12}
5	Social Cognitive Theory	γ_{11} = 0.18 γ_{12} = 0.55 γ_{13} = -0.01		γ_{11} = 0.18 γ_{12} = 0.55		5c	33%	0.01 (1)	0.92	1.000	0.01 for γ_{13}
6	Social Cognitive Theory	γ_{11} = 0.14 γ_{12} = 0.14 γ_{13} = 0.10		γ_{12} = 0.19		5d	4%	3.23 (2)	0.20	0.935	1.99 for γ_{11}

[a] Paths from the initial model that were not significantly contributing to the model ($t < 1.96$) were removed.

[b] Explained variance of (perceived) fat intake adolescents, calculated as square root of paths affecting (perceived) fat intake.

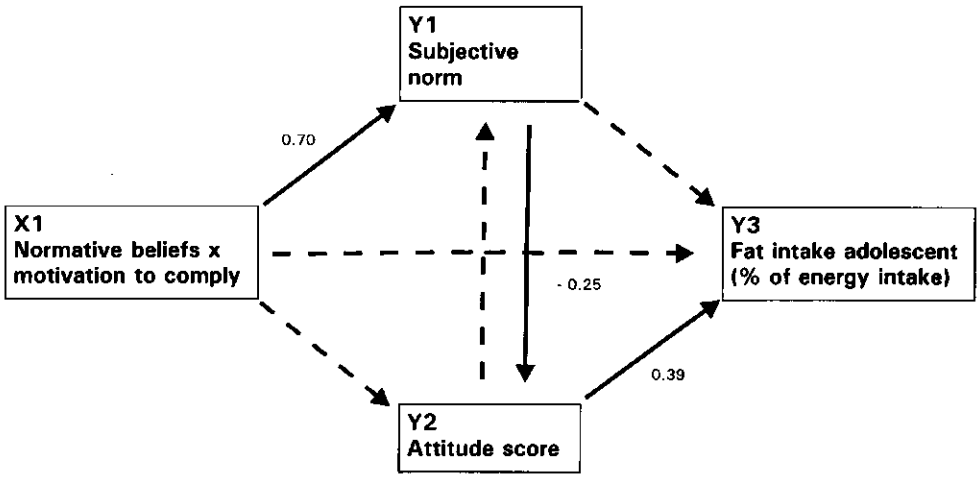

Figure 4a. ***Fat consumption of adolescents*** **explained with the Theory of Reasoned Action**

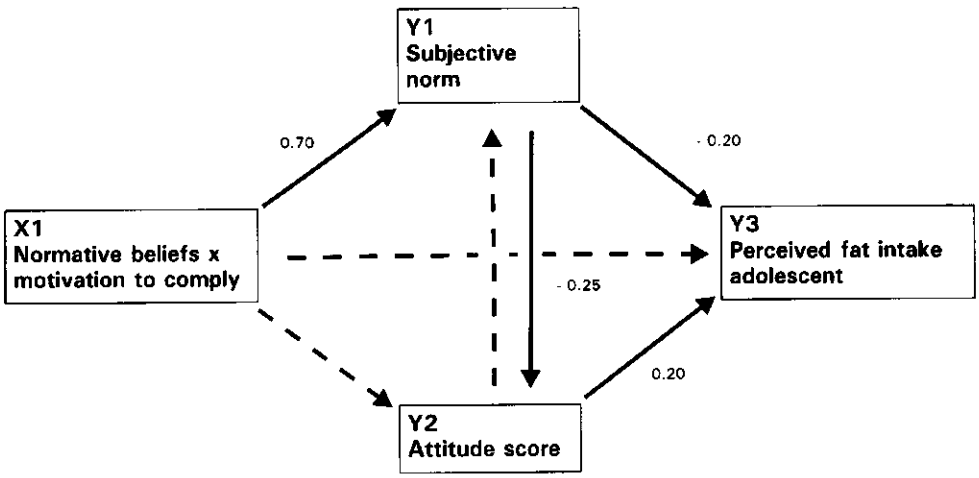

Figure 4b. ***Perceived fat consumption of adolescents*** **explained with the Theory of Reasoned Action**

attitudes, with path coefficients of 0.27 and 0.45, respectively.

Models derived from the Social Cognitive Theory

Figure 5a,b,c,d show estimated coefficients of structural models derived from the Social Cognitive Theory. The models do explain up to 6% of the variance in actual fat intake and up to 33% of variance in perceived fat intake. The models have an acceptable to good fit, as shown by the Adjusted Goodness of Fit Index and χ^2/df ratio. **Figure 5a** shows that actual fat intake of adolescents was significantly predicted by mother's fat intake, but not by those of father and best friend. **Figure 5b** shows that adolescents' estimation of fat intake of parents and best friend did not significantly predict fat intake of adolescents. The perceived fat intake of adolescents was predicted by their estimation of their father's fat intakes, and to a lesser extent by the estimation of their mother's fat intake (**Figure 5c**). Perceived fat intakes of best friends, did not predict adolescents' self estimated fat intakes. **Figure 5d** shows that adolescents' estimation of their own fat intake is predicted by actual fat intake of their fathers, and not by fat consumption of their mothers and best friends.

Models of the Social Cognitive Theory on the level of foods were evaluated for model 3, where actual behaviour of the adolescents is predicted by actual behaviour of their network members. In total 16 foods, from high-fat to low-fat foods, were tested. Path coefficients were positive, but not always significantly predicting adolescents' intake. Consumption frequencies of potatoes, chinese food, and croquettes by adolescents were significantly explained by the frequency in which their mothers consumed these foods. Adolescents intake of croissants, rolls, apple pie, chocolate sprinkles on bread, chinese food, and rice and pasta, was significantly predicted by their fathers' intake of these food items. The adolescents' intake of beer, croissant, bread, candy bar, and croquettes was significantly predicted by the frequency in which their best friends consumed these foods. Consumption of fruit, the amount of butter/margarine on bread, and cake was not significantly predicted by the behaviour of any member of this social network.

Results of both theories: explained variance of subjective norm and modelling

The subjective norm explained 1% of actual and 6% of perceived fat intake. Modelling explains up to 6% of the variance in actual fat intake and up to 33% of variance in perceived fat intake.

The results of all models derived from the Theory of Reasoned Action and the Social Cognitive Theory were in line for boys and girls, with path coefficients being

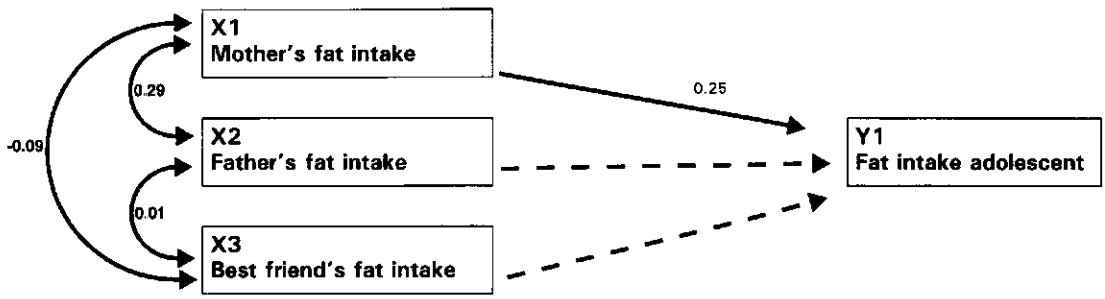

Figure 5a. ***Fat intake of adolescents*** **explained from fat intakes of other social network members, using the Social Cognitive Theory**

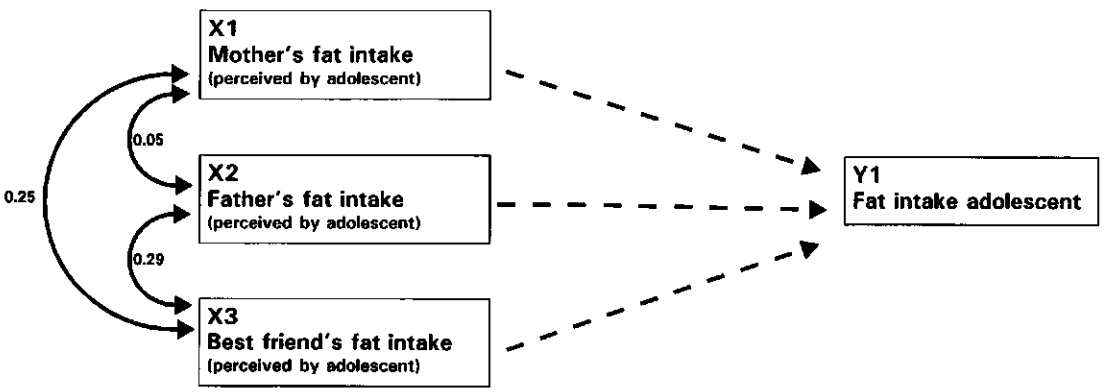

Figure 5b. ***Fat intake of adolescents*** **explained from fat intakes of other social network members as perceived by the adolescents, using the Social Cognitive Theory**

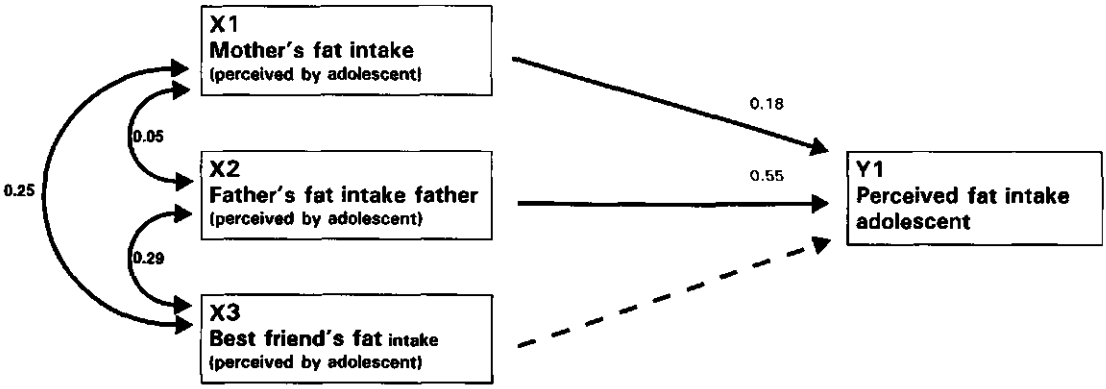

Figure 5c. *Perceived fat intake of adolescents* explained from fat intakes of other social network members as perceived by the adolescents, using the Social Cognitive Theory

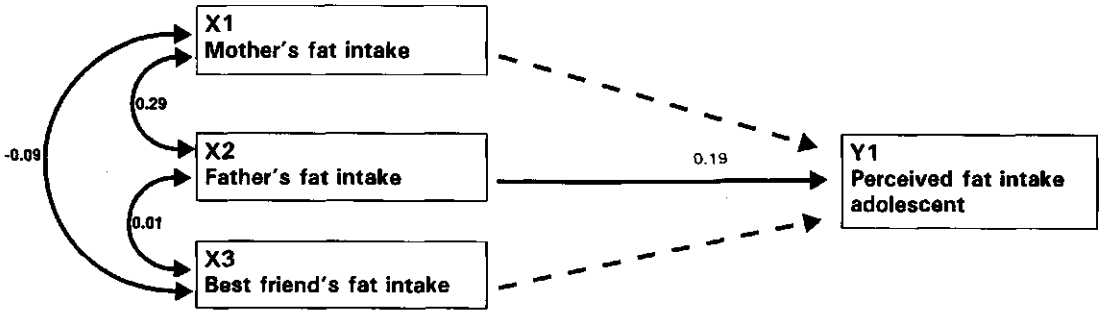

Figure 5d. *Perceived fat intake of adolescents* explained from fat intakes of other social network members, using the Social Cognitive Theory

in general stronger for girls (data not shown). Some paths were not significant for boys, probably due to the smaller sample size of boys (n = 45) than that of girls (n = 77). These results do not support any differences in parental influences on food and fat intake between boys and girls.

DISCUSSION

The Theory of Reasoned Action and the Social Cognitive Theory both predicted only a small percentage of variance in fat intake in adolescents. The Theory of Reasoned Action suggest that pressure from the social environment resulted in a negative effect on adolescents' fat intake: the more pressure adolescents felt to consume a low-fat diet, the more fat they consumed. The results from the Social Cognitive Theory models suggested that fat consumption of adolescents was positively influenced by behaviour of their mother. Fat intake of father and best friend did not affect fat intake of adolescents. This does not mean that one model is better in estimating the influence of the social environment, because both theories assess different aspects of influence of the social environment.

Theory of Reasoned Action: the subjective norm

The subjective norm appeared to influence adolescents' fat intake not directly, but through the attitudes towards fat intake. The *negative* path from subjective norm towards attitudes might be interpreted in several ways. If we assume that the subjective norm really measures social influence, then it could be concluded that subjects in our study oppose against their social environment. If however, subjective norm is conceived as only the willingness of the subject to recognize that his eating behaviour is being influenced by the opinion of significant others, than the negative path coefficient is not an indication of actual opposing behaviour but rather of pretended opposing. Another explanation is that adolescents only perceived pressure from the social environment with respect to their fat intake when they consumed a high fat diet.

Focus group discussions between adolescents and between parents did not support that opposing behaviour was important [7]. Reactions of dislike towards questions on subjective norm, normative beliefs and motivation to comply suggested that the subjective norm question was at least for some people not assessing social pressure but perceived independency from the social environment.

Similarly to our results, attitudes usually explain most of the variance of the

intake of fat or high-fat foods, whereas the subjective norm explained a small amount [10]. With respect to the adverse reactions that we experienced towards answering the questions on subjective norm, normative beliefs, and especially motivation to comply, this was only reported by one other study in the Netherlands [11,12], so a cultural difference in reactions to these questions or a language problem can not be excluded.

In accordance with our findings for fat intake, Mesters and Oostveen reported minimal social pressure from friends and classmates on Dutch adolescents to consume sweet snacks or fat snacks [30]. Dennison and Shepherd reported moderate influences from perceived behaviour of friends (ß = 0.16-0.23), and small influences from subjective norm (ß = 0.06-0.08) on adolescents' consumption of chips, fruit, chocolate and sweets [31].

We found that attitudes were better predictors of actual behaviour than of perceived behaviour in this group of 15-year old adolescents, which is in contrast to findings of Brug et al. in a group of Dutch adults [17].

Social Cognitive Theory: modelling

Assessing the impact of modelling nutritional behaviour by evaluating the impact of perceived behaviour of others on adolescents' perceived behaviour ("What do important others eat?"), suggested a large influence from fathers and only a small influence from mothers. However, actual fat intake of the adolescent was dependent only from mother's fat intake. Mothers were mostly responsible for meal preparation and food purchases, and more often shared meals with their children[7]. Although responsibility does not necessarily lead to control of eating behaviour of the nuclear family members, the data support that mothers do have more influence than fathers on the fat intake of their adolescent children. Surprisingly, adolescents perceive this differently and strongly overestimate their resemblance in fat intake with their fathers. This perceived similarity with the diet of their father may have originated from the similar position they have within the household: most fathers and most children were not responsible for food purchases and preparation. Adolescents might have been unaware of what their fathers eat outside of the home, and assumed they eat the same as they do.

Fat intake

A point of discussion is fat intake as outcome variable. Fat intake is not one action, therefore it might be not ideal for testing in these socio-psychological models. Further, actual fat intake as calculated from the food frequency questionnaire

yielded different results than the perceived intake, when it was used as outcome variable in models. The variable perceived fat intake was assessed by the following question "I think the fat content of my diet is ..", which was anchored with "very low (=1)" and "very high (=7)". It is clear that while answering this question the subject has to construct, more or less consciously, a reference group. Subjects appear to choose often a reference group that consumes more fat than they do [17,32]. Further, subjects may think of fat intake as a high consumption of high-fat foods, or have a more abstract picture of fat intake. It is likely that this choice between reference groups influenced the estimations and the correlations between them. Altogether, a clearer assessment of perceived fat intake, mentioning a point of reference, is needed in future studies.

Sample

This study was not carried out in a representative Dutch sample, although adolescents from three educational levels were included: more adolescents from the higher educational level participated. More girls than boys were in the sample, but gender did not appear to influence results.

Real impact of social environment on fat intake

The explained variance of the actual fat intake which is attributed to the social environment is relatively small for all models. The subjective norm explained 1% of the variance in fat intake of adolescents, whereas modelling behaviour explained up to 6%.

We have to consider that not all sources of influence from the social environment were evaluated: the best friend but not the full group of peers, parents but not brothers and sisters. In addition, pressure and modelling were assessed, but no other social influences such as social facilitation. Therefore, the magnitude of social influences on fat intake might be larger than observed here. It is also possible that fat intake in these networks is strongly dependent on cultural influences, leaving little variance to be explained for interpersonal influences.

Future research

The subjective norm as an estimation of social influences on fat intake, and assessment of modelling by asking perceived behaviour of important others might not exactly assess what we expect them to assess. These questions to estimate social influences on food intake have to be further investigated. Studies in which both the subjective norm and modelling are assessed provide good information on the importance of the two types of social influences [17]. However, we have to

acknowledge that the meaning of both assessments is not perfectly clear: what exactly do we measure?

It is doubted whether "overall" measurements of socio-psychological determinants of fat intake capture these influences correctly; social influences are not stable influences, but they are bound to the situation. Research investigating stability of the social influence concepts over a range of situations would be very helpful.

This study focused on current behaviour, but effects of social environment on dietary change is even more important. Future research should include some carefully designed interventions in the food habits of social networks, e.g. introducing new foods into families.

Conclusions

- Subjective norm and attitudes were not independently acting on fat intake of adolescents.
- Mothers influenced fat intake of their 15 year old children more than fathers and friends did.
- Perceived fat intake was weakly correlated with actual fat intake in adolescents. Models explaining actual fat intake yield did not yield similar results.

Implication for nutrition education

The implication of this study for nutrition education is that parents influenced fat intake of these 15 year old boys and girls more than the best friends of these adolescents. Mother has the largest influence on fat intake of adolescents, but adolescents perceive more similarity in fat intake with their fathers. Intervention programs targeting the nuclear family are more likely to be effective than programs focusing on peer influences.

ACKNOWLEDGEMENTS

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7

Social facilitation of food intake is mediated by meal duration

Feunekes GIJ, de Graaf C, van Staveren WA.
Physiology & Behavior 1995; 58: 551-558.

ABSTRACT

The effect of the number of others present on the amount of food eaten was investigated in the Netherlands by studying spontaneous meal size in 50 free-living young males and females. Subjects recorded food consumption, number of others present, hunger, taste of the food, food availability, and atmosphere at each eating or drinking moment for four ($n = 30$) or seven consecutive days ($n = 20$). The results of the study with four and the study with seven recording days were comparable. The mean Pearson within-person correlation coefficient between the number of others present and meal size was 0.24 ($n = 50$, $p < 0.05$). This correlation was significant for breakfast (0.40, $p < 0.05$) and snacks (0.18, $p < 0.05$), but not for lunch ($r = 0.19$, $p > 0.05$) and dinner ($r = 0.15$, $p > 0.05$). A path analysis showed no direct effect of the number of others on meal size, but revealed that social facilitation of spontaneous meal size was mediated by meal duration.

INTRODUCTION

People tend to eat more when in the company of others compared with eating alone [1-9]. This may be considered as an example of social facilitation, which is defined as the enhancement of a certain behaviour due to the sheer presence of others [10]. Various studies of de Castro et al. showed social facilitation of spontaneous meal size in the United States. A positive association between energy intake at an eating or drinking moment and the number of others present at that moment was found for the three main meals, breakfast, lunch, and dinner, and also for snacks [2-4,6], during week days as well as weekend days [7], for meals ingested with or without alcohol, and for meals consumed at home, in a restaurant and elsewhere [3]. A study in which the number of others present at a meal was manipulated suggested that the effect of the presence of others on energy intake is a causal effect [11].

The reasons why people would eat more when more others are present are yet unknown, and might be conscious and subconscious. The effect of the number of other people present at a meal on the meal size may be a direct effect, but it may also be an indirect effect that is mediated by one or more intervening variables (**Figure 1**). For example, at meals eaten with others there might be relatively more food available, subjects might have larger feelings of hunger, the atmosphere might be more sociable, the food might taste nicer, or the meal might simply last longer. All these factors are potential mediators of an effect of the number of others present on energy intake.

In this paper we present two observational studies in which several social and situational factors were related to the amount eaten. A specific objective of both studies was to investigate whether the effect of social facilitation was mediated by other factors. Study I was designed to investigate whether social facilitation could also be demonstrated in the Netherlands. Study II was carried out to investigate whether the findings of the first study could be replicated. More data per subject were collected in Study II to increase the reliability of the correlation coefficients and thus increase the possibility of finding social facilitation. Further, in the latter study the planning of the amount eaten at a meal was studied. Do people plan to eat more when more others are present?

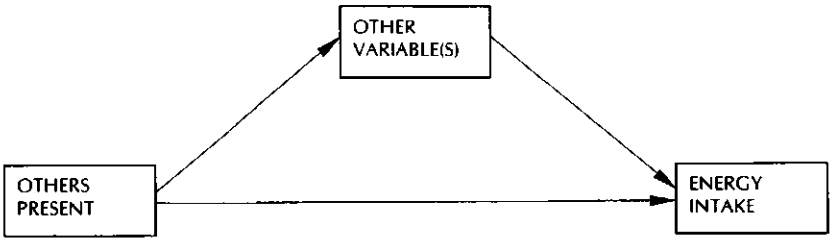

Figure 1. Basic model to investigate social facilitation of food intake at an eating moment

METHODS

Subjects

Participants were recruited by an advertisement in the Wageningen University newspaper. Fifteen males and 15 females were enrolled in Study I, and 20 other subjects, 10 males and 10 females, took part in Study II. Subjects were excluded from participation on the basis of the following criteria; restrained eating, absence of variation in the number of others with whom meals were usually shared, dieting, and obesity. The restrained eating score on the Dutch Eating Behaviour Questionnaire had not to exceed 3.3, which was the 80th percentile of the restraint score distribution in a representative group of 19 to 31 year old Dutch males and females [12]. None of the subjects followed an energy-restricted diet in the past 6 months, and none of them had a Body Mass Index above 25 kg/m^2.

The subjects were informed only about the general purpose of the study: to investigate associations between various meal characteristics. All subjects completed the study and received their personal nutrient intake values and a financial reward.

Measurements and procedure

A pocket sized (14.5 x 10.5 cm) diary was developed according to the model of

de Castro's food diary [13]. The diary had to be filled out at each eating or drinking occasion. Subjects recorded all foods they consumed and simultaneously they recorded situational aspects such as "when", "where", "with whom", and "doing what". They also recorded the meal type and they rated subjective hunger feelings, the taste of the meal, the atmosphere, and the availability of more food. In Study II the "amount planned to eat beforehand" and the "amount eaten" were added to the diary (**Table 1**). A new eating moment started when a subject started to eat or drink, or when location, company or both changed during an eating moment. An eating or drinking moment will be referred to as a 'meal' in this paper. Meal size was defined as the energy content of the meal.

The diary and the procedure were explained to the subjects individually. They were instructed to eat as much and as often as they usually did. Subjects kept the diary for one practice day, which was not used in the analysis. The diary of this practice day was checked for completeness, and more instructions were given if necessary. Participants kept the food diary for four consecutive days in Study I, and the participants of the second study kept diaries for seven consecutive days to increase the reliability of the estimates of the correlation coefficients. The day of the week on which the subjects started to keep the food diaries was randomly assigned. The diaries were checked at the end of the observation period.

In Study II more information on the subjects and their compliance was collected than in Study I. In Study II occupation, number of housemates, and the frequency of preparing cooked meals were assessed. Further, the verification procedure to check completeness of diaries which de Castro has used in several studies [2,4,6,14] was practised. Subjects were informed that their food diaries would be verified with individuals with whom they shared meals. Halfway through, and at the end of the seven-day period the subject had to provide the name and telephone number of an individual with whom a randomly assessed meal was shared on the preceding day. The eating companion was asked to provide information about the type of food and the amount of food in household measures which the subject had been eating. In no case the diary report of the subject was in contradiction to the report of the eating companion.

External eating scores and restrained eating scores were computed from responses on the Dutch Eating Behaviour Questionnaire [12]. Body weight without shoes and jacket was assessed on a calibrated scale (SECA, Laméris Instruments,

Table 1. Questions in food diary, to be filled out at each eating or drinking occasion (= meal)

Variable	Assessment
Meal type	Breakfast, lunch, dinner, or snack
Duration of meal	Time at start and end of meal: to the minute
Hunger	At start and end of meal: 10 point Likert-scale, 1 = weak to 10 = strong
Number of others present	Individuals with whom the subject was in direct contact, not strangers eating at same location: number of men and number of women
Relation with company	Who, e.g. partner, friends, strangers
Location	Where, e.g. home, work, restaurant
Activity	Doing what, e.g. reading, watching TV, working
Atmosphere	10 point Likert-scale, 1 = unsociable to 10 = sociable
Taste	10 point Likert-scale, 1 = unpleasant to 10 = pleasant
Availability of food	Difficulty to get more food, on 10 point Likert-scale, 1 = small to 10 = large effort
Intended amount to eat[a]	Estimated at start of meal, on 10 point Likert-scale, 1 = small to 10 = large amount
Amount eaten[a]	Estimated at end of meal, on 10 point Likert-scale, 1 = small to 10 = large amount
Food consumption	Type and brand of food, amount in household measures, recipes, additions

[a] Only in Study II

Utrecht, The Netherlands) to the nearest 0.5 kg, and height was assessed to the nearest 0.5 cm using a wall-mounted stadiometer.

Data analysis

Conversion into nutrients

Nutrient intake was calculated with the 1986 version of the Dutch nutrient data base, which was extended with food codes used in the Dutch Food Consumption Survey 1987/1988 and a food consumption study in 1991 [15-17].

Statistical analysis

Average meal characteristics were calculated for each subject separately, and then averaged over all subjects. Pearson correlation coefficients between meal characteristics were also calculated for each subject separately. These within-person correlation coefficients were rescaled to a normal distribution by z-transformation, $z = 0.5 \ln (1+r)/(1-r)$, and averaged [19]. The average z-score was then transformed back again to the mean correlation coefficient, $r = (e^{2z} - 1)/(e^{2z} + 1)$. Z-transformed values were used for statistical tests with significance set at $\alpha = 0.05$. The correlations were calculated with minimum meal sizes of 0 and 50 kcal, but as the values obtained were similar, the results will be presented only for meals above 50 kcal which is the cut-off point most often used by de Castro [3,20].

Correlations were calculated for all meals together, and separately for breakfast, lunch, dinner and snacks to investigate whether overall correlations were influenced by meal type. For example, a significant overall association between the number of others present at a meal and the meal size which is not found for each meal type separately could be due to the habit of having smaller meals such as breakfast alone and larger meals such as dinner in the company of others. Differences between groups were tested with a t-test for independent samples [19]. These analyses were performed using the SAS statistical analyses package (SAS Institute Inc, Cary, NC).

To investigate whether the correlation between the number of others present at a meal and meal size represented a direct effect on meal size, or whether it was due to an indirect effect of the number of others on meal size which was mediated by other variables, a path analysis using the LISREL-program within SPSSX (SPSS

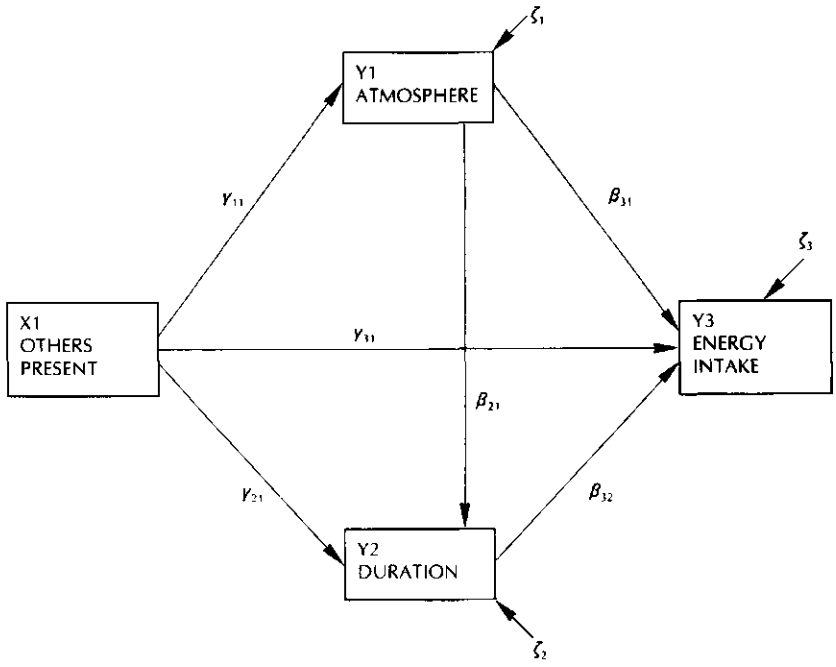

Figure 2. Structural model for social facilitation of food intake at an eating moment

Inc, Chicago, IL) was carried out. A path analysis on observational data can not really prove a causal effect, but it can establish the effects as more or less reasonable relative to other specifications. Only those variables which were in both studies related to meal size and to the number of others present were included in the model as potential mediating factors in social facilitation of food intake. The analysis started with the non-recursive saturated model as shown in **Figure 2**, using the average of the within-subject Pearson correlation coefficients. Paths with non-significant coefficients (t-values < 1.96) were successively removed to improve the fit of the model. Errors in the assessments were assumed to be unrelated, and the maximum likelihood procedure was used for the estimation of the effects. The analyses were carried out with all data, and then separately for breakfast, lunch, dinner and snacks to investigate whether a similar pattern was found for the separate meal types.

Table 2. Subject characteristics and average daily food intake [a]

Variable (unit)	Study I (n = 30)	Study II (n = 20)
Age (yrs)	22 ± 2	23 ± 2
Body weight (kg)	67.5 ± 8.1	68.9 ± 9.3
Height (m)	1.76 ± 0.10	1.78 ± 0.10
BMI (kg/m^2)	21.7 ± 1.8	21.7 ± 1.7
External eating score	3.1 ± 0.5	3.1 ± 0.4
Energy (MJ/day)	10.6 ± 2.9	11.5 ± 2.1
Fat (En%)[b]	35.3 ± 4.8	35.2 ± 4.8
Alcohol (En%)[b]	3.1 ± 3.6	4.4 ± 3.8

[a] Mean ± SD.

[b] En%, percent of energy intake.

RESULTS

Subjects

The groups of subjects of Study I and Study II were comparable concerning age, anthropometric characteristics, external eating scores and food intake (**Table 2**). On average five meals with a minimum energy content of 50 kcals were consumed per day. Roughly half of the meals were main meals, and half were snacks. During the four days of Study I the 30 subjects recorded altogether 1024 meals of which 648 meals contained more than 50 kcals; 105 breakfasts, 104 lunches, 118 dinners, and 321 snacks. During the seven days of Study II the 20 subjects recorded 988 eating or drinking moments, of which 729 contained more than 50 kcals; 130 breakfasts, 122 lunches, 134 dinners, and 346 snacks. About half of the meals, 52% in Study I, and 54% in Study II (52%/54%), took place at home, 21%/24% at the home of friends or family, 23%/15% at a public place out of the home (e.g. work, restaurant, pub, cinema), and 4%/5% during travelling. Thirty-four percent/28% of all meals were consumed without company, 39%/36% together with partner, family members or friends, and 15%/25% with housemates. Only 0.5%/0.2% of all meals were eaten with strangers. In about half (56%/51%)

of the eating or drinking occasions, eating or drinking was the main occupation, while other eating moments took mainly place when studying, working or reading (31%/32%), and watching television or listening to music (10%/14%).

From the data of Study II it was known that most of the subjects were students (n = 18), two were working. These subjects of Study II lived together with a mean number of 4.9 (SD 2.7) others, varying from 2 to 10. The main meal was on most days of the week, 3.8 (SD 1.4), prepared by other people such as friends, partner, housemates or parents. Two days a week (SD 1.4) the subjects prepared a cooked meal themselves. On the remaining days they ate a ready-to-eat meal or ate in a (student) cafeteria. It is not expected that the participants of Study I differed much from the subjects of Study II in occupation, living arrangements or eating practices.

Study I

Table 3 gives the meal characteristics of Study I per meal type. Of the main meals, breakfast was the smallest (mean 1.65 MJ) and shortest meal (mean 18 min), with least others present (mean 1.1), whereas dinner was the largest (mean 3.59 MJ) and longest (40 min) meal, which was eaten in larger company (mean 3.6 others). Hunger at the start of a meal was smallest for snacks, the mean energy content was smallest for snacks (0.90 MJ), and the reduction in hunger after eating a snack was also the smallest of all meal types. The taste of the food eaten and the atmosphere were on average scored on the "pleasant" side of the scale, whereas the difficulty to get more food appeared to be small.

In **Table 4** mean within-subject Pearson correlations between meal size and various meal characteristics are presented. Separate correlations were calculated for each meal type to avoid a spurious correlation: energy content of the meals goes up in the direction breakfast (1.7 MJ), lunch (2.4 MJ), dinner (3.6 MJ), together with the mean number of others present, 1.1 at breakfast, 2.5 at lunch and 3.6 at dinner. A significant overall correlation of 0.22 was found between the number of others present and meal size, but on the level of meal type this association was 0.05 ($p > 0.05$) for snacks, 0.25 ($p > 0.05$) for lunch, 0.26 ($p > 0.05$) for dinner, and 0.52 ($p < 0.05$) for breakfast. The duration of the meal was significantly associated with meal size for all meals except for lunch. Hunger before the start

Table 3. Study I: Characteristics[a] of breakfast, lunch, dinner and snack, based on 4-day diaries (n = 30)

Meal characteristic	All meal types	Breakfast	Lunch	Dinner	Snack
Energy (MJ)	1.65 ± 0.42	1.65 ± 0.74	2.41 ± 0.92	3.59 ± 0.93	0.90 ± 0.34
Number of others present	2.5 ± 1.8	1.1 ± 1.2	2.5 ± 2.5	3.6 ± 2.3	2.4 ± 2.2
Duration (min)	24 ± 8	18 ± 7	24 ± 9	40 ± 14	21 ± 11
Hunger before meal[b]	5.6 ± 1.3	6.0 ± 1.5	6.7 ± 1.4	7.0 ± 1.5	4.7 ± 1.4
Hunger reduction[c]	2.4 ± 0.8	3.0 ± 1.4	3.8 ± 1.4	4.7 ± 1.5	1.1 ± 0.6
Taste of food[b]	7.8 ± 0.4	7.4 ± 0.6	7.8 ± 0.6	8.0 ± 0.8	7.8 ± 0.5
Atmosphere[b]	7.2 ± 0.5	6.5 ± 0.8	7.1 ± 0.8	7.7 ± 0.7	7.2 ± 0.7
Difficulty to get more food[b]	3.7 ± 1.3	2.8 ± 1.4	3.7 ± 1.9	3.3 ± 1.5	4.1 ± 1.5

[a] Mean ± SD.

[b] On 10-point Likert scale.

[c] Hunger reduction = hunger before meal - hunger after meal.

Table 4. Study I: Pearson within-person correlation coefficients[a] between meal size (MJ) and other meal characteristics (n = 30)

Meal characteristic	All meals	Breakfast	Lunch	Dinner	Snack
Number of others present	0.22 ± 0.32[b]	0.52 ± 0.81[b]	0.25 ± 0.79	0.26 ± 0.79	0.05 ± 0.33
Duration of meal	0.54 ± 0.31[b]	0.64 ± 0.79[b]	0.17 ± 0.84	0.51 ± 0.70[b]	0.44 ± 0.47[b]
Hunger before meal	0.48 ± 0.22[b]	0.29 ± 0.88	0.24 ± 0.79	0.47 ± 0.61[b]	0.04 ± 0.32
Taste	0.11 ± 0.31	0.18 ± 0.84	0.16 ± 0.79	0.39 ± 0.61[b]	0.00 ± 0.35
Atmosphere	0.15 ± 0.22[b]	0.43 ± 0.86	-0.01 ± 0.73	0.30 ± 0.80	0.12 ± 0.28[b]
Difficulty to get more food	-0.18 ± 0.30[b]	-0.33 ± 0.86	-0.07 ± 0.84	-0.02 ± 0.74	-0.07 ± 0.45

Table 5. Study II: Pearson within-person correlation coefficients[a] between meal size (MJ) and selected meal characteristics (n = 20)

Meal characteristic	All meals	Breakfast	Lunch	Dinner	Snack
Number of others present	0.27 ± 0.22[b]	0.26 ± 0.57	0.10 ± 0.49	-0.04 ± 0.45	0.37 ± 0.35[b]
Duration of meal (min)	0.45 ± 0.25[b]	0.55 ± 0.55[b]	0.30 ± 0.68	0.44 ± 0.51[b]	0.60 ± 0.45[b]
Hunger before meal	0.47 ± 0.20[b]	0.48 ± 0.43[b]	0.49 ± 0.54[b]	0.29 ± 0.44[b]	0.08 ± 0.19
Taste	0.26 ± 0.19[b]	0.46 ± 0.39[b]	0.37 ± 0.53[b]	0.18 ± 0.57	0.25 ± 0.25[b]
Atmosphere	0.24 ± 0.15[b]	0.27 ± 0.42[b]	-0.05 ± 0.58	0.28 ± 0.46[b]	0.25 ± 0.21[b]
Difficulty to get more food	-0.09 ± 0.22	-0.27 ± 0.39[b]	-0.01 ± 0.72	0.14 ± 0.42	-0.03 ± 0.36
Intended amount	0.59 ± 0.22[b]	0.49 ± 0.47[b]	0.65 ± 0.60[b]	0.32 ± 0.43[b]	0.34 ± 0.27[b]

[a] Mean ± SD.

[b] Significantly different from zero, $p < 0.05$.

of the meal was positively correlated with the energy consumed at main meals ($r = 0.24$ to 0.47), although the association was only significant for dinner. For snacks, energy intake was not related to hunger before eating the snack ($r = 0.04$, $p > 0.05$). The reduction in hunger after a meal, which is the hunger prior to the meal minus the hunger after the meal, was significantly associated with meal size for all meal types with correlations ranging from 0.32 to 0.61. Taste of the meal was significantly associated with the amount of energy eaten for dinner only ($r = 0.39$, $p < 0.05$). Atmosphere appeared to be associated with meal size for most meals but was only significant for snacks ($r = 0.12$, $p < 0.05$). The effort to get more food was not related to meal size.

Study II

In general, the meal characteristics of Study II were similar to the meal characteristics found in the first study (data not shown). In **Table 5** the mean within-subject Pearson correlations between meal size and other meal characteristics are shown. The magnitude of the correlation coefficients were in general comparable to those of Study I. The standard deviations of the coefficients were considerably lower which is most likely due to the increased number of meal moments per subject. Concerning social facilitation, the mean association between the number of others present and meal size was similar to the correlation found in Study I, but now only the association for snacks was significantly different from zero ($r = 0.37$, SD 0.35). The duration of the meal was again significantly associated with meal size for all meals except for lunch. Atmosphere was significantly related with meal size for all meal types except for lunch. Taste was significantly associated with meal size for all meal types except for dinner, which was just the reverse of the results of Study I.

The amount intended to eat at the meal was on average 4.9 (SD 0.8) on the 1 to 10 scale, and this was exceeded by only 0.2 (SD 0.4) by the self-rated amount eaten as recorded afterwards. The amount intended to eat beforehand and the self-rated amount eaten were significantly correlated, $r = 0.87$ (SD 0.39). The amount intended to eat before the meal was significantly related to the calculated meal size (in MJ), with a mean correlation of 0.59 (SD 0.22). A significant correlation of 0.61 (SD 0.29) was found between the actual meal size (in MJ) and

the self-rated amount eaten. This suggests that the subjects were good in estimating beforehand the size of the meal they would consume, and that their estimation of the meal size was well in accordance with the energy content of the meal.

The number of others present was weakly correlated with the self-rated amount eaten, $r = 0.15$ (SD 0.22) $p<0.05$. The number of others present was weakly correlated with the amount which the subject planned to eat beforehand, $r = 0.13$ (SD 0.23) $p<0.05$, which suggests that to some extent subjects know they will consume more when more others are present. There was not a significant association between the number of others present and the extent to which the intended amount was exceeded, $r = 0.07$ (SD 0.21) $p>0.05$.

Combining the data of study I and II

Putting the data of the two studies together ($n = 50$) gave significant associations between the meal size and most meal characteristics. The correlation between the number of others present and meal size was overall 0.24, and positive for all meal types ($r = 0.19$ for lunch, $r = 0.15$ for dinner), but only significantly for breakfast ($r = 0.40$) and snacks ($r = 0.18$). There were significant associations between meal size and meal duration ($r = 0.51$), hunger ($r = 0.48$), taste ($r = 0.17$), atmosphere ($r = 0.19$) and the difficulty to get more food ($r = -0.14$), respectively. The associations between meal size and meal characteristics were not always significant for all four meal types, but for most meal characteristics the associations were in line for snacks, breakfast, lunch, and dinner. The association between the number of others present and meal size tended to be higher for subjects with a relatively high external eating score (cut-off point score = 3.09). There was not a significant difference ($t(48) = 1.63$, $p = 0.11$), but $r = 0.27$ (SD 0.25) for the subjects with a relatively high external eating score ($n = 26$), compared to $r = 0.16$ (SD 0.23) ($n = 24$) for the others.

Social facilitation mediated by other factors

A mediating factor of the effect of the number of others present on meal size would most probably be related to both meal size and company size. **Table 6**

Table 6. Pearson within-person correlations[a] between the number of others present and meal charateristics

Meal characteristic	All meals	Breakfast	Lunch	Dinner	Snack
Study I (n = 30)					
Duration of meal	0.35 ± 0.35[b]	0.62 ± 0.76[b]	0.46 ± 0.82	0.56 ± 0.83[b]	0.26 ± 0.44[b]
Hunger before meal	0.01 ± 0.29	-0.09 ± 0.68	-0.08 ± 0.66	0.27 ± 0.77	-0.18 ± 0.33[b]
Taste	0.15 ± 0.31[b]	0.51 ± 0.66[b]	-0.20 ± 0.90	0.23 ± 0.83	0.06 ± 0.35
Atmosphere	0.45 ± 0.31[b]	0.68 ± 0.67[b]	0.84 ± 0.74[b]	0.50 ± 0.76[b]	0.53 ± 0.40[b]
Difficulty to get more food	0.10 ± 0.26[b]	-0.13 ± 0.85	-0.24 ± 0.80	0.32 ± 0.62[b]	0.12 ± 0.34
Study II (n = 20)					
Duration of meal	0.47 ± 0.35[b]	0.39 ± 0.54[b]	0.38 ± 0.45[b]	0.42 ± 0.55[b]	0.49 ± 0.39[b]
Hunger before meal	-0.01 ± 0.23	0.11 ± 0.71	-0.01 ± 0.40	-0.13 ± 0.43	-0.09 ± 0.27
Taste	0.19 ± 0.22[b]	0.07 ± 0.64	-0.02 ± 0.51	0.13 ± 0.50	0.26 ± 0.26[b]
Atmosphere	0.45 ± 0.25[b]	0.53 ± 0.56[b]	0.43 ± 0.49[b]	0.38 ± 0.59[b]	0.54 ± 0.26[b]
Difficulty to get more food	0.01 ± 0.21	-0.20 ± 0.53	-0.25 ± 0.49	-0.28 ± 0.33[b]	0.07 ± 0.35
Intended amount	0.13 ± 0.23[b]	-0.01 ± 0.49	0.11 ± 0.51	0.14 ± 0.41	0.11 ± 0.29
Excess eaten[c]	0.07 ± 0.21	-0.09 ± 0.57	0.10 ± 0.63	-0.02 ± 0.34	0.06 ± 0.34

[a] Mean ± SD.

[b] Significantly different from zero, $p < 0.05$.

[c] Excess eaten = eaten amount - intended amount.

shows the associations between the meal characteristics and the number of others present during an eating or drinking moment. It appeared that atmosphere during the meal and the duration of the meal were significantly correlated with the number of others present for most meal types. Hunger feelings, taste of the food, and availability of more food, were not systematically associated with the number of others present. The number of others present at a meal was not related to the amount that the subject intended to eat before the meal, nor was there a significant correlation between the number of others and the amount eaten above the intended amount (=excess eaten).

The variables atmosphere and meal duration are related both to the number of others present and to energy intake and are consequently potential mediating factors of the effect of social facilitation. The structural model that was tested is shown in **Figure 2. Figure 3** shows the results of the path analysis on social facilitation when all meal types are considered together. It shows that social facilitation took place by increasing meal duration. Firstly, with more people present, the meal duration increased (path coefficient = 0.32), and consequently the meal size increased (path coefficient = 0.51). Apart from the direct effect on meal duration, the number of others present exerted an additional effect (0.45 * 0.18 = 0.08) on meal duration via a positive effect on the atmosphere. There was no direct influence of the number of others on energy intake (path coefficient = 0.04, ns), and no influence from atmosphere on energy intake (path coefficient = 0.03, ns). This model had an adjusted goodness of fit of 0.994 and explained 28% of the variance, with a chi-square of 0.12 (2 df).

None of the other factors that have been assessed in this study, such as hunger, taste, and availability of more food, served as a mediating factor between the number of others present and meal size. The path back from energy intake to meal duration was never significantly contributing to the model, so meal duration positively influences meal size, but meal size does not significantly influence meal duration.

Overall, the path between atmosphere and meal duration was of borderline significance, with a path coefficient of 0.18 and a t-value of 1.2 (n=50). The value of this path coefficient was positive for all meal types, but only statistically significant for dinner; the path coefficients were 0.56, 0.25, 0.15 and 0.10 for dinner, breakfast, snacks, and lunch, respectively. Omitting the path between

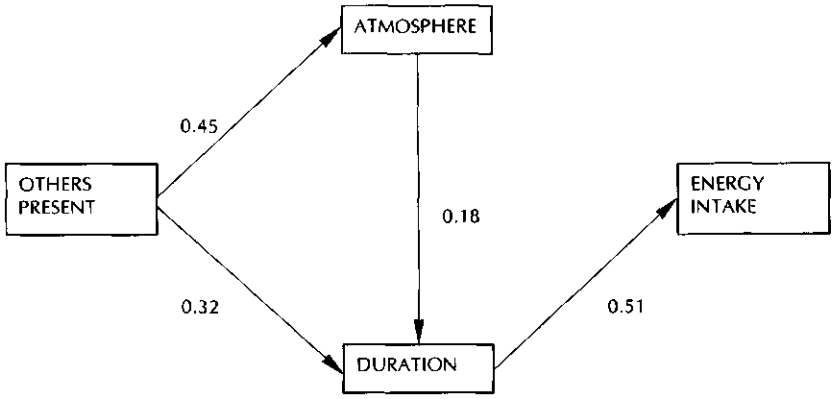

Figure 3. Model of social facilitation of food intake with standardized path coefficients (n = 50)

atmosphere and meal duration would give a model with an adjusted goodness of fit index of 0.948, a chi-square of 1.58 (3 df) and 31% explained variance.

In general, the path analyses for the meal types separately confirmed the existence of the main route of social facilitation of energy intake by increased meal duration. For the separate meal types, path coefficients varied from 0.45 to 0.70 between number of others and atmosphere, from 0.26 to 0.52 between number of others and meal duration, and from 0.48 to 0.61 from meal duration to energy intake. For lunches, the paths were somewhat different, as the path between atmosphere and energy intake which did not appear to be important in any other analyses, was significant here (path coefficient = 0.19) and the path between duration and energy intake did not significantly contribute to the fit of the model.

DISCUSSION

The most important result of this study was that social facilitation of spontaneous meal size in these young Dutch adults was not a direct effect of the number of

others present on the amount of energy consumed with the meal, but an indirect effect mediated by meal duration. In both Study I and Study II the duration of the meal and the atmosphere during the meal were associated with meal size and with the number of others present. This led to analyzing social facilitation data in a new way, using path analysis. The path model supports the existence of social facilitation of meal size by extending meal duration, which was partly due to a more sociable atmosphere. The intermediate function of meal duration in social facilitation means that the subjects of this sample spent more time eating and drinking when more others were present and consequently ate more. Hunger, taste and availability of the food did not play a role as an intermediate in social facilitation; with more others present the subjects were not hungrier, the food did not taste better, and there was not more food available.

In this study, the most important variables in determining meal size were hunger and meal duration. Part of the effect of meal duration on meal size was caused by the number of others present at a meal. Taste, atmosphere and food availability were less important in determining meal size, which might be due to the small variance in these variables in this sample; these free-living young subjects, predominantly students sharing a household with others, ate in general the food they liked, in a sociable atmosphere and had no strong limitations in food availability.

These subjects seemed to be well able to estimate the relative size of their meals. The similarity of the average amount intended to eat and the amount eaten, and the small but significant association between the number of others and intended meal size suggests that the subjects expected at least to some extent to eat more when they ate with a larger number of others. The presence of others did not lead to exceeding the amount the subject intended to eat beforehand. This suggests that social facilitation might be, at least partly, a conscious and anticipated effect. However, it is possible that the subjects' rating of the amount eaten, recorded when a meal was finished, was influenced by their rating of the amount intended to eat, recorded at the start of the meal. Further, social facilitation of food intake might be a stronger effect for subjects who were more influenced by external stimuli, as indicated by their external eating score.

The magnitude of the correlation coefficient between the number of others and meal size in this study, on average 0.24, was not as high as the observations

of de Castro, who found significant associations of at least 0.3 for all meal types, resulting in social facilitation being a factor at least as powerful as hunger in determining meal size [4,7,20]. The relatively low magnitude of the correlation could not be due to differences in data collection, because our diary and instructions were made according to those of de Castro. Food consumption of the subjects at various eating moments was in line with observations of the eating companion. Energy intake was in accordance with those of comparable subjects in the Dutch Food Consumption Survey 1992 [21], and energy requirements [22]. The correlational analysis was carried out in the same way as described by de Castro. A low association could not be due to a lack of variation in the size of the company with whom a meal was shared. The variation in the number of others present was at least as large as in the de Castro studies [3], with a mean number of others present at a meal moment of 2.5 (SD 1.8) in Study I and 2.1 (SD 1.0) in Study II. De Castro reported a larger social influence of family and friends, compared to other persons [20], and Shide and Rolls reported social facilitation of dinner size when comparing eating alone versus eating with friends, but not with strangers [5]. As our subjects rarely ate with strangers, and shared most of their meals with partner, family, friends and housemates, the type of eating companion was not expected to cause the relatively low correlation between the number of others present and meal size.

The relatively low association between the number of others and meal size could emerge from a difference between our Dutch sample and de Castro's American sample. Our sample consisted of young Dutch adults, with a mean age of 22 years (SD 2), whereas the subjects in the de Castro studies are Americans with a mean age of 42 (SD 14) years old [20]. The living situation of our Dutch subjects, mostly students sharing a household with a number of others, may be different from the group of subjects studied in the United States. The results per meal type may differ from the results of other studies due to the meal type definition. In the current study the subjects recorded the meal type themselves whereas de Castro coded the meal types according to the time period in which they occurred [3]. Last but not least, the possibility of a cultural difference cannot be excluded.

The path analyses showed that social facilitation of energy intake was mediated by meal duration. Although the positive correlation between the number

of others present and meal size was not statistically significant for all meal types, the influence of the social environment would not be expected to differ between meal types. This was confirmed by the results of the path model which was in general in line for all meal types. The fact that there was no statistically significant path "back" from energy intake to meal duration strongly supports the order of the variables in the model as shown in **Figure 3**; the number of others influences meal duration and this consequently affects energy intake. The model confirms the findings of de Castro that meal duration increased when meals were eaten socially[4] with a different statistical method. Social facilitation of food intake may happen due to social interaction, which leads to an extension of the duration of the meal and consequently to an increase in food consumption.

Social facilitation played a role in determining meal size in this group of young Dutch adults by extending meal duration. The meal based approach using food diaries leads to interesting associations between meal characteristics and food intake and is worth further exploration. Future research should give attention to who shows social facilitation and who does not show social facilitation. Not merely the presence of others and their number should be the focus, but who the others are, and what they do during the meal needs further investigation. To investigate whether cultural effects play a role, data should be gathered in a range of countries, in several age and sex subgroups. More attention in research on social facilitation should be given to the role of communication during a meal moment, and also to the role of atmosphere during a meal. The type of food consumed related to social facilitation may reveal interesting patterns.

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8

General discussion

This thesis described several studies of which the main goal was the quantification of social influences on fat intake. The influences of the social environment were restricted to those exerted by family members, close friends, and meal time companions. Social influences on nutrition behaviour were studied using both quantitative and qualitative methods. First, the main findings are described, and thereafter the findings are put into perspective: what is the impact of the social environment on fat intake, and who is influencing who? Then, the methodology used in these studies is discussed. Finally, recommendations for further research and implications for nutrition education and policy are formulated.

MAIN FINDINGS

The social environment had an important impact on eating behaviour, explaining up to 40% of the variance in fat intake. The concepts subjective norm, modelling behaviour, and social facilitation, explained some variance in dietary intake, with a maximum of 6% for modelling. Associations in fat intake within nuclear families were largest between spouses and between siblings. Parent-child associations in fat intake were similar for children of a wide range of ages. Social influences were embedded in family food rules and habits, and interacted with other determinants of food choice.

INFLUENCES OF THE SOCIAL ENVIRONMENT ON FAT INTAKE IN PERSPECTIVE

What is the impact of the social environment on dietary intake?

The impact of social influences in determining food or fat intake can be answered by estimating the amount of variance of dietary intake that these influences explain.

I. Resemblance in intakes

The maximum amount of variance that the social environment could explain, was derived from resemblances in intakes of family members and friends, which is expected to be a result of a range of social influences: up to 40% of the fat intake

could be explained by what another family member consumed (**Chapter 4** and **Chapter 5**).

We found a moderate to high resemblance in 2-day fat intake within nuclear families in the Netherlands in the sample of the Dutch National Food Consumption Surveys of 1987/1988 and 1992. Pearson correlations for fat intake (percent of energy intake, En%) were highest between spouses and between siblings ($r = 0.50$ to 0.60). The associations between the fat intake (En%) of parents and children was around 0.40, and appeared to be surprisingly similar for children of all ages. Within nuclear families, associations were strong for foods eaten at home and weak for foods eaten elsewhere (**Chapter 4**).

The results of the unique network study on food habits, including nuclear family members and friends, showed that within the nuclear families the consumption of most food items in the past four weeks was significantly correlated. This resemblance in food intake resulted in moderate but significant associations in fat intake (En%) between parents ($r = 0.30$), and between the 15 year old adolescents and their mothers ($r = 0.19$), and fathers ($r = 0.18$). For both adolescent friends and adult friends, consumption of some foods was significantly correlated, but fat intake was not. Frequency of eating meals together was not clearly related to resemblance in fat intake within the social network (**Chapter 5**).

The results from our studies on resemblance in dietary intake within nuclear families (**Chapters 4** and **5**) are similar in that significant associations in fat intake were found within the nuclear family; the spouse-spouse association was higher than the parent-child association, and no clear gender differences in resemblances were detected. Associations within the nuclear families that have been found in our studies are within the range of those reported in the literature [1-7].

Across cultures, resemblance within social networks might be higher, because in the current samples the range in fat intake was limited. We cannot assume that all resemblance found is due to influences of the social environment. Other factors might also have caused some resemblance: e.g. spouse selection [8], and genetic influences [2,9].

Two concepts from socio-psychological theories, the *subjective norm* and *modelling*, were applied to quantify specific types of social influences on the fat intake of adolescents ($n = 122$) (**Chapter 6**).

II. Subjective norm

The subjective norm, which reflects the perceived pressure of significant others, explained on average only 1% of the variance of the fat intake of adolescent, whereas attitudes towards fat intake explained 15%. Path analysis suggested that the subjective norm exerted its influence on fat intake in adolescents via attitudes towards fat intake. The subjective norm did not directly influence fat intake in adolescents (n = 122), but it modified attitudes towards fat intake in a negative way (path coefficient = -0.25): the more pressure the adolescents felt to consume a low-fat diet, the less likely it was that they complied. This might be explained by (pretended) opposing behaviour, or it might be that adolescents only perceive or evoke pressure from their environment when they have a high-fat diet (**Chapter 6**).

This interrelationship between attitudes and subjective norm illustrates how the influences of the social environment are embedded within other determinants of food intake, confirming the difficulties we expected in the quantification of social influences on food intake. Further evidence was found in the qualitative work, in which statements were made about the interrelationships between the social environment and time constraints, finances, food availability, and hunger (**Chapter 5**).

III. Modelling

Modelling refers to the imitation of behaviour of others considered to be rewarding, and it appeared to act positively on fat intake of adolescents: the mother was the main person who determined the fat intake of the adolescent (path coefficient = 0.25). In contrast, the adolescents estimated their fat intake to be more in agreement with their father's fat intake (path coefficient = 0.55). Altogether, mother's fat intake explained 6% of the variance of the fat intake of the adolescent son or daughter, and father's fat intake did not predict the fat intake of the child when mother's fat intake was in the model. Perceived fat intake was weakly related to fat intake calculated from a food frequency questionnaire. Surprisingly, father's fat intake as perceived by the adolescent explained 30% of the adolescent's perceived fat intake, and mother's fat intake as perceived by the adolescent explained only 3%.

IV. Effect of meal companions

Social facilitation was not studied especially for the effects on fat intake. Social facilitation affected food intake significantly in a group of young adults: the number of other people present explained about 5% of the energy intake of a meal occasion (**Chapter 7**). In this group the positive effect of the presence of others on energy intake was comparable to the impact of the taste of the food and the pleasantness of the atmosphere, but smaller than the impact of hunger and total impact of meal duration.

Overall, the impact of the social environment is expected to explain up to 40% of fat intake.

Influences within social networks: who is influencing who and how?

Part of the resemblance found is expected to be due to the cohabitional effect [10]: a shared family environment and shared food availability limits food choices and therefore is expected to lead to resemblance in intake. The influences that family members and peers have on each others eating behaviour are multidirectional. Within families it is assumed that parents have a greater impact on their children's diet than vice versa [11]. In a group young Dutch women, most of them reported that they adopted nutritional habits from their mother, while only one quarter of the group thought that they had influenced their mother's dietary habits [12]. This was confirmed by the focus group and family discussions that we performed: the general pattern was that parents set the rules and did take wishes and preferences of their children into account.

Associations within nuclear families in fat intake were similar for mother-child and father-child pairs. However, fathers appeared less influential:

(i) In the sample of the Dutch National Food Consumption Survey (**Chapter 4**), a very weak father-child association in fat intake was present for foods consumed out of the house. Further, no significant father-daughter association in fat intake was present when one of the parents followed a therapeutic diet.

(ii) Fathers, on average, prepared meals and bought foods far less often than mothers. However, no responsibility for food selection and preparation does not necessarily mean no influence on food intake. But, from the focus group and family interviews it appeared that fathers were not strongly involved even when they

prepared or bought foods: their wives often made shopping lists for them, and cooking did not necessarily involve deciding what was prepared.
(iii) Structural models that were used to predict fat intake of adolescents revealed that the mother's fat intake had a stronger influence than fat intakes of the father and the best friend (**Chapter 6**).

Altogether, these findings suggested the father-child resemblance was more a result of their mutual resemblance to mother's dietary intake. One of the intriguing findings of Chapter 6 was that adolescents, boys and girls, estimated their fat intake closer to their fathers fat intake than to their mother's intake.

Social facilitation is the described as the effect of the sheer presence of meal companions. Social facilitation of food intake was shown to be mediated by meal duration in a sample of 50 young Dutch adults, using path analysis on observational data (**Chapter 7**). An association of 0.24 between energy intake and the number of meal companions was found. When more people were sharing a meal, an eating episode took longer, and more food was consumed. This confirms the mediation of social facilitation by meal duration which de Castro suggested on the basis of correlational evidence [13].

METHODOLOGICAL CONSIDERATIONS

Dietary assessment methods

Food frequency questionnaire. The food frequency questionnaire described in **Chapter 2** and **Chapter 3**, was considered acceptable to classify subjects according to intake of energy, fats, and cholesterol. Validation studies using the dietary history method as a reference were carried out in different age groups. The relative validity compared to the dietary history was highest for elderly people, and lowest for the adolescents. Intakes assessed by the food frequency questionnaire were, in general, higher than those estimated with the dietary history, especially for adolescents (**Table 1**). These differences are suggested to be related to the stability and simplicity of the diets of the elderly, and the sometimes restricted knowledge of adolescents concerning the types of foods they consumed.

Table 1. Relative validity of a food frequency questionnaire (FFQ) assessing intakes of energy, fats and cholesterol. Comparison results of FFQ with results of dietary history (DH) for adolescents, adults and elderly

	Adolescents (n = 77)		Adults (n = 191)		Elderly (n = 51)	
	r[a]	Diff[b] (%)	r	Diff (%)	r	Diff (%)
Energy (MJ)	0.59	14	0.83	5	0.83	5
Fatty acids (g)						
Total	0.52	40	0.78	13	0.82	7
Saturated fat	0.61	32	0.75	12	0.81	4
Monounsaturated	0.52	33	0.78	11	0.84	4
Polyunsaturated	0.42	73	0.61	24	0.84	19
Cholesterol (mg)	0.47	26	0.65	6	0.82	10
Fatty acids (En%)						
Total	0.29	21	0.65	7	0.72	3
Saturated	0.51	15	0.65	6	0.77	0
Monounsaturated	0.44	15	0.69	5	0.72	-1
Polyunsaturated	0.41	47	0.41	18	0.87	14

[a] *Pearson correlation coefficient* ($p < = 0.001$).

[b] Diff (%) = FFQ-DH/DH * 100.

No marker for total fat intake is available [14], but the validation with two biological marker of fatty acid intake enabled us to compare the dietary history and the food frequency questionnaire with an external criterion (**Chapter 2**).

Collecting the food frequency data in the network study (**Chapter 5 and 6**) differed slightly from the administration in the validity and reproducibility studies (**Chapter 2 and 3**). In the methodological studies, in order to have the situation comparable to a consultation with a dietician, the questionnaire was interviewer administered and subjects were not allowed to check brands etc. In the network study the questionnaires were self-administered. Subjects were asked to fill out the questionnaires independently, but to ask the person who was responsible for meal preparation for advice on e.g. the types of meat that were consumed. On one hand, we had less control over how the questionnaire was filled out, whether frequencies were put in the right (day/week/month) columns, but on the other

hand, people had the opportunity to check some brands etc. which was expected to improve the quality of the data.

Difference in resemblance in fat intake within nuclear families in two separate studies

The resemblance in 2-day fat intake between spouses and between parents and children that we found in the Dutch National Food Consumption Survey, (**Chapter 4**) was considerably higher than the resemblance in the families of the network study, in which fat intake of the past month was assessed by the food frequency questionnaire (**Chapter 5,6**). Major factors contributing to this were considered to be the difference in sample, and more strongly, the difference in dietary assessment methodology.

Sample

The data presented in **Chapter 4** are from an existing panel, a stratified probability sample of the Dutch population. The network study (**Chapter 5**) was carried out in a sample derived from 5 schools from all over the Netherlands, and had a reasonable response rate. The variation in intakes was similar for both studies, and therefore is not expected to cause the differences in correlations.

Dietary assessment methods

In the Dutch National Food Consumption Survey (DNFCS) a 2-day diet record was kept by all members of the household, and one subject recorded all foods that the household members consumed at home. In the network study the food frequency questionnaire referred to the intake of the last month. Differences in the dietary assessment methods that might have affected the resemblances in intakes within family are:

(i) Who filled out the questionnaire, or record?

In the DNFCS an important part of the foods was recorded by one member of the family, which is expected to give a higher resemblance than when everyone fills out his/her own questionnaire, as in the network study.

(ii) Different reference period

A method referring to a longer time-span is expected to be less affected by day-to-

day variation in food intake. On the other hand, we realise that the 28 day reference period is far beyond what can be reached with a food frequency questionnaire which has an error structure different from that of diet records [15]. The random error associated with food frequency questionnaires is considerable, and for our questionnaire probably comparable to 5 to 10 days of diet records if the attenuation coefficient for fat intake (en%) is about 0.84 [16].

(iii) Same or different moment of intake assessment for the family members

In the DNFCS the subjects recorded their food intake on exactly the same days. In the network study subjects within one family may have filled out the questionnaire with up to a few weeks time difference, making the reference period dissimilar, which could have led to a decrease of observed correlations in the network study.

Operationalisation of fat intake and determinants of fat intake

Fat intake

Our main outcome variable was fat intake, expressed as % of energy intake. We preferred this measure to fat intake in grams or a score based on the absolute intake, both of which ignore the differences in fat intake due to differences in energy intake. Attitudes, norms, etcetera were concentrated on total fat intake. We realise that saturated fat intake is more important than total fat intake for coronary heart disease risk, but it was not suitable for use in questions on the socio-psychological determinants. However, most foods that are high in saturated fat are also high in total fat, which led us to assume that this simplification did not strongly affect the results.

Attitudes towards fat

The attitude score was calculated from the difference in attitudes between full fat foods and their low-fat alternatives, and predicted fat intake very well. In real life, cross-food group choices may complicate the process of food choice. People do choose between full and low-fat alternatives, but also choose between completely different foods, or even between eating something or eating nothing.

Subjective norm

People eat foods, they do not eat fat, therefore the determinants have to be based

on the intake of foods whenever possible. For the subjective norm we did not incorporate questions on the level of foods, because subjects in an earlier study did not like these questions at all [17]. We assumed that the question on aggregate level, "People that are important to me think that I should eat a low-fat diet", would be better accepted than questions on food level such as "People that are important to me think that I should drink low-fat milk". This assumption appeared to be correct.

Statistical analysis

Measuring resemblance or association in intakes

Resemblance in intake refers to linear association and similarity in level. The simple correlation coefficients which we used reflect only linear association in intakes. An alternative for assessing resemblance in continuous data and taking the level of intake into account, would be the intraclass correlation coefficient. However, when the level of fat intake in the groups is similar, the outcome of these correlation coefficients is similar.

The size of the correlations within social networks depends on the resemblance in intakes, but also on the variability of the measurement and the range of intakes in the sample. Cross-cultural samples with a wider range in intakes would therefore be likely to yield higher correlations. As has been discussed earlier, a cross-cultural study also has conceptual advantages.

Lisrel path analyses

The path analysis used in **Chapter 6** and **Chapter 7** is an interesting and relatively new method to evaluate and explain behaviour. It is important that path analyses are based on a theory, to be able to interpret the results adequately [18]. A path analysis on observational data cannot in itself prove a causal effect, but can establish the effects as more or less reasonable, relative to other specifications.

CHANGING FAT INTAKE

For nutrition education, marketeers, and policy makers, the main findings of this

thesis is that social influence should be taken into account when aiming to alter food intake. In addition, when the main focus is on other determinants, it should be realised that these might also be influenced by the social environment.

In the Netherlands, the majority of people are not likely to respond to campaigns aiming to reduce fat intake which give suggestions as to how to make the reduction: either they do not think that they consume too much fat, or they think they ate too much fat in the past but have made favourable changes [19-21]. Similar findings come from the UK where people's attitudes are favourable towards consuming a low-fat diet, but their dietary fat intake is still above recommendations [22,23]. Research focusing on how to motivate people to change their fat intake, has recently acknowledged the relevance of the process that people go through when they make dietary changes, as described by the Stages of Change Theory [24]. Subjects who are in precontemplation, and never thought about reducing fat intake, need input other than people who are trying to maintain a low-fat diet. The change process requires nutrition education tailored according to the stage of change of a subject. For the majority of people, creating an awareness of their own fat intake would be the most appropriate intervention, rather than giving specific advice about how to lower fat intake, and motivation to adhere to a low-fat diet. In the Netherlands, using the VET Expres computer programme which is based on the food frequency questionnaire described in Chapter 2 and 3 could be useful. It gives an estimate of the fat, fatty acid, cholesterol and energy content in their diet of an individual and shows which foods or food groups are the main contributors to fat intake [25,26]. The interactive mode of the programme enables subjects to visualise the effect of replacement of high-fat foods by low-fat foods, so that subjects can decide themselves which changes they want to make, depending on their own priorities.

Social influences are considered to be important at all stages of dietary change, but especially at the later stages when people take action and try to maintain their dietary changes [27]. It might be that fathers who are changing their dietary intake might lead in a spin-off in their families. On one hand, fathers do not appear to be too much involved or influential, but results of **Chapter 6** suggest hidden forces, because of the perceived resemblance in fat intake of children and their fathers. This topic has to be further explored.

RECOMMENDATIONS FOR FUTURE RESEARCH

Future research on dietary assessment methods

Development of methods

Food frequency questionnaires were first developed in the 1960's, and they are currently the main tool used to assess food intake in nutritional epidemiology. Careful evaluation of these instruments is more needed than ever. A problem in validating food consumption methods is that there is no gold standard available, which leaves us having to "calibrate" using a method which is expected to give a reasonable estimate of intake. Validation studies testing more than one questionnaire [28], and include biological marker(s) as external criteria are considered most appropriate [14]. Reproducibility studies should be carried out with validation studies: an assessment which is not reproducible cannot be expected to give a valid estimate.

Looking for the "gold standard" has been given less attention in the past years. It is acknowledged that we will never be able to assess dietary intake without errors, but it is very important to obtain insight into the error structure [15,29]. In the past year, there has been some discussion on the improvement of the uniformity in presentation of validation studies [30-32].

The work of Kaaks et al. may give a new dimension to validation studies: they showed that a truly valid reference measurement is not needed to assess the validity of a method using structural equation models [33]. This illustrates that adapting innovative statistical methods gives new dimensions to validity studies.

Use of food frequency questionnaires

Users of food frequency questionnaires need to carefully select a questionnaire that suits their purposes. For example, very short questionnaires which can be telephone administered [34,35] appeared to give acceptable results in ranking individuals according to fat intake. When an estimation of percentage of fat in the diet is needed, or when a small change in fat intake has to be picked up, or a larger change in a small group, more elaborate methods are needed. Methods assessing fat intake of the past 24 hours which are used in nutrition education campaigns to make people aware of their fat intake have limited value considering the day-to-day

variation of fat intake [36,37].

Social influences as determinant of fat intake

Our studies focusing on the impact of social environment on food choice yielded interesting results, but this relatively new area needs to be explored further. Confirmation of our results is needed before we can generalise our findings. More knowledge on the influences of the social environment will improve predictions of dietary behaviour and dietary change.

In surveys, the subjective norm and questions on modelling might not give what we expect them to measure. Socio-psychological theories use overall concepts, referring to what people "usually" think (attitude) or would do (intentions). However, the impact of the social environment might be especially large at unexpected occasions [38]. Concepts that give a better estimations of social influences have to be situation specific. A questionnaire can be developed based on qualitative research, and evaluated with confirmative factor analysis.

Sample

Studies of social influences should be carried out in a range of groups: people living alone or with others; couples without children; elderly people living independently or in institutions. The influence of friends can be further explored focusing on the peer group as a whole instead of just the best friend. Cross-cultural studies, using similarly developed questionnaires, will improve the understanding of social influences.

Interventions

Influences of the social environment cannot be extracted fully, so it is best to do look at changes in food intake, or changes in social environment. Spontaneous changes in the social environment can serve as "natural experiments" e.g. when children leave the parental home; when people start to live together; when people are temporarily not living together; and will give an impression of how dietary intake is affected.

IN CONCLUSION

The influences of the social environment have been shown to be potentially powerful determinants of dietary intake. Social influences were interrelated with other determinants, and specific concepts only quantified a part of the influences. Future research should focus on the role of social environment plays in dietary change. Interventions targeting at nuclear families are expected to be more effective than interventions concentrating on peers.

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SUMMARY

This thesis described studies which assessed the impact of the social environment on food intake, using both quantitative and qualitative methods. The main goal was the quantification of social influences on fat intake. Social influences on food intake were defined as all influences that one or more subjects had on the eating behaviour of others, either direct or indirect, conscious or subconscious. Difficulties in quantifying social influences on food intake were the diversity of these influences in character and in time frame, the infeasibility of extracting social influences, and the unawareness of people regarding these influences.

Firstly, a food frequency questionnaire to assess the intake of fats and cholesterol was developed, on the basis of data of the Dutch National Food Consumption Survey. Subjects were asked to recall the consumption of 104 items during the past four weeks. The relative validity of this food frequency questionnaire was tested against the dietary history of 191 men and women for the intake of energy, total fat, saturated, monounsaturated and polyunsaturated fatty acids, and cholesterol. Pearson correlation coefficients between intakes assessed by the two methods, ranged from 0.38 for linoleic acid (% of energy) to 0.83 for energy intake. Mean intakes of energy and nutrients were overestimated by the food frequency questionnaire relative to the dietary history by 5% to 30%. Using linoleic acid concentrations in erythrocytes and adipose tissue as biological markers of dietary intake, the food frequency questionnaire and the dietary history appeared comparable in their ability to rank individuals according to linoleic acid intake (Chapter 2). The reproducibility of the food frequency questionnaire was assessed in a group of 93 men and women. The mean difference in average nutrient intake between two assessments 8 weeks apart was small, with a maximum of 5% for cholesterol intake, but the variance of individual differences was considerable. Pearson correlation coefficients between two assessments 8 weeks apart ranged from 0.71 for polyunsaturated fatty acid intake (when expressed as % of energy intake) up to 0.91 for energy intake. The reproducibility was similar in males and females. Items that were consumed frequently had a high reproducibility, whereas items that were consumed infrequently had a poor reproducibility (Chapter 3). On the basis of results from studies of validity and

reproducibility (Chapters 2 and 3), the food frequency questionnaire was considered to be a suitable tool to estimate and monitor the intake of energy, fat, fatty acids and cholesterol.

Studies on the impact of the social environment on dietary intake focused either on influences on the long-term or habitual dietary intake (Chapter 4,5,6), or influences on the short-term i.e. influences exerted during a meal (Chapter 5 and 7). The social environment studied was restricted to family members, close friends, and meal time companions. Up to 40% of the variance of the fat intake could be explained by influences of the social environment. The maximum value of 40% was obtained from the resemblance in fat intake within nuclear families. Specific influences of the social environment, subjective norm, modelling, and social facilitation, were quantified and appeared to explain between 1% and 6% of the variance in dietary intake in specific groups. The total impact of the social environment on dietary intake does not have to equal the total of the specific effects, because the concepts may overlap.

To assess resemblance in fat intake in social network in the Netherlands, two studies were carried out: one with food consumption data of nuclear families participating in the Dutch National Food Consumption Survey, the other with data of social networks including nuclear family members and friends. A moderate to high resemblance was found in two-day fat intake within a sample of 1077 nuclear families in the Netherlands, who participated in the 1992 Dutch National Food Consumption Survey. Pearson correlations for fat intake (percent of energy intake, En%) were highest between spouses ($r = 0.54$) and between siblings ($r = 0.65$). The associations between parents and children for the fat intake (En%) ranged between 0.37 and 0.44, and appeared to be surprisingly similar for children of all ages. Within the nuclear families associations were strong for foods eaten at home and weak for foods eaten elsewhere. No clear gender differences in fat intake resemblance were detected. Reported adherence to a therapeutic diet by one of the parents did not erase within-family intake correlations, suggesting that family resemblance is a dynamic phenomenon. Results were replicated in the dataset of the Dutch National Food Consumption Survey of 1987/1988, which included 1052 households (Chapter 4). A subsequent study explored the influence of nuclear family members on food intake, and also the influence of best friends. Fat consumption was assessed by the food frequency questionnaire (Chapter 2 and 3)

in 361 social networks consisting of 15 year old adolescents (n = 347); their mothers (n = 309); their fathers (n = 270); their best friends (n = 240); the best friends of mothers (n = 79), and best friends of fathers (n = 29). Ten family interviews and four focus group interviews were carried out in a sub sample to interpret the quantitative work. The consumption of most food items in the past four weeks was significantly correlated within the nuclear families. This resemblance in food intake resulted in moderate but significant associations in fat intake (En%) between the parents (r = 0.30), between the 15 year old adolescents and their mothers (r = 0.19), and these adolescents and their fathers (r = 0.18). No significant correlations for fat intake were found between friends, but the consumption of specific foods was related. Frequency of eating meals together was not clearly related to resemblance in fat intake within the social network (Chapter 5). The qualitative work revealed that food habits were embedded in family food rules, and interacted with other determinants. Altogether, both in the sample of the Dutch National Food Consumption Survey (Chapter 4), and in the network study (Chapter 5) significant associations were found within the nuclear family; the association in fat intake was higher for spouses than for parents and children, and no clear gender differences in resemblance were found. Best friends did not seem to be very influential in affecting fat intake of adolescents and adults.

In Chapter 6, social influences on the fat intake of the adolescents were quantified using path analyses. The subjective norm, which assessed pressure from the social environment (Theory of Reasoned Action) explained 1% of the variance in fat intake, and modelling behaviour (Social Cognitive Theory) explained 6% of the variance in fat intake in adolescents. The subjective norm concept appeared to influence fat intake of adolescents by negatively influencing attitudes towards fat (path coefficient = -0.25), suggesting either that adolescents opposed against pressure from their environment or that they only perceived pressure from the social environment when they consumed a high fat diet. Fat intake of mother explained more of the fat intake of adolescents than fat intake of the father and the best friend. Quantifying social influences on perceived fat intake gave different results than quantifying social influences on "actual" fat intake as derived from the food frequency questionnaire. Models yielded similar results for boys and girls.

The number of others present increased spontaneous meal size (r = 0.24) in 50 free-living young males and females. Subjects recorded food consumption,

number of others present, hunger, taste of the food, food availability, and atmosphere at each eating or drinking moment for four (n = 30) or seven consecutive days (n = 20). A path analysis showed no direct effect of the number of others on meal size, but revealed that social facilitation of spontaneous meal size was mediated by meal duration. With more people present, a meal moment takes longer, and consequently people eat more. Hunger, taste of the food, and food availability were not involved in social facilitation (Chapter 7).

In conclusion, it appeared that the impact of the social environment is considerable, explaining up to 40% of the variance in fat intake. The concepts subjective norm, modelling, and social facilitation each explain part of this variance. Future research should concentrate on the mechanisms of social influences on dietary intake, for example by studying changes in dietary intake due to alterations in the social environment.

SAMENVATTING

De studies in dit proefschrift beschrijven de invloed van de sociale omgeving op eetgedrag. In dit onderzoek zijn zowel kwalitatieve als kwantitatieve methoden gebruikt. Het belangrijkste doel was het kwantificeren van de invloeden van de omgeving op de vetinneming. Sociale invloeden op het voedingsgedrag zijn gedefinieerd als invloeden die een of meer individuen hebben op het eetgedrag van anderen, direct of indirect, bewust of onbewust. Een probleem bij het kwantificeren van invloeden van de sociale omgeving op het voedingsgedrag is dat deze invloeden verschillen in aard en in het tijdsbestek waarin ze van invloed zijn. Verder is het vrijwel onmogelijk om sociale invloeden van de omgeving te isoleren en zijn mensen zich niet altijd van deze invloeden bewust.

Een voedselfrequentievragenlijst om de inneming van vet en cholesterol vast te stellen werd ontwikkeld met behulp van gegevens van de Nederlandse Voedselconsumptiepeiling. Deelnemers gaven aan hoe vaak ze de 104 voedingsmiddelen van de vragenlijst in de laatste vier weken hadden gegeten. De relatieve validiteit van deze voedingsvragenlijst om de inneming van energie, totaal vet, verzadigd, enkelvoudig en meervoudig onverzadigde vetzuren en cholesterol vast te stellen, is bepaald door de resultaten te vergelijken met die van een dietary history interview bij 191 volwassen mannen en vrouwen. Pearson correlatie-coëfficiënten tussen de inneming verkregen met de twee methoden varieerden van 0.38 voor energiepercentage linolzuur tot 0.83 voor energie-inneming. De voedselfrequentiemethode overschatte de inneming van energie en nutriënten, vergeleken met de dietary history, tussen 5 en 30%. Het linolzuurgehalte in rode bloedcellen en onderhuids vetweefsel werd gebruikt als biologische merker van de vetzuurinneming. De voedselfrequentievragenlijst en de dietary history bleken vergelijkbaar in hun vermogen om individuen te ordenen naar linolzuurinneming (Hoofdstuk 2). De reproduceerbaarheid van de voedselfrequentievragenlijst is bepaald in een groep van 93 mannen en vrouwen. Er was een klein verschil in de gemiddelde innemingen zoals geschat door de eerste meting en tweede meting 8 weken later, met een maximum van 5% voor cholesterolinneming, maar de variantie van individuele verschillen was aanzienlijk. Pearson correlatiecoëfficiënten tussen de herhaalde metingen varieerden van 0.71 voor meervoudig onverzadigd vet, uitgedrukt als % van de energie-inneming, tot 0.91 voor energie-inneming. De

reproduceerbaarheid was niet verschillend voor mannen en vrouwen. Vaak gegeten voedingsmiddelen waren goed reproduceerbaar en weinig gegeten voedingsmiddelen waren slecht reproduceerbaar (Hoofdstuk 3). Op basis van de resultaten van de studies naar validiteit en reproduceerbaarheid werd de voedselfrequentievragenlijst geschikt bevonden om de inneming van energie, vet, vetzuren en cholesterol vast te stellen en deze in de tijd te volgen.

De studies naar de invloed van de sociale omgeving op het voedingsgedrag waren gericht op langere (Hoofdstukken 4,5 en 6) of op kortere termijn invloeden (Hoofdstukken 5 en 7). De sociale omgeving was beperkt tot gezinsleden, goede vrienden en disgenoten. Tot 40% van de variantie in de vetinneming kon verklaard worden door invloeden vanuit de sociale omgeving. Deze maximumwaarde van 40% is gebaseerd op de overeenkomst in vetinneming tussen gezinsleden. Specifieke invloeden van de sociale omgeving, zoals subjectieve norm (druk van omgeving op eetgedrag), 'modelling' (observatie eetgedrag van anderen) en 'social facilitation' (bevordering van eetgedrag door aanwezigheid van anderen), werden gekwantificeerd en bleken 1% tot 6% van de variantie in voedselinneming voor specifieke groepen te verklaren. De totale invloed van de sociale omgeving op voedingsgedrag kan niet gezien worden als de som van deze specifieke effecten, aangezien ze mogelijk overlap vertonen.

De samenhang in vetinneming in sociale netwerken is vastgesteld bij twee groepen: gezinnen die deelnamen aan de Nederlandse Voedselconsumptiepeilingen en sociale netwerken bestaande uit gezinsleden en vrienden. Een matige tot grote samenhang werd gevonden vetconsumptie in een steekproef van 1077 Nederlandse gezinnen die deelnamen aan de Nederlandse Voedselconsumptiepeiling van 1992. Vetinneming was bepaald met een twee-daagse opschrijfmethode. Pearson correlaties voor het energiepercentage vet in de voeding gaven aan dat de samenhang het hoogst was tussen ouders ($r = 0.54$) en tussen broers en zussen ($r = 0.65$). De samenhang in energiepercentage vet in de voeding tussen ouders en kinderen varieerde van 0.37 tot 0.44 en verschilde weinig voor jongere en oudere kinderen. De samenhang in vetinneming was niet verschillend voor beide geslachten. Binnen gezinnen bestond een grote samenhang in de vetconsumptie bij thuis gegeten voedsel en een zwakke samenhang voor buitenshuis gegeten voedsel. De overeenkomst in gedrag binnen het gezin bestaan indien een van de ouders een dieet volgde, hetgeen suggereert dat de samenhang een dynamisch

verschijnsel is. De resultaten werden gerepliceerd in gegevens van 1052 huishoudens die deelnamen aan de voorlaatste Nederlandse Voedselconsumptiepeiling uit 1987/1988 (Hoofdstuk 4). Als vervolg hier op onderzochten we de invloed van gezinsleden en vrienden op de meer gebruikelijke voedselconsumptie. De vetconsumptie werd bepaald met de voedselfrequentievragenlijst (Hoofdstukken 2 en 3) in 361 sociale netwerken bestaande uit een 15-jarige jongen of meisje (n = 347), zijn/haar moeder (n = 309), vader (n = 270), beste vriend(in) (n = 240), moeders beste vriend(in) (n = 79) en vaders beste vriend(in) (n = 29). Tien interviews met gezinnen en vier focus groep interviews zijn uitgevoerd ter ondersteuning van het kwantitatieve onderzoek. Binnen gezinnen bleek er een significante samenhang te bestaan voor de consumptie van de meeste voedingsmiddelen die de laatste vier weken waren gegeten. Deze samenhang in voedselinneming resulteerde in een matige doch significante samenhang in het energiepercentage vet in de voeding tussen ouders (r = 0.30), 15-jarigen en hun moeders (r = 0.19) en vaders (r = 0.18). Tussen vrienden werd geen significante samenhang in vetconsumptie waargenomen, maar de consumptie van bepaalde voedingsmiddelen was wel geassocieerd. De frequentie waarin gezinsleden met elkaar aten was niet duidelijk gerelateerd aan de samenhang in hun vetinneming (Hoofdstuk 5). Het kwalitatieve onderzoek liet zien dat sociale invloeden zijn verweven met regels ten aanzien van voeding en dat er interactie plaatsvindt tussen sociale invloeden en andere determinanten van voedselkeuze. Zowel in de steekproef van de Nederlandse Voedselconsumptiepeiling (Hoofdstuk 4) als in de netwerk studie (Hoofdstuk 5) werden significante associaties gevonden tussen gezinsleden. De samenhang was hoger tussen ouders onderling dan tussen ouders en kinderen, terwijl geen invloed van geslacht op de samenhang werd waargenomen. De beste vriend leek weinig invloed te hebben op de vetinneming, zowel bij jongeren als bij volwassenen.

In Hoofdstuk 6 zijn sociale invloeden op de vetinneming van jongeren gekwanticifeerd door middel van padanalyse. De subjectieve norm (Theorie van beredeneerd gedrag) verklaarde 1% van de variantie in vetinneming van jongeren, terwijl 'modelling' gedrag (Sociale cognitieve theorie) 6% verklaarde. De subjectieve norm bleek de vetinneming van jongeren te beïnvloeden door een negatieve invloed op de attitudes ten aanzien van vet (padcoëfficiënt = -0.25), hetgeen suggereert dat de jongeren zich afzetten tegen de druk vanuit de omgeving

of dat ze slechts druk vanuit hun omgeving waarnemen indien ze een vetrijke voeding gebruiken. De vetinneming van moeders verklaarde meer de vetinneming van jongeren dan de vetinneming van vader en beste vriend. Modellen waarmee de sociale invloed op de *waargenomen* vetinneming gekwantificeerd werd, gaven andere resultaten dan modellen die de 'werkelijke' vetinneming zoals bepaald met de voedselfrequentievragenlijst verklaarden. Resultaten van modellen waren vergelijkbaar voor jongens en meisjes.

Bij een studie die gericht was op het effect van de aanwezigheid van anderen op de voedselinneming, bleek dat jonge vrijwilligers (n = 50) in aanwezigheid van (meer) anderen significant meer aten (r = 0.24). De deelnemers noteerden gedurende vier (n = 30) of zeven opeenvolgende dagen (n = 20) alles wat ze aten en dronken en bovendien per eetmoment het aantal aanwezigen, hoeveel honger ze hadden, smaak van het voedsel, gezelligheid en beschikbaarheid van meer voedsel. Een padanalyse liet zien dat het aantal aanwezigen niet direct de maaltijdgrootte beïnvloedde, maar dat deze 'social facilitation' van voedselinneming plaats vond door verlenging van de maaltijdduur. In aanwezigheid van meer andere mensen duurt een eetmoment langer, waardoor er meer eten gegeten wordt. Honger, smaak en beschikbaarheid van het voedsel waren niet van invloed op 'social facilitation' (Hoofdstuk 7).

Concluderend, de sociale omgeving kan een aanzienlijke invloed uitoefenen op het voedingsgedrag. In deze studies kon tot 40% van de variantie in vetinneming verklaard door invloeden van de social omgeving. De subjectieve norm, 'modelling' gedrag, en 'social facilitation' verklaarden ieder een deel van deze variantie. Toekomstig onderzoek dient zich te richten op mechanismen van de invloed van de sociale omgeving op voedingsgedrag, bijvoorbeeld door het bestuderen van gedragsveranderingen als gevolg van veranderingen in de sociale omgeving.

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Gerda

About the author

Gerda Feunekes was born on June 24, 1965, in Leek, the Netherlands. After completing secondary school, VWO at the Nienoordcollege in Leek, she started studying Human Nutrition at Wageningen Agricultural University in 1983. In 1989 she obtained her MSc-degree in Human Nutrition, with Human Nutrition and Physiology and Biochemistry as major topics. She spent 6 months at the Institute of Physiology of the University of Glasgow (UK) as part of her MSc training. From 1990 to 1995 she was appointed as a research associate at the Department of Human Nutrition, Wageningen Agricultural University. She started with a project involving the development and validation of a food frequency questionnaire to assess the intake of fats and cholesterol. In 1992, she started working on influences of the social environment on food intake. In 1994 she followed a course in LISREL (linear structural modelling) at the University of Nijmegen, and a workshop in focus group interviews by Richard Krueger in Portland, Oregon, USA. In 1995 she participated in the second European Nutrition Leadership Programme, in Luxembourg, and she followed an Advanced Course in Nutritional and Lifestyle Epidemiology organised by the Wageningen Centre for Nutrition and Epidemiology. Currently, she works at the Department of Epidemiology and Public Health of Wageningen Agricultural University, writing a review article about the assessment of alcohol intake. Thereafter, she will start working at the Unilever Research Laboratory in Vlaardingen as a technical consumer researcher.

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