

Validation of a New Norwegian web-based food diary for
children and adolescents: assessing self-reported intake of
fruits, berries and vegetables, using biological markers

Master of Science in Health Sciences

Master thesis in Public Nutrition

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Britt Marlene Kåsin

Abstract

Background: Researchers at the Department of Nutrition, University of Oslo, in collaboration with the Technical university of Denmark, have developed a new self-administered web-based food diary for use among children and adolescents in the next nationwide dietary survey (Ungkost-3). Before this new tool can be applied it needs to be validated.

Aims: The purpose of the study is to evaluate how valid the web-based food diary is in ranking individuals according to self-reported intake of fruits, berries and vegetables (FBV), by using plasma concentrations of carotenoids as an objective reference to the subject's true intake. Further, to investigate if the capability of ranking differs significantly between participants' when considering weight status and parents' education level.

Subjects: A sample of 262 children, 122 at age eight or nine and 140 at age twelve or thirteen, completed the study. The participants were recruited from eligible public primary and secondary schools in Bærum, a municipality outside Oslo.

Results: This master thesis demonstrated weak to moderate correlation coefficients when ranking participants according to self-reported dietary intake of FB, V and FBV. Significant positive correlation coefficients ranged from 0.17 to 0.36 when comparing self-reported intake of FB, V and FBV to plasma concentrations of carotenoids. Further, significant positive correlation coefficients ranged from 0.12 to 0.40 when comparing high carotenoid foods to plasma concentrations of corresponding carotenoids. Participants with high levels of total plasma concentrations of carotenoids were found to report a significantly higher amount of FB, V and FBV, versus those who had low levels of total plasma carotenoids. Overall, 68 % of the participants fell into the same or adjacent quartiles when cross-classified by estimated FBV intake and total plasma concentrations of carotenoids, and 9 % was cross-classified into the opposite quartile. Some significant differences were found in the correlation coefficients between the self-reported intake of FB, V and FBV and plasma concentrations of carotenoids, when considering weight status and parents' education level.

Conclusion: The results from this study imply that the web-based food diary has a low to moderate validity when ranking individuals according to self-reported intake of fruits, berries and vegetables, by using plasma concentrations of carotenoids as an objective reference to the subject's true intake. Further, the findings were not clear enough to draw any conclusions that can imply that the capability of ranking differs significantly between participants' when considering weight status and parents' education level.

Table of contents

List of tables	I
List of figures	II
List of appendices	III
List of abbreviations	IV
1.0 Introduction	1
2.0 Background	2
2.1 Dietary assessment methods.....	3
2.2 Challenges in assessment of dietary intake.....	4
2.2.1 Body weight related to reporting dietary intake.....	6
2.2.2 Parental education related to reporting dietary intake.....	6
2.3 Validity in dietary assessment methods.....	7
2.4 Biomarkers to validate a dietary assessment method.....	8
2.4.1 Recovery biomarkers.....	8
2.4.2 Concentration biomarkers.....	9
2.5 Carotenoids in general.....	9
2.5.1 Carotenoids in human diet.....	10
2.5.2 Carotenoids in human tissue and blood.....	10
2.5.3 Sensitivity and bioavailability.....	11
2.5.4 Carotenoids as a biomarker of dietary intake.....	13
3.0 Purpose and objectives	14
3.1 Research questions.....	14
4.0 Method	16
4.1 Planning.....	16
4.2 Study design.....	16
4.3 Subjects.....	17
4.4 Collection of dietary data.....	20
4.4.1 Web-based food diary.....	20
4.4.2 Calculation of reported intake and creation of fruits, berries and vegetable intake variables.....	22
4.5 Collection of blood samples.....	23
4.5.1 Dried spot method.....	24

4.5.2 Storage and processing	24
4.6 Anthropometry	25
4.6.1 Iso-BMI: cut off points.....	25
4.7 Parental education	26
4.8 Statistics	26
5.0 Results	28
5.1 Description of the sample.....	28
5.2 Comparison between self-reported intake of FB, V and FBV and plasma concentrations of carotenoids	30
5.3 Comparison between self-reported intake of high carotenoid foods and plasma concentrations of carotenoids	31
5.4 Comparison between groups: low versus high levels of plasma concentrations of carotenoids and self-reported intake	32
5.5 Cross-classification of self-reported intake of FB, V and FBV and plasma concentrations of carotenoids.....	34
5.6 Comparing the correlation coefficient between groups	36
5.6.1 Iso- BMI	36
5.6.2 Parental education level	38
6.0 Discussion	41
6.1 Methodology	41
6.1.1 Participation rate and motivation	41
6.1.2 Participant characteristics and generalizability	42
6.1.3 The web-based food diary	44
6.1.4 The usability of the reference method.....	46
6.2 Discussion of results.....	49
6.2.1 Ranking of participants according to self-reported intake of FBV	49
6.2.2 Ranking of participants according to self-reported intake of FB	52
6.2.3 Ranking of participants according to self-reported intake of V	54
6.2.4 Ranking of participants according to self-reported intake of high carotenoid foods	56
6.2.5 Body weight related to reporting of dietary intake of fruits, berries and vegetables	58
6.2.6 Parental education related to reporting dietary intake of FBV	59
6.3 Ethical concerns	60
7.0 Conclusion.....	61

8.0 Future perspectives and suggestions for the implementation of Ungkost-3	63
9.0 References	65
10.0 Appendices	75

List of tables

Table 1: Definition of foods included in variables of self-reported intake of FB, V, FBV and high carotenoid foods, from the web-based food diary.....	23
Table 2: Extracts from T. J. Cole et al. (2000) international cut off points for body mass index for overweight and obesity in childhood, by sex between age 8 and 14, defined to pass through body mass index of 25 and 30 kg/m ² at age 18.....	26
Table 3: Characteristics of participants (n 262)	28
Table 4: Self-reported intake of FB, V, FBV and high carotenoid foods, g/d (n 262).....	29
Table 5: Plasma concentrations of carotenoids, μM (n 262).....	29
Table 6: Spearman’s correlation between self-reported intake of FB, V and FBV, and plasma concentration of carotenoids (n 262).....	31
Table 7: Spearman’s correlation between intakes of high carotenoid foods ¹ and plasma concentration of single carotenoids (n 262)	32
Table 8: Mann-Whitney U-test: comparison between groups with low ¹ versus high ² levels of total plasma concentration of carotenoids and self-reported intake of FB, V and FBV	33
Table 9: Man-Whitney U-test: comparison between groups with low ¹ versus high ² levels of plasma concentration of single carotenoids and self-reported intake of corresponding high carotenoid foods*	34
Table 10: Cross-classification of quartiles by participant’s self-reported intake of FB, V and FBV and total plasma concentrations of carotenoids ¹ (n 262).....	35
Table 11: Cross-classification of quartiles by participant’s self-reported intake of FBV ¹ and plasma concentrations of single carotenoids (n 262)	35
Table 12: Spearman’s correlation between self-reported intakes of FB, V and FBV (g/day) and plasma concentrations of carotenoids (μM), by weight groups normal ¹ and overweight ² 37	
Table 13: Spearman’s correlation between self-reported intakes of high carotenoid foods ^a (g/day) with corresponding plasma carotenoids (μM), by weight groups normal ¹ and overweight ²	38
Table 14: Correlation coefficients between self-reported intake of FB, V and FBV (g/day) and plasma concentrations of carotenoids (μM), by parental education level low ¹ and high ² 39	
Table 15: Spearman’s correlation between self-reported intakes of high carotenoid foods ^a (g/day) with corresponding plasma carotenoids (μM), by parental education level low ¹ and high ²	40

List of figures

Figure 1: Overview of recruitment, registration period and collection of blood samples and height- and weight measurements, in the validation study	17
Figure 2: Included subject in the validation study.	19
Figure 3: Example of design for selecting foods in the web-based food diary, as presented to the participants	21
Figure 4: Portion sizes of carrots in the web-based food diary, as presented to the participants	21

List of appendices

Appendix 1: Request for participation to the school principal, 4th grade

Appendix 2: Request for participation to the school principal, 8th grade

Appendix 3: Information letter to parents, 4th grade

Appendix 4: Information letter to parents, 8th grade

Appendix 5: Consent form

Appendix 6: Instructional letter to participants

Appendix 7: Welcome e-mail

Appendix 8: “Thank you for participating” e-mail

List of abbreviations

WCRF	World Cancer Research Fund
AICR	American Institute for Cancer Research
WHO	World Health Organization
UNGKOST	A nationwide food consumption survey among children and adolescents in Norway
FFQ	Food Frequency Questionnaire
24 hour recall	24hR
KBS	A dietary calculation system developed and used at the Department of Nutrition, University of Oslo
BMI	Body Mass Index, kg/m ²
Iso-BMI	A definition of overweight and obesity in childhood (2-18 yr.)
FBV	Fruits, berries and vegetables
FB	Fruits and berries
V	Vegetables

1.0 Introduction

This master thesis is part of a larger validation study on a new web-based food diary for use in the next Norwegian national dietary survey (Ungkost-3) among children and adolescents at the ages of nine and thirteen, conducted at the Department of Nutrition, University of Oslo (DN-UiO). The main study is conducted by a PhD-student, Anine Medin, who is also one of my mentors.

Three reference methods are used in the main study to validate the food diary: direct observation of school lunches, accelerometers to estimate energy expenditure, and biological markers of the intake of fruits, berries and vegetables. In my part of the study, I have focused on validation using biological markers on the intake of fruits, berries and vegetables. Both master students participated in all parts of the collection of data.

The purpose of the study is to evaluate how accurately children and adolescents report their intake of fruits, berries and vegetables (FBV) in a web-based food diary, by using biological markers of intake as an objective reference to the subject's true intake. The reference measurement will be the sum of plasma carotenoids, as well as single carotenoids; Lutein, zeaxanthin, β -cryptoxanthin, α -carotene, β -carotene and lycopene collected by blood samples using the "Dried Blood Spot Method" (Mcdade, Williams, & Snodgrass, 2007), one- two weeks after the participants have conducted four days of registration in the food diary.

Further, to investigate if the capability of ranking differs significantly between participants' when considering weight status and parents' education level. The results of this study will be a part of the evaluation-study on the new web-based food diary.

2.0 Background

Intake of fruit and vegetable has an important role in the diet. There is convincing evidence that a daily intake of 400-500 grams of fruits, berries and vegetables reduces the risk of coronary heart disease, high blood pressure, and various cancers in addition to having a reducing effect on weight gain, overweight, and obesity (WCRF & AICR, 2007; WHO, 2003).

Data from the nationwide dietary survey UNGKOST-2000 shows that Norwegian children and adolescents eat less than half of the amount of fruits and vegetables that are recommended, 225–255 g per day (Andersen, Overby, & Lillegaard, 2004). Studies show that there is risk of overweight during childhood and adolescence persisting into adulthood (Harlan, 1993; Srinivasan, Bao, Wattigney, & Berenson, 1996).

Dietary habits, physical activity, and high body mass index are among the risk factors that have a great impact on social inequalities in health in the Norwegian population (Næss, Rognerud, & Strand, 2007). Results from UNGKOST-2000 showed a slight, but not significant increase of fruit and vegetable consumption among children whose parents had a higher education (Øverby & Andersen, 2002).

To study the relationship between food intake and health in a population, we need dietary data and thus good methods for collecting these data. Collecting dietary data is an important tool of the public system for mapping the diet in the Norwegian population (Øverby & Andersen, 2002). In 1993 the first nationwide food consumption survey among 13 - and 18-year olds (UNGKOST-93) was conducted in Norway. Seven years later, in 2000-2001, the next nationwide food consumption survey (UNGKOST-2000) among 4-, 9- and 13 year olds, was conducted. Both these surveys were paper-based, developed by the Department of Nutrition, University of Oslo (DN-UiO), in collaboration with the Norwegian Directorate of Health and Social Affairs. To move the research field forward, researchers at DN-UiO, in collaboration with the Technical University of Denmark, have developed a new self-administered web-based food diary for use among children and adolescents.

The transition from a paper-based to a web-based food diary is important to maintain an effective approach to collecting dietary data as well as creating a food diary that is easy to use, self-explanatory, and applicable to the target group: children and adolescents. However, collecting good dietary data from children and young people is challenging because it requires methods that are appropriate for the age group and their cognitive development (McPherson, Hoelscher, Alexander, Scanlon, & Serdula, 2000).

Before this new tool can be applied in the next nationwide food consumption survey, it needs to be validated. Whether conducting studies in children or adults, there are no dietary assessment methods today that come without error which will affect the interpretation of the results (Andersen, 2000). Therefore, it is important to study the validity of new dietary assessment methods to reduce misinterpretation.

2.1 Dietary assessment methods

There are various methods of dietary assessment. Data on the amount of total food available in a country, or food balance data, can be used to assess the amount of food available for consumption in a population. This type of information can be useful in monitoring trends in diet within a country and in comparing the availability of food in different countries. There are also methods that assess diet on a household level, such as food accounts, household records, inventory methods and list-recall methods. However, neither of these data can be used to make suggestions about diet for individuals (Bates, Nelson, & Ulijaszek, 2005).

In the field of nutritional epidemiology, providing accurate estimation of nutritional intake is essential, and there are several methods that can be used to assess the diet in individuals (Welch et al., 2001). There are two main methods of the assessment of diet in individuals; retrospective and prospective.

Retrospective methods involve the subject to recall what they have eaten over a specific period of time. This can include both remembering food items and portion sizes. 24-h recall is used to record consumed food and drink from the previous 24 hours. Food-frequency questionnaires (FFQ) are used to collect information about the usual consumption of food and

drink, where the respondent is asked to register the usual frequency and quantity of specific food items. A diet history is used to collect dietary information regarding usual dietary habits and participants are asked to describe foods they are likely to consume and the amount they typically eat. The retrospective methods generally require less equipment and are less time-demanding than the prospective methods. However, they rely on the subject's memory and perception of portion sizes (Bates et al., 2005; Nelson, 2005).

Prospective methods collect data on the current food consumption of the individual. Weight inventory method is the most common technique amongst the prospective methods and involves subjects to weigh each food item prior to consumption and to keep a record of everything they eat and drink. This method provides a high precision of food consumption and portion sizes. However, it requires high motivation from the subject and it is labour-intensive (Bates et al., 2005). A food record or diary is a dietary assessment method where participants are asked to continuously register what they eat and drink for a period of time. The quantification of food and drink items can be carried out using estimates such as food photographs of portion sizes or household measures (Andersen & Drewnowski, 2007).

When measuring dietary intake, the underlying purpose is usually to gain information on the quantity of energy and nutrients available for metabolism in the body. However, the dietary intake in individuals varies when it comes to both type and amount of foods, from day to day, from week to week and from year to year. Thus, measurements in individuals' diets are not likely to mirror the usual long term intake (Rutishauser, 2005). Additionally, different methods are suitable in different research situations, and they all come with different requirements regarding time and effort from both researchers and participants. What these methods all have in common is that they are all associated with a different extent of errors that will affect the data (Welch et al., 2001).

2.2 Challenges in assessment of dietary intake

Self-reported dietary intake is connected to several challenges, especially in children (Biltoft-Jensen et al., 2013). The use of self-reporting in dietary assessment methods challenges the participants' memory of daily dietary intake, and can thus be the cause of measurement errors

(Carlsen et al., 2011; Kaaks, 1997).

Children under the age of 12 are considered to be dependent on parental assistance to report dietary intake because their recall skills, knowledge about foods and ability to estimate portion sizes are limited (Livingstone, Robson, & Wallace, 2004). Estimating the dietary intake of young children presents challenges due to their reliance on their parents, e.g. there can be an issue with weighing or monitoring foods consumed away from home (Foster et al., 2007). Therefore, it is important to choose a method that correlates with the development stage of the subjects and aids their memory, e.g. the use of photographs of foods and portion sizes (Harlan, 1993; Livingstone & Robson, 2000). The quantification of food and drink items can be carried out using estimates such as food photographs of portion sizes or household measures. Using estimated food portion sizes accompanied with visual images can be a less demanding method because it does not require the participant to, for instance, weigh every meal, and therefore can be seen as a less burdensome method and an alternative to weighed intakes (Foster et al., 2007).

Among adolescents there may be other factors that may contribute to poor compliance, such as concerns with body-image, increase in meals consumed outside of the home, as well as unstructured eating patterns, something that can lead to incorrect records of the subject's true intake (Livingstone et al., 2004).

Another major concern is change in food intake amongst the participants, as an effect of participating in a dietary study (Barrett-Connor, 1991), e.g. under-eating throughout the collecting period can pose as a source of error (Goris, Westerterp-Plantenga, & Westerterp, 2000). Underreporting (failure to record what is actually eaten) is also a common error related to dietary assessment, at the individual level (Bates et al., 2005).

Because the majority of dietary assessment methods rely on the participant's memory and self-assessment, they are most likely to be subject to recall bias and misreporting (McPherson et al., 2000). Among children, misreporting seems to be connected to determinants such as weight status and social desirability (Bornhorst et al., 2013).

2.2.1 Body weight related to reporting dietary intake

BMI and attitudes towards own body weight are associated with under- and over-reporting of dietary intake (Johansson, Solvoll, Bjorneboe, & Drevon, 1998). Studies have shown that as with obese adults, obese children and adolescents underreport their food intake to a greater degree than those who are normal weight (Bandini, Schoeller, Cyr, & Dietz, 1990; Livingstone & Black, 2003; Livingstone et al., 2004).

These findings are consistent with studies done by Bandini et al. (1990) who observed that children who were obese were found to be twice as likely to under-report, compared to children who were not obese. Further, a high BMI is related to a higher degree of underestimating. Waling and Larsson (2009), reported that amongst children classified as overweight or obese, both a higher BMI and higher age were associated with a higher degree of underestimation of energy intake.

2.2.2 Parental education related to reporting dietary intake

Several studies indicate that there is a relationship between parental education level and children's dietary habits (Klesges, Stein, Eck, Isbell, & Klesges, 1991; Rogers, Emmett, & Team, 2003; Wachs & McCabe, 2001). Cribb, Jones, Rogers, Ness, and Emmett (2011), conducted a study where they assessed whether dietary habits among 10-year old children are associated with maternal education level. They found that maternal education level is related to the quality of the child's diet. Healthy foods such as almost all types of fruits and vegetables, were found to be positively associated with a higher maternal education level, especially fresh fruits ($p < 0.001$) where intakes increased with 22 % in the high education group (79%), compared to the low education group (57%) (Cribb et al., 2011).

In a review done by Livingstone and Black (2003), where they explored markers of the validity of energy intake using the double labelled water technique, they also investigated different factors associated with underreporting in adults. The effects of socioeconomic status and/or education on validity amongst adults were less clear. The authors suggest that both the well-educated and less well-educated may underreport due to factors such as consciousness of health and diet, and poor literacy skills, respectively (Livingstone & Black, 2003).

It is necessary to examine the effect that different variables have on the validity of different dietary assessment tools, e.g. socioeconomic status, overweight and obesity, in order to get a better understanding of the strengths and limitations of each tool (McPherson et al., 2000).

2.3 Validity in dietary assessment methods

Validity is an important qualification for the measuring instrument to be considered appropriate for scientific use (Hjartåker & Veierød, 2007). Validity refers to a method's ability of measuring what it is intended to measure (Bonita, Beaglehole, & Kjellström, 2006). Reproducibility indicates precision of a method, and refers to the method's ability to produce the same answer when repeated under the same conditions on different occasions (Bates, Margetts, & Nelson, 1997).

A challenge that is related to measuring the validity of dietary data is that one cannot know the individual's "true" intake with certainty. The purpose of conducting validation studies on dietary assessment methods is therefore to measure and document how well the method measures the true intake. Further, it serves to provide important information on what kind of measurement errors are related to the method and how they may affect the results. This is done by comparing results from the method that is being tested with a reference method, usually with another dietary assessment method that is considered more accurate (Andersen, 2000). A method is considered valid if the result resembles the truth. Further, systematic errors should be non-present and random errors should be as small as possible (Bonita et al., 2006).

Two important concepts in validity are internal and external validity. Internal validity refers to if we can trust the results of an observation, and to what degree the results are correct for the individuals being studied, e.g. the analysis of blood done in different laboratories may produce different results and thus may be a source of systematic errors (Bonita et al., 2006). External validity or generalizability refers to the degree of which the results of a study can be applied to the study population. The sample selection should be as similar as possible to the population of interest, i.e. it should be representative, as the selected sample can be used to make conclusions about all such individuals (Altman, 1991).

2.4 Biomarkers to validate a dietary assessment method

Biochemical status measurements are selected and tailored for each nutrient, which is often measured in assessable human tissue and body fluids such as blood and urine (Bates et al., 2005). Thus, biomarkers can be used to validate dietary assessment method, as they represent or reflect dietary intake of foods and nutrients (Van Dam & Hunter, 2013).

In nutritional epidemiology self-reporting methods are extensively used because they are easy to use and cost efficient (Brevik et al., 2004). An important reason for why biomarkers are potentially useful as nutritional assessment strategies is that the information they provide has no reliance on the subjects being studied. One can therefore avoid biases such as the participant's memory of intake, perception, over- or underreporting of foods, the ability to estimate portion sizes, as well as socially desirable responses, which is a great source of measurement errors in self-reporting methods and can lead to incorrect records of the subject's true intake (Bates et al., 2005; Biloft-Jensen et al., 2013). Thus, dietary biomarkers can theoretically be considered objective measurements, and can be useful as a standard to validate methods of diet assessment (Kaaks, 1997).

2.4.1 Recovery biomarkers

Recovery biomarkers are biomarkers that can be used to estimate absolute intakes (Van Dam & Hunter, 2013). Examples of recovery biomarkers are doubly labelled water and 24 hour urinary nitrogen excretion (Hjartåker & Veierød, 2007). Doubly labelled water is a technique that is a commonly used reference measure of energy expenditure in free-living subjects and is considered a gold standard. The method involves the oral administration of a dose of cautiously weighed water containing enriched quantities of the stable isotopes deuterium (^2H) and oxygen-18 (^{18}O). Samples of blood and urine are collected at baseline, the dose day, and up to two weeks later. The difference in the declining rate between these two isotopes and body water pool is used as a measure of CO_2 production, that can be used to calculate total energy expenditure (Trabulsi & Schoeller, 2001). 24-hour urine nitrogen can be used to estimate absolute protein intake in individuals. In this method the individual's protein intake is precisely measured and compared to urine samples from a complete 24-hour period. This method is considered to be the most used recovery biomarker (Bingham, 2002).

Doubly labelled water and urinary nitrogen excretion are both viewed as good reference methods that can be translated into absolute levels of intake, i.e. it has a direct relation to dietary intake given that the individual is in energy- or nitrogen balance (Van Dam & Hunter, 2013). However, recovery biomarkers are both costly and time-consuming and thus can be argued to be unsuitable for common epidemiological use (Jenab, Slimani, Bictash, Ferrari, & Bingham, 2009).

2.4.2 Concentration biomarkers

A concentration biomarker, e.g. levels of carotenoids, vitamin C or fatty acids measured in blood concentrations, correlates with intakes of the equivalent food or nutrient. However, they cannot be translated into an absolute estimate of dietary intake (Jenab et al., 2009).

Nonetheless, the biomarker value can be used to rank individuals by their intake, and nutritional biomarkers are mostly concentration biomarkers. Due to the practical limitations related to the use of recovery biomarkers in validation studies, concentration biomarkers are often used as an alternative and they have the potential to provide valuable information (Van Dam & Hunter, 2013).

2.5 Carotenoids in general

Carotenoids are pigments which are synthesized in plants and microorganisms, and occur naturally in fruit and vegetables (Eroglu & Harrison, 2013). Carotenoids are classified into two groups. The first group is known as carotenes and consists of carotenoid hydrocarbons, e.g. α -carotene and β -carotene. The other group is the carotenoids containing oxygen, called xanthophylls, e.g. lutein and zeaxanthin (Goodwin, 1984). Biochemically, the typical feature of the carotenoids is the polyene chain, which is a long conjugated double-bond system that permits them to absorb light (Eroglu & Harrison, 2013).

A nutritionally important function of carotenoids in humans is vitamin A activity (Bender, 2003) α - and β -carotene and β -cryptoxanthin are precursors of vitamin A. They can be converted to retinol in the body and are therefore referred to as provitamin A carotenoids (Eroglu & Harrison, 2013). The xanthophyll carotenoids lutein and zeaxanthin, also referred

to as non-provitamin A carotenoids, have no vitamin A activity. However, epidemiologic studies suggest that these compounds may have a protective role in the eye (Ribaya-Mercado & Blumberg, 2004).

2.5.1 Carotenoids in human diet

Carotenoids are found in various colored fruits and vegetables. Green or dark vegetables such as broccoli, leek, peas, spinach and red pepper are sources of lutein. Red pepper is a source of zeaxanthin and carrots are a good source of α -carotene. Apricot, avocado, carrots, sweet potato, pumpkin and exotic fruits such as mango are examples of sources of β -carotene. Tomato, tomato products, grapefruit and watermelon are sources of lycopene. Citrus fruits, such as oranges and orange juice are sources of β -cryptoxanthin (Maiani et al., 2009). Thus, α -carotene and β -carotene and lycopene can be used as biomarkers on fruit and vegetable intake. Further, β -cryptoxanthin can be used as a biomarker on fruit intake (Jansen et al., 2004). Zeaxanthin and lutein can be used as biomarkers of vegetable intake (Al-Delaimy et al., 2005; Jansen et al., 2004).

However, the concentration of carotenoids in fruits and vegetables is affected by factors such as variety within plants, time of harvest, ripeness, as well as both growing and storage conditions (Gross, 1991). One other contributor to concentrations of carotenoids may be fortified foods or supplements (Crispim et al., 2011; Willett, Stampfer, Underwood, Taylor, & Hennekens, 1983).

2.5.2 Carotenoids in human tissue and blood

Though there are many hundred types of carotenoids found in nature, there are relatively few carotenoids found in human tissue (Al-Delaimy et al., 2005; Crews et al., 2001), and the following six carotenoids: α -carotene, β -carotene, β -cryptoxanthin, zeaxanthin, lycopene and lutein represent more than 95% of total blood carotenoids (Maiani et al., 2009).

The portion of the carotenoids that is not metabolized in the gut is incorporated into chylomicrons and passed into the blood through the lymph (Bendich & Olson, 1989). The transportation of carotenoids in blood is done alone by lipoproteins (Mathews-Roth &

Gulbrandsen, 1974). In a fasted state, α -carotene, β -carotene and lycopene are carried by low-density lipoproteins (LDL). β -cryptoxanthin, lutein and zeaxanthin are carried by high-density lipoproteins (HDL) and to some degree very low-density lipoproteins (Johnson & Russell, 1992; Parker, 1988; Traber, Diamond, Lane, Brody, & Kayden, 1994).

Carotenoids are present in human tissue such as kidney, adrenal, liver and adipose tissue, where the last two seem to be the main store sites (Parker, 1989). The total body pool of carotenoids contains about 100-150 mg in a well-nourished person. Out of this, about 1 % is present in the serum, normally at a concentration of 0.4-1.5 $\mu\text{g/ml}$ (0.8-8 $\mu\text{M/l}$). However, the concentration is highly dependent on average daily intake of an individual (Bendich & Olson, 1989; Parker, 1989).

In childhood and adolescence, the concentrations may be lower. In the third National Health and Nutrition Examination survey (NHANES III) serum β -carotene concentration in children was around 0.34 $\mu\text{mol/L}$, and dropped to 0.28 $\mu\text{mol/L}$ or less in teenagers. These low levels were also reflected for α -carotene, β -cryptoxanthin, zeaxanthin and lutein (Hollowell et al., 2002).

2.5.3 Sensitivity and bioavailability

Carotenoids are primarily obtained from dietary intake of fruits and vegetables and they are not strictly regulated by the homeostatic mechanisms. Therefore, carotenoid concentration in human tissue and serum is considered to be very sensitive to dietary intake (Van Dam & Hunter, 2013; Willett et al., 1983). Thus, levels of carotenoid concentrations in human serum and plasma can fluctuate from day-to-day and may vary between individuals (Cooney et al., 1995; Olmedilla, Granado, Blanco, & Rojas-Hidalgo, 1994; Tangney, Shekelle, Raynor, Gale, & Betz, 1987).

Bioavailability refers to the capability of a dietary component to be absorbed and available for storage or use in the human body (Maiani et al., 2009). However, there are several factors which can affect carotenoid bioavailability from foods among individuals.

Dietary fat and cooking methods

Applying fat when preparing vegetables increases the bioavailability of fat-soluble carotenoids (Van Dam & Hunter, 2013). Nagao, Kotake-Nara, and Hase (2013), found that dietary fat and oils increases the bioaccessibility of the hydrophobic (fat-soluble) carotenes such as β -carotene, but not for lutein which is less hydrophobic than β -carotene.

Heat treatment, such as boiling, may also increase the bioavailability of carotenoids found in vegetables (van het Hof, West, Weststrate, & Hautvast, 2000). Additionally, cooking techniques such as pureeing or chopping vegetables enables the absorption of the carotenoids (Van Dam & Hunter, 2013). Stahl and Sies (1992) studied the variation of the uptake of lycopene from both unprocessed and processed (boiled) and tomato juice and found that only the processed tomato juice led to increased lycopene concentrations in human serum.

Body weight

An association has been shown between the plasma concentration of carotenoids and plasma lipids levels (Coyne et al., 2005). A previously published study shows that concentrations of α -tocopherol and β -carotene in plasma were significantly lower in non-dieting obese boys, compared to control subjects consisting of normal weight children (Decsi, Molnar, & Koletzko, 1997).

Seasonal and diurnal variation

Another important issue is to know if there is a change in plasma levels of the current nutrient during the year or during the day, as this can be a confounder if not taken into consideration (Nierenberg & Stukel, 1987). Plasma levels of carotenoids may differ according to the seasons due to decreased or increased access to carotenoid-rich foods (Bates, Villard, Prentice, Paul, & Whitehead, 1984).

In relations to diurnal variations, it is shown that although a variability within subjects does exist over a 24-h period, blood samples may be obtained at any suitable time between 0800 and 1400 as diurnal variations in plasma carotenoid concentrations within this time are statistically indistinguishable, while levels obtained at 1700 were slightly lower (Cantilena, Stukel, Greenberg, Nann, & Nierenberg, 1992).

2.5.4 Carotenoids as a biomarker of dietary intake

Concentration biomarkers, such as carotenoids, are related to dietary intake, but not in a direct manner because they are affected by individual differences in digestion, distribution, excretion and metabolism i.e. they do not translate into absolute intake (Jenab et al., 2009). Therefore, the measurement of carotenoids in human blood can not provide a precise quantitative estimate of dietary intake of fruit and vegetables (Bates et al., 2005).

Nevertheless, they are considered good markers for dietary intake of fruit and vegetables (Bates et al., 1997), and carotenoids have been shown to have a dose-response relationship between intake of and levels of carotenoids in plasma, and could be an equitable biomarker for assessing short-term intake in individuals (Rock, Swendseid, Jacob, & McKee, 1992). The use of plasma carotenoids as biomarkers for fruit and vegetable intake has been investigated in several studies, due to the association between the sum of plasma carotenoids and consumption of fruit and vegetables (Andersen et al., 2005; Campbell et al., 1994; Jansen et al., 2004). Further, research suggests that total carotenoids or a combination of key carotenoids may serve as a useful and more robust biomarker of fruit and vegetable intake, than single carotenoid measurements (Brevik et al., 2004).

3.0 Purpose and objectives

The purpose of the study is to evaluate how valid the web-based food diary is in ranking individuals according to self-reported intake of fruits, berries and vegetables (FBV), by using plasma concentrations of carotenoids as an objective reference to the subject's true intake.

Further, to investigate if the capability of ranking differs significantly between participants' when considering weight status and parents' education level.

3.1 Research questions

- I. Is there a significant correlation between the total plasma concentrations of carotenoids, as well as single plasma carotenoids; Lutein, zeaxanthin, β -cryptoxanthin, α -carotene, β -carotene and lycopene, and self-reported intake of FB, V and FBV in a web-based food diary among 9 and 13 year olds?
- II. Is there a significant correlation between plasma concentrations of single carotenoids; Lutein, zeaxanthin, β -cryptoxanthin, α -carotene, β -carotene and lycopene, and self-reported intake of corresponding, high carotenoid foods in a web-based food diary among 9 and 13 year olds, e.g. is there a significant correlation between plasma concentrations of lutein and self-reported intake of high lutein foods?
- III. Do participants with high versus low total plasma concentrations of carotenoids from blood samples differ in terms of self-reported intake of FB, V and FBV?
- IV. Do participants with high versus low levels of single plasma carotenoid concentrations from blood samples differed in terms of the amount of self-reported intake of corresponding high carotenoid foods?

- V.** How accurate can the web-based food diary classify participant's by quartiles of self-reported dietary intake of FB, V and FBV according to total plasma concentrations of carotenoids, and by self-reported intake of FBV according to single plasma carotenoids; Lutein, zeaxanthin, β -cryptoxanthin, α -carotene, β -carotene and lycopene?
- VI.** Is there a significant difference in the correlation between the total plasma concentrations of carotenoids, as well as single plasma carotenoids; Lutein, zeaxanthin, β -cryptoxanthin, α -carotene, β -carotene and lycopene, and self-reported intake of FB, V and FBV in a web-based food diary, with regard to weight status (Iso-BMI) and parental education?

4.0 Method

4.1 Planning

The planning and recruitment of the participating schools were done between January and July in 2013, by the PhD-student, Anine Medin. Prior to the period of collection of data, the two participating master students underwent a training period. The training included a course in conducting a blood sample using the dried spot method, measuring weight and height according to standard methods (Lien et al., 2010), as well as other necessary preparations.

Further, before conducting any weight and height measurements, those who were to be participating in the data collection had to be familiar with *The Helsinki declaration* and the *National guidance for weighing and measuring*, for use in public health work and school health service, published by The Norwegian Directorate of Health. Furthermore, those taking the blood samples had to be prepared to support a subject who may feel dizzy or faint, and if required, be able to administer first aid.

4.2 Study design

This is a validation study. The recruitment process was divided into three stages (Figure 1). First, several schools were invited to join the study through a written invitation addressed to the school principal. Secondly, if we got the principals acceptance, the children and their parents received an invitation letter in which they were asked to participate in the study. The letter contained information about the study; an invitation for participation and an informed consent form. Finally, before the children were included in the study, the written informed consent had to be signed by their parents. Arrangements to return the consent forms in subsequent days were necessary in order to include additional participants who wanted to join after this information session. This was possible because the schools were located in the same

municipality, within driving distance. Written informed consent from parents or guardians was in this way collected from all subjects, prior to enrolment.

After inclusion, the participating students had to complete a four days registration in the web-based food diary, where they reported their diet for at least three weekdays and one weekend day. They were asked to fill out the food diary at home. One-two weeks after the registration we visited the school to collect blood samples, using the dried spot method. Additionally, we collected height and weight measurements during these school visits. Participants had to complete all of these steps and to wear the accelerometers provided to estimate energy expenditure for one week, before they were awarded with a gift card for two tickets to their local cinema. The period for collection of data was between September and December 2013.

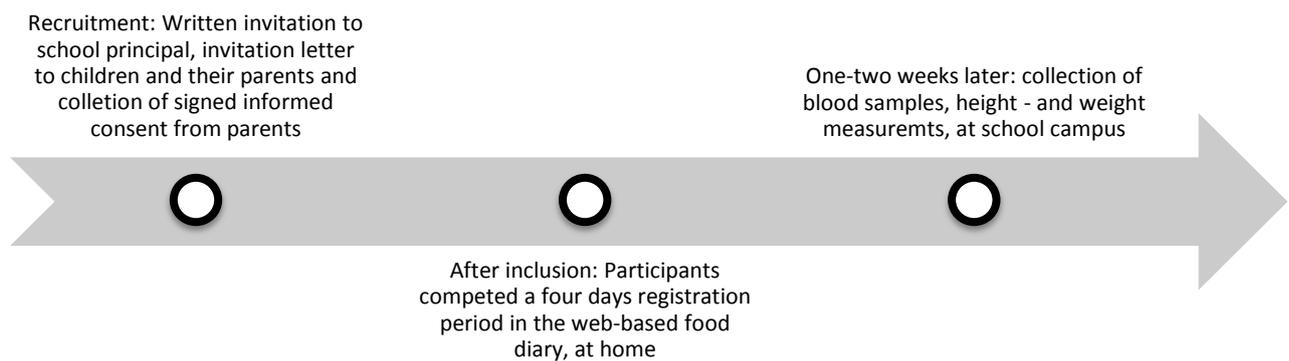


Figure 1: Overview of recruitment, registration period and collection of blood samples and height- and weight measurements, in the validation study

4.3 Subjects

The participants are recruited from eligible public primary and secondary schools in Bærum, a municipality outside Oslo. These schools are located within driving distance from the University of Oslo, due to feasibility and costs. A total of 414 participants were invited to participate in the present study, out of which 276 agreed to participate by returning the signed consent form. Nine of those withdrew. The final study sample consisted of 267 children, 124

at age eight or nine and 143 at age twelve or thirteen, out of which five participants had insufficient blood samples. Thus, there were 262 children, 122 at age eight or nine and 140 at age twelve or thirteen included in the present study (Figure 2).

A sample size of 100 to 200 individuals is suggested to be sufficient, when using a correlation coefficient to assess the association between two methods (Cade, Thompson, Burley, & Warm, 2002). This is confirmed by (Willett & Lenart, 2012), who describes 100 to 200 individuals as a reasonable sample size. This amount allows for both the exclusion of subjects due to factors such as illness, in addition to being acceptable for providing a variety of likely degrees of validity (Willett & Lenart, 2012).

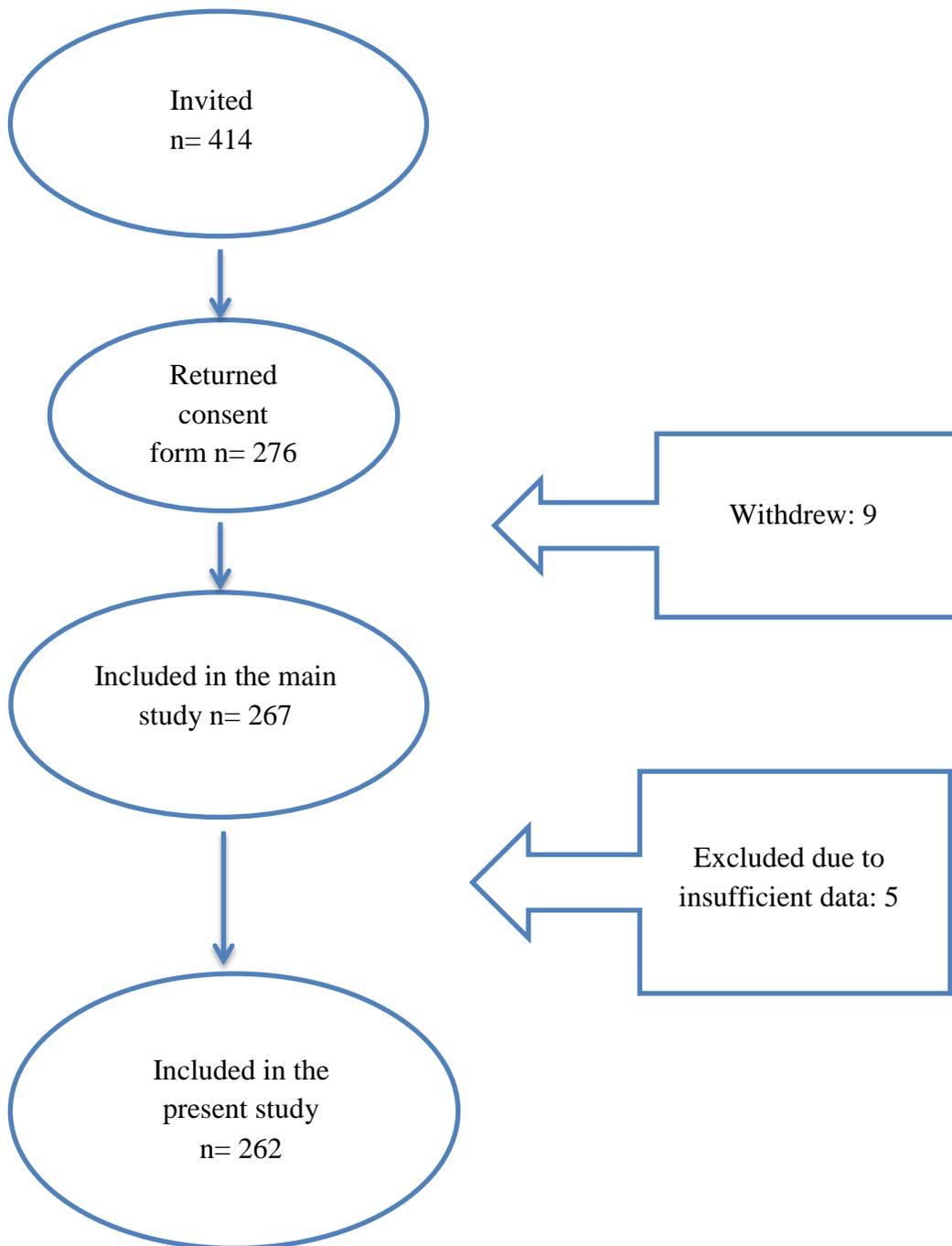


Figure 2: Included subject in the validation study.

4.4 Collection of dietary data

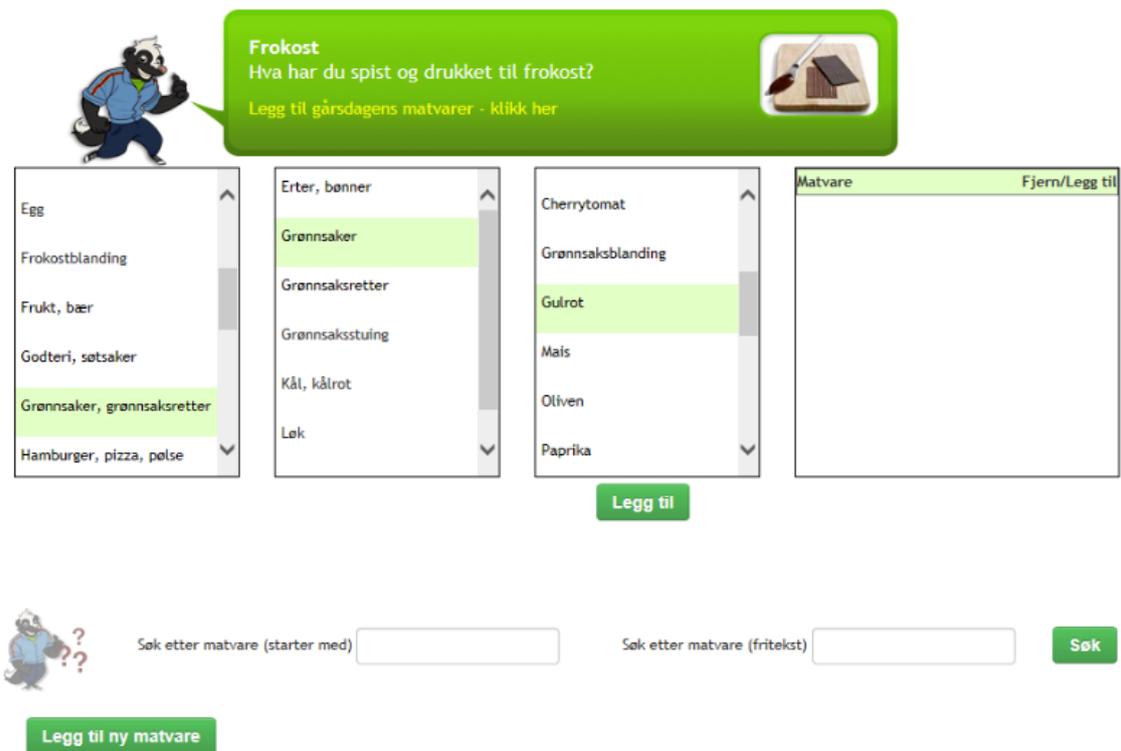
4.4.1 Web-based food diary

A food diary is a dietary assessment method in which participants are asked to register what they eat and drink for a period of time. The participants' parents received a username and password to log into the online web-based diary. The first stage presented to the participants included a welcome message and a short presentation of the web-based food diary.

Additionally there were links to useful information regarding the registration process in the food diary.

The program guided participants through the registering of breakfast, morning snack, lunch, afternoon snack, dinner and evening snack, using an animation character named Tim to communicate with the participants. Participants were asked to fill out the food diary each day in a retrospective manner: after having consumed the last meal of the day, they had to recall what they ate the whole day and register it in the food diary. They were also asked to register where the meals was consumed, as well as how much time they had spent eating and where they got the food from. If a participant forgot to fill out one day, a reminder was sent out to their reported email account. A project assistant was available for questions or assistance both by phone and email during the registration process.

The present food dairy contains about 550 food items. All food groups and food items were in alphabetical order. Participants were first to select the appropriate food category, then to choose the groups that they thought the food they had eaten were placed in, then to select the right food item (Figure 3). Finally the participants were asked to select portion size and number of portions eaten. The quantification of the food and drink items was carried out using food photographs of different portion sizes. Portion size is estimated using three or four different digital images, where the participants choose the picture they found best matched their meal (Figure 4). Participants also had the option of searching for foods by typing in the first letters, to add foods in an open field that they could not find, or to add foods reported the previous day.



Frokost
Hva har du spist og drukket til frokost?
Legg til gårsdagens matvarer - klikk her

Egg
Frokostblanding
Frukt, bær
Godteri, søtsaker
Grønnsaker, grønnsaksretter
Hamburger, pizza, pølse

Erter, bønner
Grønnsaker
Grønnsaksretter
Grønnsaksstuing
Kål, kålrot
Løk

Cherrytomat
Grønnsaksblanding
Gulrot
Mais
Oliven
Paprika

Matvare Fjern/Legg til

Legg til

Søk etter matvare (starter med) Søk etter matvare (fritekst) Søk

Legg til ny matvare

Figure 3: Example of design for selecting foods in the web-based food diary, as presented to the participants

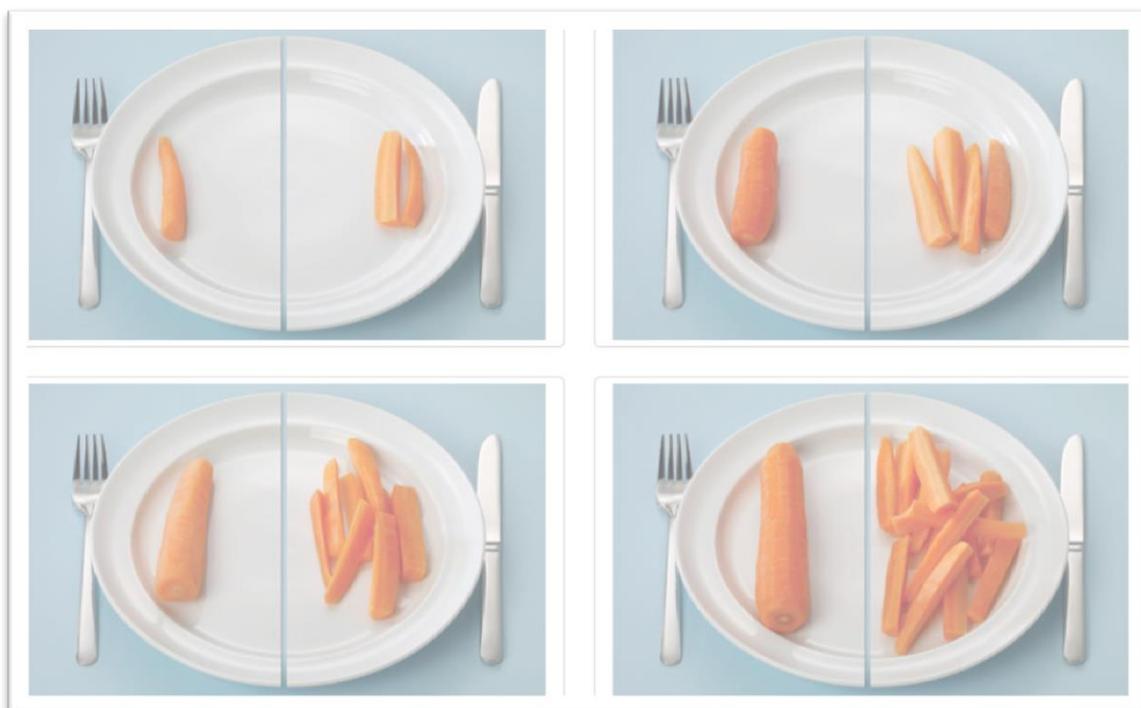


Figure 4: Portion sizes of carrots in the web-based food diary, as presented to the participants

After registering a meal, the participants were asked a follow up question asking if they had remembered to report drinks they had with the meal or if they had forgotten any foods, such as jam, sugar or milk. Additionally, participants were asked to register issues related to eating habits, e.g. if the foods they reported is what they usually ate. The food diary included additional fruits and vegetables from open fields, where the participants could write in food dishes or food items that were not included in the food diary. Portion sizes were recorded along with the foods item in the food diary, corresponding to a given value for portion sizes in grams.

4.4.2 Calculation of reported intake and creation of fruits, berries and vegetable intake variables

The reported dietary intake of fruits, berries and vegetables from the web-based food diary was calculated using the Norwegian food and nutrient database KBS AE-10, developed at the Department of Nutrition, University of Oslo. KBS translated the reported foods to mean grams per day for each individual. Total intake of vegetables, fruits and berries was categorized as food groups and individual food items. Dietary supplements were coded as reported or not reported.

Variables were created to represent intake of fruits, berries, vegetables and high carotenoid foods (Table 1). The variables were calculated for each participant's average intake per day from the registration period. Variables of high carotenoid foods was based on values of carotenoid content from a review on the main dietary sources of carotenoid in Europe, supplemented by an American database of carotenoid content of US foods (Holden et al., 1999; Maiani et al., 2009). Potatoes are not included in the Norwegian recommendations for daily intake of fruits and vegetables and are therefore not included.

Table 1: Definition of foods included in variables of self-reported intake of FB, V, FBV and high carotenoid foods, from the web-based food diary

Variable (g/day)	Definition
FB	This variable included fresh and dried fruits, orange juice, and mashed frozen berries. This variable does not include jam, seeds or nuts
V	This variable included fresh, frozen and conserved vegetables
FBV	This variable is the total score of the variables FB and V
High lutein food	Broccoli, leek, peas, red pepper and spinach
High zeaxanthin foods	Peppers, red
High α-carotene foods	Raw and boiled carrots
High β-carotene foods	Dried apricot, avocado, broccoli, raw and boiled carrot, leek, mango, red pepper, spinach, tomato and cherry tomato
High lycopene foods	Tomato, cherry tomato, hermetical tomato, tomato puree, ketchup, tomato soup powder and watermelon
High β-Cryptoxanthin foods	Citrus fruits : orange, clementine, lime, lemon and orange juice

FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

4.5 Collection of blood samples

The collection of blood samples were done by a PhD student at the University of Oslo, Anine Medin, accompanied by the two master's students. The planning was done in cooperation with the school nurse. The procedures for collection of the blood samples were based on the work of Elburg, Hulshof, and West (2003): a manual for the determination of retinol and carotenoids in blood and human milk, and guidelines provided by the lab that conducted the analysis, Vitas.

4.5.1 Dried spot method

Blood samples were conducted using the Dried Spot Method. This method was chosen because it is less invasive than sampling venous blood with a needle. You only need to draw a small sample from the child's finger and it provides a valid sample for carotenoids (Mcdade et al., 2007).

The blood was not drawn on a fasting state. Further, the participants were not instructed to avoid consumption of any fruits, vegetables or juices on the day of the blood sampling. Samples were drawn within 08.00 in the morning and 14.00 in the afternoon, due to considerations for diurnal variation (Cantilena et al., 1992). Before sampling the identity of the participant was checked. Then, the procedure for the collection of blood was explained to each individual, so that the subject was properly informed and made aware of the procedure and possible impending pain or discomfort.

To ensure the quality of the blood samples, each subject was positioned sitting down in a chair and asked to avoid strenuous exercise. This is important because strenuous exercise before blood collection can affect the occurrence of differences in the concentration of blood components, due to variations in blood volume (Burtis, Ashwood, & Bruns, 2012). To prevent haemolysis in blood samples, any squeezing or milking of the finger was avoided during the sampling (Elburg et al., 2003).

4.5.2 Storage and processing

The sampling paper was left to dry thoroughly by air in a dark container, allowing no sunlight to come into contact with the samples and destroy the carotenoids (Kaaks, 1997). The samples dried at room temperature (20- 25 degrees C), for a few hours until they were dry enough to be packaged. All samples were transported back to the University of Oslo to be stored in a freezer (-70 degrees C), for a maximum period of four months. All samples were stored in the freezer within 12 hours, except seven samples who were stored within 14 hours.

When all samples were collected, they were transported to a lab, Vitas, and analyzed using established methods. Carotenoids were measured in dried whole blood, collected with the

dried spot method, and the measured concentrations was converted to plasma values by dividing with a hematocrit value of 0.5.

4.6 Anthropometry

Iso- BMI was calculated using the measured height and weight. Measurements of the participants' weight and height were done according to standard methods (Lien et al., 2010). The participants were not given any information concerning their own, or others' weight and height. However, participants could access the information on weight and height through a written request from a guardian.

The weight was measured to the nearest 0.1 kg on an electronic digital scale (TANITA TBF-300). During weighing, the participants wore only light clothing. Pants and t-shirts were kept on in order to maintain a safe and comfortable environment for the participants.

For the height measurements, pre-mounted altimeters that are already in schools were used where appropriate. The criteria were that they had to be calibrated before use. The calibration was done according to the *National guidance for weighing and measuring*, provided by The Norwegian Directorate of Health. In the schools where there was an altimeter, or where the local altimeter did not deviate more than 3mm, a separate tape measure and angle meters were used to control the proper measurement. The participant was instructed to stand upright with a straight back, either barefoot or wearing socks, against the measuring tape that had been attached to the wall. Height was measured to the nearest 1 mm.

4.6.1 Iso-BMI: cut off points

Iso-BMI cut off point developed by Cole, Bellizzi, Flegal, and Dietz (2000) was used to define overweight and obesity among the study subjects. The cut off points are commonly presented in half years age, but we have chosen to use only whole years due to the fact that we only have access to the participant's age in whole years (Table 2). In the analysis, Iso-BMI was categorized into two categories: normal and overweight, whereof the overweight class included participants who were classified as both overweight and obese.

Table 2: Extracts from T. J. Cole et al. (2000) international cut off points for body mass index for overweight and obesity in childhood, by sex between age 8 and 14, defined to pass through body mass index of 25 and 30 kg/m² at age 18

Age (years)	Overweight Body mass index 25 kg/m ²		Obese Body mass index 30 kg/m ²	
	Male	Female	Male	Female
8	18.44	18.35	21.60	21.57
9	19.10	19.07	22.77	22.81
12	21.22	21.68	26.02	26.67
13	21.91	22.58	26.84	27.76
14	22.62	23.34	27.63	28.57

4.7 Parental education

Highest parental education level was collected in the consent form that the parents completed before inclusion, with answers grouped accordingly: from less than seven years of completed education to more than four years completed education at university level.

Parental education level was defined by the highest completed school education achieved by one of the parents. Low education level was given to those who had completed primary and secondary education up to 14 years, and high education level was given to those who had attended a university or university college for up to four years or at an advanced level of more than four years of education at a university or university college.

4.8 Statistics

The statistical computer program IBM SPSS statistics 20 has been used for conducting all analysis. All variables were checked and appropriate statistical methods were used depending on the data distribution. Only total plasma carotenoids were normally distributed. Descriptive

statistics were calculated for all participants. Self-reported intake and plasma concentrations of carotenoids are presented as median (25th and 75th quartiles). Additionally, mean (SD) is presented for all variables to give a total view of the data. Total plasma carotenoid concentrations between users and non-users of dietary supplements were compared by using the independent t-test.

Spearman's test for correlation was applied to rank participants according to self-reported dietary intakes of FB, V and FBV and total, as well as single, plasma carotenoid concentrations. Additionally, Spearman's test for correlation was applied to rank participants according self-reported intake of high carotenoid foods and corresponding single plasma carotenoid concentrations, e.g. high α -carotene foods were evaluated against corresponding plasma concentration of α -carotene.

Further, a Mann-Whitney U-test was applied to evaluate if participants who had low versus high levels of total plasma concentrations of carotenoids differed in terms of the amount of self-reported intake of FB, V and FBV, as well as to evaluate if participants with low versus high levels of single plasma concentrations of carotenoids differed in terms of the amount of self-reported intake of corresponding high carotenoid foods.

Cross-classification was used to investigate how many (percentage) of the participants were classified in the same or adjacent quartile, and how many were classified in the opposite quartile, according to self-reported dietary intake of FB, V and FBV and total plasma concentrations of carotenoids and according to self-reported intake of FBV and single plasma concentrations of carotenoids.

Finally, correlation coefficients were compared between normal and overweight/obese participants as well as participants with high and low parental education level. Spearman's test for correlation was done in a split sample and Fisher r-to-z transformation was used to assess the significance of the difference between two correlation coefficients found in two independent samples.

All p-values are two sided, and 5 % significant level is applied.

5.0 Results

5.1 Description of the sample

Table 3 shows the characteristics of the sample, 122 participants from 4th grade and 140 from 8th grade. Information about parental education was available for 95.8% of the total population. Participants' age and information about dietary intake of supplements was available for 100 % of the total population. Iso-BMI was also estimated for all individuals.

Table 4 and 5 give an overview of the self-reported intake of fruit, berries and vegetables and plasma concentrations of carotenoids. The independent-samples T-test showed no differences in mean total plasma concentrations of carotenoids between the supplement users and non-supplement users ($p=0.82$, two tailed). For that reason, both users and non-users of dietary supplements were analyzed together in the present study.

Table 3: Characteristics of participants (n 262)

Characteristics	4 th grade (n 122)	8 th grade (n 140)
Age, in years (mean (SD))	8.8 (0.33)	12.9 (0.32)
Gender		
Girls	68 (56)	78 (56)
Boys	54 (44)	62 (44)
Parental education level		
Low	13 (11)	27 (19)
High	103 (84)	108 (77)
Missing	6 (5)	5 (4)
Iso-BMI		
Normal	105 (86)	120 (86)
Overweight/obese	17 (14)	20 (14)
Supplements**		
Supplement users	77 (63)	75 (54)
Non-supplement users	45 (37)	65 (46)

Results are shown in n (%), unless otherwise stated. *Highest completed school education level among one of the parents. Low = completed a primary and secondary school (up to 14 years). High = university or university college for up to 4 years or more than 4 years at a university or university college. **Self-reported intake of dietary supplements from the web-based food diary.

Table 4: Self-reported intake of FB, V, FBV and high carotenoid foods, g/d (n 262)

Self- reported intake (g/d)	Median (P25, P75)	Mean (SD)
FB	100 (33, 180)	129 (126)
V	48 (23, 85)	63 (60)
FBV	165 (80, 271)	192 (145)
High β-carotene foods	22 (7, 48)	33 (40)
High zeaxanthin foods	0 (0, 1)	4 (9)
High lutein foods	1 (0, 17)	10 (18)
High lycopene foods	10 (0, 26)	18 (26)
High β-cryptoxanthin foods	8 (0, 50)	40 (62)
High α-carotene foods	2 (0, 17)	12 (20)

FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

Table 5: Plasma concentrations of carotenoids, μ M (n 262)

Plasma concentration of carotenoids (μ M)	Median (P25, P75)	Mean (SD)
Lutein	0.21 (0.17-0.27)	0.22 (0.08)
Zeaxanthin	0.054 (0.036-0.072)	0.058 (0.028)
β-cryptoxanthin	0.16 (0.11-0.23)	0.19 (0.13)
α-carotene	0.12 (0.07-0.19)	0.15 (0.13)
β-carotene	0.46 (0.33-0.65)	0.53 (0.26)
Lycopene	0.74 (0.57-0.95)	0.78 (0.31)
Total sum	1.87 (1.48-2.33)	1.93 (0.63)

5.2 Comparison between self-reported intake of FB, V and FBV and plasma concentrations of carotenoids

The Spearman's correlation coefficients between self-reported intake of fruits, berries and vegetables and plasma concentrations of carotenoids are presented in Table 6. The significant positive Spearman's correlation coefficients ranged from 0.17 to 0.36. Self-reported intake of FB showed significant correlations with plasma β -cryptoxanthin and α -carotene. The self-reported intake of V correlated significantly with plasma lutein, α -carotene, β -carotene and the total sum of plasma concentrations of carotenoids. Self-reported intake of total FBV showed the highest number of significant correlations with plasma concentrations of carotenoids, whereof there were found significant correlations with plasma lutein, β -cryptoxanthin, α -carotene, β -carotene and the total sum of plasma concentrations of carotenoids.

Of the single carotenoids plasma α -carotene had the highest positive correlation with FB, V, and FBV. Inverse correlation coefficients were found for lycopene and self-reported intake of FB, V and FBV, but none of these correlations were significant.

Table 6: Spearman's correlation between self-reported intake of FB, V and FBV, and plasma concentration of carotenoids (n 262)

Plasma concentrations of carotenoids (μM)	Self-reported intake (g/day)		
	FB	V	FBV
Lutein	.11	.21**	.19**
Zeaxanthin	.01	.05	.05
β -cryptoxanthin	.22**	.01	.21**
α -carotene	.24**	.36**	.36**
β -carotene	.12	.22**	.19**
Lycopene	-.07	-.01	-.06
Total sum	.10	.19**	.17**

* $P < 0.05$, ** $P < 0.01$. FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

5.3 Comparison between self-reported intake of high carotenoid foods and plasma concentrations of carotenoids

The Spearman's correlations coefficients between self-reported intake of high carotenoid foods and corresponding plasma concentrations of carotenoids are presented in Table 7. Of the high carotenoid food groups the high α -carotene foods had the highest correlation coefficients with plasma concentrations of α -carotene and β -carotene. High β -carotene foods were most strongly correlated with plasma concentrations of α -carotene and β -carotene. High lycopene foods were most strongly correlated with plasma concentrations of lutein and lycopene, and high β -cryptoxanthin foods had the highest correlation coefficients with plasma concentrations of β -cryptoxanthin and α -carotene. All these correlations were significant.

An inverse non-significant correlation coefficient was found for high lutein foods and corresponding plasma concentration of lutein. Further, high lutein foods had the highest significant correlation coefficients with plasma concentrations of α -carotene and β -carotene.

Similar findings were observed for high zeaxanthin foods, which had the highest significant correlation coefficient with plasma concentrations of α -carotene and β -carotene.

Table 7: Spearman's correlation between intakes of high carotenoid foods¹ and plasma concentration of single carotenoids (n 262)

Plasma concentration of single carotenoids (μ M)	Self-reported intake (g/d)					
	High α -carotene foods	High β -carotene foods	High lutein foods	High lycopene foods	High β -cryptoxanthin foods	High zeaxanthin foods
α -Carotene	.40**	.45**	.21**	.05	.16*	.13*
β -Carotene	.24**	.30**	.19**	.03	.10	.13*
Lutein	.04	.20**	.10	.18**	.04	-.01
Lycopene	-.06	-.07	-.02	.13*	-.04	-.03
β -Cryptoxanthin	.03	.04	.06	-.04	.38*	.05
Zeaxanthin	-.07	.02	.04	.06	.12*	-.00

* $P < 0.05$, ** $P < 0.01$. ¹ High α -carotene foods: raw and boiled carrots. High β -carotene foods: dried apricot, avocado, broccoli, raw and boiled carrot, leek, mango, red pepper, spinach, tomato and cherry tomato. High lutein foods: broccoli, leek, peas, red pepper and spinach. High lycopene foods: tomato, cherry tomato, hermetical tomato, tomato puree, ketchup, tomato soup powder and watermelon. High β -cryptoxanthin foods: citrus fruits; orange, clementine, lime, lemon and orange juice. High zeaxanthin foods: peppers, red.

5.4 Comparison between groups: low versus high levels of plasma concentrations of carotenoids and self-reported intake

The Mann-Whitney U-Test revealed a significant difference between participants with low levels of total plasma concentration of carotenoids versus participants with high levels of total plasma concentration of carotenoids, according to self-reported intake of FB, V and FBV (Table 8). Participants with high levels of total plasma concentrations of carotenoids were found to have reported a significant higher amount of FB, V and FBV than those who had low levels of total plasma concentrations of carotenoids.

Additionally, there was found a significant difference between participants with low levels versus participants with high levels of plasma concentration of β -cryptoxanthin, α -carotene and β -carotene, according to the amount of self-reported intake of corresponding β -cryptoxanthin foods, high α -carotene foods and high β -carotene foods (Table 9). Here, participant with a high plasma concentration of carotenoids reported a significantly higher amount of the corresponding high carotenoids food groups than those who had low levels of total plasma concentrations of carotenoids. E.g. participants with high plasma concentrations of β -cryptoxanthin reported to have eaten 50 g/day of the high β -cryptoxanthin foods, compared to the participants with low plasma concentrations of β -cryptoxanthin who reported to have eaten 0 g/day.

Participants with low versus high levels of single plasma concentrations of lutein, zeaxanthin or lycopene did not differ significantly in terms of the amount of self-reported intake of corresponding high lutein foods, high zeaxanthin foods or high lycopene foods (Table 9)

Table 8: Mann-Whitney U-test: comparison between groups with low¹ versus high² levels of total plasma concentration of carotenoids and self-reported intake of FB, V and FBV

Total plasma concentration of carotenoids	Self-reported intake (mean g/day)		
	FB	V	FBV
Low (n 65)	80	39	132
High (n 65)	122	58	187
p value	.049	.016	.008

¹ Low= 25 % with the lowest level of plasma concentration of total carotenoids. ² High= 25 % with the highest level of plasma concentration of total carotenoids. FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

Table 9: Man-Whitney U-test: comparison between groups with low¹ versus high² levels of plasma concentration of single carotenoids and self-reported intake of corresponding high carotenoid foods*

Plasma concentration of corresponding single carotenoids	Self-reported intake of high carotenoid foods (mean g/day)					
	High lutein foods	High zeaxanthin foods	High β -cryptoxanthin foods	High α -carotene foods	High β -carotene foods	High lycopene foods
Low (n 65)	2	0	0	0	15	6
High (n 65)	2	0	50	13	39	11
p value	.35	.96	P <0.001	P <0.001	P <0.001	.16

¹ Low= 25 % with the lowest level of plasma concentration of single carotenoids. ² High= 25 % with the highest level of plasma concentration of single carotenoids. * High α -carotene foods: raw and boiled carrots. High β -carotene foods: dried apricot, avocado, broccoli, raw and boiled carrot, leek, mango, red pepper, spinach, tomato and cherry tomato. High lutein foods: broccoli, leek, peas, red pepper and spinach. High lycopene foods: tomato, cherry tomato, hermetical tomato, tomato puree, ketchup, tomato soup powder and watermelon. High β -cryptoxanthin foods: citrus fruits; orange, clementine, lime, lemon and orange juice. High zeaxanthin foods: peppers, red.

5.5 Cross-classification of self-reported intake of FB, V and FBV and plasma concentrations of carotenoids

Table 10 shows the proportions that were classified in the same or adjacent quartile by self-reported intake of FB, V and FBV and total plasma concentrations of carotenoids and the proportions which were misclassified in the opposite quartile by the intake and plasma values. Overall, 68 % of the participants fell into the same or adjacent quartiles when classified by estimated FBV intake and total plasma concentrations of carotenoids and 9 % was classified into the opposite quartile. Equivalent comparisons were done for self-reported intake of FBV and single plasma concentrations of carotenoids (Table 11). The percentage of participants who were misclassified into the opposite quartile was lowest when classified by self-reported intake of FBV and plasma concentrations of single carotenoids β -cryptoxanthin and α -carotene, and highest when classified by self-reported intake of FBV and plasma concentrations of single carotenoids lycopene and lutein.

Table 10: Cross-classification of quartiles by participant's self-reported intake of FB, V and FBV and total plasma concentrations of carotenoids¹ (n 262)

Self-reported intake, g/day	% Same and adjacent quartile	% Opposite quartile*
FB^a	66	10
V^b	68	8
FBV^c	68	9

¹ Quartiles 1-4 for total plasma concentrations of carotenoids were <1.48, 1.48-1.86, 1.87-2.32, >2.33 μM . ^a Quartiles 1-4 for self-reported intake of FB were <33, 33-99, 100-182 >180 g/day. ^b Quartiles 1-4 for self-reported intake of V were <23, 23-47, 48-85, >85 g/day. ^c Quartiles 1-4 for self-reported intake of FBV were <80, 80-164, 165-271, >271 g/day. * Quartile, which is located on the opposite side, e.g. the percentage with intake of FBV located on the 1st quartile, corresponds to the 4th quartile of plasma concentrations of carotenoids. FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

Table 11: Cross-classification of quartiles by participant's self-reported intake of FBV¹ and plasma concentrations of single carotenoids (n 262)

Plasma concentrations of carotenoids, μM	% Same and adjacent quartile	% Opposite quartile*
Lutein^a	68	10
Zeaxanthin^b	63	9
β-Cryptoxanthin^c	68	6
α-Carotene^d	74	5
β-Carotene^e	68	8
Lycopene^f	60	12

^a Quartiles 1-4 for self-reported intake of FBV were <80, 80-164, 165-271, >271 g/day. ^a Quartiles 1-4 for plasma concentrations of lutein were <0.17, 0.17-0.20, 0.21-0.27, >0.27 μM . ^b Quartiles 1-4 for plasma concentrations of zeaxanthin were <0.036, 0.036-0.053, 0.054-0.072, >0.072 μM . ^c Quartiles 1-4 for plasma concentrations of β -cryptoxanthin were <0.11, 0.11-1.15, 0.16-0.23, >0.23 μM . ^d Quartiles 1-4 for plasma concentrations of α -carotene were <0.07, 0.07-0.11, 0.12-0.19, >0.19 μM . ^e Quartiles 1-4 for plasma concentrations of β -carotene were <0.33, 0.33-0.45, 0.46-0.65, >0.65 μM . ^f Quartiles 1-4 for plasma concentrations of lycopene were <0.57, 0.57-0.73, 0.74-0.95, >0.95 μM . * Quartile, which is located on the opposite side, e.g. the percentage with intake of FBV located on the 1st quartile, corresponds to the 4th quartile of plasma concentrations of carotenoids.

5.6 Comparing the correlation coefficient between groups

5.6.1 Iso- BMI

Table 12 and 13 shows correlation coefficients between self-reported intake of FB, V and FBV, high carotenoid foods, and plasma concentrations of carotenoids, in normal and overweight participants.

Although some differences were observed in correlation coefficients between normal and overweight participants, a statistically significant difference was only found between the groups according to self-reported intake of FB and plasma concentrations of single carotenoid zeaxanthin ($p=0.03$) and self-reported intake of V and plasma concentrations of single carotenoid lycopene ($p=0.01$). In both these cases, overweight participants had a significant inverse correlation coefficient, while positive non-significant correlations were observed for the participants of normal weight. Further, a significant difference was found between the two weight groups regarding the observed correlation coefficients between high zeaxanthin foods and plasma concentrations of zeaxanthin ($p=0.02$) and between high lycopene foods and plasma concentrations of lycopene ($p= 0.01$).

Table 12: Spearman's correlation between self-reported intakes of FB, V and FBV (g/day) and plasma concentrations of carotenoids (μM), by weight groups normal¹ and overweight²

Plasma concentrations of carotenoids (μM)	Self-reported intake (g/day)					
	FB		V		FBV	
	Normal (n 225)	Overweight (n 37)	Normal (n 225)	Overweight (n 37)	Normal (n 225)	Overweight (n 37)
Lutein	.13*	-.14	.23**	.11	.20**	.03
Zeaxanthin	.05	-.33*	.05	.09	.08	-.15
β-Cryptoxanthin	.19**	.29	.03	-.02	.19**	.28
α-Carotene	.21**	.34*	.32**	.55**	.32**	.51**
β-Carotene	.10	.14	.21**	.30	.18**	.23
Lycopene	-.06	-.15	.06	-.38*	-.03	-.28
Total sum	.10	-.02	.22**	.01	.18**	-.00

* $P < 0.05$, ** $P < 0.01$.¹ Participants classified as normal weight, based on the international cut-off points for BMI (Cole et al., 2000).² Participants classified as overweight/obese, based on the international cut-off points for BMI (Cole et al., 2000). FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

Table 13: Spearman's correlation between self-reported intakes of high carotenoid foods^a (g/day) with corresponding plasma carotenoids (µM), by weight groups normal¹ and overweight²

Self-reported intakes of high carotenoid foods, g/day	Normal (n 225)	Overweight (n 37)
High lutein foods	.09	.14
High zeaxanthin foods	-.27	.18
High β-cryptoxanthine foods	.40**	.33*
High α-carotene foods	.40**	.41*
High β-carotene foods	.30**	.36*
High lycopene foods	.17**	-.31

* P < 0.05, ** P < 0.01.^a High α-carotene foods: raw and boiled carrots. High β-carotene foods: dried apricot, avocado, broccoli, raw and boiled carrot, leek, mango, red pepper, spinach, tomato and cherry tomato. High lutein foods: broccoli, leek, peas, red pepper and spinach. High lycopene foods: tomato, cherry tomato, hermetical tomato, tomato puree, ketchup, tomato soup powder and watermelon. High β-cryptoxanthin foods: citrus fruits; orange, clementine, lime, lemon and orange juice. High zeaxanthin foods: peppers, red.¹ Participants classified as normal weight, based on the international cut-off points for BMI (Cole et al., 2000).² Participants classified as overweight/obese, based on the international cut-off points for BMI (Cole et al., 2000). FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

5.6.2 Parental education level

The correlation coefficient between self-reported intake of FB, V and FBV, high carotenoid foods, and plasma concentrations of carotenoids, for participants with high and low levels of parental education level is presented in Table 14 and 15. The participants with low parental education had both more significant correlation coefficients and higher significant correlation coefficients, between reported FB and plasma concentrations of carotenoids than the participants with high parental education. Out of these, the correlation coefficient between self-reported intake of FB and plasma concentrations of lutein (p= 0.04), plasma concentrations of zeaxanthin (p= <0.001) and plasma concentrations of β -cryptoxanthin (p =0.004) were significantly different for the two education groups.

For total self-reported intake of FBV and plasma concentrations of carotenoids differences in correlation coefficients between the two education groups were only significant for plasma concentrations of zeaxanthin (p= <0.001). There was no significant difference between the

participants with high and low parental education level regarding the correlation coefficients between self-reported V intake and plasma concentrations of carotenoids. Further, a significant difference was found between the two education groups regarding the observed correlation coefficients between high β -cryptoxanthin foods and plasma concentrations of β -cryptoxanthin ($p=0.05$).

Table 14: Correlation coefficients between self-reported intake of FB, V and FBV (g/day) and plasma concentrations of carotenoids (μM), by parental education level low¹ and high²

Plasma concentrations of carotenoids (μM)	Self-reported intake (g/day)					
	FB		V		FBV	
	Low (n 40)	High (n 211)	Low (n 40)	High (n 211)	Low (n 40)	High (n 211)
Lutein	.40*	.06	.30	.22**	.43**	.153*
Zeaxanthin	.51**	-.09	.25	.05	.54**	-.03
β-Cryptoxanthin	.59**	.16*	-.03	.06	.48**	.18**
α-Carotene	.17	.28**	.40*	.37**	.28	.40**
β-Carotene	.18	.14*	.21	.25**	.26	.23**
Lycopene	.15	-.09	-.15	.03	.01	-.05
Total sum	.39*	.07	.02	.24**	.31	.17*

* $P < 0.05$, ** $P < 0.01$. ¹Low = completed a primary and secondary school (up to 14 years). ²High = completed university or university college for up to 4 years or more than 4 years at a university or university college. FB: fruits and berries, V: vegetables, FBV: total fruits, berries and vegetables.

Table 15: Spearman's correlation between self-reported intakes of high carotenoid foods^a (g/day) with corresponding plasma carotenoids (μM), by parental education level low¹ and high²

Self-reported intake of high carotenoid foods, g/day	Low (n 40)	High (n 211)
High lutein foods	.05	.13
High zeaxanthin foods	-.06	.02
High β -cryptoxanthin foods	.60**	.33**
High α -carotene foods	.49**	.42**
High β -carotene foods	.29	.32**
High lycopene foods	-.03	.17*

* $P < 0.05$, ** $P < 0.01$. ^a High α -carotene foods: raw and boiled carrots. High β -carotene foods: dried apricot, avocado, broccoli, raw and boiled carrot, leek, mango, red pepper, spinach, tomato and cherry tomato. High lutein foods: broccoli, leek, peas, red pepper and spinach. High lycopene foods: tomato, cherry tomato, hermetical tomato, tomato puree, ketchup, tomato soup powder and watermelon. High β -cryptoxanthin foods: citrus fruits; orange, clementine, lime, lemon and orange juice. High zeaxanthin foods: peppers, red. ¹Low = completed a primary and secondary school (up to 14 years). ²High = completed university or university college for up to 4 years or more than 4 years at a university or university college.

6.0 Discussion

The main purpose of this present study is to evaluate how valid the web-based food diary is in ranking individuals according to self-reported intake of fruits, berries and vegetables (FBV), by using plasma concentrations of carotenoids as an objective reference to the subject's true intake.

The discussion is divided into two parts. In the first part, the methodology will be discussed. This section includes a discussion of the recruitment process and the study population in relation to participation rate, participant characteristics and generalizability. Further, the collection of dietary data with the web-based food diary will be discussed followed by a clarification of the usability of the reference method. The second part addresses the discussion of the results and the validity of the web based food diary, followed by ethical considerations. Finally, a conclusion and future suggestions for the implementation of Ungkost-3 will be presented.

6.1 Methodology

6.1.1 Participation rate and motivation

The participation rate in the present validation study was 64 %. In UNGKOST-2000 the participation rate was 83 % (Øverby & Andersen, 2002). An evaluation study done on a short questionnaire used among Norwegian 4th and 8th graders in UNGKOST-2000 had a participation rate of 74% (Lillegaard, Overby, & Andersen, 2012). Another validation study where a 24-h recall questionnaire on the intake of fruit and vegetable among Norwegian 6th graders were compared to a 7-day precoded food diary, had a participation rate of 89% (Andersen, Bere, Kolbjornsen, & Klepp, 2004).

Further, there were great variations in the response rate between classes in this present study. In the secondary schools, the response rate varied from 30-100 %, while in the primary

schools the response rate ranged between 50-70 %. An interesting observation was that the first classes we visited in the schools had the lowest percentage of participants. Possible explanations for this could be that project staff became better at informing and engaging the students to participate after gaining experience in the field, or might have been due to chance, i.e. that certain students with high peer influence participated in the study.

Participants, who completed the four days food registration, wore the accelerometers provided to estimate energy expenditure for one week, and completed the session where information about height, weight and blood samples were collected, were provided with compensation in form of a gift card for two tickets to their local cinema. Some students expressed that this was a motivation for joining and completing the study, especially those in the secondary schools. Providing participants with a form of compensation was also done in UNGKOST-2000, where participants received 100 NOK for completing the study (Øverby & Andersen, 2002). Further, we felt that many students wanted to participate in the project after the information session in the classrooms prior to the registration period, which was held by project staff.

6.1.2 Participant characteristics and generalizability

Reported characteristics of FBV intake

Median self-reported intake of FBV amongst the participants in this study was 165 g/day. The reported intake of FBV in this study is lower than what was found in UNGKOST 2000, where participants reported about 250 g/day of fruit and vegetables and potatoes (Øverby & Andersen, 2002). When excluding the consumption of potatoes, 4th graders reported a mean intake of fruits, berries, juice and vegetables of 211 g/day and the 8th graders reported 212 g/day in UNGKOST-2000 (Andersen, Overby, et al., 2004).

Anthropometry and parental education

The proportion of participants that was classified as overweight or obese based on the cut off values defined by Cole et al. (2000) was 14% of the 4th graders and 14% of 8th graders. These findings are in coherence with results from a previous report, published by The Norwegian Directorate of Health, where they measured body mass index, waist circumference

and skin fold thickness in Norwegian 9- and 15-year olds. Here, it was reported that among Norwegian 9-year-old girls, 14.7% were overweight and 4.7% were obese. Amongst boys, 12.8% were classified as overweight and 2.8% as obese. For 15-year olds, the numbers were as follows: 11.6% of girls were overweight and 1.3% was obese. Among the boys there were 9.2%, who were defined as overweight and 4.4% were obese (Anderssen, Kolle, Steene-Johannessen, Ommundsen, & Andersen, 2008).

The participants' parental education level in this study was relatively high, where 84 % of the 4th graders' and 77 % of the 8th graders' parents reported a high educational level. Statistics from Statistics Norway in 2012 show that 27.1 % of Norwegian women and 32.5 % of Norwegian men had a high education level; a higher education up to 4 years in duration or a higher education more than 4 years in duration. However, there are great geographical differences in Norway. For instance, the percentage of people that have a high education level in the capital, Oslo, are 46.5 %, compared to a county in the north, Finnmark, where 24.4 % have a higher educational level (SSB, 2012).

External validity

A relatively high participation rate is one of the strengths in this study, as this result in a more representative selection of participants and reduces the influence of non-response bias. The amount of participants from each age group, with 122 participants from 4th grade and 140 from 8th grade, were sufficient relative to the criteria's proposed by Cade and co-workers (2002) and Willet & Lennart (2012), where a sample size of 100 to 200 individuals is suggested to be sufficient in order to assess an association between two methods when using a correlation coefficient. Further, the present validation study was conducted in the same settings, as the web-based food diary in the Ungkost-3 survey. However, the sample was recruited from various schools in Bærum municipality, and thus the samples distribution is not representative for the whole country.

The physical characteristic of the participants, expressed through body weight, indicates that the study population is comparable to a general population of Norwegian children and adolescents. However, the high parental education level found amongst the participants weakens the external validity. Parental education level is an important environmental factor of dietary intake in children and adolescents (Pearson, Biddle, & Gorely, 2009; Van der Horst et

al., 2007), and a Norwegian study have reported that adolescents with highly educated parents report a higher consumption of fruit and vegetable than adolescents with less educated parents (Bere, van Lenthe, Klepp, & Brug, 2008). It could therefore be assumed that children of educated parents may be overrepresented due to parental involvement in their child's diet. In this present study it is assumed that the 8th graders have completed the registration in the web-based food diary on their own, while the 4th graders got help from parents. Parental education level may therefore have had a potential impact on the reporting of intake of fruits, berries and vegetables, especially amongst the 4th graders. The importance of this bias is emphasized in this study; by investigating if the web-based food diary's capability of ranking individuals according to reported fruit and vegetable intake differs significantly between participants when considering parental education level.

6.1.3 The web-based food diary

Web-administration of dietary assessment tools has become more common due to the increased internet access (Thompson & Subar, 2013). In Norway it is estimated that 93 % of all households have access to the Internet (SSB, 2013). Using the Internet to administer the food diary can therefore be argued to be an effective and appropriate method to collect data. Additionally, a self-administered web-based food diary is less costly and easier to administer than interview administered questionnaires (Thompson & Subar, 2013). There were not too many participants that were in contact with the project staff regarding problems with registration in the web-based food diary or logging in, which implies that the collection of data from the registration period was probably not affected by technical problems in this present study.

Reporting of food items and portion sizes

There are several possible sources of error associated with the registration of foods and portion sizes that may have affected reporting in this study. Under-reporting of foods are common reporting errors in dietary assessment methods (Macdiarmid & Blundell, 1998). The web-based food diary is a combination of different traditional dietary assessment methods where participants are asked to register what they eat for four consecutive days. The method includes an element of recall, as the participants are encouraged to fill out the food diary at

the end of the day, or as soon as possible the next day, if they are unable or forget to register by the end of the day. Therefore, the web-based food diary relies on the participant's memory and perception as they are likely to have to recall what they ate.

Participants had to register all foods in a meal, e.g. bread, cheese and paprika and beverages, in addition to portion sizes for four consecutive days. Others have emphasized that participants may underreport if there is a high number of foods eaten (Baranowski & Domel, 1994). It could be possible that participants only reported the main foods in a meal, and leaving sides or garnish of fruits, berries and vegetables out to reduce time spent on registration.

Estimating the correct portion sizes is a large source of error in dietary assessment methods (Gibson, 2005). Photographs of foods to aid participants to estimate portion sizes was used in the previous Norwegian national dietary surveys in children and adolescents, UNGKOST-2000 (Øverby & Andersen, 2002). A study conducted by Lillegaard, Øvreby, and Andersen (2005) shows that photographs of food can be a suitable tool for estimating portion sizes amongst 9- 19 year olds. In this study they observed that when food and portion size differed from the presented photograph, 48% chose the correct photograph. In cases where the photograph was exactly the same as the food presented to the participants, 82% chose the correct photograph. Some of the food-items in the web-based food diary in this present study lack corresponding images of the portion size. In these cases, pictures of other food items are presented. For example, there is a picture of liver pate used to describe other spreadable toppings, like mackerel in tomato sauce, chocolate spread, and spreadable cheeses. Most photographs used to represent portion sizes of fruits, berries and vegetables in this present study were photographs of the current food item and thus this is not believed to have affected the results. However, it may be that the participants had difficulty in choosing the right portion size if the image presents the food item in another form, e.g. paprika presented in the form of stick slices might have been difficult to compare to the right size if the participant ate rings of paprika instead.

Further, fruits and vegetables can vary in size. The portion sizes in the web-based food diary correlates to standard amounts, and the amount reported may therefore be incorrect in relation to the actual amount eaten. Paprika is represented by four alternative images of portion sizes

and the difference in β -carotene between the four portion sizes is as followed: 99 mcg, 231 mcg, 468.6 mcg and 699.6 mcg. If a participant chose an image that was adjacent to the correct portion size, the β -carotene difference between these portion sizes could have a considerable effect on the results.

To improve the accuracy of self-reported intake of fruits, berries and vegetables amongst participants in the Ungkost-3 survey, it could have been useful to give the participants a short training in registration; especially focusing on portion-size estimations in the web-based food diary to help increase the accuracy of reporting. Weber et al. (1999), found that a 45 min training session significantly improved the ability to estimate portion sizes amongst 9-10 year olds. Studies with adults have also shown that training in estimating portion-sizes may reduce estimation errors (Bolland, Yuhas, & Bolland, 1988; Yuhas, Bolland, & Bolland, 1989).

The importance of registration of all fruits, berries and vegetables must be especially emphasized to the participants without weakening the accuracy of reporting the whole diet. In the present study, we observed that some students took notes of what they ate during the school lunch period. It could be useful to provide all participants with note pads with instruction to take notes of what they eat as a part of the study design in Ungkost-3, to improve the recall memory of the participants.

6.1.4 The usability of the reference method

When applying biomarkers to validate a dietary assessment tool, it is important to clarify what the biomarker measures and possible sources of error related to the method. There are many factors that can affect the usability of biological markers (Jenab et al., 2009). Cade et al. (2002), defines three main factors that may be a source of error that should be taken into consideration when comparing a dietary assessment tool to biomarkers of dietary intake: The ability of the biological reference method to assess absolute true intake, individual differences related to metabolism and bioavailability, and the biochemical analysis.

Variations between the biomarker and true intake

As carotenoids cannot be synthesized in humans, plasma levels of carotenoids in the blood may be used to predict approximate dietary intake of fruit and vegetables (Bates et al., 2005).

A biomarker of intake does not measure the same thing as a dietary assessment method. However, the errors associated with the biochemical measure are independent from those of a dietary assessment method (Cade et al., 2002).

In this study, the relationship between self-reported intake of fruit, berries and vegetables and plasma concentrations of carotenoids in blood were mainly investigated through correlation coefficients. In a review of development, validation and utilization of a FFQ done by Cade and colleagues (2002), it is stated that the use of correlation coefficients is the most common method for assessing validity and was used in 83 % of the validation studies included in the review. However, it is also emphasized that this statistical method only measures the degree of relationship between two methods and not the agreement (Cade et al., 2002). Therefore, it is important to acknowledge that the use of the correlation coefficient in this present study reflects the relationship between the self-reported intake of fruit, berries and vegetables and plasma concentration of carotenoids and this is not the same as the relationship between self-reported intake of fruit, berries and vegetables and the absolute true dietary intake.

Individual differences related to metabolism and bioavailability

In this study, plasma concentrations carotenoids were compared to dietary variables of fruit, berries and vegetables intake from the web-based food diary. This has been done in several other studies (Al-Delaimy et al., 2005; Campbell et al., 1994; Carlsen et al., 2011). Because plasma concentrations of carotenoids are compared to grams of intake-, and not dietary estimates of nutrient intake, the observed correlation coefficients found in this present study is not influenced by inaccuracies that can exist in a nutrient database for carotenoids.

Nevertheless, both the content and bioavailability of carotenoids in different fruits, berries and vegetables may vary due to factors such as degree of maturity, storage, and harvest conditions (Maiani et al., 2009), e.g. the amount of carotenoids may be different in two oranges if they have been grown in different places. This may result in variations in plasma levels of carotenoids between individuals who have eaten the same amount of oranges, if e.g. the oranges they ate came from different countries.

Both dietary fat and cooking methods such as boiling, heating and chopping may increase the bioavailability in fruit and vegetables (Stahl & Sies, 1992; Van Dam & Hunter, 2013; van het Hof et al., 2000). The design of this present study does not permit assumptions regarding

these issues. In this study, dietary intake is based primarily on fresh, frozen and conserved fruit, berries and vegetables. Carrots are included as both raw and boiled. However, the reported intake of all fruit, berries and vegetables is defined by g/day and not by estimated carotenoid content because a database does not exist on the carotenoid content of Norwegian or Nordic foods. Further, the amount of dietary fat is not included in the analysis. As a result, the level of plasma carotenoid concentrations amongst the participants may be affected by the amount of dietary fat in the diet and cooking methods. This may be a source of error in this study. It might also be a possible reason for the low correlations found in this present study.

Including factors such as concentrations of cholesterol and triglycerides have been suggested to improve the usability of blood concentrations of carotenoids as biomarkers of fruit and vegetable intake (Van Dam & Hunter, 2013). This was not done in the present study. In a study where the investigation focused on the usability of serum concentrations of carotenoids as a biological marker of fruit and vegetable intake in women participating in the New York Woman's Health Study, it was adjusted for serum cholesterol and triglyceride levels. However, these adjustments only increased the rank order correlation for dietary intake of vegetables slightly, and the authors state that these adjustments may therefore not be necessary (Van Kappel et al., 2001).

Collection of blood samples and biochemical analysis

It has been argued by others that measurements of carotenoids in human plasma from a single blood sample might not be good enough to categorize individuals by dietary intake (Tangney et al., 1987). Cantilena and co-workers emphasizes that multiple serum samples are preferred to increase the significance of seasonal variations. However, as the data collection period in this validation study was short and the participants registered their food intake for four consecutive days, the collection of multiple samples to account for seasonal variation was not possible. In relation to diurnal variation, all blood samples were drawn between 0800 and 1400, which is considered to be a sufficient precaution to avoid day to day variations in carotenoid concentrations (Cantilena et al., 1992).

Both the sampling and treatment of the samples was carried out according to a strict protocol and this is one of the strengths in this study. The blood samples were collected within one-two weeks after the registration period. Others have observed that blood samples collected close to

the registration period may increase the associations between intake and the biomarker (Andersen et al., 2005). To ensure the accuracy of biological markers, precautions were taken - the samples were stored in a dark container, allowing no sunlight to come in contact with the samples to destroy the carotenoid. Further, both storage and analysis were carried out according to established methods.

Plasma concentration of carotenoids compared to other studies

A part of the quality control of the data in this study was to evaluate whether the results of blood analyses were within normal range. This was done by comparing the results to other studies. The individual plasma carotenoid concentrations found in this study are comparable or greater than the plasma or serum concentrations found in other studies conducted on children and adolescents (Burrows, Warren, Colyvas, Garg, & Collins, 2009; Ford, Gillespie, Ballew, Sowell, & Mannino, 2002; Neuhouser et al., 2001).

6.2 Discussion of results

In general, this master thesis demonstrated weak to moderate correlation coefficients when ranking participants according to self-reported dietary intake of FB, V and FBV. Significant positive correlation coefficients ranged from 0.17 to 0.36, when comparing self-reported intake of FB, V and FBV to plasma concentrations of carotenoids. Significant correlation coefficients were found to be ranging from 0.12 to 0.40, when comparing high carotenoid foods to plasma concentrations of corresponding carotenoids.

6.2.1 Ranking of participants according to self-reported intake of FBV

When evaluating the reported intake of total FBV with plasma concentrations of carotenoids, it was found that the web-based food diary capability to rank individuals according to reported FBV intake was small to moderate. Significant Spearman's correlation coefficients ranging from 0.17 to 0.36 between self-reported intake of FBV and total plasma concentrations of carotenoid as well as single carotenoids; Lutein, β -cryptoxanthin, α -

carotene and β -carotene. The correlation coefficient between self-reported FBV and total plasma concentrations of carotenoids were significant, but quite low ($r=0.17$).

Previous studies have investigated the relationship between estimates of the intake of fruit and vegetables and plasma concentrations of carotenoids in adults, and found similar correlation coefficients. In a study where they validated intakes of fruit, juice and vegetables from an FFQ in Norwegian adults, by using carotenoid and flavonoid biomarkers and the method of triads, there were found a partial correlation coefficients of 0.28 between total plasma concentrations carotenoids and dietary intake of fruit, juice and vegetables from a FFQ, in a sub study. This correlation coefficient was adjusted for BMI (Carlsen et al., 2011). In a study to validate the intake of carotenoids, fruits and vegetables estimated by a Food Frequency Questionnaire for adolescents (FFQA) amongst fifth and eighth graders, using the method of triads, the partial correlation coefficients found between the intakes of fruit and vegetables estimated by the FFQA and serum β -carotene levels were 0.24 (Slater, Enes, Lopez, Damasceno, & Voci, 2010).

However, the correlation coefficients in this study were lower compared with an evaluation study done by Biltof-Jensen and co-workers on a web-based dietary assessment software for children. Here, they found a Spearman's correlation coefficient of 0.58 and a partial correlation coefficient, adjusted for sex, BMI and energy expenditure, of 0.49 between estimated carotenoid intake from fruit, juice and vegetables and total plasma carotenoid concentration. In this study, they used an American database of the carotenoid content in US foods to estimate the carotenoid intake for each individual, by pairing all reported food to their carotenoid content. Thus, the authors highlights that the content in Danish or Nordic foods was not accurately reflected in the study (Biltoft-Jensen et al., 2013). However, the correlation coefficient found by Biltof-Jensen et al (2013) is not directly comparable to the correlation coefficients in this present study, because the present study compares plasma concentrations of carotenoids to grams of intake and not estimates of carotenoid intake.

In the literature, the level of agreement between self-reported dietary intake and plasma concentration of carotenoids is described as limited to their associations, often as correlations. When validating a dietary assessment method, these correlations can be used as an estimate of the lower limit of the validity (Kaaks, 1997). However, these correlation coefficients are

expected to be below 0.6 (Crispim et al., 2011; Jenab et al., 2009). Others implies that the observed correlation coefficients may be <0.4 (Kaaks, 1997). Still, a correlation coefficient lower than 0.3 is suggested as too low to detect a respectable relationship between the test- and the reference method (Cade et al., 2002).

When comparing groups of participants, it was found that those who had high concentrations of total plasma carotenoids also reported a higher amount of FBV versus those who had low concentration of total plasma carotenoids in this present study. In another study, where they assessed if plasma concentrations differed in populations that consumed high and low amounts of mixed fruit and vegetables, they observed statistical differences in plasma carotenoids between groups of participants with high and low intake of fruit and vegetables (Campbell et al., 1994).

Additionally, 68 % of the participants fell into the same or adjacent quartiles when classified by self-reported intake of total FBV and total plasma concentrations of carotenoids, and 9 % were highly misclassified into the opposite quartile. For self-reported intake of FBV and single plasma carotenoids the percentage of participants who fell into the same and adjacent quartile ranged from 60- 74 %, and the percentage that were strongly misclassified ranges from 5-12 %. The best results were found between participants' self-reported intake of FBV and single plasma concentration of α -carotene, where 74 % fell into the same and adjacent quartile and 5 % were grossly misclassified. These results were not as good, compared to the study done by Biltof-Jensen and co-workers, where 82 % were classified into the correct or adjacent quartile, 17 % were misclassified and 1 % was grossly misclassified, when cross-classified by fruit, juice and vegetable intake and total plasma carotenoid concentrations (Biltoft-Jensen et al., 2013). Further, others have rated a grossly misclassification level of 9-17 % as relatively high (Andersen, Bere, et al., 2004).

However, these results imply that the method in the present study can distinguish between high and low intakes of total FBV, according to total plasma concentrations of carotenoids, and that the method to some extent can classify the participants according to quartiles of intake of total FBV, according to total plasma concentrations of carotenoids. Compared to the correlation coefficient, the results from the Mann-Whitney U-test and the cross-classification

add an important additional indication of the quality and ability of the web-based food diary to measure dietary intake.

6.2.2 Ranking of participants according to self-reported intake of FB

The self-reported intake of FB compared with plasma concentrations of carotenoids was found to have the lowest amounts of significant correlation coefficients compared to the results found for FBV and V. Additionally, no significant correlation coefficient was found between self-reported intake of FB and total plasma concentration of carotenoids.

Self-reported intake of FB had a correlation coefficient of 0.24 with plasma α -carotene and 0.22 with plasma β -cryptoxanthin. Citrus fruits such as orange and orange juice are a major source of β -cryptoxanthin in the diet (Maiani et al., 2009; O'Neill et al., 2001). The correlation coefficient found between self-reported FB intake and plasma concentrations of β -cryptoxanthin is consistent with results of other studies and it might show that β -cryptoxanthin can be used as a mark of dietary intake of fruit (Block, 2001; Brevik et al., 2004; Campbell et al., 1994; Jansen et al., 2004).

There was not observed a significant correlation coefficient between self-reported intake of FB and plasma concentrations of lutein and β -carotene. Good sources to lutein in the human diet consist primarily of vegetables such as broccoli, leek, peas, red peppers and spinach. Additionally, vegetables such as avocado, broccoli, raw and boiled carrots, leeks, red peppers, spinach, tomatoes and cherry tomatoes are good sources of β -carotene in the human diet (Maiani et al., 2009). This could be an explanation for why there was no significant observed correlation coefficient between self-reported V intake and plasma concentrations of lutein and β -carotene.

Although the highest amounts of lutein and β -carotene are found in vegetables, there are several fruits that contain a smaller amount of both of these carotenoids, e.g. commonly consumed fruits such as bananas contain both lutein and β -carotene. There have been studies that have investigated the absorption of lutein and β -carotene, when given in combined oral doses to adults, indicating that carotenoids interact with each other throughout the absorption and metabolic process. Kostic, White, and Olson (1995), found that lutein affected the

absorption of β -carotene negatively, when given in a combined dose. This was also supported in another study (van den Berg & van Vliet, 1998). This could imply that fruits containing lutein and β -carotene, such as bananas, could have affected the correlation coefficients between self-reported intake of FB and plasma concentrations lutein and β -carotene in this present study.

An inverse non-significant correlation coefficient was also found for plasma concentrations of lycopene and self-reported intake of FB. Others have found that lycopene levels were well predicted by tomato intake in adult men and women (Al-Delaimy et al., 2005). The lack of a significant correlation coefficient between self-reported intake of FB and plasma concentrations of lycopene may therefore reflect that specific plasma carotenoids can be appropriate biomarkers of particular fruits and vegetables. This argument may also apply to the lack of a significant correlation coefficient between self-reported intake of FB and plasma concentrations of zeaxanthin, as zeaxanthin is mainly found in red peppers (Maiani et al., 2009).

By comparing groups of participants, it was found that those with high levels of total plasma carotenoid concentrations also reported a statistically significant higher amount of FB, versus those who had low levels of total plasma concentrations of carotenoids. These results imply that the method in the present study can distinguish between high and low intakes of FB, according to total plasma concentrations of carotenoids.

Additionally, the method, to some extent, can classify the participants according to quartiles of intake of FB, according to total plasma concentrations of carotenoids, as 66 % of the participants fell into the same or adjacent quartiles when classified by self-reported FB and total plasma concentrations of carotenoids. This result is similar compared to the one in which participants were classified according to quartiles of intake of FBV, according to total plasma concentrations of carotenoids in this present study. Further, 10 % were grossly misclassified into the opposite quartile. Self-reported intake of FB had the highest percentage of participants who were grossly misclassified into the opposite quartile, compared to self-reported intake of V and FBV. This, in combination with the lowest amount of significant correlation coefficients for the self-reported intake of FB, may indicate a low accuracy in the reporting of FB in this present study. To the author's knowledge no studies have yet

compared quartiles of intake of FB, according to plasma carotenoids, or evaluated if subjects with high and low levels of plasma concentrations of carotenoids differs in terms of self-reported intake of FB, in children and adolescent. This is of interest for future research.

6.2.3 Ranking of participants according to self-reported intake of V

When evaluating the self-reported intake of V with plasma concentrations of carotenoids, it was found that the web-based food diary capability to rank individuals according to self-reported V intake was small to moderate, with significant Spearman's correlation coefficient ranging from 0.19 to 0.36. The correlation coefficient between self-reported V and total plasma concentrations of carotenoids were significant, but quite low ($r=0.19$). The highest correlation coefficient between self-reported intake of V and plasma carotenoids were observed between self-reported intake of V and plasma concentrations of α -carotene. A possible reason for this might be that carrots, a vegetable commonly consumed in Norway, are a good source of α -carotene,

Further, a non-significant inverse correlation coefficient between self-reported intake of V and plasma concentrations of lycopene was also found. This inverse correlation between self-reported intake of V and plasma concentrations of lycopene were also observed in the study done by Biltoft-Jensen and co-workers (2013). The non-significant inverse correlation coefficient between self-reported intake of V and plasma concentrations of lycopene could have several explanations. In a study where plasma carotenoid response was determined by a controlled diet high in fruits and vegetable amongst adult men and woman, they found that plasma concentrations of lycopene increased significantly after consumption of high lycopene foods after 6 days. This may indicate that plasma lycopene can be used as a marker of short-term intake (Yeum et al., 1996). However, the major sources of lycopene in the controlled diet in that study were vegetable juice and tomato sauce. Additionally, lycopene seems to be present mainly in tomatoes, as well as in tomato-products: tomato puree, ketchup, tomato soup powder are also high in lycopene (Maiani et al., 2009). These items were not included in the variable for self-reported V intake in this present study and this could have influenced the results, because plasma concentrations of lycopene are compared against a variety of vegetables that may not be high in lycopene. With this argument in mind, self-reported intake of V showed a significant correlation coefficient of 0.22 with plasma concentrations of β -

carotene in this study, and compared to lycopene, β -carotene is present in a range of fruits and vegetables (Maiani et al., 2009).

Further, plasma lycopene showed a consistently non-significant inverse correlation with the dietary intake variables of self-reported intake of FB, V and total FBV. It has been suggested that the sum of carotenoids may have a stronger correlation coefficient with total fruit and vegetable consumption if the single carotenoid lycopene is not included. This is due to that lycopene is likely to have a higher concentration in plasma than other carotenoids (Jansen et al., 2004). In this study plasma level of lycopene was found to have a higher median concentration level than the other carotenoids included.

There were found no significant correlation coefficients between self-reported intake of V and plasma concentrations of β -cryptoxanthin or zeaxanthin. Similar observations were done in the sub-study referred to earlier in the discussion, where they validated intakes of fruit, juice and vegetables from an FFQ in Norwegian adults, using carotenoid and flavonoid biomarkers and the method of triads (Carlsen et al., 2011). In that study they found no significant correlations between intake of vegetable from an FFQ and plasma concentrations of β -cryptoxanthin or zeaxanthin. The lack of correlation between self-reported intake of V and plasma concentrations of β -cryptoxanthin may possibly be explained by the fact that β -cryptoxanthin can be used as a mark of dietary intake of fruit, as discussed previously. Further, zeaxanthin seems to be found in fewer types of vegetables than other carotenoids, and is found mainly in red peppers (Maiani et al., 2009). This could result in a narrower dietary intake of zeaxanthin amongst the participants and could possibly explain some of the lack of significant correlation coefficients between self-reported intake of V and plasma concentrations of zeaxanthin. It is possible that a larger sample could lead to better results in this case.

In this present study, self-reported intake of V had a higher number of significant correlation coefficient with plasma carotenoid concentrations than self-reported intake of FB. This might reflect that reporting of V was more accurate than the reporting of FB. It may also indicate that the bioavailability of the included vegetables was higher compared to the included fruits and berries in this study.

When comparing groups of participants, it was found that those who had high levels of total plasma concentrations of carotenoids also reported a significant higher amount of V, versus those who had low levels of total of plasma concentrations of carotenoids. These results imply that the method in the present study can separate between high and low intakes of V, according to total plasma concentrations of carotenoids. Further, 68 % of the participants fell into the same or adjacent quartiles when classified by self-reported V and total plasma concentrations of carotenoid. The amount that was grossly misclassified into the opposite quartile were 8 %, this is 1 % lower than for the participants who were grossly misclassified into the opposite quartile when classified by self-reported intake of FBV and total plasma carotenoid concentrations. As with FB, no studies on children and adolescents have yet compared quartiles of intake of V, according to plasma carotenoids, or evaluated if subjects with high and low levels of plasma concentrations of carotenoids differs in terms of self-reported intake of V, to the author's knowledge. This is of interest for future research.

6.2.4 Ranking of participants according to self-reported intake of high carotenoid foods

In the present study, self-reported high carotenoid foods were also compared to plasma concentrations of corresponding single carotenoids. Here, carotenoid content in foods was based on values of carotenoid content from a review on the main dietary sources of carotenoid in Europe, supplemented by an American database of carotenoid content of US foods (Holden et al., 1999; Maiani et al., 2009)

Statistical significant correlations coefficients found between plasma concentrations of single carotenoids; β -cryptoxanthin, α -carotene, β -carotene and lycopene and self-reported intake of corresponding high carotenoid foods were found to be low to moderate, ranging from 0.12-0.40. Three out of six high carotenoid food groups had correlation coefficients of ≥ 0.3 with plasma concentrations of corresponding single carotenoids. Others have done similar findings. Campbell et al. (1994), compared foods with high carotenoid content to plasma concentrations of corresponding single carotenoids and found correlation coefficients ranging from 0.11 to 0.46, amongst American adult men and women in a cross sectional study.

Overall, the plasma concentrations of single carotenoids had stronger correlation coefficients with the corresponding high carotenoid food groups than with the dietary intake variables of self-reported intake of FB, V and FBV. This may reflect the fact that different fruit, berries and vegetables generally contains different amounts of single carotenoids, and that several fruits, berries and vegetables contain more than one type of single carotenoids. For example, carrots contain high amounts of both α -carotene and β -carotene (Holden et al., 1999), whereof the level of α -carotene is found to be between 2840-4960 $\mu\text{g}/100\text{g}$ and the level of β -carotene is 4350- 8840 $\mu\text{g}/100$ gram (Maiani et al., 2009). The moderate correlation coefficient observed in this study between plasma concentrations of single α -carotene and self-reported intake of high β -carotene foods ($r=0.45$) may be explained by the fact that both the high α -carotene foods and the high β -carotene foods included carrots. High correlations between plasma concentrations of α -carotene and β -carotene rich foods have also been observed by others (Campbell et al., 1994).

Self-reported intake of high lycopene foods showed a low significant positive correlation coefficient with corresponding plasma concentrations of lycopene ($r= 0.13$). In this present study, the variable of high lycopene foods included tomatoes, cherry tomatoes, hermetical tomatoes, watermelon, in addition to tomato-products such as tomato puree, ketchup, and tomato soup powder. Compared to the non-significant inverse correlation coefficient observed between self-reported intake of V and plasma concentrations of lycopene, whereof the variable for V did not include tomato-products such as tomato puree, ketchup, and tomato soup powder; this may be a possible explanation for the significant correlation coefficient found between plasma lycopene and high lycopene foods.

However, other foods such as pizza are also good sources of lycopene in the diet (Holden et al., 1999), and therefore consumption of other lycopene rich foods may have increased plasma concentrations of lycopene. The fact that lycopene rich foods, such as pizza, were not included in the analyses, could be a possible explanation for the low correlation found between plasma lycopene and lycopene-rich foods. Intake of fruit and vegetables is often seen as a part of a healthy eating pattern, where the intake of healthy foods may lead to a lower intake of unhealthy foods (Van Kappel et al., 2001). Thus, it could be argued that the intake of e.g. pizza does not necessarily go hand in hand with a high intake of healthy, lycopene rich vegetables, such as tomatoes.

Additionally, lycopene is considered to be highly affected by cooking and processing methods that affect the bioavailability (Giovannucci et al., 1995; Stahl & Sies, 1992). This may be another possible explanation for the low correlation coefficient found between plasma lycopene and high lycopene foods.

Further, significant differences were shown for high versus low levels of plasma concentrations of β -cryptoxanthin, α -carotene and β -carotene in relation to self-reported intake of corresponding high β -cryptoxanthin foods, high α -carotene foods and high β -carotene foods. This was not the case for high versus low levels of plasma concentrations of lycopene, zeaxanthin or lutein in relation to corresponding high lycopene foods, high zeaxanthin foods, or high lutein foods. For the high zeaxanthin foods and high lutein foods, these results are consistent with the non-significant correlation coefficients found between high zeaxanthin foods and high lutein foods with corresponding plasma concentrations of carotenoids.

6.2.5 Body weight related to reporting of dietary intake of fruits, berries and vegetables

In this study, some differences were found in the correlation coefficients between normal weight and overweight participants, but only a few of these differences were significant. A statistically significant difference was only found between the groups according to self-reported intake of FB and plasma concentrations of single carotenoid zeaxanthin ($p=0.02$) and self-reported intake of V and plasma concentrations of single carotenoid lycopene ($p=0.01$). In both these cases, overweight participants had a significant inverse correlation coefficient while positive non-significant correlations were observed for the normal weight participants. Further, there was found a significant difference between the two weight groups regarding the observed correlation between high zeaxanthin foods and plasma concentrations of zeaxanthin ($p=0.02$) and between high lycopene foods and plasma concentrations of lycopene ($p= 0.01$).

In a study conducted by Andersen and co-workers (2006) , the association between BMI and the serum concentration of α -carotene, β -carotene, β -cryptoxanthin, zeaxanthin/lutein, and lycopene in adults was examined in The CARDIA-study. The results from this study indicated that there exists a strong inverse relationship between BMI and the five measured serum

carotenoids, except for serum lycopene. The authors points out that a one of the possible reasons for why lycopene acts differently than the other carotenoids is related to that lycopene is highly fat-soluble and may be taken up in adipose tissue more easily in individuals with a high fat mass. This could lead to a smaller impact of dietary intake of lycopene, and perhaps other carotenoids, on blood values (Andersen et al., 2006).

However, the results in this present study do not provide any clear indications on whether weight status affects the reporting of fruits, berries and vegetables and the small differences observed could be due to within-person variation or due to the low number of participants classified as overweight. Thus, the findings are not clear enough to draw any conclusions that can imply that weight status affects the reporting of fruits, berries and vegetables in the web-based food diary. A larger sample size of participants classified as overweight might have found stronger results.

6.2.6 Parental education related to reporting dietary intake of FBV

Statistical analyzes carried out on the differences in the groups defined by parental education level, also show small differences in the accuracy of reported intake between groups.

The correlation coefficient between self-reported intake of FB and plasma lutein ($p=0.04$), plasma zeaxanthin ($p<0.001$) and plasma β -cryptoxanthin ($p=0.004$) were significantly different between the two education groups. For total self-reported intake of FBV and plasma concentrations of carotenoids, the differences in correlation coefficients between the two education groups were only significant for plasma zeaxanthin ($p<0.001$). Additionally, a significant difference was found between the two education groups regarding the correlation coefficient between high β -cryptoxanthin foods and plasma levels of β -cryptoxanthin ($p=0.05$).

Other studies have adjusted the partial correlation for parental education level (Biltoft-Jensen et al., 2013). However, data on the effect of parental education level on the accuracy of self-reporting of fruit, berries and vegetables amongst children and adolescents in the literature are limited. Horner et al. (2002), reported that in adult women with lower levels of education report their dietary energy intake with more precision than those with higher education.

However, in this present study, the findings are not clear enough to draw any conclusions that can imply the web-based food diary requires a high degree of parental education level. As with the analysis on the normal and overweight participants, the small sample size of the low parental education level group may have limited the analysis. Thus, additional studies with a larger sample size of the low parental education level group would be required to draw any conclusions that can imply that the web-based food diary requires a high degree of parental education level, regarding the reporting of fruits, berries and vegetables in the web-based food diary.

6.3 Ethical concerns

This master thesis is part of a larger evaluation-study, which will be conducted according to the Helsinki Declaration guidelines, and was approved by The Norwegian Social Science Data Services (NSD). It is the University of Oslo (UiO) Department of Nutrition which is responsible for this study, where professor Lene Frost Andersen at the University is responsible for data processing. The Regional Ethics Committee for Medical Research (REK) has stated that the project will not need the committee's approval.

In the study we collected data on the students' diet, weight, height, age and blood test results. Furthermore, there were recorded data on parental education. All information was treated confidentially and was stored de-identified, i.e. using a code, and not the name or other identifying information that could be linked to the individual children. Blood samples and the list of names will be destroyed at the end of the overall project 04.03.2019.

7.0 Conclusion

The purpose of the study is to evaluate how valid the web-based food diary is in ranking individuals according to self-reported intake of fruits, berries and vegetables (FBV), by using plasma concentrations of carotenoids as an objective reference to the subject's true intake. Further, to investigate if the capability of ranking differs significantly between participants' when considering weight status and parents' education level.

Self-reported intake of FB, V and FBV from the web based food diary was found to be significantly correlated with plasma concentrations of carotenoids, but correlation coefficients were low to moderate. There was found significant positive correlation coefficients between self-reported intake of FBV and total plasma concentrations of carotenoid as well as single carotenoids; Lutein, β -cryptoxanthin, α -carotene and β -carotene. Significant positive correlation coefficients were found between self-reported FB and single plasma carotenoids β -cryptoxanthin and α -carotene, but self-reported FB did not show a significant correlation coefficient with total plasma concentrations of carotenoids. Self-reported V correlated significantly with total plasma concentrations of carotenoids, as well as single carotenoids; Lutein, α -carotene and β -carotene. Further, significant positive correlation coefficients were found between plasma concentrations of single carotenoids; β -cryptoxanthin, α -carotene, β -carotene and lycopene and self-reported intake of corresponding high carotenoid foods.

Participants with high versus low levels of total plasma concentrations of carotenoids differed significantly in terms of self-reported intake of FB, V and FBV. Participants with high versus low levels of single plasma concentrations of β -cryptoxanthin, α -carotene and β -carotene differed significantly in terms of corresponding high carotenoid foods.

Moreover, the results in this present study implies that the web-based food diary, to some extent, can accurately classify the participants by quartiles of intake according to self-reported intake of FB, V and FBV and quartiles of total plasma concentrations of carotenoids, as well as FBV and single plasma carotenoids; lutein, zeaxanthin, β -cryptoxanthin, α -carotene, β -carotene and lycopene.

Thus, the results from this present study imply that the web-based food diary has a low to moderate validity when ranking individuals according to self-reported intake of FB, V and FBV, by using plasma concentrations of carotenoids as an objective reference to the subject's true intake.

Regarding to participants weight status and parental education there were some small differences found in the correlation coefficients between the self-reported intake of FB, V and FBV and plasma concentrations of carotenoids. However, the findings were not clear enough to draw any conclusions that can imply that the capability of ranking differs significantly between participants' when considering weight status and parents' education level.

Finally, the web-based food diary is designed to assess total self-reported dietary intake of the whole diet amongst children and adolescents. The results of this present study is aimed to evaluate self-reported intake of fruits, berries and vegetables and should therefore be viewed in conjunction with the other reference methods included in the main validation study in order to assess the overall validity of the web-based food diary.

8.0 Future perspectives and suggestions for the implementation of Ungkost-3

National diet surveys that provide information about how much fruits, berries and vegetables people eat provide an important overview of what needs to be implemented into the national health promotion. For instance, it can serve as an important argument for health promotion implementations, such as the provision of fruit and vegetables in schools. As of today, we do not have enough knowledge on the dietary habits of Norwegian children and adolescents. Therefore, it is crucial to gain knowledge of both positive and negative current trends in the diet of children and adolescents in relation to daily intake of fruit, berries and vegetables.

The following suggestions are formulated based on the experiences and results from this master thesis and may contribute to improve the accuracy of self-reported fruit, berries and vegetable intake amongst participants in the Ungkost-3 survey.

There should be a number of project staff that travels around to the participating schools to inform about the survey, specify the importance of collecting dietary data, and to be available to answer questions. Further, the project staff should demonstrate how to register in the web-based food diary to give the participants a short training in registration, especially focusing on portion-size estimations, in the web-based food diary. The importance of registration of all FBV must be emphasized to the participants, without weakening the accuracy of reporting the whole diet. A way to increase the memory of the participants could be to provide all participants with note pads and instruct them to take notes of what they eat throughout the day. This may increase the accuracy of reporting.

A form of reward for the participants should also be offered in the main study. Further, it is of high importance to create and maintain a good relationship with both the school administration and teachers in the school classes included in the main study, as their involvement can have a positive effect on the students' motivation and relationship to the study.

9.0 References

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10.0 Appendices

Appendix 1: Request for participation to the school principal, 4th grade

Appendix 2: Request for participation to the school principal, 8th grade

Appendix 3: Information letter to parents, 4th grade

Appendix 4: Information letter to parents, 8th grade

Appendix 5: Consent form

Appendix 6: Instructional letter to participants

Appendix 7: Welcome e-mail

Appendix 8: “Thank you for participating” e-mail

Appendix 1: Request for participation to the school principal, 4th grade

UiO : **Institutt for medisinske basalfag**
Det medisinske fakultet

Til rektor



Gaustad, 15. april 2013

Forespørsel om deltakelse i forskningsprosjekt

Vi viser til hyggelig samtale på telefon **dato/navn** og vil gjerne presentere forskningsprosjektet nærmere.

Forskning har vist at kostholdet en tilegner seg i barne- og ungdomsårene ofte følger en inn i voksen alder og kan ha stor betydning for helse og sykdom senere i livet. Kartlegging av hva vi spiser er derfor viktig. Universitetet i Oslo har i samarbeid med Danmarks Tekniske Universitet utviklet en ny matdagbok på internett for å registrere hva vi spiser og drikker. Matdagboken skal brukes i den neste landsdekkende kostholdsundersøkelsen blant barn og ungdom i Norge (UNGKOST). Før vi kan ta matdagboken i bruk, må vi finne ut hvor god den er. Dette vil vi undersøke i forskningsstudien. Forskningsgruppen vår ved Universitetet i Oslo har mange års erfaring fra forskning på dette feltet.

UNGKOST-undersøkelsene brukes av Helsedirektoratet for å videreutvikle mat- og ernæringspolitikken i Norge. Skolen og elevenes deltagelse i prosjektet vil gi viktige bidrag til dette. Elevene vil også få innsikt i hvordan et forskningsprosjekt gjennomføres i praksis, noe som vil kunne dekke deler av Kunnskapsløftets kompetansemål «Forskerspiren» i naturfag for 4. trinn.

Vi inviterer herved din skole til å delta i dette prosjektet. For en mer detaljert beskrivelse av prosjektet og hva deltakelse innebærer, se vedlagt informasjon. Vi ber om tilbakemelding så snart som mulig og senest innen ___dag XX.XX.13 om hvorvidt din skole ønsker å delta. Vennligst bruk vedlagt svarslipp. For videre organisering, vil vi gjerne også ha kontaktinformasjon til kontaktlærere på 4. klasstrinn.

Vi håper på et positivt svar, og ser frem til å høre fra dere.

Med vennlig hilsen,

Sign.

Lene Frost Andersen, professor
Prosjektansvarlig

Sign.

Anine Medin, stipendiat
Prosjektkoordinator

UiO : Institutt for medisinske basalfag

Det medisinske fakultet

Praktisk gjennomføring av forskningsprosjektet

Vi vil bruke tre referansemetoder for å evaluere matdagboken:

- Måling av aktivitet med aktivitetsmåler: Elevene skal ha på seg en liten brikke som registrerer all aktivitet i totalt 7 dager.
- Observasjon i lunsjmåltidet på skolen: Hva elevene spiser vil bli observert av forskere i lunsjpausen på skolen og sammenliknes med hva elevene registrerer i matdagboken.
- Mini-blodprøve ved stikk i fingeren: Innholdet av stoffer som kommer fra matvarer som er spist eller drukket skal måles i elevenes blod.

Dataene fra matdagboken skal sammenliknes med målingen av markørene, aktivitetsmålerdata og informasjonen fra observasjonen av skolemåltidene for å vurdere hvor godt de samsvarer.

Hva vil vi be skolen om ved deltakelse i prosjektet?

Erfaringer fra tidligere studier har vist oss at den beste måten å nå ut til barn og ungdom er gjennom skolen de går på. Hvis din skole sier ja til å delta i prosjektet vil vi derfor gjerne be om lov til å gjøre følgende:

1. Bruke ranselposten til å gi elevene i 4. klasse en individuell forespørsel om å være med i prosjektet. Se informasjonsskriv til foresatte, vedlegg 1. Det skriftlige materialet vil bli sendt til dere, vi vil bare be om at dere viderefremidler til og fra elever/foresatte i ranselposten.
2. Komme til skolen i løpet av en periode på 2 uker for å:
 - a. Informere de av elevene som har sagt ja til å delta i studien hvordan de skal bruke matdagboken og en aktivitetsmåler.
Tidsbruk: Vi må regne 1-2 skoletimer til dette, avhengig av hvor stor klassen er.
 - b. Observere de elevene som har sagt ja til studien i matpausen 4 dager på rad. Våre prosjektmedarbeidere vil kun være tilstede i forbindelse med matpausen.
Tidsbruk: Dette skal ikke påvirke undervisningen eller ta tid fra dere.
 - c. Måle vekt og høyde, samt ta en mini-blodprøve av de elevene som har sagt ja til å delta i studien. Mini-blodprøven vil bli tatt ved hjelp av et lite stikk i fingertuppen og overføring av noen bloddråper til et spesielt prøvepapir. Vi trenger tilgang til et ledig rom ved skolen til dette. Vi har prosjektmedarbeidere som skal gjøre blodprøvetakingen.
Tidsbruk: Elevene som deltar i prosjektet vil enkeltvis bli tatt ut av undervisningen for prøvetaking. Dette tar omkring 10-15 min.

Økonomi, forsikring, godkjenning og ansvar

Prosjektet er tilrådd av Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste (NSD). Studien er finansiert gjennom forskningsmidler fra Universitetet i Oslo og Johan Throne Holst fond. Ingen av prosjektmedarbeidene har noen interessekonflikter i studien. Studien er forsikret gjennom pasientskadeloven. Professor Lene Frost Andersen ved Universitetet i Oslo er databehandlingsansvarlig

Mer informasjon?

Skulle det være behov for mer informasjon ta da gjerne kontakt med prosjektkoordinator og stipendiat Anine Medin, mobil: 474 63 893, epost: a.c.medin@medisin.uio.no



Institutt for medisinske basalfag
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Sognsvannsveien 9, 0372 Oslo

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E-post: a.c.medin@medisin.uio.no
www.med.uio.no/imb

UiO : Institutt for medisinske basalfag
Det medisinske fakultet

Svarslipp

Jeg har mottatt og lest informasjonen om forskningsprosjektet og gir mitt samtykke til at

..... skole

deltar i forskningsprosjektet «Matdagbok på nett for barn og ungdom».

Sted

Dato

Underskrift rektor

Navn, telefonnummer og e-post adresse til involverte lærere på skolen

Navn (blokkbokstaver)	Signatur	Telefon	E-post
1. Kontaktlærer 4.trinn			
2. Kontaktlærer 4.trinn			
3. Kontaktlærer 4.trinn			
4. Kontaktlærer 4.trinn			

Vennligst returner utfylt svarslipp senest innen ___dag XX.XX.13

Benytt en av følgende alternativer:

- Scanne og sende på e-post til: a.c.medin@medisin.uio.no
- Fakse til: 22 85 15 31
- Sende i post til: Anine Medin, Avdeling for ernæringsvitenskap,
Postboks 1046 Blindern, 0317 Oslo



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Appendix 2: Request for participation to the school principal, 8th grade

UiO : **Institutt for medisinske basalfag**
Det medisinske fakultet

Til rektor



Gaustad, 15. april 2013

Forespørsel om deltakelse i forskningsprosjekt

Vi viser til hyggelig samtale på telefon **dato/navn** og vil gjerne presentere forskningsprosjektet nærmere.

Forskning har vist at kostholdet en tilegner seg i barne- og ungdomsårene ofte følger en inn i voksen alder og kan ha stor betydning for helse og sykdom senere i livet. Kartlegging av hva vi spiser er derfor viktig. Universitetet i Oslo har i samarbeid med Danmarks Tekniske Universitet utviklet en ny matdagbok på internett for å registrere hva vi spiser og drikker. Matdagboken skal brukes i den neste landsdekkende kostholdsundersøkelsen blant barn og ungdom i Norge (UNGKOST). Før vi kan ta matdagboken i bruk, må vi finne ut hvor god den er. Dette vil vi undersøke i forskningsstudien. Forskningsgruppen vår ved Universitetet i Oslo har mange års erfaring fra forskning på dette feltet.

UNGKOST-undersøkelsene brukes av Helsedirektoratet for å videreutvikle mat- og ernæringspolitikken i Norge. Skolen og elevenes deltagelse i prosjektet vil gi viktige bidrag til dette. **Elevene vil også få innsikt i hvordan et forskningsprosjekt gjennomføres i praksis, noe som vil kunne dekke deler av Kunnskapsløftets kompetansemål «Forskerspiren» i naturfag for 8. trinn.**

Vi inviterer herved din skole til å delta i dette prosjektet. For en mer detaljert beskrivelse av prosjektet og hva deltakelse innebærer, se vedlagt informasjon. Vi ber om tilbakemelding så snart som mulig og **senest innen ___dag XX.XX.13** om hvorvidt din skole ønsker å delta. Vennligst bruk vedlagt svarslipp. For videre organisering, vil vi gjerne også ha kontaklinformasjon til kontaktlærere på 8. klasse trinn.

Vi håper på et positivt svar, og ser frem til å høre fra dere.

Med vennlig hilsen,

Sign.

Lene Frost Andersen, professor
Prosjektansvarlig

Sign.

Anine Medin, stipendiat
Prosjektkoordinator

UiO : Institutt for medisinske basalfag

Det medisinske fakultet

Praktisk gjennomføring av forskningsprosjektet

Vi vil bruke to referansemetoder for å evaluere matdagboken:

- o **Måling av aktivitet med aktivitetsmåler:** Elevene skal ha på seg en liten brikke som registrerer all aktivitet i totalt 7 dager.
- o **Mini-blodprøve ved stikk i fingeren:** Innholdet av stoffer som kommer fra matvarer som er spist eller drukket skal måles i elevenes blod.

Dataene fra matdagboken skal sammenliknes med målingen av markørene, aktivitetsmålerdata og informasjonen fra observasjonen av skolemåtidene for å vurdere hvor godt de samsvarer.

Hva vil vi be skolen om ved deltakelse i prosjektet?

Erfaringer fra tidligere studier har vist oss at den beste måten å nå ut til barn og ungdom er gjennom skolen de går på. Hvis din skole sier ja til å delta i prosjektet vil vi derfor gjerne be om lov til å gjøre følgende:

1. **Bruke ranselposten** til å gi elevene i 8. klasse en individuell forespørsel om å være med i prosjektet. Se informasjonsskriv til foresatte, vedlegg 1. Det skriftlige materialet vil bli sendt til dere, vi vil bare be om at dere viderefremidler til og fra elever/foresatte i ranselposten.
2. **Komme til skolen** i løpet av en periode på 2 uker for å:
 - a. **Informere** de av elevene som har sagt ja til å delta i studien hvordan de skal bruke matdagboken og en aktivitetsmåler.
Tidsbruk: Vi må regne 1-2 skoletimer til dette, avhengig av hvor stor klassen er.
 - b. **Måle** vekt og høyde, samt ta en mini-blodprøve av de elevene som har sagt ja til å delta i studien. Mini-blodprøven vil bli tatt ved hjelp av et lite stikk i fingertuppen og overføring av noen bloddråper til et spesielt prøvepapir. Vi trenger tilgang til et ledig rom ved skolen til dette. Vi har prosjektmedarbeidere som skal gjøre blodprøvetakingen.
Tidsbruk: Elevene som deltar i prosjektet vil enkeltvis bli tatt ut av undervisningen for prøvetaking. Dette tar omkring 10-15 min.

Økonomi, forsikring, godkjenning og ansvar

Prosjektet er tilrådd av Personvernombudet for forskning, Norsk samfunnsvitenskapelig datatjeneste (NSD). Studien er finansiert gjennom forskningsmidler fra Universitetet i Oslo og Johan Throne Holst fond. Ingen av prosjektmedarbeiderne har noen interessekonflikter i studien. Studien er forsikret gjennom pasientskadeloven. Professor Lene Frost Andersen ved Universitetet i Oslo er databehandlingsansvarlig

Mer informasjon?

Skulle det være behov for mer informasjon ta da gjerne kontakt med prosjektkoordinator og stipendiat Anine Medin, mobil: 474 63 893, epost: a.c.medin@medisin.uio.no



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UiO : Institutt for medisinske basalfag
Det medisinske fakultet

Svarslipp

Jeg har mottatt og lest informasjonen om forskningsprosjektet og gir mitt samtykke til at

..... skole

deltar i forskningsprosjektet «Matdagbok på nett for barn og ungdom».

Sted

Dato

Underskrift rektor

Navn, telefonnummer og e-post adresse til involverte lærere på skolen

Navn (blokkbokstaver)	Signatur	Telefon	E-post
1. Kontaktlærer 8.trinn			
2. Kontaktlærer 8.trinn			
3. Kontaktlærer 8.trinn			
4. Kontaktlærer 8.trinn			

Vennligst returner utfylt svarslipp senest innen ___dag XX.XX.13

Benytt en av følgende alternativer:

- Scanne og sende på e-post til: a.c.medin@medisin.uio.no
- Fakse til: 22 85 15 31
- Sende i post til: Anine Medin, Avdeling for ernæringsvitenskap,
Postboks 1046 Blindern, 0317 Oslo



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Appendix 3: Information letter to parents, 4th grade



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 internetlink 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 databehandlingsansvarlig. 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 aidentifisert, 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

Institutt for medisinske basalfag

Avdeling for ernæringsvitenskap
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Mobil: 474 63 893
Telefaks: 22 85 15 31
E-post: a.c.medin@medisin.uio.no
www.med.uio.no/imb

Utgitt august 2013



Appendix 4: Information letter to parents, 8th grade



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 8. 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 to metoder for å måle kvaliteten på matdagboken:

- Måling av energiforbruk med aktivitetsmåler.
- 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 8. 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, alene eller 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 dager**
 - Aktivitetsmåleren er en liten brikke som festes ved hoften med et elastisk bånd.
 - Vi deler brikken ut til eleven 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 databehandlingsansvarlig. 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, og blodprøvesvar. Videre vil vi registrere data om familiestruktur, samt foresattes etnisitet og utdanningsnivå.

Alle opplysninger vil bli behandlet fortrolig og vil bli lagret aidentifisert, 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

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Mobil: 474 63 893. E-post: a.c.medin@medisin.uio.no

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www.med.uio.no/imb

Utgitt april 2013



Appendix 5: Consent form



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Det medisinske fakultet



Fyll ut og returner denne siden

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 foreldre/foresatt(e): _____

Telefonnummer til foreldre/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 snarest til kontaktlærer via eleven. Bruk vedlagte konvolutt. Siste svarfrist er XX. XX. 2013.



Fyll ut og returner denne siden

Utdanningsnivå foreldre/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:

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)

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

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

Samtykkeerklæringen (begge sider av arket) fylles ut og returneres snarest til kontaktlærer via eleven. Bruk vedlagte konvolutt. Siste svarfrist er XX. XX. 2013.

Appendix 6: Instructional letter to participants

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 7: Welcome e-mail

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

Bruerveiledningen 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 8: “Thank you for participating” e-mail

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