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Original Article

Food choice is reflected in serum markers and anthropometric measures in healthy 8-yr-olds

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SUMMARY

Background: In healthy 4-yr-olds 17% were overweight/obese and high fat intake was associated with lower body weight and BMI.
Aim: The objective was to analyse food intake and the relationship to anthropometry at the age of 8 yrs.
Design: One-hundred and fourteen 8-yr-olds were investigated. Questionnaires were used for lifestyle, health and food choice combined with a 24-h dietary recall. Serum concentrations of vitamin D (25(OH) D) and phospholipid fatty acid concentrations were measured in 97 children.
Results: Percentage of overweight/obesity was similar to 4-yr-olds. Saturated fat intake was higher than recommended. Consumption of full fat milk was negatively associated to BMI, like protein and fat intake per kg body weight. A moderate intake of fat fish was associated with higher serum concentrations of omega-3 fatty acids. Serum 25(OH)D levels were correlated to the intake. Junk food was mainly restricted to weekends and associated to higher energy, fat and sucrose intake, without association to anthropometry.
Conclusion: Food pattern was similar to that at 4 yrs of age suggesting that food habits were established at an early age. High saturated fat intake was not negatively influencing anthropometry. Serum markers reflected the intake of fish, milk and vitamin D.

1. Introduction

The global epidemics of obesity and diabetes,[1] and the epidemiological indications that these problems are based on early growth pattern and nutrition,[2] have given more attention to the feeding of infants and children. In Sweden, a large nutritional study was performed at the beginning of the 80s[3] including children 4, 8 and 13 yrs old. Since then society, lifestyle, and availability and choices of food have changed. More recent studies have shown that 17–23% of healthy children were overweight already at the age of 4–5 yrs,[4,5] and that 25% of the daily energy intake was supplied by so called junk foods in both preschool and school children.[4,6] The prevalence and severity of overweight are increasing.[7,8]

The general recommendation of low fat intake and substitution of saturated fat for vegetable oils to combat the worldwide increase of obesity and cardiovascular diseases has been questioned.[9] The recommendations have lead to increased intake of omega-6 fatty acids and carbohydrates, which might stimulate adipogenesis.[10] In a previous study we found that healthy 4-yr-olds with a rapid increase of weight and height from birth, had higher insulin levels than those with normal growth, but this was not at that age associated to overweight and obesity.[11] The overweight children had a lower intake of $n-3$ fatty acids and a lower total fat intake.[4] It is not known if this unexpected pattern would characterize more age groups, but higher fat intake has been reported to be associated with lower weight in children.[4,12]

Low fish intake and/or low intake of vitamin D have been found in several studies of children,[3,4] but usually without reporting the serum concentrations of vitamin D (25(OH)D). Vitamin D deficiency has in recent years been associated with increased risks of different cancers, hypertension and infectious diseases beside its well established role in bone health.

The aim of our study was to analyse food intake and food choice in healthy 8-yr-olds in a cohort investigated at the age of 4 yrs, and to examine if these parameters were related to anthropometry, blood parameters and socioeconomic variables.

Abbreviations: $n-3$, omega-3; 25(OH)D, 25-hydroxy vitamin D; FFQ, food frequency questionnaire; EI, energy intake.

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2. Subjects and methods

A total of 120 children who had previously participated in a similar study at the age of 4 yrs were invited to participate in the follow-up study. Ninety-two children agreed to participate. Since the drop-out rate was higher in the area with low socioeconomic status, 45 children from two school classes in such area were invited to participate in the study and 28 of the children accepted. The only exclusion criterion was parents' inability to understand the Swedish language, assessed by the teachers at the school. In total 120 children (65 males), including three pairs of twins (all girls) with a mean (SD) age of 8.21 (0.38) yrs participated in the study. Questionnaires were filled out by the parents for 116 children, and 99 of the children accepted blood sampling. Two children were excluded from further analysis because one was diagnosed with cystic fibrosis and one had increased fasting glucose levels where investigation showed heterozygosity for MODY 2 diabetes. One-hundred and fourteen children (62 males) were thus eligible for investigation. The data collection was performed between December 2003 and December 2004.

The study was approved by the Ethics Committee of University of Gothenburg and informed consent was obtained from the children and the parents.

2.1. Anthropometry

The children were weighed and measured with standardized equipment. In two cases the values were lost. BMI and the *z*-scores for height, weight[13] and BMI[14] were calculated. The International Obesity Task Force (IOTF) cut-offs were used for the definition of overweight and obesity.[15]

2.2. Socio-economy questionnaire

In the questionnaire on socioeconomic variables the parents were asked about country of birth, educational level, income, living conditions and family size.

2.3. Food frequency questionnaire

The parents of the children, who participated as 4-yr-olds and accepted to take part in the follow-up, rejected to participate in another 7-day food registration, which they found had been too time consuming. A validation study was performed between the 7-day food registration and the food frequency questionnaire (FFQ) used in the study of healthy 4-yr-olds in 1999/2000, and designed with special attention to products rich in fat.[16] The results, tested with Bland–Altman plot, showed good agreement between the methods for calcium, iron, vitamin D and fat intake (SE, Master Thesis 2003, University of Gothenburg, Göteborg, Sweden). A decision was therefore made to revise the FFQ, to include all nutrients and combine the questionnaire with a 24-h dietary recall. Initially the FFQ contained 49 different food items but was extended to include 69 products. The revised questionnaire was also extended to contain supplementary questions on the amount of milk consumed daily, meal pattern e.g. times for main meals eaten during the day and to be validated against the 24-h recall.

The parents were told that the questionnaire should give a descriptive picture of the child's habitual intake over the last year and they were asked to fill out the FFQ together with the child, since it should also cover the intake during time spent at school and in after school care. There were five response alternatives; seldom/never, 1–2, 3–5 or 6–7 times/week and several times/day. When analysing the FFQ the response alternatives were grouped as seldom/never, weekly (1–2 times/week) or regularly ($\geq$3 times/week) except for the intake of fish and potato chips, which were only grouped as seldom/never and >1/week because of the small number of subjects eating these particular foods regularly. Questions were also asked regarding vitamins or other food supplements.

2.4. 24-h Dietary recall

Energy and nutritional intake was assessed by a 24-h dietary recall, which was completed together with the child and one or both parents and performed by a registered dietician (SE). The child was first asked to recall everything he or she had eaten during the previous day, and then he/she was asked to clarify if anything else was eaten with or between the meals. The parents supported the child by confirming type of foods, brands and fat content of the products. The children were also shown pictures of different portion sizes of common meals such as pasta, rice, stews and vegetables (Matmallen, National Food Administration 1999). Other portion sizes were described using household measures. To summarize the recall, the dietician described the daily intake and the child and/or the parents could agree that the recall was representative for the intake during the previous day.

The 24-h recall was then coded and energy and nutrient intake was calculated using the computer software for nutrient calculation MATs (Rudans Lättdata, 6th ed. 1999). This program contained the food database of the National Food Administration (1999), which contained around 1500 foods and dishes.

To validate the self-reported dietary intake and check for underreporting the ratio of reported energy intake (EI) (assumed to equal energy expenditure) to estimated basal metabolic rate (BMR_{est}) was used.[17] BMR_{est} was predicted using the Schofield equation based on sex, age, height and weight.[18]

2.5. Blood sampling

The blood sampling was performed in the morning after an overnight fast and after local anaesthetics with an EMLA plaster (Astra-Zeneca, Södertälje, Sweden). Analysis of 25(OH)D in serum was performed according to routine (Sahlgrenska University Hospital, Göteborg, Sweden). Serum phospholipid fatty acid pattern was analysed with capillary gas chromatography and has previously been reported.[19]

2.6. Statistical analysis

Statistical analyses were performed using the software program SPSS® 14.0 for Windows (SPSS Inc., Chicago, Illinois, USA). Statistical tests were chosen as appropriate after checking distributional assumptions. Data are given as mean (standard deviation, SD) or median (interquartile range, IQR). Student's *t*-test and Pearson correlation coefficients were used for symmetric, continuous observations and Kruskal–Wallis test, Mann–Whitney's *U*-test and Spearman rank correlation coefficients for data with non-normal distribution. Binary or ordinal logistic regression was used to investigate the associations between two or more categories of food intake and explanatory variables such as gender of the child or parental education. Statistical significance was set at $p < 0.05$ (2-sided test).

3. Results

3.1. Anthropometry

The data are given in Table 1. No difference was seen in height, weight or BMI between boys and girls. Nineteen children (17%) were overweight/obese (12 boys) according to the IOTF definition.[15]