NUTRITION AND HEALTH IN INFANCY AND CHILDHOOD

An epidemiological approach to the assessment of dietary habits, their determinants and implications

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Av
Lars Åke Persson
Med lic
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The dietary assessment techniques used in these epidemiological studies are evaluated (e.g. 24-hour recall, 7-day recording of food intake and dietary history technique).

The infant feeding habits in three communities are described and the variation of those habits in different strata is discussed. Breastfeeding habits are analysed using multivariate techniques.

The energy and nutrient intake of weaned infants aged 6 and 12 months was characterized by a good supply of most nutrients in comparison with recommended dietary allowances. The mean energy intake of the studied, normally-growing infants at 6 months was 80 per cent of the recommended intake.

The growth velocity during the first three months of life for entirely breastfed infants was found to be higher than for mixed-fed or formula-fed infants. The need for a revision of present growth standards for use in breastfed populations during the first 6 months of life is discussed.

An attempt was made to formulate a causal model for dental caries, including dietary factors and caries-preventive activities, and to make some quantitative interpretations from this model and the present set of data.

Dietary habits associated with different short- or long-term health risks were analysed in the ages 4, 8 and 13 years. The dietary intake of iron was satisfactory and no cases of iron deficiency anaemia were found. On average 10 per cent of the daily energy intake derived from sucrose. The fat intake was characterized by a high intake of saturated fat and a low P/S ratio. Most children had a daily sodium intake above recommended levels. The prevalence of obesity differed between different social strata, especially in the oldest age group. Overweight children did not have a higher energy intake than normal-weight children. The need for a population approach to prevention in childhood of some diet-related health problems in adult life is discussed.

The present dietary patterns and health of children in northern Sweden are compared with the situation 15 and 50 years ago, when nutrition surveys were performed in the same areas.

KEY WORDS: Breastfeeding, dietary habits, growth, dental caries, obesity, CHD risk factors, infancy, childhood, epidemiology.
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LARS ÅKE PERSSON

UMEÅ 1984
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INTRODUCTION

Good dietary habits are prerequisites of health, growth and development in infancy and childhood. Expressed in an epidemiological context, the diet is part of the environment where social, physical and biological factors interact with each other and with the genetic core of the child. World-wide, an inappropriate nutrition is the greatest health problem in childhood. While children in non-privileged societies are suffering from undernutrition we are becoming aware of other forms of childhood malnutrition in affluent societies; overnutrition and dietary patterns associated with risk for degenerative diseases.

Fifty years ago an extensive nutrition survey was performed in the north of Sweden (Odin, 1934). At that time problems of undernutrition were common; underweight and iron deficiency anaemia were prevalent. Thirty years later a second nutrition survey was performed; child health, dietary habits and socio-economic conditions were investigated in rural and urban areas in the county of Västerbotten in northern Sweden (Samuelson, 1971a). The present studies were partly performed in the same areas. Those earlier surveys were in various ways followed by interventions and preventive activities. Hopefully the results of this thesis may contribute not only to the description and analysis of dietary habits in childhood but also to the third stage in an epidemiological approach: the intervention, where the health of children is promoted and disease is prevented.

Concepts of nutrition and health

There are close ties between nutrition and health. This is a general truth, but it is perhaps most evident during the periods of rapid growth. The World Health Organization gives a positive definition of health, defining it as a state of complete physical, social and mental well-being, so that the presence of a good nutrition becomes an essential component of health itself. Thus, measuring nutrition in childhood becomes an important part of a health surveillance system (WHO, 1981a) and proper nutrition constitutes an essential component in primary health care (WHO, 1978a).

The study of dietary habits is not the same as the study of nutritional status. The measurements of dietary intake give some indirect information which, together with anthropometric and other data, constitutes the nutritional status of the individual. The nutritional status is a balance account, where nutrient input (which is a function of dietary intake and absorption) and nutrient output (which is a function of maintenance, growth and physical activity) are considered (Lechtig et al., 1976).

A child's physical growth reflects, maybe better than other measurements its state of nutrition and health. Anthropometric measurements of infants and children are widely used not only to evaluate health as a function of growth but also to assess the quality of their environment (Jelliffe, 1966; Karlberg et al., 1968; Kristiansson, 1980).
Many approaches are used and many disciplines are engaged in the study of nutrition in childhood. The special contribution of epidemiology is to describe the frequency and distributions of dietary habits, growth or other components of nutritional status in populations, to analyse and quantify the relationships between nutritional status, its determinants and consequences for the health of children, and to use this information as a point of departure for interventional activities (MacMahon & Pugh, 1970).

AIMS

Based upon epidemiological studies of dietary habits in childhood this thesis deals with the distribution of health rather than disease. The aims are to study the distribution of feeding habits or dietary habits in different ages, to search for determinants of the observed distributions and to analyse some possible implications of those habits regarding health and growth. To achieve this, a number of objectives were specified;

- To evaluate the validity and reliability of dietary assessment techniques used in the present studies.
- To describe feeding habits of Swedish infants and to analyse the role of socio-environmental conditions as determinants of those habits.
- To describe the energy and nutrient intake of weaned infants and to compare this with current recommendations.
- To analyse the variation in physical growth associated with different feeding habits and to evaluate the present growth standards for use in breastfed populations.
- To measure the prevalence of dental caries and to discuss the role of dietary habits and other possible caries-related factors in the present situation.
- To describe health-risk related dietary habits in 4-, 8- and 13-year-old children, to analyse the distribution of these habits in different socio-economic strata and to discuss the associations between dietary habits and other health parameters, e.g. anthropometric measurements, blood pressure and haematological investigations.

- To discuss the development of dietary habits and health in childhood in the north of Sweden during the last 50 years according to available information from nutrition surveys in this area.
MATERIALS AND METHODS

This thesis gives examples of two epidemiological designs: a longitudinal and a cross-sectional study. The longitudinal study emanates from Child Health Centres, where almost all Swedish infants and young children attend regularly and where data on growth and development are easily available. The cross-sectional study was performed in conjunction with a multicentre nutrition survey, organized by Swedish National Food Administration.

In a longitudinal study of feeding habits and growth in infancy (II, III, V) three socio-demographically different areas of Sweden were represented; one district in the town of Umeå in the north of Sweden, one district in the town of Trollhättan and the community of Bengtsfors, both in the county of Älvsborg in the south-west of Sweden (Figure 1). Umeå is a university town and the administrative centre of its county, Trollhättan is dominated by heavy industries and Bengtsfors is a sparsely-populated rural area containing a small municipality. A study of the dietary intake of weaned infants (IV) was performed in the town of Umeå.

A cross-sectional study on dietary habits and health of children aged 4, 8 and 13 years was performed in a sparsely-populated rural area in the northern mountain foreland (Vilhelmina-Dorotea), in the town of Umeå and in the county of Älvsborg, a mixed rural and urban area in the south-west of Sweden (represented by its county town, Vänersborg, in Figure 1).

Study populations

In the longitudinal study all parents of infants born from May 1979 to May 1980 in those three areas were invited to participate in the study. Twelve per cent of the infants could not be followed due to various reasons (II). The remaining group of infants consisted of 160 in Umeå, 61 in Trollhättan and 91 infants in Bengtsfors.

Figure 1. Map showing areas of investigation.
In the cross-sectional study a stratified random sample of 935 children aged 4, 8 and 13 years from three areas was selected. Children moving out from the areas before the interviews (25 cases) and children with chronic serious diseases (9 cases) were excluded. The remaining group, consisting of 901 children, was reduced by refusal to take part (9 per cent) and technical reasons (3 per cent for 24-hour recalls and 9 per cent for 7-day records and dietary histories). Thus, 792 children were studied by means of 24-hour recalls and 738 children by means of 7-day records or dietary history interviews. The omitted children did not differ from the examined children in distribution of father’s occupation, dental health or distribution of weight-for-height measurements (VI, VII).

Dietary assessment techniques (I) were studied in the above mentioned samples as well as in a group of 15 boarding-school children from the community of Vilhelmina.

**Study methods**

Dietary information was collected by dietitians, who were trained to perform their interviews in a standardized manner.

**Twenty-four-hour recalls** of dietary intake were taken in all age groups and were used for estimation of group mean values of dietary intake. These data are used when comparisons are made between the different age groups.

**Seven-day records** of food intake were performed in the 4- and 8-year-old groups. These data were used to estimate an individual's dietary intake.

**Dietary history** interviews were performed to estimate individual intakes in the 13-year-old group. This was done because of experiences in a pilot study; it was found to be difficult to get the necessary co-operation for one week of food recording in this group of teenagers.

**Short questions** on breastfeeding duration and age at introduction of various foods were asked in the infant study, and short questions on frequencies of food intake were employed in all age groups.

Different methods were used on the same individuals, which enabled methodological comparisons (I). Breastfeeding data were also validated against information in the records of Child Health Centres. Interviews on infant feeding habits were performed at 6 and 12 months, which enabled an evaluation of the reliability of those data.

Dietary data for energy and nutrient analyses were processed using a food data bank from the Swedish National Food Administration. These routines are presented and discussed in detail in paper I.

**Anthropometric measurements** (V, VII) were performed using standardized routines and controlled equipment. Weight, length (0 to 19.5 months) or height (4, 8 and 13 years) data were collected. Infants were generally measured 8 times from birth to 19.5 months of age. Since ages at examination varied, interpolation routines were used to make comparisons possible (V, VII). In a comparison between the prevalence of obesity in the present cross-sectional study and in the study by Samuelson (1971 b) in the same areas, the original data of the latter study were re-processed using the same computer routine in order to increase comparability.

**Socio-demographic data** and additional information about previous health problems etc. were collected in interviews by dietitians or paediatricians.

**Clinical examination** was performed on all children. In the longitudinal study the infants were repeatedly examined according to the routines of the Child Health Centres. Children taking part in the cross-sectional study were clinically examined and blood samples were taken (haemoglobin).

**Dental examination** was performed on all children in the cross-sectional study (VI). A caries examination including posterior bite-wing radiographs was performed and decayed, missing and filled surfaces (dmfs, DMFS) were recorded.

**Statistical methods**

A number of multivariate techniques were used in the analyses; multiple regression (V), path analysis (VI) (Nie et al.,1975), AID analysis (III and this thesis) (Sonquist et al., 1973), logistic regression (III, VII and in this
thesis) and survival analysis according to Cox’s proportional hazards model (III) (Dixon, 1981). Discriminant analysis (VII) and Guttman scalogram techniques (II) were also used (Nie et al., 1975).

Study design

In the infant study a longitudinal design was chosen. This enabled a description of the breastfeeding duration and weaning pattern of individual infants and an analysis of growth velocities in relation to feeding habits and other possible determinants.

The children aged 4, 8 and 13 years were studied cross-sectionally. This enabled a description of dietary habits at the time of the study and analyses of associations between those habits and determinants, which are rather stable over time, e.g. socio-demographic factors. Some associations between dietary habits and health were discussed but the limitations of the cross-sectional study in this respect are obvious; the relation in time between the supposed »cause« and the »effect« can not be monitored.

Areas with different socio-demographic characteristics were represented in the studies. Dietary habits of Swedish children from different social strata could therefore be analysed.
RESULTS AND COMMENTS

All infants and children were clinically examined. Twenty-nine per cent of the infants had a disease diagnosis registered at the maternity ward or at the paediatric ward in the neonatal period - usually minor adaptation difficulties and hyperbilirubinemia (V). Nine per cent were admitted after the neonatal period but before 6 months of age and four per cent were admitted to hospital between 6 and 12 months of age. No clinical signs of nutritional deficiencies were found in any age group. Mean haemoglobin values for boys were 128 (S.D. 9), 135 (S.D. 8) and 145 (S.D. 10) g/l in children aged 4, 8 and 13 years. The corresponding values for girls were 130 (S.D. 9), 134 (S.D. 9) and 140 (S.D. 10) g/l. Blood pressure was measured in the cross-sectional study. Mean systolic/diastolic pressures were 105/66, 101/63 and 109/68 mm Hg for children aged 4, 8 and 13 years.

MEASURING CHILDREN’S DIETS (I)

Epidemiological studies on dietary habits in infancy and childhood face a number of difficulties, which are more or less specific for those ages; the rapid change of food habits and nutrient intake in some ages, the limited ability of young children to co-operate and the need for correct dietary information from the different adults who care for the child at home, at school or in day-care centres. Dietary study methods, constructed for use in adult populations, may be inappropriate in younger age groups.

Breastfeeding prevalence data obtained in retrospective interviews at 6 months had a good validity. The reliability of breastfeeding and weaning data decreased over time; there was a tendency to overestimate the breastfeeding duration and refer the introduction time of various foods to a later month in the second interview at 12 months.

Short questions on food frequencies were shown to be a poor screening instrument and suffered from systematic biases when used in groups of 4- and 8-years-old children. The validity of this method may be better when used in infancy, when food habits are less diversified.

Group mean estimations of dietary intake of 4- and 8-year-old children obtained by 24-hour recalls were close to those of 7-day records from the same individuals. Dietary intake according to dietary histories in the 13-year-old group gave much higher estimations than those of the 24-hour recalls of the same individuals. The dietary history technique was shown to be rather reliable when repeated after 3 months in the same group of boarding-school children, keeping the menu constant. The internal validity of food recording, examined by use of chemical analysis of duplicate portions, was fairly good.

The group mean estimations of nutrient intakes did not differ significantly between hypothetical 1- or 3-day records and the 7-day records of 4- and 8-year-old children. However, the intra-individual variation of the daily intake of energy and nutrients was great.
Valid estimations of the individual levels of dietary intake require longer registration periods than a few days. This is especially the case regarding dietary components, which have an uneven distribution over the different foods, such as vitamin C, iron or sucrose. The daily variation of dietary intake varied significantly, even for groups of children; energy, carbohydrate and sucrose intake had a maximum on Saturdays while the intake of protein and iron showed their minimum levels on Saturdays and Sundays. There was no seasonal variation in dietary intake except for vitamin C, which was higher in winter time.

**DIETARY HABITS AND THEIR DETERMINANTS (II, III, VI, VII and unpublished results)**

**Infant feeding**

Feeding habits and dietary habits in infancy and childhood are influenced by a number of factors. The family, friends and neighbours, the media, the health services and schools are examples of sources of influence. In epidemiological studies complex interactions between different social and environmental influences must be simplified in order to make description and analysis possible. However, the multivariate nature of the problems needs to be considered in the choice of methods for data analysis. In the present studies some aspects of the feeding and dietary habits have been analysed with regard to possible associations with social and environmental factors.

In the present study the incidence of breastfeeding was high; only one per cent were not breastfed at the time of discharge from the maternity ward. During the first months of life the breastfeeding prevalence was quite homogenous in the studied areas; about 75 per cent of the infants were still breastfed (entirely or partly) at three months (Figure 2). About one third of the infants had received formula feeding during the first month of life. Two types of formula were used: a milk-based »starting» formula and a milk-based cereal »follow-up» formula. The shift from the first to the second type of formula took place at 4 — 5 months of age. Between 3 and 6 months small volumes of semi-solids and solids were introduced — initially used mainly as »educational» diets.

![Figure 2. Infant feeding in three Swedish communities. Breastfeeding prevalence over time (B) and cumulative incidence of introduction of formula (F) and introduction of semi-solids and solids (S).](image)

The breastfeeding habits in the studied groups of infants were analysed in three ways, according to the formulation of the problem (III): breastfeeding duration of different subgroups as a summary measure was analysed by means of AID analysis; the breastfeeding prevalence at 3 months — since breastfeeding is recommended especially for the first 3 — 4 months— was analysed in a logit regression and the breastfeeding pattern as a whole was analysed by means of survival analysis according to Cox’s proportional hazards model.

The educational background and the smoking habits of the mother were shown to be significant predictors of breastfeeding prevalence at 3 months. The »relative risk» of not being breastfed at 3 months of age was 8 times greater for the infant of the smoking mother with primary education than for the non-smoking, university-educated mother. The breastfeeding pattern as a whole was shown to be significantly associated with the educational background of the mother, her smoking habits, her age and whether the child had been admitted to a paediatric ward in the neonatal period. The probability of continued breastfeeding was lower for the youngest and the oldest mothers and the children who had been admitted to a paediatric ward during the first days of life. This was not the case for the group of pre-term infants or the group...
which had an abnormal delivery diagnosis. The health problems which caused the admittance to the paediatric ward were usually minor adaptation difficulties and hyperbilirubinemia.

Parents belonging to higher socio-economic strata or having longer education were more prone to act in accordance with present feeding recommendations regarding breastfeeding duration, time of introduction of complementary foods and gluten-containing foods and the use of sucrose-rich foods in infancy (II). At 12 months of age higher education of the mother was associated with higher frequencies of consumption of vegetables, fruits, potatoes and meat. Higher education was also negatively associated with consumption of foods containing much sucrose at 12 months.

Sucrose consumption in childhood (VI and unpublished results)

On average, 10 per cent of the daily energy intake derived from naturally occurring or added sucrose in groups of children aged 4, 8 and 13 years. The food group consisting of sweets, snacks etc contributed 50 per cent of the daily sucrose intake, bread and other cereal products to 15 per cent and fruits and berries to another 15 per cent.

AID analyses of sucrose intake (based upon the 7-days records) were performed in the 4- and 8-year-old groups. Number of in-between meals per day (< 2, > 2), socio-economic group (defined by the education of the mother), number of children in the family (1, 2 or more than 2), sex of the child and geographical area were used as independent variables. The number of in-between meals was shown to be the most powerful predictor in both age groups (Figure 3). There was also a tendency for a higher consumption among boys, at least among children who took more than two in-between meals per day. In the 8-year-old group the socio-economic background appeared as a predictor. Among the children, where the mother had university education, the total sucrose intake was on a lower level in spite of frequent snacks; the sucrose content in the snacks was not as high as in the other groups. A larger family was also associated with a higher sucrose intake for the 8-year-old child. In the 13-year-old group the same set of independent variables

![Figure 3. AID analysis of sucrose intake in children aged 4 and 8 years. The figures in the circles indicate the new groups formed by the consecutive splits in the analyses. The vertical position of the groups indicate their mean daily sucrose intake (in grams). Group sizes in the analysis of 4-year-old children: 1:238, 2:54, 3:184, 4:92, 5:92, 6:62, 7:30. Groups sizes in the analysis of 8-year-old children: 1:233, 2:87, 3:146, 4:25, 5:121, 6:61, 7:60, 8:49, 9:38. Area 1 indicates the northern rural area, 2 indicates the northern urban area and 3 the southern area.](image)
was not available, but there were no significant differences in relative amounts of energy from sucrose or sucrose consumption, or in absolute values between strata defined by sex, geographical area or socio-economic group.

Fat intake (VII)
Differences in fat intake (relative amount of energy from total fat, saturated fatty acids, poly-unsaturated fatty acids or amount cholesterol per 4.18 MJ) between strata defined by geographical area, sex or mother's education were generally small in children aged 4, 8 and 13 years. The mean value of saturated fat intake was significantly lower and the value of poly-unsaturated fat was higher among 8-years-old children in the northern urban area. Dietary cholesterol values were also significantly lower among both 4- and 8-year-old children in that area.

DIETARY INTAKE — RECOMMENDATIONS AND REALITY (IV, VII and unpublished results)
Recommendations of daily dietary allowances have been established for healthy populations. These recommendations — except for energy — are estimated to exceed the requirements of most individuals and thereby to ensure that the needs of nearly all in the population are met (Food and Nutrition Borad, 1980; Swedish National Food Administration, 1981). The energy recommendations are, however, established to represent the average needs of a group of healthy individuals. The Swedish recommendations on dietary allowances are usually close to the American RDA.

Energy intake (IV and unpublished results)
The estimated group mean energy intakes of weaned 6- and 12-month-old infants and the 4-, 8- and 13-year-old children according to 24-hour recalls are summarized in Table 1. There was a general tendency towards lower energy intakes than the RDA figures.

The relative contribution of macronutrients to the daily energy intake in different ages are summarized in Table 2. The fat intake was relatively low in infancy while in later childhood the contribution from fat was above the recommended maximum level of 35 per cent (Swedish National Food Administration, 1981).

The very dominating role of milk-based cereal

Table 1. Dietary components (means) by age of infants and children

<table>
<thead>
<tr>
<th>Dietary component</th>
<th>0.5</th>
<th>1</th>
<th>4</th>
<th>8</th>
<th>13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>n=76</td>
<td>n=136</td>
<td>n=259</td>
<td>n=263</td>
<td>n=270</td>
</tr>
<tr>
<td>Energy, kcal</td>
<td>676</td>
<td>1027</td>
<td>1555</td>
<td>2011</td>
<td>2219</td>
</tr>
<tr>
<td>kcal/kg</td>
<td>87</td>
<td>100</td>
<td>84</td>
<td>71</td>
<td>44</td>
</tr>
<tr>
<td>RDA (1980)</td>
<td>110</td>
<td>105</td>
<td>85</td>
<td>86</td>
<td>54</td>
</tr>
<tr>
<td>Protein, grams</td>
<td>26</td>
<td>43</td>
<td>53</td>
<td>70</td>
<td>81</td>
</tr>
<tr>
<td>grams/kg</td>
<td>3.3</td>
<td>4.2</td>
<td>2.9</td>
<td>2.5</td>
<td>1.6</td>
</tr>
<tr>
<td>RDA</td>
<td>2.2</td>
<td>2.0</td>
<td>1.5</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>Fat, grams</td>
<td>21</td>
<td>36</td>
<td>61</td>
<td>80</td>
<td>90</td>
</tr>
<tr>
<td>Carbohydrates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>grams</td>
<td>91</td>
<td>127</td>
<td>189</td>
<td>241</td>
<td>257</td>
</tr>
<tr>
<td>Sucrose, grams</td>
<td>3</td>
<td>9</td>
<td>38</td>
<td>46</td>
<td>44</td>
</tr>
<tr>
<td>Calcium, mg</td>
<td>785</td>
<td>863</td>
<td>995</td>
<td>1241</td>
<td>1401</td>
</tr>
<tr>
<td>Iron, mg</td>
<td>11</td>
<td>12</td>
<td>11</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>RDA</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Vitamin A, mg RE*</td>
<td>1.0</td>
<td>1.4</td>
<td>1.1</td>
<td>1.5</td>
<td>2.1</td>
</tr>
<tr>
<td>Vitamin D, /µg*</td>
<td>8.9</td>
<td>6.0</td>
<td>3.8</td>
<td>4.6</td>
<td>5.1</td>
</tr>
<tr>
<td>Vitamin C, mg</td>
<td>78</td>
<td>83</td>
<td>53</td>
<td>62</td>
<td>58</td>
</tr>
</tbody>
</table>

*Oral drops not included. Vitamin D expressed as cholecalciferol.
Table 2. The relative contribution of macronutrients to the daily energy intake in children aged 0.5, 1, 4, 8 and 13 years. Results obtained from 24-hour recalls.

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>Carbohydrate</th>
<th>Protein</th>
<th>Fat</th>
<th>thereof</th>
<th>thereof</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Per cent of energy from</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Carbohydrate</td>
<td>Protein</td>
<td>Fat</td>
<td>thereof</td>
<td>thereof</td>
</tr>
<tr>
<td>0.5</td>
<td>16</td>
<td>29</td>
<td>55</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>17</td>
<td>33</td>
<td>50</td>
<td>4</td>
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</tr>
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<td>37</td>
<td>49</td>
<td>9</td>
<td></td>
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<tr>
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<td>15</td>
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Table 2. The relative contribution of macronutrients to the daily energy intake in children aged 0.5, 1, 4, 8 and 13 years. Results obtained from 24-hour recalls.

The dietary intake of vitamin D was supplemented by oral drops, containing 10 ug cholecalciferol and 0.3 mg retinol per daily dose to pre-school children. Of the examined infants 94 per cent received these drops at 6 months and 88 per cent at 12 months. Thus, the total dietary intake in infancy of vitamin D was high in relation to the recommended allowances (Figure 5). In the older age groups the dietary intake of vitamin D was considerably lower than the dietary allowances.

Meal pattern (II and unpublished results)
The median number of meals was 4 at 6 months and 5 at 12 months. The distribution...
Table 3. The contribution from different food groups to the daily dietary intake of infants and children in different ages. Results obtained from 24-hour recalls.

<table>
<thead>
<tr>
<th>Dietary component</th>
<th>Per cent derived from</th>
<th>Age years</th>
<th>Vegetables</th>
<th>Fruits</th>
<th>Potatoes, roots</th>
<th>Milk, cheese</th>
<th>Meat, fish, eggs</th>
<th>Bread, cereals</th>
<th>Fats, oils</th>
<th>Sweets, snacks etc</th>
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\(^{a-h}\) Major parts from milk-based cereal formulas: a—57, b—26, c—64, d—25, e—50, f—24, g—66 and h—41 per cent.
of meals around the clock is shown in Figures 6 and 7. The 12 month data indicate that another meal often was added between 4 and 6 pm. The frequency of night meals was higher among breastfed infants.

In the Swedish recommendations on dietary allowances some advice about the meal pattern is also included (Swedish National Food Administration, 1981). The daily energy intake is recommended to be distributed over 3 main meals and 1 – 2 in-between meals. This recommendation is given for children over 3 years of age and adults. In the present investigation the median numbers of meals per day (according to 7-day records) were 5.4 and 5.1 in the 4- and 8-year-old groups respectively. Eighty-two per cent of those children had breakfast all days of the week, 10 per cent 6 days and 8 per cent 5 days of the week or less. Breakfast was most frequently omitted on Saturdays and Sundays.

**DIETARY INTAKE AND PHYSICAL GROWTH (V and unpublished results)**

In a regression analysis the entirely breastfed infants were shown to have a higher weight- and length-velocity than mixed- or formula-fed infants during the first 3 months of life (V). The artificially-fed infants caught up in growth during the next three months and there were no differences in attained weight or length from 6 months of age that could be explained by previous feeding habits. The higher initial weight- and length-velocities of breastfed infants were not caused by any catch-up due to unfavourable intra-uterine factors. In fact, entirely breastfed infants were heavier at birth; a difference which could be explained by differences in the mothers’ smoking habits during pregnancy.
The growth velocities and attained weights of groups of breastfed, mixed-fed or formula-fed infants are illustrated in Figure 8.

**Figure 8.** Weight velocity and attained weights from birth to 19.5 months for three cohorts, defined by different feeding regimens. Cohort (a), formula introduced during the first month of life, 108 infants. Cohort (b), formula introduced between 1.0 to 4.9 months of age, 100 infants. Cohort (c), entirely breastfed at least to 4.9 months of age. Figures in brackets indicate the ages of the attained weights and the corresponding limitations of weight velocity intervals.

The attained weights and heights of 4-, 8- and 13-year-old children in the investigated rural and urban areas in the north of Sweden were on average above, but did not significantly differ from, the Swedish reference values according to Karlberg (1976) as is shown in Figure 9. The corresponding values are also given from the 1967 study in the same areas (Samuelson, 1971 b).

Age at first menstruation was examined by a retrospective question to the teenage girls. Age in months at first menstruation or age at interview if not having menstruated were registered, and the results were analysed using

**Figure 9.** Attained heights and weights for boys (a) and girls (b) aged 4, 8 and 13 years in the 1980 study (black dots) and in the 1967 study (white dots). Means ± 1 S.D. given after logarithmic transformation of the data. Reference curves (means and shadowed area indicating ± 1 S.D.) according to Karlberg et al. (1976). Logarithmic scales.
a life-table technique (Dixon, 1981). Median age at the first menstruation was 13.0 years (Figure 10).

Figure 10. Lifetable analysis of cross-sectional menarche data. Per cent of girls not having menstruated at different ages. Mean ages at menarche in earlier Swedish studies indicated (Lundh, 1925; Samuelson, 1942; Furu, 1976).

DIETARY HABITS AND HEALTH RISKS
(VI, VII and unpublished results)

A number of dietary habits in childhood may represent health risks in the short- or long-term perspective. A frequent intake of sucrose may increase the risk of dental caries and obesity. Patterns of fat intake have been associated with the risk of cardiovascular disease. The level of sodium intake has been associated with the risk of hypertension in populations and an inadequate iron intake may increase the prevalence of iron deficiency anaemia. The distribution of these health-risk related dietary habits and some of the aforementioned possible associations were analysed in the cross-sectional study of 4-, 8- and 13-year-old children.

Dental caries (VI)

An attempt was made to suggest a causal model of dental caries and to discuss some quantitative interpretations of this model. Dental caries is a multifactorial disease but only a limited number of possible determinants such as social conditions, dietary habits and different caries-preventive measures were included. The analyses were performed using the path analysis technique (Nie et al., 1975). In a path analysis one commits oneself to a specific causal model and the direct and indirect effects of changes in independent variables are described by interpreting a set of linear relationships. In this study this enabled questions such as: »How can the caries situation be improved to a given extent?». In the present set of data, significant factors in the path diagrams of the different age groups were meal pattern, educational background of the mother, tooth brushing habits (with fluoride tooth paste), use of fluoride tablets in pre-school ages, mouth rinsing with fluoride at school and the organization of the dental health care for children (VI). However, the association between dietary habits and dental caries was generally weak in the present cross-sectional material. It is possible that the level and frequencies of sucrose intake for all children are such, that differences in caries experiences can not be explained as a function of this intake. Caries preventive measures then become more important as determinants of level of disease.

Salt intake (VII)

The estimated mean daily intake of sodium was 1.9, 2.5 and 3.3 grams respectively in the 4-, 8- and 13-year-old children. This estimation is based upon the average content of sodium in Swedish foods and dishes (Swedish National Food Administration, 1978) and the individual variation in use of table salt has not been taken into account. WHO has recommended keeping the salt intake (sodium chloride) below 5 grams per day (WHO, 1982 a); 40 per cent of the 4-year-old children, 80 per cent of the 8-year-old children and 95 per cent of the 13-year-old children had an estimated intake above this level.

According to a logit regression analysis of the present material the probability of having a high diastolic blood pressure (+2 S.D.) increased with sodium intake and relative weight-for-height in the 8-year-old group, but not in the other age groups. This statistical association found in one of the age groups should not immediately be interpreted in causal terms; the finding was not consistent over all three age groups and the study had a cross-sectional design, which limits the possibilities of causal interpretations.
Fat intake (VII)
Recommendations regarding dietary fat intake have been set by a WHO expert committee (WHO, 1982 a) as appropriate measures in the prevention of coronary heart disease in a population; recommended intake of saturated fat is less than 10 per cent of energy intake, of poly-unsaturated fatty acids 3 per cent of energy or more and of dietary cholesterol less than 100 mg per 4.1 MJ. In the Swedish dietary recommendations (Swedish National Food Administration, 1981) it is recommended that 25 to 35 per cent of the daily energy intake be derived from fat and that the ratio between poly-unsaturated fatty acids and saturated fatty acids be increased to about 0.5. In this population fat intake was characterized by a high intake of cholesterol and saturated fatty acids and a relatively low P/S ratio (VII). Only one individual of the 4- and 8-year-old children and eight of the 13-year-old children received a diet within the limits set by the WHO recommendations.

Overweight and dietary habits (VII)
On average 9 per cent of the 4-year-old, 10 per cent of the 8-year-old and 11 per cent of the 13-year-old children were overweight (defined as weight-for height 110.0 to 119.9 per cent of standard). There was a significant sex difference; overweight was more prevalent among boys than girls. The prevalence of obesity (defined as weight for height ≥ 120 per cent of standard) was 5, 3 and 16 per cent in the 4-, 8- and 13-year-old groups respectively (Table 4). There were no significant differences between sexes or geographical areas but a significant social gradient; the probability of obesity was highest among children, whose mother had the shortest education. No such difference was present in a re-analysis of the corresponding anthropometric data from the study by Samuelson some 15 years earlier, (Samuelson, 1971 b).

The dietary habits of obese and overweight children versus normal-weight children was examined by use of discriminant analysis. The overweight children had an energy intake which was equal to that of normal-weight children expressed in absolute figures. If the energy intake was expressed per kg bodyweight it was 20 per cent lower than that of normal-weight children. Generally, the dietary habits (energy distribution over the meals, the distribution over the macronutrients, over food groups, the frequencies of different meals and the frequencies of different foods) were very similar in both groups.

Table 4. Probability of obesity of children aged 4, 8 and 13 years in studies 1967 and 1980 in the county of Västerbotten. Probability figures given for significant predictors or combinations of these according to logit analysis.

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<td>4</td>
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<td>8</td>
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DIETARY HABITS IN A CHANGING SOCIETY (Unpublished results)
Since 1930 three nutrition surveys of children have been performed in the county of Västerbotten in northern Sweden. These studies give unique information about a quinquennium of rapid development in child health and nutrition.

From 1929 to 1931 Odin and Westin organized an extensive survey of socio-economic conditions, dietary habits and health among children and adults in the north of Sweden (Odin, 1934). In 1967 Samuelson studied dietary habits and health among 4-, 8- and 13-year-old children, partly in the same areas employed 35 years earlier (Samuelson, 1971 a). In the present survey samples were investigated from the same age groups and geographical areas as in the 1967 study.
In the 1930 study, dietary information was obtained through frequency questionnaires on food consumption during one week. Results from a small study in the rural coastal area in 1930 with weighed food records are here used to estimate the energy intake. In the comparisons between the 1967 and the 1980 study results of 24-hour recalls are used. There are some minor differences between the food data banks used in the processing of those two latter studies; the contents of vitamins and minerals are now estimated to be higher in some cases, although losses of some vitamins in the preparation of dishes are systematically considered in the last study.

The general conditions for families in the north of Sweden in the 1920s were characterized by poor economy, bad dwellings and large families. About 50 per cent of the children stated that 4 or more individuals slept in the same room and 25 per cent of the children shared their bed with 2 or more other family members.

Socio-demographic conditions have changed considerably thereafter. The sizes of families have continuously decreased — the «average» family now has less than 2.0 children. There has also been a rapid change in the educational level of parents during the last 15 years. More parents have received higher education, especially in the urban area where the university is located. Increasing numbers of mothers have employment and the pre-school children are often cared for in day-care centres. This is especially the case in the urban area, where one third of the 4-year-old children attended day-care centres in 1967 while two thirds did so in 1980. The proportion of 8-year-old school children who have no adult company when arriving home from school has increased from 5 to 19 per cent in the urban area, while the situation is unchanged in the rural area: 3 — 4 per cent.

In the 1920s dietary habits were characterized by small variation and an insufficient intake of vitamins and iron. The most prevalent dietary pattern was described as a lacto-cereal diet, in which chrispbread, barley gruel and porridge, potatoes and butter were included. Meat, vegetables and fruits were rarely consumed. Excessive coffee-drinking was common; 71 per cent of the children consumed 1 — 3 cups per day and 10 per cent had more than 3 cups a day.

In 1930 the estimated mean energy intake of a small group of children in a rural coastal area was 100 per cent of the present recommended dietary allowances (Food and Nutrition Board, 1980). The corresponding average figure in the 1967 study was close to 100, although it was lower in the urban area (92 per cent). In the present study energy intake was on average 87 per cent of the RDA figures, showing no difference between urban and rural areas (Figure 11).

![Figure 11. Intake of energy and some nutrients of children aged 4, 8 and 13 years expressed as percentages of the RDA (1980).](image-url)
The relative contribution of protein to the energy intake shows a small increase during these 50 years: 13, 14 and 15 per cent derived from protein in 1930, 1967 and 1980 respectively. Fat contributed 35 per cent in the 1930 estimation and 42 per cent in 1967. The present corresponding figure was 37 per cent — this decrease was mainly achieved through a lower intake of fat from milk and an increasing consumption of cereals.

No specified information on the intake of vitamins and minerals is available from the 1930 study. From the foods listed it is obvious, however, that iron intake as well as vitamin C intake was low. The intakes of some minerals and vitamins in the two latter studies, expressed as percentages of recommended intakes, are also displayed in Figure 11. Nowadays the relatively high intake of iron is partly achieved by the use of iron-fortified cereal products.

In the Swedish dietary allowances it is recommended, that the daily energy intake is distributed over the meals in the following way: breakfast 1/4, lunch 1/3, dinner 1/3 of the daily intake and the rest over 1 — 2 in-between meals. From 1967 to 1980 the distribution of energy intake over different meals of the day has changed — an increasing amount is consumed as small in-between meals (Figure 12).

In the 1930 study iron deficiency anaemia was very common. The average haemoglobin values were low and even lower in children living in overcrowded dwellings. Thirty years later only a few cases of iron deficiency anaemia were found (Samuelson & Sjölin, 1972) and in the present study there was none at all. The mean haemoglobin values improved markedly (Figure 13).

The proportion of children suffering from dental caries was relatively low in the 1930 study, especially in the rural area. Thereafter the caries prevalence increased and in 1967 all investigated children in the rural area suffered from caries. During the last 15 years, however, the situation has improved (Table 5).
Table 5. Per cent of children having caries in primary and permanent teeth in studies 1930, 1967 and 1980 in the county of Västerbotten

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DISCUSSION AND CONCLUSIONS

In the longitudinal study of infant feeding and growth the total groups of newborn infants in three areas were studied. In the cross-sectional study stratified random sampling from three geographical areas was used. The omitted children did not differ from the studied population regarding anthropometry, dental health or social group. Therefore it seems reasonable to consider the results as being representative of the studied age groups and geographical regions.

MONITORING DIETARY HABITS AND GROWTH

In all dietary studies valid, reliable and objective methods are desired. In other words, the method should truly measure what it is intended to measure; it should give the same results on repeated trials under unchanged conditions and it should be standardized for systematic use and comparison in different studies. Moreover, if the method is simple, easy to use and cheap the perfect combination is achieved.

Reports on methodological studies of dietary methods never confer all these positive features to a single method (Pekkarinen, 1970; Marr, 1971; Block, 1982). All methods must be judged upon their own merits and the choice of method must be guided by the specific aims of the study.

The collection of data on breastfeeding duration and weaning constitutes a special methodological problem. Infant feeding habits change over time which calls for a longitudinal design. A longitudinal monitoring may be expensive however and involve the risk of an observer's effect on the studied condition. In the present studies feeding information was collected once every 6 months in infancy. This was shown to provide valid breastfeeding data. A retrospective collection of all breastfeeding data at 12 months would have suffered from a systematic bias: with the passage of time many mothers tended to overestimate breastfeeding duration and the age at which various complementary foods were introduced. During the last decade many breastfeeding surveys have been performed and national systems of breastfeeding surveillance have been established. Usually a cross-sectional design is used (Kent, 1981; Martinez, 1981; WHO, 1981 b) in these studies. Reports on methodological evaluations of breastfeeding studies are scarce. The present results show the need for such evaluations and give examples of possible approaches.

The results of the present assessments of dietary methods, as well as of previous methodological studies, indicate that 24-hour recalls of food intake provide valid estimations of group means of dietary intake (Samuelson, 1970), although the ability to remember the last 24-hour intake increases with age (Meredith et al., 1951). It is important to note however that the intra-individual variation of dietary intake is so great that a 24-hour recall should not be used to classify the individual intake. For groups of children
the variation of dietary intake over the days of the week was significant. Thus, an even distribution of the 24-hour recall interviews throughout the week is necessary.

Very few attempts have been made to validate the food recording method in groups of children. In the present study the internal validity was fairly good when assessed by use of duplicate portions. In an indirect evaluation in adult populations, using output of urinary nitrogen, the recording method was considered inappropriate for individual estimations (Isaksson, 1980).

The dietary history technique was originally used to classify individuals into a rating scale from »excellent» to »very poor» intake (Burke, 1947). The present results support the findings of previous studies, i.e. that dietary history gives too high group mean values (Young et al., 1953; Jain et al., 1980; Räsänen, 1979). The reliability was fairly good in the present study. In a dietary history interview an experienced dietitian is a prerequisite.

**Recommendations on energy allowances** are established at a level thought to be consonant with good health for average persons in each age group and within a given activity category (Food and Nutrition Board, 1980). Normally growing 6-month-old infants in the present studies had an energy intake which was 80 per cent of the recommended level. This is in accordance with the results of a number of studies reviewed by Whitehead et al. (1981). The need for proper energy recommendations is perhaps even greater in infancy than during other periods of life, since infancy is characterized by rapid growth, changing feeding habits and — in many societies — a risk of food contamination.

The mean energy intakes of children aged 4, 8 and 13 years were also lower than the recommended allowances and were lower than the corresponding intakes in the 1967 study within the same area (Samuelson, 1971 a). In spite of this, there was a higher prevalence of obesity in the 13-year-old group. This may indicate that children are physically less active in the present society. These findings are in accordance with experiences from Great Britain (Durnin et al., 1974).

In Sweden a national *growth standard* obtained by a longitudinal study of 212 children has been used during the last decade (Karlb erg et al., 1976). These reference data, like the WHO reference data (WHO, 1978) were obtained from populations in which breastfeeding was less prevalent than in the present study. It has been questioned whether or not standards such as these are adequate for use in the assessment of growth of breastfed infants during the first 6 months of life (Whitehead & Paul, 1981; Underwood & Hofvander, 1982). The present study underlines the need for a revision of growth standards for early infancy. There is no need for *national* standards during infancy and early childhood, since differences in growth attributed to ethnic factors alone are very limited during that period (Habich et al., 1974). A revised growth standard for early infancy should preferably be based on a longitudinal study of a greater sample than in the present study (312 children) — or in the present Swedish growth standard (212 children). A larger sample is needed to obtain valid estimations even of the outer centiles.

In the present studies, weight-for-height values which exceeded the standard by 20 per cent were defined as obesity. This practical definition has been used in many studies but has some disadvantages. The distribution of weights is skewed upwards, especially for the 13-year-old girls at puberty, and the gain in height of many obese children has been accelerated by overnutrition. Direct measurements of body fatness (skinfold thickness) at standard sites are more appropriate measurements of obesity — provided the measurements are made in a standardized way. In the present situation, when comparisons between different areas and studies were made, the weight-for-height measurement was considered to be most practical.

**DIETARY HABITS AND THEIR DETERMINANTS**

**Infant feeding**

During the last centuries there have been great variations in attitudes to and practices of infant feeding. In the beginning of the 18th century the famous scientist Carl Linneus wrote when visiting the north of Sweden: »Everywhere I saw the women giving milk to their children by cow-horns, wondering at the country folk who don't care to breastfeed» (Linnaeus, 1732). In many 18th and 19th
century Swedish historical sources, physicians often complained about artificial feeding. These feeding habits varied considerably between different regions and social strata and were believed to have strong connection with high infant mortality. In some areas successful breastfeeding campaigns were launched, followed by a decrease in infant mortality (Broström et al., 1983). The need for a proper infant care and nutrition was also emphasized by the authorities, who requested yearly reports on this matter from the general practitioners at the end of the last century.

In the beginning of the 1940s most Swedish infants were breastfed during the first months of life, according to official statistics. From 1940 to 1970 there was a continuous decline in breastfeeding prevalence in Sweden as well as in other European countries (Vahlquist, 1975) and the United States (Mayer, 1968). The present studies confirm the trend reported during the last decade, back to breastfeeding (Hofvander & Sjölin, 1979).

The analysis of breastfeeding habits in different strata (III) indicates a number of factors associated with different feeding habits: characteristics of the family, of the mother and also of the early infant care in hospitals. The history of infant feeding and the present variation in feeding habits in different strata show the need of a continuous monitoring of breastfeeding habits. Monitoring is important for breastfeeding promotion in the Mother and Child Health activities. Such information is also requested by the WHO for its world-wide surveillance of infant feeding habits (WHO, 1982 b). A continuous surveillance would also provide the base-line for future studies on possible long-term health effects of different infant feeding practices.

Dietary habits in childhood

In the 1930 nutrition survey in the north of Sweden a number of preventive health services were suggested (Odin, 1934). During the following decades free child health, school health and dental health services were established for all children. Schoolchildren were given free lunches, estimated to supply one third of the daily energy intake. Day-care centres for pre-school children were established throughout the country. Housing conditions improved and more people received higher education. More mothers obtained employment and the sizes of families decreased.

These socio-economic changes were also accompanied by changing food habits. A rich variety of foods became available throughout the country. Dietary habits became more diversified, which decreased the risk of nutrition deficiencies. Some specific actions were also undertaken by the authorities and by the food manufacturers, e.g. fortification of cereal products with iron, which started in 1944 and at present supplies 6.5 mg iron per 100 grams of cereal. These dietary changes are probably a major factor in the successful eradication of iron deficiency anaemia in childhood.

In a study 1960 of healthy children in Stockholm aged 7 to 14 years, the protein intake was on average 2.0 grams per kg bodyweight (Sterky, 1962). In the 1967 study by Samuelson in the county of Västerbotten the intake was 3.3, 2.6 and 1.6 grams per kg bodyweight in the age groups 4, 8 and 13 years respectively. The present values for children aged 4 and 8 years are slightly lower than the corresponding figures from 1967. The protein intakes of all age groups are within the ranges given by the Swedish dietary recommendations but high in comparison with the American RDA. There is no evidence to show that a high protein intake is either beneficial or harmful for infants and children except for the special case of pre-term infants receiving a high protein diet (Goldman et al., 1974).

In the beginning of the 1970s the Swedish National Board of Health and Welfare (1973) started a campaign about diet and physical activity based partly upon the experiences of the study by Samuelson in the late sixties. During the following years dietary habits have changed in positive directions (e.g. the relative intake of energy from fat has decreased and breakfasts seem to supply a sufficient proportion of the daily energy intake) and in negative directions (e.g. an increasing amount of the energy intake is consumed as in-between meals, often rich in sucrose content). There is also evidence that physical activity has decreased. The effects of this campaign have not been evaluated, but from the present results one could conclude that the development is not altogether good.
The analysis of infant feeding habits (II, III) as well as the example of variations in sucrose intake show that regional differences in those habits seem to be less important than differences between different social strata within each region. Differences between rural and urban areas — as described in the study by Odin (1934) and also by Samuelson (1971 a) — or between north and south are generally small in the present study.

The influences on the dietary habits of children are many and difficult to analyze. Parents share the responsibility for food preparation and teaching of good food habits with staff at day-care centres and teachers and other staff at school. The dietary habits of a child can be viewed as results of an interaction between social and environmental influences in response to opportunities (Bandura, 1977). As was shown in the example of sucrose intake of 4- and 8-year-old children a number of factors were associated — at least statistically — with higher or lower intake; the general meal pattern of the child, characteristics of the family (number of children) and of the mother (educational background).

DIETARY HABITS — IMPLICATIONS AND PERSPECTIVES

Secular trend in physical growth
During the last 100 years Swedish children have been getting larger and growing to maturity more rapidly (Ljung et al., 1974). The heights and weights in the present material of children born 1967, 1972 and 1976 were slightly above, but not significantly different from, the values in the longitudinal material studied by Karlberg et al. (1976) of children born 1955–58. Data from Taranger et al. (1978) of 18-year-old Swedish boys show that the increase per decade in attained weight is now very low — below 1 cm per 10 years. The estimated distribution of age at first menstruation in the present material corresponds rather well with the results reported by Samuelson (1971) in the same area. The secular trend in body size is maybe reaching its end. There is no clear evidence as to the cause of this secular trend, but it is assumed that better nutrition during infancy and childhood is the main factor (Marshall & Tanner, 1981).

Iron intake and anaemia
The present intakes of iron were above the recommended level in children aged 0.5, 4 and 8 years, 80 per cent of the recommendation in 1-year-old children and 89 per cent of the recommendation in 13-year-old children. These intakes are higher than the corresponding values in the 1967 study in the north of Sweden and also higher than intakes recently reported from Finland (Räsänen & Ahlström, 1975) and they seem to be sufficient for the prevention of iron deficiency anaemia in these ages. However, about one third of the 13-year-old girls were not yet losing iron through menstruations. The prevalence of iron deficiency anaemia in Swedish women of child-bearing ages is reported to be 6–7 per cent (Hallberg et al., 1979).

Sugar intake and dental caries
The present estimated levels of daily sucrose intake (data from 7-day records and dietary history) correspond to an intake of 15, 18 and 25 kg per child per year for 4-, 8- and 13-year-old children respectively. A reduction of the average per capita consumption of sugar to 15 kg per year has been suggested — assuming a widescale use of fluoride prophylaxis — to achieve a major improvement in dental health (Sheiham, 1983). Our knowledge about how to achieve such a change in dietary habits is however limited (Saylor et al., 1982). In the present study (VI) an example is given of a research approach, in which the relative effect of different caries-preventive activities can be evaluated and cost-effectiveness estimations of intervention programmes can be made.

Obesity in childhood
In the present study the prevalence of obesity among children aged 13 years was slightly higher than some 15 years earlier. This increase had only taken place in the group where the mother had the shortest education. Taranger et al. observed that the regular trend in increase of attained weight for 18-year-old boys was relatively higher than the corresponding changes regarding height. In a Swedish study of 5491 ten-year-old children in the town of Uppsala, overweight and obesity were the most common physical health problems according to examinations in the school health services (Mellbin et al., 1982). In a study from the same area it was shown that markedly inactive
single children from lower class families were particularly at risk regarding the development of obesity during the first years at school (Vuille & Mellbin, 1979).

The energy intake and eating behaviours of obese children were not significantly different from those of normal-weight children in the present study. This is in accordance with an increasing number of reports indicating that obese or obese-prone children are already in a state of »overfeeding» at a »normal» intake and that they have a lower ability to compensate for overfeeding (James & Sahakian, 1981). An explanation to the observed social difference in obesity in the 13-year-old group may be differences between social groups in attitudes towards obesity and in readiness and opportunities to restrict energy intake and increase physical activity.

Salt intake and the risk for hypertension

Very few children in the present study had a salt intake below the »maximum» level in the WHO recommendations (WHO, 1982). Statistics of sold quantities of sodium-containing foods per capita reveal that a 20 per cent reduction in sodium intake has taken place during the last two decades, probably related to changes in methods of food preservation (Westin, 1980). However, new foods and snacks with a high salt content have been introduced and are becoming popular among children, e.g. chips and salted peanuts. In this study there was a close correlation between sodium and protein in the diet.

The association between a high salt intake and an increased risk of having a high diastolic pressure in one of the three age groups in the present cross-sectional investigation should not be immediately interpreted as causal. However, there is rather consistent evidence from a number of epidemiological studies that the population frequency of adult hypertension is associated with the habitual salt intake (Blackburn & Prineas, 1983). The phenomenon of »tracking» of blood pressure has also been reported in childhood (Szklo, 1979). A prospective longitudinal study of dietary intake and blood pressure is needed to elucidate this problem.

Fat intake and CHD risk factors

The relative intake of energy from fat had decreased during the last fifteen years in the county of Västerbotten. However, a lower energy intake from fat does not necessarily imply a higher ratio between polyunsaturated and saturated fatty acids (P/S ratio) (VII). »Milk and milk products» and »meat, fish and eggs» were the major sources of fat in the diet of children aged 4, 8 and 13 years. Their fat intake pattern can be described as typical for a high-incidence area of coronary heart disease (CHD): a high intake of saturated fatty acids and cholesterol, and a low P/S ratio (WHO, 1982 a). An increase in the ratio between polyunsaturated and saturated fatty acids in the diet is recommended — mainly through a lower intake of saturated fat (Swedish National Food Administration, 1981).

Prevention in childhood of later health problems

A WHO reference group has pointed out that most of the CHD cases related to cholesterol-associated risk occur, not from the few at high risk, but from the many exposed to a lesser risk (WHO, 1982 a). Although hypertension and CHD are diseases of adulthood the underlying disease processes start much earlier in life. There are reasons to believe that overweight and obesity are among the greatest physical health problems of Swedish schoolchildren. The fact that a very small number of individuals had a salt and fat consumption pattern in accordance with current recommendations underlines the necessity of a population approach to prevention. We have enough knowledge about causal links between dietary habits and health risks to be able to deliver the message, but our knowledge is insufficient when it comes to methods of prevention. There are very few intervention studies in childhood and adolescent populations. In the Oslo Youth Study attempts have been made to change eating attitudes and behaviours related to cardiovascular risks (Tell, 1982). The North Karelia Youth project in Finland evaluates the feasibility and effectiveness of a number of interventions to influence health behaviour and cardiovascular disease risk factors (Puska et al., 1982). There is a need to establish interdisciplinary research, where representatives of many disciplines (e.g nutrition, social and behavioral sciences and medicine) together search for successful strategies in the promotion of health.
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