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Dietary intake and consumption of plant-based substitutes in vegans, vegetarians and pescatarians in Norway

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Preface

During the last 7 years, I have become passionate about sustainability and animal welfare. As a result, I changed my own diet gradually, and I have now been a vegan for nearly two years. Because I applied for the Health Science Research Programme, I had to start planning my master thesis early in autumn 2019. At that time, there was an ongoing project on vegans and vegetarians, and I remember thinking I was "one year too late". Luckily, in the process of applying for the research program, I was invited to join the project by the project leader, Professor Sigrun Henjum. She also kindly offered to be my supervisor.

I want to thank Sigrun Henjum for welcoming me into the project and for invaluable and professional guidance through all stages of the working process, both on the master thesis and as a student at the Health Science Research Program at OsloMet. I also want to thank Sigrun for being an inspiration with her relentless drive and positive support during these years.

A big thank you to Associate Professor Marianne Morseth for kind help and support in the final stages of writing.

Thank you to all my fellow students both at the Master Program in PHN and at the Health Science Research Program at OsloMet. Last but not least, I want to thank my wonderful husband for everlasting patience and IT support, and all my friends and family for hours of conversation on the phone during this year of strict quarantine.

Abstract

Background: The number of people choosing to eat a plant-based diet is rapidly increasing. At the same time, the market for plant-based meat and dairy substitutes is growing fast.

Objective: The main objective in this study was to assess the total dietary intake and the intake of plant-based meat and dairy substitutes in vegan, vegetarian and pescatarian diets in Norway.

Method: 24-hour recall was used to assess the total dietary intake of macro- and micronutrients, including supplements, and the intake of plant-based substitutes in a sample of 158 participants (83 vegans, 47 vegetarians and 28 pescatarians). Food intake was registered meticulously and nutrient content calculated in FoodCalc.

Results and conclusion: The main findings indicate that vegans, vegetarians and pescatarians in Norway have beneficial macronutrient intake, with median energy percentages within the levels of the Nordic Nutrition Recommendations. In addition, the overall median intake of most micronutrients met the average requirement. However, the proportion of participants meeting the average requirements was low for iodine (55 %), vitamin D (57 %) and selenium (58 %), suggesting a risk of inadequate intake of these micronutrients in plant-based diets. Use of supplements were reported by 68 % of the participants, and supplements was the single main source of vitamins D and B, iron, zinc, selenium and iodine. The results indicated high intake of plant-based substitutes in the group, as intake of meat- and dairy substitutes were reported by 44 % and 68 % of the participants respectively. Most meat substitutes reported, were based on soy, and most dairy substitutes based on oats or soy. Dietary practice was a predictor of both meat- and dairy substitutes, and vegans had significantly higher odds than pescatarians. In addition, health motivated dietary practice and animal welfare motivated dietary practice were strong predictors of dairy substitute intake.

Sammendrag

Bakgrunn: Antallet personer som velger å spise et plantebasert kosthold øker raskt. Samtidig opplever markedet for plantebaserte kjøtt- og meierierstatninger en kraftig vekst.

Mål: Målet med denne oppgaven var å vurdere det totale næringsinntaket og inntaket av plantebaserte kjøtt og meierierstatningsprodukter i veganske, vegetariske og pescetariske kosthold i Norge.

Metode: 24-timers kostintervju ble brukt til å vurdere det totale inntaket av makro- og mikronæringsstoffer, og inntaket av plantebaserte erstatninger i et utvalg på 158 deltakere (83 veganere, 47 vegetarianere og 28 pescetarianere). Inntak av all mat og drikke ble nøyaktig registrert, og næringsinntaket ble kalkulert i FoodCalc.

Resultater og konklusjon: Hovedfunnene indikerer at veganere, vegetarianere og pescetarianere i Norge har et gunstig inntak av makronæringsstoffer, med median energiprosent innenfor anbefalingen i Nordic Nutrition Recommendations. Mediant inntak av de fleste mikronæringsstoffene møtte gjennomsnittlig behov i det samlede utvalget. Den lave andelen av deltakere som møtte gjennomsnittlig behov for jod (55%), vitamin D (57%) og selen (58%), kan likevel indikere at gruppen har økt risiko for utilstrekkelig inntak av disse mikronæringsstoffene. Bruk av kosttilskudd ble rapportert av 68 % av deltakerne, og kosttilskudd var den største kilden til vitamin D og B, jern, sink, selen og jod. Videre tyder resultatene på at gruppen har et høyt inntak av plantebaserte erstatninger, ettersom inntak av kjøtt- og meierierstatninger ble rapportert av henholdsvis 44% og 68% av deltakerne. De fleste kjøtterstatningene som ble rapportert var basert på soya, og de fleste meieriferstatningene var basert på havre eller soya. Type kosthold var en prediktor for både kjøtt- og meieriprodukter, og veganere hadde signifikant høyere odds enn pescetarianere. I tillegg var helse som motivasjon for valg av kosthold og dyrevelferd som motivasjon for valg kosthold sterke prediktorer for inntak av meierierstatninger.

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AR	Average requirement
CVD	Cardio vascular disease
CHD	Coronary heart disease
BMD	Bone mineral density
DRVs	Dietary reference values
FAO	Food and Agriculture Organization
FBDGs	Food based dietary guidelines
FCT	The Norwegian Food Composition Table
GBD	Global Burden of Disease
GHG	Greenhouse Gas
LDL	Low density lipoprotein
LI	Lower intake level
NASEM	National Academies of Sciences, Engineering, and Medicine
NCDs	Non-communicable diseases
NEVO	The Dutch food composition database
NNR	Nordic Nutrition Recommendations
NPHS	National Public Health Survey
NSD	Norwegian Centre for Research Data
REC	Regional Committees for Medical and Health Research Ethics
RI	Recommended intake
SDGs	Sustainable Development Goals
UK	United Kingdom
UL	Upper Level

1.0 Introduction

In order to provide the growing world population with sufficient, nutritious food with low environmental impact, a change towards more sustainable and healthy diets is necessary (FAO and WHO, 2019). However, there are diverging views on what sustainable and healthy eating constitutes. In recent years, many reports on how to live within the planetary boundaries, have called attention to the need for more plant-based diets, particularly in the western countries (FAO, IFAD, UNICEF, WFP, & WHO, 2020; Willett et al., 2019; WWF, 2020). In line with the increased concern for climate change and health, plant-based eating is rapidly gaining popularity, and vegetarianism is the fastest growing culinary trend in European countries (Sebastiani et al., 2019).

Plant-based eating or vegetarianism entails excluding meat and/or other foods of animal origin from the diet (Melina, Craig, & Levin, 2016). In Norway it is estimated that more than 10 % are substituting meat or other animal derived foods for plant-based alternatives on a regular basis, (National Public Health Survey, 2021). Approximately 1 % are vegans, 4 % vegetarians and 7 % flexitarian. A report on Norwegian meatless eating habits, found that health was the main reason for wanting to reduce the intake of red meat (Bugge & Alfnes, 2018). Other reasons are concern for animal welfare or wishing to eat more sustainable. The latter was investigated in the recent Norwegian National Public Health Survey (2021), where 62 % reported changing their diets during the last three years to eat a more sustainable or environmentally friendly diet. Traditional vegan, vegetarian and pescatarian diets, have long been associated with health benefits (Dinu, Abbate, Gensini, Casini, & Sofi, 2017). Vegetarians and vegans have been found to have lower body mass index and reduced risk of several chronic diseases such as cardiometabolic disease, compared to omnivores (Benatar & Stewart, 2018; Fraser, 1999; Hemler & Hu, 2019; Key et al., 2014).

Well composed plant-based diets are rich in vegetables, legumes, whole grains, nuts and seeds, which contribute to increased intake of beneficiary nutrients like dietary fibres and polyunsaturated fatty acids (Melina et al., 2016). However, exclusion of foods of animal origin does not necessarily make the diet healthy. The diets content of micronutrients and n-3 fatty acids, in addition to the sources of protein should be carefully considered to avoid deficiencies (Melina et al., 2016; Norwegian Directorate of Health, 2021). Furthermore, there is an expanding range of plant-based substitutes available in Norway, and consumption of these products may affect the quality of vegetarians and vegans' diets and consequently their health. In order to assess this, we need to know more about the consumption of such products.

Although, multiple studies have investigated the composition and possible health effects of vegan and vegetarian diets, little is known about the nutrient intake in Norwegian plant-based diets. To our knowledge there are no studies on the dietary intake in Norway that give a detail information on the intake of macro-and micronutrients, or the intake of meat and dairy substitutes in plant-based diets. Therefore, the objective of this project was to assess the overall nutrient intake and the consumption of plant-based substitutes in vegan, vegetarian, and pescatarian diets in Norway. The project has been a two-part study. In the first part, intake and status of iodine (Groufh-Jacobsen et al., 2020), vitamin B_{12} (paper submitted to a journal) and iron (Henjum, Groufh-Jacobsen, Stea, Tonheim, & Almendingen, 2021) was assessed. The second, which is the work of this master thesis, assessed the overall nutrient intake and consumption of plant-based substitutes. In the second part, the master student conducted all the dietary interviews with the participants and analysed the data, including calculations of nutrient intake in FoodCalc.

2.0 Theoretical background

2.1 Current diets and global challenges

Two of the major challenges today are degradation of environmental and natural resources, and malnutrition in all its forms (FAO and WHO, 2019). Both are accelerating, and both are strongly linked with the food system. The way we produce and consume food is a threat to the environment as it is a substantial driver of land conversion, and one of the main contributors to deforestation and loss of biodiversity (FAO, 2019). In addition, agriculture alone accounts for 70 per cent of the freshwater withdrawals. Furthermore, the present food system is responsible for 20-35 per cent of the global Greenhouse Gas (GHG) emissions, with livestock contributing to about 14 per cent of the total (FAO, 2019; FAO and WHO, 2019). Reducing GHG emissions is essential to mitigate climate change, by keeping the global rise in temperature within the 2°C target set by the Paris Agreement for Climate Change in 2050 (UNSCN, 2017). This pose a significant challenge as the demand for food is expected to increase by almost 50 per cent by 2050. As a consequence, GHG emissions linked to the food system could account for approximately half of the total emissions allowed to reach the 2°C

target. Moreover, social and demographic changes will lead to a growing demand for animal-source foods which will add to the environmental strain (UNSCN, 2017).
The impact of global warming has already begun to threaten agriculture, affecting food security among already vulnerable populations (FAO, 2019). Although the global food production at present is sufficient to feed the world, there are huge inequalities in access (FAO and WHO, 2019). Today, there are 2 billion people affected by food insecurity, of which there are 690 million suffering from hunger (FAO et al., 2020). Meanwhile, 1/3 of the world population are overweight or obese, and the trend is increasing. Unhealthy diets are one of the largest risk factors for non-communicable diseases (NCDs), such as diabetes type 2, cardiovascular disease and certain cancers, and contributed to 11 million deaths and 255 million Disability Adjusted Life Years in 2017 (GBD 2017 Diet Collaborators, 2019).

2.2 Sustainable and healthy diets

2.2.1 Sustainable diets

To address these challenges, the Sustainable Development Goals (SDGs) was adopted in 2015, and three of the 17 goals to achieve by 2030, are directly linked to food and food systems; Goal 2 - Zero hunger, Goal 3 - Good health and wellbeing, and Goal 12 - Responsible production and consumption. Pivotal to reaching these goals is a global shift towards sustainable diets, which has been defined by the Food and Agriculture Organization (FAO) as

"those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources" (FAO, 2012).

Although, sustainable diets often are understood in terms of environmental impact, this definition reflects the many dimensions of sustainable diets, and highlights the need for diets to be healthy and nutritionally adequate in order to be sustainable.

2.2.2 Healthy diets

Healthy diets should prevent all forms of malnutrition and promote growth and development (FAO and WHO, 2019). The term "malnutrition" was earlier understood as undernutrition, such as wasting (low weight/height), stunting (low height/age), underweight or deficiencies in vitamins or minerals. However, today, malnutrition in all its forms, also include obesity and diets which increase the risk of NCDs. As mentioned, NCDs are one of the largest causes of mortality and disability, and Global Burden of Disease (GBD) Study (2018) found many of the leading risk factors for NCDs to be diet related. The dietary risk factors identified in the study are presented in table 1.

Table 1 Dietary risk factors for NCDs, identified in the GBD Study

GBD: Dietary risk factors for NCDs		**Healthy diets**	
Low intake	**High intake**	**Increase intake**	**Limit intake**
Fruits	Red meat	Fruits	Energy from free sugars
Vegetables	Processed meat	Vegetables (except starchy root vegetables	Energy from total fats
Legumes	Sugar sweetened beverages	Legumes	Saturated fats
Whole grains	Trans fatty acids	Whole grains	Trans fats
Nuts	Sodium	Nuts	Salt
Seeds			
n-3 fatty acids from seafood		**Choose**	
n-6 polyunsaturated fatty acids		Choose unsaturated fats over saturated fats	
Calcium		Choose iodized salts	
Fibre			

(FAO and WHO, 2019; GBD 2017 Diet Collaborators, 2019)

Table 1 also outlines the main dietary factors that contribute to a healthy diet, mainly increased intake of plant-based foods such as vegetables, fruits, legumes, whole grains and nuts. In addition to these recommendations, moderate amounts of eggs, dairy, poultry and fish, and small amounts of red meat may be included (FAO et al., 2020).

2.3 Plant-based diets

2.3.1 Definitions

Plant-based diets is a collective term for a variety of eating patterns excluding animal-based foods (Melina et al., 2016). Vegan, vegetarians, pescatarian and flexitarian diets are examples of such eating patterns (Norwegian Directorate of Health, 2015b). In a vegan diet all foods of animal origin are excluded, including honey, beeswax, certain flavour additives, colouring agents and preservatives. A vegetarian diet excludes flesh of meat and fish but may include dairy (lacto-vegetarian) or egg (ovo-vegetarian) or both (lacto-ovo-vegetarian). In a pescatarian diet, fish and/or seafood are included, sometimes in addition to dairy and egg. The plant-based diets are diverse and many variants do not strictly fit with any of these categories. This is especially true with flexitarian diets, which as the name implies, are flexible, and allows for all varieties of plant-based eating where meat is limited or excluded on a regular basis (Bugge & Alfnes, 2018).

2.3.2 Prevalence worldwide

The number of people following a plant-based diet has increased considerably in the western world in the last years (Alcorta, Porta, Tárrega, Alvarez, & Vaquero, 2021). According to the website “Vegan Society” the number of vegans in the United Kingdom (UK) quadrupled from 2014 to 2019 reaching 600.000 vegans (1.6 % of the UK population) in 2019 (The Vegan Society). In Germany, 2.9 % classifies themselves as vegan and 4.3 % as vegetarians (The Vegan Society). Similar trends are seen in United States (U.S), where the number of vegans increased by 500% from 2014 to an estimated 19.6 million in 2017 (The Vegan Society). The numbers of Australian vegans reached 2.1 million in 2016, accounting for approximately 11.2 % of the country’s population (Roy Morgan, 2016) .

2.3.3 Environmental sustainability

Current evidence strongly suggests that a dietary shift towards healthy plant-based diets would contribute to alleviate the threat of NCDs and environmental degradation.
Multiple studies have found GHG emission, and land and water use to be proportional to the reduction of animal source foods in the diet (Aleksandrowicz, Green, Joy, Smith, & Haines, 2016; Chai et al., 2019; Hallström, Carlsson-Kanyama, & Börjesson, 2015). Also studies examining the environmental sustainability in specific plant-based diets have reached similar conclusion (Fresán & Sabaté, 2019; J. Sabaté & Soret, 2014), as have studies on “the Mediterranean diet”, which is known to be rich in plant-based foods (Castañé & Antón, 2017; Sandro Dernini & Berry, 2015; S. Dernini et al., 2017). These findings are further corroborated by sustainability analysis on specific foods or food groups, which have found plant-based foods, such as pulses/legumes, grains and vegetables to have considerably lower environmental footprint compared to both meat and dairy (Clune, Crossin, & Verghese,

2017). Environmentally sustainable diets are however, not necessarily healthy (FAO et al., 2020).

2.3.4 Environmental sustainability and health

Several reports have investigated the combined effects on both health and the environment in global adoption of different diets (FAO et al., 2020; Willett et al., 2019; WWF, 2020). The conclusions indicates that diets with considerably lower share of animal-based foods are beneficial for both human and planetary health. A modelling study by Springmann et al. (2018) estimated the joint effects on environment and health by adopting different diets in 150 countries across the world The study found that widespread adoption of vegan, vegetarian, pescatarian and flexitarian diets designed to meet public health objectives could reduce the risk of diet-related mortality by approximately 20 % and GHG emission by 54-87 % while being nutritionally adequate.

2.3.5 Composition

A well-planned plant-based diet can be both healthy and nutritionally adequate through all stages of life, including childhood and pregnancy (Melina et al., 2016). The staple foods in plant-based diets are whole grains, legumes, vegetables and fruits seeds (Melina et al., 2016; Norwegian Directorate of Health, 2015b). Most diets also contain ample amounts of berries, nuts and seeds. In addition, varying amounts of dairy, egg and/or fish may be consumed as previously described. Different substitute products for meat, dairy and egg, which are often made from soy, peas, various cereals or fungi can also be part of a plant-based diet (Frank B. Hu, Otis, & McCarthy, 2019; Röös, Garnett, Watz, & Sjörs, 2018; Santo et al., 2020). Plant-foods are usually a good source of dietary fibres, folate, Vitamin C, unsaturated fatty acids and other plant composites, such as polyphenols (Melina et al., 2016; NNR, 2012). Protein quality in plant-based diets has been discussed, but given that energy requirements are met and protein from a variety of plant-sources (legumes and whole grains) are eaten during the day, the diet will provide all essential amino acids (Hever, 2016). Because most plant-based foods (whole grain, vegetables, fruits, berries and legumes) are low in energy, plant-based diets typically contain less kilocalories compared with omnivorous diets (Bakaloudi et al., 2020).

2.3.6 Plant-based diets and health benefits

Adhering to vegan, vegetarian or pescatarian diets has long been associated with health benefits and reduced risk for several chronic diseases (Benatar & Stewart, 2018; Key et al., 2014), such as lower risk of cardiovascular disease (CVD) (Fraser, 1999; Hemler & Hu, 2019; Frank B Hu, 2003), some cancers (Fraser, 1999; Key et al., 2014) and type 2 diabetes (Olfert & Wattick, 2018). Vegetarian and vegan diets are also associated with a favourable cardio metabolic risk profile compared with omnivore diets, including lower BMI (Appleby, Thorogood, Mann, & Key, 1999; Benatar & Stewart, 2018), lower blood pressure (Benatar & Stewart, 2018), and decreased levels of total cholesterol (Dinu et al., 2017), low-density lipoprotein cholesterol (LDL) and triglycerides (Benatar & Stewart, 2018). One of the suggested explanations for the health benefits associated with plant-based diets, are the exclusion of red- and processed meats, due to the adverse effects of these foods (Larsson & Orsini, 2013; WCRF & AICR, 2018). Another, is that the health benefits are due to the positive effects of increased intake of plant-based foods in the diet (Leitzmann, 2014). Both explanations are in line with current evidence of dietary risk factors for NCDs (GBD 2017 Diet Collaborators, 2019) (table 1) and the recommendations for healthy diets (FAO and WHO, 2019).

2.3.7 Plant-based diets and health risks

Although plant-based diets can be beneficial, the healthiness of these diets depends on the actual food intake, not simply excluding animal-based foods (Melina et al., 2016). Eating patterns emphasizing less nutritious foods, often mentioned as “empty calories”, i.e., white bread, rice or pasta, deep-fried fast foods, sweets and snacks is unhealthy whether or not animal-source foods are a part of the diet (Hemler & Hu, 2019). An American study, including more than 200 000 participants, examined the effect on coronary heart disease (CHD) for healthy plant-based diets versus unhealthy plant-based diets by creating health indexes (Satija et al., 2017). The indexes were based on the content of high-quality plant-foods, weighed as healthy (whole grains, legumes, vegetables, fruits, nuts oils, tea and coffee), and animal-based and low-quality plant-foods, weighed as unhealthy (refined grains, sugary beverages, potatoes/fries, sweets/deserts, fruits juices,). Whereas healthy plant-based diets substantially lowered the risk of CHD, the unhealthy plant-based diets were associated with higher CHD risk (Satija et al., 2017).

Although, healthy plant-based diets can be nutritionally adequate, there are some concerns about the potential of inadequate intake of essential nutrients (Sobiecki, Appleby, Bradbury, & Key, 2016). Foods of animal origin are the main source of several micronutrients (table 2). Some of these nutrient cannot be provided from plant-foods, or have less bioavailability when sourced from plants (Melina et al., 2016). It is therefore important to include foods, that combined, ensures sufficient intake of critical nutrients, and use of supplements may be necessary (Melina et al., 2016). The following sections will address the micronutrients of concern, which are listed in table 2 with their animal- and plant-based food sources.

Table 2 Micronutrients of concern in a plant-based diet and their animal- and plant-based food sources

Nutrient	Animal-based food source in the Norwegian diet	Plant-based food source
B12	Meat, dairy, fish, shellfish, egg, all animal source food	Fortified plant-based milk substitutes
Vitamin D	Fatty fish, fortified milk, eggs	Fortified plant-based milk substitutes
Calcium	Cow's milk, cheese, other dairy products	Cabbage, kale, broccoli, bok choi, white beans, almonds, sesame seeds, tahin, calcium-set tofu, figs
Zinc	Meat, milk, dairy products	Soy-based products, legumes, whole-grains, seeds, nuts
Selenium	Fish, seafood, eggs, animal source food	Brazil nuts, wheat imported from North America, plant-foods grown in selenium rich soil
Iron	Meat,	Legumes, leafy greens, soybeans, dried fruits, quinoa, tahin
Iodine	Marine fish, shellfish, milk, dairy, eggs	Sea vegetables (Nori, wakame)

(Hever, 2016; Melina et al., 2016; Nordic Council of Ministers, 2014)

2.3.7.1 Vitamin D

Vitamin D can be synthesized in the skin from cholesterol and ultraviolet light when exposed to sunlight (Gallagher, 2012). However, due to the latitude of the Northern countries, dietary intake may be necessary to maintain adequate vitamin D status during the winter. (NNR, 2012). The vitamin is fat-soluble, and is found as vitamin D_3 in some animal-based foods (table 2), and as vitamin D_2 in some mushrooms (NNR, 2012). Because of limited sources in plant-based diets, supplementation may be necessary to maintain vitamin D status in plant-based diets (Melina et al., 2016). The primary function of vitamin D is to stimulate the absorption of calcium. Along with parathyroid hormone, vitamin D also contributes to stimulate release of calcium from bone, and is thereby vital to maintain normal concentration of calcium in the blood. Deficiency of vitamin D may result in bone demineralization, and in severe cases osteoporosis or rickets in children. In addition, vitamin D may be involved in the immune system, onset of autoimmune disease, muscle strength and infections (Gallagher, 2012; NNR, 2012).

2.3.7.2 Vitamin B_{12}

Vitamin B_{12} (cobalamin), refers to a group of cobalt-containing compounds (Gallagher, 2012), which is vital to normal blood formation and neurological function (NNR, 2012). The absorption of vitamin B_{12} is dependent on hydrochloric acid and pepsin in the stomach, and the binding of intrinsic factor. Malabsorption due to impaired gastric function, is therefore the major cause of deficiency, and frequent in elderly people (NNR, 2012). However, as vitamin B_{12}, in adequately nourished individuals, is stored in sufficient amounts in the body, clinical symptoms of deficiency usually develop only after prolonged insufficient intake. B_{12} deficiency is nevertheless the most severe consequence of a poorly planned plant-based diet, as it can cause irreversible damage to the nervous system, megaloblastic anemia, dementia and stroke (Melina et al., 2016; NNR, 2012). As shown in table 2, plant-based foods are not a reliable sources of B_{12}, as it is mainly found in animal-foods (NNR, 2012).

2.3.7.3 Calcium

Calcium is the most abundant mineral in the body, and 99 % is found in teeth and bones (Gallagher, 2012). The remaining 1 % of free calcium is required in nerve transmissions, heart and muscle contraction and enzymatic reactions (NNR, 2012). Because of these vital functions, the calcium homeostasis is strictly regulated to maintain a constant concentration in plasma. As calcium is released from bones if the intake is insufficient to maintain the plasma concentration, inadequate intake may influence bone mineral density (BMD) in children, adolescents and postmenopausal women (Gallagher, 2012). As shown in table 2, there are both animal-based and plant-based sources of calcium in the diet, but the bioavailability of calcium from plant foods may be reduced (NNR, 2012). Absorption of calcium is inhibited by oxalate and phytate, which is found in several green vegetables and whole grains. Reduced absorption may also occur in diets containing more than 30 g/d of dietary fibres (Gallagher, 2012), which are likely in plant-based diets (Allès et al., 2017; Elorinne et al., 2016; Kristensen et al., 2015; Sobiecki et al., 2016). However, calcium absorption increases with increasing physiological needs, and with decreased content of calcium in the diet.

2.3.7.4 Iron

Iron is involved in numerous vital functions in the body, mainly due to its oxidation and reduction properties (Gallagher, 2012). The nutrient is the oxygen-binding compound in haemoglobin, necessary to transfer and transport oxygen from the lungs to the tissues, and carbon dioxide from the tissues to lungs. Iron is also essential to the function of cytochrome enzymes, that are needed in cellular respiration and energy generation (Gallagher, 2012). In food, iron exists in the form of haem iron or non-haem iron (NNR, 2012). The haem iron is mainly found in meat, and is usually more efficiently absorbed than the non-haem iron found in plant foods (table 2). Absorption of non-haem iron is inhibited in foods with high phytate content, by oxalate, calcium and by tannins (polyphenols) in tea (Gallagher, 2012; NNR, 2012). Ascorbic acid (vitamin C) can, however, enhance absorption. Iron deficiency anaemia, is the world's most common micronutrient deficiency (NNR, 2012). Although, the prevalence of this disease in Norway is relatively low, iron deficiency may occur in infants, young children and women of reproductive age, due to increased needs for iron (NNR, 2012).

2.3.7.5 Zinc

Zinc is a component in several proteins and essential for more than 300 enzymes (Gallagher, 2012). The nutrient is involved in the synthesis and metabolism of carbohydrates, lipids, proteins and nucleic acids (Gallagher, 2012; NNR, 2012). In addition, zinc is important for normal immune function (NNR, 2012). The main sources of zinc in Norway are meat, milk, dairy and whole grains (table 2). Whole grains is also an important source of zinc in plant-based diets, as well as dry beans and nuts (Gallagher, 2012). Absorption of zinc is inhibited by phytates, and may also be reduced by high intakes of calcium and iron (Gallagher, 2012). Sever zinc deficiency with clinical manifestation is rare in Norway (NNR, 2012), and the consequences of moderate or mild deficiency are not yet established.

2.3.7.6 Selenium

Selenium is a part of several proteins distributed in tissues in the whole body (Gallagher, 2012). The nutrient acts as a co-factor to antioxidants and in the metabolism of thyroid hormones (NNR, 2012). The content of selenium in foods varies greatly, as it depends on the soil where the foods were grown or the animals grazed (NNR, 2012; Gallagher, 2012). Fish, seafood and eggs are the most important sources of selenium in Norway, as domestically grown grains and vegetables contains limited amounts of the nutrient, due to low selenium content in Norwegian soil (NNR, 2012). Apart from brazil nuts, there a therefor few plant-based sources of selenium, unless the food is imported from countries with higher concentrations in the soil.

2.3.7.7 Iodine

Iodine is trace mineral necessary for the synthesis of thyroid hormones, and therefore essential for normal thyroid function and cellular metabolism (Gallagher, 2012; Nordic Council of Ministers, 2014). Iodine deficiency is the main cause of goitre, and in pregnant or lactating women, moderate and mild deficiency is associated with impaired child development (Zimmermann, Jooste, & Pandav, 2008). Although, iodine deficiency continues to be one of the most common nutrient deficiencies globally, severe deficiency with goitre was eradicated in Norway by mandatory iodisation of cow's fodder (NNR, 2012). However, studies have shown that women in reproductive age and vegans and vegetarians may be at risk of insufficient iodine intake and status (Brantsæter et al., 2018; Groufh-Jacobsen et al., 2020; Henjum et al., 2018). The most important sources of iodine in Norway are marine fish, shellfish, cow's milk and dairy (NNR, 2012). In vegan diets iodine can be obtained from seaweed products or kelp (Gallagher, 2012).

2. 4 Plant-based substitutes

2.4.1 Market

The market for plant-based substitutes has grown tremendously in the recent years, both in Norway (Grundekjøn, 2021) and in Europe (Smart Protein Project, 2021). Analysing the market for meat and dairy substitutes in 11 European countries, the Smart Protein Project (2021) revealed that sales values reached € 3.6 billion in 2020, which was 49 % higher than in 2018. The greatest proportional increase in sales values were seen in Germany (97 %), and the sales values for plant-based milks and meat equalled € 369 million and € 181 million respectively. Among other countries reporting a surge in the sales values were UK (73 % growth), Netherlands (50 % growth) and Spain (48 % growth) (Smart Protein Project, 2021). For Denmark, the only Nordic country to be included in the analysis, the sales values had grown by 29 %. Across most countries, increased sales values of oat-based milk and dairy substitutes were seen, but the sales value of soy-based products also remains high (Smart Protein Project, 2021). Plant-based substitutes are high in demand also in Norway, and Orkla's revenue for this segment grew by 30 % from 2019 to 870 million NOK in 2020 (Elle, 2021). In addition to animal welfare, concern for health or the environment are suggested as main drivers of this rapid increase in the plant-based substitute market (Ismail, Hwang, & Joo, 2020; Paul, Kumar, Kumar, & Sharma, 2020). Although, the demand for plant-based milks was initiated to accommodate people with cow's milk allergy or lactose intolerance, the late years popularity has been attributed to health concerns and following vegetarian or vegan diets (Mäkinen, Wanhalinna, Zannini, & Arendt, 2016)

2.4.1 Meat substitutes

Plant-based meat substitutes are products designed to replace meat and meat products in the diet (Bohrer, 2019). Early forms of meat substitutes i.e., tofu or tempeh were made from soy and subjected to a low grade of processing (Bohrer, 2019). Today, a wide selection of products intended to mimic the function, taste and texture of meat in the diet, i.e.; “plant-burgers”, “plant-sausages” or “plant-mince” are available (Curtain & Grafenauer, 2019). Technological development has enabled the production of substitutes that offer the consumer a sensory experience similar to that of eating meat (Frank B. Hu et al., 2019). This new generation of plant-based meat analogues, of which the brand “Beyond meat” is an example, has become widely popular (Frank B. Hu et al., 2019; Santo et al., 2020). Many plant-based meat substitutes are still made from soy, though products based on protein isolates from peas, wheat, chickpeas, beans and fungi (mycoprotein) are also common (Frank B. Hu et al., 2019; Santo et al., 2020). Additionally, there are products based on starchy root vegetables such as beetroot, sweet potatoes and potatoes (Coop, 2021; HOFF, 2021).

2.4.2 Dairy substitutes

Plant-based dairy substitutes includes a wide range of non-dairy products used as replacement for milk, cheese, yoghurts, creams, ice creams and other cooking ingredients which are usually based on cow’s milk (Röös et al., 2018). The main raw ingredients in non-dairy milks are soy, oats, rice, almond and coconut (Paul et al., 2020), although variants based on other ingredients as quinoa, hemp and seeds are also available (Mäkinen et al., 2016). Plant-based milk substitutes has long been on the market (Alcorta et al., 2021; Silva, Silva, & Ribeiro, 2020), but the substitutes for cheese were relatively recently introduced in regular grocery stores in Norway. The raw ingredients in these cheese substitute products, have to our knowledge not yet been examined. However, cheese substitutes made from fermented tofu have existed since 1500s in Asia (SoyInfo Center). Other cheese substitutes have been used for decades in pizza as a cheaper alternative to regular cheese (Bachmann, 2001). Due to limitations in flavour, these products have not gained general popularity until the last years, but are now available in a range of varieties intended to mimic products such as parmesan, cream cheese and cheddar (Go'Vegan; Violife).

2.4.3 Plant-based substitute products and nutrition

The term plant-based is in general associated with “healthy” and “sustainable” (Van Loo, Hoefkens, & Verbeke, 2017), and marketing strategies for substitute products highlights the nutritional benefits of the plant-based raw ingredient in the product (Oatly, 2021; Orkla; Vanga & Raghavan, 2018). Although, the raw ingredients may be associated with positive health effects, this may not apply to the final products (Choudhury, Singh, Seah, Yeo, & Tan, 2020). During processing, nutrients such as vitamins, minerals and trace elements may be lost, and less healthy ingredients such as salt, sugar and saturated fatty acids (SFA) may be added, altering the nutrient value of the final product. Consequently, many plant-based substitutes meet the NOVA criteria for ultra-processed foods (Gehring et al., 2020; Monteiro et al., 2018). The healthiness of these products have been therefore been questioned (Wickramasinghe et al., 2021),.s

Studies have however, found the nutrient content in meat substitutes to vary widely, both across and within different product categories (Curtain & Grafenauer, 2019; Frank B. Hu et al., 2019). When compared to regular meat, the substitutes are suggested to contain less saturated fat and more dietary fibre, but also generally higher levels of salt (Bohrer, 2019; Curtain & Grafenauer, 2019). Furthermore, studies have found the protein content in substitutes to be similar to the content in meat, though the quality of protein in these products has been less examined (Bohrer, 2019). Plant-based milks have also been found to vary greatly in nutrient content (Mäkinen et al., 2016; Silva et al., 2020; Vanga & Raghavan, 2018). This variation has mainly been explained by the different nutritional properties of the raw ingredients, and plant-based milks based on soy, has been found most nutritionally comparable to cow’s milk, mostly due to the protein content (Vanga & Raghavan, 2018). Because plant-based dairy substitutes do not contain comparable amounts of micronutrients to products based on cow’s milk, fortification or enrichment of plant-based milks with calcium, vitamin B_{12}, riboflavin or iodine is widely used (Mäkinen et al., 2016). Although, many variants of plant-based substitutes on the Norwegian market are fortified, this is not true for all products (Alpro, 2021; Oatly, 2021). Vegan and vegetarians seeking to increase their intake of the aforementioned micronutrients should therefore consider the content of each product carefully.

2.5 Diets in Norway

2.5.1 National goals and strategies

Through the commitments to the SDGs and the Paris agreement, Norway aims to reduce premature mortality from NCDs by one third (UN, 2015), and GHG emissions by at least 50 % compared to the 1990's level, by 2030 (Ministry of Climate and Environment, 2021). Healthy and sustainable diets are central to achieve both targets (Norwegian Environment Agency, 2020; Sælensminde, Johansson, & Helleve, 2016). In Norway, NCDs are the cause of more than 50 % of early mortalities (before the age of 75), and unhealthy diets are one of the main risk factors for these diseases (Norwegian Ministries, 2017). It is also suggested that unhealthy or suboptimal diets are responsible for 8000 deaths per year in Norway (Norwegian Ministries, 2017). Reduction of NCDs is therefore incorporated in the National Action Plan for a Healthier Diet (2017). Among the population targets in this plan, are reducing intake of added sugar, saturated fats and salt in the diet, while increasing the consumption of vegetables, fruits, berries, whole grains and fish. Increased intake of these foods in addition to limited intake of meat is also described by the plan as a sustainable diet

Increasing the intake of plant-based foods and fish, while reducing the intake of red and processed meat in the population is also one of proposed measures in the report "Klimakur" (2020). This measure is suggested to potentially reduce GHG emission in the agricultural sector by 2.9 million tons CO_2-equivalents. In comparison, this reduction exceeds the estimates for all other measures in the agricultural sector combined. The estimation assumes that the whole population adapt the dietary guidelines for red or processed meat, and limit the intake to maximum 500 g per week (Klimakur, 2020).

2.5.2 The Norwegian diet, dietary guidelines and sustainability

The targets and measures for diets mentioned in the previous section, reflects the main recommendations in the Norwegian dietary guidelines (2015a). In addition, the guidelines also recommend maintaining energy balance and variation in the diet. According to "Trends in the Norwegian Diet 2020 (2021), there has been a positive development in the intake of added sugar, which has decreased by 25 % the last decade. Likewise, a positive trend in seen in the intake of vegetables, which have increased substantially the last ten years. However, compared to the guidelines, the intake of vegetables, whole grains, berries and fruits, fish and dietary fibres are still too low, and the intake of salt, sugar and saturated fat too high.

In 2017, an evaluation of the Norwegian dietary guidelines from a sustainability perspective was conducted (National Nutrition Council, 2017). The report, which included the importance of self-sufficiency in addition to health and environmental sustainability aspects, concluded that the current recommendations are sustainable. However, a modelling analysis by Springmann et al. (2020) estimated that global adoption of the Norwegian dietary guidelines would exceed the GHG emission target set by the Paris Agreement by a factor of 3.49. In comparison, the equivalent estimate for global adoption of vegan diets was 0.25 lower than the Paris Agreement target.

2.5.3 Nutrition recommendations

Although, micronutrient deficiencies remain a widespread challenge in populations where food insecurity and hunger persist (WHO, 2020), deficiencies in vitamins and minerals are less common in Norway, today (NNR, 2012). Early dietary recommendations focused on preventing diseases and conditions caused by deficiencies of specific nutrients (Mozaffarian, Rosenberg, & Uauy, 2018). Today's advice, however aims at preventing NCDs in the population and communicate these in portions of foods, rather than amounts of nutrients. This current generation of food based dietary guidelines (FBDGs), considers the health effects of the total diet based on the contributions from different foods and nutrients (NNR, 2012 ; Norwegian Dietary Guidelines2015a). Nevertheless, the FBDGs are also based on recommendations for specific macro-and micronutrients, developed to meet the needs in healthy populations with adjustments made for gender, age and life stages (reproductive age, planning pregnancy, pregnancy, breast feeding, post menopause).

2.5.3.1 Dietary reference values for evaluation of diet adequacy

Several competent bodies have established dietary reference values (DRVs). Using average requirement (AR) and upper level (UL) as comparison values is in line with the recent proposal for harmonized dietary reference values for WHO, FAO, National Academies of Sciences, Engineering, and Medicine (NASEM), where AR and UL are considered the core values for evaluating population intakes (Allen, Carriquiry, & Murphy, 2019). The AR, which corresponds to the term estimated average requirement (EAR), is the lowest long-term intake that is estimated to meet the requirement of half of the healthy individuals in the population, given that requirement is normally distributed (NNR, 2012). The intake is considered to be adequate if 97.5% of a population has a habitual intake above the estimated average requirement.

2.5.3.1 Nordic Nutrition Recommendations

In the Nordic countries, the Nordic Nutrition Recommendations (NNR) constitutes the scientific basis for each country's FBDGs (Christensen et al., 2020). The recommendations emerged from a collaboration between the Nordic Council of Ministers, and Food and health authorities in Denmark, Finland, Sweden, and Norway. Since first published in 1980, the NNR has regularly been revised and updated based on the best available scientific evidence. In addition to recommendations for macro- and micronutrients, the following dietary reference values (DRVs) are defined: 1) average requirement (AR); 2) recommended intake (RI); 3) upper intake level (UL); 4) lower intake level (LI); 5) reference values for energy and FBDGs.

2.5.4 Plant-based diets in Norway

2.5.4.1 Prevalence

Plant-based eating is on the rise in Norway, and in the National Public Health Survey (NPHS) (2021), approximately 10 % of the 8852 participants reported to eat more plant-based. The majority of these participants were flexitarians (6.9 %), followed by vegetarians (3.7 %) and vegans (1 %). Although more women (13 %) than men (8 %) reported to eat more plant-based, there was no difference in gender in the number of vegans. Among people living in Oslo, 20 % reported to follow a plant-based diets, which was twice the percentage in other counties. The survey suggests that younger people (18- 29 year) are more likely to eat vegan or vegetarian. However, 6.8 % of participants in above 75 years reported to have a flexitarian diet. The survey conducted by Ipsos for Orkla last year, reported even higher proportions of plant-based eaters (Ipsos for Orkla, 2020). The survey included 1000 participants, of which 4 % reported to follow a vegan diet, and another 4 % to be vegetarian. In additional 1 % reported to be pescatarian, while 12 % defined themselves as flexitarian.

2.5.4.2 Motivation

There are many different reasons for choosing to adhere to a plant-based diet, the most common being health, animal welfare and the environment (Hopwood, Bleidorn, Schwaba, & Chen, 2020). In Norway, health has been one of the main motivational factors for eating plant-based since the establishment of the predecessor for "The Norwegian Vegetarian

Society" (Norsk Vegetarforening) in 1930 (Thorbjørnsen, 2016), and according to Bugge and Alfnes (2018), health was still the most important reason for following a plant-based diet in 2018. However, 62 % of the participants in the recent NPHS, reported changing their diets in the last three years for reasons of sustainability and environmental concern (NPHS, 2021). Among the changes frequently reported was, reducing meat intake and eating a vegetarian meal for supper.

A dietary shift towards more plant-based eating is necessary to mitigate climate change and ensure a sustainable food system (FAO and WHO, 2019). Although, there are many potential health benefits associated with eating plant-based, the healthiness and adequacy of plant-based diets ultimately depends on the actual food intake. No previous studies in Norway have investigated the total dietary intake in the vegan, vegetarian and pescatarian population. Little is also known about the consumption of plant-based substitutes in this population. Because of the rising popularity of plant-based diets in Norway and the limited knowledge of the actual food intake in Norwegian vegan, vegetarian and pescatarian diets, it is of high importance to study the total dietary intake, including the intake of plant-based substitutes.

3.0 Purpose and objectives

The purpose of this master thesis is to assess total dietary intake and intake of plant-based substitutes in vegans, vegetarians and pescatarians in Norway.

The main objectives are:

1) To calculate the intake of macro- and micronutrients and compare to recommendations in NNR 2012
2) Compare the intake of micronutrients to the Average Requirements (AR) in NNR (2012)
3) To assess the contribution of different food groups to the intake of selected micronutrients
4) To assess the intake of meat- and dairy substitutes
5) To explore the raw ingredients in the meat- and dairy substitutes
6) In logistic regression analyses, assess predictors for meat- and dairy products.

4.0 Methods

The following chapter describes the study design, the sample selection, data collection, data entry and the statistical analysis used.

4.1 Study design

This study had a cross sectional design and was part of a study on micronutrient (iodine and B12) intake and status in vegans, vegetarians and pescatarians in Norway. The data collection in the first part included biological samples of blood and urine in addition to information on dietary practice. Because of the limited knowledge about the total nutrient intake in this population and the rapid increase in the plant-based substitute market, we wanted to further examine dietary intake in the sample. After finishing the first part of the study, we therefore applied for more resources and ethical approval to extend the study. Participants who had given informed written consent to further questioning in the first part of the study, were contacted by text message and asked if they were willing to answer follow up questions. Thus, the second part of the study assessed total dietary intake, including use of meat and dairy substitutes, and was performed over phone by the master student. This master thesis includes the data from the second part of the study.

4.2 Sample

4.2.1 Participant recruitment

Participants were recruited through convenience sampling and snowball sampling (Etikan, Musa, & Alkassim, 2016; Groufh-Jacobsen et al., 2020). These methods were chosen due to the relatively low prevalence of people adhering to a vegan, vegetarian and pescatarian diet in Norway. Initially, information about the study was shared on the OsloMet website and the website of Health Professionals for Plant-based Diets (HEPLA), in addition to closed groups for vegetarians and vegans on Facebook. Snowball sampling was used for further recruitment, by asking participants to spread information and invite friends and family with plant-based diets to participate (Bowling, 2014).

Appointments for phone interviews were made with those who gave an affirmative answer. Those who did not answer the first text, were contacted a second time. If no answer was given after two text messages, the person was considered not interested in participation. Similarly, participants who did not answer their call at the scheduled time, and did not make contact after receiving a following text message, were also excluded. Three participants were further excluded after the telephone interviews. Two of these were excluded due to intake of meat or poultry, reported in the initial questionnaire, and one due to fasting, which had not been clearly identified as an exclusion criterion. The recruitment to the present study is presented in the flow chart below (figure 1).

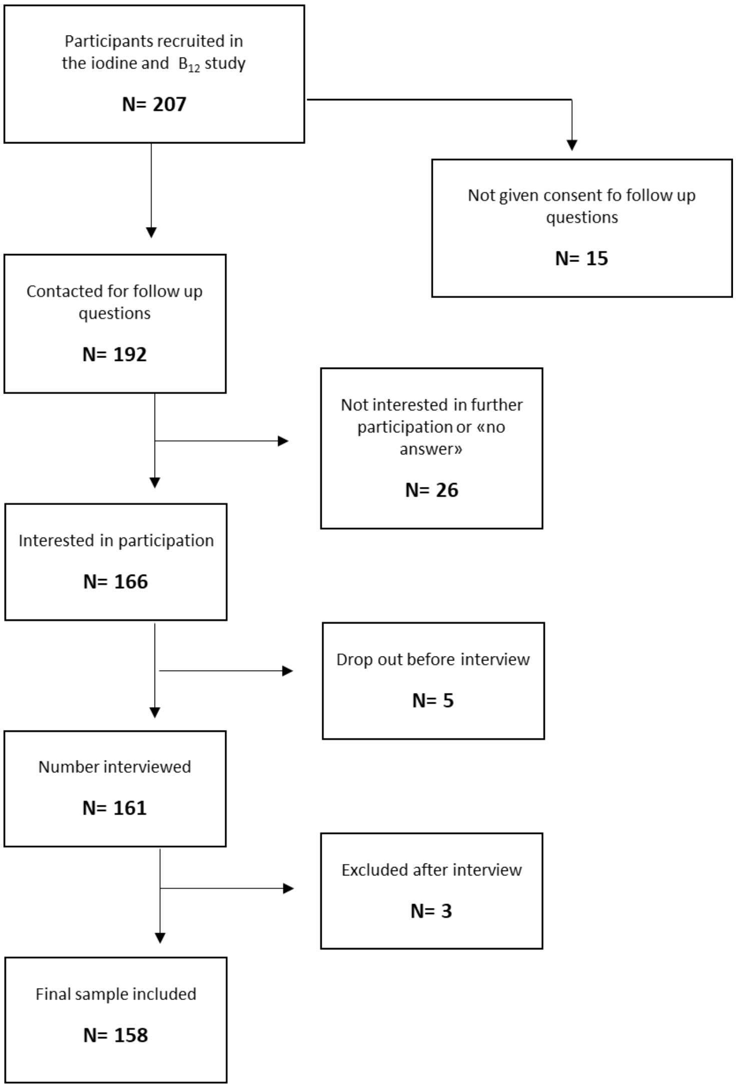

Figure 1 Flow chart of recruitment of vegans, vegetarians and pescatarians in Norway

4.2.2 Sample size

A total of 207 participants aged 18 -60 years were recruited (Groufh-Jacobsen et al., 2020). The inclusion criteria were 1) Kept a vegan or vegetarian diet for at least 6 months, 2) Above 18 years of age, 3) Not currently medicated for thyroid related disease. Participants were excluded if they reported thyroid disease, pregnancy, recent exposure to iodine-containing medications and contrast agents, meat-consumption or if they had taken vitamin B12 injections.

The final sample included 158 participants, of which 83 were vegans, 47 vegetarians and 28 pescatarians. Classification into the respective dietary groups was made based on the background questionnaire (Appendix 2). The participants were asked about inclusion of cow's milk, cheese based on cow's milk, eggs, fish, poultry and red meat in their diet. Participants who answered "never" for all the above were classified as vegans. Participants who answered "never" for poultry, red meat and fish, but "seldom", "sometimes", or "often" for the remaining food groups were defined as vegetarians. Those who answered never for poultry and red meat, but "seldom", "sometimes", or "often" for fish were classified as pescatarians. Participants who in the subsequent data collection reported to have changed their dietary habits were reclassified into the appropriate dietary group. This was also the case for participants who reported food intake in the follow up that coincided with a less strict diet than the diet indicated by the questionnaire. For example, participant previously classified as vegans who reported intake of dairy in the subsequent interview (Melina et al., 2016).

4.3 Data

4.3.1 Data collection

4.3.1.1 Questionnaire

An electronic questionnaire was used to collect information on background variables (age, gender, weight, height, occupation, smoking habits, etc.) and dietary practices (Appendix 2) (Groufh-Jacobsen et al., 2020). Additionally, motivation and duration of current dietary practice and knowledge about nutritional composition of plant-based diets were assessed. The questionnaire was based on a previously validated questionnaire (Henjum et al., 2018), adapted, pilot tested and modified to fit the target group before study start (Groufh-Jacobsen et al., 2020). All participants completed the questionnaire at initial recruitment in the first study in the presence of a master student, who was available for questions.

4.1.1.2 Dietary intake, 24-hour dietary recall

In the second part of the study, a single semi-structured, 24-hour dietary recall (24HR) was used to collect data on total intake of food and beverages, including supplements and plant-based substitutes. This method was chosen as it is one of the most used methods to assess dietary intake, and because it allows for detailed records of each individual's intake of food. In order to avoid participants knowingly or unknowingly adjusting their diet, participants were not informed in advance about the content of the interview.

During the 24HR, all participants were asked to give detailed recalls of all food and beverage consumed in a timeframe of 24 hours the previous day (Gibson, 2005, pp. 41-42). At first, participants were encouraged to talk freely without interruption, beginning with the first meal or first consumption of any food or beverage. Participants were encouraged to describe as many ingredients in dishes or recipes as they could recall. In cases where a specific recipe had been used, and the recipe was available from a website, the participants described the name of the website and recipe, for the master student to search online. Potential recipes identified in the online search were then described to the participants to confirm that the correct recipe was identified. The participants were also asked if they had made any changes to the recipe in quantity or type of ingredients.

Secondly, clarifying or probing questions about quantity was asked. For example; "Compared to the whole …, how big was the part you ate?", "How many … do you think your portion contained?", "How many decilitres do you think that glass/bowl contained?" and "What do you think … would equal in table spoons/tea spoons?". The descriptions of quantity given by the participants included amount in decilitres (dl), table spoons, tea spoons, cups, glasses, bowls or plates. Also, the size of glasses, bowls and plates in addition to size and share of whole product, portion or recipe, number pieces/products, intake in cm of product, and in some cases quantity in grams were described by the participants.

If not specified by the participants during the initial recount of intake, questions about type or brand, whether the food was organic, cooking method, content of fat, sugar or wholemeal was asked. These included; "Do you know the content of wholemeal in the bread?"; "How many quarters on the package label "brødskalaen" indicating wholemeal content were red or black?", Do you remember the name and brand of this meat-substitute?", "Do you know the percentage of sugar in that jam/marmalade?", "Do you remember the name and brand of the cereal/vegetable mix?" "Was this amount of rice/pasta in raw or cooked quantity?", "Did you prepare the vegetables in any way? By boiling, damping, frying, woking?"and "Do you know the percentage of fat in that cream?"

During the final stages of the interview, questions aimed at helping participants remember additional intake were asked. In example; “Did you have anything to drink with that meal?” Did you eat any snacks or sweets during the day?” “Can you remember eating or drinking anything before or after you…?”, “Did you use any cooking fats or oils?” and “Did you add any sugar/salt/spices in dish?” Finally, all participants were asked if they had used any supplements the last 24 hours. If this was the case, they were asked to recount brand and dosage if possible. Those who could not remember the product name, were asked to describe the container and packaging to enable identification of the product. Based on these descriptions, online searches for the product were conducted during the interview, and potential supplements were described to the participants for verification.

4.3.2 Data entry, recording and registration

4.3.2.1 Dietary intake-food identification

The information on dietary intake obtained in the 24-hour recalls was registered in an excel spread sheet. Each participant’s intake of food or beverages reported in the interview was registered with the participants identification number, and each food or beverage were registered in a separate row. All food or beverage were also assigned a food identification number (food code). For most items the food code were retrieved from The Norwegian Food Composition Table (FCT), representing the most compatible product registered in this database (Norwegian Food Safety Authority, 2020). Food coding was performed systematically, and “rules” of coding were established for all foods that were described insufficiently or ambiguously i.e., bread was coded as “mellomgrov kneip” (25-50% wholemeal) in all cases where the participant could not recall which type of bread they had eaten. When possible, the chosen code included how the food was prepared or cooked. For example, a food code for cooked carrots were used in registration of carrots in soups or casseroles. In cases where no comparable food or beverage was found in FCT, the Swedish Food Composition Database (Livsmedelsdatabasen) (Swedish National Food Agency, 2020) or the Dutch Food Composition Database (NEVO) (Dutch National Institute for Public Health and the Environment, 2019), were searched for suitable matches. These databases were chosen as most of the reported products missing from FCT were plant-based replacement products, and Sweden and Netherlands are known to have a wider collection of these products on the market (Enjoli, 2021

; Hälsans kök, 2021; Oatly, 2021; Vivera, 2021). Moreover, some products reported, were of well-known Swedish or Dutch brands (Hälsans kök, 2021; Oatly, 2021; Vivera, 2021), making it more likely that they were registered in Livsmedelsdatabasen. In addition, both databases were easy to access through free of charge downloading (Swedish National Food Agency, 2020) or online (Dutch National Institute for Public Health and the Environment, 2019) versions. In cases where no suitable match was not found in either of the three databases, nutrient content was registered from the package information, or from the producer’s own websites. This applied to all dietary supplements and some foods and beverages.

A separate spread sheet designed to mimic the FCT was generated to register nutrient content of all foods and beverages that were not found in the FCT. A food code in the same format as the food codes in the FCT was generated for each product. The available information on nutrient content obtained from the two international databases, producer’s websites or product package, were registered in gram, milligram or microgram per 100 grams produce for all foods. However, the nutrient content of supplements was registered per unit, i.e., tablet/capsule/pill as information on dosage was usually given in units as opposed to in grams.

4.3.2.2 Dietary intake-conversion into grams

The quantity of consumed foods and beverages was converted into grams based on the description given by the participants before registration in the excel spread sheet (intake file). In cases where the participant described quantity as share of a product, but did not know the total weight, amount or size of the whole product, this information was obtained from producer’s website, online stores or the package of a physical product. Information about the total weight of the product were used to calculate weight of intake i.e., the weight of two sausages from a packet of five with total weight of 600 g was calculated as (600/5) x 2. The online diet-tool, “Kostholdsplanleggeren” (Norwegian Directorate of Health and the Norwegian Food Safety Authority, 2020), and the document “Weights, measures and portion sizes for foods” (2015) was used to standardize calculation of quantity into grams. If no such information was available, the foods were weighed by the master student for an approximate calculation. The mean of two weightings were used for each product. Whenever the quantity of products was described in another measure than in “Kostholdsplanleggeren” or “Weights, measures and portion sizes for foods” the following conversions were applied: 1 dl = 7 tablespoons, 1 table spoon = 3 tea spoons. Supplements was registered as 100 g per unit;

tablet, capsule, pill. Thus, registered intake of 100 g supplement would equal nutrient content of one tablet, capsule or pill. Accordingly, intake of i.e., two tablets, capsules or pills was registered as 200 g.

4.3.2.3 Dietary intake-standardized recipes

Standardized recipes were developed for bakery, dishes, mixes of nuts, granola, salads and etc. and used to calculate approximate intake in cases where participants could not give a detailed account of all the ingredients and their quantity (appendix). This applied to most of the take-away or restaurant dishes as well as the vegetarian or vegan versions of foods or dishes traditionally made with dairy or meat, i.e., pizza, kebab, sushi, spring rolls, cakes, waffles, cinnamon buns. The quantities of the ingredients in the standard recipes were divided or multiplied according to the total quantity of the dish or food the participant reported to have consumed.

4.3.2.4 Dietary intake of meat and dairy substitutes

Each participant’s intake of meat and dairy substitutes reported in the 24-hour recall, was pulled from the raw data by food codes using functions in Microsoft Excel. The substitutes were categorized into the following subtypes of product. Meat substitutes; “burgers”, “sausages”, “mince and balls”, “nuggets and schnitzel”, “cold cuts and spreads” and “other” and dairy substitutes; “milk”, “cheese”, “yoghurt”, “cream and crème fraiche” and “ice cream”. The category “others” contained various meat substitutes products intended to replace filets, salad meats, among others. These products were combined in a single category because there were either too few products in each subcategory, or identification of a specific category was difficult. All information about the raw material of the substitute products were primarily obtained from the manufacturer’s website. In cases of insufficient information about ingredients on the manufacturer’s website, information was obtained from an online grocery store which offered the product for sale.

4.3.3 Estimation of nutrient intake from 24-hour recalls

The program “FoodCalc” was used to calculate intake of nutrients per person and per food group (Lauritsen, 2019). This program combines nutrient content data from food composition tables with data on the quantity of foods consumed, usually an “intake-file” to calculate dietary intake of nutrients. In this study, the total dietary intake of nutrients and the intake of nutrients from supplements alone, were calculated for each person. Six micronutrients of concern were selected for further examination in cut point analysis. In addition, the contribution of different food groups to the intake of the seven selected micronutrients (vitamin D, vitamin B12, calcium, iron, zinc, selenium and iodine) was assessed. Intake of nutrients was calculated per food group for 36 different groups. Food groups were decided partly based on classification in the FCT, but most were divided further into subgroups. Additional categories of different meat and dairy substitutes and foods frequently consumed in a plant-based diet were also included. The food groups are presented in table 3.

Table 3 Food groups used in calculation of nutrients

1	Milk and dairy	10	Vegetables*	19	Juice and smoothies*	28	Meat substitutes*
2	Egg	11	Leafy, green vegetables and kales*	20	Other beverages*	29	Various vegetarian*
3	Fish and seafood	12	Root vegetables*	21	Energy drinks*	30	Seaweed products*
4	Oils, fats, butter	13	Fruits and berries*	22	Alcohol*	31	Tofu*
5	Whole grains*	14	Legumes and pulses*	23	Salty snacks*	32	Yeast
6	Grains*	15	Sweet spreads and jams*	24	Various foods	33	Salt, stock, soy sauce*
7	Sweet baked goods*	16	Sweet beverages*	25	Plant-based milk substitutes*	34	Protein powder
8	Nuts and seeds*	17	Desserts/puddings*	26	Dairy substitutes*	35	Supplements
9	Potatoes	18	Sweets and chocolates*	27	Dairy substitutes, sweet*	36	Spices*

* Subgroups of food groups in the FCT

4.3.4 Control of error in registration

Preliminary descriptive analysis in SPSS was conducted on the FoodCalc file to check for errors in registration. Extreme values and outliers were examined for all nutrients, and checked against the excel spread sheet and the written record from interviews. Because several mistakes were uncovered, a full review of the written records from interviews and the spread sheet was conducted, before re-running the FoodCalc. The procedure was repeated several times, until no more mistakes could be found by examining outliers and extreme values.

4.3.5 Reference values for assessment of dietary intake

In this master, the assessment of adequacy of dietary intake was based on average requirements (AR) from the NNR for adults (table 4) (NNR, 2012), and calculated using the cut-point method for six of the seven selected micronutrients (Gibson, 2005, pp. 2017-2018). This method uses the AR as a level of adequacy (cut-point), and estimates the prevalence of adequate and inadequate intake by counting the number of individuals with intake above and below the AR respectively. However, the test was only conducted on micronutrients, which met the assumption of equal distribution of requirements around the AR.

Table 4 Recommendations for micronutrient intake, Nordic Nutrition Recommendations 2012

Micronutrient		**Vitamin A (RAE)**	**Vitamin D (µg)**	**Vitamin E (α-TE)**	**Thiamine (mg)**	**Riboflavin (mg)**
RI/d[1]	Women/Men*	700/900	10	8/10	1.1/1.4	1.3/1.7
AR/d[2]	Women/Men*	500/600	7.5	5/6	0.9/1.2	1.1/1.4
Micronutrient		**Niacin (NE)**	**B_6 (mg)**	**Folate (µg)**	**B_{12} (µg)**	**Vitamin C (mg)**
RI/d[1]	Women/ Men*	15/18	1.2/1.5	300 (400)**	2	75
AR/d[2]	Women/Men*	12/15	1.0/1.3	200	1.4	50/60
Micronutrient		**Calcium (g)**	**Phosphorus (mg)**	**Magnesium (mg)**	**Sodium (mg)**	**Potassium (g)**
RI/d[1]	Women/Men*	800	600	280/350	2.4[3]	3.5/3.5
AR/d[2]	Women/Men*	500	450	-	-	-
Micronutrient		**Iron (mg)**	**Zinc (mg)**	**Iodin (µg)**	**Selenium (µg)**	**Copper (mg)**
RI/d[1]	Women/Men*	15/9	7/9	150	50/60	0.9
AR/d[2]	Women/Men*	10/7	5/6	100	30/35	0.7

[1] Recommended intake per day
[2] Average requirement per day
[3] Population goal
* One value if the same level recommended for women and men
** Women of reproductive age

4.4 Statistical analyses

Statistical analysis was conducted in IBM SPSS version 27. (IBM Corp., Armonk, Ny, USA). Normal distribution was tested by Shapiro-Wilks and visual examination of QQ plots and histograms. Variables with non-normally distributed data in at least one of the dietary groups, were presented in median and Inter Quartile Range (IQR). Chi-Square test was used for categorical data and Kruskal-Wallis test with pairwise comparisons was for non-normally distributed continuous data. A significance level of 0.05 was used for all tests. Binary logistic regression was performed to examine the association of seven independent variables (gender, age, diet, duration, health motivation, animal welfare motivation, climate motivation) and intake of meat substitutes and dairy substitutes respectively. The independent variables to be tested were selected based on theory (Bohrer, 2019; Gehring et al., 2020; Haas, Schnepps, Pichler, & Meixner, 2019; Ismail et al., 2020; Silva et al., 2020). Dummy variables were created for all categorical variables with more than two categories. First, univariate analysis was performed. Then an adjusted analysis where only variables significantly associated with the outcome based on backwards selection of variables was performed. Tables and figures were produced using IBM SPSS version 27 and Excel, Microsoft Office Home and Student 2016.

4.5 Ethical considerations

The first part of the study was approved by the Regional Committees for Medical and Health Research Ethics, 2019/653/REC South East and the Norwegian Centre for Research Data/NSD/101332 (Appendix 3). In addition, we applied for ethical approval to conduct the second part of the study (Appendix 4). Written consent was obtained from all participants at initial recruitment and prior to study start (Appendix 1) (Groufh-Jacobsen et al., 2020). The participants were informed about the purpose of the study and their right to withdraw at any time. Further, the participants were informed about how personal data would be treated and stored, and that only researchers and master students involved in the study would be allowed access. The participants could optionally fill in contact information in the consent form if they agreed to answer further questions (Appendix 1). All personal and sensitive data was stored on an encrypted memory stick, and only the master student knew the password.

5.0 Results

5.1 Participants

Background characteristics are presented in table 5. A total of 158 participants, of which 117 (74.1%) women and 41 (25.9%) men, were included in the study. More than half (52.5%) of the participants were classified as vegans, nearly one third (29.7%) as vegetarians and less than one fifth (17.7%) as pescatarians. Women were overrepresented in all dietary groups, and the average age at the time of recruitment was 27 years. Almost all participants (96.9%) reported Norway as country of birth or having lived in Norway for at least 10 years. About one third of the participants were students and almost two thirds in current employment, only a small percentage (3.8%) reported work status as unemployed. The majority of the participants (83.2%) reported educational level as ≥1-4 years college/university. The median duration of dietary practice was 4 years and most participants (92,1%) reported to be informed about how to compose a nutritionally adequate plant-based diet. Motivations for eating plant-based reported by participants were animal welfare (84.8%) climate change (72.8%) and health (52.5%). Most participants (71.5%) were defined as being normal weight, and there was little variation between dietary groups. Overweight was present in 24.7% of the total sample, and the highest percentage (29.8%) was seen in vegetarians. Participants defined as underweight, accounted for 3.8%. Finally, 8.9% of the participants reported smoking.

Table 5 Background characteristics of vegans (n=83), vegetarians n=47) and pescatarians (n=28).

Background		Total		Vegans		Vegetarians		Pescatarians		p -value[1]
		n	(%)	n	(%)	n	(%)	n	(%)	
Participants		158	(100)	83	(52.5)	47	(29.7)	28	(17.7)	
Gender	Female	117	(74.1)	54	(65.1)	37	(78.7)	26	(92.9)	0.01
	Male	41	(25.9)	29	(34.9)	10	(21.3)	2	(7.1)	
Age*		27	(24-33)	28.00	(24-35)	28	(24-33)	27	(22-30)	0.27
BMI (kg/m^2)	<18.50	6	(3.8)	2	(2.4)	3	(6.4)	1	(3.6)	0.57
	18.50-24.99	113	(71.5)	61	(73.5)	30	(63.8)	22	(78.6)	
	≥25.00	39	(24.7)	20	(24.1)	14	(29.8)	5	(17.9)	
Duration*		4	(2-7)	3	(2-5)	4	(2-11)	5	(2-10)	0.19
Marital status	Single	79	(50.0)	37	(44.6)	25	(53.2)	17	(60.7)	0.29
	Cohabitant/ Married	79	(50.0)	46	(55.4)	22	(46.8)	11	(39.3)	
Education level	≤12 years	28	(17.7)	15	(18.1)	9	(19.1)	4	(14.3)	0.86
	≥1-4 years college/ university	130	(82.3)	68	(81.9)	38	(80.9)	24	(85.7)	
Work status	Unemployed	6	(3.8)	4	(4.8)	1	(2.1)	1	(3.6)	0.86
	Student	50	(31.6)	27	(32.5)	13	(27.7)	10	(35.7)	
	Employed	102	(64.6)	52	(62.7)	33	(70.2)	17	(60.7)	
Years in Norway	1-10	5	(3.2)	4	(4.8)	1	(2.1)	0	(0.0)	0.48
	>10	31	(19.6)	13	(15.7)	12	(25.5)	6	(21.4)	
	Country of birth	122	(77.2)	66	(79.5)	34	(72.3)	22	(78.6)	
Smoking habits	Yes	14	(8.9)	7	(8.4)	6	(12.8)	1	(3.6)	0.39
	No	144	(91.1)	76	(91.6)	41	(87.2)	27	(96.4)	
Nutritional knowledge [2]	Yes	139	(92.1)	77	(96.3)	38	(84.4)	24	(92.3)	0.06
	No/do not know	12	(7.9)	3	(3.75)	7	(15.6)	2	(7.7)	
Motivation[23]	Climate	115	(72.8)	62	(74.7)	33	(70.2	20	(71.4)	
	Health	83	(52.5)	46	(55.4)	21	(44.7)	16	(57.1)	
	Animal Welfare	134	(84.8)	74	(89.2)	41	(87.2)	19	(67.9)	

*Median (IQR), age and duration of dietary practice

[1] p-values for Chi-Square test for categorical data, and Kruskal-Wallis for continuous data

[a-b] Dietary groups with the same superscripts, have proportions that differ significantly in the post hoc test ($p<0.05$)

[2] The question was included in the questionnaire after pilot testing; therefore, information is missing for 7 participants

[3] It was possible to choose more than one option; the total therefore exceeds 100%

5.2 Dietary intake of macronutrients and micronutrients (objective 1)

5.2.1 Macronutrients

Table 6 presents the median (IQR) intake of macronutrients in absolute values (g) and in relative energy percentage (E%). Neither energy or fat intake differed significantly between dietary groups, and all groups had median energy percentages from fat within the recommendation of 25-40 E%. Median E% from saturated fatty acids (SFA) was 6 E% (IQR=

4-9), 10 E% (IQR= 6-15) and 10 E% (IQR= 5-14) in vegans, vegetarians and pescatarians respectively (p<0.01). Vegans had significantly lower intake of SFA than both vegetarians (p<0.01) and pescatarians (p<0.01), and similar trends were seen in absolute intake of SFA (g). Only vegans were found to have median SFA E% that complied with the recommendations of <10 E%. No significant differences were detected between groups when comparing absolute intake or E% from monounsaturated fatty acid (MUFA). The median MUFA E% was within the recommended range of 10-20 E% in all dietary groups, but percentages were in the lower end. Although absolute polyunsaturated fatty acid (PUFA) intake did not differ significantly between dietary groups, the relative median intake of PUFA reported by vegans which was 8 E% (IQR= 6-10), was significantly higher than the median reported by vegetarians (6%, IQR= 5-8; p=0.01). However, the median PUFA E% was within the recommended 5-10 E% in all groups. The relative intake of omega-3 was 1.2 E% (IQR= 0.7-1.8) in pescatarians, 0.5 E% (IQR= 0.4-1.0) in vegetarians and 0.7 E% (IQR= 0.5-1.2) in vegans. Compared with pescatarians the E% was lower in both vegetarians (p<0.01) and vegans (p=0.01), and pescatarians were the only group within recommendations of ≥1 E% of omega-3.

Pescatarians also reported a significantly higher relative protein intake than both vegans (p=0.03) and vegetarians (p=0.02). However, all dietary groups were within the recommended range of 10-20 E%, as the median E% from protein was 13 E% (IQR= 11-15), 13 E% (IQR= 10-15) and 15 E% (IQR= 13-17) in vegans, vegetarians and pescatarians respectively. Neither absolute (p=0.27) or relative carbohydrate intake (p=0.13) differed between groups, and the relative intake was within the recommendations of 45-60 E%. Although the absolute intake of added sugar did not differ significantly between groups, it accounted for a significantly higher E% in vegetarians than in both vegans (p=0.01) and pescatarians (p=0.04). However, the relative median intake of added sugar, which equalled 2 E% in both vegans (IQR= 0-5) and pescatarians (IQR= 1-5), and 4 E% (IQR= 1-8) in vegetarians, were well below the recommendations of <10 E% from added sugar in all groups. The median intake of dietary fibre was 5.2 g/MJ (IQR= 4.1-6.0) in vegans, 3.8 g/MJ (IQR= 2.8-4.7) in vegetarians and 4.2 g/MJ (IQR= 2.7-5.1) in pescatarians, and thereby above the recommendations of 3 g/MJ in all groups. Vegans reported significantly higher intake compared with both vegetarians (p<0.01) and pescatarians (p<0.01). No significant differences were found in salt intake, but only pescatarians reported median salt intake above the recommendations of ≤6 g.

Table 6 Total dietary intake of macronutrients (g and E%) in vegans, vegetarians and pescatarians, and recommended daily intake (RI) according to NNR 2012

	Total (n=158)		**Vegans (n= 83)**		**Vegetarians (n= 47)**		**Pescatarians (n=28)**		**P-value[1]**	**NNR**
	median	**(IQR)**	**median**	**(IQR)**	**median**	**(IQR)**	**median**	**(IQR)**		RI E%
Kilocalories	2052	(1546-2516)	2076	(1521-2683)	2056	(1588-2467)	1910	(1490-2389)	0.76	-
Fat (g)	72	(50-100)	71	(50-99)	71	(50-110)	79	(47-99)	0.94	-
SFA (g)*	17	(11-28)	15[ab]	(9-20)	20[a]	(12-39)	22[b]	(10-34)	<0.01	-
TFA (g)*	0	(0-0)	0[ab]	(0-0)	0[a]	(0-1)	0[b]	(0-1)	<0.01	-
MUFA (g)*	25	(16-37)	25	(16-37)	25	(15-39)	27	(19-40)	0.77	-
PUFA (g)*	16	(11-26)	17	(12-29)	13[a]	(10-24)	15	(10-21)	0.10	-
Omega-3 (g)	1.6	(1.0-3.0)	1.6[a]	(1.1-3.0)	1.3[b]	(0.7-2.4)	2.3[ab]	(1.4-4.4)	0.01	-
Protein (g)	63	(50-85)	63	(51-86)	63	(48-80)	64	(55-88)	0.48	-
Carbohydrate (g)	235	(191-304)	238	(191-306)	237	(192-315)	214	(178-263)	0.27	-
Added sugar (g)	11	(3-34)	9	(1-25)	23	(4-39)	10	(3-25)	0.05	-
Dietary fibre (g)	37	(27-49)	40[ab]	(32-56)	30[a]	(24-43)	32[b]	(22-44)	<0.01	-
Salt (g)	5.8	(3.5-8.7)	6.0	(3.6-9.9)	5.2	(3.4-8.1)	7.0	(3.4-8.4)	0.51	≤6
Alcohol g	0.0	(0.0-0.0)	0.0	(0.0-0.0)	0.0	(0.0-0.0)	0.0	(0.0-0.0)	0.80	< 5
Fat (E%)	33	(26-39)	31	(25-38)	35	(27-40)	33	(26-44)	0.29	25-40
SFA (E%)*	8	(5-11)	6[ab]	(4-9)	10[a]	(6-15)	10[a]	(5-14)	<0.01	<10
TFA (E%)*	0	(0-0)	0[ab]	(0-0)	0[a]	(0-0)	0[b]	(0-0)	<0.01	**
MUFA (E%)*	11	(8-15)	11	(8-15)	12	(9-14)	12	(9-16)	0.34	10-20
PUFA (E%)*	7	(5-10)	8[a]	(6-10)	6[a]	(5-8)	7	(5-9)	0.03	5-10
Omega-3 (E%)	0.7	(0.5-1.2)	0.7[b]	(0.5-1.2)	0.5[a]	(0.4-1.0)	1.2[ab]	(0.7-1.8)	<0.01	≥1
Protein (E%)	14	(11-15)	13[b]	(11-15)	13[a]	(10-15)	15[ab]	(13-17)	0.05	10-20
Carbohydrate (E%)	50	(43-55)	51	(44-56)	50	(41-56)	47	(39-51)	0.13	45-60
Added sugar (E%)	2	(1-6)	2[a]	(0-5)	4[ab]	(1-8)	2[b]	(1-5)	0.03	<10
Dietary fibre (g/MJ)	4.4	(3.5-5.7)	5.2[ab]	(4.1-6.0)	3.8[a]	(2.8-4.7)	4.2[b]	(2.7-5.1)	<0.01	>3

[1] P-value for difference between different dietary groups, Kruskal Wallis Test
[ab] Dietary groups with the same superscripts differed significantly in the post hoc test (p<0.05)
* SFA – saturated fatty acids; TFA- trans fatty acids; MUFA – monosaturated fatty acids; PUFA – polyunsaturated fatty acids
** As low as possible

5.2.2 Micronutrients

Table 7 presents the intake of micronutrients in the sample. Overall, the median intake was equal to or above the AR for most micronutrients in all dietary groups, with the few following exceptions. Vegans reported median intake of vitamin A below the AR (women and men), and vegetarians reported median intake of vitamin D and iodine below the AR. Furthermore, the vegetarians had median intake of vitamin A, niacin and selenium below the AR estimated for men, though within the AR estimated for women. In all dietary groups, the 25[th] percentile for intake was equal to, or above, the AR for the following micronutrients; vitamin E, thiamine, folate, calcium, zinc, copper and phosphorus.

No significant differences in median (IQR) intake between groups were found for the following micronutrients, vitamins A and D, folate, calcium, magnesium, zinc, phosphorus or iodine. Significant differences in intake were observed between vegans and vegetarians for ten micronutrients. Vegans reported significantly higher median (IQR) intake than vegetarians of all the B vitamins (all p<0.01) except folate, and for vitamin E, vitamin C, iron, potassium, and copper (all p=0.01). The median (IQR) intake of B_6, was significantly higher in vegans also when compared to pescatarians (p<0.01). Pescatarians however, reported a significantly higher median intake of selenium than both vegans (p=0.02) and vegetarians (p=0.01).

Table 7 Total dietary intake of micronutrients in vegans, vegetarians and pescatarians (n=158) and the daily average requirement (AR) based on NNR 2012.

	Total (n=158)		Vegans (n= 83)		Vegetarians (n= 47)		Pescatarians (n=28)		P-value[1]	NNR
	median	(IQR)	median	(IQR)	median	(IQR)	median	(IQR)		AR/d[2]
Vitamin A RAE	528	(278-862)	489	(267-897)	509	(254-652)	627	(406-906)	0.27	500/600
Vitamin D (µg)	10	(2-25)	16	(2-27)	5	(2-16)	10	(2-26)	0.10	7.5
Vitamin E (α-TE)	18	(13-27)	21[a]	(14-30)	16[a]	(12-21)	19	(13-24)	0.02	5/6
Thiamine (mg)	2.0	(1.2-2.9)	2.4[a]	(1.5-3.2)	1.5[a]	(1.2-2.4)	1.9	(1.3-2.3)	0.01	0.9/1.2
Riboflavin (mg)	2.0	(1.1-2.9)	2.2[a]	(1.5-3.1)	1.4[a]	(0.8-2.2)	2.0	(1.4-2.8)	0.01	1.1/1.4
Niacin (NE)	20	(13-29)	23[a]	(15-31)	14[a]	(10-21)	19	(13-25)	<0.01	12/15
B_6 (mg)	2.5	(1.4-3.5)	3.0[ab]	(2.1-4.0)	1.8[a]	(1.0-3.0)	2.0[b]	(1.5-2.8)	<0.01	1.0/1.3
Folate (µg)	470	(307-685)	520	(365-753)	396	(263-607)	450	(289-663)	0.06	200
B_{12} (µg)	5	(2-15)	10[a]	(2-26)	2[a]	(1-7)	5	(2-9)	<0.01	2
Vitamin C (mg)	157	(87-257)	195[a]	(110-319)	128[a]	(48-196)	143	(91-251)	0.01	50/60
Calcium (mg)	748	(525-1090)	744	(511-1022)	724	(521-1066)	871	(654-1195)	0.31	500
Iron (mg)	17	(10-29)	20[a]	(12-31)	12[a]	(8-24)	17	(10-31)	0.01	10/7
Potassium (g)	3.7	(2.5-4.7)	3.8[a]	(2.8-5.1)	3.2[a]	(2.1-4.1)	3.9	(3.0-4.7)	0.03	-
Magnesium (mg)	428	(325-603)	477	(340-685)	418	(313-541)	392	(328-575)	0.27	-
Zinc (mg)	11	(8-17)	13	(8-18)	8	(7-13)	12	(8-17)	0.08	5/6
Selenium (µg)	38	(17-79)	38[b]	(16-80)	32[a]	(16-57)	54[ab]	(33-99)	0.03	30/35
Copper (mg)	1.9	(1.4-2.7)	2.2[a]	(1.4-3.0)	1.6[a]	(1.2-2.5)	1.8	(1.3-2.4)	0.03	0.7
Phosphorus (mg)	1381	(962-1729)	1366	(929-1742)	1313	(923-1623)	1445	(1190-1858)	0.20	450
Iodine (µg)	130	(42-196)	157	(37-195)	93	(33-188)	146	(81-200)	0.23	100

[1]P-value for Kruskal-Wallis Test, difference between dietary groups

[ab] Dietary groups with the same superscripts differed significantly in the post hoc test (p<0.05)

[2] Average requirements, estimated value that meets the need of 50 percent of the population (AR women/AR men). One value if the same level is recommended for women and men

5.3 Average requirement of selected micronutrients (objective 2)

The number of participants meeting the average requirement (AR) for dietary intake of selected micronutrients is presented in table 8. The overall highest percentage of participants meeting the AR was found for zinc (93 %), and the lowest for iodine (55 %), vitamin D (57

%) and selenium (58 %). Chi-Square Test for differences between dietary groups was significant for two micronutrients; vitamin D ($p=0.02$) and selenium ($p=0.01$). Pairwise comparisons found the percentage of participants meeting the AR for vitamin D to differ significantly only between vegans (66 %) and vegetarians (40 %) ($p<0.05$). For selenium, pescatarians had a significantly higher percentage of participants meeting the AR (82 %) than both vegans (53 %) and vegetarians (51 %). Chi-Square for vitamin B_{12} was borderline significant ($p=0.051$), and pairwise comparisons found the percentage of pescatarians meeting the AR (93 %) to be significantly higher than the percentage of vegetarians meeting the AR (70 %) ($p<0.05$). The most consistently high percentages of participants meeting the AR across groups were seen for zinc, ranging from 91 % of the vegetarians to 96 % of the pescatarians. A similar consistence was found in calcium, ranging from 77 % of the vegetarians to 86 % of the pescatarians. For iodine, 68 % of the pescatarians and approximately half of the vegans (55 %) and vegetarians (47 %) met the AR.

Table 8 Vegans, vegetarians and pescatarians (n=158) meeting average requirement (AR) of selected micronutrients: vitamin D, B12, calcium, zinc, selenium and iodine

	Total (n=158)		Vegans (n=83)		Vegetarians (n=47)		Pescatarians (n=28)		P-value[3]
	n	%	n	%	n	%	n	%	
Vitamin D	90	57	55[a]	66	19[a]	40	16	57	0.02
Vitamin B_{12}	127	80	68	82	33[b]	70	26[a]	93	0.05
Calcium	125	79	65	78	36	77	24	86	0.62
Zinc[2]	147	93	77	93	43	91	27	96	0.71
Selenium[2]	91	58	44	53[a]	24	51[b]	23	82[ab]	0.01
Iodine	87	55	46	55	22	47	19	68	0.21

[1]Intake meeting average requirement based on NNR

[2]Different cut-off values in women and men according to the average requirement.

[3]P-value for Chi-Square Test, difference between dietary groups

[ab] Dietary groups with the same superscripts differ significantly proportions in the post hoc test ($p<0.05$)

5.4 Contribution from different food groups to the intake of selected micronutrients (objective 3)

5.4.1 Vitamin D

The major source of vitamin D (90 %) in the diet were supplements (figure 2), and only 10 % came from food. The largest non-supplement source of vitamin D was plant-based milk which accounted for 3 % of the intake. Oils and fats contributed to 2 %, fish and seafood to 1 % and minor sources to 4 % of the vitamin D intake.

5.4.2 Vitamin B_{12}

Supplements accounted for almost the entire dietary intake of B_{12}, (98 %) (figure 3). Only 2 % of vitamin B_{12} came from food, of which the largest contributions were from “fish and seafood”, “milk and dairy”, “plant-based milks and plant-based cheese".

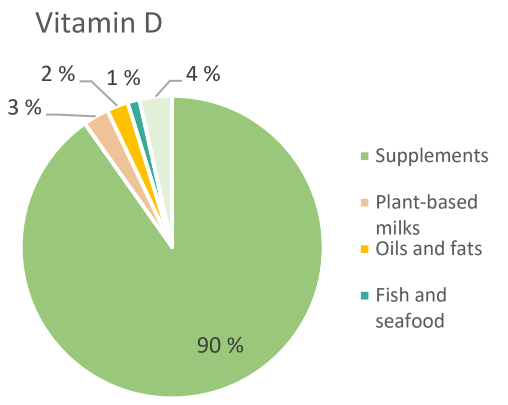

Figure 2 Sources of vitamin D in the diet, Minor sources (13 food groups)

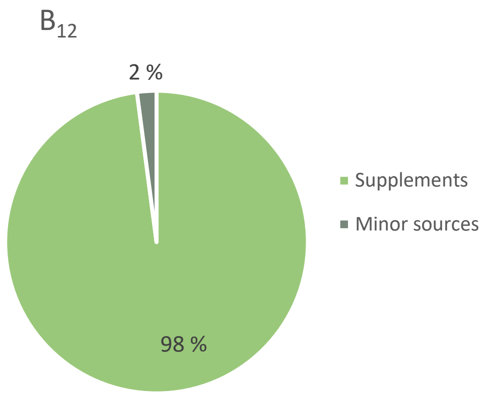

Figure 3 Sources of vitamin B_{12} in the diet, Minor sources (22 food groups)

5.4.3 Calcium

The three largest sources of calcium in the diet were “milk and dairy” (16 %), “plant-based milks” (15 %) and “tofu” (13 %) (figure 4). In addition, “plant-based dairy”, “leafy and green vegetables” and wholemeal grains contributed to 15 % of the calcium in the diets, while supplements accounted for 5 %. “Vegetables”, “nuts and seeds”, fruits and berries” and “legumes and pulses” made up 16 % of the calcium, and the remaining 20 % were from 24 minor sources.

5.4.4 Iron

The single major dietary source of iron was supplements (44 %) (figure 5), while “wholemeal grains” was the largest food source (14 %). “Nuts and seeds” accounted for 5 %, and “legumes, pulses”, “grains” and “vegetables” each contributed to 4 % of the iron, while “plant-based milks”, “fruits and berries” and “meat substitutes” contributed to 3 % each. The remaining 16 % came from 24 minor sources.

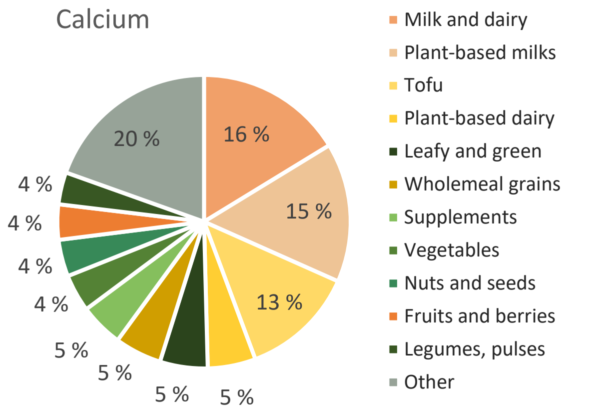

Figure 4 Sources of calcium in the diet, “Other” = 24 minor sources with contributions less than 3 %

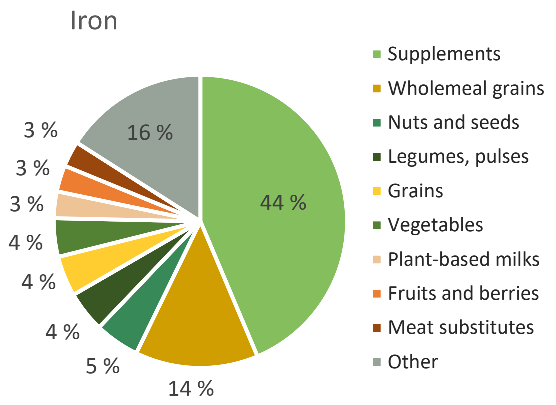

Figure 5 Sources of iron in the diet, “Other” = 24 minor sources with contributions less than 3 %

5.4.5 Zinc

The single largest source of zinc in the diet was supplements (29 %) (figure 6). The largest non-supplement sources were “wholemeal grains” (18 %), “grains” (8 %) and “legumes, pulses” (8 %). Additionally, “milk and dairy”, “legumes and pulses”, “vegetables”, “fruits and berries” and “plant-based milks” contributed to 19 % of the dietary zinc, while 22 minor sources combined accounted for 18 %.

5.4.6 Selenium

Supplements were also the single major source of dietary selenium (36 %) (figure 7). The largest food sources, including “legumes, pulses” (10 %), “wholemeal grains” (10 %), “grains” (8 %), “fish and seafood” (7 %) and “nuts and seeds” (6 %), which collectively contributed to 41 % of the selenium intake. Three smaller food sources, “Plant- based milks”, “milk and dairy” and “meat substitutes accounted for 11 % of the selenium intake, while 19 minor sources made up the remaining 12 %.

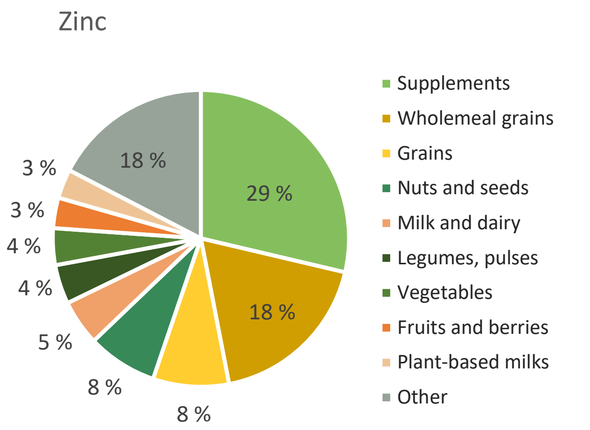

Figure 6 Sources of zinc in the diet, “Other” = 22 minor sources with contributions less than 3 %

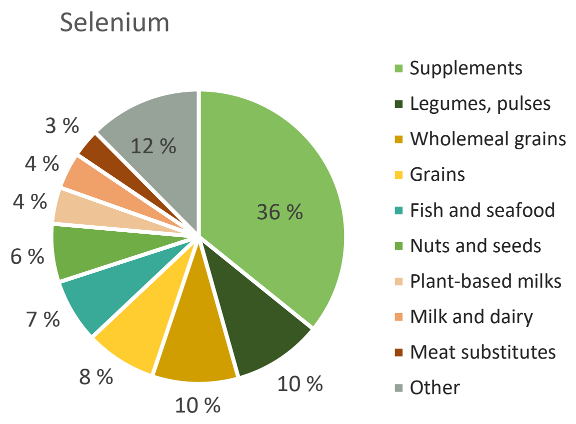

Figure 7 Sources of selenium in the diet, “Other” = 19 minor sources with contributions less than 3 %

5.4.7 Iodine

Supplements accounted for more than half of the dietary iodine intake (55 %) (figure 8). The largest food-based sources were “milk and dairy” (9 %) and “beverages, including coffees with milk” (8 %). Smaller food sources contributed to 14 % of the iodine, and these were “fish and seafood” (4 %), “fruits and berries” (3 %), “seaweed products” (3 %), “meat substitutes” (2 %) and “vegetables” (2 %). The remaining 14 % came from 24 minor food sources.

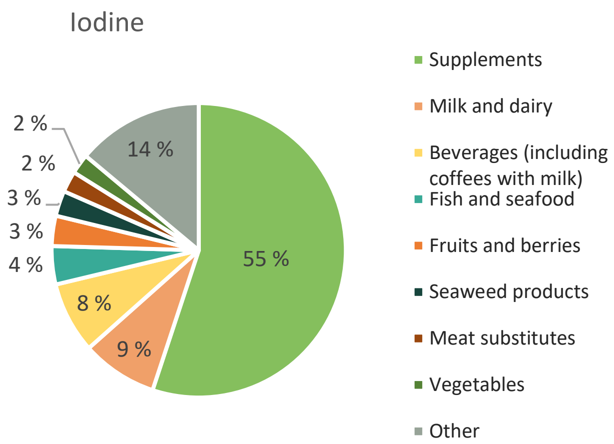

Figure 8 Sources of iodine in the diet, “Other” = 24 minor sources with contributions less than 2 %

5.4.8 Nutrient intake from supplements

Supplements were one of the main sources of most of the selected micronutrients (figure 1-2,4-7). However, supplements were a source of several other micronutrients than those presented in figures 1-7, and the median intake of all micronutrients from supplements are presented in table 9. Several 62 vegans (75 %), 28 vegetarians (60 %) and 17 pescatarians (61 %) reported use of supplements, in total 107 participants (68 %). Overall vegans reported the highest median intake of micronutrients from supplements in comparison to the other dietary groups. Significant differences in intake from supplements between dietary groups were found for vitamin D (p=0.01), B_6 (p=0.03), B_{12} (p<0.01) and calcium (p<0.01). Pairwise comparison showed the difference in supplement intake of vitamin D to be between vegans and vegetarians only (p<0.01), with the highest intake in vegans. Vegans also reported significantly higher intake of B_6 from supplements than pescatarians (p=0.02). The intake of B_{12} from supplements was significantly higher in vegans than both vegetarians and pescatarians (both p<0.01). In addition, vegans reported slightly higher median intake of calcium from supplements than vegetarians and pescatarians (both p<0.01).

Table 9 Intake of 15 selected micronutrients from supplements in vegans, vegetarians and pescatarians (n=107)

	Total (n=107)		**Vegans (n=62)**		**Vegetarians (n=28)**		**Pescatarians(n=17)**		**P-value[1]**
	median	**(IQR)**	**median**	**(IQR)**	**median**	**(IQR)**	**median**	**(IQR)**	
Vitamin A (RAE)	0	(0-500)	224	(0-500)	0	(0-250)	0	(0-313)	0.10
Vitamin D (µg)	20	(6-25)	20[a]	(10-30)	10[a]	(0-20)	10	(0-58)	0.01
Thiamine (mg)	0.6	(0.0-1.1)	0.7	(0.0-1.1)	0.0	(0.0-1.3)	0.6	(0.0-1.4)	0.51
Riboflavin (mg)	1.4	(0.0-1.6)	1.4	(0.5-1.6)	0.3	(0.0-1.6)	0.7	(0.0-1.6)	0.13
Niacin (NE)	8	(0-16)	8	(0-16)	0	(0-16)	8	(0-19)	0.43
B_6 (mg)	1.4	(0.0-2.0)	1.4[a]	(0.7-2.0)	1.1	(0.0-1.6)	0.7[a]	(0.0-1.6)	0.03
Folate (µg)	100	(0-400)	100	(0-200)	42	(0-350)	100	(0-400)	0.90
B_{12} (µg)	9.0	(2.0-25.0)	10.0[ab]	(9.0-50.0)	2.0[a]	(0.0-21.3)	2.0[b]	(0.0-7.0)	0.00
Vitamin C (mg)	40	(0-80)	40	(0-80)	25	(0-80)	75	(0-85)	0.79
Calcium (mg)	0	(0-100)	0[ab]	(0-173)	0[b]	(0-0)	0[a]	(0-0)	<0.01
Iron (mg)	7	(0-15)	7	(0-15)	1	(0-15)	15	(0-39)	0.13
Zinc (mg)	0	(0-10)	5	(0-10)	0	(0-10)	0	(0-12)	0.58
Selenium (µg)	0	(0-60)	0	(0-60)	0	(0-60)	0	(0-58)	0.87
Copper (mg)	0.0	(0.0-0.2)	0.0	(0-0)	0.0	(0.0-0.2)	0.0	(0.0-0.9)	0.64
Iodin (µg)	150	(0-150)	150	(70-150)	113	(0-150)	75	(0-150)	0.09

[1]P-value for Kruskal-Wallis Test, difference between dietary groups
[a-b] Dietary groups with the same superscripts, have proportions that differ significantly in the post hoc test (p<0.05)

5.5 Intake of plant-based substitutes (objective 4)

In total, 108 participants (68 %) reported intake of dairy substitutes and 69 participants (44 %) reported intake of meat substitutes in the 24HR. Approximately 1/3 of the participants had consumed both dairy and meat substitutes (33 %). Chi-Square was significant for difference in intake of "dairy substitutes" (p<0.01), and "meat and dairy substitutes" (p=0.02) between the different dietary groups. Although, Chi-Square for intake of meat-substitutes was non-significant, pairwise comparison found the percentage of participants reporting intake of meat substitutes to be significantly higher in vegans (52 %) than in pescatarians (29 %) ($p<0.05$). Similar differences between vegans and pescatarians were found in proportion of participants reporting intake of both meat and dairy substitutes ($p<0.05$). The proportion of vegans (81 %) that had reported intake of dairy substitutes was significantly higher than the percentage of both vegetarians (57 %) and pescatarians (50 %) ($p<0.05$). Figure 10 shows the percentage of participants within each dietary group that reported intake of meat and dairy substitutes. Across all dietary groups, the percentage of participants reporting consumption was higher for milk and dairy substitutes than for meat substitutes.

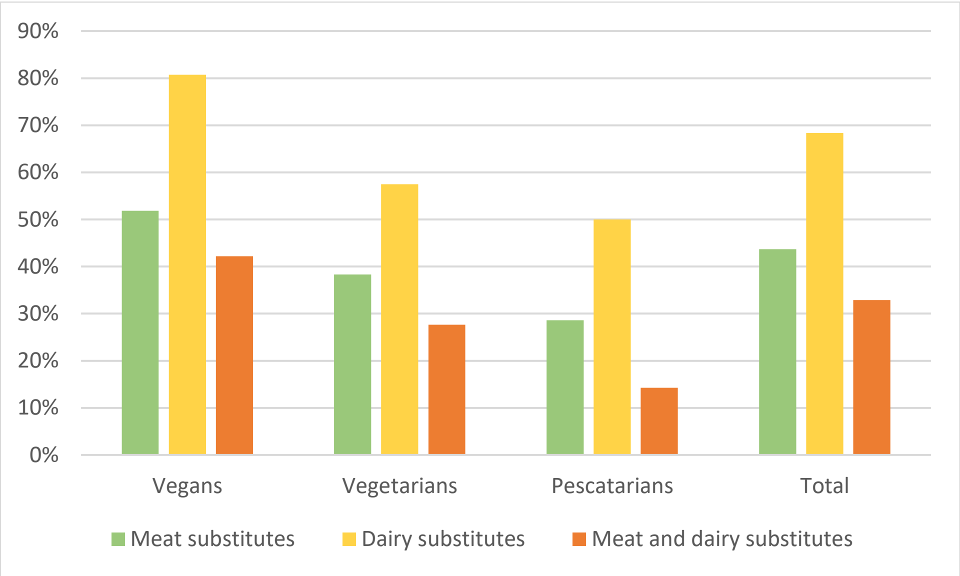

Figure 10 Percentage of vegans, vegetarians and pescatarians (n=158) reporting intake of meat substitutes and dairy substitutes reported in the 24HR

Figures 11 and 12 below present different categories of meat and dairy substitutes reported in the 24HRs. Some participants reported consumption of products in several different categories. The most frequently reported products were "cold cuts and spreads" (23 %) and "burger" (21%) in meat substitutes, and "milk" (53 %) and "cheese" (21 %) in dairy substitutes. Products in the three categories "mince/balls", "nuggets/schnitzel" and "sausages" were reported in approximately similar frequency (14-16%). The least frequently reported meat substitutes were in the category "other" which consisted of a variety of products from smaller product categories (27 %), while "ice cream" (4 %) was the dairy substitute least reported.

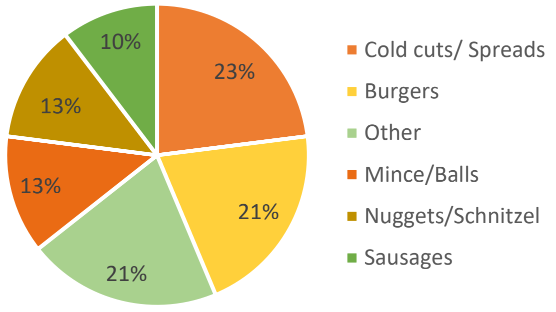

Figure 11 Meat substitute categories reported in 24HR, based on the number of participants reporting intake of a substitute product in each category. "Other" includes various substitute products for chicken, beef and pork bites/filets, spreads and cold cuts.

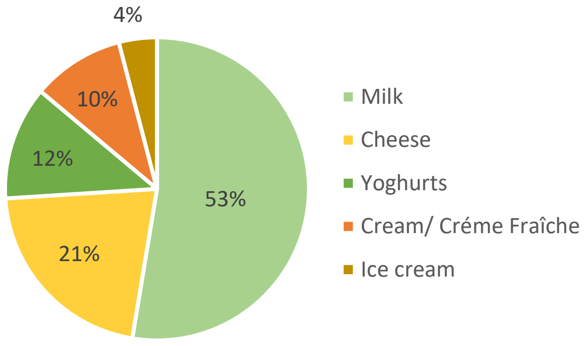

Figure 12 Dairy substitute categories reported in 24HR, based on the number of participants reporting intake of a substitute product in each category. "Cheese" includes hard cheeses and cream cheese

5.6 Raw ingredients in plant-based substitutes (objective 5)

Figure 13 presents the proportions within each category of plant-based meat substitute products according to main raw-ingredient and frequency of intake. In all, except one category, soy-based products were the most frequently reported, accounting for 44 % of the sausages, 56 % of the burgers, 54 % of the mince and balls, 64 % of the nuggets and schnitzels and 94 % of other products. In cold cuts and spreads, however, 50 % of the reported products were based on peas, as were 33 % of the burgers. The nuggets and schnitzels which were not soy-based were made from mixes of legumes and vegetables (36 %), and legumes and vegetables were also the main ingredients in 25 % of the cold cuts and spreads.

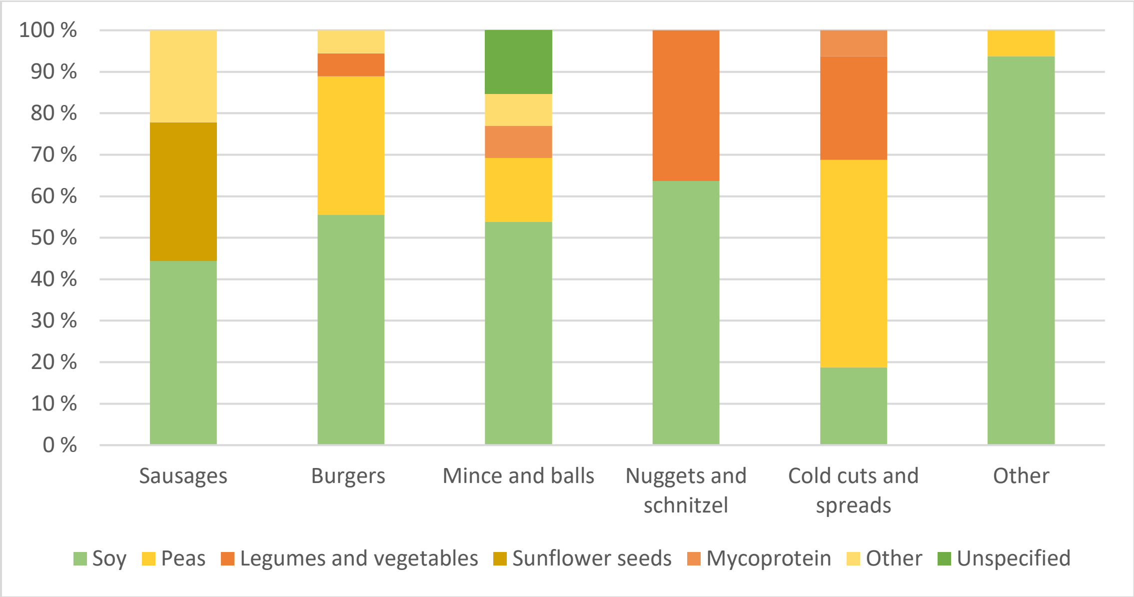

Figure 13 Proportions within each category of meat substitute products reported in 24HR, according to raw ingredients and frequency of intake.

In figure 14, the proportional intake of plant-based dairy substitutes within each category is presented, according raw ingredients in the products and frequency of reported use. Most of the reported plant-based dairy substitutes for milk, were based on oats (47 %) or soy (42 %) (figure 14). The majority of the yoghurts were soy-based (61 %), and the remaining products in this category were based on coconut milk (26 %) and oats (13 %). While the majority of creams and crème fraîche (67 %) were oat-based, 80 % of the cheese was based on modified starch. The percentages different raw materials in ice creams were relatively equally distributed, though oats and unspecified raw materials accounted for the largest proportions (each 22 %) of the reported intake.

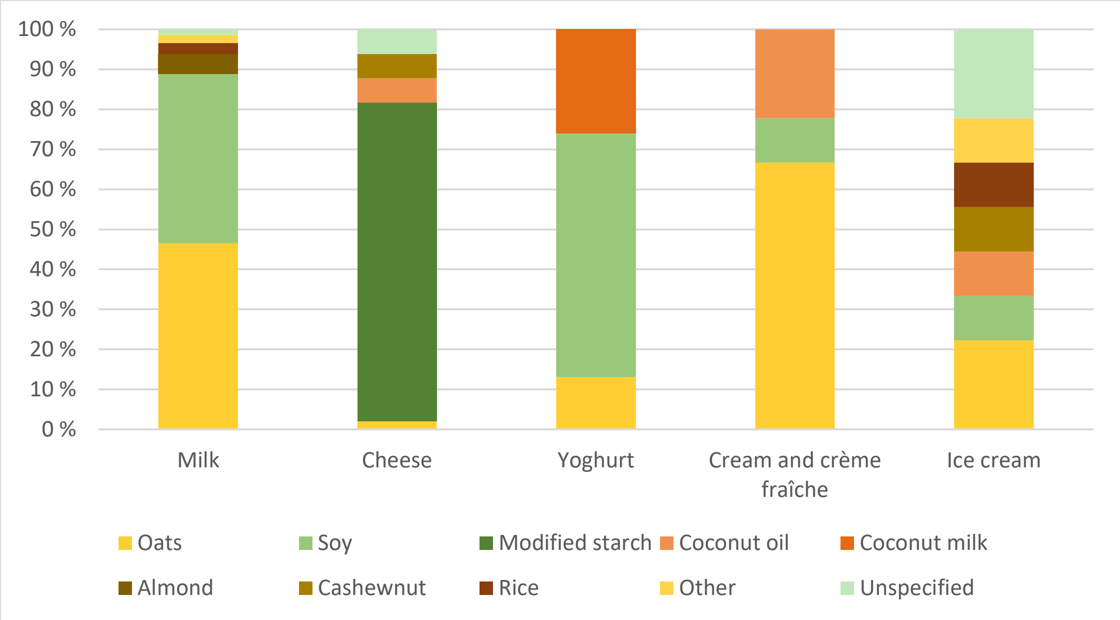

Figure 14 Proportions within each category of dairy substitute products reported in 24HR, according to raw ingredients and frequency of intake.

5.7 Predictors of plant-based substitutes in logistic regression (objective 6)

Logistic regression analysis predicting intake of meat substitutes in vegetarians, vegans and pescatarians was performed. As shown in table 10, only dietary practice, was a significant predictor in the adjusted model after backwards elimination. Compared to vegans (reference group) the pescatarians had a significantly lower odds of reporting intake of meat substitutes (OR 0.37, C.I 0.15-0.94, p=0.04).

Table 10 Logistic regression predicting intake of meat substitutes in vegans, vegetarians and pescatarians (n=69).

	Bivariate model				Adjusted model[1]			
	OR	95% CI		P-value	OR	95% CI		P-value
Gender (female as reference)	1.16	0.57	2.37	0.69				
Age (years)	1.01	0.97	1.04	0.63				
Diet (vs vegan)								
Vegetarian	0.58	0.28	1.20	0.14	0.58	0.28	1.20	0.14
Pescatarian	0.37	0.15	0.94	0.04	0.37	0.15	0.94	0.04
Duration (years)	0.99	0.90	1.08	0.77				
Health motivation (vs.no) [2]	1.60	0.83	3.08	0.16				
Animal welfare motivation (vs.no)[2]	0.83	0.30	2.29	0.72				
Climate motivation (vs. no)[2]	1.25	0.58	2.69	0.56				

[1] Adjusted model created by backward elimination (starting with all variables tested in bivariate models), no variables were significantly associated with dairy substitute intake were kept in the model. [2]Missing information in 7 participants

In the logistic regression analysis predicting intake of dairy substitutes, four predictors (age, dietary practice, health motivation and animal welfare motivation) made significant contributions in the adjusted analysis. The weakest predictor among these was age (OR 1.08, C.I 1.02-1.14, p=0.01), and the strongest was animal welfare motivation (OR 5.17, C.I. 1.43-18,63), followed by health motivation (OR 3.47, C.I 1.52-7.94, p<0.01). The OR indicates that those reporting animal welfare as a motivation for their dietary practice had about 5 times greater odds of dairy substitute intake than those who did not report animal welfare as a motivation for dietary choice. The results also indicate that those reporting health as a motivation for their dietary practice had 3.5 times greater odds of dairy substitute intake, than those who did not. Dietary practice was also associated with intake of dairy substitutes, and OR of vegetarian diet (OR 0.32, C.I 0.13-0.78, p=0.01) indicates that the odds of dairy substitute intake was 68% lower in vegetarians than in vegans (the reference dietary group). Similarly, the odds of dairy substitute intake were 67 % lower in pescatarians than in vegans (OR 0.33, C.I 0.11-0.94, p=0.04).

Table 11 Logistic regression predicting intake of dairy substitutes in vegans, vegetarians and pescatarians (n=108).

	Bivariate model			Adjusted model[1]		
	OR	95% CI	P-value	OR	95% CI	P-value
Gender (female as reference)	1.16	0.53 2.53	0.70			
Age (years)	1.06	1.01 1.11	0.01	1.08	1.02 1.14	0.01
Dietary group (vs vegan)						
Vegetarian	0.32	0.15 0.71	0.01	0.32	0.13 0.78	0.01
Pescatarian	0.24	0.10 0.60	0.00	0.33	0.11 0.94	0.04
Duration (years)	0.96	0.88 1.06	0.45			
Health motivation (vs.no) [2]	2.89	1.41 5.92	0.00	3.47	1.52 7.94	0.00
Animal welfare motivation (vs.no)[2]	2.95	1.06 8.22	0.04	5.17	1.43 18.63	0.01
Climate motivation (vs. no)[2]	1.40	0.64 3.10	0.40			

[1] Adjusted model created by backward elimination (starting with all variables tested in bivariate models), variables significantly associated with dairy substitute intake were kept in the model. [2]Missing information in 7 participants

6.0 Discussion

6.1 Discussion of methods

6.1.1 Study design

In cross sectional studies, data are collected at a given point in time, providing a “snap-shot” of the case or population in question (Veierød & Thelle, 2007). This study design is therefore well suited for prevalence and descriptive studies, though unsuitable for investigating cause and effect. As the main objective of this study was to map and assess dietary intake, and not to draw conclusions about causation, a cross sectional study design was considered appropriate.

6.1.2 Sampling/study participants

6.1.2.1 Sampling methods

Conventional convenience sampling (Etikan et al., 2016), was used to recruit participants, continued by snowball sampling (Bowling, 2014, pp. 209-210; Shorten & Moorley, 2014). There were several arguments for using convenience sampling (Etikan et al., 2016). Firstly, the biological tests could only be performed during a predetermined time frame when the bioengineer was available. As convenience sampling is an efficient recruitment method, it allowed large number of participants to be recruited in time for the study start. Secondly, for reasons of feasibility, participants living too far from Oslo/Kjeller to meet in person for biological tests, could not be included in the study. Convenience sampling enabled the recruitment strategy to target individuals living in close proximity to Oslo/Kjeller. In addition, the number of vegans, vegetarians and pescatarians in the overall population is small (Bugge & Alfnes, 2018), making the target population a hard-to-reach-group. Hence, snowball sampling appeared an appropriate method to meet the required number of participants needed for statistical power (Bowling, 2014, pp. 209-210; Shorten & Moorley, 2014).

Both convenience sampling and snowball sampling are non-probability sampling methods, selecting participants in a non-random way. This means that individuals in the target population do not have equal opportunity to participate (Etikan et al., 2016). Consequently, the sample cannot be taken to represent all vegans, vegetarians and pescatarians in Norway, and findings are therefore not generalizable to the whole of this population. However, since there are no official records of people adhering to plant-based diets, random sampling would not have been possible, and the sampling methods chosen were considered the best option.

Nevertheless, non-probability sampling increases the risk of self-selection bias, which occurs when the individuals who volunteer possesses characteristics that differ systematically from the characteristics of those who do not volunteer (Gibson, 2005, pp. 10,14). In this study it is likely that most participants live in, or in close proximity to, Oslo. Potential participants from other parts of the country, are therefore not represented in the sample. However, as adhering to plant-based diets in Norway is likely to be more common among people living in Oslo than other parts of the country (NPHS, 2021), the sample may nevertheless, represent the majority of vegans, vegetarians and pescatarians in Norway. It is also possible that recruiting through social media and websites might have excluded those who do not use digital platforms regularly. As age is negatively associated with the use of social media (Khoros, 2018), participants of old age may be underrepresented in the sample. Another possible self-selection bias that could have influenced the sample, is if those who are more interested in living and eating healthily are also more interested in participating in health-and diet-related studies. If so, the study sample may be more knowledgeable about healthy eating and in consequence eat healthier than those who did not volunteer to participate. This self-selection bias may have influenced the sample since the recruitment processes relied on volunteering. Good knowledge about how to compose a nutritious plant-based diet was reported by 88 % of the participants, indicating that the self-selection bias mentioned above may have been present. This is also consistent with, 52.5 % of the sample naming health as a motivation for their current dietary practice.

Higher education (≥ 1-4 years of college/university) was reported by 82.3 % of participants. The relatively high percentage may be due to the sampling methods, the use of the OsloMet website, and spreading the word through fellow students. In Norway, higher education is positively associated with eating healthier diets (Norwegian Ministries, 2017). Consequently, it can be argued that the diets in the sample are healthier than in the target population. However, studies have also suggested that higher education is positively associated with pant-based eating (Hartmann & Siegrist, 2017). Therefore, the high percentage of people with ≥ 1-4 years of college/university education in the sample could simply reflect the educational level in the target population. If so, it would strengthen the external validity, that is generalizability of the results to the vegan, vegetarian and pescatarian population in Norway.

6.1.2.2 Final sample

The final sample in this study included 158 participants, of which 83 vegans, 47 vegetarians and 28 pescatarians. The sample included 74 % women, making the gender distribution unequal. Due to the non-probability sampling methods, it is not possible to know whether the percentage of women and men in the sample is representative of the gender distribution in the target population. The suggestion that women are more likely to both be interested in health, and to volunteer as participants in health-related studies, could indicate that the higher percentage of female participants was due to self-selection bias. However, it is also known that more women than men are eating plant-based, making it likely that the gender distribution in the sample could reflect the population of interest (Modlinska, Adamczyk, Maison, & Pisula, 2020; Ruby, 2012).

6.1.3 Method of data collection – 24HR

Assessing dietary intake is challenging due the complex nature of eating habits (Naska, Lagiou, & Lagiou, 2017). There is no single method that does not introduce some measurement error, and the methods of assessing dietary intake have different strengths and weaknesses (Gibson, 2005; Naska et al., 2017; Rutishauser, 2005; Shim, Oh, & Kim, 2014). Choosing the most appropriate method depends on the research question, the study population and the available resources at hand.

One of the main arguments for choosing to use single 24HR in this study, was that the method imposes a lower burden on participants compared to the methods that require participants to record their dietary intake (Gibson, 2005, p. 43). 24HR is also suitable for data collection over the phone, which was considered likely to further improve participant convenience. Another reason was that 24HR generally has a higher response rate than the prospective methods, such as estimated or weighed foods records, which is suggested to be due to the lower inconvenience (Gibson, 2005, p. 50; Rutishauser, 2005). Although not foreseen, the decision to conduct the interviews over the phone also proved fortunate when the social restrictions due to Covid-19 was imposed, as the data collection could continue without adjustments. A strength of 24HR is that it gives a detailed record of actual dietary intake on specific day. Since the participants were not informed in detail about the nature of the interview, they did not have the opportunity to alter their diet before the 24HR, which strengthens the internal validity. There are, however, some weaknesses to this method, and one main limitation is that 24HR does not provide information on habitual intake (Rutishauser, 2005). This disadvantage could partly be overcome by conducting a repeated 24HR, which would allow for statistical analysis to control for day-to-day variation. The validity of repeated 24HR studies have been questioned as studies have shown greater underreporting when the interview is repeated (Subar et al., 2003). Nevertheless, due to limited time and recourses, a repeated 24HR was not possible in this study. Another recommended method to validate 24HR, is to use an external variable, a “biomarker”, to measure nutritional status (Gibson, 2005, p. 161). In the paper on iodine (Groufh-Jacobsen et al., 2020), the dietary intake of iodine in the 24HR was validated. A strong association between urinary iodine concentration and iodine intake was found, demonstrating that the main iodine sources in the diet had been captured in the 24HR (Groufh-Jacobsen et al., 2020). However, 24HR is commonly used to assess and monitor dietary intake in larger groups, and can help identify subgroups at risk of inadequate nutrient intake (Naska et al., 2017). The method is also considered appropriate for comparison of diets between groups (Rutishauser, 2005). As the main aim of this study was to assess the dietary intake at group level, single 24HR was considered an appropriate method.

6.3.1 Estimation of portion size

One of the major sources of measurement errors in dietary assessments is incorrect estimation of portion sizes (Gibson, 2005, p. 113). During the actual recall, the error can arise if participants fail to identify or describe accurately the quantity of the food or beverage consumed. These descriptions can as discussed be influenced by different biases, but independent of bias, estimation of quantity and size may differ between individuals. One such example is the conception of the terms “average”, “medium”, “small” and “large” which is unlikely to be the same for all participants and the interviewer. A limitation of this study was therefore that no visual aids in form of photographs were used to establish mutual understanding of quantity. However, as previously described, clarifying questions were asked throughout the recalls, to help the participants visualize and describe the quantity of food in a way that would limit misconceptions between interviewer and participants. The detailed descriptions obtained could indicate that the method of questioning may have contributed to reduce errors in estimation of portion sizes.

6.1.4 Coding errors

The two factors influencing the calculation of nutrient intake are the food composition table and the registered quantity of each food. Accurate registration and coding of the dietary recalls is therefore vital to limit both random and systematic errors (Gibson, 2005). Random errors weaken the precision, and thereby reliability of the method. Although efforts, previously described, were made to limit random errors in data registration, the possibility of random errors cannot be excluded. However, checking the FoodCalc results repeatedly against the Excel intake file and the food composition table, in addition to the systematic reviewing the Excel intake file and the written records of interviews, will have reduced the number of mistakes in registration and coding.

6.1.4.1 Conversion of described quantities into grams

Overall, the detail in the descriptions is likely to have reduced errors in conversion of described quantity into weight in grams. The use of the standardized estimations from "Kostholdsplanleggeren" (Norwegian Directorate of Health and the Norwegian Food Safety Authority, 2020) and "Weights, measures and portion sizes for foods" (Dalane et al., 2015), in addition to the use of a standard for conversion between household measures, is also likely to have limited measurement errors in coding. Another measure which might have reduced coding error in estimation of portion sizes and in assigning food codes was the development of standardized recipes. These allowed a standard for estimating and coding of foods and dishes in cases where the participant for different reasons, could not recount the ingredients in accurate detail.

6.1.4.2 Food codes

Another source of measurement error is poorly chosen food codes (Gibson, 2005, pp. 105, 119-120). Choosing food codes that do not match the nutrient composition of the actual consumed foods, could lead to false results. The potential impact on the results may be considerable if wrongly coded foods are consumed in large quantities in the sample, or if there are large discrepancies in nutrient content between the food code and the actual consumed food. Thus, rigorous questioning about type of food, brand, cooking method, percentage of fat etc., was an important measure and is a strength of this study, as it might have limited errors in choosing food codes. Another strength, is that coding was performed systematically, to ensure that all foods were coded consistently, which can reduce gross errors (Anderson, 1986 in Gibson, 2005, p. 119). The use of additional food composition data from NEVO and Livsmedelsdatabasen allowed nutrients from a wider range of foods than those registered in the Norwegian FCT to be estimated. Although there might be different standards of enrichment in Sweden, Netherlands and Norway, which could bias the results, it was the preferred option. Though considered beyond the scope of this thesis, the validity and reliability of the food composition tables could also impact calculation of nutrients (Gibson, 2005, p. 65).

6.1.5 Validity and reliability

The validity and reliability in quantitative research depend on the limitation of bias, and "no research method is without bias" (Bowling, 2014, p. 222). Nevertheless, the aim should always be to conduct research with rigor, to reduce the sources of potential bias and error, and thereby increase the validity and reliability. In this study, validity concerns whether the results reflect the true dietary intake in the sample (internal validity), and whether it reflects the true dietary intake in the vegan, vegetarian and pescatarian population in Norway (external validity) (Gibson, 2005, p. 11). Validity is vulnerable to systematic error and bias which alters the result in a consistent direction (Gibson, 2005, p. 14). Reliability refers to the reproducibility and consistency of measurement, and depends on the limitation of random errors (Gibson, 2005, pp. 11-12). Although reproducibility (reliability) is a prerequisite of validity, a dietary assessment method can be reproducible without being valid. Repeated measures of dietary intake in the same individual may give the same result, but the measurement does not necessarily reflect the individual's true dietary intake. For example, systematically forgetting to ask about meals after dinner, or in between meal snacks, would give reproducible, but not valid, results.

A potential limitation in this study, is that most interviews were conducted from Monday to Friday. Thus, dietary intake on Fridays and Saturdays are underrepresented. Because the dietary intake on these weekend days is likely to differ from that of the regular weekdays, this could introduce a systematic bias and be a potential threat to internal validity. However, a proportional number of interviews were conducted on Mondays, and consequently the data includes dietary intake on weekend days from Sundays. Although a different recruitment strategy could have resulted in more interviews on Friday and Saturday, this could also have compromised the response rate. Therefore, the decision was made to allow participants to freely choose time and day when scheduling the interviews. Because the interviews were conducted from the middle of January to the end of June, seasonal variation of the diet was included.

6.1.5.1 Recall bias

The 24HR is a retrospective method, and data quality is therefore largely dependent on the participants ability to remember their previous food intake in accurate detail (Gibson, 2005; Naska et al., 2017). Participants failing to remember can introduce recall bias (Naska et al., 2017). To limit this bias, probing questions were asked to help participants remember, as previously mentioned in the methodology chapter (4.1.1.2). In addition, participants were given time without interruption to think before answering. The short period of time between the food intake and the 24HR could also limit the memory bias compared with other recall methods (Gibson, 2005, p. 112). Nevertheless, it is not possible to assume that recall bias did not occurred.

6.1.5.2 Respondent bias-underreporting

Dietary assessment methods that rely on self-reporting food intake can be subjected to respondent bias, and among the most common in 24HR are underreporting, social desirability and social approval biases (Gibson, 2005, pp. 106-109). When underreporting, the participant intentionally or subconsciously reports a lower dietary intake than the actual intake. Several studies have found underreporting of energy intakes in 24HR (Johansson, Wikman, Åhrén, Hallmans, & Johansson, 2001; Poppitt, Swann, Black, & Prentice, 1998; Subar et al., 2003; Trabulsi & Schoeller, 2001), and BMI, gender and age are among the factors associated with this bias. Increased BMI has been associated with increased risk of underreporting (Novotny et al., 2003; Subar et al., 2003), and Johansson et al. (2001) found high BMI to be the main predictor of underreporting. In the present study more than 75 per cent of participants had a BMI defined by WHO as normal. Although height and weight were self-reported, the lower percentage of overweight is consistent in studies of plant-based diets. The risk of underreporting due to high BMI might therefore be lower. Studies have also suggested that women are more likely to underreport dietary intake than men (Hebert, Clemow, Pbert, Ockene, & Ockene, 1995; Novotny et al., 2003), and if such a gender difference exists, the large percentage of female participants in this study could pose a risk of underreported intake in the sample. However, the observation of gender differences in underreporting is not consistent (Johansson et al., 2001).

6.1.5.3 Social desirability

Underreporting in 24HR is also found to be associated with social desirability, the tendency to avoid criticism (Hebert et al., 1995; Miller, Abdel-Maksoud, Crane, Marcus, & Byers, 2008). Social desirability can lead to selective underreporting of foods or dietary habits that are perceived as unhealthy, and Poppitt et al. found that the major cause of underreporting was failing to report between-meals snacks (Poppitt et al., 1998). In the present study, all participants were informed at the start of the interview that the interviewer was a master student in public health nutrition. This information could potentially have led to participants fearing judgment of their diet as not healthy enough, and thereby increased the risk of underreporting. Such feelings might also have been enforced if the participant felt that the diet on day in question was not representative of the habitual intake. In cases where participants expressed this concern, the master student explained shortly that the purpose of the method was not to assess each individual's diets, but the average intake in a group. However, it cannot be dismissed that the low intake of added sugar found in this study could have been influenced by social desirability. Although social desirability is usually associated with underreporting, it might in the present study possibly have led to overreporting. Plant-based eating has long been subjected to more or less founded prejudice assumptions about inadequacies and severe deficiencies (Joan Sabaté, 2003). If the study participants had previous experience with judgmental comments or attitudes about plant-based diets being dangerous for their health, they might have wanted to give the impression of eating larger quantities the foods known to be nutritious. In addition, all participants were informed that the purpose of the study was to assess vegan and vegetarian diets. The need to "prove" that plant-based eating can be both adequate and healthy, might have therefore have introduced social desirability in form of overreporting.

6.1.5.4 Social approval

Another potential respondent bias, closely related to social desirability is social approval, defined by Gibson (2005, p. 109) as the tendency to seek praise. Social approval is associated with selective overreporting of foods that are perceived to be healthy, such as fruits and vegetables (Miller et al., 2008). Although, not significant, Johansson et al. found that those who reported a low food intake level also reported larger portions of socially desirable foods such as vegetables and wholegrains (Johansson et al., 2001). Social approval and social desirability might have introduced overreporting of healthy foods, and underreporting of unhealthy foods. However, it is also possible that those who volunteered to participate, did so with a genuine interest in contributing to increased knowledge of the dietary adequacy of plant-based diets. If that is the case, the participants intentions might be to achieve valid results, and this could act as a buffer against intentional under-or overreporting.

6.1.5.5 Interviewer bias

The interviewers in 24HR should strive to conduct each interview in a similar manner to limit interviewer bias. Because the master student conducted all the interviews, interviewer bias is less likely to have occurred than if there were multiple interviewers (Gibson, 2005, p. 110). However, it is possible that the later interviews were more detailed and exact due improvement in interview technique, including conscious use of open rather than close ended questions. The first 24HR were registered in the excel spreadsheet input file before later interviews were conducted. Although this allowed for adjustments in probing questions, no major changes to the structure of the interviews were made, and it is therefore unlikely that later interviews are widely different to earlier interviews. To create as similar conditions as possible, the interviews were scheduled sufficient time apart to avoid time pressure, and efforts were made to establish the same level of rapport in all interviews. Nevertheless, it cannot be ruled out that participants experienced the interview and the interaction in different ways, and that this might have influenced the data. Although, a more prominent principle in qualitative research, researcher reflexivity should be discussed due to the master student following a vegan diet. The master student reflected upon own expectations and values in advance and during the project, to avoid influencing the study process or results. However, the master student's knowledge about plant-based diets could be considered an advantage, as it made identification of specific foods, ingredients and supplements frequently consumed by vegans and vegetarians easier.

6.1.6 Statistical analysis

All statistical tests were performed to assess the differences between dietary groups (vegans, vegetarians and pescatarians). Because of the gender differences in both intake and requirements, it was a limitation in the study that the tests were not also performed on females and males separately. This choice was due to the relatively low number of male participants which would result in a number of individuals in some gender and diet specific groups that was considered too low. Another limitation was that no statistical adjustments for bioavailability of nutrients were made. Due to the use of a single 24HR in this study, data on habitual intake which is usually required for using fixed AR cut point method (Gibson, 2005, pp. 217-218) , was not obtained. In addition, it should be noted that the AR levels set in NNR are based on Nordic conditions and average Nordic diets, which contains meat. Because of uncertain bioavailability of several micronutrients from plant-based diets (Platel & Srinivasan, 2016), the AR might be higher in vegans and vegetarians for some nutrients. However, as there are differences between countries in nutrient recommendations, and no universal agreement on specific ARs for nutrients from plant-based diets the AR currently in use in Norway was chosen. The proportion of participants meeting the AR for iron was not analysed because the assumption of symmetrical distribution of requirements in the group about the AR are not met for iron requirements of premenopausal women (Gibson, 2005, pp. 2017-2018). The assumptions for each statistical analysis were checked and confirmed before all tests.

6.2 Discussion of results

6.2.1 Summary of main results

This thesis provides an insight into total nutrient intake in vegans, vegetarians and pescatarians in Norway. The main findings in this study were that the dietary intake of macronutrients was within the recommendations. In addition to the low intake of SFA in vegans, beneficial levels of intake were reported for dietary fibre, added sugar and salt in all groups. Vegans had higher median intakes of most micronutrients than vegetarians, due to higher intake of supplements. Use of supplements was reported by more than 2/3 of the participants and was the single major dietary source of all of the selected micronutrients, except calcium. However, the percentage of participants meeting the AR for the selected micronutrients indicates inadequate intake of vitamin D, selenium (in vegetarians and vegans) and iodine, in addition to moderate risk of inadequate intake of B_{12} (in vegetarians and vegans). Vegans reported higher median intakes of vitamins D and B_{12} and calcium from supplements than vegetarians. Intake of meat substitutes was reported by 69 participants and intake of dairy substitutes by 108 participants. For both substitutes, vegans had the highest proportion of participants reporting intake. While, soy was the dominant raw ingredient in the meat substitutes, the main raw ingredients in the dairy substitutes were oats, soy and modified starch. Dietary practice was the only significant predictor of meat substitute intake, and compared with vegans (reference dietary group), the pescatarians had a lower odds of reporting intake. There were four predictors of use of dairy substitutes, of which animal welfare motivation for dietary practice was the strongest, followed by health motivation for dietary practice. Dietary practice was also a predictor of dairy substitute intake. Compared with vegans (reference dietary group), both vegetarians and pescatarians had lower odds of reporting dairy substitute intake.

6.2.2 Dietary intake of macronutrients (objective 1)

6.2.2.1 Fatty acids

The reported E% from fat (vegans 31, vegetarians 35, and pescatarians 33 E%) was within the recommendations in NNR (2012) for all dietary groups, and similar to the intake of 34 E% from total fat observed in the general Norwegian population (Norkost 3, 2012). However, the distribution of different fatty acids in the present sample differed between groups, with vegans reporting the lowest relative intake of SFA (6 E%) and the highest intake of PUFA (8 E%). This distribution was as expected, because animal-based foods are the main sources of SFA, while plant-based foods are sources of PUFA. The results were also consistent with previous observations presented in a systematic review (Bakaloudi et al., 2020). The findings are of importance because of the strong evidence suggesting that replacing SFA with PUFA in the diet may lower low-density lipoprotein (LDL) cholesterol (Mozaffarian, Micha, & Wallace, 2010), and thereby reduce the risk of atherosclerotic cardiovascular disease (Ference & et al., 2017). Limiting SFA is therefore one of the recommendations for a healthy diet (table 1) (FAO and WHO, 2019). In consistence with these recommendations, reducing the intake of SFA to 12 E% in the Norwegian population, is one of the targets in the National Action Plan for a Healthier diet (2017). However, based on the report “Trends in the Norwegian diet 2020” (2021), the relative SFA intake in the population is 15 E%, which is considerably higher than both the population target and the recommendations (<10 E%) in NNR (2012).

6.2.2.2 Carbohydrates and protein

The relative carbohydrate intake in this study was approximately 50 E% in all groups and within the recommendations in NNR (2012). The intake was also comparable to most studies in the systematic review by Bakaloudi et al. (2020), which reported intakes of carbohydrates among vegans, typically above 50 E%. The median relative intake of protein in vegans and vegetarians (both 13 E%) and pescatarians (15 E%) in this study, was similar to findings in two large European cohort studies (Allès et al., 2017; Sobiecki et al., 2016). The adequacy of protein and amino acids intakes in plant-based diets are debated, mainly due to the amino acid distribution in plant-based proteins, which is considered less optimal than in animal-based proteins (Mariotti & Gardner, 2019). However, plant-based diets will provide all essential amino-acids in quantities sufficient to meet requirements, given that total energy intake is adequate and the diet contains protein from both legumes and cereals (Mariotti & Gardner, 2019). The overall 25th percentile of total energy intake in this study (1546 kcal), could suggests a low energy intake in 25% of the participants, and thereby an increased risk of inadequate protein and amino acid intake. However, low energy intake might in part be due to underreporting (Gibson, 2005).

6.2.2.3 Added sugar

All groups in this study reported intake of added sugar well below the recommendations of <10 E% and well below the estimated average intake in the Norwegian diet (Norwegian Directorate of Health, 2021). A possible explanation for the low intake of added sugar, is that the participants in this study are more conscious about their health and have more nutritional knowledge than the population in general. This is supported by the high percentages of participants reporting no smoking habits (91 %) and nutritional knowledge about how to meet their dietary needs (92%). Moreover, 82 % of the participants reported education at college or university level, which is considerably higher than in the general population (35 %) (SSB, 2020). College or university education is associated with favourable lifestyle habits (NIPH, 2016), and in both the NPHS (2021) and Norkost 3 (2012), consumption of sugary beverages were negatively associated with higher education.

6.2.2.4 Dietary fibre

In line with studies comparing dietary fibre intake between plant-based and omnivorous diets (Allès et al., 2017; Bowman, 2020; Clarys et al., 2014; Rizzo, Jaceldo-Siegl, Sabate, & Fraser, 2013; Sobiecki et al., 2016), all groups in the present study reported higher intakes of dietary fibre (5 g/MJ, 4 g/MJ and 4 g/MJ) than the estimated average intake in the general population (2.3 g/MJ) (Norwegian Directorate of Health, 2021). These results are as expected, since plant-based foods such as wholegrains, legumes, vegetables, fruits, nuts and seeds are rich in dietary fibres. To support this, studies have found intake of dietary fibre to increase with dietary restrictions (Allès et al., 2017; Clarys et al., 2014; Rizzo et al., 2013; Sobiecki et al., 2016). However, this was only partly the case in the present study since the intake of dietary fibre was similar in vegetarians and pescatarians. Eating foods containing dietary fibre is associated with lower body weight and has been linked with reducing CVD risk factors and lower risk of colon cancer (Hemler & Hu, 2019; WCRF & AICR, 2018). The high content of dietary fibres in plant-based diets is therefore proposed as a potential explanation for the lower relative risk of certain NCDs in vegetarian and vegan populations (Hemler & Hu, 2019).

6.2.2.5 Salt

The overall intake of salt in this study was 5.8 g, ranging from 5.2 g in vegetarians to 7 g in pescatarians. This is considerably lower than the estimations of average salt intake in the Norwegian population of approximately 10 g/day (Norwegian Ministries, 2017), and within the 2023 target of 8 g per day. However, only vegetarians and vegans met the recommendations in NNR (2012) of ≤6 g/day. Reduction in salt intake is one of the main national and global targets for the prevention of NCDs, largely due to the adverse effect of sodium on blood pressure (NCD-Strategy, 2013; World Health, 2013). Although, relatively low levels of salt intake were reported in this study, great variations are observed across previous studies, and there is no current evidence to conclude that plant-based diets contain less salt than omnivorous diets as (Bakaloudi et al., 2020).

6.2.3 Dietary intake of micronutrients (Objective 1)

The median intake of most micronutrients met the AR, with a few exceptions. These results may be due to well composed diets or use of supplements, or likely a combination of both. However, across all groups, the median vitamin A intake was lower than previously observed in European plant-based diets (Allès et al., 2017; Elorinne et al., 2016; Kristensen et al., 2015; Sobiecki et al., 2016). As vitamin A in vegan and vegetarian diets is mainly found as beta carotene in orange or dark green vegetables (Gallagher, 2012), a possible explanation for the relatively low vitamin A intake, is low intake of these vegetables. Another potential cause is underestimation of intake in dishes not prepared by the participant, or underestimation of the actual size of vegetables. Vegans reported significantly higher intake than vegetarians of nine micronutrients, including iron and all B vitamins, except folate. Because vegetarians include animal-source foods in their diets, they were expected to have higher intakes of most micronutrients sourced from animal foods. However, for the same reason, vegetarians may to a greater extent than vegans, overestimate the nutritional adequacy of their diets, and be less vigilant about supplements. Furthermore, classification of participants into dietary groups did not consider the amounts of animal-based foods consumed. In consequence, participants consuming marginal amounts of animal-source foods could be classified as vegetarians or pescatarians.

6.2.4 Average requirement and intake of selected micronutrients (Objective 2)

6.2.4.1 Vitamin D

Although the median intake of vitamin D was above the AR in both vegans and pescatarians, 34 % of the vegans and 43 % of the pescatarians did not meet the AR. An even higher proportion (60 %) of the vegetarians reported vitamin D intake below the AR. Since the main sources of vitamin D are animal-based foods, the most likely explanation for the higher intake of vitamin D in vegans, is supplement (Elorinne et al., 2016; Weikert et al., 2020). This is supported by the low intakes of vitamin D observed in studies assessing intake merely from food, both in vegans (Allès et al., 2017; Waldmann, Koschizke, Leitzmann, & Hahn, 2003; Weikert et al., 2020), and in vegetarians (Allès et al., 2017; Bowman, 2020; Sobiecki et al., 2016). Overall, the results in the present study are comparable to previous studies, indicating an increased risk of inadequate vitamin D intake in plant-based diets without supplements.

6.2.4.2 Vitamin B_{12}

In this study, adequate intake of vitamin B_{12} was observed in 82 % of the vegans, 70 % of the vegetarians and 93 % of the pescatarians, and pescatarians differed significantly from vegetarians. Correspondingly, the median vitamin B_{12} intake was above the AR in all dietary groups. Since vitamin B_{12} is mainly found in animal-source foods, it was unexpected that vegans had significantly higher median intake than vegetarians. However, considering the wide IQR in vegans (2 µg-26 µg), the higher intake of vitamin B_{12} observed in this group is most likely due to differences in supplementation, rather than in food intake. This explanation is also supported in previous studies (Schüpbach, Wegmüller, Berguerand, Bui, & Herter-Aeberli, 2017; Sobiecki et al., 2016; Waldmann et al., 2003). In contrast to the present results, previous studies have found proportions of participants with inadequate vitamin B_{12} intake to increase with increased exclusion of animal-source foods (Allès et al., 2017; Sobiecki et al., 2016). Notably, in contrast to the present study, these studies did not included supplements in the assessments, and the prevalence of inadequacy in vegans may therefore have been over-estimated. In addition, the different recommendations for AR across countries, complicates direct comparison of prevalence of inadequate intake. The present study’s relatively high proportions of participants below the AR for B_{12} is nevertheless worrying due to the serious health consequences caused by prolonged B_{12} deficiency, namely neurological degeneration and anaemia (NNR, 2012).

6.2.4.3 Calcium

No significant differences in proportions of participants meeting the AR for calcium was found between vegans, vegetarians or pescatarians in this study. All dietary groups reported median and 25^{th} percentile intake of calcium above the AR. As milk and dairy are the most important sources of calcium in Norway, (NNR, 2012), it was unexpected that vegans did not report lower calcium intake than vegetarians and pescatarians. A possible explanation could be the higher percentage of vegans than vegetarians and pescatarians reporting use of plant-based milks, as many of these are fortified with calcium. The median intake, and prevalence of inadequate intake of calcium, in vegans in this study were consistent with other studies (Allès et al., 2017; Clarys et al., 2014; Kristensen et al., 2015; Schüpbach et al., 2017; Sobiecki et al., 2016), while vegetarians and pescatarians reported considerably lower intakes than previously observed (Clarys et al., 2014; Rizzo et al., 2013; Schüpbach et al., 2017; Sobiecki et al., 2016). As calcium is essential for maintaining good bone health, the consequences of plant-based diets on BMD and fracture risk have been questioned (Iguacel, Miguel-Berges, Gomez-Bruton, Moreno, & Julian, 2019). The findings in the present study could indicate that more than 20% of the vegetarians and vegans may be at risk of inadequate calcium intake, and suggest that vegans and vegetarians should plan their diets to avoid adverse effects on bone health.

6.2.4.4 Iron

In the present study, all dietary groups had median intakes of iron that met the AR. These results are in line with previous studies, (Allès et al., 2017; Clarys et al., 2014; Elorinne et al., 2016; Kristensen et al., 2015; Rizzo et al., 2013; Sobiecki et al., 2016; Weikert et al., 2020) As most plant-based diets include considerable amounts of plant-based sources of iron, such as whole grains, legumes and dried fruits and berries (Melina et al., 2016), the results are not unexpected. However, bioavailability of the non-haem iron from plant sources may vary dependent on the presence of inhibitors or enhancers, thus dietary intake of iron may not reflect the iron status in vegans and vegetarians (Gallagher, 2012). Despite multiple observations of adequate iron intake in vegetarians and vegans, these groups have also been found to have higher risk of low or depleted iron stores, compared to omnivores (Haider, Schwingshackl, Hoffmann, & Ekmekcioglu, 2018; Pawlak, Berger, & Hines, 2018). However, the recent paper by Henjum et al. (2021) examining iron status in the present study's sample found most participants to have sufficient iron status. Iron supplementation was reported by 9 % of the participants and use of supplements was not identified as a predictor of increased iron status in the sample. Furthermore, the paper observed no differences in iron status between the dietary groups, and gives support to the present findings (Henjum et al., 2021).

6.2.4.5 Zinc

In all dietary groups, the proportion of participants meeting the AR for zinc were above 90 %, and consistent with the median and 25th percentile intake, which was also above the AR in all groups. These results could indicate a low risk of inadequate zinc intake, similar to findings in the "NutriNet Santé study (Allès et al., 2017), but in contrast to several other studies (Elorinne et al., 2016; Kristensen et al., 2015; Sobiecki et al., 2016; Weikert et al., 2020). Animal-based foods are generally considered main sources of zinc, and the relatively high intake observed in the present study might therefor in part be explained by supplementation. Moreover, as the bioavailability of zinc from plant-based foods is assumed to be lower than from animal-based foods, meeting the AR recommended by NNR (2012) which is based on mixed animal and plant-based diets, might not reflect adequate zinc status in the participants. This is corroborated in a study which found high prevalence of inadequate zinc intake in vegans and vegetarians when using a bioavailability-adjusted AR (Sobiecki et al., 2016). The bioavailability-adjusted AR was based on The Institute of Medicine report on zinc requirements recommendations, which suggest that AR for zinc is multiplied by 1.5 when applied to vegans or vegetarians (IOM, 2001). In further support to the argument of increased zinc requirements in plant-based diets, a Swiss study (Schüpbach et al., 2017) found lower plasma concentration of zinc in vegans and vegetarians compared with the omnivores despite similar dietary intakes of zinc in all groups.

6.2.4.6 Selenium

In the present study, pescatarians had the highest proportion of participants (82 %) meeting the AR for selenium. Approximately half of both the vegans (47 %) and the vegetarians (49 %) did not meet the AR, suggesting a high risk of inadequate selenium intake in these groups.

Two European studies have also found lower intakes (Sobiecki et al., 2016; Weikert et al., 2020) and serum concentrations (Sobiecki et al., 2016) of selenium in vegans than in omnivores. However, a Swiss study (Schüpbach et al., 2017), detected no difference between vegans, vegetarians and omnivores in selenium status. The median selenium intake reported by vegans in the present study was below values observed in previous studies, even in studies reporting intake from food alone (Allès et al., 2017; Elorinne et al., 2016; Sobiecki et al., 2016). Overall, the present findings corroborate studies suggesting vegans and vegetarians to be at potential risk of inadequate selenium intake. The results are also consistent with animal-based foods being the most important source of selenium in Norwegian diets (NNR, 2012). As the selenium content in Norwegian soil is low, domestically grown plant-foods contain little selenium, which also might explain the present results.

6.2.4.7 Iodine

The median intake of iodine was above the AR in vegans and pescatarians, and only slightly lower than the AR in vegetarians. However, the wide IQR in all dietary groups suggest great variations in iodine intake, which are most likely due to supplementation, including the use of kelp (Groufh-Jacobsen et al., 2020). The sources of iodine in the Norwegian diet are mainly fish, shellfish, egg and cow milk (due to iodization of cow fodder) (NNR, 2012). Because pescatarians, as opposed to the two other dietary groups, include all these food groups in their diet, the higher 25th percentile of iodine reported in this group, might reflect the respective eating patterns. The proportions of participants reporting iodine intake below the AR in the present study was consistent with the published paper by Groufh-Jacobsen et al. (2020). Low intake and inadequate iodine status in vegetarian and vegan diets have also been previously observed both nationally (Brantsæter et al., 2018; Henjum et al., 2018) and internationally (Eveleigh, Coneyworth, Avery, & Welham, 2020; Kristensen et al., 2015; Sobiecki et al., 2016; Waldmann et al., 2003).

6.2.5 Contribution from different food groups to the intake of selected micronutrients (objective 3)

Overall, supplements was the single major dietary source of all the selected micronutrients, except calcium. For vitamins B_{12} and D, which are almost exclusively found in animal-based foods (NNR, 2012), it would be expected that supplements accounted for most of the intake. It is however interesting that milk, dairy, fish and seafood did not supply a larger proportion of the total intake of these vitamins among vegetarians and pescatarians. A potential explanation is low absolute intake in grams of these food groups. It could also be that the very high intake from supplements of vitamin B_{12} (five times the AR) and vitamin D (nearly three times the AR) in the vegans (n=62), might have skewed the proportion. Although, also obtained mainly from animal-source foods in Norway, a more likely distribution was seen for iodine as animal-source foods accounted for 21% of the total intake. In accordance low iodine intakes in vegan diets without use of supplements (Sobiecki et al., 2016; Waldmann et al., 2003), the plant-based food sources, were limited and only accounted for one quarter of the iodine intake.

Overall, whole grains was the main food source (non-supplement) of the selected micronutrients. Because this food group is considered one of the main plant-based sources of both iron and zinc, this observation was as expected (NNR, 2012). Also nuts and seeds, legumes and pulses, grains, fruits and berries and vegetables were important plant-based dietary sources. The contributions from multiple food sources to the intake of the selected micronutrients in this study, underlines the necessity of dietary diversity in plant-based diets to ensure intake of essential nutrients in adequate amounts.

6.2.5.1 Supplements

In this study, use of supplements was reported by 68 % of participants. In comparison, 46 % of participants in the NPHS (2021) reported daily or regular use of supplements. Comparable numbers were found in a Danish study on vegans where 69 % of the sample reported supplement use (Kristensen et al., 2015). The present study's higher proportion of vegans reporting use of supplements compared to the two other dietary groups, may either indicate that vegans are more aware of the potential risk of deficiencies of plant-based diets in general, or that they consider their diets to be too restricted to obtain adequate intake of certain micronutrients. These explanations are both supported by a Finnish study (Elorinne et al., 2016) and a recent German Study (Weikert et al., 2020), in which more than 90 % of vegan participants reported supplementation. These rates were however, higher than those observed in a another German study which found 46 % of the participants using supplement, with no difference between strict vegans and moderate vegans (lacto-ovo vegetarians) (Waldmann et al., 2003).

6.2.6 Intake of plant-based substitutes in the diet (Objective 4)

Plant-based dairy substitutes were reported by 68 % of the sample and meat substitutes by 44 % in the 24HR. Considering the increased selection of substitute products available in Norway (Grundekjøn, 2021), and that vegans, vegetarians and pescatarians may want to replace animal-based foods in their diets, these results were not surprising. Using substitute products may offer this population a convenient way of maintaining parts of previous dietary habits. Consistent with this explanation, the products reported by most participants in the 24HR were cold cuts and spreads, plant-based milks and cheese, which all represent important food groups in the Norwegian diet.

In this study, vegans had significantly higher odds of reporting meat and dairy substitute intake than pescatarians. A possible explanation for this result, may be that vegans exclude more animal-based foods from their diets than pescatarians, and therefore consequently need to replace a larger part of their diets with plant-based foods. This explanation is corroborated in several studies, which suggest that consumption of substitute products increases with increased avoidance of animal-based foods (Allès et al., 2017; Gehring et al., 2020; Haddad & Tanzman, 2003; Papier et al., 2019). Another potential explanation for the large proportion of vegans reporting use of substitutes, is that they consider these products to be good sources of protein (soy-based meat substitutes) or calcium and vitamins B_{12} or D (fortified plant-based milks). As the main ingredient in the early meat substitutes, tofu and tempeh (Alcorta et al., 2021) soybeans have long been recognized as source of high-quality protein in vegetarians diet (Alcorta et al., 2021; Messina, 2016; Papier et al., 2019). In addition, soybeans are recommended as a source of iron, potassium, zinc and selenium in diets excluding meat. Furthermore, many variants of plant-based milks on the Norwegian market are fortified with vitamin B_{12} and vitamin D (Alpro, 2021; Dream, 2021; Gryr, 2021; Oatly, 2021).

6.2.7 Raw ingredients in plant-based substitutes (objective 5)

The large proportion of soy-based products reported in all meat substitute categories is consistent with soy being one of the most common raw ingredients in these products (Alcorta et al., 2021). However, peas and legumes and vegetables were also frequently reported, which may reflect a growing interest in alternative plant-based protein sources (FoodProFuture, 2017; Smart Protein, , 2019). Both in Europe (Smart Protein, 2019) and in Norway (FoodProFuture, 2017), projects have been initiated to identify protein rich plants that can thrive in the Northern climate. The projects are also working on how to develop these plants into products with high protein content, that will appeal to the consumers. Most plant-based milks, yoghurts, cream and crème fraiche reported in the 24HR were based on either soy or oats. These results are comparable with the consistently high sales values of soy-based dairy, in addition to a substantial growth in sales values for oat-based products seen in Europe (Smart Protein Project, 2021). Most of the cheese was based on modified starch. Although, this ingredient is not a good source of protein, the products are marketed as “cheese alternatives”, which may cause them to be wrongfully perceived as a good protein source. The proportions of raw ingredients were estimated based on how frequently each product was reported, consequently the actual amount of raw ingredients from substitute products was not assessed. However, the assessment gives an indication of preferences of raw ingredients.

6.2.8 Predictors of plant-based substitute intake in logistic regression (objective 6)

Dietary practice motivated by animal welfare, was the strongest predictor of dairy substitute intake. As animal welfare is a one of the most common motives for adhering to plant-based diets in general and vegan diets in particular (Hoffman, Stallings, Bessinger, & Brooks, 2013; Ruby, 2012), this result was not surprising. However, the wide C.I, indicates uncertainty in the estimate, which could be due to insufficient sample size (n=108) and the small proportion of participants (15 %) not reporting animal welfare as a motivation for dietary practice.

Interestingly, health motivated dietary practice was the second strongest predictor of plant-based dairy substitute intake. The association might indicate that dairy substitutes are perceived as healthy, or as previously mentioned, as an important source of certain micronutrients. In support of this finding, health has been suggested as one of the drivers for the growing demand for substitute products (Ismail et al., 2020), which is reflected in marketing of the products as “good for you”, implying that they hare healthy (Alpro, 2021; Hälsans kök, 2021). Although many of the raw ingredients in plant-based substitutes are confirmed as both healthy and sustainable (Clune et al., 2017; Norwegian Directorate of Health, 2015a), there is limited evidence to the nutrient quality and sustainability of the final products (Alcorta et al., 2021; Choudhury et al., 2020), and a recent study suggested that high intake of plant-based substitute products could decrease the nutritional quality in plant-based diets (Gehring et al., 2020). Nevertheless, the impact of plant-based substitutes on diet quality and health remains to be further investigated and nuanced (Wickramasinghe et al., 2021).

7.0 Conclusion

The results of this thesis indicate that vegan, vegetarian and pescatarian diets in Norway may have a beneficial macronutrient composition, since all groups reported advantageous fatty acid distribution with low E% from SFA. In addition, the results indicate a low intake of added sugar and salt and high intake of dietary fibres in the plant-based diets. As for micronutrients, results suggest a risk of inadequate intake of vitamin D and iodine in all groups, and of selenium in vegans and vegetarian. Vegans and vegetarians may also have a moderate risk of inadequate vitamin B_{12} intake. The vegans reported higher median intake of most micronutrients than vegetarians, probably due to higher intake of supplements. Supplements were also the main contributor to the intake of all except one of the selected micronutrients. Combined, these results suggest that use of supplements may be necessary to maintain adequate intake of vitamins D, B_{12}, and iodine in plant-based diets. Furthermore, the need for supplementation may also apply to the diets less restrictive than the vegan diet. According to the results, plant-based substitutes were included in the diet by 2/3 participants. However, it may seem that vegans could be more inclined to consume plant-based substitutes than vegetarians and pescatarians. Moreover, intake of dairy substitutes was predicted by having animal welfare, or health, as motivation for dietary practice. The results also imply that use of plant-based milks may dominate among the dairy-substitutes being the most frequently reported. A majority of the reported meat substitutes were based on soy, while large proportions of the dairy substitutes were based on oats, soy or modified starch.

Based on the high intake of plant-based substitutes found in this study, and the limited knowledge of the nutrient content in these products, the impact of these products on diet quality and health, should be investigated in future studies. In addition, the low intake of vitamin D and selenium observed in the participants and the proportions of vegans and vegetarians at moderate risk of intake of B_{12}, suggest further studies are needed to assess the status of these nutrients in vegans, vegetarians and pescatarians. Future studies on nutrition and health in plant-based diets, should also include flexitarian diets, as these are increasing most rapidly in the population.

References

Abel, M. H., & Totland, T. H. (2021). *Self reported dietary habits and body weight in adults in Norway - Results from the National Public Health Survey 2020*. Retrieved from Oslo: Norwegian Institute of Public Health: https://www.fhi.no/publ/2021/resultater-fra-den-nasjonale-folkehelseundersokelsen-2020/

Alcorta, A., Porta, A., Tárrega, A., Alvarez, M. D., & Vaquero, M. P. (2021). Foods for Plant-Based Diets: Challenges and Innovations. *Foods, 10*(2), 293. Retrieved from https://www.mdpi.com/2304-8158/10/2/293

Aleksandrowicz, L., Green, R., Joy, E. J. M., Smith, P., & Haines, A. (2016). The Impacts of Dietary Change on Greenhouse Gas Emissions, Land Use, Water Use, and Health: A Systematic Review. *PLOS ONE, 11*(11), e0165797. doi:https://doi.org/10.1371/journal.pone.0165797

Allen, L. H., Carriquiry, A. L., & Murphy, S. P. (2019). Perspective: Proposed Harmonized Nutrient Reference Values for Populations. *Advances in Nutrition, 11*(3), 469-483. doi:10.1093/advances/nmz096

Allès, B., Baudry, J., Méjean, C., Touvier, M., Péneau, S., Hercberg, S., & Kesse-Guyot, E. (2017). Comparison of Sociodemographic and Nutritional Characteristics between Self-Reported Vegetarians, Vegans, and Meat-Eaters from the NutriNet-Santé Study. *Nutrients, 9*(9). doi:10.3390/nu9091023

Alpro. (2021). Alpro. Retrieved from https://www.alpro.com/no/

Appleby, P. N., Thorogood, M., Mann, J. I., & Key, T. J. (1999). The Oxford Vegetarian Study: an overview. *American Journal of Clinical Nutrition, 70*(3 Suppl), 525S-531S. doi:10.1093/ajcn/70.3.525s

Bachmann, H.-P. (2001). Cheese analogues: a review. *International Dairy Journal, 11*(4), 505-515. doi:https://doi.org/10.1016/S0958-6946(01)00073-5

Bakaloudi, D. R., Halloran, A., Rippin, H. L., Oikonomidou, A. C., Dardavesis, T. I., Williams, J., . . . Chourdakis, M. (2020). Intake and adequacy of the vegan diet. A systematic review of the evidence. *Clin Nutr*. doi:10.1016/j.clnu.2020.11.035

Benatar, J. R., & Stewart, R. A. H. (2018). Cardiometabolic risk factors in vegans; A meta-analysis of observational studies. *PLoS ONE [Electronic Resource], 13*(12), e0209086. doi:10.1371/journal.pone.0209086

Bohrer, B. M. (2019). An investigation of the formulation and nutritional composition of modern meat analogue products. *Food Science and Human Wellness, 8*(4), 320-329. doi:https://doi.org/10.1016/j.fshw.2019.11.006

Bowling, A. (2014). *Ebook: Research Methods in Health: Investigating Health and Health Services*. Maidenhead, United Kingdom: McGraw-Hill Education.

Bowman, S. A. (2020). A Vegetarian-Style Dietary Pattern Is Associated with Lower Energy, Saturated Fat, and Sodium Intakes; and Higher Whole Grains, Legumes, Nuts, and Soy Intakes by Adults: National Health and Nutrition Examination Surveys 2013-2016. *Nutrients, 12*(9). doi:10.3390/nu12092668

Brantsæter, A. L., Knutsen, H. K., Johansen, N. C., Nyheim, K. A., Erlund, I., Meltzer, H. M., & Henjum, S. (2018). Inadequate Iodine Intake in Population Groups Defined by Age, Life Stage and Vegetarian Dietary Practice in a Norwegian Convenience Sample. *Nutrients, 10*(2), 230. doi:10.3390/nu10020230

Bugge, A. B., & Alfnes, F. (2018). *Kjøttfrie spisevaner - hva tenker forbrukerne? (Meat-free eating habits- What do consumers think?)* (14). Retrieved from Oslo: Forbruksforskningsinstituttet SIFO:

Castañé, S., & Antón, A. (2017). Assessment of the nutritional quality and environmental impact of two food diets: A Mediterranean and a vegan diet. *Journal of Cleaner Production, 167*, 929-937. doi:https://doi.org/10.1016/j.jclepro.2017.04.121

Chai, B. C., van der Voort, J. R., Grofelnik, K., Eliasdottir, H. G., Klöss, I., & Perez-Cueto, F. J. A. (2019). Which Diet Has the Least Environmental Impact on Our Planet? A Systematic Review of

Vegan, Vegetarian and Omnivorous Diets. *Sustainability, 11*(15), 4110. Retrieved from https://www.mdpi.com/2071-1050/11/15/4110
Choudhury, D., Singh, S., Seah, J. S. H., Yeo, D. C. L., & Tan, L. P. (2020). Commercialization of Plant-Based Meat Alternatives. *Trends in Plant Science*. doi:https://doi.org/10.1016/j.tplants.2020.08.006
Christensen, J. J., Arnesen, E. K., Andersen, R., Eneroth, H., Erkkola, M., Høyer, A., . . . Blomhoff, R. (2020). The Nordic Nutrition Recommendations 2022 - principles and methodologies. *Food & nutrition research, 64*, 10.29219/fnr.v29264.24402. doi:10.29219/fnr.v64.4402
Clarys, P., Deliens, T., Huybrechts, I., Deriemaeker, P., Vanaelst, B., De Keyzer, W., . . . Mullie, P. (2014). Comparison of Nutritional Quality of the Vegan, Vegetarian, Semi-Vegetarian, Pesco-Vegetarian and Omnivorous Diet. *Nutrients, 6*(3), 1318-1332. Retrieved from https://www.mdpi.com/2072-6643/6/3/1318
Clune, S., Crossin, E., & Verghese, K. (2017). Systematic review of greenhouse gas emissions for different fresh food categories. *Journal of Cleaner Production, 140*, 766-783. doi:https://doi.org/10.1016/j.jclepro.2016.04.082
Coop. (2021). Coop Vegetardag gjør det enkelt å velge kjøttfrie alternativer! Retrieved from https://coop.no/emv/dagligvare/coop/coop-vegetar/produktene
Curtain, F., & Grafenauer, S. (2019). Plant-Based Meat Substitutes in the Flexitarian Age: An Audit of Products on Supermarket Shelves. *Nutrients, 11*(11), 2603. doi:http://dx.doi.org/10.3390/nu11112603
Dalane, J. Ø., Bergvatn, T. A. M., Kielland, E., & Carlsen, M. H. (2015). *Weights, measures and portion sizes for foods*. Retrieved from Norwegian Food Safety Authority, University of Oslo and Norwegian Directorate of Health: https://www.matportalen.no/verktoy/the_norwegian_food_composition_table/weights_measures_and_portion_sizes_for_foods
Dernini, S., & Berry, E. M. (2015). Mediterranean Diet: From a Healthy Diet to a Sustainable Dietary Pattern. *Frontiers in Nutrition, 2*, 15-15. doi:10.3389/fnut.2015.00015
Dernini, S., Berry, E. M., Serra-Majem, L., La Vecchia, C., Capone, R., Medina, F. X., . . . Trichopoulou, A. (2017). Med Diet 4.0: the Mediterranean diet with four sustainable benefits. *Public Health Nutrition, 20*(7), 1322-1330. doi:10.1017/S1368980016003177
Dinu, M., Abbate, R., Gensini, G. F., Casini, A., & Sofi, F. (2017). Vegetarian, vegan diets and multiple health outcomes: A systematic review with meta-analysis of observational studies. *Critical Reviews in Food Science and Nutrition, 57*(17), 3640-3649. doi:10.1080/10408398.2016.1138447
Dream. (2021). Dream products. Retrieved from https://have-a-dream.eu/en/products
Dutch National Institute for Public Health and the Environment. (2019). Dutch Food Composition Database (NEVO). Retrieved from https://nevo-online.rivm.nl/. https://nevo-online.rivm.nl/
Elle, I. (2021). Åpner sin tredje Naturli' Café på under et år. *Kapital*. Retrieved from https://kapital.no/reportasjer/naeringsliv/2021/05/06/7653123/orkla-med-suksess-pa-gronn-matsatsning
Elorinne, A. L., Alfthan, G., Erlund, I., Kivimäki, H., Paju, A., Salminen, I., . . . Laakso, J. (2016). Food and Nutrient Intake and Nutritional Status of Finnish Vegans and Non-Vegetarians. *PLOS ONE, 11*(2), e0148235. doi:10.1371/journal.pone.0148235
Enjoli, A. (2021
). How the Netherlands Is Leading the Vegan Food Industry. Retrieved from https://www.livekindly.co/netherlands-leading-vegan-food-industry/
Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of Convenience Sampling and Purposive Sampling. *American Journal of Theoretical and Applied Statistics, 5*(1), 1-4. doi:10.11648/j.ajtas.20160501.11
Eveleigh, E. R., Coneyworth, L. J., Avery, A., & Welham, S. J. M. (2020). Vegans, Vegetarians, and Omnivores: How Does Dietary Choice Influence Iodine Intake? A Systematic Review. *Nutrients, 12*(6), 1606. doi:10.3390/nu12061606

FAO. (2012). *Sustainable diets and biodiversity: Directions and solutions for policy, research and action. Proceedings of the International Scientific Symposium: Biodiversityand Sustainable Diets United Against Hunger, FAO Headquarters, Rome, Italy, 3-5 November 2010* (9789251073117). Retrieved from Rome: http://www.fao.org/3/i3004e/i3004e00.htm
FAO. (2019). *FAO's work on climate change - United Nations Climate Change Conference 2019*. Retrieved from http://www.fao.org/3/ca7126en/ca7126en.pdf
FAO, IFAD, UNICEF, WFP, & WHO. (2020). *The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets.* Retrieved from Rome
FAO and WHO. (2019). *Sustainable healthy diets – Guiding principles*. Retrieved from Rome: https://doi.org/10.4060/CA6640EN
Ference, B. A., & et al. (2017). Low-density lipoproteins cause atherosclerotic cardiovascular disease. 1. Evidence from genetic, epidemiologic, and clinical studies. A consensus statement from the European Atherosclerosis Society Consensus Panel. *European Heart Journal, 38*(32), 2459-2472. doi:10.1093/eurheartj/ehx144
FoodProFuture. (2017). FoodProFuture. Retrieved from https://foodprofuture.no/
Fraser, G. E. (1999). Associations between diet and cancer, ischemic heart disease, and all-cause mortality in non-Hispanic white California Seventh-day Adventists. *The American Journal of Clinical Nutrition, 70*(3), 532s-538s. doi:10.1093/ajcn/70.3.532s
Fresán, U., & Sabaté, J. (2019). Vegetarian Diets: Planetary Health and Its Alignment with Human Health. *Advances in nutrition (Bethesda, Md.), 10*(Suppl_4), S380-S388. doi:10.1093/advances/nmz019
G. B. D. Disease Injury Incidence Prevalence Collaborators. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *Lancet, 392*(10159), 1789-1858. doi:https://doi.org/10.1016/S0140-6736(18)32279-7
Gallagher, M. L. (2012). Intake: The Nutrients and Their Metabolism. In L. K. Mahan, S. Escott-Stump, & J. L. Raymond (Eds.), *Krause's Food and the Nutrittion Care Process* (13 ed.): Elsevier.
GBD 2017 Diet Collaborators. (2019). Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet, 393*(10184), 1958-1972. doi:10.1016/s0140-6736(19)30041-8
Gehring, J., Touvier, M., Baudry, J., Julia, C., Buscail, C., Srour, B., . . . Allès, B. (2020). Consumption of Ultra-Processed Foods by Pesco-Vegetarians, Vegetarians, and Vegans: Associations with Duration and Age at Diet Initiation. *J Nutr*. doi:10.1093/jn/nxaa196
Gibson, R. S. (2005). *Principles of Nutritional Assessment* (2 ed.). New York: Oxford University Press.
Go'Vegan. Go' Vegan Meierialternativer. Retrieved from https://www.govegannordic.no/produkter/meierialternativer/
Groufh-Jacobsen, S., Hess, S. Y., Aakre, I., Folven Gjengedal, E. L., Blandhoel Pettersen, K., & Henjum, S. (2020). Vegans, Vegetarians and Pescatarians Are at Risk of Iodine Deficiency in Norway. *Nutrients, 12*(11). doi:10.3390/nu12113555
Grundekjøn, C. (2021). Vegetarboom i Norge: Kjedene kjemper om «morgendagens kunder». *E24*. Retrieved from https://e24.no/det-groenne-skiftet/i/M35Vw0/vegetarboom-i-norge-kjedene-kjemper-om-morgendagens-kunder
Gryr. (2021). Gryr. Retrieved from https://gryr.no/
Haddad, E. H., & Tanzman, J. S. (2003). What do vegetarians in the United States eat? *The American Journal of Clinical Nutrition, 78*(3), 626S-632S. doi:10.1093/ajcn/78.3.626S
Haider, L. M., Schwingshackl, L., Hoffmann, G., & Ekmekcioglu, C. (2018). The effect of vegetarian diets on iron status in adults: A systematic review and meta-analysis. *Critical Reviews in Food Science & Nutrition, 58*(8), 1359-1374. doi: 10.1080/10408398.2016.1259210
Hallström, E., Carlsson-Kanyama, A., & Börjesson, P. (2015). Environmental impact of dietary change: a systematic review. *Journal of Cleaner Production, 91*, 1-11. doi:10.1016/j.jclepro.2014.12.008

Hartmann, C., & Siegrist, M. (2017). Consumer perception and behaviour regarding sustainable protein consumption: A systematic review. *Trends in Food Science & Technology, 61*, 11-25. doi:https://doi.org/10.1016/j.tifs.2016.12.006

Hebert, J. R., Clemow, L., Pbert, L., Ockene, I. S., & Ockene, J. K. (1995). Social desirability bias in dietary self-report may compromise the validity of dietary intake measures. *Int J Epidemiol, 24*(2), 389-398. doi:10.1093/ije/24.2.389

Hemler, E. C., & Hu, F. B. (2019). Plant-Based Diets for Cardiovascular Disease Prevention: All Plant Foods Are Not Created Equal. *Curr Atheroscler Rep, 21*(5), 18. doi:10.1007/s11883-019-0779-5

Henjum, S., Brantsæter, A. L., Kurniasari, A., Dahl, L., Aadland, E. K., Gjengedal, E. L. F., . . . Aakre, I. (2018). Suboptimal Iodine Status and Low Iodine Knowledge in Young Norwegian Women. *Nutrients, 10*(7), 941. doi:10.3390/nu10070941

Henjum, S., Groufh-Jacobsen, S., Stea, T. H., Tonheim, L. E., & Almendingen, K. (2021). Iron Status of Vegans, Vegetarians and Pescatarians in Norway. *Biomolecules, 11*(3), 454. Retrieved from https://www.mdpi.com/2218-273X/11/3/454

Hever, J. (2016). Plant-Based Diets: A Physician's Guide. *Permanente Journal, 20*(3), 15-082. doi: 10.7812/TPP/15-082

HOFF. (2021). HOFF Liv Laga. Retrieved from https://www.hoff.no/222/hoff-liv-laga

Hoffman, S. R., Stallings, S. F., Bessinger, R. C., & Brooks, G. T. (2013). Differences between health and ethical vegetarians. Strength of conviction, nutrition knowledge, dietary restriction, and duration of adherence. *Appetite, 65*, 139-144. doi:https://doi.org/10.1016/j.appet.2013.02.009

Hopwood, C. J., Bleidorn, W., Schwaba, T., & Chen, S. (2020). Health, environmental, and animal rights motives for vegetarian eating. *PLOS ONE, 15*(4), e0230609. doi:10.1371/journal.pone.0230609

Hu, F. B. (2003). Plant-based foods and prevention of cardiovascular disease: an overview. *The American Journal of Clinical Nutrition, 78*(3), 544S-551S. doi:10.1093/ajcn/78.3.544S

Hu, F. B., Otis, B. O., & McCarthy, G. (2019). Can Plant-Based Meat Alternatives Be Part of a Healthy and Sustainable Diet? *JAMA, 322*(16), 1547-1548. doi:10.1001/jama.2019.13187

Hälsans kök. (2021). Hälsans kök. Retrieved from https://www.halsanskok.no/

Haas, R., Schnepps, A., Pichler, A., & Meixner, O. (2019). Cow Milk versus Plant-Based Milk Substitutes: A Comparison of Product Image and Motivational Structure of Consumption. *Sustainability, 11*(18), 5046. Retrieved from https://www.mdpi.com/2071-1050/11/18/5046

Iguacel, I., Miguel-Berges, M. L., Gomez-Bruton, A., Moreno, L. A., & Julian, C. (2019). Veganism, vegetarianism, bone mineral density, and fracture risk: a systematic review and meta-analysis. *Nutrition Reviews, 77*(1), 1-18. doi:10.1093/nutrit/nuy045

Institute of Medicine (US) Panel on Micronutrients. (2001). Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc. In. Retrieved from https://www.ncbi.nlm.nih.gov/books/NBK222317/

Ipsos for Orkla. (2020). *The Orkla Sustainable Life barometer*. Retrieved from https://annualreport2020.orkla.com/assets/orkla/pdfs/2020/en/Orkla_AnnualReport_2020_UK.pdf

Ismail, I., Hwang, Y.-H., & Joo, S.-T. (2020). Meat analog as future food: a review. *Journal of animal science and technology, 62*(2), 111-120. doi:10.5187/jast.2020.62.2.111

Johansson, G., Wikman, Å., Åhrén, A.-M., Hallmans, G., & Johansson, I. (2001). Underreporting of energy intake in repeated 24-hour recalls related to gender, age, weight status, day of interview, educational level, reported food intake, smoking habits and area of living. *Public Health Nutrition, 4*(4), 919-927. doi:10.1079/PHN2001124

Key, T. J., Appleby, P. N., Crowe, F. L., Bradbury, K. E., Schmidt, J. A., & Travis, R. C. (2014). Cancer in British vegetarians: updated analyses of 4998 incident cancers in a cohort of 32,491 meat eaters, 8612 fish eaters, 18,298 vegetarians, and 2246 vegans. *The American Journal of Clinical Nutrition, 100*(suppl_1), 378S-385S. doi:10.3945/ajcn.113.071266

Khoros. (2018, 2021). The 2021 Social Media Demographics Guide. Retrieved from https://khoros.com/resources/social-media-demographics-guide

Kristensen, N. B., Madsen, M. L., Hansen, T. H., Allin, K. H., Hoppe, C., Fagt, S., . . . Pedersen, O. (2015). Intake of macro- and micronutrients in Danish vegans. *Nutrition Journal, 14*(1), 115. doi:10.1186/s12937-015-0103-3

Larsson, S. C., & Orsini, N. (2013). Red Meat and Processed Meat Consumption and All-Cause Mortality: A Meta-Analysis. *American Journal of Epidemiology, 179*(3), 282-289. doi:10.1093/aje/kwt261

Lauritsen, J. (2019). Foodcalc v.1.3. . Retrieved from https://github.com/jesperldk/FoodCalc

Leitzmann, C. (2014). Vegetarian nutrition: past, present, future. *The American Journal of Clinical Nutrition, 100*(suppl_1), 496S-502S. doi:10.3945/ajcn.113.071365

Mariotti, F., & Gardner, C. D. (2019). Dietary Protein and Amino Acids in Vegetarian Diets-A Review. *Nutrients, 11*(11). doi:10.3390/nu11112661

Melina, V., Craig, W., & Levin, S. (2016). Position of the Academy of Nutrition and Dietetics: Vegetarian Diets. *Journal of the Academy of Nutrition and Dietetics, 116*(12), 1970-1980. doi:https://doi.org/10.1016/j.jand.2016.09.025

Messina, M. (2016). Soy and Health Update: Evaluation of the Clinical and Epidemiologic Literature. *Nutrients, 8*(12), 754. doi:10.3390/nu8120754

Miller, T. M., Abdel-Maksoud, M. F., Crane, L. A., Marcus, A. C., & Byers, T. E. (2008). Effects of social approval bias on self-reported fruit and vegetable consumption: a randomized controlled trial. *Nutrition Journal, 7*(1), 18. doi:10.1186/1475-2891-7-18

Ministry of Climate and Environment. (2021). *Meld. St. 13 (2020–2021) Klimaplan for 2021–2030* Retrieved from https://www.regjeringen.no/no/dokumenter/meld.-st.-13-20202021/id2827405/?ch=1

Modlinska, K., Adamczyk, D., Maison, D., & Pisula, W. (2020). Gender Differences in Attitudes to Vegans/Vegetarians and Their Food Preferences, and Their Implications for Promoting Sustainable Dietary Patterns–A Systematic Review. *Sustainability, 12*(16), 6292. Retrieved from https://www.mdpi.com/2071-1050/12/16/6292

Monteiro, C. A., Cannon, G., Moubarac, J.-C., Levy, R. B., Louzada, M. L. C., & Jaime, P. C. (2018). The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutrition, 21*(1), 5-17. doi:10.1017/S1368980017000234

Mozaffarian, D., Micha, R., & Wallace, S. (2010). Effects on Coronary Heart Disease of Increasing Polyunsaturated Fat in Place of Saturated Fat: A Systematic Review and Meta-Analysis of Randomized Controlled Trials (Meta-analysis: PUFA Intake and CHD). *PLoS Medicine, 7*(3), e1000252. doi:10.1371/journal.pmed.1000252

Mozaffarian, D., Rosenberg, I., & Uauy, R. (2018). History of modern nutrition science—implications for current research, dietary guidelines, and food policy. *BMJ, 361*, k2392. doi:10.1136/bmj.k2392

Mäkinen, O. E., Wanhalinna, V., Zannini, E., & Arendt, E. K. (2016). Foods for Special Dietary Needs: Non-dairy Plant-based Milk Substitutes and Fermented Dairy-type Products. *Critical Reviews in Food Science and Nutrition, 56*(3), 339-349. doi:10.1080/10408398.2012.761950

Naska, A., Lagiou, A., & Lagiou, P. (2017). Dietary assessment methods in epidemiological research: current state of the art and future prospects. *F1000Res, 6*, 926. doi:10.12688/f1000research.10703.1

National Nutrition Council. (2017). *Bærekraftig kosthold- vurdering av de norske kostrådene i et bærekraftperspektiv*.

NIPH. (2016, 15.10.2018). Social inequalities in health Retrieved from https://www.fhi.no/en/op/hin/groups/social-inequalities/

Nordic Council of Ministers. (2014). *Nordic Nutrition Recommendations 2012: Integrating nutrition and physical activity* (5th ed.). Copenhagen, Denmark: Nordic Council of Ministers.

Norwegian Directorate of Health. (2015a). The Norwegian Dietary Guidelines. Retrieved from https://www.helsedirektoratet.no/brosjyrer/helsedirektoratets-kostrad-brosjyre-og-plakat#lastnedbrosjyrepdf
Norwegian Directorate of Health. (2015b). Næringsrik vegetarkost (Nutritious vegetarian diet). Retrieved from https://helsenorge.no/kosthold-og-ernaring/vegetarisk-kosthold/naringsrik-vegetarkost
Norwegian Directorate of Health. (2021). *Trends in the Norwegian diet 2020*. Retrieved from https://www.helsedirektoratet.no/rapporter/utviklingen-i-norsk-kosthold
Norwegian Directorate of Health and the Norwegian Food Safety Authority. (2020). Kostholdsplanleggeren. Retrieved from https://www.kostholdsplanleggeren.no/. Retrieved 2020, from Norwegian Directorate of Health and the Norwegian Food Safety Authority https://www.kostholdsplanleggeren.no/
Norwegian Environment Agency. (2020). *Klimakur 2030: Tiltak og virkemidler mot 2030 (M-1625)*. Retrieved from https://www.regjeringen.no/contentassets/1092a287729448e5826b0df5832794bd/klimakur-2030.pdf
Norwegian Food Safety Authority. (2020). Norwegian Food Composition Database 2020. Retrieved from www.matvaretabellen.no. www.matvaretabellen.no
Norwegian Ministries. (2017). *Norwegian National Action Plan for a Healthier Diet (2017–2021)- Healthy diet, meal enjoyment and good health for everyone!* Retrieved from https://www.regjeringen.no/contentassets/fab53cd681b247bfa8c03a3767c75e66/norwegian_national_action_plan_for_a_healthier_diet_an_outline.pdf
Norwegian Ministry of Health and Care Services. (2013). *NCD-Strategy 2013 – 2017 For the prevention, diagnosis, treatment and rehabilitation of four noncommunicable diseases: cardiovascular disease, diabetes, COPD and cancer.* Oslo: Norwegian Ministry of Health and Care Services.
Novotny, J. A., Rumpler, W. V., Riddick, H., Hebert, J. R., Rhodes, D., Judd, J. T., . . . Briefel, R. (2003). Personality characteristics as predictors of underreporting of energy intake on 24-hour dietary recall interviews. *Journal of the American Dietetic Association, 103*(9), 1146-1151. doi:https://doi.org/10.1016/S0002-8223(03)00975-1
Oatly. (2021). The Original Oatly. Retrieved from https://www.oatly.com/no/products
Olfert, M. D., & Wattick, R. A. (2018). Vegetarian Diets and the Risk of Diabetes. *Current diabetes reports, 18*(11), 101-101. doi:10.1007/s11892-018-1070-9
Orkla. Naturli. Retrieved from https://www.orklafoods-ooh.no/produkter/naturli-plantebasert/kjotterstatning/
Papier, K., Tong, T. Y., Appleby, P. N., Bradbury, K. E., Fensom, G. K., Knuppel, A., . . . Key, T. J. (2019). Comparison of Major Protein-Source Foods and Other Food Groups in Meat-Eaters and Non-Meat-Eaters in the EPIC-Oxford Cohort. *Nutrients, 11*(4), 824. doi:10.3390/nu11040824
Paul, A. A., Kumar, S., Kumar, V., & Sharma, R. (2020). Milk Analog: Plant based alternatives to conventional milk, production, potential and health concerns. *Critical Reviews in Food Science and Nutrition, 60*(18), 3005-3023. doi:10.1080/10408398.2019.1674243
Pawlak, R., Berger, J., & Hines, I. (2018). Iron Status of Vegetarian Adults: A Review of Literature. *American Journal of Lifestyle Medicine, 12*(6), 486-498. doi:10.1177/1559827616682933
Platel, K., & Srinivasan, K. (2016). Bioavailability of Micronutrients from Plant Foods: An Update. *Crit Rev Food Sci Nutr, 56*(10), 1608-1619. doi:10.1080/10408398.2013.781011
Poppitt, S. D., Swann, D., Black, A. E., & Prentice, A. M. (1998). Assessment of selective under-reporting of food intake by both obese and non-obese women in a metabolic facility. *International Journal of Obesity, 22*(4), 303-311. doi:10.1038/sj.ijo.0800584
Rizzo, N. S., Jaceldo-Siegl, K., Sabate, J., & Fraser, G. E. (2013). Nutrient profiles of vegetarian and nonvegetarian dietary patterns. *J Acad Nutr Diet, 113*(12), 1610-1619. doi:10.1016/j.jand.2013.06.349

Roy Morgan. (2016). The slow but steady rise of vegetarianism in Australia Retrieved from http://www.roymorgan.com/findings/vegetarianisms-slow-but-steady-rise-in-australia-201608151105
Ruby, M. B. (2012). Vegetarianism. A blossoming field of study. *Appetite, 58*(1), 141-150. doi:https://doi.org/10.1016/j.appet.2011.09.019
Rutishauser, I. H. (2005). Dietary intake measurements. *Public Health Nutr, 8*(7a), 1100-1107. doi:10.1079/phn2005798
Röös, E., Garnett, T., Watz, V., & Sjörs, C. (2018). *The role of dairy and plant based dairy alternatives in sustainable diets*. Retrieved from https://pub.epsilon.slu.se › roos_e_et_al_190304
Sabaté, J. (2003). The contribution of vegetarian diets to health and disease: a paradigm shift? *The American Journal of Clinical Nutrition, 78*(3), 502S-507S. doi:10.1093/ajcn/78.3.502S
Sabaté, J., & Soret, S. (2014). Sustainability of plant-based diets: back to the future. *Am J Clin Nutr, 100 Suppl 1*, 476s-482s. doi:10.3945/ajcn.113.071522
Santo, R. E., Kim, B. F., Goldman, S. E., Dutkiewicz, J., Biehl, E. M. B., Bloem, M. W., . . . Nachman, K. E. (2020). Considering Plant-Based Meat Substitutes and Cell-Based Meats: A Public Health and Food Systems Perspective. *Frontiers in Sustainable Food Systems, 4*(134). doi:10.3389/fsufs.2020.00134
Satija, A., Bhupathiraju, S. N., Spiegelman, D., Chiuve, S. E., Manson, J. E., Willett, W., . . . Hu, F. B. (2017). Healthful and Unhealthful Plant-Based Diets and the Risk of Coronary Heart Disease in U.S. Adults. *Journal of the American College of Cardiology, 70*(4), 411-422. doi:https://doi.org/10.1016/j.jacc.2017.05.047
Schüpbach, R., Wegmüller, R., Berguerand, C., Bui, M., & Herter-Aeberli, I. (2017). Micronutrient status and intake in omnivores, vegetarians and vegans in Switzerland. *Eur J Nutr, 56*(1), 283-293. doi:10.1007/s00394-015-1079-7
Sebastiani, G., Herranz Barbero, A., Borras-Novell, C., Alsina Casanova, M., Aldecoa-Bilbao, V., Andreu-Fernandez, V., . . . Garcia-Algar, O. (2019). The Effects of Vegetarian and Vegan Diet during Pregnancy on the Health of Mothers and Offspring. *Nutrients, 11*(3). doi:10.3390/nu11030557
Shim, J.-S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and health, 36*, e2014009-e2014009. doi:10.4178/epih/e2014009
Shorten, A., & Moorley, C. (2014). Selecting the sample. *Evidence Based Nursing, 17*(2), 32-33. doi:10.1136/eb-2014-101747
Silva, A. R. A., Silva, M. M. N., & Ribeiro, B. D. (2020). Health issues and technological aspects of plant-based alternative milk. *Food Research International, 131*, 108972. doi:https://doi.org/10.1016/j.foodres.2019.108972
Smart Protein. (2019). Smart Protein. Retrieved from https://smartproteinproject.eu/
Smart Protein Project. (2021). *Plant-based foods in Europe: How big is the market? The Smart Protein Plant-based Food Sector Report by Smart Protein Project, European Union's Horizon 2020 research and innovation programme (No 862957)*. Retrieved from https://smartproteinproject.eu/plant-based-food-sector-report
Sobiecki, J. G., Appleby, P. N., Bradbury, K. E., & Key, T. J. (2016). High compliance with dietary recommendations in a cohort of meat eaters, fish eaters, vegetarians, and vegans: results from the European Prospective Investigation into Cancer and Nutrition–Oxford study. *Nutrition Research, 36*(5), 464-477. doi:https://doi.org/10.1016/j.nutres.2015.12.016
SoyInfo Center. History of Fermented Tofu - A Healthy Nondairy / Vegan Cheese (1610-2011). In. Retrieved from https://www.soyinfocenter.com/books/149
Springmann, M., Spajic, L., Clark, M. A., Poore, J., Herforth, A., Webb, P., . . . Scarborough, P. (2020). The healthiness and sustainability of national and global food based dietary guidelines: modelling study. *BMJ, 370*, m2322. doi:10.1136/bmj.m2322
Springmann, M., Wiebe, K., Mason-D'Croz, D., Sulser, T. B., Rayner, M., & Scarborough, P. (2018). Health and nutritional aspects of sustainable diet strategies and their association with

environmental impacts: a global modelling analysis with country-level detail. *The Lancet Planetary Health, 2*(10), e451-e461. doi:10.1016/S2542-5196(18)30206-7

Statistics Norway. (2020, 19.06.2020). Educational attainment of the population. Retrieved from https://www.ssb.no/utdanning/statistikker/utniv

Subar, A. F., Kipnis, V., Troiano, R. P., Midthune, D., Schoeller, D. A., Bingham, S., . . . Schatzkin, A. (2003). Using Intake Biomarkers to Evaluate the Extent of Dietary Misreporting in a Large Sample of Adults: The OPEN Study. *American Journal of Epidemiology, 158*(1), 1-13. doi:10.1093/aje/kwg092

Swedish National Food Agency. (2020). The Food Database. Retrieved from http://www7.slv.se/SokNaringsinnehall/. http://www7.slv.se/SokNaringsinnehall/

Sælensminde, K., Johansson, L., & Helleve, A. (2016). *Samfunnsgevinster av å følge Helsedirektoratets kostråd*. Retrieved from https://www.helsedirektoratet.no/rapporter/samfunnsgevinster-av-a-folge-helsedirektoratets-kostrad/

The Vegan Society. Statistics. Worldwide. Retrieved from https://www.vegansociety.com/news/media/statistics/worldwide

Thorbjørnsen, P. W. (2016). *Vegetar & Vegan ABC (Vegetarian & Vegan ABC)*. Oslo: Norsk Vegetarforening (The Norwegian Vegetarian Society)

Totland, T. H., Melnæs, B. K., Lundberg-Hallén, N., Helland-Kigen, K. M., Lund-Blix, N. A., Myhre, J. B., . . . Andersen, L. F. (2012). *Norkost 3 En landsomfattende kostholdsundersøkelse blant menn og kvinner i Norge i alderen 18-70 år, 2010-11.* Retrieved from Norwegian Directorate of Health: https://www.helsedirektoratet.no/tema/kosthold-og-ernaering/statistikk-og-undersokelser-om-ernaering

Trabulsi, J., & Schoeller, D. A. (2001). Evaluation of dietary assessment instruments against doubly labeled water, a biomarker of habitual energy intake. *American Journal of Physiology-Endocrinology and Metabolism, 281*(5), E891-E899. doi:10.1152/ajpendo.2001.281.5.E891

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development (A/RES/70/1)*. Retrieved from New York: https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf

UNSCN. (2017). *Sustainable diets for healthy people and a healthy planet.* . Retrieved from Rome:

Van Loo, E. J., Hoefkens, C., & Verbeke, W. (2017). Healthy, sustainable and plant-based eating: Perceived (mis)match and involvement-based consumer segments as targets for future policy. *Food Policy, 69*, 46-57. doi:https://doi.org/10.1016/j.foodpol.2017.03.001

Vanga, S. K., & Raghavan, V. (2018). How well do plant based alternatives fare nutritionally compared to cow's milk? *Journal of Food Science and Technology, 55*(1), 10-20. doi:10.1007/s13197-017-2915-y

Veierød, M. B., & Thelle, D. S. (2007). Tverrsnittstudier. In P. Laake, A. Hjartåker, D. S. Thelle, & M. B. Veierød (Eds.), *Epidemiologiske og kliniske forskningsmetoder* (1 ed.). Oslo: Gyldendal Akademiske.

Violife. Violife, Our products. Retrieved from https://violifefoods.com/

Vivera. (2021). Vivera. Retrieved from https://vivera.com/

Waldmann, A., Koschizke, J. W., Leitzmann, C., & Hahn, A. (2003). Dietary intakes and lifestyle factors of a vegan population in Germany: results from the German Vegan Study. *European Journal of Clinical Nutrition, 57*(8), 947-955. doi:10.1038/sj.ejcn.1601629

WCRF, & AICR. (2018). *Diet, Nutrition, Physical Activity and Cancer: a Global Perspective. Continuous Update Project Expert Report 2018*. Retrieved from https://www.wcrf.org/dietandcancer

Weikert, C., Trefflich, I., Menzel, J., Obeid, R., Longree, A., Dierkes, J., . . . Abraham, K. (2020). Vitamin and Mineral Status in a Vegan Diet. *Deutsches Arzteblatt international, 117*(35-36), 575-582. doi:10.3238/arztebl.2020.0575

WHO. (2020, 01.04.2020). Malnutrition. Retrieved from https://www.who.int/news-room/fact-sheets/detail/malnutrition

Wickramasinghe, K., Breda, J., Berdzuli, N., Rippin, H., Farrand, C., & Halloran, A. (2021). The shift to plant-based diets: are we missing the point? *Global Food Security, 29*, 100530. doi:https://doi.org/10.1016/j.gfs.2021.100530

Willett, W., Rockstrom, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., . . . Murray, C. J. L. (2019). Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet, 393*(10170), 447-492. doi:10.1016/s0140-6736(18)31788-4

World Health, O. (2013). *Global action plan for the prevention and control of noncommunicable diseases 2013-2020*. Geneva: World Health Organization.

WWF. (2020). *Bending the Curve: The Restorative Power of Planet-Based Diets.* Retrieved from WWF, Gland, Switzerland:

Zimmermann, M. B., Jooste, P. L., & Pandav, C. S. (2008). Iodine-deficiency disorders. *Lancet, 372*(9645), 1251-1262. doi:10.1016/s0140-6736(08)61005-3

Appendices

Appendix 1: Consent form

OSLO METROPOLITAN UNIVERSITY

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKTET

JODSTATUS BLANT VEGANERE OG VEGETARIANERE I NORGE

Dette er et spørsmål til deg om å delta i et forskningsprosjekt for å undersøke jodstatus blant veganere og vegetarianere i Norge. Jod er et næringsstoff som er helt nødvendig for kroppen å få tilført i små mengder. I flere tiår har man antatt at nordmenn har hatt god jodstatus og fått tilstrekkelig jod gjennom maten. Noen nyere undersøkelser har imidlertid antydet at flere undergrupper i befolkningen får i seg mindre jod via kosten enn det som er anbefalt. Forskere ved OsloMet vil med denne undersøkelsen kartlegge jodstatus blant veganere og vegetarianere. Kroppens jodstatus bestemmes ved å analysere konsentrasjonen av jod i en urinprøve. I tillegg vil skjoldbruskkjertelhormon bli analysert i en blodprøve. I prosjektet vil vi derfor be deg om å avgi en blodprøve og en urinprøve, samt å svare på noen spørsmål om jod.

HVA INNEBÆRER PROSJEKTET?

Dersom du samtykker til å være med i prosjektet vil du få informasjon om blodprøven og urinprøven, samt det utstyret du trenger. Prøvene vil bli brukt til å analysere konsentrasjonen av jod og skjoldbrukskjertelhormoner. I tillegg vil du bli bedt om å svare på et spørreskjema med spørsmål om jod, om livsstil og bakgrunn, slik som alder, vekt, kostvaner og om bruk av kosttilskudd.

MULIGE FORDELER OG ULEMPER

Ditt enkle bidrag er av stor betydning. Prosjektet vil gi viktig kunnskap om jodstatus blant veganere og vegetarianere i Norge. Den eneste ulempen for deg er tiden du bruker til å svare på spørsmålene og avgi blod og urinprøve. Du vil motta et informasjonsskriv om jod når du har levert svar og urinprøve.

FRIVILLIG DELTAKELSE OG MULIGHET FOR Å TREKKE SITT SAMTYKKE

Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykke tilbake uten å oppgi noen grunn. Alle opplysninger om deg vil da bli anonymisert. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg. Dersom du trekker deg fra prosjektet, kan du kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner.

Dersom du ønsker å delta, undertegner du samtykkeerklæringen på siste side og lever det til prosjektmedarbeider. Dersom du senere ønsker å trekke deg eller har spørsmål til prosjektet, ta kontakt med Sigrun Henjum telefonnummer 41550907.

HVA SKJER MED INFORMASJONEN OM DEG?

Opplysningene som registreres om deg skal kun brukes slik som beskrevet i hensikten med prosjektet. Du har rett til innsyn i hvilke opplysninger som er registrert om deg til å få korrigert eventuelle feil i de opplysningene som er registrert. Du har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene.

Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger. En kode knytter deg til dine opplysninger gjennom en navneliste som skal oppbevares adskilte fra øvrige data. Det er kun Sigrun Henjum som har tilgang til denne listen. Kodenøkkelen som kan identifisere deg med de innsamlede opplysningene vil bli slettet etter prosjektperioden og etter dette vil opplysninger og analysesvar kun foreligge anonymisert. Opplysningene som innhentes i prosjektet skal lagres på en sikker server ved OsloMet. Det er kun medarbeidere i prosjektet som vil ha tilgang til opplysningene på serveren. Sigrun Henjum er databehandlingsansvarlig og databehandler er tjenester for sensitive data (TSD) ved UiO.

.

HVA SKJER MED PRØVER SOM BLIR TATT AV DEG?

Prøvene vil bli merket med kodenøkkel og vil bli oppbevart ved OsloMet til alle prøvene i prosjektet er klare for analyse. Det som er igjen etter analysene vil bli kastet. Jodkonsentrasjonen (og eventuelt andre stoffer av betydning for jodkonsentrasjonen) i urin vil bli målt på Norges miljø- og biovitenskapelige universitet på Ås, som bruker internasjonalt anerkjente metoder for å måle jodkonsentrasjon. Blodprøvene vil bli analysert for skjoldbruskkjertelhormoner og vitamin B12 markører ved Hormonlaben på Aker Universitetssykehus. Dersom vi finner for høye eller for lave hormonverdier i blodet eller unormale jod eller B12 verdier, vil vi ta kontakt slik at du kan bli undersøkt av lege. Det er kun urin og blod som skal utleveres, og koden som knytter deg til dine personopplysninger vil ikke bli utlevert. Det skal opprettes en forskningsbiobank «Jodstatus og vitamin B12 status blant vegetarianere og veganere i Norge» for dette prosjektet som er godkjent av Regional komité for medisinsk og helsefaglig forskningsetikk. Opplysningene om deg skal oppbevares inntil fem år etter prosjektslutt (31.12.2026) av dokumentasjonshensyn. Opplysningene i denne perioden skal kun oppbevares av dokumentasjonshensyn, de skal ikke benyttes til videre forskning.

GODKJENNING

Regional komité for medisinsk og helsefaglig forskningsetikk har vurdert prosjektet, og har gitt forhåndsgodkjenning 2019/653/REK sør-øst. Prosjektet avsluttes 31.12.2021.

Etter ny personopplysningslov har behandlingsansvarlig institusjon, OsloMet, og prosjektleder, Sigrun Henjum, et selvstendig ansvar for å sikre at behandlingen av dine opplysninger har et lovlig grunnlag. Dette prosjektet har rettslig grunnlag i EUs personvernforordning artikkel 6 nr. 1a og artikkel 9 nr. 2a og ditt samtykke. Du har rett til å klage på behandlingen av dine opplysninger til Datatilsynet.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet kan du ta kontakt med prosjektleder Sigrun Henjum, telefon: 41550907 og e-post: shenjum@oslomet.no.

Personvernombud ved institusjonen er Ingrid S. Jacobsen, e-post: personvernombud@oslomet.no.

NSD – Norsk senter for forskningsdata AS, på epost (personverntjenester@nsd.no) eller telefon: 55 58 21 17.

JEG SAMTYKKER TIL Å DELTA I PROSJEKTET OG TIL AT MINE PERSONOPPLYSNINGER OG MITT BIOLOGISKE MATERIALE BRUKES SLIK DET ER BESKREVET

Sted og dato | Deltakers signatur

Deltakers navn med trykte bokstaver

Fint hvis du oppgir et telefonnummer i tilfelle vi må kontakte deg for oppklarende spørsmål:

_ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

Appendix 2: Questionnaire

OSLO METROPOLITAN UNIVERSITY

Spørreskjema – Jod og B12 status hos vegetarianere og veganer

ID-nummer i prosjektet ☐☐☐☐

Dagens dato: ☐☐ ☐☐ ☐☐☐☐

Bakgrunnsinformasjon

1. Din alder? ☐☐ år

2. Kjønn: ……..

3. Høyde og vekt:

Hvor høy er du? ☐☐☐ cm

Hvor mye veier du? ☐☐☐ kg

4. Hva er din sivilstatus
☐ Samboer
☐ Gift
☐ Enslig
☐ Enke

Hvis mann, gå direkte til spørsmål 8 herfra.

5. Har du barn? Hvis ja, antall ………

6. Ammer du et eller flere barn nå?

☐ Ja, helt ☐ Ja, delvis ☐ Nei

7. Planlegger du å bli gravid de neste to årene?

☐ Ja ☐Nei ☐ Jeg er gravid nå

8. Hvilket land er du født i?
☐ Norge
☐ Annet……………………………………..

9. Hvor mange år har du bodd i Norge? ☐☐

10. Hvilket språk snakker du mest hjemme?

☐ Norsk ☐ Annet, hvilket: ____________

11. Hva er din høyeste fullførte utdannelse:
☐ <12 år (ikke fullført videregående)
☐ 12 år videregående/fagbrev
☐ 1-4 års høgskole/universitet etter videregående
☐ Mer enn 4 år høgskole/universitet

12. Yrkesstatus:
☐ Hjemmeværende
☐ Arbeidsledig
☐ Student
☐ Yrkesaktiv

13. Hvis student, hva studerer du? ……………………

14. Hvis student, hvilket studieprogram
☐ Bachelorgrad
☐ Mastergrad
☐ Doktorgrad

15. Røykevaner: Røyker du nå?
☐ Nei
☐ Nei, men jeg røkte før
☐ Ja, av og til
☐ Ja, daglig

Hvor mye i gjennomsnitt røyker du per dag?
Antall:……………………………

16. Snuser du?
☐Nei ☐Ja, Av og til ☐Ja, daglig

17. Har du hatt sykdommer knyttet til skjoldbruskkjertelen?
☐ Ja, for høyt stoffskifte
☐ Ja, for lavt stoffskifte
☐ Nei

Hvis ja, bruker du medisiner for dette nå?
☐ Ja ☐Nei

Navn på medisiner:.……………………

Kunnskapsspørsmål

18. Vet du hva jod er?

☐Ja ☐Nei ☐Hørt om det, husker ikke hva det er

19. Hvor har du hørt om jod?

☐ Helsepersonell
☐ Media (internett, avis, tv)
☐ Skole
☐ Familie og venner
☐ Jeg har ikke hørt om jod

20. Hva er de viktigste kildene til jod i kosten?

☐ Kjøtt
☐ Melk- og meieriprodukter
☐ Frukt og grønnsaker
☐ Fisk og sjømat
☐ Brød og kornvarer
☐ Vegetabilske oljer
☐ Salt tilsatt jod
☐ Kosttilskudd
☐ Tang/tare
☐ Vet ikke

21. Jod er viktig for?

☐ Normal vekst og utvikling hos barn
☐ Forebygge blindhet
☐ Normal fosterutvikling
☐ Normal styrke i skjelett og tenner
☐ Opprettholde normalt stoffskifte
☐ Unngå ryggmargsbrokk
☐ Vet ikke

22. Hva vet du om lavt og høyt inntak av jod i Norge?

☐ For lavt inntak av jod er et problem i Norge i dag
☐ For høyt inntak av jod er et problem i Norge i dag
☐ Lavt inntak er ikke et problem i dag, var det før
☐ Vet ikke

23. Jeg tror jeg får nok jod gjennom kosten?

☐ Enig
☐ Uenig
☐ Vet ikke

24. Jeg har fått informasjon om jod fra helsepersonell

☐ Ja
☐ Nei
☐ Husker ikke

25. Et vegetarisk/vegansk kosthold er tilstrekkelig for å i møtekomme behovet for jod uten tilskudd
(et kosthold uten fisk, egg og meieriprodukter)

☐ Enig
☐ Uenig
☐ Vet ikke

26. Det er helt trygt å benytte tang/tare tilskudd og matvarer og dette er en god kilde til jod

☐ Enig
☐ Uenig
☐ Vet ikke

27. Kroppen vil tilpasse seg hvis jodmangel forekommer, tilskudd vil derfor ikke være nødvendig

☐ Helsepersonell
☐ Media (internett, avis, tv)
☐ Skole
☐ Familie og venner
☐ Jeg har ikke hørt om jod

28. Jeg har vagt å ha et vegansk/ vegetarisk kosthold på grunn av:

☐ Venner
☐ Media (internett, avis, tv)
☐ Dokumentarer
☐ Klima
☐ Bedre helse
☐ Dyrevelferd
☐ Annet …………………………

29. Jeg har satt meg inn i hva det vil si å ha et vegansk/vegetarisk kosthold, og vet hvordan jeg skal dekke næringsbehovet fra kilder som blir ekskludert i mitt kosthold

☐ Enig
☐ Uenig
☐ Vet ikke

Kryss av på utsagnene som beskriver ditt nåværende kosthold:

	Aldri = 0 ganger	**Sjelden** = <1 gang per mnd	**Noen ganger** = 1-4 ganger i mnd	**Ofte** = 2 eller flere ganger i uken
Jeg bruker kumelk	☐	☐	☐	☐
Jeg bruker ost på kumelk	☐	☐	☐	☐
Jeg bruker egg	☐	☐	☐	☐
Jeg bruker fisk	☐	☐	☐	☐
Jeg bruker fjærkre	☐	☐	☐	☐
Jeg bruker rødt kjøtt	☐	☐	☐	☐

Kosthold og kosttilskudd

1. Tok du vitamin og mineraltilskudd med jod i går eller i dag tidlig?

☐ Ja ☐ Nei

Hvis ja, hvilket ……………………………………………………………………….

2. Bruker du tang og/ eller tare eller tang- og/eller tareprodukter?
(eks: sjøspagetti, havsalat, kombu, wakame, tørket tang/ tare mm)

☐ Ja ☐ Nei

Hvis ja, hvilken type ………………………………………………………………..
Hvor er det kjøpt……………………………………………………………………

2.1 Hvor ofte bruker du dette? ☐ daglig ☐ 4-6 ganger/uke ☐ 1-3 ganger/uke ☐ sjeldnere enn ukentlig
2.2 Hvor mye bruker når du spiser dette (mengde i gram)……………………………

3. Spiser du matvarer som inneholder tang/ tare
(eks: sushi som er pakket inn i noori slik som maki, taresalt, krydder med tare, olje med tare, bakverk med tare mm)

☐ Ja ☐Nei

Hvis ja, hvilken type……………………………………………………………………

3.1 Hvor ofte bruker du dette? ☐ daglig ☐ 4-6 ganger/uke ☐ 1-3 ganger/uke ☐ sjeldnere enn ukentlig

4. Tar du kosttilskudd som inneholder alger/ tang/ tare?

☐ Ja ☐Nei

Hvis ja, hvilken type……………………………………………………………………
4.1 Hvor er det kjøpt…………………………………………………………………..
4.2 Hvor mye bruker du (dose/ antall tabletter) ………………………………………

4.3 Hvor ofte bruker du dette? ☐ daglig ☐ 4-6 ganger/uke ☐ 1-3 ganger/uke ☐ sjeldnere enn ukentlig

5. Tok du vitamin og mineraltilskudd med B12 i går eller i dag tidlig?

☐ Ja ☐Nei

Hvis du tar flere ulike typer, fyll inn for hvert produkt du bruker under tilskudd 1, tilskudd 2 osv.
5.1 Tilskudd 1
Beskriv type……………………………………………………………
Hvor er det kjøpt……………………………………………………….
Hvor mye bruker du (eks: antall tabletter, mengde olje osv) …………………………………………………

Hvor ofte bruker du dette? ☐ daglig ☐ 4-6 ganger/uke ☐ 1-3 ganger/uke ☐ sjeldnere enn ukentlig

5.2 Tilskudd 2
Beskriv type……………………………………………………………
Hvor er det kjøpt……………………………………………………….
Hvor mye bruker du (eks: antall tabletter, mengde olje osv) …………………………………………………

Hvor ofte bruker du dette? ☐ daglig ☐ 4-6 ganger/uke ☐ 1-3 ganger/uke ☐ sjeldnere enn ukentlig

5.3 Tilskudd 3
Beskriv type……………………………………………………………
Hvor er det kjøpt……………………………………………………….
Hvor mye bruker du (eks: antall tabletter, mengde olje osv) …………………………………………………

Hvor ofte bruker du dette? ☐ daglig ☐ 4-6 ganger/uke ☐ 1-3 ganger/uke ☐ sjeldnere enn ukentlig

6. Tar du eller har du tatt injeksjon med vitamin B12?

☐ Ja ☐ Nei

Hvis ja, når tok du sist injeksjon med B12? …………………………………………..

Hvor ofte har du i gjennomsnitt drukket eller spist disse de siste 4 ukene?

		Sjelden/ aldri	Sjeldnere enn ukentlig	1-3 ganger per uke	4-6 ganger per uke	1-2 ganger per dag	3-4 ganger per dag	5 + ganger per dag
1.	Brød/knekkebrød, alle typer (2 skiver)	☐	☐	☐	☐	☐	☐	☐
2.	Frokostblandinger med korn/gryn (usøtet musli, havregrøt) (1 porsjon)	☐	☐	☐	☐	☐	☐	☐
3.	Andre frokostblandinger (corn flakes, honni korn, sjokopuff etc) (1 porsjon)	☐	☐	☐	☐	☐	☐	☐
4.	Ris/pasta kokt (porsjon á 150g)	☐	☐	☐	☐	☐	☐	☐
5.	Kumelk, alle typer gitt i antall glass (ca 2 dl) (og inkludert kaffe latte/cappuccino)	☐	☐	☐	☐	☐	☐	☐
6.	Alternativ melk (havre, ris, mandel, soya) ca 2 dl	☐	☐	☐	☐	☐	☐	☐
7.	Yoghurt/surmelk, all typer gitt i antall beger (ca2dl)	☐	☐	☐	☐	☐	☐	☐
8.	Alternativ yoghurt (havre, ris, mandel, soya kokkos), gitt i antall beger (ca2dl)	☐	☐	☐	☐	☐	☐	☐
9.	Rød fisk både til middag og som pålegg (laks, makrell, ørret, tunfisk) (Porsjon á ca 100 g)	☐	☐	☐	☐	☐	☐	☐
10.	Hvit fisk både til middag og som pålegg (torsk, sei, hyse, etc) (Porsjon á ca 100 g)	☐	☐	☐	☐	☐	☐	☐
11	Fiskekaker, fiske- boller, pudding og pinner (1 porsjon)	☐	☐	☐	☐	☐	☐	☐
12	Sushi med fisk/skalldyr (porsjon á ca 10 biter)	☐	☐	☐	☐	☐	☐	☐
13	Kjøtterstattning (Soya, tofu tempeh)	☐	☐	☐	☐	☐	☐	☐
14	Linser, bønner, kikerter (hummus)	☐	☐	☐	☐	☐	☐	☐
15	Olivenolje/rapsolje (til salat og matlaging)	☐	☐	☐	☐	☐	☐	☐
16	Hvit ost, av kumelk (2 skiver)	☐	☐	☐	☐	☐	☐	☐
17	Vegansk ost	☐	☐	☐	☐	☐	☐	☐
18	Ost, brunost (2 skiver)	☐	☐	☐	☐	☐	☐	☐
19	Egg hele (kokt, stekt) og i matlaging (pannekaker/vafler)	☐	☐	☐	☐	☐	☐	☐
20	Kaker, sjokolade, iskrem, smågodt	☐	☐	☐	☐	☐	☐	☐
21	Saltet snacks (f.eks. potetchips, peanøtter)	☐	☐	☐	☐	☐	☐	☐

22	Søte drikker (som saft, Cola, Fanta, nektar, juice, smoothie) (2 dl)	☐	☐	☐	☐	☐	☐	☐
23	Kunstig søte drikker (Cola Zero, Pepsi Zero osv)	☐	☐	☐	☐	☐	☐	☐
24	Vann som drikke (2 dl)	☐	☐	☐	☐	☐	☐	☐
25	Kaffe (1,5 dl)	☐	☐	☐	☐	☐	☐	☐
26	Te	☐	☐	☐	☐	☐	☐	☐
27	Energidrikk	☐	☐	☐	☐	☐	☐	☐
28	Farris	☐	☐	☐	☐	☐	☐	☐
29	Grønnsaker alle typer (f.eks. gulrot, kål, brokkoli, løk, erter, tomat, salat, agurk)	☐	☐	☐	☐	☐	☐	☐
30	Frukt og bær alle typer (f.eks. epler, pærer, banan, jordbær, druer, appelsin)	☐	☐	☐	☐	☐	☐	☐
31	Poteter (porsjon á 1 middels stor eller 2 små)	☐	☐	☐	☐	☐	☐	☐
32	Nøtter (valnøtter, hasselnøtter, mandler o.l.)	☐	☐	☐	☐	☐	☐	☐

Takk for at du deltok i dette forskningsprosjektet om jod og B12!

Appendix 3: REC approval

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst	Anders Strand	22844167	27.05.2019	2019/653/REK sør-øst C
			Deres dato:	Deres referanse:
			19.03.2019	

Vår referanse må oppgis ved alle henvendelser

Sigrun Henjum
HiOA

2019/653 Jodstatus og vitamin B12 status blant vegetarianere og veganere i Norge

Forskningsansvarlig: Oslomet - Oslo Metropolitan University
Prosjektleder: Sigrun Henjum

Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt. Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk (REK sør-øst) i møtet 09.05.2019. Vurderingen er gjort med hjemmel i helseforskningsloven (hforsknl) § 10.

Prosjektomtale
Vegetarisk kosthold er den kostholds-trenden som vokser raskest i Europa. Jod og vitamin B12 er næringsstoffer som kun forekommer i animalske matvarer og vegetarianere er utsatt for å få for lite av disse dersom de ikke tar tilskudd. Jod og vitamin B12 er essensielle næringsstoffer som inngår i skjoldbruskjertelhormoner og styrer normal energiomsetning og dannelse av normale blodceller. Nyere undersøkelser har vist at flere undergrupper i befolkningen får i seg mindre jod via kosten enn det som er anbefalt. Målet med dette prosjektet er å undersøke status for inntak av jod og vitamin B12 hos veganere og vegetarianere. Status bestemmes ved å analysere konsentrasjonen av jod i en urinprøve. I tillegg vil skjoldbruskkjertelhormoner og markører på vitamin B12 status bli analysert i en blodprøve. Prosjektet vil også beregne inntak av disse næringsstoffene fra kost og kosttilskudd og gi viktig kunnskap om inntak og status av jod og vitamin B12 hos vegetarianere.

Vurdering
Komiteen mener at dette er et potensielt nyttig prosjekt, spesielt sett i lys av endringer i matvaner hos deler av befolkningen, men har følgende bemerkninger til utformingen av prosjektet.

Det opplyses i søknadsskjema at serum, plasma og urin skal lagres i eksisterende biobank «Jodstatus gravide kvinner» (ansvarshavende Sigrun Henjum). Komiteen kan ikke se at formålet med det nå omsøkte prosjektet er dekket av formålet til denne biobanken. Komiteen setter derfor som vilkår for godkjenning at (1) prosjektet oppretter en ny prosjektspesifikk biobank for oppbevaring av materiale i det nå omsøkte prosjektet, denne kan være samlokalisert med den eksisterende biobanken. Komiteen godkjenner derfor opprettelse av prosjektspesifikk biobank «Jodstatus og vitamin B12 status blant vegetarianere og veganere i Norge» med ansvarshavende Sigrun Henjum. Komiteen setter en tidsavgrensning for forskningsbiobanken tilsvarende oppbevaringstiden for prosjektdata, det vil si til 31.12.2026. Deretter skal materialet behandles i henhold til helseforskningsloven § 30.

Det opplyses i samtykkeskrivet at prosjektet vil gi tilbakemelding til deltagere dersom de finner for høye eller lave hormonverdier i blodet. Komiteen mener at det samme bør gjelde dersom prosjektet finner unormale jod eller B12 verdier, og setter dette som vilkår (2) for godkjenning. Informasjon om dette skal

Besøksadresse: Gullhaugveien 1-3, 0484 Oslo
Telefon: 22845511
E-post: post@helseforskning.etikkom.no
Web: http://helseforskning.etikkom.no/
All post og e-post som inngår i saksbehandlingen, bes adressert til REK sør-øst og ikke til enkelte personer
Kindly address all mail and e-mails to the Regional Ethics Committee, REK sør-øst, not to individual staff

skrives inn i samtykkeskrivet.

Samtykkeskrivet bør videre oppdateres i henhold til personvernforordningen (GDPR), med informasjon om behandlingsgrunnlag, kontaktinformasjon personvernombud og klagerett Datatilsynet. Samtykkeskrivet bør også oppdatere navn/logo for forskningsansvarlig institusjon. Komiteen setter derfor som vilkår for godkjenning at (3) samtykkeskrivet revideres og endelig versjon sendes komiteen til orientering før det tas i bruk.

På disse tre vilkår har komiteen ingen forskningsetiske innvendinger til gjennomføringen av prosjektet.

Vedtak
Komiteen har gjort en helhetlig forskningsetisk vurdering av alle prosjektets sider. Prosjektet godkjennes, på de ovenfor beskrevne vilkår, med hjemmel i helseforskningsloven § 10.

Komiteen gjør samtidig oppmerksom på at etter ny personopplysningslov må det også foreligge et behandlingsgrunnlag etter personvernforordningen. Det må forankres i egen institusjon.

Komiteen godkjenner opprettelse av forskningsbiobanken «*Jodstatus og vitamin B12 status blant vegetarianere og veganere i Norge*» i tråd med det som er angitt i prosjektsøknaden. Biobankregisteret vil bli underrettet ved kopi av dette brev.

Tillatelsen er gitt under forutsetning av at prosjektet gjennomføres slik det er beskrevet i søknaden og protokollen, og de bestemmelser som følger av helseforskningsloven med forskrifter.

Tillatelsen gjelder til 31.12.2021. Av dokumentasjons- og oppfølgingshensyn skal opplysningene likevel bevares inntil 31.12.2026. Opplysningene skal lagres avidentifisert, dvs. atskilt i en nøkkel-og en opplysningsfil. Opplysningene skal deretter slettes eller anonymiseres, senest innen et halvt år fra denne dato.

Komiteens avgjørelse var enstemmig.

Komiteens vedtak kan påklages til Den nasjonale forskningsetiske komité for medisin og helsefag, jfr. helseforskningsloven § 10, tredje ledd og forvaltningsloven § 28. En eventuell klage sendes til REK sør-øst C. Klagefristen er tre uker fra mottak av dette brevet, jfr. forvaltningsloven § 29.

Sluttmelding og søknad om prosjektendring
Prosjektleder skal sende sluttmelding til REK sør-øst på eget skjema senest 30.06.2022, jf. hfl. § 12. Prosjektleder skal sende søknad om prosjektendring til REK sør-øst dersom det skal gjøres vesentlige endringer i forhold til de opplysninger som er gitt i søknaden, jf. hfl. § 11.

Med vennlig hilsen

Britt Ingjerd Nesheim
professor dr. med.
leder REK sør-øst C

Anders Strand
Rådgiver

Kopi til:postmottak@oslomet.no; OsloMet ved øverste administrative ledelse post@oslomet.no; Biobankregisteret: biobankregisteret@fhi.no

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK sør-øst C	Anders Strand		23.01.2020	11876
			Deres referanse:	

Sigrun Henjum

11876 Jodstatus og vitamin B12 status blant vegetarianere og veganere i Norge

Forskningsansvarlig: OsloMet - storbyuniversitetet

Søker: Sigrun Henjum

REKs vurdering

REK viser til endringsmelding mottatt 15.01.2020, for prosjekt 2019/653 «Jodstatus og vitamin B12 status blant vegetarianere og veganere i Norge». Sekretariatet har behandlet meldingen på fullmakt fra REK sør-øst C, med hjemmel i helseforskningsloven §11.

Den omsøkte endringen består i at prosjektet nå skal inkludere spørsmål angående deltageres konsum av kjøtt- og melkeerstatningsprodukter. Komiteen anser dette som relevant for prosjektets formål, og har ingen innvendinger til at dette gjøres.

Vedtak

Godkjent

Komitéen har vurdert endringsmeldingen og godkjenner prosjektet slik det nå foreligger med hjemmel i helseforskningslovens § 11.

Tillatelsen er gitt under forutsetning av at prosjektendringen gjennomføres slik det er beskrevet i prosjektendringsmeldingen og endringsprotokoll, og de bestemmelser som følger av helseforskningsloven med forskrifter.

Vennligst oppgi vårt referansenummer i korrespondanse.

Med vennlig hilsen,
Jacob C. Hølen
Sekretariatsleder REK Sør-Øst

Anders Strand
Rådgiver

Kopi til: postmottak@oslomet.no

Klageadgang
Du kan klage på komiteens vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes til REK sør-øst C. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK sør-øst C, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag (NEM) for endelig vurdering.