



Intake of various food groups among girls and boys with different utilisation of school meals

Results from EsKiMo II

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Abstract

Children and adolescents spend a large part of their time at school, which is why the quality of school meals is of great importance. In this study, the extent to which intakes of various food groups among children and adolescents were in line with the recommendations of the Optimised Mixed Diet (OMD) were examined according to frequency of utilisation of school meals, based on data from the second Eating study as a KiGGS Module (EsKiMo II). Among 6- to 11-year-old boys, more frequent (\geq three times weekly) utilisation of school meals is associated with more frequently meeting or exceeding the OMD recommendation for fruit consumption. The same is true among 12- to 17-year-old girls for eggs and fats/oils used for cooking or spreads, and among 12- to 17-year-old boys for fish. The results from EsKiMo II show that regular uptake of school meals is associated with differences in intakes of various food groups with respect to the OMD recommendations.

Keywords: school meals, food intake, EsKiMo II, children and adolescents

Introduction

As the number of all-day schools in Germany increases, so does the importance of providing health-promoting school meals [1]. A balanced diet is the foundation of optimal physical and mental performance in children and adolescents [2]. As a key environment where young people spend much of their lives, school can make a valuable contribution to health-promoting nutrition in these young people.

Data from the second Eating study as a KiGGS Module (EsKiMo II, 2015–2017) show that 86.6% of children and adolescents in Germany have the opportunity to have a hot lunch at school. Among the pupils who have the option of school meals, 43.2% have a school meal at least once a week. The availability and utilisation of school meals have both doubled compared to the first KiGGS module nutrition survey (EsKiMo I, 2006). However, the overall utilisation of school meals is under 50%, which is still relatively low. School meal provision has been expanded in recent years, especially in the federal states in former West Germany, however uptake in these federal states is still significantly lower than in the federal states in former East Germany [3]. In addition to these regional differences, there are also some age-related and school-specific differences. About 39% of 6- to 11-year-old girls and boys in Germany have school meals at least three times a week. In 12- to 17-year-olds, the figure is around 13% [4].

The three most frequently cited reasons for not eating school meals (or not eating them more often) are that a hot meal is available at

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home, that there are no lessons in the afternoon and that the food in the school cafeteria does not taste good [3]. To increase the uptake of school lunches, school cafeterias should take the food culture and taste preferences of the pupils into account. However, at the same time, school meals should also be health-promoting and optimised in terms of nutrition. In 2007, the German Nutrition Society developed a quality standard for school meals, however this has only been made legally binding in a few federal states [5].

It is unclear whether children and adolescents who frequently have school lunch have a better nutrition profile in terms of food group-based dietary recommendations. Many countries have dietary recommendations for the general population and some also have dietary recommendations for specific population groups. These recommendations are often depicted using a graphic. Germany has the 10 guidelines of the German Nutrition Society for a wholesome diet, the German Nutrition Society nutrition wheel and the German three-dimensional food pyramid [6]. These guidelines apply to all age groups. In addition to this, Germany also has the recommendations of the Optimised Mixed Diet (OMD) for children and adolescents. These recommendations specify concrete, age-specific quantities of different food groups for average daily consumption. The OMD concept was first developed by the former Research Institute of Child Nutrition in Dortmund – now it is managed by the Department of Child Nutrition Research at the Children's University Hospital of Bochum (*Forschungsdepartment Kinderernährung der Universitätskinderklinik Bochum*). The OMD concept provides unique, scientifically sound recommendations for intake of various food groups in children and adolescents that have been proven in practice [7].

This article presents the results of in-depth analyses based on EsKiMo II regarding the intakes of various food groups in 6- to 17-year-old school pupils in Germany in relation to the frequency of their utilisation of school meals. It investigates the extent to which frequent utilisation of school meals is associated with differences in consumption of various food groups and differences in the extent to which the recommended intakes according to the OMD are achieved [7].

Methods

Study population and assessment instruments

As part of the second wave of the "German Health Interview and Examination Survey for Children and Adolescents" (KiGGS Wave 2, 2014–2017), the second "Eating study as a KiGGS Module" (EsKiMo II, 2015–2017) was conducted. EsKiMo II is a survey of the dietary behavior of children and adolescents aged 6 to 17 years living in Germany. A total of 2,644 persons (1,285 children [6 to 11 years] and 1,359 adolescents [12 to 17 years] from the 167 study sites of KiGGS Wave 2) participated in EsKiMo II. The study design and procedures of EsKiMo II are described in detail elsewhere [8, 9]. Positive votings from the Ethics Committee of Hannover Medical School (number 2275-2015) and the German Federal Commissioner for Data Protection and Freedom of Information have been

obtained. Legal guardians and adolescents aged 14 years and above gave their written consent prior to participation [9].

Dietary assessment

In the case of the 6- to 11-year-olds, the parents (or guardians) were asked to keep a food diary (weighed dietary record) for three consecutive days and on one other separate day after a briefing by trained nutritionists. The weighed dietary records were recorded using the food coding software EAT (version 3) from the University of Paderborn. This software was specifically designed for coding dietary records and it was first used in the Consumption Survey of Food Intake among Infants and Young Children (*Verzehrstudie zur Ermittlung der Lebensmittelaufnahme von Säuglingen und Kleinkindern*, VELS) [10]. The software makes it possible to record various parameters, including the date and time of consumption, the name of the food, the quantity consumed, the remaining quantity, the place of consumption, the condition at the time of purchase, the packaging and the method of preparation. The foods were coded using the German Nutrient Database (*Bundeslebensmittelschlüssel* [BLS], version 3.02, Max Rubner-Institut [Federal Research Institute of Nutrition and Food]) [11]. In the case of the 12- to 17-year-olds, trained nutritionists carried out modified dietary history interviews using the DISHES software. They recorded the usual diet of the preceding four weeks by asking about the frequency of consumption and the portion sizes of the foods eaten at meals. The German Food Database (BLS) version 3.02 was integrated in the DISHES software to allow the foods to be coded [9, 12]. The consumption data obtained using both instruments were processed and analysed using the statistical software SAS version 9.4 (SAS Institute, Cary, NC, USA). First of all, composite dishes (e.g. pizza or *Käsespätzle* [noodles with cheese]) were first broken down into their individual components based on the recipe information (from the BLS or from individual recipes given in the food diaries), then the foods were assigned to the eleven OMD food groups. Certain foods could be assigned to an OMD food group directly (e.g. cakes or jellies), so these were not broken down into components. Fresh fruit and processed fruit were counted as fruit, but fruit juice was not. Foods considered "tolerated foods" (i.e. less nutritionally desirable foods) included confectionery, pastries, salty snacks (e.g. potato chips), sweet spreads and soda. In



accordance with the relevant recommendations, milk and dairy products were evaluated against the OMD recommendations using conversion factors due to the variation in their calcium contents. Milk, kefir, buttermilk, soured milk, yogurt, whey, condensed milk and cream were multiplied by a factor of 1, soft cheese, fresh cheese and quark were multiplied by a factor of 2 and hard cheese and semi-hard cheese were multiplied by a factor of 7. The quantities shown for dairy products therefore correspond to milk equivalents and not to the directly consumed quantities of these foods in grams. For the present analyses, the food groups “bread/cereal (flakes)” and “potatoes” were combined into “carbohydrate-rich foods” (meaning complex carbohydrates). In accordance with the OMD concept, the intake levels of the foods were determined in g/day, or in kcal/day in the case of “tolerated foods” (mean value over 4 days for 6- to 11-year-olds and over 28 days for 12- to 17-year-olds) and were compared at the individual level to the OMD reference values differentiated by age group and gender.

School meals

All participants were asked in a short interview whether and how often they had school meals. The possible responses were “every day”, “3 or 4 times a week”, “once or twice a week” and “less often”. In order to create groups of a size that could provide meaningful results, these categories were each grouped into the two categories “at least three times a week” and “at most twice a week”.

Socioeconomic status (SES)

The socioeconomic status (SES) of the family was determined using information from the previous KiGGS Wave 2 study. An index was created based on the information provided by the parents about their occupational status, their level of education and their net household income. Subsequently, the participants were allocated to one of three categories: low SES, medium SES and high SES [13].

Statistical evaluation

Children and adolescents for whom no food diary ($n = 95$), no DISHES interview ($n = 6$) or no complete information on school meals ($n = 10$) was available were excluded from the analyses, as were those who did not attend school ($n = 140$). As a result, 2,393 pupils (1,094 children and 1,299 adolescents) were included in the statistical evaluation. Differences in the food group intakes of girls and boys were anticipated, so the evaluations were carried out in a gender-specific manner. In addition, the evaluations were carried out separately for 6- to 11-year-olds and 12- to 17-year-olds since different dietary assessment methods were used for each of these groups.

Data were analysed using survey procedures that take the cluster design of the sample into account, using the statistical software SAS version 9.4 (SAS Institute, Cary, NC, USA). Since the food group values were not normally distributed, the pupils' absolute consumption of food groups was initially compared using medians and quartiles. Subsequently, the mean values were determined and the differences in mean were statistically tested in analyses of variance, adjusted for age, SES and region

(former East and West Germany). It was also investigated whether those children and adolescents who achieved the OMD recommendations or consumed more than the recommended amount differed significantly with regard to the frequency of utilisation of school meals. Differences in this regard were tested using the chi-squared test. A p -value smaller than 0.05 was considered a statistically significant result.

A weighting factor was used to account for deviations in population structure with regard to age, sex, region of the country (*Bundesland*/federal state) (as of 31 Dec 2015), nationality (as of 31 Dec 2014) and the distribution of educational attainment among the parents (microcensus 2013 [14]), as well as differences in rates of participation due to the time of year when the data was collected, the socioeconomic status of the family and the type of school the child attends [15].

Results

♦ Table 1 in the online supplement (→ www.ernaehrungs-umschau.de) provides some sociodemographic characteristics of the sample used for the evaluation. The proportion of girls and boys was roughly equal. The SES categories were defined so that the lower quintile of the population distribution corresponds to low SES and the upper quintile corresponds to high SES, i.e. 20% of the distribution in each case. Without weighting, children and adolescents from low SES families would be underrepresented and those from high SES families would be overrepresented. The application of the weighting factor results in a distribution that is approximately equal to the actual distribution in the population. As a result, the proportion of 6- to 11-year-olds from families with a low SES was 17.2% and the proportion of those from families with a high SES was 21.2%. The corresponding percentages for 12- to 17-year-olds were 17.9% and 18.4%, respectively. Due to the original sample design of the KiGGS study, participation among the federal states in former East Germany was disproportionately high. After weighting, the proportion of participants from the federal states in former East Germany was 17.8% for 6- to 11-year-olds and 16.2% for 12- to 17-year-olds. The proportion of participants who have school meals at least three



| Girls | School meals \geq 3 times per week n = 238 | | | School meals < 3 times per week n = 304 | | | Significance level |
|-------------------------------------|---|-----------------|-------------------------|--|-----------------|-------------------------|-----------------------------|
| | Food intake | | | Food intake | | | Difference adj. mean values |
| | Mean value | adj. mean value | 95% confidence interval | Mean value | adj. mean value | 95% confidence interval | p-value |
| beverages (g/day) | 900.3 | 900.3 | 815.3–985.4 | 983.8 | 966.9 | 913.2–1,020.6 | 0.2216 |
| fruit (g/day) | 127.5 | 126.5 | 102.8–150.3 | 116.3 | 117.8 | 102.8–132.9 | 0.5513 |
| vegetables (g/day) | 100.7 | 103.7 | 90.3–117.1 | 88.6 | 86.7 | 77.7–95.7 | 0.0551 |
| carbohydrate-rich foods (g/day) | 224.4 | 231.3 | 214.0–248.6 | 222.1 | 220.5 | 207.6–233.4 | 0.3461 |
| meat (g/day) | 62.2 | 64.0 | 55.9–72.1 | 64.4 | 64.2 | 58.7–69.7 | 0.9665 |
| fish (g/day) | 9.2 | 9.1 | 5.0–13.2 | 8.9 | 9.0 | 6.4–11.6 | 0.9758 |
| eggs (g/day) | 12.1 | 12.7 | 10.0–15.4 | 10.5 | 10.6 | 8.5–12.6 | 0.2627 |
| fat ^a (g/day) | 13.9 | 13.9 | 12.0–15.8 | 13.0 | 13.3 | 11.8–14.8 | 0.6141 |
| dairy products ^b (g/day) | 268.5 | 267.6 | 232.7–302.4 | 242.0 | 239.0 | 217.6–260.3 | 0.1649 |
| tolerated foods (kcal/day) | 393.3 | 367.6 | 326.3–408.9 | 444.5 | 452.7 | 418.3–487.2 | 0.0025* |
| Boys | School meals \geq 3 times per week n = 225 | | | School meals < 3 times per week n = 327 | | | Significance level |
| | Food intake | | | Food intake | | | Difference adj. mean values |
| | Mean value | adj. mean value | 95% confidence interval | Mean value | adj. mean value | 95% confidence interval | p-value |
| beverages (g/day) | 1,048.1 | 1,081.8 | 983.8–1,179.8 | 1,101.5 | 1,085.6 | 1,031.6–1,139.6 | 0.9498 |
| fruit (g/day) | 127.6 | 122.2 | 101.3–143.0 | 106.3 | 110.0 | 98.1–122.0 | 0.3442 |
| vegetables (g/day) | 95.8 | 92.8 | 79.7–105.9 | 87.9 | 90.2 | 81.8–98.7 | 0.7412 |
| carbohydrate-rich foods (g/day) | 257.9 | 262.7 | 239.3–286.1 | 241.5 | 238.8 | 229.4–248.2 | 0.0684 |
| meat (g/day) | 75.7 | 74.4 | 65.0–83.7 | 78.5 | 78.2 | 71.4–85.0 | 0.5161 |
| fish (g/day) | 10.8 | 11.0 | 7.7–14.3 | 10.7 | 10.5 | 8.3–12.7 | 0.7815 |
| eggs (g/day) | 12.7 | 11.2 | 8.5–13.9 | 10.9 | 11.4 | 9.6–13.2 | 0.8803 |
| fat ^a (g/day) | 15.3 | 15.2 | 12.9–17.4 | 13.1 | 13.2 | 11.9–14.5 | 0.1467 |
| dairy products ^b (g/day) | 326.0 | 327.4 | 295.4–359.4 | 273.7 | 273.7 | 250.1–297.4 | 0.0072* |
| tolerated foods (kcal/day) | 501.9 | 496.6 | 433.6–559.7 | 483.1 | 488.3 | 445.8–530.9 | 0.8451 |

Tab. 3: Mean intake of food groups (in g or kcal/day) among 6- to 11-year-olds in the EsKiMo II study (n = 1,094) by frequency of utilisation of school meals – raw and adjusted for age, SES and region

^a fats/oils used for cooking or spreads; ^b quantity calculated as milk equivalent

* statistically significant differences (a difference is assumed to be statistically significant at $p < 0.05$)

adj. mean = adjusted mean; SES = socioeconomic status

times a week is 36.0% for 6- to 11-year-olds and 12.9% for 12- to 17-year-olds.

6- to 11-year-olds

Achievement of OMD recommendations by frequency of school meals

For girls, there were no significant differences in the proportions of those who achieved the OMD recommendations depending on the frequency of utilisation of school meals. The 11.6% of boys who utilised school meals frequently (\geq three times per week) were significantly more likely to achieve the OMD recommendation for fruit than their comparison group (4.2%, $p = 0.0147$) (♦ Table 2 in the online supplement → www.ernaehrungs-umschau.de).

Intake levels of the various food groups by frequency of utilisation of school meals

The intake levels for each food group were compared between those who had a school lunch at least three times a week and those who did so less often. The food groups where the difference in median intake is at least 10% are mentioned in the following passage.

In terms of median consumption, girls who had a school lunch at least three times a week consumed more fruit, vegetables and eggs and fewer beverages and less energy from “tolerated foods” than girls who had school meals



at most twice a week. Among boys, those who had a school lunch at least three times a week consumed more fruit, eggs, fats/oils used for cooking or spreads and dairy products and less meat than boys who had school meals less often (♦ Table 2 in the online supplement).

When the possible influences of age, SES and region on consumption behavior are taken into account, the differences in diet associated with different frequency of utilisation of school meals remain for “tolerated foods” among girls and for dairy products among boys. Girls who have school meals more frequently consume an average of 368 kcal/day from “tolerated foods”, while the average in the case of infrequent school meals is 453 kcal/day. Boys who eat at the school cafeteria at least three times a week consume significantly more dairy products (327 g) per day than boys who have school meals less frequently (274 g) (♦ Table 3).

12- to 17-year-olds

Achievement of OMD recommendations by frequency of school meals

Girls who have a school lunch at least three times a week are significantly more likely to achieve the OMD recommendations for eggs (36.3%) and fats/oils used for cooking or spreads (45.1%) than girls who have school meals less frequently (19.4%, $p = 0.0081$ and 26.3%, $p = 0.0042$, respectively). Boys who have a school lunch at least three times per week are significantly more likely to achieve the OMD recommendation for fish (41.0%) than their comparison group (27.9%, $p = 0.0257$) (♦ Table 4 in the online supplement → www.ernaehrungs-umschau.de).

Intake levels of the various food groups by frequency of utilisation of school meals

There are also differences in the consumption of different food groups among 12- to 17-year-olds associated with utilisation of school meals. In terms of median consumption, girls who have school lunch at least three times a week consume more carbohydrate-rich foods, eggs, and dairy products than girls who have school lunch less frequently. Boys who have school meals at least three times a week consume more fruit, vegetables, and meat than boys who have school meals less often. In terms of median consumption, adolescents of both genders who have school lunch at least three times a week consume fewer beverages, more fish, more fats/oils used for cooking or spreads, and more energy from “tolerated foods” than their comparison groups (♦ Table 4 in the online supplement).

When the possible influences of age, SES and region on consumption behavior are taken into account, girls who have school meals more frequently consume more carbohydrate-rich foods (327 g) on average than those who have school meals less frequently (285 g). For boys, there are no significant differences in the mean intake levels between the two groups when the aforementioned influencing factors are taken into account (♦ Table 5).

Discussion

Achievement of recommended intakes

According to results of EsKiMo II, the nutrition of children and adolescents in Germany largely does not meet the OMD recommendations. While fluid intake is sufficient for the majority of 12- to 17-year-olds, many 6- to 11-year-olds do not drink enough fluids. Furthermore, most children and adolescents do not eat or drink enough fruit, vegetables, milk and dairy products and foods rich in complex carbohydrates. By contrast, consumption of meat and sausage products and “tolerated foods” is too high [4]. This situation is largely confirmed by the results of the HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study, which showed insufficient consumption of fruit, vegetables, and milk and excessive consumption of meat, sausages, and confectionery for 12- to 17-year-olds from 11 European cities [16]. Many other studies have also found that children and adolescents consume too little fruit and vegetables and too much meat and meat products [17–19].

When school meals are utilised more frequently, some OMD recommendations are achieved significantly more often. This applies to the recommendations for fruit intake among 6- to 11-year-old boys, for intake of eggs and of fats/oils used for cooking or spreads among 12- to 17-year-old girls, and for intake of fish among 12- to 17-year-old boys. However, the consumption of vegetables in particular remains far too low for most children and adolescents – even those who have school meals frequently. Less than 2% achieve the recommended intakes in this regard. Similarly, in both observed age groups, only very few boys and girls are within the recommended limits for “tolerated foods”.

Intakes of various food groups

The intake of some food groups is significantly greater when school meals are utilised more frequently. These results are encouraging with regard to fruit, vegetables, fish and dairy products. The lower intake of “tolerated foods” among 6- to 11-year-old girls and of meat among boys of the same age is equally encouraging. However, the amount of energy from “tolerated foods” increased in the 12- to 17-year-old age group as frequency of school meals increased, and for boys, meat consumption also increased with more frequent utilisation of school meals.



| Girls | School meals \geq 3 times per week n = 109 | | | School meals < 3 times per week n = 585 | | | Significance level |
|-------------------------------------|---|-----------------|-------------------------|--|-----------------|-------------------------|-----------------------------|
| | Food intake | | | Food intake | | | Difference adj. mean values |
| | Mean value | adj. mean value | 95% confidence interval | Mean value | adj. mean value | 95% confidence interval | p-value |
| beverages (g/day) | 1,534.3 | 1,587.1 | 1,408.2–1,766.1 | 1,712.0 | 1,709.0 | 1,612.4–1,805.5 | 0.2275 |
| fruit (g/day) | 163.0 | 158.8 | 124.9–192.8 | 166.5 | 168.1 | 153.8–182.3 | 0.6172 |
| vegetables (g/day) | 234.9 | 243.8 | 190.8–296.8 | 208.8 | 207.1 | 190.1–224.2 | 0.2020 |
| carbohydrate-rich foods (g/day) | 325.1 | 326.7 | 289.5–363.9 | 286.5 | 285.4 | 271.2–299.7 | 0.0412* |
| meat (g/day) | 88.6 | 89.7 | 71.5–108.0 | 86.6 | 86.7 | 78.3–95.1 | 0.7615 |
| fish (g/day) | 9.8 | 9.7 | 6.4–12.9 | 8.4 | 8.6 | 6.9–10.2 | 0.5581 |
| eggs (g/day) | 18.0 | 18.5 | 15.1–21.8 | 15.1 | 15.1 | 13.1–17.1 | 0.0963 |
| fat ^a (g/day) | 27.7 | 27.9 | 24.0–31.8 | 24.0 | 23.9 | 22.3–25.5 | 0.0621 |
| dairy products ^b (g/day) | 336.0 | 334.3 | 275.7–392.9 | 279.1 | 279.3 | 257.8–300.7 | 0.0785 |
| tolerated foods (kcal/day) | 435.6 | 435.0 | 331.2–538.9 | 402.5 | 407.1 | 372.9–441.4 | 0.6069 |
| Boys | School meals \geq 3 times per week n = 115 | | | School meals < 3 times per week n = 490 | | | Significance level |
| | Food intake | | | Food intake | | | Difference adj. mean values |
| | Mean value | adj. mean value | 95% confidence interval | Mean value | adj. mean value | 95% confidence interval | p-value |
| beverages (g/day) | 1,804.6 | 1,880.9 | 1,670.3–2,091.5 | 2,011.9 | 1,994.9 | 1,895.6–2,094.2 | 0.3179 |
| fruit (g/day) | 151.8 | 146.7 | 114.2–179.1 | 134.7 | 134.2 | 117.4–151.0 | 0.4819 |
| vegetables (g/day) | 194.9 | 191.9 | 148.3–235.5 | 176.2 | 175.4 | 159.0–191.8 | 0.4839 |
| carbohydrate-rich foods (g/day) | 365.7 | 372.4 | 334.4–410.4 | 355.6 | 353.5 | 338.0–368.9 | 0.3599 |
| meat (g/day) | 130.9 | 136.5 | 120.0–153.1 | 129.0 | 128.5 | 118.8–138.2 | 0.3692 |
| fish (g/day) | 15.4 | 17.5 | 11.8–23.2 | 12.7 | 12.3 | 10.0–14.6 | 0.0675 |
| eggs (g/day) | 20.3 | 21.8 | 16.7–27.0 | 20.9 | 20.8 | 18.4–23.1 | 0.7048 |
| fat ^a (g/day) | 34.6 | 33.0 | 27.9–38.1 | 29.5 | 29.3 | 27.1–31.5 | 0.1720 |
| dairy products ^b (g/day) | 377.4 | 385.9 | 323.8–448.0 | 409.9 | 413.2 | 374.4–451.9 | 0.4388 |
| tolerated foods (kcal/day) | 593.4 | 582.8 | 485.2–680.5 | 542.2 | 548.0 | 502.8–593.3 | 0.5134 |

Tab. 5: Mean intake of food groups (in g or kcal/day) among 12- to 17-year-olds in the EsKiMo II study (n = 1,299) by frequency of utilisation of school meals – raw and adjusted for age, SES and region

^a fats/oils used for cooking or spreads; ^b quantity calculated as milk equivalent

* statistically significant differences (a difference is assumed to be statistically significant at $p < 0.05$)

adj. mean = adjusted mean; SES = socioeconomic status

The lower intake of fluids associated with a more frequent utilisation of school meals requires further examination by beverage type in future analyses. In the present study, total fluid intake includes both desirable energy-free beverages and less desirable beverages, such as sodas.

After adjusting for age, SES, and region, it also became apparent that the 6- to 11-year-old girls who had school meals more frequently consumed significantly less energy from tolerated foods than the girls who had school

meals less frequently. Their total energy intake was also lower on average than that of girls who had school meals less frequently (data not shown). This suggests that school meals could support the maintenance of an optimal energy balance and thus help prevent obesity in the long term.

6- to 11-year-old boys who ate at the school cafeteria at least three times a week consumed significantly more dairy products than boys who had school meals less frequently. This is an initial indication that school meals could also make a positive contribution to bone health. However, no conclusions about direct causality can be drawn from these observed correlations.



International reviews from 2017 and 2018, which comprised mainly studies from the United States, revealed differences in children's dietary behaviors depending on whether it was a school day or a day off from school, such as a summer vacation day or a weekend day. It was found that children consume more snacks and fewer fruit and vegetables on days off school and on less structured days than on school days. In these reviews, school lunches were associated with higher overall nutritional quality than lunches children ate at home [20, 21].

In France, 3 to 17-year-olds who had school meals at least three times a week consumed fruit, vegetables, fish, and dairy products more frequently, but they also consumed cookies, cakes, ice cream, sweet desserts, and pizzas more frequently. They consumed sandwiches, soft drinks, chocolate, and confectionery less frequently than those who had school meals less frequently [22]. In Canada, 14 to 17-year-old students who had school lunch consumed more vegetables, fruit, and whole grains and fewer sugar sweetened beverages than those who had their lunch elsewhere [18].

The nature of school meals varies around the world. In Finland, Sweden and Germany (partly subsidised) hot meals are offered. In Denmark, Norway and the Netherlands, lunches are traditionally brought in from home [23]. This makes it difficult to compare the impact of school meals at the international level. Some studies directly compare the composition of school meals and meals eaten at home or brought in from home. For example, in a Dutch study, it was observed that children consumed more milk and dairy products and fewer sugar sweetened beverages in a lunch eaten at home compared to a lunch brought in from home and eaten at school [17]. A study conducted in Sheffield, UK observed that 8 to 10-year-olds who had school lunches consumed vegetables more frequently but also consumed cakes and cookies more frequently, and that they consumed fruit, meat products, confectionery, and undesirable beverages less frequently than those who brought their lunch from home [24]. Among 15 to 17-year-olds in Ireland, meals brought in from home contained more fruit, wholegrain bread, cheese, and red meat and fewer processed meats, chips, and energy-rich beverages than the meals provided at school [25].

Nutritionally balanced school meals can make an important contribution to a healthy diet among school pupils. Interventions at the level of school catering services could help improve nutrition among pupils. Effective measures include providing fruit and vegetables free of charge [26]. Expanding school meals by providing appealing, high-quality meals at affordable prices could increase the proportion of children and adolescents who take advantage of them and help improve the nutrition of all children and adolescents, regardless of their social or cultural backgrounds. Acceptance of school meals could also be increased by providing attractive spaces to eat in, by providing sufficiently long break times and by taking the food preferences of children and adolescents into account or actively involving them in the composition of a balanced lunch. A pleasant dining atmosphere and ample time for conscious enjoyment of the eating experience and for participation could also lead to an increased awareness of nutrition. Restricting the sale of snacks and sweetened beverages could reduce consumption of "tolerated foods".

The results of this study are subject to some limitations. For instance, it is not possible to exclusively or causally attribute these results to the nutritional quality of school meals. Only a part of the midday meals a school pupil eats each week are school meals, and midday meals only account for a portion of total food intake over the course of a day. This portion of total food intake is what was analysed in this study. In addition, the intake data for 6- to 11-year-olds are based on food records covering a maximum of four days, one of which was a weekend day in most cases. Furthermore, in the 12- to 17-year-old age group, for which the period covered by the interview was four weeks, any vacation days there may have been were not taken into account. Therefore, the number of days on which lunch was actually eaten at school is an additional limiting factor. Another limitation is that the dietary assessment was based on self-reported data, and inaccurate estimations of intake therefore cannot be ruled out. In addition, assessment of food intake at school relies more heavily on the child's or adolescent's memory, which means that these data may be more likely to be biased than the data on meals eaten at home.

Comparing the data with the OMD recommendations is useful, but this approach also has certain limitations. Since the food groups are relatively broad, the nutritional quality of the individual foods within these groups can vary widely. For example, sweetened beverages are counted as part of fluid intake, even though consuming them is not recommended. Fruit juices are also included in fluid intake and are not included in the fruit intake, which leads to an underestimation of fruit consumption. In the future, more detailed specifications for what should be counted in each food group would be helpful in terms of allowing a more nuanced analysis. In addition, the recommendations for nutrient intakes on which the food group intake recommendations are based are largely extrapolations from the requirements for adults and they do not take the individual growth and developmental status of the children and adolescents into account [2, 7].

Nevertheless, the results from EsKiMo II show that for certain food groups, regular utilisation of school meals can be associated with an improvement in consumption behavior among children and adolescents. Other measures such as the EU school programme supported by the European Union – which not all schools are participating in yet – may con-



tribute to an increase in fruit and vegetable consumption [27].

The OMD is exemplary for how food based dietary recommendations for children and adolescents in Europe can be developed [7]. One advantage of using it as a benchmark is that it provides age-specific amounts of food based dietary guidelines that take the different energy requirements of children and adolescents at different stages of development into account. The OMD recommendations focus on daily requirements. They are well suited for the evaluation of intakes of different food groups in different population groups, as was done in EsKiMo II. They were also used for evaluations in the HELENA study, as well as other studies. In the HELENA study, evaluation was also done using the US food pyramid, which led to very similar results [16]. Both the DGE Quality Standards for school meals and the OMD recommendations aspire to a nutritionally balanced diet. The DGE Quality Standards refer to school meals in Germany. They specify how often individual food groups should be offered. When considered in the context of other factors in the environment, such as break times, these standards provide a very comprehensive basis for food provision in schools. In addition to specifying how often certain food groups should be provided, the standards also provide specifications for the specific quantity that should be provided for certain food groups, but these standards are for individual meals and not for the entire day. In this way, the same goal is addressed at various levels. On the whole, it would be desirable to make the implementation of the DGE Quality Standards for school meals mandatory at the federal level in order to ensure that schools offer nutritionally balanced meals. Both the German Alliance for Non-Communicable Diseases (*Deutsche Allianz Nichtübertragbarer Krankheiten* – DANK Initiative) and the Scientific Advisory Board of the German Federal Ministry of Food and Agriculture (BMEL) support this position [28, 29]. With the establishment of the Networking Centers for School Catering at the federal state level in 2008 and the National Quality Centre for Nutrition in Daycare Centres and Schools (*Nationales Qualitätszentrum für Ernährung in Kita und Schule*, NQZ) in 2016, an important step was taken to improve the quality of the meals provided in schools [30]. The implementation of a monitoring system for school catering would make it possible to

collect comprehensive data with a special focus on the requirements for school catering, to identify areas where action is needed, and to continuously improve school catering [31].

Conclusion

Results from EsKiMo II suggest that regular utilisation of school meals is associated with differences in intakes of various food groups. School meals have a key role to play in shaping the living environment in a way that promotes health. Schools are a place where improvements can be made to the nutrition of a particularly large number of children and adolescents, regardless of their social and cultural background, by offering a lunch that is in line with dietary recommendations.

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Conflict of interest

The authors declare no conflict of interest.

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