Validation of a new web- based food diary through direct observation

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Master thesis in clinical nutrition

Department of Nutrition, Faculty of Medicine

UNIVERSITY OF OSLO

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Summary

Background: Unhealthy diet and overweight are major risk factors for chronic diseases. Prevention of overweight should be established at early age. It is important to develop tools in order to gain knowledge about children's current diet. To establish better dietary assessment tools, and to reduce errors related to the method, validation is important.

Purpose: The main purpose of this study was to assess the accuracy of recorded school lunches in the web-based food diary, by using observation of 4th graders during school lunch as an objective reference to the subject's true intake. Investigation of interobserver reliability (IOR) during data collection was conducted to ensure sufficient quality of the data.

Subject and methods: The final selection of children was 117 4th graders from different elementary schools in the municipality of Bærum. Direct observations of the children during school lunches were conducted. Observations were later compared to intake recorded by the children using the web-based food diary.

Results: The number of observed and recorded items was 495 and 450 respectively. Food items in the meal component groups 'sweets and snacks', 'spreads' and 'fruits, berries and vegetables' were most frequently omitted. Mean omission rate and intrusion rate were 27% and 19% respectively. Median omission rate was 25% and median intrusion rate was 0%. Total match in portion sizes was 60%. There were no significant differences in total omission rate and intrusion rate in relation to gender or weight status, only regarding parental education level. Assessment of IOR showed a total agreement above 85% regarding identification of items for each observer-pair, but below 85% regarding portion sizes for two of the observer-pairs.

Conclusion: Omission rates and intrusion rates were generally lower in this study compared to other studies using school lunch observations as a reference method. The accuracy of portion sizes was lower than the accuracy of recorded items. However, the IOR regarding portion sizes was too low to make any conclusions. IOR regarding items were satisfactorily high, thus the accuracy of observed items is also considered high. The web-based food diary appears to be a useful tool for assessing dietary intake in children. For future use of the food diary, focus should be on how all food items consumed, also the smaller food items like spreads, fruits and vegetables should be recorded accurately.

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Abbreviations

BMI	Body Mass Index
BMR	Basal Metabolic Rate
DLW	Double Labeled Water
FFQ	Food Frequency Questionnaire
IOR	Inter Observer Reliability

1. Introduction

This master thesis is a part of a larger project, a validation study of a web-based food diary, which will be used among 4th and 8th graders in the next UNGKOST survey. This project was developed by PhD candidate Anine Medin and professor Lene Frost Andersen, at the Department of Nutrition, University of Oslo. Two master students, Britt Marlene Kåsin and I, participated in this project and conducted the data collection together with Anine Medin during the period from September 2013 to December 2013. Three different methods to validate this new web-based food diary have been used in this project, observation, carotenoids biomarkers and activity monitoring. My master thesis covers direct observation. I participated in all the data collection, which included observations, anthropometrics, collection of blood samples and activity monitoring.

1.1 Overweight and lifestyle diseases

Six of the most important risk factors for disease and death in Europe are closely related to diet; high blood pressure, high plasma cholesterol, overweight/obesity and low intake of fruits, berries and vegetables. The two other risk factors are smoking and physical inactivity. The World Health Organization and the health authorities in different countries has estimated that most chronic diseases, such as cardiovascular diseases, type 2 diabetes, cancers and obesity can be prevented by eating healthy, doing physical activity and by avoiding smoking (1).

Concerns about children's eating habits and the increasing incidence of overweight and obesity among children have been raised (2-5) as it is a major risk factor for chronic diseases like coronary heart disease and diabetes type 2 (1, 5, 6). A recent study among 10- to 12-year-olds from seven European countries (7) found that 15.1% of the Norwegian boys and 13.8% of the Norwegian girls were overweight, 0.4% of the boys and 2.4% of the girls participating in the study were obese. In a report by The Norwegian Directorate of Health (8) the prevalence of overweight in a nationwide sample of 4th grade girls and boys were 14.7% and 12.8% respectively, and the prevalence of obese girls and boys were 4.7% and 2.8% respectively. Eating habits established in an early age will probably accompany the children further in life (9). Children who are overweight have a higher probability to remain overweight as adults or

becoming obese (10-12). Therefore, primary prevention of lifestyle diseases should be established at an early stage of the child's development (9, 13).

To prevent overweight and lifestyle diseases, scientists need tools to assess dietary intake and physical activity in order to establish public health strategies (14). To make diet guidelines and interventions to improve children's diet, it is important to gain knowledge about their current diet. Children are the future and the greatest prevention potential lies with them, therefore it is important to address this group. They are important target groups for dietary assessment methods (15-17). Assessment of school-age children's dietary intake is important for both research, nutrition monitoring and intervention efforts (18). It is important to improve and renew such tools to be in line with recent development in the field, in order to continuously collect data regarding changes in diet and lifestyle. Therefore, a new web-based food diary has been developed. Several dietary assessment methods such as 24-hour recalls (19), food frequency questionnaires (FFQ) (20), and food diaries (21) have been developed for use by school-age children.

1.2 Dietary assessment methods

Dietary assessment methods give us dietary data at an individual level. They can be prospective or retrospective (22-24), open or closed. A closed method consists of a limited number of food items in the study. In an open method, every food items can be included (22). It is important to consider the purpose of the study and both economical and practical conditions when choosing a dietary assessment method (22).

Prospective methods, like food records, collect current diet. In retrospective methods, like 24-hour recall, food frequency questionnaire (FFQ) and diet history, subjects have to recall past diet. For both methods, there is a possibility that reported diet does not reflect either actual or usual diet. The respondents can choose not to report certain items, as sweets, crisps and alcoholic beverage. They may also choose to report or consume more foods regarded as healthy, as fruits and vegetables (24). Underreporting is a consistent problem related to dietary assessment methods (23).

The advantage of prospective methods is the direct measure of current diet. However, this method is labour-intensive for the participants, and it can be challenging to recruit and maintain

a representative sample of participants. High subject motivation is needed. Good literacy and numeracy skills are also required. In populations where literacy levels are low, this method is useless (24).

Retrospective methods are often less expensive than prospective methods, and also quicker and easier to administer. Retrospective methods can also be used to look at diet in the past, e.g. in studies of chronic diseases. However, there are many sources of biases that can affect retrospective dietary assessments. These methods require subjects to recall their diet. Respondents have to remember food items, beverages and amounts consumed over a specific period of time, e.g. 24 hours, or their usual consumption of foods and beverages (24). Errors related to memory can result in lower accuracy of reported food items and beverages (23, 24). This can especially be a problem with elderly subjects and children under the age of about 12 (24). Good skills regarding portion size estimations are also important, and this may also be a problem for children under the age of 12. For 24-hour recall and diet history, the presence of an interviewer may cause subjects to highlight the good aspects of their diet and to suppress the bad ones (24). Daily variation in diet can also be challenging to assess using retrospective methods, unless repeated 24-hour recalls. It can also be difficult to assess usual diet of subjects without regular eating habits (24).

Choice of dietary assessment method should depend on what is to be examined. A 24-hour recall or a single day registration are not representative for the usual diet, but can be used to obtain an average value at a group level. If 24-hour recalls are repeated, the usual diet can be obtained. Diet history and FFQ measure habitual food intake of individual subjects. A weighted-food diary has the ability to provide good data on energy and nutrient intake (23).

1.2.1 Dietary records

The main principle of a dietary record is that food consumed is recorded as it occurs. Participants have to record what they consume at each meal. The recording period last from 3 to 14 days (23), 3 to 7 days are usual (22, 25, 26). The level of details varies. Dietary records can be completely open, or less open where the participants mark the food items and beverages that are consumed each day (23).

The most detailed version of a dietary record is a weighed-food diary. Each food item and beverage are weighed before consumption, and after if there are any leftovers, and recorded in a food diary (23, 24). A weighed-food diary gives the most accurate amounts (23), and is traditionally preferred as reference method for validation of other dietary assessment methods because of the high level of details (22). However, this method has a great burden on the participants, and it is difficult to recruit subjects for longer periods. It can be difficult to recruit subjects from large geographic areas due to necessary instructions and support. Although this method can provide good data, it is not commonly used in extensive studies, because of the load and resource intensity (22). Compared to a weighted-food diary, a pre-coded food diary is less detailed. This version consists of lists of food items grouped together in meals, according to commonly eaten foods and typical meal pattern in the country where the food diary is to be used. Food amounts are presented in units of predefined household measures or as portion sizes estimated from photographs. In addition, a booklet with series of photographs usually accompanies the pre-coded food diary to illustrate these units and portion sizes (27, 28).

Compliance is one problem with dietary records. It can be tedious, time-consuming and labour-intensive to write down everything that has been consumed during the period. There can also be a difference in characteristics of people who are willing to do this completely, and those who will not (25). Dietary records require good literacy and motivated subjects (26). The participant burden depends on the number of days recording, more than three to four days require a high subject motivation (23). This motivation is important to avoid changes in diet, with less complex eating situations, in order to ease the recording process. This can lead to a reduction in food intake and also a more monotonous diet (23, 25, 29). A reduction in food intake, especially snacks and other food items high in fat and sugar may occur (25, 29). Errors related to change in diet are independent of errors due to poor memory or inaccurate recording (24). The main consequence of these errors is underestimation (23-25, 29).

Web-based food diary

In order to optimize research within the field of diet and nutrition in Norway, it is important to develop easy-to-use, updated and web-based dietary assessment tools that can make it easier for both respondents and researchers to use. Data transfers and processing will be easier using a web-based food diary. Paper-versions of food diaries need to be transferred to computers by scanning before further processing in possible. A web-based version will also be more available

to other scientists. These are the reasons why a new web-based food diary has been developed. This food diary is intended used in the next Norwegian nationwide dietary survey among children and adolescents (UNGKOST 3), which is planned in 2015. However, before it can be used in an extensive study, validation is necessary.

1.3 Nationwide dietary surveys in Norway

Norwegian nationwide dietary surveys and subsequent validation have been done regularly since the 1990s (14). The first nationwide dietary survey (UNGKOST-93) was conducted among adolescents aged 13 and 18. This dietary survey consisted of a 12 pages self-administered FFQ (14). A paper based pre-coded food diary was developed for the nationwide dietary survey among 4-, 9- and 13-year-olds conducted in 2000-2001(21). Several validation studies of this method have been published (27, 30-32).

1.3.1 Challenges with dietary assessment of children

Dietary assessment methods are both used for children and adults. All methods are dependent on the child's literacy and cognitive recall abilities, but also on parental awareness. Cognitive- and developmental stage has to be considered in the choice of methods (17). It is important to adapt dietary assessment methods to different age groups (33). For children there are different cognitive aspects that can affect the reporting of dietary intake. Children have limited reading and writing skills, their memory and attention are restricted, and knowledge about food, portion sizes and food preparation are limited. From the age of 7 to 8, there seems to be a rapid increase in children's ability to make unassisted recalls. However, this ability is limited to food eaten in the immediate past, within the previous 24 hours. At this age, children may remember their regular food intake, but may have challenges with remembering more irregular eating pattern, associated with weekend days. At the age of 8 to10, children seem to have the ability to report their own food intake. Fourth graders, being 9-year-olds, are just above the age able to give reasonable accurate dietary information. Children younger than this are likely to be in an earlier cognitive stage (13).

Validity of dietary reports depends on children's cognitive stage and ability to correctly report their dietary intake (13). However, when parents or guardians are reporting on behalf of the children, or are assisting them during reporting, their ability to correctly report will also

influence the accuracy of the reports (13, 34). In a study where they looked at how 7 to 11 year-old children, assisted by a parent or guardian, reported diet in 24-hour recalls, they found that the children had considerable knowledge about their own diet and food details. However, parents or guardians contributed by adding additional food details and by prompting the children (34). This study shows the importance of the presence of both child and a parent or guardian during reporting.

1.4 Validation of dietary assessment methods

To establish better dietary assessment tools, and reduce errors related to the methods, validation is important. Validation of dietary assessment methods is conducted to give us knowledge of the ability of an instrument to measure what it is intended to measure, and to give us knowledge of the types of errors connected to the method. Validity can be examined by comparing the results from the test method with the results from the reference method (22, 35). It is important to validate dietary self-report methods with other reference methods, to determine if the method is measuring the actual intake (26).

Both systematic errors and random errors can affect the results from dietary assessment methods. Systematic errors affect the results in one certain direction. A valid method is without systematic errors, and measures what it is supposed to measure. A method without random errors is called a reproducible method and gives the same results when it measures the same phenomena repeatedly (23).

Traditionally, validation of a dietary assessment method were done by comparing results from the method used with results from another dietary assessment method considered as more accurate, such as weighed-food record (22). However, a more accurate measure of the validity is when results from a dietary assessment method are compared with another method independent of the subject's ability and willingness to report dietary intake, as is the case for direct observation. This will give an objective measure of the dietary intake (23). Ideally, data from the dietary assessment method is compared with two reference methods, of which one can be another dietary assessment method and the other a valid biological marker (35).

The reference method has to be independent of the dietary assessment method used, and should be more accurate, but measure the dietary intake on the same level as the test method. If the

test method measures dietary intake on an individual level, the reference method also should. The reference method should not influence the test method, and it is important that errors related to the reference method are independent of errors related to the test method. It is also important to choose a subpopulation of the population that later on will be investigated using the test method. These are important considerations to make when choosing a reference method (35).

1.4.1 Direct observation

Direct observation as a method can be considered as a 'gold standard' in validation of dietary assessment tools, as it is independent of the subject's memory and ability to recall food intake and therefore can provide unbiased and accurate information about the actual intake (25, 36-38). Direct observation was therefore used as a reference method for validation of the new web-based diary.

Direct observation is usually conducted in a defined environment for a specific period of time. The observers typically watch subjects during a meal such as school lunch, and take notes of actual intake, items and amount consumed, including what is traded or spilled (37, 39-41). Several validation studies on children's dietary reports of school lunches have used observation during school lunch as a reference method (39-50). Lunches prepared and packed at home present challenges for the observers because of the diversity in food items, not standardized portions and opaque containers (51). Therefore there are a limited number of studies regarding observation at school with home-prepared lunch packages (36, 51, 52).

Direct observation is considered as a labor intensive, time consuming and costly method due to the amount of human resources and number of hours needed to conduct the observations (25, 37, 39, 40, 46, 53, 54). This is also the case for conducting the training prior to data collection, which is essential to produce reliable and accurate results (36, 38). Training prior to observation and assessment of inter-observer reliability before and during the observation period will reduce the risk of identifying wrong items and making incorrect estimations of quantities (36-38, 55).

Interobserver reliability

There is usually more than one observer present during an observation session (37, 40, 43, 46, 53). Assessment of interobserver reliability (IOR) is therefore necessary in order to determine if the information collected is independent on who conducted the observations, and to ensure quality of the information (37). Adequate IOR is defined as at least 85% agreement (37). When different observers watch the same subject, the IOR reflects the level of consistency between the observations (37). Assessment of IOR is important during training and data collection. Data collection should not start until 85% agreement is achieved (37). This level of agreement is often more easily achieved for item identification. However, agreement on portion sizes can be more challenging, at least when portion sizes are compared without allowances for discrepancies (36). In most studies where they have assessed IOR, both items and portion sizes have been included in the calculations, and 25% discrepancy in portion size estimation have been considered as an agreement (40, 43-45, 53).

Training

Training and experience are important components of the direct observation method as it can affect the accuracy and reliability of the observations (36, 55). It has been shown that observers with academic training in nutrition identified the packed lunch contents, portion sizes and amount consumed with a high degree of accuracy and reliability, almost without discrepancies between observers. Training observers with prior nutrition knowledge may be favorable when assessing food intake among children at school (36).

The number of hours required for training varies from 10 to 56 (36, 38, 56). In a study by Richter et al (36) nutrition students underwent 10 hours of training. Observation of sample lunches in a food laboratory, observation of voluntary lunch eaters in a simulated classroom environment and observation of school children's lunches in the school environment were conducted. In another study by Conway et al (56), the observers, some with nutritional science background and some without, received 16 hours in observation training. Several typical school bag lunches were made and type of foods and amounts were recorded. A pilot test of procedures in the field and IOR in two middle schools were also conducted. In a study by Ball et al (38), five observers, one with a bachelor degree in nutrition and four with graduate degrees in public health or anthropology, were trained in visually estimating amounts, portion sizes and

type of foods and beverage served to children in child-care facilities. The training period lasted for 56 hours over a period of one month. For all these training procedures, a high degree of correctly observed items and agreement between observers were achieved. In a study by Bolland et al (55) they found that a 10-minute training session in estimating quantities by using different food models, considerably improved the estimation of quantities of foods. This improvement could last up to four weeks after the session.

Match, omission and intrusion

Matches, omissions and intrusions are important to investigate when analyzing and comparing data from dietary assessment tools and direct observations. This will give us a measure of how valid the dietary assessment tool is, and what the main problems are when using self-reporting in such tools. Match is when an item, defined as both food items and beverages, is both observed and reported consumed at the same meal. Omission is when an item is observed consumed, but not reported consumed at the same meal. Intrusion is when an item is reported consumed, but not observed consumed at the same meal (40, 42-46, 53). This is illustrated in figure 1.

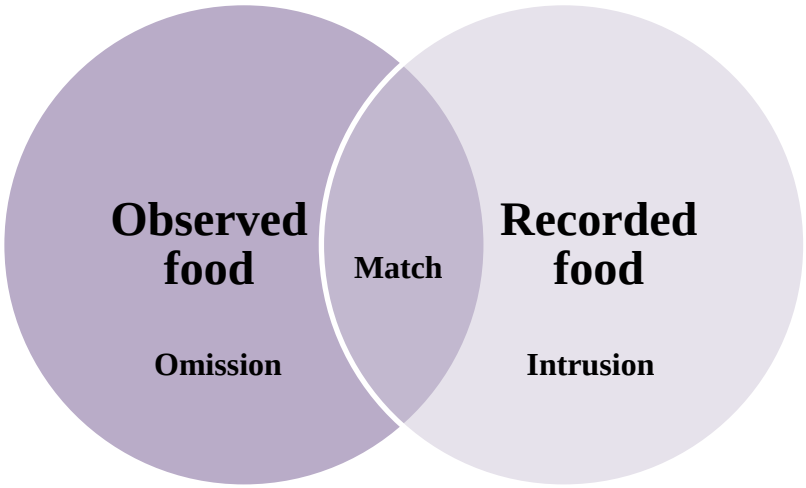

Figure 1. Match, omission and intrusion.

To detect potential sources of errors related to the dietary assessment method, it is important to look at the accuracy of all recorded items, in terms of matches, omissions and intrusions, but also the accuracy of recorded items for different meal components considered as important. It is

important to investigate where potential sources of errors lies, in order to implement actions to increase the accuracy of recordings.

1.5 Factors that can affect the validity of a method

Underreporting has shown to be a problem when people report their dietary intake. Underreporting occurs when people report a energy intake that is lower than the true intake (57). Studies show that participants that most often underreports are older overweight women (58). Factors that may be associated with underreporting include age (13, 16, 27, 32, 59), gender (58, 60, 61) and body mass index (BMI) (62-64), but also other factors as reading and spelling abilities (64) and body image and social desirability (65) seems to be factors that may affect the validity. Therefore, these factors are important to consider when validating a dietary assessment method.

1.5.1 Age

Age seems to affect the validity of dietary assessment methods used on children and adolescents. There is a trend towards an increased degree of underreporting with increasing age (13, 16, 27, 32, 59, 66). Validation studies of the pre-coded food diary used in UNGKOST-2000 (27, 32), using activity monitors to measure energy expenditure, showed that Norwegian 8^{th} graders underreported their energy intake to a larger degree than the 4^{th} graders, 34% and 24% respectively in two studies on 8^{th} graders (32) compared to 18% of the 4^{th} graders (27). A study by Champagne (59) showed that 12-year-olds underreported by 33%, 11-year-olds by 20%, 10-year-olds by 22% and 9-year-olds by 19%. This shows an increase in underreporting with increasing age.

For children under the age of 7, parents or other caregivers usually are responsible for the dietary reports. Children above this age might take greater responsibility in self-reporting. Compared to adolescents, younger children usually have a more structured eating pattern which can make it easier to remember what has been eaten during the day. Most of the meals are usually eaten at home, there is less access to unsupervised eating and parents have a great impact on the child's eating habits. Due to this, parents often have the ability to assist the children during recording (13).

1.5.2 Gender

The literature is not consistent on how gender affects the validity of a dietary assessment method. In a review of 11 studies on adults, where energy intake was compared to energy expenditure measured by the double labeled water (DLW) method, no significant differences between the sexes regarding underreporting were found for any of the studies (66). However, other studies on adults have found that women have a higher degree of underreporting than men (58, 61). Sjøberg et al (60) compared energy intake measured by diet history to energy expenditure measured by the DLW method in a sample of 18 boys and 17 girls, aged 15 to 17 years. The girls underreported by 18% and the boys overreported by 7%. In another study (67) including adolescents at the age of 15, they found no significant difference between the sexes regarding underreporting. In that study, energy intake recorded in a 7-day diet record was compared to energy expenditure measured by the DLW method and by estimated basal metabolic rate (BMR). Bandini et al (68) neither found no association between underreporting and gender, when comparing recorded intake to energy expenditure measured by DLW method.

1.5.3 Overweight

The problem with underreporting seems to be greatest among overweight subjects. For normal weight subjects this bias is considerably reduced, but can still be large in weight-conscious subjects (69). Studies have shown a consistent association between underreporting and overweight among adults (62-64, 70). A study where they compared recorded intake to energy expenditure measured by the DLW method showed that overweight adolescents underreported their energy intake by 41% and normal weight adolescents by 19% (68). In a study by Johansson et al (58), including 16- to 79-year-olds in Norway, they found an association between underreporting, overweight and the desire for weight change. This shows that attitudes about own body weight may influence reported energy intake.

This trend is not that evident in younger children. A study of 8- to 12-year-old girls showed that body weight and percentage body fat did not have any impact on the degree of underreporting (71). This study used a 7-day dietary record as dietary assessment method, and DWL as reference method. Neither Lillegaard and Andersen (27) found any association between BMI and underreporting in a group of Norwegian 9-year-olds, using a food diary. Energy expenditure was measured by activity monitors. However, a Swedish study among 9- to 11

year- old children, using diet history as dietary assessment method, found that the degree of underreporting increased with increasing BMI (72). A study by Baxter et al (73) found that 4th grade children with high BMI, categorized as BMI above the 85th percentile for that age group, omitted more kilocalories and intruded less kilocalories, compared to 4th grade children with low BMI, categorized as $\geq 5^{th}$ and $< 50^{th}$ percentile. This was the case for both boys and girls

1.5.4 Differences in socioeconomic status

Studies of how socioeconomic status affects the validity of dietary assessment methods used on adults have been done. These studies have shown that there are no clear association between underreporting and socioeconomic status and education (66). However, in a study by Pryer et al (74) they found, by comparing 7-day weighed food records to estimated BMR, that underreporting were more common in the manual social class and among those who received state benefits, compared to those in higher social classes. In contrast, Horner et al (65) found that women with higher education underreported more than women with lower education. Reported intake was collected by FFQs and compared to energy expenditure measured by activity monitors.

1.5.5 General or specific underreporting

Underreporting is a well-known problem when measuring dietary intake. However, it is uncertain if this underreporting of energy intake is due to selective underreporting of certain food items or a general underreporting of all type of foods. Nevertheless, it seemed to be a tendency towards underreporting of fat- and carbohydrate-containing foods among overweight adults in a study by Heitmann and Lissner (70). The study by Johansson et al (58), including 16-79 year olds in Norway, also showed that under-reporters consumed less foods rich in fat and sugar compared to the other subjects. A Swedish study (60) looked at adolescents at the age of 15 to 17, and found that underreporting girls had 33% lower intake of energy from in-between meals compared to girls with adequate reports. Over-reporting boys had 57% higher energy intake from in-between meals than boys with adequate reports. However, energy-adjusted intake of specific foods did not differ significantly, and no pattern towards underreporting of specific foods was shown (60). The same result was found among a group of Norwegian 9-year-olds. The children did not underreport sweets, soda and other unhealthy food items to a higher degree than foods regarded as healthy like fruit and vegetables (27).

2. Purpose and aims

2.1 Purpose of study

The new web-based food diary that has been developed is intended used in the next nationwide Norwegian dietary survey among children and adolescents (UNGKOST 3). To reduce errors related to the dietary assessment method, validation is important. Observation may provide unbiased information about actual intake, and will therefore be used as validation method.

The main purpose of this study was to assess the accuracy of recorded school lunches in the web-based food diary by using observation of 4th graders during school lunch as an objective reference to the subject's true intake. Assessment of interobserver reliability (IOR) during data collection was conducted to ensure sufficient quality of the data.

2.2 Aims

The specific aims are described as follows:

1. To investigate how accurate 4th graders record items consumed for school lunch in the web-based food diary, through direct observation.
    - Examine the distribution of matches, omissions and intrusions for all items combined and for items in different meal component groups.
    - Examine omission rates and intrusion rates for all items observed and recorded by each child, and for different meal component groups.
2. To calculate the percentage of correctly recorded portion sizes for matching items.
3. To investigate if omission rates and intrusion rates for all items observed and recorded by each child, and for different meal component groups differ among 4th graders in relation to gender, weight status or parental education level.
4. To assess interobserver reliability (IOR) during the observation period.

3. Subjects and methods

3.1 Study design

Assisted by schools, 4th graders were recruited. They received an invitation, containing information about the study, and a consent form (appendix 1 and appendix 2). After parental consent was given, the three observers visited the schools and informed the children about the web-based food diary, and how to manage the diary. In addition to the user manual accompanying the food diary, the children and parents also received written instruction about how to record the meals (appendix 3). Three observers conducted observations during school lunches. Weight and height were measured according to standard methods. All participants who completed the study received two cinema tickets each.

As mentioned in the introduction, this master thesis is part of a larger project. As a master student I participated in all of the data collection, which in addition to observations and anthropometrics, also included collection of blood samples and activity monitoring.

3.2 Recruitment

PhD candidate Anine Medin recruited the schools before the data collection began. The children received the invitation and the consent form from their teachers in order to bring it home. The teachers were asked to remind the children about the deadline for handing in the consent. Collection of consents was done after a few weeks. The children, who had forgotten to hand in the consent or had decided that they after all wanted to join the project, were allowed to bring in the consent the next day.

3.3 Subjects

Four elementary schools with a total of nine 4th grade classes, representing different areas of Bærum participated in this study. A total of 196 4th graders were invited to participate, 96 boys and 100 girls, and 128 agreed to participate by returning the signed consent form. This counts for 65% of all invited subjects. This number was reduced to 124 after four children withdrew from the study during data collection. This number was further reduced to the final selection of

117 4th graders, 64 girls and 53 boys, after exclusion of seven children due to two missing observations and five missing school lunch recordings (figure 2). The five excluded school lunch recordings lacked specified information about the school meal. Only data recorded by the children for lunches specified as eaten at school were included.

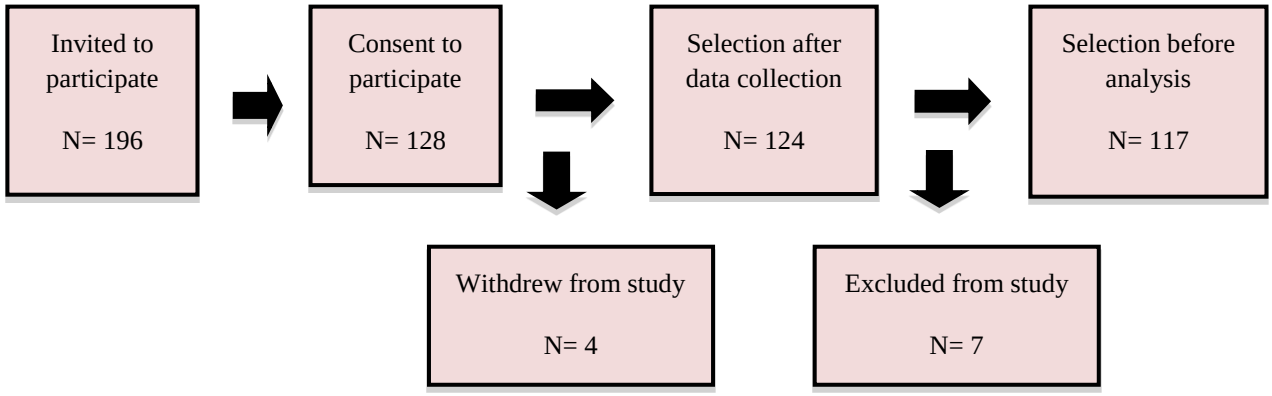

Figure 2. Flowchart of subjects

3.3.1 Sample size calculation

For the entire validation study, sample size calculations were made based on correlation coefficients, as correlations between intake of fruits and vegetables recorded in the food diary and the concentrations of caretonoids in blood is one of the validation methods. This showed that 115 participants were enough to assess an unattenuated correlation of 0.5 (75). However, it was important to have enough participants completing the whole study and a primary sample size of 120 participants was considered as appropriate based on earlier experiences. Sample size calculation was not based on observation as a method. However, sample sizes used in other comparable observation studies are less than calculated for the present study (40, 44, 49, 53, 73), and a sample size of 115 is therefore considered as sufficient.

3.4 Data collection

3.4.1 Web-based food diary

The web-based food diary used in this project has been developed through collaboration between the Department of Nutrition, University of Oslo and the Division of Nutrition, Technical University of Denmark. The food diary is constructed based on earlier experience with paper versions (14, 21, 27, 30, 31), and other experiences made by other research groups who also have developed web-based diet assessment tools for children (Baylor College of Medicine (USA); Durham University (UK), Ghent University (Belgium), Technical University of Denmark).

The participants reported their diet for four consecutive days, three weekdays and one weekend day. The participants were guided through six daily eating occasions in the diary; breakfast, morning snack, lunch, afternoon snack, dinner and evening snack. The diary is based on segmented eating occasions during the day, meals and snacks, as this is preferable in terms of memory (76). For breakfast, lunch and dinner, they also had to specify were the meals were eaten. Six alternatives, including the alternative 'eaten at school', were possible to choose from.

Different food groups and items appeared at each eating occasion. The participants were led through three different categories before they could choose the correct food items. The first step was to choose the main category name, e.g. Fruit and berries. The second step was to choose the subcategory name, e.g. Fruit, and the final choice was the product name, e.g. Apple (figure 3 and figure 4). It was also possible to search for different foods and beverages in a database of about 550 different items. All items were linked to a photo database with different portion sizes to pick from, as this has proved to be important to reduce errors in portion size estimation (77, 78). If the consumed item did not exist in the diary, the children could record the name of the product and the amount in an 'open field'.

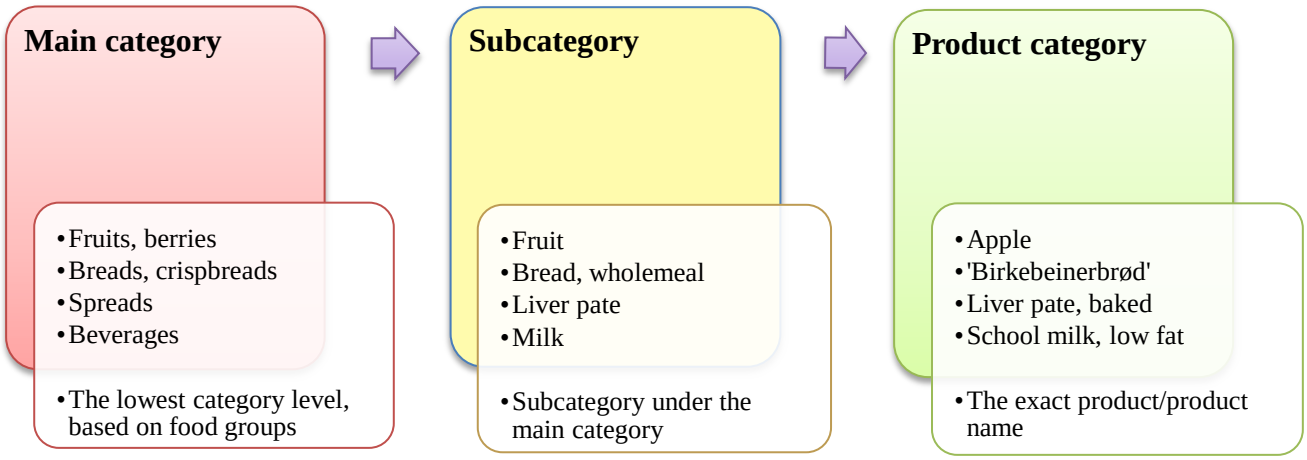

Figure 3. Categorization levels in the food diary, including examples.

An animated character, text and voice were made to ease the recording process and make it more fun to use the food diary. If the child did not record beverage at a meal, this character asked if the participant had forgotten to record this or not. When a meal was recorded, the character asked the participant to take an extra look at what was recorded, and to see if something was forgotten. To ensure that the participants remembered to record margarine/butter, jam and additional other items like milk and sugar on the cereals, some of the recorded food items would flash with the text ‘more’, and a voice and text reminding of these items. Finally, at the end of the registration they were asked if they had eaten any candy or chocolate during the day, in order for the children to record this if they had forgotten it during registration. This may reduce the number of missing recordings due to recall abilities.

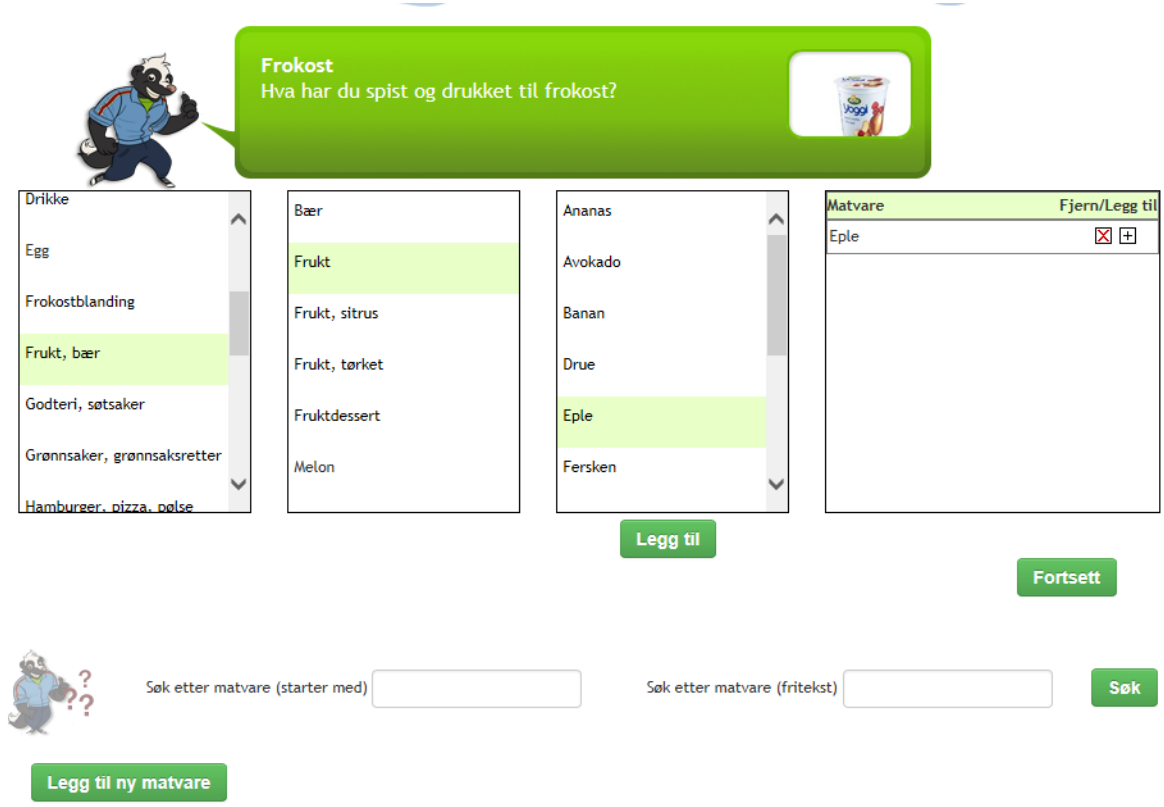

Figure 4. Example of layout in the food diary.

In the information given to both parents and children (appendix 2-5), it was pointed out that the children themselves should record in the food diary, but assistance by parents or other guardians were advised. They were also instructed to record in the diary the same evening, as this is preferable (42, 43, 46, 79). This was pointed out in the user manual accompanying the food diary, in the information sheet (appendix 3) and during information sessions held in the classes. However, if participants did not record the same day, parents were reminded the next day by e-mail. All of these actions were done with the purpose of reducing the number of missing and incorrect recordings in the food diary. In addition, a computer game with a high score list was included in the food diary to motivate the children to complete the web-based food diary every day.

3.4.2 Direct observation

Number of children and observers

Observations of children in the 4th grade were conducted at schools during lunchtime. All children participating in the study and present during the observation period were observed. Each child was observed once. Each observer was observing a maximum of three children during one lunch break.

The children recorded in the food diary either on Wednesday, Thursday, Friday and Saturday, or on Sunday, Monday, Tuesday and Wednesday. It was only possible to observe the children on the three school days. One observer was able to observe a maximum of 9 children over the recording period, and three observers were all together able to observe 27 children during the same period of three days. A few times when there were only one or two children left to observe, only two observers were used.

Identification of the children during observation

Before observing a group, the observers decided on who were going to observe whom. To be able to identify the children during observation, small name badges with name on both sides were made. These were placed on the children's desk, and were used for all children in the class during the observation period in order to make the observation blinded for the children. Names associated with ID numbers of the children, as well as class and school, were typed on the observation form for each child (appendix 6).

Distance to the children

The observers moved around as desired in the classroom, but had to do this discretely. Observations close up to the children was almost always possible to conduct, as the children often were watching television programs or movies on the smart board while eating. However, a constant balance between the challenges with observation and the importance of not affecting the children were important. Allowing the observers to move around during observation could contribute to better blinding, in order not to affect the children that actually were being observed.

Registration of the observed food intake

The observers used a standard form during observation (appendix 6). The observers wrote freely in the memo field during observation. Immediately after observation, the observers categorized all observed items, and selected appropriate pictures of portion sizes that matched the amount, by using tablet computers. These contained all items found in the web-based food diary, with corresponding images showing different portion size categories, and were essential during categorizing.

Category level

In the observation form there were three categories; main category (category 3), subcategory (category 2) and product category (category 1), corresponding to the categories used in the web-based food diary (figure 3). Observations were always done at the highest possible category level. However, observations were not always possible at the product category level, and in these cases observation were done at the subcategory level. However, for some observations, the main categories were used. What categorization level that was appropriate for observations were decided in the protocol before observation started. E.g. product names for breads were not considered possible to observe, thus different kinds of breads was observed at the subcategory level (figure 3). These considerations were used as basis for observation. However, when observations were not possible to conduct at the selected category levels, categorization of these items had to be done at a lower categorization level. When for example spread[1] was observed between two slices of bread, without being able to identify the type of spread, the main category 'spreads' was registered in the observation form, without specifying it more closely. For beverage in colored drinking bottles, observations also had to be done at the main category 'beverages'.

When the exact item observed was not found in the food diary, the item had to be categorized in an appropriate category by the observer after observation.

Excluded food items

Some of the items were not considered possible to observe or to observe correctly. This was the case for butter/margarine and mayonnaise/remoulade, usually used under other spreads. In order to avoid introducing errors these were excluded.

[1] Spread is defined as cold cuts, cheese and all other kinds of spreads like jam, liver pate and caviar.

Questionable observations

Sometimes there were cases when it was not possible to observe a participant's lunch adequately due to packaging that hid the food or for other reasons. When an item was not possible to identify with certainty, it was specified as uncertain.

Portion sizes

In the food diary, the participants had the possibility to pick from four different portion size categories for most of the picture series (figure. 5). For some food items, as yoghurt, there were three portion size categories to pick from, quarter, half and whole. For bread it was possible to pick from two portion size categories, half and whole slice. It was possible to choose more than one portion of different items.

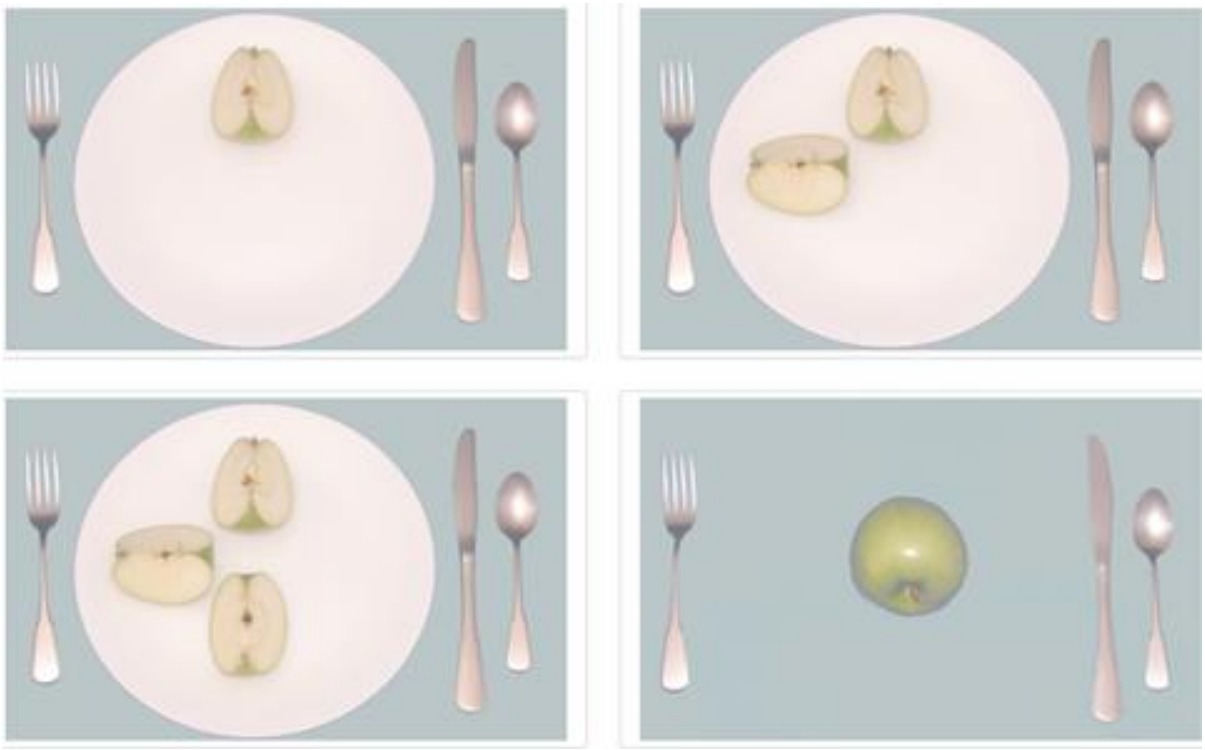

Figure 5. Example of portion size categories in the food diary.

When portion sizes could not be observed

What portion sizes the participants consumed were only noted by the observer when clearly observable. For beverages in drinking bottles, portion size estimations were almost always impossible to conduct. This was also the case for spreads between two slices of bread.

3.4.3 Comparison of observations and recordings

Comparison of food items and beverages

All data recorded by the children for lunches, specified as eaten at school the actual day when being observed, were extracted from the food diary. All data had to correspond to the ID numbers of the children and the actual dates.

Comparison of observed and recorded items had to be done at the same category level. The category level chosen for observation was always used, even though all items recorded by the children were in the product category. Based on this, items were classified as matches, omissions and intrusions.

When the food items did not exist in the food diary

Judgment was used when items did not exist in the food diary. The children got instruction either to choose a similar item or write the exact item in the 'open field' in the diary. In these cases considerations whether the chosen substitute was a match or not were made.

Excluded food items

All observations of items recorded as uncertain in the observation forms were excluded, regardless of whether the children had recorded the items in the food diary, or not. Ten items were excluded before analysis, due to uncertain observations.

Meal component groups

Meal component groups were selected based on items frequently observed consumed during school lunches or foods considered as important otherwise. The meal component groups include different items in one or more main categories (Figure 3). Items in the meal component groups 'spreads', 'dinner leftovers' and 'all beverages', correspond to items in the respective main categories named 'spreads', 'dinners' and 'beverages'. Regarding the meal component groups 'breads and cereals', 'fruits, berries and vegetables' and 'sweets and snacks', items in these meal component groups belong to different main categories. Table 1 shows an overview of the meal component groups used in this thesis.

Table 1. Overview of meal component groups and description

Meal component group	Description
Breads and cereals	This meal component group consists of all breads and cereals.
Spreads	This group consist of cold cuts, cheese and all other kinds of spreads like jam, liver pate and caviar.
Fruits, berries and vegetables	All types of fruits, berries and vegetables were included in this group. Nuts were also included.
Dinner leftovers	All food items/dishes usually consumed for dinner. All food items/dishes under the main category 'Dinners' were included in this lunch meal component group.
Sweets and snacks	All sweet bakery products like buns, cakes and biscuits were included in this group, together with other sweets like milk chocolate. Salty snacks were also included.
All beverages	This group consist of all kind of beverages, included school milk.
School milk	School milk either recorded as school milk or as low/extra low fat milk in the food diary was included in this group.

For beverage it was only possible to look at all beverages together, this because it was impossible to know what the colored drinking bottles contained. Analysis with water separately was for example not possible to conduct. School milk is a widely used product among school children, and results for this product were possible to analyze separately due to easily observable cartons.

Comparison of portion sizes

Only items already considered as matches were used when comparing portion sizes. Further, only items with the same portion size categories and the same picture series were compared. All observed portion sizes registered as uncertain were excluded. For matched items, recorded by the children in the 'open field', described portion sizes from records and observations had to match exactly by description.

3.4.4 Interobserver reliability (IOR)

To assess IOR, some of the children were double- observed, which means that two observers were observing the same child at the same time. IOR analyzes was conducted both before and continuous during data collection, this to ensure quality to the observations during the study.

IOR observations were conducted in one or two classes at each school, either the day before the ordinary observations started or before the weekend, depending on the start of the observation period. To utilize the resources and make the IOR observations similar for all observers, each observed three children at one IOR session. The three observers were divided into three pairs. Each observer observed three children at one IOR session. Two pairs conducted IOR observations on one child each. The third pair (randomly selected) double- observed two children. In total, IOR observations were conducted on four children at each session. The setup for IOR observations is shown in table 2. The same procedure was repeated during the entire observation period, making a total of seven classes observed due to IOR assessment. To ensure quality of the IOR observations, there were no interactions between the observers before categorizations were done and the observation forms were signed.

Table 2. Setup for IOR observations

Observers	A+B	A+B	A+C	B+C	C[a]
Child	a	b	c	d	e

[a] Observation by C[a] alone to ensure that each observer observed three children.

Each observer was compared with the other observers, in pairs. Percent agreements between the observers, for each school and in total were calculated, both regarding identification of items and estimation of portion sizes. Observed items were categorized in the fixed portion sizes in the food diary (figure 5). The objective was for each observer-pair to have at least 85% agreement on both identification of items and portion sizes, in total for all schools during the entire observation period (37). Agreements on identification of items and portion sizes were calculated based on total items observed.

3.4.5 Training of observers

The observers were trained in visual identification of foods and beverages, and assessment of amount and portion sizes before the data collection began. Three weeks of training prior to data collection were conducted in order to reach at least 85% agreement on identification of items between the observers in each pair.

Training sessions

Training sessions were based on earlier experiences with training prior to observation (36), and included three different stages (figure 6). All stages had to be completed before the next one, and before the data collection could begin. In part 1 of stage 1, different pre-identified lunch packages were observed. Five different lunch packages were made up of foods and beverages found in the food diary, and portion sizes were chosen from the picture series. Each of the observers had to identify 85% of all items and 85% of all portion sizes correctly in the five lunch packages. This was also the case for part 2 of this stage. However, in this part IOR were assessed, and total agreement between observers in each pair had to be at least 85%. If match were less than 85% in part 1 or agreement between observers were less than 85% in part 2 of the first stage, five more lunch packages had to be observed, until satisfactory results were achieved. The foods and beverages used were typical items found in the Norwegian lunch packages (80). IOR was also assessed in stage 2, and agreement had to be at least 85% regarding both identification of items and estimation of portion sizes. The observers had to identify the items, estimate the portion sizes, and assess how much three voluntary lunch eaters consumed. All three observers were observing the same three people at the same time. To make the last stage (stage 3) possible to conduct, two different elementary schools were recruited. These schools were not a part of the rest of the project. Two 4^{th} grade classes from each school participated. The children were not identified by name, just a number. In each class, four children were double- observed during school lunch. This was done in the exact same way as described for IOR during data collection, in the section ‘Interobserver reliability (IOR)’. At this stage, the objective also was for each observer-pair to have at least 85% agreement, both regarding identification of items and estimation of portion sizes.

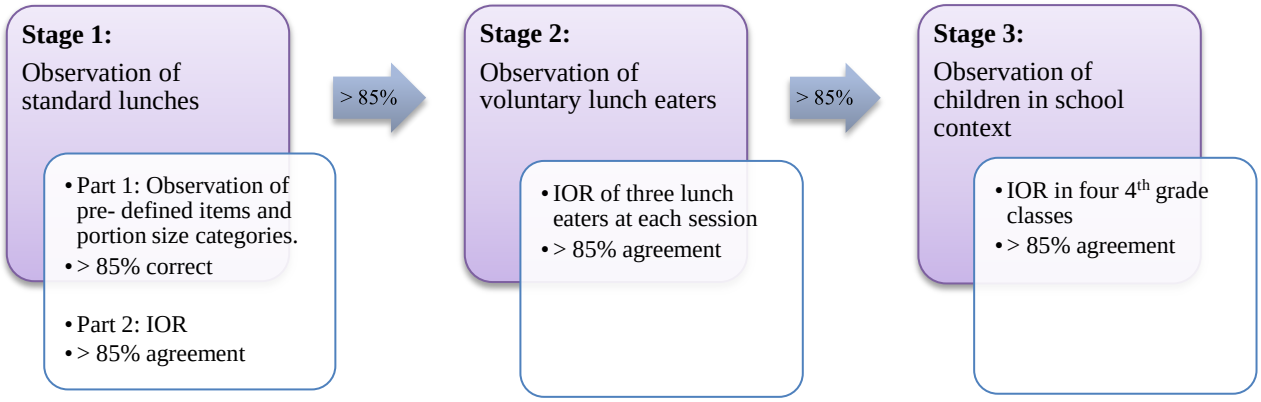

Figure 6. Training stages prior to observation.

In the course of the training period, all stages were completed successfully regarding identification of items. Stage 1 and 2 were also completed successfully regarding portion sizes. At stage 3, total agreement on portion sizes between the three observers in pairs were respectively 70%, 65% and 86%, for all four classes observed. For two of the observer-pairs, this was below the 85% limit.

3.4.6 Anthropometric measurements

Prior to data collection, measurements of height and weight were practiced. Measurements of the participants height and weight were conducted according to standard methods (81). BMI was calculated based on height and weight measurements, and age and gender specific Iso-BMI were used (82, 83).

Measurement of height

Height was measured while the child was standing with heels in contact with the floor and the wall, with feet together, and parts of the back and head in contact with the wall, where a tape measure was attached. This tape measure was calibrated by a 2 m folding rule (EU-approved, with max-deviation of 1, 4 mm). The child had to look straight ahead while holding the head steady. The angle measure was led down to the head and height was measured to the nearest mm.

Measurement of weight

The electronic digital weight (TANITA TBF-300) was used. Weight was measured to the nearest 0.1 kg. The children wore pants and lightweight shirts during weighing.

Iso-BMI

Overweight and obesity in adults are defined by BMI ≥ 25 and BMI ≥ 30 respectively. Age and gender specific cut off points are used to define overweight and obesity in children. These iso-BMI cut off points are developed by Cole et al (83) and the values for the actual age groups are shown in table 3. Cut off points for whole years of age were used, as we only had this information.

Table 3. Overview of Iso- BMI for the actual age groups

	Overweight (BMI 25 kg/m^2)		**Obesity** (BMI 30 kg/m^2)	
Age	**Boys**	**Girls**	**Boys**	**Girls**
8	18,44	18,35	21,60	21,57
9	19,10	19,07	22,77	22,81

When analyzing omission rates and intrusion rates regarding weight status, the categories overweight and obese were merged into one category due to a negligible number of obese children. Two different weight status categories were analyzed, 'normal weight' and 'overweight'. Omission rates and intrusion rates regarding weight status were not analyzes for girls and boys separately, due to a small selection of overweight children.

3.4.7 Parental education level

Through the consent form (appendix 1), background information about gender, age, and parental[2] education level were collected. There were five different education levels to choose from. The lowest level was 7 years or less in school. Second level was completed elementary school or lower secondary school, including 7 to 9 years in school. Third level was upper

[2] Parental education level also covers education levels of actual guardians.

secondary school, including up to 12 years in school. The fourth level included a maximum of 4 years in University/College, and the highest level was attending University/College for more than four years.

Parental education level was defined as the highest education level for either parent. 'Lower' education was chosen to correspond to the three first education levels, and 'higher' to the two highest levels, which correspond to university or college education. Analysis of results regarding the two highest education levels showed no significant differences by Kruskal Wallis test, so they were merged together.

3.5 Ethics

This study is conducted according to the Helsinki Declaration guidelines, and was approved by The Norwegian Social Science Data Services (NSD).

This project was not covered by the REK (regional committees for medical and health research ethics) committee's mandate, and could be conducted without approval from REK.

3.6 Statistics

For each school lunch recorded and observed, matches, omissions and intrusions were tallied. Omission rates and intrusion rates were calculated in order to determine the accuracy of recorded items for each child. Calculations of total omission rates and intrusion rates were made based on the total number of items observed and recorded by each child. Omission rates and intrusion rates for the different meal component groups were based on the number of items observed and recorded by each child in the specific meal component group.

SPSS version 20.0, statistical software for windows (SPSS Inc., Illinois, USA) was used to conduct all statistical analyzes for omission rates and intrusion rates, presented as means, standard deviations and medians.

Omission rates and intrusion rates were not normally distributed, and the non-parametric alternative, Mann Whitney U test was used to analyze differences in omission rates and intrusion rates regarding gender, weight status and parental education level. The results are presented by means and standard deviations, medians and p-values.

All p-values were two-tailed and results were considered to be statistically significant at $p < 0.05$. P-values for match rates (not shown in tables) correspond to p-values for omission rates, as omission rate = 100 - match rate.

3.6.1 Calculations of match rate, omission rate and intrusion rate

Match rate = (sum of matches/ (sum of omissions + sum of matches)) x 100
= 100 - omission rate

Omission rate = (sum of omissions/ (sum of omissions + sum of matches)) x 100
= 100 - match rate

Intrusion rate = (sum of intrusions/ (sum of intrusions + sum of matches)) x 100

These calculations are obtained from articles on observation by Baxter et al (40, 42-46, 53). Omission rates and intrusion rates are calculated separately as omissions and intrusions represent different kinds of errors related to reporting, and therefore are interesting to examine separately. As match rate is equal to 100 - omission rate, only omission rates are presented in tables.

3.6.2 Calculation of percent match in portion sizes

Calculations of percent match in portion sizes were conducted in Microsoft Excel 2010.

Percent match in portion sizes = Total number of items with matching portion sizes / Total number of items possible to match in portion size

3.6.3 Calculation of IOR

Calculations of IOR were conducted in Microsoft Excel 2010.

Percent agreement on identification of items = Total number of agreements on identification of items between the two observers / Total number of items observed

Percent agreement on portion sizes = Total number of agreements on portion sizes between the two observers / Total number of items observed

4. Results

4.1 Subjects characteristics

Table 4. Characteristics of the 4th graders

Characteristics	**Total (n=117)**		**Boys (n=53)**		**Girls (n=64)**	
	Frequency (%)	Mean	Frequency (%)	Mean	Frequency (%)	Mean
Age		8.9		8.8		8.9
8 year-olds	13 (11.1)		9		4	
9 year-olds	104 (88.9)		44		60	
Parental education						
Lower[a]	12 (10.3)		4 (7.5)		8 (12.5)	
Higher[b]	99 (84.6)		47 (88.7)		52 (81.3)	
Missing[c]	6 (5.1)		2 (3.8)		4 (6.3)	
Iso-BMI						
Normal weight [d]	102 (87.2)		47 (88.7)		55 (85.9)	
Overweight[e]	13 (11.1)		5 (9.4)		8 (12.5)	
Obese[f]	2 (1.7)		1 (1.9)		1 (1.6)	
Overweight or obese[g]	15 (12.8)		6 (11.3)		9 (14.1)	

[a] Lower education corresponds to upper secondary school or less.

[b] Higher education corresponds to university/college education.

[c] Missing information about parental education level.

[d] Iso-BMI < 25.

[e] Iso-BMI ≥ 25, but < 30.

[f] Iso-BMI ≥ 30.

[g] Iso-BMI ≥ 25. This group are used during analysis, as the group 'overweight'.

The selection in this study was 117 4th graders. Table 4 shows mean age, distribution of gender, parental education level and iso-BMI categories for all of the participants in the study, and for girls and boys separately.

Most of the children were normal weight 9-year olds, whose parents had higher education. Compared with the boys, a higher percentage of the girls were overweight or obese. The percentage of parents with higher education was highest among the boys.

4.2 Direct observation

4.2.1 Distribution of matches, omissions and intrusions

Table 5. Distribution of matches, omissions and intrusions for total number of items[a] and for items in the different meal component groups, for all 117 subjects

	Observed items[a]	Recorded items[a]	Matches	Omissions	Intrusions
Meal component group	**Nr of items**				
Total	495	450	359	136	91
Breads & cereals	105	104	96	9	8
Spreads	137	118	96	41	22
Fruits, berries and vegetables	105	79	60	45	19
Dinner leftovers	20	14	13	7	1
Sweets & snacks	15	5	3	12	2
All beverages	93	113	81	12	32
School milk	49	50	46	3	4

[a] item is defined as both food items and beverages.

The number of items observed and recorded was 495 and 450 respectively. The distribution of matches, omissions and intrusions for total number of items and for items in the different meal component groups are shown in table 5. The total number of observed items was higher than the total number of recorded items, thus the number of omissions was higher than the number of intrusions. The number of observed items was also higher than the number of recorded items in each of the different meal component groups, except for the meal component groups ‘all beverages’ and ‘school milk’. The highest number of observed and recorded items was for the meal component group ‘breads and cereals’, ‘spreads’ and ‘fruits, berries and vegetables’, and ‘all beverages’. The number of omissions in the meal component group ‘breads and cereals’ and ‘all beverages’ was low. Items in the meal component groups ‘spreads’ and ‘fruits, berries and vegetables’ were frequently omitted and were therefore interesting to investigate further. Along with the meal component group ’all beverages’, the two meals component groups ‘spreads’ and ‘fruits, berries and vegetables’ also had the highest number of intrusions.

Table 6. Omissions in the meal component group 'spreads'; food items and numbers of omissions observed for all 117 subjects

Omitted spreads	Number of omissions	% of omissions
Total	41	100.0
Cheese, yellow	7	17.0
Cheese, brown and 'prim'	4	9.8
Cold cuts, ham and others[a]	9	22.0
Cold cuts, sausage	8	19.5
Liver pate	4	9.8
Caviar and other fish spread	3	7.3
Mayonnaise salad	1	2.4
Spreads, unspecified[b]	5	12.2

[a] Cold cuts, others consist of the food items saveloy, chicken and turkey cuts.
[b] When only able to observe the main category name, spreads.

Table 7. Observed cases of omissions in the meal component group 'spreads' for all 117 subjects

Observed cases of omissions for spreads	N with observed cases	% of cases
Total	33	100.0
Only spread eaten without bread, forgot 1 type of spread	2	6.1
Only bread recorded, forgot 1 type of spread	8	24.2
Only bread recorded, forgot 2 types of spreads	7	21.2
Forgot both bread and 1 type of spread	2	6.1
Forgot 1 of 2 types of spreads	4	12.1
Forgot 1 of 3 types of spreads	2	6.1
Forgot 2 of 3 types of spreads	1	3.0
Recorded another similar type of spread[a]	4	12.1
Recorded another type of spread[b]	3	9.1

[a] E.g. observed salami, recorded ham.
[b] E.g. observed liver pate and recorded ham.

The number of omissions was high in the meal component group 'spreads'. Yellow cheese and cold cuts was most often omitted (table 6). In most of the cases the children recorded bread, but forgot to record either one or two types of spreads (table 7).

Table 8. Omissions in the meal component group 'fruits, berries and vegetables'; food items and numbers of omissions for all 117 subjects

Omitted fruits, berries and vegetables[a]	**Number of omissions**	**% of omissions**
Total	45	100.0
Cucumber	7	15.6
Paprika	5	11.1
Carrot	6	13.3
Apple	6	13.3
Grapes	4	8.9
Nectarine, pineapple, kiwi, clementine, banana	6	13.3
Blueberries, strawberries	4	8.9
Cherry tomatoes, lettuce, pickles	5	11.1
Raisins	2	4.4

[a] Some of the food items in the meal component group are in the same cell due to few omitted items.

Table 9. Portion sizes[a] of omitted food items in the meal component group 'fruits, berries and vegetables' for all 117 subjects

Portion sizes[a]	**Numbers of omitted portion sizes**	**% of omitted portion sizes**
Total	45	100.0
1 (smallest)	19	42.2
2 (small)	13	28.9
3 (medium)	6	13.3
4 (large)	4	8.9
Uncertain[b]	3	6.7

[a] From the picture series in the food diary, all consisting of 4 portion size categories for the actual food items. Portion size 1=smallest portionsize, portion size 4=largest portion size.

[b] Observed between two slices of bread.

The highest number of omissions was found in the meal component group 'fruits, berries, vegetables and nuts'. Cucumber and paprika mostly used as garnish, and carrot and apple bites was most frequently omitted (table 8). In most of the cases garnish or only small portions were omitted (table 9). At one occasion were a child was observed eating grapes, grapes were omitted and raisins were recorded instead, however not observed (an intrusion). This was the only case where an omission and intrusion occurred at the same time, in this meal component group.

4.2.2 Omission rates and intrusion rates

Table 10. Mean and median omission rates and intrusion rates for total number of items and for items in different meal component groups, for all 117 subjects

	Omission rate[a] %			Intrusion rate[b] %		
Meal component group	**N[c]**	**Mean (SD)**	**Median**	**N[d]**	**Mean (SD)**	**Median**
Total	117	27 (27)	25	117	19 (26)	0
Breads and cereals	101	8 (27)	0	101	8 (27)	0
Spreads	93	29 (43)	0	80	18 (34)	0
Fruits, berries and vegetables	67	42 (47)	0	50	21 (37)	0
Dinner leftovers	17	35 (46)	0	13	8 (28)	0
Sweets and snacks	12	85 (31)	100	4	38 (48)	25
All beverages	84	10 (29)	0	106	28 (45)	0
School milk	49	6 (24)	0	50	8 (27)	0

[a] Omission rate = (sum of omissions/ (sum of omissions + sum of matches)) x 100. Omission rates were undefined if a child was observed to have consumed nothing in the meal component group, regardless of what was recorded.

[b] Intrusion rate = (sum of intrusions/ (sum of intrusions + sum of matches)) x 100. Intrusion rates were undefined if a child was observed to have consumed something in the meal component group, but not recorded anything.

[c] N subjects in the category, observed consuming items in the meal component group.
[d] N subjects in the category, recorded consuming items in the meal component group.

Mean and median total omission rate were 27% and 25% respectively, and mean and median intrusion rate were 19% and 0% respectively (table 10). Total omission rate was higher than total intrusion rate. Omission rates were also higher than intrusion rates for each of the meal component groups, except for the meal component groups 'all beverages' and 'school milk'. The highest mean and median omission rate and intrusion rate were found for the meal

component group ‘sweets and snacks’. However, in this meal component group there was few observed and recorded food items. The lowest mean omission rates and intrusion rates were found for the meal component groups ‘school milk’ and ‘breads and cereals’. A low mean omission rate was also found for the meal component group ‘all beverages’, however, for this group there was a notable high mean intrusion rate. In contrast, a high mean omission rate and low mean intrusion rate was found for the meal component group ‘dinner leftovers’. Most of the children were observed eating food items in these two meals component groups ‘fruits, berries and vegetables’ and ‘spreads’. For the meal component group ‘fruits, berries and vegetables’, mean omission rate was remarkable high. Mean omission rate for the meal component group ‘spreads’ was also quite high, and higher compared to the mean total omission rate.

Table 11. Distribution of omission rates for all 117 subjects

Omission rate %	**0**	**≤10**	**≤20**	**≤30**	**≤40**	**≤50**	**≤60**	**≤70**	**≤80**	**≤90**	**<100 (=100)**
Nr of subjects	43	43	57	72	81	98	105	110	113	114	114 (3)
% of subjects	37	37	49	62	69	84	90	94	97	97	97 (3)

Almost half of the number of subjects had omission rates less or equal to 20%, and just above a third had 0 in omission rate. Only few subjects had omission rates over 60% (table 11).

Table 12. Distribution of intrusion rates for all 117 subjects

Intrusion rate %	**0**	**≤10**	**≤20**	**≤30**	**≤40**	**≤50**	**≤60**	**≤70**	**≤80**	**≤90**	**<100 (=100)**
Nr of subjects	65	65	74	82	94	104	106	112	113	114	114 (3)
% of subjects	56	56	63	70	80	89	91	96	97	97	97 (3)

More than half of the number of subjects had 0 in intrusion rate, and just a few subjects had intrusion rates over 50%.

Comparison of omission rates and intrusion rates regarding gender

There were no significant difference between boys and girls regarding total omission rate and intrusion rate (table 13). Concerning meal component groups, there was only a significant

difference in intrusion rates for ‘fruits, berries and vegetables’ (p=0.03). Girls had a lower intrusion rate for this meal component group than boys.

Comparison of omission rates and intrusion rates regarding weight status

There were no significant differences in total omission rates or intrusion rates (table 14) in relation to weight status. Regarding meal component groups, it was only significant difference in omission rates for ‘school milk’ (p<0.01). Compared to normal weight children, overweight children had higher omission rate for the meal component ‘school milk’.

Comparison of omission rates and intrusion rates regarding parental education level

Total omission rate was significant lower (p=0.01) for children of parents with higher education, as well as total intrusion rate (p=0.04). This is shown in table 15.

Regarding meal component groups there were significant difference in omission rates (p=0.04) and intrusion rates (p=0.01) for ‘fruits, berries and vegetables’. There were also significant difference in omission rates (p=0.02) and intrusion rates (p=0.01) for ‘spreads’. Omission rates were also significant different for ‘all beverages’ (p=0.03) and ‘school milk’ (p<0.01). For ‘breads and cereals’ only intrusion rates were significant different (p<0.01). This is also shown in table 15. Children of parents with higher education also had lower omission rates and intrusion rates for these meal components compared to children whose parents had lower education

Table 13. Omission rates and intrusion rates for girls and boys

	Omission rate[a] %							Intrusion rate[b] %						
	Girls			*Boys*				*Girls*			*Boys*			
Meal component group	**N[c]**	**Mean (SD)**	**Median**	**N[c]**	**Mean (SD)**	**Median**	**P[e]**	**N[d]**	**Mean (SD)**	**Median**	**N[d]**	**Mean (SD)**	**Median**	**P[e]**
Total	64	29 (30)	20	53	24 (22)	25	0.59	64	22 (29)	0	53	16 (23)	0	0.28
Breads and cereals	54	10 (30)	0	47	6 (25)	0	0.42	54	9 (29)	0	47	6 (25)	0	0.60
Spreads	50	34 (46)	0	43	24 (39)	0	0.39	42	22 (39)	0	18	13 (28)	0	0.43
Fruits, berries and vegetables	40	36 (45)	0	27	51 (49)	0	0.25	32	14 (34)	0	38	33 (41)	0	0.03
Dinner leftovers	7	29 (49)	0	10	40 (46)	25	0.54	6	17 (41)	0	7	0 (0)	0	0.28
Sweets and snacks	8	77 (37)	100	4	100 (0)	100	0.18	4	38 (48)	25	0	-	-	-
All beverages	44	9 (29)	0	40	11 (29)	0	0.46	57	27 (43)	0	49	30 (46)	0	0.78
School milk	20	10 (31)	0	29	3 (19)	0	0.35	18	0 (0)	0	32	13 (34)	0	0.12

[a] Omission rate = (sum of omissions/ (sum of omissions + sum of matches)) x 100 = 100 – match rate. Omission rates were undefined if a child was observed to have consumed nothing in the meal component group, regardless of what was recorded.

[b] Intrusion rate = (sum of intrusions/ (sum of intrusions + sum of matches)) x 100. Intrusion rates were undefined if a child was observed to have consumed something in the meal component group, but not recorded anything.

[c] N subjects, in the category, observed consuming items in the meal component group.
[d] N subjects, in the category, recorded consuming items in the meal component group.

[e] Mann Whitney U test.

Table 14. Omission rates and intrusion rates for normal weight and overweight children

	Omission rate[a] %							**Intrusion rate[b] %**						
	Normal weight[c]			***Overweight[d]***				***Normal weight[c]***			***Overweight[d]***			
Meal component group	**N[e]**	**Mean (SD)**	**Median**	**N[e]**	**Mean (SD)**	**Median**	**P[g]**	**N[f]**	**Mean (SD)**	**Median**	**N[f]**	**Mean (SD)**	**Median**	**P[g]**
Total	102	26 (27)	33	15	31 (27)	25	0.44	102	19 (26)	0	15	21 (28)	0	0.80
Breads and cereals	88	10 (29)	0	13	0 (0)	0	0.23	87	8 (27)	0	14	7 (27)	0	0.91
Spreads	82	27 (42)	0	11	47 (48)	50	0.15	71	16 (33)	0	9	31 (43)	0	0.15
Fruits, berries and vegetables	59	44 (50)	25	8	36 (48)	0	0.93	44	20 (37)	0	6	26 (39)	13	0.39
Dinner leftovers	14	29 (43)	0	3	67 (58)	100	-	12	8 (29)	0	1	0 (-)	0	-
Sweets and snacks	11	83 (32)	100	1	100 (-)	100	-	4	38 (48)	25	0	-	-	-
All beverages	72	9 (27)	0	12	17 (39)	0	0.54	92	28 (45)	0	14	29 (47)	0	0.99
School milk	42	2 (15)	0	7	29 (49)	0	<0.01	44	7 (25)	0	6	17 (41)	0	0.41

[a] Omission rate = (sum of omissions/ (sum of omissions + sum of matches)) x 100 = 100 - match rate. Omission rates were undefined if a child was observed to have consumed nothing in the meal component group, regardless of what was recorded.

[b] Intrusion rate = (sum of intrusions/ (sum of intrusions + sum of matches)) x 100. Intrusion rates were undefined if a child was observed to have consumed something in the meal component group, but not recorded anything.

[c] Iso-BMI < 25.
[d] Iso-BMI ≥ 25.

[e] N subject, in the category, observed consuming items in the meal component group.
[f] N subjects, in the category, recorded consuming items in the meal component group.

[g] Mann Whitney U test**.** P-values are not presented for meal component groups where N is <4 in one of the categories.

Table 15. Omission rates and intrusion rates in relation to parental education level

	Omission rate[a] %							**Intrusion rate[b] %**						
	Lower education[c]			***Higher education[d]***				***Lower education[c]***			***Higher education[d]***			
Meal component group	**N[e]**	**Mean (SD)**	**Median**	**N[e]**	**Mean (SD)**	**Median**	**P[g]**	**N[f]**	**Mean (SD)**	**Median**	**N[f]**	**Mean (SD)**	**Median**	**P[g]**
Total	12	48 (32)	50	99	25 (26)	20	0.01	12	40 (38)	55	99	17 (24)	0	0.04
Breads and cereals	8	13 (35)	0	89	8 (27)	0	0.74	10	30 (48)	0	87	6 (23)	0	<0.01
Spreads	9	61 (49)	100	80	25 (41)	0	0.02	6	50 (45)	50	71	15 (33)	0	0.01
Fruits, berries and vegetables	4	88 (25)	100	60	39 (46)	0	0.04	4	75 (50)	100	43	15 (31)	0	0.01
Dinner leftovers	3	67 (58)	100	12	29 (45)	0	-	1	0 (0)	0	9	0 (0)	0	-
Sweets and snacks	2	100 (0)	100	10	82 (34)	100	-	1	100 (-)	100	3	17 (29)	0	-
All beverages	9	28 (44)	0	70	7 (25)	0	0.03	11	36 (50)	0	90	28 (44)	0	0.57
School milk	4	50 (58)	50	42	2 (15)	0	<0.01	2	0 (0)	0	45	9 (29)	0	-

[a] Omission rate = (sum of omissions/ (sum of omissions + sum of matches)) x 100 = 100 – match rate. Omission rates were undefined if a child was observed to have consumed nothing in the meal component group, regardless of what was recorded.

[b] Intrusion rate = (sum of intrusions/ (sum of intrusions + sum of matches)) x 100. Intrusion rates were undefined if a child was observed to have consumed something in the meal component group, but not recorded anything.

[c] Lower education is upper secondary education or less.
[d] Higher education is university/college education.

[e] N subject, in the category, observed consuming items in the meal component group.
[f] N subjects, in the category, recorded consuming items in the meal component group.

[g] Mann Whitney U test. P-values are not presented for meal component groups where N is <4 in one of the categories.

4.2.3 Match in portion sizes

Table 16. Match in portion size for total number of items, and for items in different meal component groups, for all 117 subjects

Meal component group	Items with possible match in portion sizes[a]	Items with match in portion sizes	% match in portion sizes[b]
Total	269	162	60
Breads and cereals	91	61	67
Spreads	74	30	41
Fruits, berries and vegetables	56	31	55
Dinner leftovers	11	4	36
Sweets and snacks	3	2	67
School milk	29	25	86

[a] Only portion sizes of food items and beverages already considered as matches in items, with the same portion size categories and the same picture series in the food diary were compared.

[b] There was no allowances for discrepancies when matching portion sizes.

From the 269 items with possible match in portion sizes, 162 were matches, corresponding to a match of 60% (Table 16). Match in portion sizes for the different meal component groups are also given in table 16. For beverages it was only possible to compare portion sizes for school milk, as there were only two occasions of reliable portion size observations for other beverages than school milk. The highest match in portion sizes, 86%, was for recorded and observed items in the meal component group ‘school milk’. The lowest match in portion sizes was for items in the meal component groups ‘dinner leftovers’ and ‘spreads’. However, in the meal component group ‘dinner leftovers’ there were few items with possible match in portion sizes. In the meal component group ‘spreads’ there was a high number of items with possible match in portion sizes.

4.2.4 Interobserver reliability (IOR)

Table 17. Percent agreement on identification of items and portion sizes between observers

	% agreement on identification of items			% agreement on portion sizes[a]		
Schools	**Observer-pair 1**	**Observer-pair 2**	**Observer-pair 3**	**Observer-pair 1**	**Observer-pair 2**	**Observer-pair 3**
1	100	100	100	50	75	75
2	100	100	100	100	75	83
3	100	82	83	88	91	61
4	88	100	85	76	92	90
Total all schools	92	96	88	78	88	77

[a] There was no allowances for discrepancies when matching portion sizes.

Seven IOR sessions were conducted during the observation period. The agreements on identification of items were between 82% and 100%, for each observer-pair at the different schools. A decrease in the agreement on identification of items occurred in the middle of the observation period, for two of the observer pairs at school 3. For the two pairs, the agreement was respectively 82% and 83%. However, for all schools combined, the total agreement on identification of items for the observer-pairs was between 88% and 96% (table 17), and within the required limit of 85%.

Agreements on portion sizes lie between 50% and 100%, for each observer-pair at the different schools, and therefore have a degree of uncertainty. However, for all schools together, the total agreement regarding portion sizes, for all schools and all observer-pairs are respectively 78%, 88% and 77%, and reasonable high (table 17).

5. Discussion

5.1 Study population

5.1.1 Sample size and recruitment

In this validation study, 65% of all invited subjects did consent to participate. This recruitment rate is quite similar compared to other observation studies on 4th grader's school meals, where recruitment rate range from 56% to 73% (40, 43, 53, 73). The children, who changed their mind to join the project or had forgotten to bring the consent on collection-day, were allowed to bring the consent the next day. Allowing for this led to a far higher participation from the actual collection-day to the next day. The day the consent was collected, information about the project was given and this may have contributed to this increase in participation rate. Four children withdrew from the study and seven were excluded. Two cinema tickets were given to each participant who completed the entire project and this may have contributed to a low number of withdrawals. The final sample of 117 children counts for 60% of all invited subjects. The final sample is larger than the estimated sample size needed for the entire project, and is higher than used in other observation studies, ranging from 23 to 104 subjects (40, 44, 49, 53, 73).

There may be differences in characteristics between the ones who usually participate in a study and the ones who do not, and it is important to try recruiting a diverse selection of subjects. The recruitment process is important, and use of time and resources are essential in this process, as it may lead to a more diverse selection when used successfully. Information given directly to the children when visiting schools, allowing them to bring the consent the next day, and receiving cinema tickets for completing the study may have contributed to a wider selection of subjects compared to not doing so. Maybe the ones who usually do not participate in studies may participate when the recruitment process are emphasized. This needs to be considered in the next UNGKOST survey, because it is important to get a wide selection of participants due to different diet in different groups of the population.

5.1.2 Generalizability

Schools were not randomly selected, only schools in Bærum were recruited, however from different areas. Accuracy of reported dietary intake may be related to differences in subject characteristics. Subjects from different districts and cities in Norway may have different characteristics, and the accuracy of reported intake may therefore vary across different areas.

In this study the majority of subjects, 87.2%, were normal weight children. The prevalence of overweight was 12.5% for girls and 9.4% for boys. The prevalence of obesity was 1.9% for girls and 1.6% for boys. These numbers are slightly lower than the numbers reported by The Norwegian Directorate of Health in 2008 (8), where the prevalence of overweight in a nationwide sample of 4th grade girls and boys were 14.7% and 12.8% respectively, and the prevalence of obesity were 4.7% and 2.8% respectively. The Norwegian Institute of Public Health (84) has published more recent numbers on the prevalence of overweight among 3rd graders, and results were quite similar to numbers reported by the Norwegian Directorate of Health regarding 4th graders. Among 3rd graders 18% of the girls and 14% of the boys were either overweight or obese. As described earlier, the relation between weight status and accuracy of reporting by children are not evident (27, 71-73). In the present study, no differences in total omission rate or intrusion rate regarding weight status were found. As the relation between accuracy of reporting by children and weight status are not clear, it is difficult to predict if results could have been different using a more representative sample of the Norwegian population. However, there was not a remarkable difference between the numbers regarding overweight and obesity found in our study and the numbers for the national population of 3rd and 4th graders.

Parental education level in this study was high, 88.7% of the girl's parents and 81.3% of the boy's parents reported high educational level, which corresponded to university or college education. Data from Statistics Norway (85) shows that 27.1 % of Norwegian women and 32.5 % of Norwegian men had university or college education in 2012. However, results for different areas in Norway show that 46.5% had higher education in the capital city, Oslo, compared to only 24.5% in Finnmark, a county in the north of Norway (85). Parental education level in the population studied is much higher than for the overall Norwegian population. The accuracy of recordings might have been different using a more representative sample of the Norwegian population. In the present study, children with less educated parents

had higher total omission rate and intrusion rate compared to those with more educated parents.

5.2 Methodological issues

5.2.1 Web-based food diary

This new web- based food diary is designed to make recording easier, user-friendlier and more fun for the children, compared to traditional paper versions of food diaries. This may increase the probability of completed food records, and may also contribute to higher accuracy of recordings. The hierarchic organization of foods and beverages and the search field in the food diary should ease the process of finding the right food names. Prompts during the entire recording process should reduce errors related to memory, and thus also reduce the number of lacking recordings of items.

The main principle of a food record or diary is that food consumed is recorded as it occurs (23). This web-based food diary has a retrospective perspective as the children are instructed to record in the food diary in the evening. When recording in the web-based food diary at the end of the day, memory will be an important factor, essential for the accuracy of the records. When using a paper version of a food diary, the participants can record in the food diary after each meal. This can lead to a reduction in errors related to memory. However, for the web-based food diary used in the present study, it was also possible to record after each meal, but this was not expected, as the children usually do not bring their computers or other web-based devises to school. A notebook to record in during the day, after each meal, for recording in the food diary later on, can reduce potential errors related to memory. This may also be beneficial in case of technical problems. However, this may also become a greater burden on the participants. Another issue related to this web-based food diary, is the inability to go back and correct a completed record for one of the previous days. This is possible in paper versions of food diaries.

The participants were instructed to record in the food diary the same evening. However, it occurred, as both informed by the children and detected during controlling of records, that they forgot to do this sometimes and therefore recorded in the food diary the next day. This was the case for approximately 10-15% of the children (data not shown). When this

happened, parents were reminded by e-mail the next day to reduce further delay. The accuracy of delayed recordings may be lower than for recordings done in the same evening. In previous validation studies (42, 43, 46, 79), where observations of school lunches have been compared to reported intake using 24-hour recalls or interviews concerning the day's intake or intake only regarding school lunch, the accuracy of reported items have shown to be dependent on the time interval between the school meals are consumed and the interviews are conducted. However, the accuracy of portion size estimations seems not to be reflected by the time interval between the school meals are consumed and the interviews are conducted (43, 86). To ensure that the children record within 24 hours, one recording day in the web-based food diary could close after 24 hours. This may reduce potential errors related to weakened memory over time. However, this may also lead to a higher burden on the actual children, as they then need to record an extra day.

In the information given to the parents and the children, it was pointed out that the children themselves should do the recording in the food diary, preferably with assistance from parents or other guardians. If parents record in the food diary without involving the children, this may be a source of error, which can lead to misreporting. In the present study, it was only four occasions where parents recorded in the food diary without involving the children (data not shown). However, when this happens, parents may record the foods and beverages packed in the lunch bag rather than what they actually consumed. Not all of the items may have been consumed, and some may have been thrown away. Food trading among the children was observed to be quite common. It is important that the parents only assist the children during recording. Whether parents are assisting the children during recording or not, may lead to differences in the accuracy of records, as parents can assist the children with practical issues related to the food diary and contribute by adding additional food details if needed (34).

Recording of foods and beverages

Foods and beverages should be easier to find using a web-based food diary compared to a paper-based version. On the other hand, a paper-based food diary may lead to more awareness of all the items listed in the food diary, as the subjects have to read through all these items in order to find the appropriate items. Thus, the children can be reminded of what they ate in the different meals, possibly leading to more accurate recordings. Food items were most often omitted in the meal components 'spreads' and 'fruits, berries, vegetables and nuts'. In the

web-based food diary there are prompts during the entire recording process. However, the prompts do not have a particular focus on these meal components. Such specific prompts should be considered included in the web-based food diary in order to increase the accuracy of these food items.

Not all foods and beverages are listed in the web-based food diary, and this can lead to misreporting. The children may either exclude the item, or chose another item, similar to the one that was consumed. However, there is an open field where they can write down the proper product. For the lunches observed, there were only a few items recorded in this field.

Another possible issue may be if the subject in order to ease the recording process, records all of one item consumed during the day as consumed in only one meal to avoid going back to the right meal and add the item. E.g. if a child record for dinner, all fruits eaten during the day, because of forgetting to record this for the previous meals, already being recorded in the food diary. There might be a risk that some items observed consumed but not recorded (omissions) and items recorded but not observed consumed (intrusions) are due to this. Omitted items may have been recorded for another meal. As to intrusions, recorded items may have been eaten in another meal. Children may also start to eat or drink something at lunch, and then finish it between lunch and dinner, and therefore record it for the meal 'afternoon snack' in the food diary. This may lead to omissions for lunch. For the meal component, 'fruits, berries, vegetables and nuts' this would be particularly interesting to investigate, as these food items are most frequently omitted.

Portion sizes

Compared to using description of portion sizes in terms of small, medium or large, or by using food models, as household measures or other food models to illustrate portion sizes, photographs of portion sizes has shown to improve the accuracy of portion size estimations (77, 78). The computer interface may also contribute to clearer portion size details compared to paper versions.

For some food items, portion sizes are shown by the same picture series, e.g. the picture series for saveloy is the same as for salami. The pictures show slices of salami, which usually are smaller than slices of saveloy. Different illustrations of food items may lead to difficulties choosing and estimating portion sizes, as shown in a previous study by Lillegaard et al (31).

For portion sizes, there is a maximum limit. For beverages, except for beverages in cartons, the largest portion size category is 2 dl. Some children may only chose the largest portion size, instead of multiplying or choosing several portion sizes. However, when looking at recorded portion sizes in the present study, it occurred that some of the children actually chose to multiply portion sizes to get the right amount.

5.2.2 Direct observation of school lunch

Direct observation can provide unbiased information about actual intake and thus give valuable information about errors related to the dietary assessment methods used (25). However, observational training is essential to produce reliable and accurate results (36, 55) The training sessions conducted prior to data collection was considered as sufficient preparation in order to do accurate observations of actual intake. Still, there will always be challenges regarding observations, especially concerning observation of all kinds of home-prepared lunch packages, consisting of a broad range of items with non-standardized portions, often inside opaque containers. Sometimes the children also watched movies or TV programs on the smart board, with lights turned off, making observations even more challenging to conduct.

The children did not seem to be affected by the observers. The study by Smith et al (87) found that observation of school meals did not affect the accuracy of 4th graders dietary reports, obtained by interview. The number of meals and snacks, meal components and kilocalories reported were some of the variables that were compared in the study by Smith et al. Thus, dietary reports made by observed children may be generalized to dietary reports by children that were not observed. However, change in eating pattern and food intake, either intentionally or not, may occur because the children are being observed. Parents' knowledge about healthy eating may for example lead to a change in the content of their children's lunch packages due to participation in the study (25). This will not affect the validation study. However, a change in diet due to participation in a study must be taken into consideration in dietary surveys, as in the next UNGKOST survey.

5.2.3 Comparison of recorded foods and observation

As mentioned earlier, looking at separate meals may lead to omissions and intrusions that would not have been present if observations and recordings for the entire day were compared. However, observations during an entire day would be extremely difficult to conduct.

To ensure that the same meals were compared, only lunches recorded as eaten at school were extracted. In this study the main purpose was to look at the accuracy of recorded foods and beverages for school meals, and only data recorded by the children for lunches specified as eaten at school could be analyzed. The five excluded school lunch records lacked specified information about the school meal. In these cases it was impossible to know which of the meals recorded in the food diary that actually was recorded as the school meal, and these were excluded to avoid introducing errors. In a few cases, breakfast was recorded as ‘eaten at school’ and lunch was recorded as ‘eaten at home’. In these cases it would be difficult to know which to choose. The children might have eaten the first meal at school, either before school lunch or at school lunch, and for this reason called it breakfast, or they might have selected the wrong place when recording where the meals were eaten. Cultural or lingual background can result in different naming of meals. Differences in eating habits, as to when meals are eaten, may also be caused by cultural backgrounds or other individual factors. However, this will not be an issue when studying results for the entire day, which usually is most essential in dietary surveys.

5.3 Interpretations of results

5.3.1 Results for all items observed and recorded

The total number of observed items was higher than the total number of recorded items, thus the total number of omissions was higher than the total number of intrusions. Omissions seem to be the main problem related to recording in the web-based food diary.

In the present study, mean omission rate and intrusion rate, for all items observed and recorded by each child, were 27% and 19% respectively. Median omission rate and intrusion rate, for all items observed and recorded by each child, were 25% and 0% respectively.

Several studies by Baxter et al (40, 42, 43, 46, 53), using observation as reference method, have presented mean omission rate and intrusion rate (table 18). One of these studies by Baxter et al (40) compared foods and beverages reported consumed for school breakfast and school lunch in 24-hour recalls conducted in the morning with observations. Means for omission rates and intrusion rates were 51% and 39% respectively. Median was 53% for omission rates and 40% for intrusion rates. Another study by Baxter et al (53) found a mean omission rate of 34% and a mean intrusion rate of 9% for recalls of school breakfast and school lunch made by interviews the same evening regarding that days intake. Median omission rate and intrusion rate were 33% and 13% respectively. A third study by Baxter et al (43), found that the mean omission rate and intrusion rate for recalls of school lunch, conducted within 90 minutes after the meal, were 16% and 5% respectively. For next-day recalls mean omission rate and intrusion rate were 32% and 13% respectively. In that study they only asked the children to recall what was eaten for school lunch. This probably makes the memorizing process easier, and may reflect results. Baxter et al (46) also looked at the accuracy of reported school lunches concerning different time intervals between consumed school lunches and recalls in another study. Accuracy of reported school lunches was highest when the 24-hour recalls were conducted after lunch during school hours or in the evening, with mean omission rates of 31% and 28% respectively, and mean intrusion rates of 16% and 22% respectively. When the 24-hour recalls were conducted in the morning, mean omission rate and intrusion rate for reported school lunches increased to 55% and 49% respectively. When time intervals between consumed meals and recalls were even longer, omission rates and intrusion rates further increased. The accuracy of school meal recalls concerning time interval between consumed meals and recalls, was also assessed in another study by Baxter et al (42). However, both school breakfast and school lunch recalls and observations were included in the assessment. They found a mean omission rate of 30% when 24-hour recalls were conducted after lunch during school hours. Mean omission rate was 56% for recalls conducted in the evening, but also for recalls conducted the next morning. Mean intrusion rate was 17% when recalls were conducted after lunch during school hours, and 33% and 37% respectively when recalls were conducted in the evening or next morning. In our study, the children were instructed to record in the food diary the same evening. However, the extent of next-days recalls or even longer delays of recordings are uncertain. Results from all of these studies by Baxter et al (40, 42, 43, 46, 53) emphasize the importance of reducing the time interval between consummation and recalls.

When comparing results from our study with results found in three of the studies mentioned above (42, 46, 53), where 24-hour recalls or interviews about the day's intake were conducted in the evening, as instructed for the recording in the web-based food diary, mean omission rate in our study was lower or equal to these results. As for mean intrusion rates, result found in our study was lower compared to results in two of these studies (42, 46). When comparing results found in our study with results found in all of these studies mentioned above (40, 42, 43, 46, 53), regardless of time intervals between consumed school lunches and recalls, mean omission rate were generally lower in our study. As for mean intrusion rate, the results found in these studies were quite different from each other. However, mean intrusion rate found in our study appears to be close to the average of all these different results. Mean omission rate was higher than mean intrusion rate in our study, consistent with results found in all of these studies by Baxter et al (40, 42, 43, 46, 53).

Compared to the two studies by Baxter et al (40, 53), presenting median rates in addition to mean rates, results for median omission rate and intrusion rate were lower in our study; this regardless of time interval between consumed school lunches and recalls. The majority of the children in our study had low omission rate and intrusion rate. Over 50% of the subjects had 0 in intrusion rate, and the median is therefore 0. In the two studies by Baxter et al (40, 53), more than 50% of the children needed to have more than 0 in intrusion rate, in order to get those results for medians. This indicates that intrusion rates were more evenly distributed among the children in these two studies, compared to the distribution of intrusion rates in our study.

Different results may be due to different dietary assessment methods used. In our study observations were compared to recorded intake for school lunches in food diaries. In the studies mentioned above (40, 42, 43, 46, 53), 24-hour recalls or interviews concerning the day's intake, or intake only regarding school lunch, were used as dietary assessment methods. The results from these studies are also quite different from each other. However, the accuracy of dietary data obtained by interviews may, to some extent, be influenced by different abilities for the interviewers to capture the actual intake. In our study parental assistance was advised. During the interviews in the studies by Baxter et al (40, 42, 43, 46, 53), there was no parental assistance. This may contribute to higher omission rates and intrusion rates, as parents can assist the children by adding details about the foods and beverages consumed and by prompting the children (34).

Standardized lunches were distributed by the schools in all of the studies by Baxter et al (40, 42, 43, 46, 53). These lunches consisted of different meal components, such as entrée, vegetable, fruit and bread. In our study children brought home-prepared lunch packages. Home-prepared lunches may be more familiar to the children, as these food items are likely to be consumed frequently by the children, and may therefore lead to more accurate food intake reported by the children. In the lunches distributed by the school, some of the food items may be unfamiliar to the children, and thus lead to less accurate reported food intake.

Each of the meal components was given different statistical weight when analyzing total omission rate and intrusion rate in the studies mentioned above (40, 42, 43, 46, 53). The meal components that made up the largest part of the meal were given a statistic weight of one, and the less important parts of the meal were given less statistic weight. A typical home-prepared lunch package observed in the 4^{th} grade classes, consisted of bread, different kind of spreads, a fruit or vegetables and school milk. All these meal components were considered as equally important for the purpose of this study, and were therefore not given statistic weights. Use of statistic weight may also lead to different results. However, omission rates probably should be lower in studies using statistic weight, as less important part of the meal or smaller food items, most probably omitted, were given less statistic weight. This was not seen when comparing results from the studies by Baxter et al (40, 42, 43, 46, 53) with results from our study. Mean omission rate and intrusion rate were generally lower in our study, even though small food items like vegetables used as garnish were emphasized equally with, for example, slices of bread. Perhaps vegetables used as garnish or other small food items should have been given a lower statistic weight. However, it would be difficult to decide on the statistical weight for different food items, and the limits for 'small food items' as all of the children had lunch packages with different content.

In all of the studies by Baxter et al (40, 42, 43, 46, 53) foods and beverages were categorized as matches unless the items reported in interviews clearly differed from the observed items. In some of these papers, it is actually specified that the accuracy of recordings may be overestimated (40, 53). In our study, items recorded by the children were compared to the categorization levels chosen by observations. When categorizing matches in our study, we most probably used a stricter categorization of matches. Still, result for total omission rate in our study was generally lower.

Table 18. Overview of observation studies where omission rates and intrusion rates have been examined

	Mean omission rate	Mean intrusion rate	Median omission rate	Median intrusion rate
Our study	28	19	25	0
Baxter et al (43)				
Same day recall (90 min after school lunch, only regarding school lunch	16	5		
Next day recall (morning after, only regarding school lunch)	32	13		
Baxter et al (40)				
24-hour recall (morning)	51	39	53	40
Baxter et al (53)				
Same day recall (evening)	34	9	33	13
Baxter et al (46)				
24-hour recall (after school lunch)	31	16		
24-hour recall (evening)	28	22		
24-hour recall (morning)	55	49		
Baxter et al (42)				
24-hour recall (after school lunch)	30	17		
24-hour recall (evening)	56	33		
24-hour recall (morning)	56	37		

Other studies, not conducted by Baxter et al, have also looked at the accuracy of reported foods and beverages, by looking at matches, omissions and intrusions. However, in these studies omission rates and intrusion rates were not calculated, but the percentage of omissions and intrusions based on all observed and reported foods and beverages (41, 49, 88). In one of these studies (88), the Danish version of the web-based food diary was validated. Observation was conducted differently, as the children's lunch packages were opened, photographed and weighted before and after eating. Additional questions concerning the meals were also posed to the children. School lunches recorded were compared to images and weights of the lunches. The percentage of matches, omissions, intrusion and faults were respectively 82%, 3%, 14% and 1%. Faults were defined as items recorded eaten that did not describe the items observed eaten. This term was not used in the present study. Both correspondence in items and portion sizes were included in these classifications. Despite different methods and calculations used to assess omissions and intrusions in the Danish version of the web-based food diary and for the web-based food diary used in the present study, the percentage of omissions seemed to be

quite low in the study by Biltoft et al (88). The percentage of intrusions was remarkably low. However, it may be easier to remember what the home-prepared lunch packages contains when these are opened, weighted and photographed, in addition to questions asked about the meal. This method may therefore affect the children and increase the awareness of food content in the lunch packages.

5.3.2 Results for items in different meal component groups

For each of the different meal component groups, except for the meal component groups 'all beverages' and 'school milk', the number of observed items was higher than the number of recorded items. Thus, the number of omissions was also higher than the number of intrusions for these meal component groups. The meal component groups 'spreads' and 'fruits, berries and vegetables' were especially interesting to investigate, as these were the meal component groups, that in addition to 'breads and cereals' and 'all beverages' had the highest number of observed and recorded items, but in contrast to the meal component groups 'breads and cereals' and 'all beverages' had a remarkably high number of omissions. However, items in the meal component group 'all beverages' had a notable high intrusion rate, also being of interest to look into.

Breads and cereals

Both mean omission rate and intrusion rate for the meal component group 'bread and cereals' were 8%. There were few omissions and intrusions in this meal component group, and mean omission rate and intrusion rate were respectively lower than mean total omission rate and intrusion rate. The children were good making correct recordings of 'breads and cereals'. For the majority of the children, bread was observed to be the main component of the school lunches. This is consistent with what was reported by The Research Council of Norway in 2011 (80). It is important that the children correctly record these food items, as they often constitute a large part of the total dietary intake.

In the study by Baxter et al (43), mentioned earlier, they compared observations of school lunches to reported intake obtained from interviews, which only included questions about the school lunches. They also looked at different meal components of the lunches distributed by the schools. For 'bread' mean omission rate was 22% and mean intrusion rate 7%. Compared

to these results, mean omission rate for 'breads and cereals' was lower, and mean intrusion rate just slightly lower in this present study. In another study by Baxter et al (40), also mentioned earlier, they also looked at different meal components. Observations of school lunches were compared to 24-hour recalls conducted in the morning. Mean omission rate and intrusion rate for the meal component 'bread/grain' was 48% and 52% respectively. In the present study, mean omission rate and intrusion rate for the meal component group 'breads and cereals' were notable lower. However, the American school lunches in the studies by Baxter et al (40, 43) consisted of meal components such as entrée, vegetable, fruit, beverage and bread. Bread was only a part of the meal. This is in contrast to the Norwegian school lunch packages in the present study, where 'bread and cereals' was found to be the main component group. It is probably easier to recall items that are consumed regularly and frequently. This can be the reason why the omission rate and intrusion rate were lower for this meal component group in the present study, compared to the results found by Baxter et al (40, 43). However, different inclusion criteria for the meal components 'bread' and 'bread/grains' analyzed in the two studies by Baxter et al (40, 43) and for the meal component group 'breads and cereals' analyzed in this thesis can make these meal components/meal components group less comparable, and results may be affected by this.

Spreads

Mean omission rate and intrusion rate for the meal component group 'spreads' were 29% and 18% respectively. Yellow cheese and cold cuts were most often omitted, and these food items were also the most frequently used types of 'spreads'. In most of the cases where the children omitted 'spreads', they managed to record bread correctly. In addition to bread, different kind of 'spreads' have proven to be the most frequently eaten food items for school lunch in Norway (80), as also seen in the present study. Even though food items in this meal component group most often do not constitute a large part of each child's school lunch, these food items will make up an important nutritional part of the children's food intake when eaten every day for lunch, and probably for others meals during the day as well.

Even though margarine/butter was excluded from analysis, it was surprising how many of the children who actually recorded this in the food diary. In many situations where only bread was recorded and 'spreads' were omitted, margarine was recorded. However, a prompt with focus on this food item was included in the food diary, and may have contributed to the high

number of recordings of margarine, found in this study. In order to decrease the number of omissions, specific prompts regarding recording of ‘spreads’ should be considered included in the web-based food diary.

Fruits, berries and vegetables

Mean omission rate and intrusion rate for the meal component group ‘fruits, berries and vegetables’ were 42% and 21% respectively. The omission rate was remarkably high. Cucumber and paprika mostly used as garnish and carrot, apple bites and grapes were most frequently omitted. Food items observed as the smallest portion size in the food diary were most often omitted in this meal component group. It may be difficult to remember these small food items when recording in the food diary. However, medium or half portions, like half an apple were also relatively often omitted. There were only few occasions were food items observed as the largest portion size category was omitted. Vegetables and fruits used as garnish may not constitute a major nutritional component for each individual child’s school lunch, but contributed to a high number of omissions. However, vegetables or fruits used as garnish were frequently consumed by the children and are important to consider when looking at the broader picture. These food items may contribute to a large part of children’s fruit and vegetable intake when eaten every day, probably also for other meals than just lunch.

A source of error is if a child starts eating a food item, e.g. apple bites at lunch, and then finishes it as a snack between lunch and dinner. If the child records all of the apple bites as ‘afternoon snack’ in the food diary, this contributes to omissions for lunch. This may occur for all kinds of items, but apple bites or other sliced fruits and vegetables may be easy to eat as a snack between meals. This may have contributed to omissions in this meal component group.

In this meal component group, there was only one occasion where a child was observed eaten a food item (grapes) that was omitted in the food diary and recorded as another similar item instead (raisins). Thus, the children were not only substituting food items, but actually left out a great number of food items in this meal component group, or as mentioned above, they might have recorded the food item for another meal.

In the study by Baxter et al (43) they looked at the meal component ‘vegetable’ for school lunch. Mean omission rate was 16% and mean intrusion rate was 12% for this meal

component. They also looked at ‘fruit’, and for this meal component, mean omission rate and intrusion rate were 23% and 0% respectively. In this thesis, the meal component group ‘fruits, berries and vegetables’ had a higher mean omission rate and intrusion rate. Baxter et al (40) also looked at the meal components ‘vegetable’ and ‘fruit’ in another study. For ‘vegetable’, mean omission rate was 72% and mean intrusion rate 50%. For ‘fruit’, mean omission rate and intrusion rate were 71% and 48% respectively. Results for mean omission rate and intrusion rate for the meal component group ‘fruits, berries and vegetables’ were notable lower in our study. However, in the two studies by Baxter et al (40, 43), the two separate meal components ‘vegetable’ and ‘fruit’ were analyzed. In this thesis, vegetables, fruits and berries were all included in one shared meal component group. These results will therefore be difficult to compare.

Dinner leftovers

For the meal component group ‘dinner leftovers’, mean omission rate and intrusion rate were 35% and 8% respectively. The omission rate was quite high. However, food items/dishes in this meal component group were not frequently observed in the school lunch packages, only twenty food items/dishes were observed eaten. Not only small food items were omitted in this group, a pizza slice and pancakes were for example also omitted.

Sweets and snacks

Mean omission rate and intrusion rate for the meal component group ‘sweets and snacks’ were 85% and 38% respectively. In this meal component group, mean omission rate and intrusion rate was very high. However, in this group the number of observed and recorded food items was low. There were only fourteen food items observed in this group, of which three were matches and eleven omissions. Three intrusions were recorded. Due to few food items in this group, it is not possible to make any conclusions. However, there seems to be a tendency towards not recording such foods. Sweets, like a little biscuit or brownie bite, were sometimes traded among the children. This may lead to misreporting, either due to forgetting, or because the parents in some cases were responsible for recording in the food diary. However, as mentioned earlier, there were only four occasions where parents recorded in the food diary without involving their children.

All beverages

For the meal component group ‘all beverages’, mean omission rate and intrusions rate were 10% and 28% respectively. However, for almost all cases of observed beverages, observation was only possible at the main category level. This may lead to a low omission rate, as it is easier to make a match on the main category level, where all kinds of beverages are included. Mean intrusion rate was higher for this meal component group, compared to the mean total intrusion rate, but also higher than mean omission rate for this meal component. The children seemed to record beverages, mostly water, regardless of drinking anything for school lunch or not. Most of the children had drinking bottles on their desks for lunch, and it may be difficult for them to remember whether or not they have been drinking from the bottle during school lunch. Even though the children often recorded water or other beverages for school lunch, there is a great possibility that the children were drinking from the bottles during the school day, maybe just before or after school lunch.

Water was often intruded (data not shown), and is probably the main reason why the number of intrusions in the meal component ‘all beverages’ is so high. However, it was not possible to analyze water alone, as children, in most of the cases had colored drinking bottles, and it was not possible to see if the content in the bottles was water or other types of beverages. Due to this it was only feasible to analyze omission rates and intrusion rates for all beverages.

Baxter et al (43) also looked at the meal component ‘beverage’, and mean omission rate and intrusion rate were 2% and 8% respectively. These rates were remarkably low. However, as discussed in the paper by Baxter et al (43), it seemed like the children were drinking the same, milk, every day for school lunch. The omission rate and intrusion rate were higher for the meal component group ‘all beverages’ used in this thesis. This is in contrast to findings in another study by Baxter et al (40), also looking at ‘beverage’, with a mean omission rate and intrusion rate of 37% and 38% respectively. However, in that study (40) 24-hour recalls, conducted in the morning, was used as dietary assessment method. The children had to recall all meals, including school lunch, consumed during the previous day. In the other study mentioned above, by Baxter et al (43) interviews were conducted the same day, within 90 minutes after school lunch, and only school meals were recalled. The short time interval between consumed meals and recalls, and the fact that only school lunches were reported may have resulted in these remarkable differences, not only regarding results for these meal

components, but also regarding results for the other meal components obtained from these two studies by Baxter et al (40, 43) that were compared to results for the meal component group 'breads and cereals' and 'fruits, berries and vegetables' in our study. Results found in these two studies mentioned above may not be comparable to results found in our study as different dietary assessment methods were used. Only four of the meal components analyzed in the studies by Baxter et al (40, 43) were possible to compare to meal component groups analyzed in this thesis. Differences in inclusion criteria for these meal components/meal component groups will probably make them less comparable, as this will affect the results.

School milk

For 'school milk', mean omission rate and intrusions were 6% and 8% respectively. The omission rate for 'school milk' was lower than for 'all beverages'. The children seem to be quite accurate in recording school milk. School milk is something the children get every day, and due to regular and frequent consumption, this item is probably easy to remember.

5.3.3 Comparison of omissions and intrusion for the selected categorization levels and the main category level

Compared to the number of intrusions, the number of omissions was higher, both for the total number of items observed and recorded, and for each of the meal component groups, except from 'all beverages' and 'school milk'. This suggests that the children not only recorded food items wrongly, by recording a food item more or less similar to the observed food item, but also actually left out a great number of food items. When putting all items observed and recorded in their respective main categories, this resulted in 16 fewer omissions and 16 fewer intrusions, and 16 more matches, as each observed omitted item belongs to the same main category as the recorded intruded item. Salami observed and ham recorded was for example considered as respectively an omission and an intrusion in the present study, but was matches in the main category. When putting these food items in the main category 'spread', these become matches. This was also the case for brown cheese observed and liver pate recorded, also having the same main category name 'spreads'. When matching recorded and observed items based on the main category names, mean omission rate and intrusion rate were 24% and 16% respectively. These results are naturally lower than the results for omission rate and intrusion rate presented in this thesis. In the present study, observations were always done at

the highest possible category level, and comparison of observed and recorded items was done at the category level chosen for observation, instead of matching all items in the main category, as the main category is too extensive and includes a wide range of different items. Most of these items will not be appropriate to consider as matches.

5.3.4 Comparison of omission rate and intrusion rate regarding gender

The literature is not consistent on how gender affects the validity of a dietary assessment method (60, 67). In the present study it was only significant difference in intrusion rates for 'fruits, berries and vegetables'. Compared to girls, boys recorded more intrusions for this meal component group.

5.3.5 Comparison of omission rate and intrusion rate regarding weight status

Thirteen children were overweight or obese, which counts for 12.8% of the sample. This selection of children might be too small to make any conclusions. However, there were no significant differences in total omission rates or intrusion rates regarding weight status in the present study. Regarding meal component groups, only omission rates for 'school milk' was significant different. In a study by Baxter et al (73) they looked at omissions of kilocalories and found that children with high BMI omitted more kilocalories, compared to children with low BMI. The children with high BMI also had fewer intrusions compared to children with low BMI. In that study they did only look at omissions of kilocalories, not omissions of items. Nevertheless, more omitted kilocalories may probably be caused by more omissions of items, or by omissions of certain items high in kilocalories. In other studies, where the relation between underreporting and BMI or body weight/percentage body fat in children has been investigated, results are not consistent (27, 71, 72). However, in these studies, energy intake versus energy expenditure has been assessed, and results are therefore not comparable to results found in the present study.

For the two meals component groups 'sweets and snacks' and 'dinner leftovers', it was not possible to analyze differences in omission rates and intrusion rates regarding weight status, as no or only few food items were observed and recorded eaten by the overweight children.

5.3.6 Comparison of omission rate and intrusion rate regarding parental education level

Studies of how socioeconomic status and education level affects the validity of dietary assessment methods used on adults are not consistent (65, 66, 74). Whether parental education level affects the validity of dietary assessment methods used on children is uncertain. However, in the present study there were significant differences in total omission rates and intrusion rates regarding parental education level. Children of parents with lower education had a significant higher omission rate and intrusion rate compared to children whose parents had higher education level. However, there were only twelve children of parents with lower education. Due to this, interpretations are difficult, although it appears to be a relation between accuracy of recording and parental education level. For meal component groups there were significant differences in omission rates and intrusion rates for 'fruits, berries and vegetables' and 'spreads'. For 'all beverages' and 'school milk' it was a significant difference in omission rates. For 'breads and cereals' only intrusion rates were significant different. In the meal component group 'fruits, berries and vegetables' only four children were observed and recorded eating food items in the category 'lower education'. In the meal component 'school milk' only four children were observed drinking this item in this category. Analysis of differences in omission rates and intrusion rates for 'sweets and snacks' and 'dinner leftovers' was not conducted, as there were only one or two children observed or recorded eaten foods in the category with parents with lower education.

Despite the low number of subjects in the category 'lower parental education' in the present study, the relation between accuracy of reporting and parental education level should be interesting to investigate further in future studies. A study by Briefel et al (62) found that reading and spelling abilities could affect the degree of underreporting. These abilities may be related to education level. Parents are usually assisting the children during recording, and the capabilities for the less educated parents to contribute during recording may be lower compared to the more educated parents. As shown in a previous study (34), parent may contribute by adding food details and by prompting the children, and this may affect the accuracy of reporting. If future studies find relations between accuracy of reporting and parental education level, further investigation of results should be included, as these results may be important in order to develop actions for the purpose of increasing the accuracy of the recordings.

5.3.7 General or specific underreporting of foods and beverages

For ‘sweets and snacks’ omission rate was as high as 91%. However, intrusions in this group rate were also high, with an intrusion rate of 50%. There were very few food items in this meal component group, only eleven subjects were observed eating food items in this group, and only four subjects recorded eating food items in this group. Even though it seems to be inaccuracy in recording of these foods, it was not enough food items in this meal component group to make any concrete interpretations of these results. Most of the food items in this group were small biscuits and small portions, often food traded. Most of these omissions are probably due to forgetting, and not intentionally underreporting.

5.3.8 Portion sizes

For portion size, the total IOR was below 85% for two of the observer-pairs, and the observations of portion sizes have a certain degree of uncertainty. For each food item or beverage, comparison of observed and recorded portion sizes, obtained from the picture series in the food diary, were done. Only 269 food items from the total of 495 observed food items were possible to match in portion sizes. This was due to uncertain observations of portion sizes or because matching of portion sizes was impossible due to different portion size categorizations and picture series. The number of uncertain observations regarding portion size was especially large for ‘all beverages’. Portion sizes of beverages were quite hard to assess because almost all beverages, except from school milk, were in colored drinking bottles. For school milk, portion size estimation was easy in most cases, as cartons were emptied. It was only two other occasions with reliable observations of portion sizes in the meal component group ‘all beverages’. Therefore, regarding beverages, only matches in portion sizes for ‘school milk’ were analyzed. The numbers of food items and beverages in the different meal component groups, with uncertain observations in portion size were not evenly spread. Thus, some of the meal component groups had a higher number of items where analysis of portion sizes was possible. In the meal component group ‘sweets and snacks’ there were only three food items to analyze regarding portion size. This is not enough to assess the accuracy for portion sizes for this meal component group.

The total match in portion sizes was 60%. For meal component group the match in portion sizes varied from 36% for ‘dinner leftovers’ to 86% for ‘school milk’. It may have been easy

to record the correct portion sizes for ‘school milk’ because the children often emptied the cartons. The picture series for ‘school milk’ have a picture of a school milk carton, and the largest portion size is when the school milk carton is emptied. For the other meal components, match in portion sizes lies between 40% and 70%. Precision regarding recording of portion sizes varies. However, the accuracy of recorded portion sizes is lower than the accuracy of recorded food items. Compared to remembering food items and beverages, portion sizes might be more difficult to remember, especially for meals eaten earlier in the day, as for breakfast and school meal, when recording in the food diary later in the evening.

These findings are in contrast to those in studies by Baxter et al, also looking at accuracy of portion size estimations (40, 43). They found that when children correctly reported food items, they were quite accurate in reporting amounts as well. However, in these studies all lunches were the same, supplied by the schools. Portion sizes was recorded as ‘none’, ‘taste’, ‘little bit’, ‘half’, ‘most’, ‘all’ or ‘more than one serving’, and differences between ranking of portion sizes reported and observed eaten, was used when analyzing accuracy of reported amounts. In the present study, every lunch packages were different, and several picture series with different portion size categories were used to illustrate portion sizes. Due to this, it was difficult to rank portion sizes, and portion sizes were either a match or no match. Results from studies by Baxter et al (40, 43) are therefore not comparable to results in our study.

5.3.9 Interobserver reliability (IOR)

For two of the observer pairs at one of the schools, a decrease in IOR occurred in the middle of the observation period. Assessment of challenges regarding observation and categorization of items were done. The number of IOR observations also had to be increased for the actual observer-pairs in order to improve the reliability of the observations. After this, IOR increased and were at least 85%. Total IOR was 86%, 88% and 88% for the three observer-pairs, and within the desired limit of 85%. The level of accuracy regarding observed items in the present study is considered high

As for portion sizes, the IOR varied relatively much, and our observations of portion sizes have some degree of uncertainty. However, the total IOR for each observer-pair, regarding portion sizes was quite high. When calculating IOR regarding portion sizes chosen from the

picture series in the food diary, these were either considered as a match or no match. Agreement on portion sizes between observers allowed no discrepancies.

A review of several studies assessing IOR (37), shows that different assessments are based on agreement of one or more variables, as for example both items and portion sizes. Few studies have only assessed IOR regarding portion sizes alone. Nevertheless, in one of the studies referred to in the review (37), by Baranowski et al, they looked at IOR for amount consumed, resulting in 83% agreement. However, in contrast to the IOR assessment used in our study, they allowed for some discrepancies in the assessment of portion sizes in that study. In several studies by Baxter et al (40, 43-45, 53), assessment of IOR have been done, and mean agreements lies between 87% and 98%. However, agreement regarding both items and portion sizes were assessed combined, and the portion sizes observed consumed had to be within one-fourth serving to be considered a match. Allowing for discrepancies may lead to higher agreement between observers. Additionally, it may be easier to identify both items and amount when the schools distribute standardized lunches.

6. Conclusion

Results from this study show that the number of observed items was higher than the number of recorded items. Thus, the number of omissions was higher than the number of intrusions, and omissions were the main problem related to recording in the web-based food diary. Items in the meal components ‘breads and cereals’, ‘spreads’ and ’fruits, berries and vegetables’ were most frequently observed and recorded. However, in contrast to the meal component ‘breads and cereals’, the meal component groups ‘spreads’ and ‘fruits, berries and vegetables’ had a remarkably high number of omissions. In most of the cases the children recorded bread, but forgot to record either one or two types of spread. Vegetables and fruits, mostly used as garnish were most frequently omitted.

The respective rates for omissions and intrusions show that observed versus recorded intake of foods and beverages differed to a relatively high degree. However, the rates for omissions and intrusions found in the present study were generally lower compared to other studies validating school lunch recalls by observation. The highest omission rate and intrusion rate was observed for the meal component ‘sweets and snacks’, however, only few food items were observed and recorded eaten. Concerning the most frequently observed and recorded items, children were accurate in recording items in the meal component group ‘breads and cereals’, but less accurate in recording food items in the meal component groups ‘spreads’ and ‘fruits, berries and vegetables’. The accuracy of portion sizes was lower than the accuracy of recorded food items.

There were no significant differences in total omission rates and intrusion rates in relation to gender or weight status, only regarding parental education level. Children of parents with lower education had a significant higher omission rate and intrusion rate compared to children whose parents had higher education level. The relation between accuracy of reporting and parental education level should be investigated further in future studies. For all schools, agreement on identification of food items was above 85% for all observer-pairs. Therefore, the observations were considered having high accuracy. For portion size, total agreement was below 85% for two of the observer-pairs, and the accuracy of observed portion sizes therefore has a degree of uncertainty.

Observation only covers the validity of the recorded school lunches in the web-based food diary. However, based on the current findings and by comparing results from other studies using 24-hour recalls or other interviews as dietary assessment methods, the web-based food diary appears to be a useful tool for assessing dietary intake in children. To assess the overall validity of the food diary, these results needs to be viewed together with the other reference methods included in the total validation study.

7. Future directions

Results from this study show that the validity of the web based food diary seems to be good. If the overall assessment of the validity of the web-based food diary appears to be good, this web-based food diary will be favorable to use in future studies. This web-based food diary may reduce the number of omissions due to items easily found and prompts during recording. The user-friendly, customized and fun design may increase the number of completed food records. However, based on results found in the present study, it is impossible to determine whether or not a web-based food diary is better than a paper-based version in capturing the actual dietary intake. Validation of recorded intake in the pre-coded food diary used in the previous UNGKOST survey included other reference methods, 4-day weighed-food diaries and activity monitoring, not comparable to the method used in the present study. Still, the validity of these two versions of food diaries can later be compared by looking at results obtained from assessment of energy intake and energy expenditure, measured by activity monitoring, as this reference method also was included as one of the three reference methods used in the total validation of this web-based food diary.

Nevertheless, in order to increase the accuracy of recordings, the importance of good information and instructions before starting recording in the food diary needs to be emphasized. Focus on recording all food items consumed, also the smaller food items like spread, and fruits and vegetables used as garnish are important. Specific prompts on these food items should be included in the web-based food diary. The importance of children themselves to record in the food diary, assisted by their parents should also be emphasizing. In addition, it is important to ensure that the children record the day's intake in the food diary the same evening. A notebook to record in during the day, after each meal, can be beneficial. This should reduce errors related to memory, and might decrease the omission rate and intrusion rate. All this should be considered in the next UNGKOST survey.

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Appendices

Appendix 1: Consent form

Appendix 2: Invitation to participate in the study

Appendix 3: Information sheet

Appendix 4: Welcome e-mail

Appendix 5: Registration e-mail

Appendix 6: Observation form

Appendix 1

UiO : Institutt for medisinske basalfag
Det medisinske fakultet

SIDE 1/2 **Fyll ut og returner denne og neste side (snu arket!)**

Kontakt prosjektkoordinator og stipendiat Anine Medin dersom du har spørsmål eller ønsker mer informasjon om prosjektet, mob: 474 63 893, eller e-post: a.c.medin@medisin.uio.no

Samtykkeerklæring for prosjektet «Matdagbok på nett for barn og ungdom»

Jeg/vi har mottatt og lest informasjonen om prosjektet. Deltakelsen er frivillig og mitt/vårt barn kan til enhver tid trekke seg uten å måtte oppgi noen grunn. Det er en forutsetning for deltakelsen at all informasjon som gis behandles strengt konfidensielt. Hvis mitt/vårt barn trekker seg fra undersøkelsen kan vi kreve at alle persondata blir slettet.

Jeg/vi samtykker i at mitt/vårt barn KAN DELTA:

Elevens navn (blokkbokstaver): _____

Skole: _____ Klasse/gruppe:_____

Sted/dato:_____Underskrift foresatt(e):_____

E-postadresse til foresatt(e):_____

Telefonnummer til foresatt(e):_____

Bakgrunnsinformasjon om eleven:

Elevens kjønn: ☐ gutt ☐ jente

Elevens alder (antall år):_____

Elev og foresattes etnisitet:

I hvilket land er foresatt 1 født? : _____

I hvilket land er foresatt 2 født? : _____

I hvilket land er eleven født? : _____

Samtykkeerklæringen (begge sider av arket)fylles ut og returneres på en av følgende måter:

1) Scannet på e-post: a.c.medin@medisin.uio.no
2) Fotografert digitalt (med f.eks. smarttelefon) og sendt på e-post: a.c.medin@medisin.uio.no
3) Per telefaks: 22 85 15 31
4) Per post. Bruk vedlagte svarkonvolutt. Porto er betalt.

MERK! Siste svarfrist er:

SIDE 2/2 **Fyll ut og returner denne og forrige side (snu arket!)**

Utdanningsnivå foresatt(e):

Foresatt 1:

1a. Hvilken relasjon har denne foresatte til barnet som blir med i undersøkelsen?

☐ Moren til barnet
☐ Faren til barnet
☐ Stemoren til barnet
☐ Stefaren til barnet
☐ Barnets kvinnelige foresatte
☐ Barnets mannlige foresatte

1b. Hva er denne foresattes høyeste fullførte utdanning?

☐ Mindre enn 7 års utdanning
☐ Folke-/grunn- /ungdomsskole (7-9)
☐ Gymnas/yrkesskole e.l. (inntil 12 år)
☐ Universitet-/høyskole (inntil 4 år)
☐ Universitet-/høyskole (mer enn 4 år)

Foresatt 2:

2a. Hvilken relasjon har denne foresatte til barnet som blir med i undersøkelsen?

☐ Moren til barnet
☐ Faren til barnet
☐ Stemoren til barnet
☐ Stefaren til barnet
☐ Barnets kvinnelige foresatte
☐ Barnets mannlige foresatte

2b. Hva er denne foresattes høyeste fullførte utdanning?

☐ Mindre enn 7 års utdanning
☐ Folke-/grunn- /ungdomsskole (7-9)
☐ Gymnas/yrkesskole e.l. (inntil 12 år)
☐ Universitet-/høyskole (inntil 4 år)
☐ Universitet-/høyskole (mer enn 4 år)

Familiestruktur:

Hvem bor eleven sammen med? (flere kryss mulig)

☐ Mor og far sammen
☐ Mor ☐ Stemor
☐ Far ☐ Stefar
☐ Eleven bor både hos mor og far. Spesifiser fordeling:_____
☐ Andre

MERK! Siste svarfrist er:

Appendix 2

UiO : Institutt for medisinske basalfag
Det medisinske fakultet

Forespørsel om deltakelse i forskningsprosjektet "Matdagbok på nett for barn og ungdom "

Til foresatte og elever i 4. klasse

HVA ER DETTE?

Dette er en forespørsel til eleven og foresatte om eleven vil delta i en forskningsstudie høsten 2013, hvor vi skal evaluere en ny matdagbok på internett.

Matdagboken skal brukes i den neste landsdekkende kostholdsundersøkelsen blant barn og ungdom i Norge (UNGKOST).

HVORFOR SKAL VI GJØRE DETTE?

Universitetet i Oslo har i samarbeid med Danmarks Tekniske Universitet utviklet en ny matdagbok på internett for å registrere hva vi spiser og drikker. Før vi kan ta matdagboken i bruk må vi finne ut hvor god den er. Dette vil vi undersøke i forskningsstudien.

Resultatene vil være svært viktige i det videre arbeidet med matdagboken som skal brukes i den neste UNGKOST-undersøkelsen. UNGKOST brukes av Helsedirektoratet for å videreutvikle mat- og ernæringspolitikken i Norge og er av stor betydning for folkehelsearbeidet blant barn og unge.

HVA SKAL GJØRES?

Vi vil bruke tre metoder for å måle kvaliteten på matdagboken:

- Måling av energiforbruk med aktivitetsmåler.
- Observasjon av barna i lunsjmåltidet på skolen.
- Måling av utvalgte stoffer i blod, ved å ta en prøve ved et lite stikk i fingeren.

HVEM KAN DELTA?

Kriteriene for deltagelse i studien er at eleven går i 4. klasse og er bosatt i Bærum, Asker eller Drammen kommune.

HVA SKAL ELEV OG FORESATTE GJØRE?

I løpet av en periode på 14 dager vil vi be om følgende:

1. **At dere registrerer hva eleven har spist og drukket i totalt 4 dager**

- Foresatte vil få tilsendt en e-post med en internettlink til matdagboken, et passord og en kort veiledning.
- Så skal eleven, sammen med foresatte, logge seg inn på matdagboken og registrere hva han/hun har spist og drukket.

2. **At eleven har på seg en aktivitetsmåler i totalt 7 hele dager**

- Aktivitetsmåleren er en liten brikke som festes ved hoften med et elastisk bånd.
- Vi deler brikken ut til barna på skolen.
- Den krever ikke at man gjør noe spesielt.

3. **At vi får ta en mini-blodprøve av eleven**

- Ved hjelp av et lite stikk i fingertuppen vil vi overføre noen få dråper blod til et prøvepapir. Hensikten er å måle innholdet av stoffer som kommer fra mat og drikke.
- Samtidig vil vi måle elevens høyde og vekt. Eleven vil ikke få informasjon om egen høyde og vekt.
- Prøven og målingene gjøres individuelt, og vil bli tatt i et annet rom enn klasserommet.

Når dette er gjort, er eleven ferdig med studien.

FORDELER OG KOMPENSASJON

- Elevens deltagelse i studien vil bidra med viktig kunnskap til den landsdekkende UNGKOST-undersøkelsen som brukes av Helsedirektoratet for å videreutvikle mat- og ernæringspolitikken i Norge.
- Alle deltakere som gjennomfører studien vil motta et gavekort på 2 kinobilletter.

ULEMPER

- Noen kan føle lett ubehag ved å få et lite stikk i fingeren i forbindelse med mini-blodprøven. Det er ingen andre ubehagelige undersøkelser i studien.

FORSIKRING OG ANSVAR

Universitetet i Oslo (UiO), ved Avdeling for ernæringsvitenskap er ansvarlig for studien. Studien er forsikret gjennom pasientskadeloven. Professor Lene Frost Andersen ved UiO er databehandlings-ansvarlig. Prosjektet er tilrådd av Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste (NSD).

HVA SKJER MED PRØVENE OG INFORMASJONEN OM ELEVEN?

I studien vil vi registrere data om elevens kosthold, vekt, høyde, alder, kjønn, etnisitet, aktivitetsnivå, blodprøvesvar og observerte lunsj. Videre vil vi registrere data om familiestruktur, samt foresattes etnisitet og utdanningsnivå.

Alle opplysninger vil bli behandlet fortrolig og vil bli lagret avidentifisert, det vil si med kode, uten navn eller andre opplysninger som kan knytte barnets identitet til opplysningene. Blodprøvene og navnelisten destrueres og alle data anonymiseres senest ved prosjektslutt 03.04.2019. Det vil ikke være mulig å identifisere elevens navn i resultatene av studien når disse publiseres.

FRIVILLIG DELTAGELSE

Det er frivillig å delta i studien. Dersom dere ønsker å la eleven delta, undertegner dere **samtykkeerklæringen** (eget ark) og besvarer spørsmålene der. Dere kan trekke samtykket til å delta i studien når som helst, uten å oppgi noen grunn. Videre kan dere be om å få slettet alle registrerte opplysninger, med mindre de allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Samtykke

Samtykkeerklæringen finner dere vedlagt som eget ark. Vennligst returner samtykket snarest til kontaktlærer via eleven. Bruk vedlagte konvolutt.

Ansvarlig for studien

Professor Lene Frost Andersen er prosjektleder og ansvarlig for studien.
Telefon: 22 85 13 74. E-post: l.f.andersen@medisin.uio.no

Kontaktperson

Kontakt prosjektkoordinator og stipendiat Anine Medin
dersom du har spørsmål eller ønsker mer informasjon om prosjektet.
Mobil: 474 63 893. E-post: a.c.medin@medisin.uio.no

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Utgitt august 2013

UiO : Institutt for medisinske basalfag
Det medisinske fakultet

Appendix 3

Tusen takk for at du vil være med i forskningsprosjektet «Matdagbok på nett».

Heng gjerne denne lappen på et synlig sted!

Slik bruker du aktivitetsmåleren:

DU SKAL BRUKE MÅLEREN I PERIODEN:_____(7 hele dager).

- Fest beltet rundt livet slik at måleren sitter på **høyre hoftekam** (se bildet). Måleren skal være godt festet og ikke henge og slenge.
- Ta den på når du våkner om morgenen, og ta den av når du legger deg om kvelden.
- Ta den av **bare når** du sover (om natten) og når du dusjer, svømmer eller bader.
- Du behøver ikke slå den av eller på, alt går automatisk. Måleren blinker når du får den tildelt. Den vil slutte å blinke morgenen etter du har fått den – dette er normalt.

Aktivitetsmåleren tåler daglig bruk, og du behøver ikke være redd for at den skal gå i stykker. Måleren må imidlertid ikke åpnes, vaskes eller lånes bort. Måleren koster 2500 kr. Du er ikke økonomisk ansvarlig for måleren, men pass godt på den.
Når du har gått med den i syv hele dager, samles brikken inn på skolen din.

Slik bruker du matdagboken på nett:

DU SKAL FYLLE UT MATDAGBOKEN I PERIODEN:_____(4 dager).

- Matdagboken finner dere på www.ungkost.no
- Dine foreldre/foresatte har fått tilsendt en e-post med linken til matdagboken, brukernavn og passord.
- Du skal fylle ut matdagboken i 4 dager etter hverandre. Det beste er å gjøre det på kvelden før du legger deg.

- Husk at du ikke alltid finner bilde av nøyaktig det du har spist!
  - Dersom du ikke finner det du har spist, prøv å velge noe som likner/nesten er det samme.
  - Noen ganger vises bilder av andre matvarer som likner – det betyr ikke at du har valgt feil.

Ikke nøl med å ta kontakt dersom noe er uklart!

Kontakt stipendiat/prosjektkoordinator Anine Medin ved spørsmål.
Mobil: 47463893, e-post: a.c.medin@medisin.uio.no

Appendix 4

Hei!

Takk for at dere vil delta i studien vår!

Deres ID-nummer i studien er XXXX.

Først vil vi be om at du som foresatt alene, eller sammen med barnet som skal delta, fyller ut et kort elektronisk spørreskjema: https://response.questback.com/universitetetioslo/4_klasse/
ID-nummeret skal tastes inn helt i begynnelsen og slutten av spørreskjemaet.

Et par dager før registreringen starter, vil du motta en ny mail med link til matdagboken og påloggingsinformasjon. Først da skal ditt barn registrere all mat og drikke i matdagboken i 4 sammenhengende dager.

Barnet skal selv fylle inn matdagboken, men kan med fordel få hjelp fra foresatte. Barnet vil også få utdelt en aktivitetsmåler. Den skal beholdes på hele tiden, bortsett fra om natten og i forbindelse med dusjing/bading.

Når alle deler av studien er fullført, vil ditt barn motta et gavekort på 2 kinobilletter som takk for innsatsen.

Ved spørsmål, ikke nøl med å ta kontakt!

Lykke til!

……

Mvh

Anine Medin
Prosjektkoordinator og stipendiat
E-post: a.c.medin@medisin.uio.no, Mob: 47 46 38 93

Appendix 5

Hei!

Ditt barn er nå registrert som bruker av matdagboken i forbindelse med forskningsstudien «Matdagbok på nett for barn og unge».

Ditt barn skal registrere alt hun/han spiser og drikker i 4 sammenhengende dager.
Det er en fordel at foresatte hjelper til med registreringen.

Matdagboken finner dere her:
http://www.ungkost.no

Dere logger inn ved hjelp av
brukernavn: XXXX
passord: XXXX

Brukerveiledningen finner dere som vedlegg.

Ved spørsmål, ikke nøl med å ta kontakt!

Lykke til med registreringen!
……

Mvh

Anine Medin
Prosjektkoordinator og stipendiat
E-post: a.c.medin@medisin.uio.no, Mob: 47 46 38 93

Appendix 6

SKJEMA_OBSERVASJON, 4.trinn Navn på observatør:_____

Dato:_____

Skole_____ Klasse:_____

FØRSTE ELEV; Fornavn og initsialer etternavn:_____ ID.nr:_____

Notater:

Mat/drikke	Kategori1	kategori2	kategori3	bildeserie (nr)	mengde (kategori)**SPIST**	Sikker ITEM (ja/nei)	Sikker MENGDE (ja/nei)	Kommentarer

ANDRE ELEV; Fornavn og initsialer etternavn:_____ ID.nr:_____

Notater:

Mat/drikke	Kategori1	kategori2	kategori3	bildeserie (nr)	mengde (kategori)**SPIST**	Sikker ITEM (ja/nei)	Sikker MENGDE (ja/nei)	Kommentarer

TREDJE ELEV; Fornavn og initsialer etternavn:_____ ID.nr:_____

Notater:

Mat/drikke	Kategori1	kategori2	kategori3	bildeserie (nr)	mengde (kategori)**SPIST**	Sikker ITEM (ja/nei)	Sikker MENGDE (ja/nei)	Kommentarer

Deler av observasjon usikker?: JA:☐ NEI:☐

Ferdig utfylt skjema
klokkeslett:_____
(Observatøren har IKKE anledning til å endre på skjema etter notert klokkeslett).

Signatur
observatør:_____