KiESEL - The Children's Nutrition Survey to Record Food Consumption for the Youngest in Germany

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Abstract

Background

With KiESEL, the Children's Nutrition Survey to Record Food Consumption, the German Federal Institute for Risk Assessment (BfR) collected representative food consumption data for children aged six months up to five years. KiESEL was one of five modules of KiGGS Wave2 (German Health Interview and Examination Survey for Children and Adolescents) conducted by the Robert Koch-Institute (RKI). The objective was to update the consumption data for children in Germany and to fill a data gap for the age group of five-year-old children. The study provides an up-to-date and comprehensive database that will be used for exposure assessment, as part of risk assessment of Germany's youngest consumers.

Methods

In the years 2014 to 2017, more than 1000 children from all over Germany participated in KiESEL. During home visits, survey staff conducted a questionnaire-based interview including a food propensity questionnaire (FPQ) on seldom eaten foods and questions concerning consumption outside home, dietary habits and diet during first year. The interviewer measured the children's height and weight. Families and childcare workers filled out a food record, covering three consecutive days and one independent day. Data are based on the FPQ and present consumption frequencies. Depending on the question, socioeconomic status (SES) and migration background were considered.

Results

1104 participants had an interview and filled out the questionnaire on usual food intake, seldom eaten foods and consumption away from home. They were included in sample1. 1008 of these participants additionally reported food consumption of at least three days (sample2). 91.2 % of the children follow no special diet and 0.8 % are vegetarians. 7 % of the older children consuming soya-drink. For some foods differences in consumption across SES or migration status were noted. Children from families with higher SES consume more often soya-based substitute milk as families with lower SES ($p < 0.00005$).

Conclusions

KiESEL gathered up-to-date consumption data for more than 1000 children living in Germany, aged six month up to including five years. The data will be used for risk assessments of the BfR and provided to national and international partners.

Background

The German Federal Institute for Risk Assessment (BfR) carries out scientific risk assessments of substances in food as part of consumer health protection. With the background of risk assessment,

exposure estimates are based on content data of substances and consumption data of the population. With regard to exposure estimation, the body weight is decisive. Higher exposure in relation to body weight are often found in children compared to adults. Infants, toddlers and young children are therefore a particularly vulnerable group in the population (1–3). Up-to-date consumption data for this age group was not available in Germany prior to the KiESEL study. In 2008, the GRETA study (German Representative Study of Toddler Alimentation) of the Research Institute of Child Nutrition (FKE) collected representative consumption data for children aged 10-36 months (4). These data can only be used for risk assessment to a limited extent, as the food was recorded in very broad categories and children older than 3 years were not considered. The last consumption survey with a focus on risk assessment was carried out nearly 20 years ago in 2001/2002 in the 6-month to 4-year age group with the VELS study (consumption study to determine the food intake of infants and young children to assess an acute toxicity risk from pesticide residues) (5). 5-year-old children were not included.

Revised nutritional recommendations (6), steadily increasing food offers (e.g. superfoods) as well as changes in global nutritional habits (7) indicate that an update of the consumption data of infants and toddlers aged between 6 months and 5 years in Germany is necessary.

As a result, the Children's Nutrition Survey to Record Food Consumption (KiESEL) was created and carried out as one of five modules of KiGGS Wave 2 (German Health Interview and Examination Survey for Children and Adolescents) (8) conducted by the Robert Koch-Institute (RKI).

The KiGGS study is part of the health monitoring system at the RKI (9). It was conducted for the first time in the years 2003-2006 and as wave 1 from 2009-2012. The aim was to collect population-related data on the health situation of children and adolescents living in Germany. KiGGS Wave 2 (2014-2017) offered again the opportunity to examine subgroups of the study population in more detail on a specific topic in the form of modules, e.g. the KiESEL study (3, 10).

The main objective of the KiESEL study was to obtain food consumption data for children aged between 6 months and 5 years for the purpose of estimating exposure to contaminants, pesticides and food additives, as well as collecting information on food fortification and microbial risks required for health assessment. In addition to the main objectives, up-to-date data on nutrient intake are collected to describe the nutritional situation of infants and toddlers, which can also serve as a scientific basis for policy decisions. Using the data on comparative exposure estimates within the European Union is also possible. The comparable methodology allows trend analyses between the VELS study and the KiESEL study. In addition, the results can be used to assess the general nutritional status of infants and young children and possible deficit areas for evaluation.

The cooperation between the BfR and the RKI also makes it possible to combine the consumption data from KiESEL with more comprehensive data from KiGGS wave 2. The generated data set combines nutrition and health data and thus more extensive evaluations are possible.

Additionally, many children in Germany are cared for outside their home, for example in kindergarten or with a day mother. In order to obtain a complete picture of the children's nutrition situation, food consumption recording needs to be continued in the child day care facilities in the same way as at home. With KiESEL these parts of the day are included in the data collection.

Methods

Pretest

The aim of the pretest was to test the developed survey instruments as well as the information materials for comprehensibility and feasibility (11). This included contact with the participants, the quality and handling of the survey instruments, the comprehensibility and duration of the questionnaire as well as the communication with care institutions (child day care centre, kindergarten etc.). The participants wrote down their experiences and comments in two satisfaction questionnaires, which were then evaluated by the KiESEL team. In this context the time schedule of the study and the general effort of the participants were tested. A total of 40 families from Berlin and Brandenburg took part in the pretest, 4 age groups were formed to determine the age-specific dietary requirements. The study instruments were refined based on the results of the pretest (data not shown). To facilitate all processes an additional graphic explanation was developed to enable the participants to fill out the records more easily. For the use of the picture book, graphic instructions were embedded and a keyword register for substitute foods was added. As another result, the study protocol for the child day care was simplified and only the most necessary columns were kept, e.g. time and place of consumption, product description with brand and specific product name, organic/conventional and the amount eaten. There was still enough space to note recipes in case the child day care workers prepared all meals by themselves or to mention the caterer.

Additionally a specific flyer with all the necessary information for the child day care centres was created.

Study design and study population

In the first step, 167 sample points, representative cities and communities for the Federal Republic of Germany, were selected for the study population of KiGGS Wave 2. The following step was to draw a randomized and stratified sample according to age and sample point from the RKI and the respective registers of the sample points. The target population and sampling for KiGGS Wave 2 is described in detail elsewhere (8).

The random selection of infants and toddlers from the cross-sectional sample for the KiESEL study has been carried out at the time of sampling of KiGGS Wave 2. To be part of the KiESEL study, previous participation in KiGGS Wave 2 was required.

KiESEL was conducted from December 2014 to October 2017. In order to ensure the representativeness of the data collection, regionality and seasonality were implemented. The study aim was to achieve at least 1000 participants. A case number of 167 children per year was aimed for so that approximately 83 participants each were planned for age and gender. The age distribution of study participants at time of

recruitment by RKI differs systematically from the age distribution at the time of investigation due to the elapsed time between these two events. Participants were age classified based on their age at time of investigation. Children elder than 5 years (n=64) were not excluded. To achieve a high participation rate, easily understandable but comprehensive information material was provided to the participants and incentives were given after the participants sent back all completed food records. Continuous training for the interviewers to establish contact and to support the participants during the ongoing protocol phase was an important component in achieving the targeted number of cases.

Participation in the study was optional. An interview was conducted after information and written consent of the legal guardians of the participating children. The study is approved by the Federal Commissioner for Data Protection and Freedom of Information and by the ethics committee of the berlin medical association (Eth-28/13). KiESEL was also audited by „aproxima - Gesellschaft für Markt- und Sozialforschung Weimar mbh“ as part of an external quality management system.

Study procedure

KiESEL's methods are based on the study protocols of EsKiMo I (Eating Study as a KiGGS module) and the VELS study (5, 12, 13). Figure 1 shows the KiESEL process. The study participants in the cross-sectional part of KiGGS Wave 2 who had given their consent to be contacted by KiESEL study members were invited to participate in KiESEL. After making an appointment by phone or email, trained nutritionists visited the participants at their home. According to the protocol, the visit was identical for each participant and took about 1 hour (mean 65 minutes and standard deviation 13 minutes, based on 1079 questionnaires where duration was indicated). During this time, an interview was conducted, instruction was given on how to complete the two food records, kitchen scales were provided, the children were measured in height and weight and open questions were answered. Age was recorded at the time of the first visit.

After the visit, the family started documenting the 3-day weighing record on a given day. If the child visited a child day care facility, this was also contacted in advance and information material was sent asking to support the family and to document the child's consumption in the food record the parents handed them over. The participants could use a free hotline provided by BfR to ask any questions related to the study and data collection. After completion, the participants were required to return the food records to the BfR, where the KiESEL study team checked and documented the arrival of the food records. If necessary the participants were called back to clarify questions about the food record. Within a fixed period of time, depending on the child's age, the letter of thanks and both single day weighing record (family and daycare) for the unrelated day was sent to the participants. After being filled out, the second food record was also sent back to the BfR and proceeded in the same way as the 3-day food record. After everything had been checked and confirmed the second letter of thanks was sent to the family. KiESEL provided the participants with a voucher and an age-appropriate toy for the child as well as a brochure about child nutrition. Participating child day care facilities had the possibility to gain a voucher for supporting the study by filling out the record in addition to the parents (3).

Route planning and realisation

The route planning should achieve a nationwide representativeness in terms of both seasonality and regionality and followed the sample points of KiGGS (8). During the field phase a total of 117 tours in 167 sample points around Germany were approached. Per KiESEL route, 2 - 4 sample points were visited. Two interviewers visited an average of three families in parallel every day, travelling between 5 and 12 consecutive days. Some sample points had to be visited several times to avoid too long period of time after receiving addresses from the KiGGS-survey, but to include also delayed KiGGS-responses. Around five weeks before the individually planned start of the survey the parents or legal guardian of the children were invited to take part in KiESEL by telephone or e-mail and an appointment was made. They received a cover letter informing them about the study, its contents and objectives. A declaration of consent was also attached, which had to be signed and was collected by the interviewer afterwards. The participants were informed about data protection issues through a data protection sheet. The visits took place exclusively at the participants' homes. The opportunity to conduct the interview in the KiESEL bus was offered to all participants, but was chosen only once.

Distribution of weekdays

At least one weekday (Monday-Friday) and one weekend-day (Saturday or Sunday) should be recorded to cover the existing differences on dietary behaviour and food choice between weekdays and weekend days. For example, some children may only eat sweets or a breakfast egg at the weekend. According to a self-developed algorithm, day combinations were assigned to the contact data. Participants were asked to start the food record on a fixed day at the latest 1 week after the interview. Where it was impossible for the participants to report on the given days (due to moving house, travel, separated parents, refusal to attend day care or other specific reason), a different combination of days was agreed upon with the interviewers.

Interview on food consumption

The interview concerning the child's food intake was carried out by means of a questionnaire. The questionnaire included general information (e.g. gender and age), the child's current dietary habits, information on its diet during the first year, the out-of-home-consumption, a food propensity questionnaire on seldom eaten foods and further questions for self-completion on the parents' attitude towards nutrition. This questionnaire provides additional information to the food records. Filling it out in paper form during the home visit enabled the parents to get their questions answered directly by the interviewer. Even though all interviewers were dieticians or nutritionists there was an interviewer's guide to ensure a standardized interview procedure, which clarified the background to the questions and questions of understanding regarding the contents of the questionnaire in general. The last part of the questionnaire included questions about the general choice of food (e.g. organic or conventional) and its preparation. Self-completion was chosen for this part to avoid a bias in the answers due to social desirability and the feeling of possible judgement by the interviewer.

All the other questions were guided by the interviewer. The questionnaire section on the frequency of consumption of seldom eaten foods is of particular interest for the risk assessment, e.g. to know the possibility of high concentrations for some contaminants (e.g. fipronil in eggs (14)). Its intention is to identify non-consumers of certain foods and to reflect the eating frequency of seldom eaten foods that are often underrepresented in other food consumption methods like dietary records or 24h-recalls (15).

After the home visit the data were entered into the web-based application LimeSurvey (16).

Food records

The food intake of the children was prospectively documented by the families and, where applicable by child day care facilities in form of a weighing and estimation record for three consecutive days and an unrelated fourth day. This 3+1 concept allows short and long-term exposure estimates (17–19). These two records should record food intake independently. To ensure this, the chosen interval between both records was 4-8 weeks for infants and 3-4 months for older children. The food and beverages were recorded in detail, including brand name, food consumed, fat content, fortification, packaging at purchase, condition at purchase, method of preparation, place of preparation or consumption and the indication if it was organic (Figure 2).

Using the kitchen scales provided by KiESEL, the quantity ready for consumption and, where appropriate the leftovers not consumed, were weighed to obtain the quantity actually consumed. In addition to the identification of the food consumed, recipes of home-prepared dishes should also be noted. In order to quantify the amounts of food consumed away from home or in child day care facilities (e.g. ice cream or snacks), estimates should be made using household sizes, recording quantities indicated on packaging or the KiESEL picture book.

The food record for day care workers was designed in a less detailed way (see section “Pretest”). Parents were also requested to ask the child day care facilities for the exact recipes of the self-prepared meals or the name of the dishes prepared by caterers. This was to facilitate the research of the recipes at caterers by the study team afterwards.

In addition, any deviations from the usual food intake caused by illness, holidays or other special occasions, as well as by the intake of medication and food supplements, should be reported for each day.

The data from the food records were digitized using the EATv3 software adapted for KiESEL, which was developed for the VELS study by the University of Paderborn (5).

Picture book

The participants and day care workers received a picture book developed by BfR, which depicts different portion sizes of different foods in a manner suitable for children (Figure 3). The picture book was only to be used if it was not possible to read off the packaging or to weigh the food for consumption away from home. It contains 65 picture series and individual pictures as a collection of pictures provided by the Research Institute for Child Nutrition Dortmund (FKE), the International Agency for Research on Cancer

(IARC), the Max Rubner Institute (MRI) and the Pilot study for the Assessment of Nutrient intake and food Consumption Among Kids in Europe (PANCAKE), as well as pictures and a set of silhouettes of different foods developed by the BfR.

For an easier use, a graphic introduction on how to use the picture book and a table of contents of different food groups can be found at the beginning. An additional keyword register was embedded to cover many foods that are not all shown in image series. The keyword register refers to the corresponding image number with which the food should be estimated alternatively. Due to this innovation more foods and especially foods that are mainly eaten by toddlers and children could easily be added and parents or day care workers were enabled to find the corresponding images more easily and in a standardized way.

The quantity data of the already existing image series were provided by the data owners and stored in the software EATv3. The KiESEL-Team reconstructed all food suggested as alternatives by the register and determined a corresponding portion size. In addition, images were also simulated, which the participants estimated by image numbers that were not specified by KiESEL as alternatives. This procedure has resulted in a steadily growing portion size database. In order to determine the quantities of the simulated image series, each portion size was simulated three times, weighed and finally the average value was calculated.

Anthropometry

To obtain reliable values for the child's weight and height, standardized measurements were taken (20). The height and weight of infants was measured while the child was lying down using a portable measuring board (seca 417, Hamburg, measuring accuracy: ± 0.5 cm) and the body weight was measured using a portable and calibrated infant scale (seca 336, Hamburg, measuring accuracy: up to 5 kg: ± 0.005 kg; 5 to 15 kg: ± 0.01 kg). For children who could stand securely, the height was measured while standing with a portable stadiometer (seca 217, Hamburg, measuring accuracy: ± 0.5 cm) and the body weight with a portable and calibrated scale (seca 877, Hamburg, measuring accuracy: ± 0.1 kg). The participants were weighed without clothes, only with underwear on. In case clothes could not be taken off or for the smaller ones nappies should stay on, a certain amount of the weight was subtracted.

If the participant refused weighing or measuring the possibility existed to use the information from the medical examination booklet all children in Germany own and where all regular examination results can be found. This occurred 35 times for body weight and 38 times for height. In some other rare cases (around 20 participants) self-declarations from the parents were accepted.

Coding

All documented foodstuff was coded using the German nutrient database (Bundeslebensmittelschlüssel (BLS)) version 3.02 (21) or in case of food specially designed for children using the codes of the German food composition database for dietary evaluation of children and adolescents (LEBTAB) (22). As dietary supplements and medicine were also recorded, a special coding system for dietary supplements was

created by the KiESEL-team, based on the main ingredients. As this is a nutrition study, medicine was only recorded but not coded.

Caterer recipes

In order to substantiate the data on the meals consumed in the child day care facilities, the caterer were contacted after reception of the food records. The main purpose of this elaborate procedure was to find out the exact recipes for the documented lunchtime meals and all other important information of their ingredients.

Portion size database

In case the participants didn't weigh their food but only noted quantities like "one leaf of basil" or "a spoon full of milk" related weights were needed. Already existing information about portion sizes like a list of food in the EAT program (EAT2006), the Monica-Mengenliste (23), information from the KiESEL picture book, manufacturer information or others were gathered to create a KiESEL portion size database. In a continuous process of data entry, new portion sizes were determined, for example by adjusting the existing ones and weighting new ones. In the end, all mentioned portions of all foods were covered. The portion size database is planned to be implemented on the BfR homepage (24).

Supplement database

In order to satisfy the requirements of the risk assessment, a supplement database was created, implying all data from the food records and the questionnaire referring to supplements. The database is divided into groups like single and dual nutrient preparations with specification, multivitamins, minerals, multi-nutrients and multi-fatty acid preparations, probiotics and others without specification. The nutrient composition of all specified dietary supplements was checked with the available product information from the photographed packaging, the Internet, other available databases and, if available, manufacturer information. More detail can be found in a separated paper about supplements in KiESEL (25).

Representative Sample Weighting

In order to ensure that estimates based on the study population are representative for Germany in the respective age group a weighting variable was prepared. This includes the age and gender distribution within the federal states, parental education and socio-economic level and nationality (German yes/no). The sample weighting takes into account the different participation probabilities within the sample design. It corrects deviations of the design-weighted net sample from the German population using population statistics from 2014/ 2015 and the distribution of education according to the CASMIN classification (Comparative Analysis of Social Mobility in Industrial Nations) from the 2013 micro census. Individual sampling weights were made available by courtesy of the KiGGS team of RKI.

Statistical Procedures

Characterization of the study population was based on sex and age. For this purpose the participants were classified according to their age in infants (<12 months), toddlers (12 – 35 months) and children

(>35 months). Information on frequencies include percentages and numbers, if appropriate. Kruskal-Wallis H test was used to assess differences for consumption frequencies between groups of socio-economic status (SES), with SES modelled as grouping variable (low SES, middle SES and higher SES). To ascertain which pairs of groups of SES differ from each other additional post hoc analyses were performed (Bonferroni correction). The Mann-Whitney U test was used to determine differences for consumption frequencies between participants with migration background and participants without migration background. In case of missing values or abstentions on SES, migration status or consumption frequencies participants were excluded from the analyses described above. A P value less than 0.05 was considered to indicate a statistically significant difference. Statistical calculations were performed by using IBM SPSS Statistics (Version 26) and Microsoft Excel 2016. All presented results are based on weighted data (otherwise mentioned in the explication).

Results

Participants and response

The KiESEL study comprises two study samples. In sample1 there are all 1104 participants that had an interview, filled out the general questionnaire, the FPQ and anthropometric data. In sample2, a subsample of sample1, there are those 1008 participants that reported at least 3 days of their food consumption, additionally to the interview. The study aim was to have a food record with three consecutive and one independent day protocolled by each participant. To value also the results of those participants who made an effort to document their consumption but did not reach the requested 3+1 days, those who reported three consecutive (49 participants) or two consecutive and one independent day (10 participants) were also included. Response rate for sample1 is 82% and for sample2 it is 75%.

Evaluation Non-participants and quality-neutral drop-outs

From all 1453 transmitted addresses by RKI (gross sample), 111 were subtracted as quality-neutral drop-outs, resulting in a net sample of 1342 potential participants. Main reason for quality-neutral drop-outs were: families could not be reached following the KiESEL contact procedures, communication was not possible due to language problems or contact information was not up-to date.

238 of the remaining 1342 potential participants denied participation actively or passively. They were counted as non-participants and systematic drop-outs. The main reasons were: “interested in KiESEL but lacking time”, “no interest/no reason given” or “effort too high”.

Age

Sample1 consists of 560 boys (respective to 565 boys using sample weighting) and 544 girls (respective to 539 girls using sample weighting) and sample2 consists of 510 boys (respective to 515 boys using sample weighting) and 498 girls (respective to 493 girls using sample weighting).

Table 1
age distribution in KIESEL - sample1 and sample2 (weighted numbers in parentheses)

	sample1			sample2*		
	(numbers using sample weighting)			(numbers using sample weighting)		
	male	female	total	Male	Female	total
0 y	59 (42)	64 (45)	123 (88)	56 (37)	62 (42)	118 (79)
1 y	92 (99)	116 (86)	208 (186)	80 (90)	110 (85)	190 (175)
2 y	99 (93)	76 (87)	175 (181)	95 (86)	69 (80)	164 (166)
3 y	89 (91)	77 (96)	166 (187)	79 (88)	68 (86)	147 (174)
4 y	97 (103)	90 (88)	187 (191)	85 (86)	78 (76)	163 (162)
5 y	95 (103)	86 (103)	181 (206)	87 (98)	77 (91)	164 (189)
>5 y	29 (33)	35 (33)	64 (66)	28 (30)	34 (32)	62 (62)
Total	560 (565)	544 (539)	1104 (1104)	510 (515)	498 (492)	1008 (1007**)
*sample2 is a sub-sample of sample1						
**difference in total numbers are caused by rounded weighted numbers						

In both samples, the number of children for every age group aimed for was achieved or surpassed except for the under-one-year-olds and the two- and three-year-old girls.

Equality in gender distribution was nearly achieved as well. For the one year-olds, the under one-year olds and the more than five-year-olds there were always slightly more girls than boys and for the two-, three-, four- and five-year-olds there were slightly more boys than girls (Table 1).

Eating habits

As to know more about the eating habits the study population can be characterized by the special diets participants were used to e.g. vegan, halal, lactose-free diet (Figure 4).

In sample1 a vegan diet was chosen by 0.4% of the participants whereas 0.4% more crossed this answer but showed no consistency in the food protocol. This additional 0.4% was not considered as vegan. 0.8% of the participants used a vegetarian diet. 1.8% of the participants followed a lactose-free and 0.4% a gluten-free diet. 0.5% of the children were used to a diet poor in fructose, whereas 0.8% were used to a diet poor in milk products and 1.1% tried to avoid foods containing nuts, eggs, wheat, fish or stone fruits due to allergy. 2.0% of the participants only ate halal food. In sample2 these findings are very similar.

Socio-economic status and education

Looking at the socio-economic status 61% of the participants belong to the category middle, 16% to the category low and 23% to the category high socio-economic status. Percentages are similar regarding the parents' education level (51%, 16% and 33%, respectively). Sample2 shows similar findings with slightly less participants with lower socio-economic status and lower educational level.

Out-of home consumption and day care

KiESEL is one of the first studies taking into account not only the food eaten at home but as well the food eaten outside home (e.g. restaurants) and in child day care. The importance of covering the child day care can be seen in the number of children being cared for in day care facilities (figure 5): this are more than half of the KiESEL participants aged 1 and 2 years (58,2%) and nearly all of the KiESEL participants aged over 3 years (97,5%).

In comparison with national statistics of being in a child day care facility, the numbers from KiESEL are different (national statistics to KiESEL 0<3 year old children: 33–48% in child day care respectively >3 year old children: 94–98% in child day care) (26).

First results of the food propensity questionnaire on seldom eaten foods

The food propensity questionnaire consists of several questions, including several foods and food groups often relevant from a risk perspective, but whose usual intake can difficultly be estimated using dietary recall or records. The question always started with “How often has your child consumed the following foods since the introduction of complementary foods (for children $\leq$ 18 months) or in the last 12 months (for children $>$ 18 months)?”

For a better overview, the answering categories were simplified (Table 2).

Table 2
Frequency categories as asked in the questionnaire and as aggregated for analysis

Category in the questionnaire	Category in the analysis
Never	never consumed
Less than once a month	rarely consumed
1-3 times a month	
once a week	frequently consumed
2-3 times a week	
4-5 times a week	
6-7 times a week	
no comment	no comment

The analyses were performed looking at the EFSA age groups: infants (<12 month), toddlers (12 month to <36 month) and children (>36 month) (15). If analyses were performed regarding influence of socio-economic status, these variables were taken from the KiGGS dataset. The presented data refer to sample1.

a) Complementary food

All complementary foods are mostly consumed by infants (22-68% consumers), a little by toddlers (5-29% consumers) and rarely by children (0-3% consumers).

Even though the cereals presented in figure 6 are considered to be rarely consumed in Germany it should be noted that for all of the complementary foods more than 6% (up to 37% for rice-based complementary food as ready-to-eat or up to 18% for corn-based complementary food as ready-to-eat) of the infants consuming it least once a week. A supplementary table "Consumption frequency of complementary food, differentiated for the different kind of cereal bases" shows the detailed data. See supplementary table_1.xlsx. Most infant consumers can be found for rice-based complementary food as ready-to-eat: 41% consume it frequently (37% even once a week) and 27% consume it rarely whereas 15% of the toddlers are frequent consumers of rice-based complementary food as ready-to-eat and 14% consume it rarely.

Millet- and corn- based complementary food as ready-to-eat is not consumed that frequently: 19% of the infants are frequent consumers of millet-based complementary food (and 13% are rare consumers) and only 6% of the toddlers consume it frequently whilst 7% consume it rarely.

Complementary food as powder/flakes is used a little less frequently for nearly all kind of cereals asked for. Rice-based complementary powder/flakes are consumed frequently by 26% of the infants and 7% of the toddlers, millet-based complementary powder/flakes are frequently consumed by 26% of the infants

and 11% of the toddlers and corn-based complementary powder/flakes are frequently consumed by 14% of the infants and by only 3% of the toddlers.

The most consumers of rice cake can be found in between the toddlers, followed by children and infants. Nevertheless, if they consume it, infants consume it more frequently. From the 58% infant consumers: 27% consume it frequently and 31% rarely. Looking at the toddlers: 22% of them consume it frequently and 45% rarely. As for the children: 12% of them consume it frequently and 49% rarely.

b) Dairy substitutes (soya drink, rice drink, oat drink) and other soya-based products

Study participants do not seem to consume dairy substitute drinks very frequently. The maximum are 7% of the children consuming soya-drink and 7% of the toddlers consuming oat-drink. For other soya-based products (e.g. tofu, desserts, custard, soya sauce) there are 22% of the toddlers and 18% of the children consuming them (Figure 7).

Oat drink seems to be the most common consumed substitute drink with more than 4% frequent consumers (mostly once a week) and 3% rare consumers for the toddlers and more than 1% frequent consumers and 5% rare consumers for the children. Soya based substitute drink follows with 5% rare consumers for the children and 3% for the toddlers and even nearly 3% frequent consumers for the children. Other soya-based products e.g. tofu on the other hand are consumed more often, at least by toddlers and children.

A supplementary table “Consumption frequency of different dairy substitute drinks and other soya based products, differentiated for the three age groups” shows the detailed data. See supplementary table_2.xlsx.

As the use of dairy substitutes may be influenced by socio-economic status (SES), we had a closer look on this influence for each substitute. It is visible, that children from families with higher SES consume more often soya-based substitute milk as families with lower ($p < 0.00005$) and middle SES ($p < 0.015$). We saw no significant influence by SES for consumption of rice drinks. The consumption of oat-drink was higher from children from families with middle ($p < 0.048$) or higher SES ($p < 0.016$) than by families with lower SES. For soya-based products, the range goes from 7% consumers for families with lower SES to 30% consumers for families with higher SES. It can be seen as well that the higher the parents' education level, the higher the consumption of soya-based substitutes (lower SES to middle SES $p < 0.006$, middle SES to higher SES $p < 0.0005$). A supplementary table “Consumption frequency of dairy substitute drinks and other soya products, differentiated for socio-economic status” shows the detailed data. See supplementary table_3.xlsx.

c) Special meat and sausage products (game, sheep/lamb, ostrich, rabbit, horse)

Consumption differences due to age and migration background are presented here. Looking at the age differences first in figure 8.

Infants seem no big consumers of these types of meat (from 0% for ostrich and horse to 9% for game meat). Toddlers and children seem to consume game meat more often but most of the time rarely. There are 4% toddlers and children that consume sheep/lamb meat frequently. They eat it mostly once a week and some consumers as well 2-3 times a week. For all the other meat and sausage products, there are less consumers, and it is consumed mostly less than once a month. There are around 30% of toddlers and children consuming game meat. 27% of the children and 32% of the toddlers consume lamb/sheep meat. 13% of the toddlers and 16% of the children consume rabbit meat. Whereas horse meat and ostrich meat are nearly not consumed (and therefore not displayed here).

A supplementary table “Consumption frequency of the different types of special meat and sausage products, differentiated for the three age groups” shows the detailed data. See supplementary table_4.xlsx.

As the migration background may influence the type of meat consumed, analyses were performed taking into account the migration background (Figure 9). Participants were classified as “with migration background” if one or both of the parents was not born in Germany. It can be seen that only for game meat and sheep/lamb meat there is a visible difference in consumption frequency. Even though game meat is consumed most often rarely, if it is consumed, it is more often consumed by participants without migration background (31% consumers vs. 17% consumers with migration background ($p < 0.0005$)). Whereas for lamb/sheep meat the relation is inverse ($p < 0.0005$). 45% of participants with migration background consume lamb/sheep meat rarely or frequently. Only 20% of participants without migration background consume this meat. There are 6% of the participants with migration background that consume it even once a week and 1% that consume it 4-5 times a week. Ostrich, horse or rabbit meat are consumed rarely and there are no differences regarding the migration background.

A supplementary table “Consumption frequency of special meat and sausage products, differentiated by migration status” shows the detailed data. See supplementary table_5.xlsx.

d) Offal

Offal is known as a very seldom eaten food but often contains high levels of several contaminants and hence can be relevant for risk assessment. Results from KiESEL confirm that infants, toddlers or children seldom eat offal (Figure 10). Only liver from pork, beef or veal and poultry liver seem to be eaten. If it is eaten, then nearly always less than once a month and more often by toddlers and children. Only 2% of the infants eat pork, beef or veal liver and do this less than once a month. Some other offal from pork, beef and veal (e.g. heart, lungs and stomach) are eaten by 4% of the toddlers and 3% children but mostly less than once a month. (Figure 10)

A supplementary table “Non-consumers of offal from different animals differentiated for the three age groups” shows the detailed data. See supplementary table_6.xlsx.

e) Fish and other marine animals

In the questionnaire, participants were asked about their consumption of 14 different fish and marine animal species. The questions with more than 10% consumers are presented in Figure 11. A supplementary table “Consumption frequency of fish and marine animals differentiated for the three age groups” shows the detailed data of each asked fish or other marine animal. See supplementary table_7.xlsx.

Infants do not seem to eat the fish species asked for very often. Most likely, they eat cold smoked fish (14% consumers, mostly less than once a month). For all the other chosen fish species there are 0-3% infant consumers only. For toddlers and children most of the consumers can be found for canned tuna and shrimps/prawns. There are 39-44% consumers of canned tuna and 2-5% of them are frequent consumers (toddlers and children, respectively). For shrimps and prawns we found similar results even though toddlers seem to eat them slightly more frequently than children. However, there are a little less consumers for shrimps and prawns than for canned tuna. Toddlers and children as well seem to like cold smoked fish (37-40% consumers for toddlers and children, respectively). Even though most of them consume it less than once a month, there are around 5% toddlers who consume it once a week and 1% of the children even 2-3 times a week. Hot smoked fish, e.g. stremel salmon or smoked mackerel, follows in the list of the most popular fishes with 27-33% consumers (toddlers and children, respectively) but it is mostly consumed less than once a month. Mussels, squid and halibut show 8-17% consumers as well.

f) Tea and tea products

Tea is presented in three groups: 1. three different types of fennel tea and ready-to-drink tea especially for children, 2. other herbal teas, 3. Rooibos tea, green tea and black tea. A supplementary table “Consumption frequency of tea and tea products, differentiated for the three age groups” shows the detailed data of each tea separately. See supplementary table_8.xlsx.

1. Baby fennel tea (loose or tea bag), baby fennel tea (instant), other fennel tea and ready-to-drink tea
Infants and toddlers mostly consume baby fennel tea (instant and ready-to-drink). Toddlers and children mostly consume other fennel tea (figure 12). One quarter of the infants are frequent consumers of baby fennel tea (loose or tea bag). 8% of the infants drink it even nearly every day. 13% of the infants are frequent consumers of instant baby fennel tea as well. Most of them consume it 2-3 times a week but 5% of the infants consume it nearly every day. This applies to 2% of the toddlers and 1% of the children as well. Nearly 40% of the toddlers and children drink other fennel tea. For the infants there are 27% other fennel tea consumers all together and 18% of them frequent consumers (3% consume it nearly every day). 11% of the toddlers and 8% of the children are frequent consumers of other fennel tea and they consume it most often several times a week. Ready-to-drink tea especially for children is not consumed very often. There are no more than 10% consumers (toddlers) and it is mostly consumed rarely, nevertheless there are 3% of the infants who consume it nearly every day.

We wondered whether the socio-economic status of the families had an influence on the choice of fennel tea. Statistical significant differences existed only for baby fennel tea (instant). Families with middle and higher SES (7% and 4% consumers, respectively) consume it, whereas 25% of the families with lower SES

consume it. Differences in consumption frequencies for fennel tea (instant) are significant between families with lower and higher SES ($p < 0.0005$) and between families with lower and middle SES ($p < 0.0005$). Most of them with lower SES drink it frequently (16%), 5% drink it nearly every day.

2. Herbal teas (peppermint, camomile and melissa)

Infants consume peppermint tea or melissa tea rarely (Figure 13). For peppermint tea there are only 2% consumers (mostly less than once a month) and for melissa tea there are 4% less frequent and 2% frequent consumers. These melissa tea numbers are similar for toddlers and children. Peppermint tea, on the other hand, is more popular with toddlers and children (22% and 40% consumers, respectively). There are even 11% of the children that consume it frequently, most of them once a week. 21% of the infants, 31% of the toddlers and 42% of the children consume camomile tea, most of them rarely. Nevertheless, there are between 8-11% who drink it frequently, the little ones mostly 2-3 times a week, the older ones mostly once a week.

Looking at the social-economic influence we only see significant values in camomile tea: The most consumers of camomile tea are from families with lower SES (46% consumers) and 20% of them consume it frequently. The differences in consumption frequencies were shown between higher and middle SES to lower SES ($p < 0.005$ and $p < 0.002$, respectively).

3. Rooibos tea, green tea and black tea

KiESEL-participants do not consume rooibos tea, green tea or black tea very often (Figure 14). Green tea is consumed the less, by only 3% of the toddlers and children. 3%, 7%, 13% of the infants, toddlers and children, respectively, consume black tea. It is consumed most often less than once a month or 1-3 times a month, but there are 2% of the children who drink it nearly every day. The consumption of rooibos tea is similar to the consumption of black tea. If it is consumed frequently, then mostly once a week.

Concerning the socio economic background of the participants, black tea was consumed more by families with lower SES in comparison with middle SES ($p < 0.002$) and also in comparison with higher SES ($p < 0.0005$). 18% of the participants with lower SES are consumers of black tea and 6% of them consume it even frequently (1% drink it nearly every day). Whereas families with higher SES show 4% consumers and families with middle SES show 9% consumers.

A supplementary table "Consumption of tea, differentiated for socio-economic status (SES)" shows the detailed data of each tea and tea product separately. See supplementary table_9.xlsx.

For some of the tea species migration status might play a role as well. For other fennel tea ($p < 0.0005$) the participants without migration background show a significant higher consumption. For baby fennel tea (instant), there are no significant differences for participants with or without migration background. Peppermint tea ($p < 0.022$) and melissa tea ($p < 0.001$) were consumed more by participants without migration status. Whereas camomile tea shows higher consumption for participants with migration status ($p < 0.0005$). The consumption of Rooibos tea shows no significant differences between both groups. Participants with migration status also show higher percentages for consumption of green tea

($p < 0.049$) and black tea ($p < 0.0005$). Especially the percentages of frequent consumers are higher for participants with migration status (1.6% for green tea and 10.2% for black tea). For black tea, there are only around 4% consumers of the participants without migration status whereas around 24% of the participants with migration status consume black tea (3.8% of them consume black tea nearly every day). A supplementary table “consumption of tea and tea products, differentiated for migration background” shows the detailed data of each tea and tea product separately. See supplementary table_10.xlsx.

As for regional differences (categorization of regions in KiESEL see the supplementary table_11): In the north-western part exists the highest percentages of black tea consumers. This difference is significant for all regions (16%, eastern part $p < 0.0015$; Northrhine-Westphalia $p < 0.021$; Bavaria/Baden-Württemberg $p < 0.038$) except for the middle of Germany (11%). The participants in north-west also drink it most frequently: 5% drink it 2-3-times a week, 2% drink it nearly every day.

g. Diverse foods and food groups

In these questions we asked for many different items. We choose the following food items to have a closer look at.

1. Sunflower seeds, other oilseeds, poppy seeds and dried fruits

Infants mostly do not eat sunflower seeds or other oilseeds (70% non-consumers, figure 15). If they eat them, they eat them rarely (mostly less than once a month). Poppy seeds are eaten even less often (87% non-consumers). Toddlers and children eat sunflower seeds and other oilseeds more often. Around 1/3 of the toddlers eat them rarely and 35% (for other oil seeds) - 43% (for sunflower seeds) eat them frequently (most frequently once a week or 2-3 times a week). Children eat them even more often. Around 40% eat them rarely and another 33% (for oilseeds) - 41% (for sunflower seeds) eat them frequently (again mostly once a week or 2-3 times a week). Poppy seeds are eaten bit less frequent. 87% of the infants and about 50% of the toddlers and children do not eat them. Around 40% of the toddlers and children eat them rarely and around 10% eat them frequently (most often once a week). Dried fruits are consumed rarely by 12% of infants and 86% do not eat them at all. 2% of the infants had a frequent consumption of dried fruits. Only 1/4 of the toddlers and 1/3 of the children do not eat dried fruits; 43-46% (toddlers and children, respectively) eat dried fruits rarely and 31-24% eat them frequently (mostly once a week or 2-3 times a week). 5% of the toddlers and 3% of the children eat dried fruits nearly every day. (Figure 15)

A supplementary table “Consumption frequency of sunflower seeds, other oilseeds, poppy seeds and dried fruit, differentiated for the three age groups” shows the detailed data. See supplementary table_12.xlsx.

2. Sweeteners, products with stevia, calorie-reduced drinks

Sweeteners are only consumed by around 5% of the toddlers and children (not at all by infants) and mostly less than once a month (figure 16). Only 0.4% of the infants consume food sweetened with stevia (less than once a month); 4% of the toddlers and 6% of the children consume it rarely and 2% consume it frequently (mostly once a week or 2-3 times a week). Calorie-reduced soft drinks were nearly not

consumed by infants whereas around 8% of the toddlers and 21% of the children are calorie-reduced soft-drink consumers. 6% of the children consume it even frequently (around 1% nearly every day).

A supplementary table “Consumption frequency of sweeteners, foods sweetened with stevia, calorie-reduced soft drinks and energy drinks, differentiated for the three age groups” shows the detailed data. See supplementary table_13.xlsx.

Focused on all consumers there are no differences in the frequency of consumption of calorie-reduced soft drinks for all three socio-economic statuses. Nevertheless, it shows that the percentages of frequent consumers are higher for participants from families with lower SES (11% for families with lower SES, 4% for families with middle SES and 1% for families with higher SES). Nearly all daily calorie-reduced soft drink consumers are from families with lower SES. Participants from families with middle or higher SES consume soft drinks with sweeteners mostly less than once a month or 1-3 times a month (Table 3).

Table 3
Influence of socio-economic status for consumption frequency of calory-reduced soft drinks

		socio-economic status (SES)			
		low	middle	high	total
calorie-reduced softdrinks	never	83.80%	85.20%	83.80%	84.70%
	< once a month	1.70%	6.70%	12.60%	7.30%
	1-3 times a month	3.50%	3.90%	1.60%	3.30%
	once a week	3.50%	2.80%	0.40%	2.40%
	2-3 times a week	2.90%	0.90%	0.40%	1.10%
	4-5 times a week	0.00%	0.30%	0.00%	0.20%
	6-7 times a week	4.60%	0.10%	0.00%	0.80%
	no comment	0.00%	0.00%	1.20%	0.30%

Differences in frequently consumption of calorie-reduced soft drinks were significant for participants with lower SES and middle SES ($p < 0.003$). Due to the low number of cases, frequently consumers of calorie-reduced soft drinks with higher SES were not included in these analysis.

Results for energy drink consumption surprised as 1.6% of the children (>3 years old) already consumed it. All of them consumed it less than once a month. Two thirds of those who already consumed it are from families with lower SES.

3. Rocket salad and fresh spinach

Infants quasi do not eat rocket salad and fresh spinach (as salad). There are only 3% rocket salad consumers and if they eat it, then most often less than once a month (figure 17). Around one third of the

toddlers and children eat rocket salad (mostly less than once a month). Around 3% eat it once a week. Fresh spinach is eaten even less. Only 12% of the toddlers and children consume it (mostly less than once a month).

4. Dark chocolate

Infants rarely eat dark chocolate (figure 18). Only 12% consume it and they consume it less than once a month. There are more than 50% consumers in both age groups and 7% of the toddlers and 8% of the children eat dark chocolate even frequently (mostly once a week).

A supplementary table for rocket salad, spinach and dark chocolate shows the detailed data. See supplementary table_14.xlsx. Tables of analysis for all the other food items that are not described in this manuscript can be found in the supplementary table “Consumption frequency of other seldom eaten foods”. See supplementary table_15.xlsx.

Discussion

All the efforts made to get enough participants had been successful. Especially contacting the future participants by phone was much more effective than sending invitation letters. The study’s aim was to cover all ages with similar amounts of children e.g. about 80 participants per age and gender. The age distribution in general as well as separately analysed for gender resulted in numbers as aimed for with only little deviations. As visible in the results, there were less under-one-year-olds, more one-year-olds and some more over five-year-olds. These results were expected and are due to the time shift between recruitment and investigation.

People with higher education and socio-economic status are found more often to be interested in nutrition and health issues and therefore are often more willing to take part in nutrition studies (25). This can be seen in the results of the KiESEL study as well where 83% of the study population show middle or higher (parental) education and socio-economic status. As this is a common fact, both variables were included in the weighting factors. As one of the aims was representativeness concerning the region, the weighted results show a very similar distribution to the data of the Federal Statistical Office.

As more than half of the KiESEL participants aged 1 and 2 years and nearly all of the KiESEL participants aged 3-5 years used to go to a day care facility, it was very important to have the food records for these consumption times as well. KiESEL is one of the first studies to take into account the out of home consumption, which provides important information for a better understanding of children consumption structure. As the numbers show, depending of the age, for 50 – 100% of the study population their consumption was only completely recorded using the two forms of the food protocols.

The results of the questionnaire on seldom eaten foods show the importance of such a questionnaire as an addition to food records or recalls.

The fact that rice cakes seem to be quite popular in all age groups and complementary food based on rice has the most infant consumers of all complementary foods asked for, may lead to further concern thinking of the existing arsenic issues of rice products and the possible contamination of complementary food as powder/flakes with mycotoxins (27, 28).

Dairy substitute drinks like soya, rice or oat drinks do not seem to play an important role in the eating pattern of younger children. Other soya-based products on the other hand seem to be slightly more often consumed. It can be seen that if they are consumed than mostly by families with middle or higher socio-economic background which reflects that these products are more expensive than normal milk products. As most often SES goes together with education level, it could be seen that the higher the parents' education level the more frequently these dairy substitute are consumed. Consumption of dairy substitutes might be not only a question of money but as well a question of awareness. We found more dairy substitute consumers within the families with middle and higher parents' educational level and that they consume it more frequently.

It can be seen that special meats are consumed rarely and that especially ostrich and horse meat are (nearly) not consumed. For other meat, age and migration background seem to be influencing factors on the meat choice. Especially game meat and lamb/sheep meat consumption are influenced by (lacking) migration background.

Infants, toddlers and children show no big preference for offal. It is consumed extremely rare and only those of pork, beef, veal or poultry are consumed.

Most fish species known to have high concentrations of heavy metals are rarely consumed by children in KiESEL. Whether they can significantly contribute to exposure needs to be checked based on dietary protocols and concentration levels for specific substances.

Tea might be interesting for several reasons. On the one hand it could be contaminated with pesticides or pyrrolizidine alkaloids, on the other hand tea consumers might be more health-conscious and therefore for e.g. rare consumers of soft drinks (29). Infants seem to drink fennel tea the most; for all other tea variations, they show only small consumer numbers. Peppermint, camomile and fennel tea seem the most consumed teas by toddlers and children whereas green, black or melissa tea are nearly not consumed. Ready-to-drink tea seems not to be very popular, nevertheless a little number of infants from families with lower SES consume it nearly every day. 20% of the infants (most often from families with lower SES) consume instant baby fennel tea and 5% consume it nearly every day.

Comparing all the numbers, the socio-economic status does not seem to have an influence on the choice whether participants prefer calorie-reduced soft drinks or tea. The percentages of consumers seems often equal for all socio-economic statuses but the frequency matters. What is important to notice is that for nearly all teas (except for green tea) and for calorie-reduced soft drinks, the percentages of frequent consumers from families with lower SES were always higher than in the other two groups. Families with

lower SES seem to drink tea and calorie-reduced soft drinks more frequently. Sweeteners or products sweetened with stevia do not seem to play an important role in food choice for the KiESEL population.

Sunflower seeds, other oilseeds, poppy seeds and dried fruits seem to be quite popular, especially the older the children get. This might be relevant for pesticide or mycotoxin intake estimation. Except from poppy seeds, there are high percentages of frequent consumers for toddlers and children even though we have to keep in mind that the consumed amounts of these foods normally are small as in most cases they might be eaten in bread or muesli.

Rocket salad is known for possibly containing high contents of nitrate (30). Children do not seem to be big consumers of rocket salad. Comparing our results with those of a consumer survey asking for seldom eaten foods conducted by BfR 10 years ago, we could see that only 3% of the KiESEL participants are frequent consumers of rocket salad (and 29% additional rare consumers) whereas 12% of the adults of the former consumer survey seemed to be frequent consumers and 57% rare consumers (31). The small percentages might also result from the fact that rocket salad is no popular food for small children as it can be quite bitter or spicy.

The consumption of dark chocolate was already an issue at the BfR because of the cadmium concentration in cocoa (32). Dark chocolate consumption is higher for children than for infants or toddlers even though there are much more seldom consumers than frequent consumers. This was similar to the findings of this previous survey for adults. Nevertheless, the consumer percentages for adults were higher than for children. It seems that children prefer milk chocolate to dark chocolate.

Conclusions

The KiESEL study collected up-to-date information on food consumption for more than 1000 children living in Germany, aged six month up to including five years. These data renew the existing consumption data for this age group collected in 2001/2002 and fill the before existing data gap for the five year old children.

The data collection method is in compliance with EFSA recommendations (33) and some methodological improvements were done in the data collection. The KiESEL study is the first study to record basic consumption data at home *and* in day care facilities. The high percentages of children cared for in these facilities show the importance of considering the out-of-home consumption that provides us with much needed information to complete the overall daily consumption and to enable calculation of the total daily exposure of the children. Further, the KiESEL survey has included a FPQ for rarely consumed foods that are often underrepresented in short-term dietary protocols. Hence, KiESEL is building a comprehensive database for exposure and intake estimates.

One of BfR's central tasks is to assess risks related to food, feed and consumer products and to enable decision makers to process in the right way to protect consumer's health in Germany. The gathered information in KiESEL will be used for estimating intake of and assessing risks connected to contaminants

(34), food additives (35), pesticides (36) or other potentially harmful substances in food. Based on these estimates, food safety evaluations will be done and maximum limits for particular substances in food can be defined.

Additionally, the data of the KiESEL study will be used for estimating nutrient intake to describe the nutritional status of infants, toddlers and children in Germany and to create a scientific basis for policy-makers.

As all this information is not only of national but also of international interest for exposure measurements and risk assessment, data will be provided to national and international partners such as the World Health Organization (WHO) (37).

Abbreviations

BfR: German Federal Institute for Risk Assessment

BLS: German nutrient database

CASMIN: Comparative Analysis of Social Mobility in Industrial Nations

EFSA: European Food Safety Authority

EsKiMo: Eating Study as a KiGGS module

FFQ: Food Frequency Questionnaire

FPQ: Food Propensity Questionnaire

FKE: Research institute for child nutrition

GRETA: German Representative Study of Toddler Alimentation

IARC: International Agency for Research on Cancer

KiESEL: The Children's Nutrition Survey to Record Food Consumption

KiGGS: German Health Interview and Examination Survey for Children and Adolescents

LEBTAB: German food composition database for dietary evaluation of children and adolescents

MRI: Max Rubner-Institute

PANCAKE: Pilot study for the Assessment of Nutrient intake and food Consumption Among Kids in Europe

RKI: Robert Koch-Institute

SES: socio-economic status

VELS: consumption study to determine the food intake of infants and young children to assess an acute toxicity risk from pesticide residues

WHO: World Health Organization

Declarations

- Ethics approval and consent to participate

The study received a positive vote from the ethics committee of the Berlin Chamber of Physicians (Ärzttekammer Berlin, Eth-28/13). Participants ranged in age from six month to five years, so all parents or legal guardian provided written informed consent prior the start of the survey. The authors confirm that study design and methods were carried out in accordance with relevant guidelines and regulations.

- Consent for publication: Not applicable
- Availability of data and materials

The datasets generated and analysed during the current study are not yet publicly available. The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

- Competing interests

The authors declare that they have no competing interests.

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- Authors' contributions

FD analysed and interpreted the study results and was a major contributor in writing the manuscript with input from all authors. NG was a major contributor in writing the theoretical parts of the manuscript. TH was a major contributor in analysing and preparing the data. NN and OL designed and supervised the study and contributed to the final manuscript. All authors read and approved the final manuscript.

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Figures

Figure 1

Study procedure KiESEL

Figure 2

Example dietary record for families in KiESEL

Figure 3

Example for portion sizes in the KiESEL picture book (origin Pancake,)

Figure 4

Different forms of special diets that participants are used to (% of participants, multiple answering permitted)

Figure 5

Percentage of children using child day care or staying at home

Figure 6

Frequency of complementary food consumption, differentiated for the different kind of cereal bases

Figure 7

Frequency of consumption for different dairy substitute drinks and other soya based products, differentiated for the three age groups

Figure 8

Consumption frequency of the different types of special meat and sausage products, differentiated for the three age groups

Figure 9

Consumption frequency of special meat and sausage products, differentiated by migration status

Figure 10

Non-consumers of offal from different animals, differentiated for the three age groups

Figure 11

Consumption frequency of fish and marine animals differentiated for the three age groups

Figure 12

Consumption frequency of fennel tea and ready-to-drink tea for children, differentiated for the three age groups

Figure 13

Consumption frequency of herbal tea differentiated for the three age groups

Figure 14

Consumption frequency of rooibos tea, green tea and black tea, differentiated for the three age groups

Figure 15

Consumption frequency of sunflower seeds, other oilseeds, poppy seeds and dried fruit, differentiated for the three age groups

Figure 16

Consumption frequency of sweeteners, foods sweetened with stevia and calorie-reduced soft drinks, differentiated for the three age groups

Figure 17

Consumption frequency of rocket salad and fresh spinach, differentiated for the three age groups

Figure 18

Consumption frequency of dark chocolate, differentiated for the three age groups

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