Adherence to the Healthy Nordic Food Index and the risk of metabolic syndrome – the Hordaland Health Study

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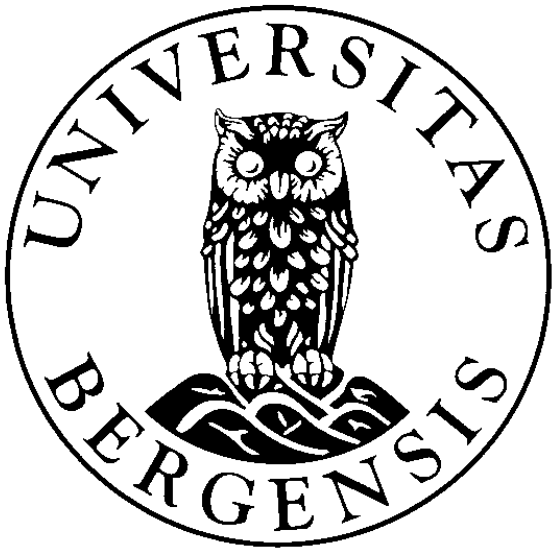
Master's thesis in Clinical Nutrition



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Lena Guldberg Rygg

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Abstract

Background and aim: The Healthy Nordic Food Index (HNFI) has been associated with beneficial effects on cardiometabolic risk factors for cardiovascular diseases and type 2 diabetes mellitus. A significant association between high adherence to the Mediterranean diet and a reduced risk of metabolic syndrome (MetS) has been reported in previous studies. To the best of our knowledge, the risk of MetS in association with adherence to HNFI has not yet been investigated in a community-dwelling population from the Nordic countries. Thus, we aimed to examine the association between adherence to HNFI and the risk of MetS and its components in a middle-aged population from Western Norway.

Methods: The study design was cross-sectional based on the Hordaland Health Study 2, a community-based study conducted in 1997-99, and included a middle-aged cohort born in 1950/51 consisting of 2533 men and women (age 46-49 years). Information on dietary intake was obtained from a 169-item semi-quantitative food-frequency questionnaire. The HNFI was calculated from six traditionally Nordic food items (fish/shellfish, cabbages, apples/pears, root vegetables, whole grain, and oatmeal/breakfast cereals). Intake above the sex-specific median resulted in one point for each food category. Three adherence groups were defined: 0-2 points (low), 3-4 points (medium), and 5-6 points (high). Associations between adherence to HNFI and the risk of MetS and its components were assessed using multinomial logistic regression with adjustments for energy intake, body mass index, smoking, hard physical activity, and education.

Results: The prevalence of MetS in the total cohort was 28.9%, with a higher prevalence in men (36.7%) than in women (22.8%). High adherers had a higher energy intake, higher education, were more physically active and were less likely to be current smokers than those with low adherence. Men with high adherence were more likely to have MetS than low and medium adherence, although this was not statistically significant. Overall, no association between adherence to HNFI and MetS was detected for the population. However, high adherence in men was associated with reduced waist circumference (RRR 0.96, 95% CI 0.92-0.99) and higher systolic blood pressure (RRR 1.01, 95% CI, 1.00-1.03) in the mutually adjusted model. High adherence in women was associated with higher serum HDL-C (RRR 1.70, 95% CI 1.05-2.74).

Conclusion: The present results do not support an association between adherence to HNFI and a reduced risk of MetS in a middle-aged population from Western Norway.

Oppsummering

Bakgrunn og mål: Healthy Nordic Food Index (HNFI) har vist seg å ha gunstige effekter på kardiometabolske risikofaktorer for hjerte- og karsykdommer og diabetes mellitus type 2. Tidligere studier har vist en signifikant sammenheng mellom høy etterlevelse til middelhavsdietten og redusert risiko for metabolsk syndrom (MetS). Etter vår beste kunnskap er ikke HNFI blitt undersøkt ved risiko for MetS i en lokalbefolkning fra de nordiske landene. Vårt mål var å undersøke assosiasjonen mellom etterlevelse av HNFI og risikoen for MetS og dets komponenter i en middelaldrende befolkning fra Vestlandet.

Metoder: Studien er en tverrsnitts studie fra Helseundersøkelsene i Hordaland 2, en studie gjennomført i 1997-99, og inkluderte en middelaldrende kohort født i 1950/51 med totalt 2533 menn og kvinner i alderen 46-49 år. Informasjon om kostholdet ble hentet fra et semi-kvantitativt matfrekvensskjema med 169 punkter. HNFI ble beregnet fra seks tradisjonelle nordiske matvarer (fisk/skalldyr, kål, epler/pærer, rotgrønnsaker, fullkorn og havregryn/frokostblandinger). Inntak over den skjønn-spesifikke median resulterte i et poeng for hver matvarekategori. Tre etterlevelsesgrupper ble definert: 0-2 poeng (lav), 3-4 poeng (middels) og 5-6 poeng (høy). Assosiasjoner mellom etterlevelse av HNFI og risikoen for MetS og dets komponenter ble vurdert ved bruk av multinomial logistisk regresjon ved justeringer for energiinntak, kroppsmasseindeks, røyking, hard fysisk aktivitet, og utdanning.

Resultater: Prevalensen av MetS i den totale kohorten var 28.9 %, med høyere prevalens hos menn (36.7 %) enn kvinner (22.8 %). Deltakere med høy etterlevelse av HNFI hadde et høyere energiinntak, høyere utdanning, var mer fysisk aktiv og hadde en lavere sannsynlighet for å være nåværende røykere enn de med lav etterlevelse. Menn med høy etterlevelse hadde større sannsynlighet for MetS, sammenlignet med lav- og middels etterlevelse, selv om resultatene ikke var statistisk signifikant. Det ble ikke funnet noen assosiasjon mellom etterlevelse av HNFI og MetS for den totale populasjonen. Imidlertid var høy etterlevelse hos menn assosiert med redusert midjeomkrets (RRR 0.96, 95 % KI 0.92-0.99) og høyere systolisk blodtrykk (RRR 1.01, 95 % CI, 1.00-1.03), i den justerte modellen. Høy etterlevelse hos kvinner var assosiert med høyere serum HDL-C (RRR 1.70, 95 % KI 1.05-2.74).

Konklusjon: Resultatene fra denne studien støtter ikke en assosiasjon mellom etterlevelse av HNFI og redusert risiko for MetS i en middelaldrende befolkning fra Vestlandet.

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List of abbreviations

AHA/NHLBI: American Heart Association/National Heart, Lung, and Blood Institute

ALA: Alpha-linolenic acid

ARA: Arachidonic acid

BMI: Body Mass Index

CI: Confidence intervals

CVD: Cardiovascular disease

DASH: Dietary Approaches to Stop Hypertension

DBP: Diastolic blood pressure

DHA: Docosahexaenoic acid

DPA: Docosapentaenoic acid

EFSA: European Health Authority for Food Safety

EPA: Eicosapentaenoic acid

FBDG: Food-based dietary guideline

FFQ: Food-frequency questionnaire

HDL-C: High-density lipoprotein cholesterol

HEI: Healthy Eating Index

HNFI: Healthy Nordic Food Index

HUSK: Hordaland Health Studies

IDF: International Diabetes Federation

LA: Linoleic acid

LCPUFA: Long-chain polyunsaturated fatty acid

LDL-C: Low-density lipoprotein cholesterol

MED: Mediterranean Diet Score

MetS: Metabolic syndrome

MUFA: Monounsaturated fatty acid

NCD: Non-communicable disease

NFBDG: Norwegian food-based dietary guideline

NHANES: National Health and Examination Survey

NNR: Nordic Nutrition Recommendations

NNR5: Nordic Nutrition Recommendations 2012

NOWAC: The Norwegian Women and Cancer Study

N/A: Not applicable

n-3: Omega-3

n-6: Omega-6

PUFA: polyunsaturated fatty acid

RCT: Randomized controlled trial

RRR: Relative risk ratios

SBP: Systolic blood pressure

SFA: Saturated fatty acid

TG: Triglyceride

T2DM: Type 2 diabetes mellitus

WC: Waist circumference

WCRF: World Cancer Research Fund

WHO: World Health Organization

24-HDR: 24-hour dietary recall

1.0 Introduction

According to the World Health Organization (WHO), non-communicable diseases (NCDs) such as cardiovascular diseases (CVD) and type 2 diabetes mellitus (T2DM) are the leading causes of mortality worldwide, accounting for 71% of all deaths globally. Every year, 41 million people die from NCDs, out of which 15 million occur in the age group 30-69 years, with higher prevalence in low- and middle-income countries. Thus, NCDs affect people of all age groups, regions, and countries worldwide. Many of these deaths are largely preventable by reducing the risk factors associated with NCDs. According to WHO, the most important modifiable risk factors for NCDs include an unhealthy diet, tobacco use, alcohol abuse, and lack of physical activity, which may contribute to metabolic changes that increase the risk of disease. These metabolic changes include high blood glucose (hyperglycemia), high blood lipids (hyperlipidemia), elevated blood pressure (hypertension), and overweight/obesity (1). For the prevention and control of NCDs, WHO has developed a global action plan which includes nine global targets, with the aim to reduce modifiable risk factors (2). Several countries worldwide, including Norway, have implemented WHOs global action plans in their health policy, which includes dietary recommendations as an important preventative strategy against metabolic abnormalities.

1.1 Metabolic syndrome

Metabolic syndrome (MetS) is a cluster of multiple risk factors that increases the risk of CVDs and T2DM. Interaction of various conditions affects the risk of metabolic abnormalities, of which an unhealthy diet, smoking, excessive alcohol consumption, and physical inactivity play an essential role. In addition, other factors such as family history, increasing age, obesity, and low socioeconomic status have all been described for the development of MetS (3). The metabolic changes often occur together, including obesity (particularly abdominal obesity), hypertension, hyperglycemia, and atherogenic dyslipidemia (4). These changes will now be presented in more detail.

Abdominal obesity, clinically presented as increased waist circumference (WC), is the form of obesity most strongly associated with MetS (5). Elevated blood pressure, also known as hypertension, is when the blood vessels persistently increase pressure (6). Hypertension is a risk factor of MetS due to higher systolic and/or diastolic blood pressure, leading to hardened arteries which decrease the blood flow and oxygen to the heart (7). Furthermore, hypertension

is strongly associated with obesity and commonly occurs in persons with insulin resistance (5). The underlying pathophysiology of hyperglycemia in MetS represents an interaction between insulin resistance and impaired beta-cell function, leading to abnormal glucose metabolism (8). Atherogenic dyslipidemia refers to the aggregation of lipoprotein abnormalities that includes low levels of high-density lipoprotein cholesterol (HDL-C) and elevated triglycerides (TGs) (4, 5). It may seem that abdominal obesity is probably the most substantial risk factor of MetS because excess adipose tissue contributes to many metabolic abnormalities that define the syndrome, such as hypertension, hyperglycemia, high serum cholesterol, and low HDL-C (5). Individuals with MetS commonly manifest a prothrombotic and proinflammatory state, where excessive adipose tissue is central to its pathophysiology (3, 5). It is therefore recommended that weight reduction should be the primary target for the intervention of MetS (5).

Insulin resistance is present in most individuals with MetS and is strongly associated with other metabolic risk factors (5). The possible involvement of insulin resistance as a linking factor has been considered, although the pathogenesis remains unclear, as does the establishment of diagnostic criteria (4). The theory that insulin resistance is an underlying mechanism of MetS is influenced by fatty acid excess because of inappropriate lipolysis. Insulin resistance in the liver appears to lead to reduced effectiveness of insulin signaling pathways, whereas insulin resistance in skeletal muscle results in reduced glycogen synthesis and glucose transport. However, no precise mechanisms have been confirmed, and the research in this area is ongoing. Other possible pathophysiologic mechanisms include low-grade inflammation and oxidative stress (3).

Over the past decade, various diagnostic criteria of MetS have been proposed by different organizations (9-11). Their diagnostic criteria are similar in many aspects but have some differences in the predominant causes of the syndrome. However, the definition of a specific cut-off value will affect the prevalence of MetS, resulting in somewhat arbitrary definitions. Therefore, in 2005, the International Diabetes Federation (IDF) and the American Heart Association/National Heart, Lung, and Blood Institute (AHA/NHLBI) collaborated to unite the various clinical definitions. This resulted in the common definition shown in Table 1, where the presence of any three of these five risk factors is required for the diagnostic criteria of MetS (4).

Table 1 Criteria for clinical diagnosis of the metabolic syndrome by IDF and AHA/NHLBI (4)

Measure	Categorical Cut Points
Elevated waist circumference	Population- and country-specific definitions Europe, men: ≥94 cm Europe, women: ≥80 cm
Elevated triglycerides	≥150 mg/dL (1.7 mmol/L)
Reduced HDL-C	Men: <40 mg/dL (1.0 mmol/L) Women: <50 mg/dL (1.3 mmol/L)
Elevated blood pressure	Systolic ≥130 and/or diastolic ≥85 mm Hg
Elevated fasting glucose	≥100 mg/dL (5.5 mmol/L)

IDF, International Diabetes Federation; AHA/NHLBI, American Heart Association/National Heart, Lung, and Blood Institute; HDL-C, high-density lipoprotein cholesterol

The global prevalence of MetS is increasing (4), and it has been suggested that the increased incidence of obesity is the primary cause (5). However, the prevalence varies across the world, depending on the diagnostic criteria used and the population being studied. Estimates of prevalence also differ across sex, age, ethnicity, and race, as well as lifestyle habits and socioeconomic status (12). The National Health and Examination Survey (NHANES) reported an overall MetS prevalence of 33% in adults in the United States, with a significantly higher prevalence in women (35.6%) compared to men (30.3%), based on the National Cholesterol Education Program Adult Treatment Panel III diagnostic criteria (13). The prevalence of MetS in the European population, by the IDF criteria, has been estimated as 41% in men and 38% in women (14). In a large Norwegian population-based study, the prevalence of MetS, defined by IDF, was 29.6% in men and women (age 20-89 years). The prevalence strongly increases with age, which the increase in body weight could explain during adulthood and old age, thus increasing the body mass index (BMI) and WC. Age dependency is evident, especially in women, with an increase from 9.2% in the 20-29 age group to 64.4% in the 80-89 age group (15). This is consistent with other findings from population-based studies, which have reported an increase in the prevalence of MetS with age regardless of the diagnostic criteria used (16-18).

1.2 Dietary assessment, recommendations, and guidelines

The basis for dietary advice for a population is linked to etiology, where one seeks to identify the role that diet plays in the prevalence of NCDs. Causality in such a context must be built on an overall assessment of documentation from different types of studies, such as epidemiological studies (especially prospective observational studies), clinical intervention studies (especially randomized controlled trials (RCTs) with isolated problems and/or relatively short-term interventions), and biological or mechanistic studies (especially cell-based and animal experimental studies) (19). Most nutrition-related NCDs develop over a long period, so collecting dietary data and assessing the average dietary intake over prolonged periods is essential. However, we cannot directly observe long-term dietary intake and must rely on self-reported data in nutritional research studies. There are various methods for collecting dietary data, and the food-frequency questionnaire (FFQ) is the most commonly used dietary assessment method when examining long-term intake. In contrast, 24-hour dietary recall interviews (24-HDR) and food records are often used to estimate intake over a shorter period of time (20).

For several decades, the Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden) have cooperated in developing dietary composition guidelines and recommended nutrient intake through the publication of the Nordic Nutrition Recommendations (NNR). The most recent edition will be published in late 2022. The 5th edition, the Nordic Nutrition Recommendations 2012 (NNR5) (21), is based on scientific knowledge, where systematic reviews formed the basis for the dietary recommendations for most nutrients and physical activity. One of the aims of NNR5 was to function as a guideline for the national food-based dietary recommendations adopted by the individual Nordic countries. In addition to NNR5, the Norwegian food-based dietary guidelines (NFBDGs) are based on research and summaries of knowledge from other international expert groups such as WHO, the European Health Authority for Food Safety (EFSA), the World Cancer Research Fund (WCRF), and national research. The aim of the food-based dietary guidelines (FBDGs) is to contribute to the prevention of chronic diet-related diseases in the population (19). More than 100 countries worldwide have developed FBDGs adapted to their respective nutritional status, eating habits, culinary culture, and food availability to ensure the required nutrients for good health and to prevent chronic diseases (22). The guidelines also include physical activity because it directly affects many NCDs. The degree of physical activity affects the energy balance and thus the body weight. However, these recommendations primarily target healthy individuals. In case

of illness and for groups with special needs, the composition of the diet must be adapted according to the current dietary requirements (19).

The Norwegian Directorate of Health has published 12 dietary guidelines to promote good health and prevent the risk of chronic diseases in the Norwegian population. The guidelines emphasize a healthy and varied diet that includes high amounts of vegetables, fruits, berries, fish, whole-grain foods, and limited amounts of red meat, processed meat, salt, and sugar. Recommendations regarding physical activity are also included (23). Adults and the elderly are recommended regular physical activity in everyday life. Being moderately physically active for at least 2.5 to 5 hours during the week (equivalent to 20-40 minutes each day) is recommended. Moderate physical activity means that your exercise is strenuous enough to make you breathe a little heavier. The recommended time can be halved if you increase the activity level to high intensity. As part of the recommended amount of physical activity, adults are advised to do exercises that increase muscle strength for large muscle groups at least two days a week. However, a higher activity level beyond the recommendations will provide more health benefits (24).

1.3 Assessment of diet quality

Traditional analyses in nutritional epidemiology have been valuable in researching nutrients and whole foods concerning the risk of chronic diseases. However, this type of analysis has several methodological and conceptual limitations. A dietary pattern emphasizes the totality of a diet and is defined as the proportions, quantities, variety, or combination of different foods, nutrients, and drinks in various diets and the frequency in which they are habitually consumed (25). More recently, researchers have studied dietary patterns as an alternative and complementary approach to investigate the relationship between diet and the risk of chronic diseases. Dietary pattern analyses have been developed to assess the overall diet quality and represent a broader picture of food and nutrient consumption as it examines the whole diet's health effects, not just the nutrients alone (26, 27). In reality, people do not eat nutrients in isolation but rather in a combination of foods containing multiple nutrients. Furthermore, foods and nutrients are known to have synergistic effects making it challenging to discover the effect of a single food or nutrient (25). As the frequency of food consumption is integrated into the definition of dietary patterns, the rare consumption of unhealthy foods and drinks will not significantly impact diet quality, whereas regular consumption is essential.

Nutrients and other dietary components may interact with each other; hence, both bioavailability and absorption of the various nutrients may be influenced (28). In addition, the effect of any individual nutrient may be too small to detect in trials. Still, the cumulative impact of food consumption in a dietary pattern may be sufficiently significant to detect. Analyses of single nutrients or whole foods may also be confounded by the impact of dietary patterns (27). It is, therefore, a reason to believe that dietary patterns may be more strongly related to health and disease than individual foods and nutrients (28). The assessment of dietary patterns is used to characterize dietary behavior in a population and to investigate the relationship between disease risk and prevention (27).

Clinical trials have shown that changes in dietary patterns have positive health outcomes (29). However, it is still unclear which dietary patterns or which particular dietary preferences are most relevant for preventing or promoting diet-related diseases (28), as dietary patterns may change over time. Much of our current knowledge about diet and the development of chronic diseases is derived from traditional research focusing on the effects of individual foods and nutrients. Several studies have found an association between fish intake (30), high consumption of fruits and vegetables (31, 32), and dairy products (33, 34) and reduced risk of MetS and/or its components.

1.4 Dietary pattern analyses

Different methods for assessing dietary patterns can be grouped into three categories: hypothesis-driven approaches such as scores and indices, data-driven methods such as factor and cluster analysis, and methods combining the two, the hybrid approach (27, 28, 35, 36).

1.4.1 The hypothesis-driven approaches

The hypothesis-driven approaches (also called the investigator-driven methods) define dietary patterns *a priori,* and the researchers define scores or indices of the overall dietary quality (36). The methods are based on current knowledge about dietary components, their health-promoting effects, and their diet-related diseases (35). They are usually based on dietary guidelines for a healthy diet or diets known to be health beneficial (27, 36). In this approach, a scoring system is used to allocate points to predefined dietary components. The scores, or dietary indices, reflect diet quality or adherence to national dietary guidelines in a population (35), such as the Healthy Eating Index (HEI) (37) or Healthy Nordic Food Index (HNFI) (38).

Some are based on a hypothesis of health-beneficial diets, such as the Mediterranean Diet Score (MED) (39) or the Dietary Approaches to Stop Hypertension (DASH) (40). The choice of which score/dietary index to use should be suitable for the specific population being studied and their local eating habits.

1.4.2 Data-driven methods

Data-driven methods (also referred to as exploratory approaches) are *posteriori* methods because the available data determine the patterns (28). Data-driven methods use mathematics to empirically derive eating behavior patterns using dietary data obtained from 24-HDR, FFQs, or diet records. Data-driven methods consist of factor and cluster analyses, where a more extensive set of dietary variables are collected and reduced to form a smaller set of variables. Factor analyses derive patterns based on the relationship between the foods or food groups, while cluster analyses derive patterns based on differences in intakes among individuals (27). Data-driven dietary patterns depend on the population. However, different patterns, such as the prudent and Western diets, have been derived in many countries (41). The prudent dietary pattern has been characterized by a high intake of fruits, vegetables, legumes, whole grains, and fish/seafood. In contrast, the Western diet is characterized by a high intake of processed and red meat, high-fat dairy products, eggs, butter, refined grains, and sugar-sweetened beverages (42).

1.4.3 The hybrid approach

The hybrid approach is a combination of the two previous methods. The most common approach is reduced rank regression which represents *a posteriori* method (43). It is partly theoretical driven, using predictor variables relevant to the researcher's study purpose (36). In addition, the hybrid approach, particularly reduced rank regression, uses the same mathematical methods and techniques for deriving factors, such as factor analysis (28). It identifies multivariate dietary patterns based on the study data, specifically relevant to the population being studied (36). The predictor variables can be risk factors, such as nutrients related to an overall dietary quality score based on recommendations for a healthy diet, the disease itself, or the outcome of interest. Biomarkers that are intermediate risk factors for a diet-related disease are another example of predictor variables used (36).

In the present thesis, the Healthy Nordic Food Index (HNFI) is chosen as the dietary assessment method.

1.5 The Healthy Nordic Food Index

HNFI was initially developed to form a dietary index for the Western countries based on traditional Nordic food items with expected health-promoting effects (38). HNFI was also developed as a local Nordic opposition to the Mediterranean diet, a dietary pattern traditionally based on cuisine from Southern Europe, which has shown significant improvement in health status (44). It may be difficult for the Western population to follow a dietary pattern based on foods from other cultures; therefore, the HNFI was highly needed. HNFI includes commonly consumed foods in the Nordic countries and foods that are likely to have beneficial health effects. The index is based on six traditionally Nordic food items (fish/shellfish, cabbages, apples/pears, root vegetables, whole grain or rye bread, and oatmeal) (38). High adherence to HNFI is associated with a healthier lifestyle (45, 46), as well as a lower risk of T2DM (47), myocardial infarction (48), and total mortality (38). However, some studies did not find any significant association between high adherence to HNFI and the risk of chronic disease (45, 49, 50). Some intervention studies have assessed the healthy Nordic diet and its beneficial effect on cardiometabolic risk factors in individuals with features of MetS. Improved lipid profile, higher insulin sensitivity, lower blood pressure, and a beneficial effect on low-grade inflammation have been reported (51-54).

Even though there are shared similarities in dietary habits as well as in the prevalence of NCDs, such as CVD, T2DM, and obesity, between the Nordic countries (21), differences in dietary intake may occur. HNFI was based on a Danish population, and as described later in the present thesis, some modifications regarding the food groups included in the index had to be made, and thus may affect the validity and comparability of the index between the Nordic populations. A recent report from the NNR2022 project has summarized food consumption and nutrient intake in the adult population of the Nordic countries (55). The mean intake of fruits and berries ranged from 100 g/day to 210 g/day, with the highest consumption among Danish women and the lowest among men in Sweden and Iceland. The consumption of vegetables was highest in Denmark and Finland and lowest in Iceland and Norway. Some countries had significant differences in the consumption of fish/seafood and red meat. The mean fish and seafood intake were highest in Norway, with a consumption of around 80 g/day for men and 55 g/day for women, twice the intake compared to men and women in Finland. The mean intake of red meat consumption ranged from 25 g/day among women in Iceland to around 170 g/day in Danish men (55). Due to significant variation within food groups in the Nordic countries, the classification of the index will be affected by this. However, HNFI is

also locally adopted, using sex-specific median values of reported intake. Thus, high adherence may be based on different absolute amounts of the food category.

1.6 Adherence to dietary patterns and MetS

Diet plays an essential role in the incidence and prevention of MetS, and different dietary patterns have shown a protective effect against the risk of MetS. A recent study (56) analyzed the positive health effects of different dietary approaches on MetS inflammatory markers. Several studies have investigated the beneficial impact of the Mediterranean dietary pattern and metabolic changes, including those associated with MetS (57). The Mediterranean diet is characterized by a high intake of olive oil, nuts, fruits and vegetables, non-refined cereals, legumes, moderate consumption of wine (mainly red), and low consumption of meat, sweets, butter, and cream. A significant association between high adherence to the Mediterranean diet and the reduced risk of MetS has been observed in different meta-analyses (58, 59). The Mediterranean diet showed a protective role on components of MetS, such as WC, HDL-C, triglycerides, systolic- and diastolic blood pressure, and glucose (58).

Another well-known dietary pattern, HEI, consists of 12 nutritional components, 9 of which assess the adequacy of the diet: total fruit, whole fruit, total vegetables, greens and beans, dairy, whole-grains, total protein foods, and seafood and plant proteins. The other three components (refined grains, sodium, and empty calories) should be consumed in moderation (60). Higher adherence to HEI has shown an inverse association with the risk of MetS and its components, such as abdominal obesity, high blood pressure, high serum TGs, and low serum HDL-C (61). Similar findings have been observed in other studies (62).

The DASH score was created to measure adherence to the DASH diet, a healthy eating pattern that has been associated with reduced CVD risk and lower blood pressure (40, 63, 64). The DASH diet promotes the consumption of fruits and vegetables, low-fat dairy products, legumes, fish, poultry, nuts, and whole-grains, and recommends limited intakes of sodium, red meat, sweets, and sugar-sweetened beverages (65). Higher adherence to the DASH diet is associated with a reduced risk of MetS. In addition, individuals with higher adherence to the DASH diet are less likely to have increased WC, decreased HDL-C levels, elevated triglycerides, and higher blood pressure (66).

1.7 Objectives

To the best of our knowledge, HNFI has not yet been investigated in association with the risk of MetS in a community-dwelling population from the Nordic countries. A recent WHO report evaluated the health effects associated with a healthy Nordic diet, and current evidence shows improvements in risk factors for both CVD and T2DM (67). Based on current evidence, assessing the overall dietary pattern in a Norwegian population and its effect on cardiometabolic health is beneficial. Thus, this thesis aims to investigate the association between adherence to HNFI and the risk of MetS and its components.

1.8 Hypothesis

Current evidence shows that high adherence to HNFI may have a beneficial effect on cardiometabolic health. This has led to the hypothesis that high adherence to HNFI is associated with a reduced risk of MetS and its components in a middle-aged population from Western Norway.

2.0 Subjects and methods

2.1 Study population

The Hordaland Health Studies (HUSK) consists of three large community-based surveys conducted in 1992/93 (The Homocysteine study/HUSK1), 1997/99 (HUSK2), and 2018/20 (HUSK3). In the present thesis, data from HUSK2 will be used. HUSK2 was conducted as a collaboration between the University of Bergen, the University of Oslo, local health services, and the Norwegian Institute of Public Health. The main purposes of HUSK2 were to prevent disease and identify potentially modifiable risk factors for different diseases in the general population. Participants underwent a brief health examination, and a non-fasting blood sample was collected at baseline. The study population in HUSK2 consists of both men and women living in Hordaland County in Norway, born in 1925/27 and 1950/51. For the present thesis, only those born in 1950/51 were included and are referred to as the middle-aged cohort. Extensive information on the study can be found at: https://husk-en.w.uib.no.

An overview of the number of individuals included in the current analyses is presented in a flow chart (Figure 1). An eligible study population of 3117 participants from HUSK2 had answered an FFQ. Participants who reported a very low (<3000 kJ/day for women and <3300 kJ/day for men) or high (>15.000 kJ/day for women and >17.500 kJ/day for men) daily energy intake were excluded (n = 78). In addition, participants with C-reactive protein (CRP) > 5 mg/L (n = 503) and those with missing measurements of MetS components (n = 3) were also excluded. Participants with a CRP above 5 mg/L were excluded to reduce the effect of inflammation as a disturbing factor. Elevated CRP could lead to falsely elevated glucose values and thus affect the diagnosis of MetS for the participants.

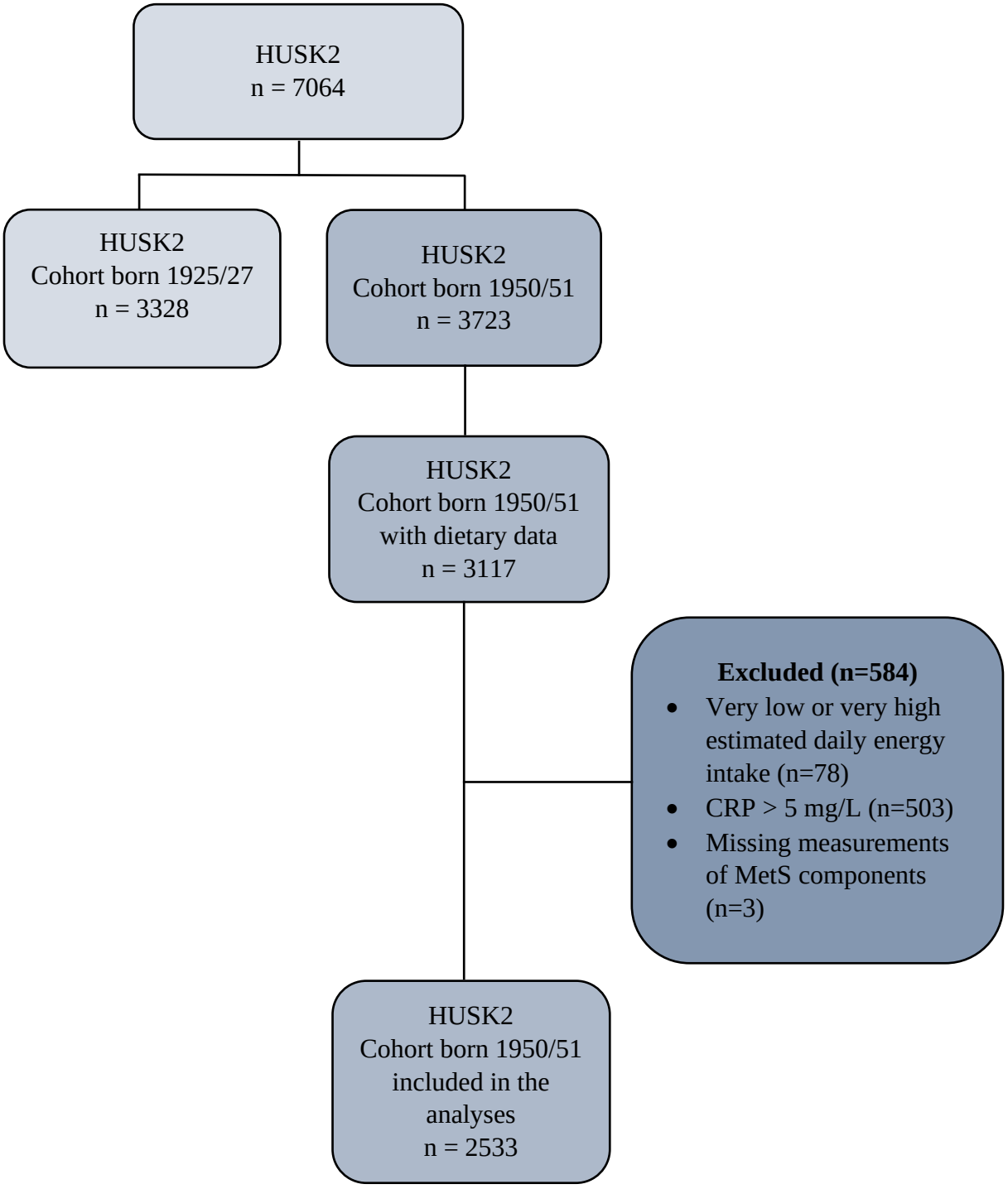


Figure 1 Flow chart of the individuals who participated in HUSK2, both men and women. Exclusion criteria and subjects included in the current analyses are listed.

2.2 Study design

This cross-sectional study investigated the adherence to the HNFI from a semi-quantitative FFQ and the association with MetS and its components in the Norwegian population. Analysis of dietary intake in a middle-aged cohort by an FFQ, the biomarker components of MetS were measured in non-fasting blood samples.

2.3 Dietary assessment

The dietary intake was obtained from a semi-quantitative FFQ developed by the Department of Nutrition, University of Oslo (68). The questionnaire includes 169 items of food and beverages, in addition to dietary supplements. The FFQ was given to the participants in paper format on the examination day and filled out at home before it was mailed to the HUSK Project Center in Bergen. The questionnaire collects data on habitual dietary intake over the last 12 months, and information about portion size and frequency of food groups consumed are included. Portion sizes are estimated by using household measures (e.g., deciliter, slices, etc.), and the frequency of consumption is given per day, week, or month. The FFQ contains different categories with information about individual food or beverage items, food groups (both as part of a meal or consumed alone), and nutrients. Dietary supplements such as fish oil capsules and cod liver (oil or capsules) were assessed in the FFQ. The use of these supplements was reported either during the whole year or only during the winter half of the year, with frequency per week and amount per time. Individuals who reported using such supplements more than once a week were defined as users.

The total dietary intake also included the intake of dietary supplements in the calculations. The quantity of the dietary intake is presented in grams per day and was calculated by using a food database and software system developed at the Department of Nutrition, the University of Oslo ("Kostberegningssystem," version 3.2; University of Oslo, Oslo, Norway). The nutrient database used in the study is mainly based on the official Norwegian food composition table (69).

The intake of alcohol was self-reported and converted into grams per day. In accordance with NNR5 (21), one unit of alcohol was defined as 10 g/day. Sex-specific cut-offs were used, and the intake was grouped into four categories; none: 0 g/day; low-moderate: women 0.1-10

g/day, men 0.1-20 g/day; moderate: women 10-20 g/day, men 20-30 g/day; high: women >20 g/day, men >30 g/day.

2.4 The Healthy Nordic Food Index

In the present study, the approach of the HNFI is used. HNFI is based on scores from dietary intake of six traditionally Nordic food items (fish/shellfish, cabbages, apples/pears, root vegetables, whole grain or rye bread, and oatmeal/breakfast cereals) (38). Based on the available questions in the FFQ, some adjustments concerning the food groups included in the index had to be made. Similar to previous studies (46, 49, 70), we replaced the original rye bread category with whole grain bread, and breakfast cereals replaced the original oatmeal category. The index components fish/shellfish, root vegetables, and cabbages were based on several questions in the FFQ. In contrast, information on the consumption of whole-grain bread, breakfast cereals, and apples/pears originated from only one FFQ questions (one on apples and one on pears). Table 2 shows the food items in the FFQ that were included in the six food groups that comprise the index.

To compute the index score for each participant, sex-specific medians of absolute intake for consumption of each food group were calculated. Participants with dietary intake equal to or above the study median were assigned one point for each of the six food groups, whereas zero points were given for those with an intake below the median. One point was allocated for the following daily dietary intakes for men: fish/shellfish ≥ 84 g, root vegetables ≥ 32 g, cabbages ≥ 24 g, apples/pears ≥ 38 g, whole-grain bread ≥ 3 slices (120g) or breakfast cereals ≥ 2 g. For women, one point was given for daily dietary intakes: fish/shellfish ≥ 65 g, root vegetables ≥ 39 g, cabbages ≥ 36 g, apples/pears 38 g, whole-grain bread ≥ 2 slices (80g) or breakfast cereals ≥ 1 g. The assigned points for each of the six food groups were summarized, giving each participant a score between 0 and 6. The sex-specific scores were further categorized into three adherence groups to ensure a sufficient number of cases within each exposure category: low (0-2 points), medium (3-4 points), and high (5-6 points) adherence.

Table 2 Food items from the food frequency questionnaire included in the calculation of the Healthy Nordic Food Index in the Hordaland Health Study

Index food category	Description of food items included in the index food category

Fish/shellfish	• Fish as the main course
	  ○ Cod, pollock, haddock
	  ○ Herring
	  ○ Mackerel
	  ○ Salmon, trout
	  ○ Processed fish products
	• Fish as a spread
	  ○ Caviar
	  ○ Mackerel
	  ○ Sardines, herring, anchovies
	  ○ Salmon, trout
	• Shellfish
	  ○ Shrimp, crab

Root vegetables	• Carrot • Swede
Cabbages	• Cabbage • Cauliflower, broccoli, Brussel's sprouts • Green cabbage, spinach
Apples/pears	• Apples • Pears
Whole grain bread	• Whole grain bread
Breakfast cereals	• Breakfast cereals, oatmeal, muesli

2.5 MetS definition

MetS were defined by the criteria for clinical diagnosis from IDF and AHA/NHLBI, using population-specific definitions for elevated WC (4). The cut-offs were as follows: WC ≥80 cm in women and ≥94 cm in men (European population); elevated TG ≥1.7 mmol/L; reduced HDL-C <1.3 mmol/L in women and <1.0 mmol/L in men; elevated systolic blood pressure (SBP) ≥130 and/or diastolic blood pressure (DBP) ≥85 mm Hg; elevated fasting glucose ≥5.5 mmol/L (serum glucose in the present study was non-fasting). For the diagnostic criteria for MetS, the presence of any three of these five risk factors is required.

2.6 Biochemical data

Non-fasting blood samples were collected. Serum samples of glucose, total cholesterol, HDL-C, and TGs were analyzed within 7 days at the Department of Clinical Chemistry, Ullevål University Hospital, Oslo, with reagents from Boehringer Mannheim (now: Roche, Basel, Switzerland) as adapted to a Hitachi 911 analyzer. Enzymatic methods measured cholesterol and TGs. HDL-C was measured by a direct, enzymatic inhibition method. Non-HDL-C was calculated using the following formula: non-HDL-C (mmol/L) = total cholesterol (mmol/L) – HDL-C (mmol/L). In addition to self-reported smoking habits, cotinine (predominant metabolite in tobacco) was measured as a biomarker of recent nicotine exposure. Participants were defined as smokers with cotinine levels ≥85 nmol/L (71). Cotinine and CRP were measured in EDTA plasma stored at -80°C until analyzed at Bevital A/S (http://www.bevital.no) by LC/MS/MS and MALDI-TOF MS, respectively.

2.7 Clinical data and assessment of other covariates

Participants underwent a brief health examination, including height, body weight, blood pressure, and WC measurements. SBP and DBP were measured three times after 10 minutes of seated rest. The mean value of the second and third measurements was used (Dinamap 845 XT equipment (Criticon). Body composition (fat mass and lean mass) was measured in a sub-cohort by dual-energy X-ray absorptiometry (Expert-XL; Lunar Company Inc., Madison, US). Measurements for height and body weight were performed in light clothing, without shoes among the participants, and measured to the nearest 0.5 kg and 1 cm, respectively. BMI was calculated as the weight ratio in kilograms to the square of height in meters.

Self-administered questionnaires provided information on various health behaviors, including physical activity (light and hard), smoking (current/former/never smoked), educational level, and medication use. In the present study, participants defined as current smokers were based on cotinine levels. As previously described (72), physical activity was defined as light physical activity (e.g., walking, gardening, housework with no sweating, or getting out of breath) or hard physical activity (sweating and getting out of breath) in the past year. Light physical activity was categorized into 0 (none), 0.25 (<1 h/wk), 0.5 (1-2 h/wk), and 1.0 (≥3 h/wk) and hard physical activity into 0 (none), 0.5 (<1 h/wk), 1.0 (1-2 h/wk), and 2.0 (≥3 h/wk). In the present study, the sum of hard physical activity scores was calculated and used the analyses.

2.8 Ethics

The HUSK study was performed in accordance with the Declaration of Helsinki. All study participants signed written informed consent, and the regional ethics committee approved the study protocol for Medical Research Ethics (REC number 2009/825).

2.9 Statistical analyses

Baseline characteristics and daily dietary intake variables were summarized and presented as means ± SD or medians (5^{th}, 95^{th}, percentiles) for continuous variables and percentages for categorical variables. The dietary variables in the current analyses are energy adjusted by the nutrient density method (73) and stated as g/1000 kcal or percentage of total energy intake. However, the food groups incorporated in the dietary index were not adjusted for energy. Therefore, adherence to HNFI was based on absolute intake.

Differences between men and women were assessed using the Mann-Whitney U test for continuous variables and Fischer's exact test for categorical variables. The study population was ranked according to the three HNFI adherence groups (0-2, 3-4, and 5-6 points). On the basis that the outcome variable has three categories, differences between the HNFI adherence groups and baseline variables were assessed using the Kruskal-Wallis test and the Chi-Square test for continuous and categorical variables, respectively.

Multinomial logistic regression evaluated the association between adherence to HNFI and the risk of developing MetS and its components. Multinomial logistic regression can be used when the outcome variable has more than two categories. The index score was treated as categorical instead of ordered so that the logistic regression analysis could fit two models comparing high adherence with low adherence and medium adherence with low adherence. The estimates from the multinomial logistic regression models are given as relative risk ratios (RRR) with 95% confidence intervals (CI). Two different models are presented for each outcome to reduce the risk of confounding. The first model was energy-adjusted, and the second was a mutually adjusted model that also included BMI (continuous), current smoking (yes/no), hard physical activity (none; <1 h/wk; 1-2 h/wk); ≥3 h/wk), and education (primary school <10y; high school; college/university). In addition, the analyses were stratified for sex.

Due to non-fasting blood samples, an additional analysis using an alternative cut-off of ≥6.0 mmol/L for defining high serum glucose was performed. Statistical software SPSS for Windows, version 28 (IBM, NY, USA) was used for the analyses. A two-sided p-value <0.05 was considered statistically significant.

3.0 Results

3.1 Baseline characteristics

A total of 2533 subjects, 1087 (42.7%) men and 1446 (57.1%) women, were included in the current analysis. As expected, significant differences between men and women were seen for almost all the outcome variables, except the use of anti-hypertensive drugs, smoking, and hard physical activity (1-2 h/week), which was similar in both sexes. Compared with women, men were more likely to use anti-hyperglycemic or lipid-modulating drugs, have a higher level of education, be more physically active, and be overweight or obese (Table 3). Mean measurements of SBP, DBP, total cholesterol, non-HDL-C, serum glucose, and median concentrations of TG and CRP were higher in men than women. Mean measurements of total body fat mass and HDL-C were higher in women than men (Table 3).

Table 3 Baseline characteristics of 2533 men and women born in 1950/51 (age 46-49 years) in the Hordaland Health Study

	Total *n = 2533*	**Men** *n = 1087*	**Women** *n = 1446*
Lifestyle			
Educational level *(%)*			
Primary school <10 y	18.7	15.2	21.3
High school	41.8	40.8	42.7
College/University	39.5	44.0	36.0
Hard physical activity *(%)*			
None	24.6	20.9	27.3
<1 h/week	28.2	31.0	26.1
1-2 h/week	32.5	31.0	33.6
≥3 h/week	14.8	17.0	13.1
Current smokers *(%)*	34.0	33.0	35.0
Biomarkers of MetS			
Waist circumference (cm)	85 ± 11	92 ± 9	79 ± 9
Serum glucose (mmol/L)	5.2 ± 1.0	5.3 ± 1.1	5.1 ± 0.9
SBP (mmHg)	127 ± 15	131 ± 15	124 ± 15
DBP (mmHg)	74 ± 11	78 ± 10	72 ± 10
Serum TG (mmol/L), *median (IQR)*	1.36 (1.01)	1.74 (1.31)	1.16 (0.73)
Serum HDL-C (mmol/L)	1.34 ± 0.37	1.16 ± 0.30	1.47 ± 0.36
Other clinical data			
BMI (kg/m^2) *(%)*			
<18.5	0.6	0.2	1.0
18.5 – 24.9	52.6	39.6	62.3

25 – 29.9	38.8	50.3	30.2
≥30	7.9	9.9	6.5
Body fat mass *(%)*	29.8 ± 9.0	23.3 ± 7.3	33.9 ± 7.4
Serum total cholesterol (mmol/L)	5.71 ± 0.94	5.81 ± 0.97	5.63 ± 0.90
Serum non-HDL-C (mmol/L)	4.37 ± 1.01	4.65 ± 1.02	4.16 ± 0.95
CRP (mg/L), *median (IQR)*	0.9 (1.4)	1.0 (1.4)	0.8 (1.4)
Anti-hyperglycemic drugs *(%)*	0.5	0.8	0.2
Anti-hypertensive drugs *(%)*	4.6	4.9	4.4
Lipid-modulating drugs *(%)*	2.1	3.2	1.3
Estrogen therapy *(%)*	N/A	N/A	16.9

Values are presented as percentages and means ± SD. Missing data: smokers (n=26), education (n=24), physical activity (n=96), BMI (n=41), body fat mass (n=384).

P values for differences between men and women were calculated using the Mann-Whitney U test or Fischer's exact test for continuous and categorical variables, respectively. Blood sampling in the Hordaland Health Study was non-fasting.

BMI, body mass index; CRP, C-reactive protein; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; IQR, interquartile range; MetS, metabolic syndrome; N/A, not applicable; SBP, systolic blood pressure; TG, triglyceride

3.2 Metabolic syndrome and its components

A total of 28.9% of the cohort was diagnosed with MetS, and the prevalence was higher in men (36.7%) compared with women (22.8%) (Table 4). When investigating individual components, the highest prevalence was seen for WC and blood pressure, with 43.7% and 40.3% in the total cohort, respectively. In contrast, the lowest prevalence was seen for serum glucose (24.4%) (12.9% when 6.0 mmol/L cut-off was used). Statistical differences between sexes were seen for TGs, blood pressure (SBP and/or DBP), and serum glucose. However, no differences in WC and HDL-C were seen for men vs. women. The number of MetS components differed between men and women. More women (30.8%) than men (22.4%) met the criteria of at least one of the five risk factors, whereas 4.0% of the men and 1.5% of the women fulfilled all the five components of MetS (Figure 2).

When using an alternative cut-off ≥6.0 mmol/L instead of ≥5.5 mmol/L for defining increased serum glucose levels (non-fasting), the overall prevalence of increased serum glucose was 12.9%, with a higher prevalence in men (16.5%) than in women (10.2%). When the cut-off ≥6.0 mmol/L for elevated glucose levels was used in the diagnostic criteria for defining MetS, the overall prevalence of MetS was 25.3%, with a higher prevalence in men (32.8%) compared to women (19.7%).

Table 4 Diagnosis of metabolic syndrome and its components in the study population of 2533 men and women born in 1950/51 (age 46-49 years) in the Hordaland Health Study

	Total	***Men***	***Women***	
	n = 2533	*n = 1087*	*n = 1446*	*p*
Metabolic syndrome	28.7	36.7	22.8	<0.001
WC[a]	43.7	43.5	43.9	0.871
Triglycerides[b]	34.6	52.0	21.5	<0.001
HDL-C[c]	32.5	31.4	33.3	0.324
Blood pressure[d]	40.3	52.0	31.5	<0.001
Serum glucose[e]	24.4	29.3	20.7	<0.001

Values are presented as percentages. *P* values for differences between men and women were calculated using Fischer's exact test for categorical variables.

Blood sampling in the Hordaland Health Study was non-fasting. HDL-C, high-density lipoprotein cholesterol; WC, waist circumference

[a] Men ≥ 94 cm, women ≥ 80 cm

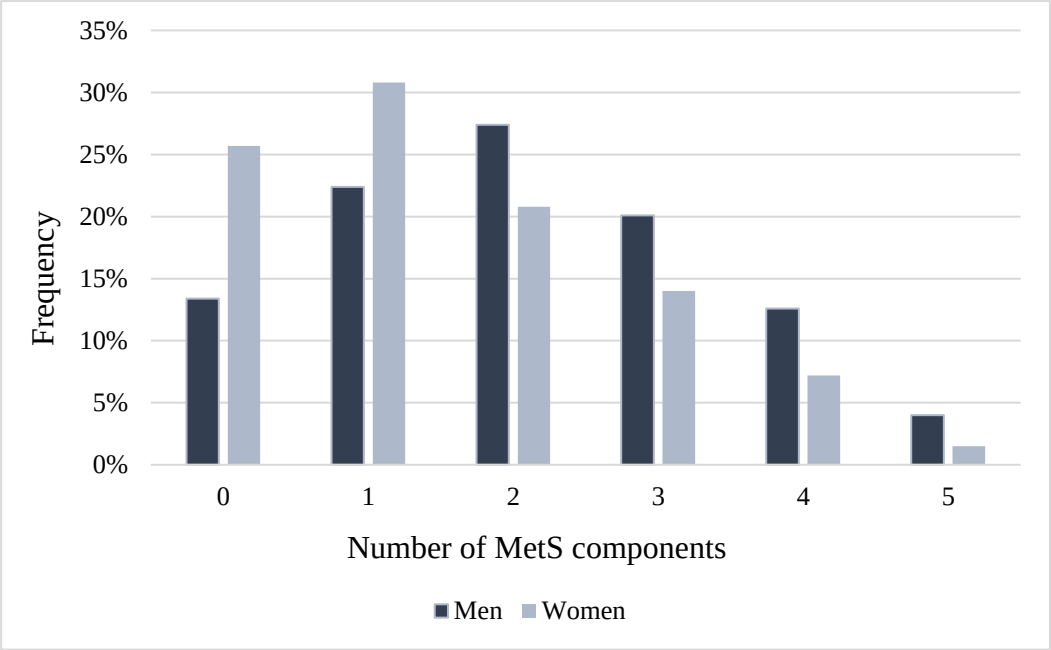
[b] ≥1.7 mmol/L

[c] Men <1.0 mmol/L, women <1.3 mmol/L

[d] Systolic: ≥130 mmHg and/or diastolic: ≥85 mmHg

[e] ≥5.5 mmol/L

Figure 2 Frequency of the number of metabolic syndrome components in 1087 men and 1446 women in the Hordaland Health Study



MetS, metabolic syndrome

3.3 Adherence to the Healthy Nordic Food Index

The distribution of the total cohort of 2533 participants to the different adherence categories was: low adherence (score 0-2) 33.8%, medium adherence (score 3-4) 44.1%, and high adherence (score 5-6) 22.1%. Looking at men and women separately, similar distribution in the different adherence groups is seen with 36.1%, 44.4%, and 19.5% for men, and 32.1%, 43.9%, and 24.0% for women in the low-, medium-, and high-adherence groups, respectively. Participant characteristics in the three adherence groups are presented in Table 6.

Comparing the HNFI adherence groups in men, no significant differences in the baseline characteristics were seen, except for the SBP, smoking, educational level, and some categories for hard physical activity. An increased SBP across the adherence groups was seen. Regarding educational level, more men in the low- and medium-adherence groups have completed college/university compared to those with high adherence; however, the differences are small. Finally, men with low adherence to HNFI are more likely to be smokers and physically inactive than men with higher adherence.

In women, significant differences were seen for HDL-C, non-HDL-C, and CRP, smoking status, BMI, educational level, and physical activity across the adherence groups. Interestingly, if one compares the participants with BMI ≥30, women with high adherence to HNFI are more likely to be obese (7.6%) compared to those with low adherence (5.7%). An increased prevalence of the number of women who have completed college/university is seen with higher HNFI adherence. On the other hand, more women with lower education are in the lowest adherence group. Like men, women with low adherence to HNFI are more likely to be smokers and physically inactive than women with higher adherence.

Daily dietary intakes for men and women in the three adherence groups are presented in Table 7. Men and women in the high adherence group had a higher energy intake compared to the lower adherence categories ($p = 0.000$). Furthermore, the intake of proteins, carbohydrates, and dietary fiber slightly increased across adherence groups. In contrast, intake of added sugar, total fat, SFA, and MUFA slightly decreased across adherence groups in both sexes. No statistical differences in the intake of PUFA and alcohol were seen for either men or women. The use of fish oil and cod liver oil increased across adherence groups in both men and women. An increased intake across adherence categories is seen for most food groups consumed. However, no significant difference is seen in the intake of meat and bread in men and in the consumption of milk and dairy products in both sexes.

Table 5 Baseline characteristics of 1087 men and 1446 women in the Healthy Nordic Food Index in the low-, medium-, and high-adherence categories in the Hordaland Health Study

	Healthy Nordic Food Index Score Men, *n = 1087*				**Healthy Nordic Food Index Score Women**, *n = 1446*			
	0-2 (low) *n = 392*	3-4 (medium) *n = 483*	5-6 (high) *n = 212*	*p*	0-2 (low) *n = 464*	3-4 (medium) *n = 635*	5-6 (high) *n = 347*	*p*
Lifestyle								
Educational level *(%)*				<0.001				0.002
Primary school <10 y	21.1	13.3	9.0		26.5	19.5	17.6	
High school	35.4	41.5	48.8		43.6	42.4	41.9	
College/University	43.5	45.2	42.2		29.8	38.1	40.5	
Hard physical activity *(%)*								
None	30.3	16.6	13.5	<0.001	35.5	27.1	17.3	<0.001
<1 h/week	32.7	32.0	25.6	0.167	25.9	26.3	25.9	0.986
1-2 h/week	23.2	33.1	40.6	<0.001	28.6	33.8	39.6	0.006
≥3 h/week	13.7	18.3	20.3	0.082	10.1	12.9	17.3	0.013
Current smokers *(%)*	42.1	29.0	27.6	<0.001	41.5	32.4	31.2	0.002
Biomarkers of MetS								
WC (cm)	93 ± 9	93 ± 9	92 ± 8	0.854	78 ± 9	80 ± 10	79 ± 9	0.156
Serum glucose (mmol/L)	5.3 ± 0.9	5.4 ± 1.1	5.3 ± 0.9	0.287	5.1 ± 1.1	5.0 ± 0.8	5.0 ± 0.9	0.279
SBP (mmHg)	129 ± 11	130 ± 11	132 ± 13	0.007	123 ± 15	125 ± 16	124 ± 14	0.102
DBP (mmHg)	78 ± 9	78 ± 11	79 ± 10	0.528	71 ± 10	72 ± 11	72 ± 10	0.106
Serum TG (mmol/L), *median (IQR)*	1.74 (1.31)	1.77 (1.33)	1.75 (1.40)	0.941	1.13 (0.72)	1.20 (0.69)	1.12 (0.69)	0.078
Serum HDL-C (mmol/L)	1.16 ± 0.32	1.15 ± 0.31	1.16 ± 0.30	0.437	1.46 ± 0.35	1.46 ± 0.35	1.52 ± 0.37	0.040

Other clinical data								
BMI (kg/m^2) *(%)*				0.229				0.041
<18.5	0	0.2	0.5		0.7	1.6	0.3	
18.5 – 24.9	42.8	39.5	34.1		66.0	58.2	64.7	
25 – 29.9	47.0	49.8	57.3		27.7	33.7	27.4	
≥30	10.2	10.5	8.1		5.7	6.5	7.6	
Body fat mass *(%)*	23.6 ± 7.4	23.3 ± 7.0	22.9 ± 7.4	0.423	33.7 ± 7.2	34.4 ± 7.5	33.3 ± 7.5	0.071
Serum total cholesterol (mmol/L)	5.81 ± 0.95	5.81 ± 0.97	5.73 ± 1.00	0.600	5.65 ± 0.84	5.62 ± 0.94	5.63 ± 0.90	0.214
Serum non-HDL-C (mmol/L)	4.65 ± 1.00	4.66 ± 1.03	4.57 ± 1.03	0.627	4.19 ± 0.89	4.16 ± 0.96	4.11 ± 0.96	0.044
CRP (mg/L), *median (IQR)*	1.0 (1.5)	0.9 (1.4)	0.9 (1.3)	0.158	0.9 (1.4)	0.9 (1.4)	0.7 (1.3)	0.026
Anti-hyperglycemic drugs *(%)*	0.5	1.0	0.9	0.681	0.4	0.2	0	0.383
Anti-hypertensive drugs *(%)*	5.1	5.0	4.2	0.890	4.7	4.3	4.3	0.922
Lipid-modulating drugs *(%)*	4.1	2.5	3.3	0.411	0.6	1.6	1.7	0.303
Estrogen therapy *(%)*	N/A	N/A	N/A	N/A	16.4	17.5	16.1	0.850

Values are presented as percentages and means ± SD.

Missing data: smokers (n=26), education (n=24), physical activity (n=96), BMI (n=41), body fat mass (n=384).

P values for differences between men and women categorized in the three adherence groups were calculated using the Kruskal-Wallis test or Chi-square test for continuous and categorical variables, respectively. Blood sampling in the Hordaland Health Study was non-fasting.

BMI, body mass index; CRP, C-reactive protein; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; IQR, interquartile range; MetS, metabolic syndrome; N/A, not applicable; SBP, systolic blood pressure; TG, triglyceride

Table 6 Daily dietary intake of 1087 men and 1446 women in the Healthy Nordic Food Index in the low-, medium-, and high-adherence categories in the Hordaland Health Study

	Healthy Nordic Food Index Score Men, *n = 1087*				**Healthy Nordic Food Index Score Women**, *n = 1446*			
	0-2 (low) *n = 392*	3-4 (medium) *n = 483*	5-6 (high) *n = 212*	*p*	0-2 (low) *n = 464*	3-4 (medium) *n = 635*	5-6 (high) *n = 347*	*p*
Energy *(kcal)*	2222 ± 569	2562 ± 595	2771 ± 531	0.000	1624 ± 418	1894 ± 465	2165 ± 460	0.000
Protein *(E%)*	15.5 ± 2.1	15.8 ± 2.2	16.4 ± 2.0	<0.001	15.9 ± 2.4	16.5 ± 2.4	16.7 ± 2.2	<0.001
Carbohydrate *(E%)*	48.7 ± 6.3	49.8 ± 5.7	50.6 ± 4.7	<0.001	49.8 ± 6.2	50.4 ± 6.1	50.7 ± 5.3	0.029
Added sugar *(E%)*	7.4 ± 4.5	7.1 ± 4.3	6.5 ± 3.4	0.089	7.7 ± 5.3	6.6 ± 4.2	6.1 ± 3.2	<0.001
Dietary fiber *(g/1000 kcal)*	9.6 ± 2.3	11.2 ± 2.6	12.4 ± 2.4	0.000	11.0 ± 2.7	12.9 ± 3.2	14.1 ± 3.0	0.000
Total fat *(E%)*	33.0 ± 5.6	32.0 ± 4.9	30.8 ± 4.1	<0.001	32.6 ± 5.3	31.4 ± 5.3	31.1 ± 4.7	<0.001
SFA *(E%)*	12.8 ± 2.5	12.1 ± 2.2	11.6 ± 1.8	<0.001	13.0 ± 2.6	12.2 ± 2.3	12.0 ± 2.1	<0.001
MUFA *(E%)*	10.6 ± 2.0	10.2 ± 1.7	9.8 ± 1.3	<0.001	10.4 ± 1.8	9.9 ± 1.8	9.9 ± 1.6	<0.001
PUFA *(E%)*	7.2 ± 2.3	7.2 ± 2.0	6.9 ± 1.7	0.263	6.8 ± 2.1	6.7 ± 1.9	6.7 ± 1.8	0.869
n-3 PUFA[a]	1.1 ± 0.4	1.3 ± 0.4	1.3 ± 0.4	<0.001	1.1 ± 0.4	1.2 ± 0.4	1.3 ± 0.4	<0.001
n-3 LCPUFA[b]	0.3 ± 0.3	0.4 ± 0.4	0.5 ± 0.4	<0.001	0.3 ± 0.4	0.4 ± 0.3	0.5 ± 0.4	0.000
n-6 PUFA[c]	6.1 ± 2.1	5.9 ± 1.8	5.6 ± 1.6	0.041	5.7 ± 1.9	5.5 ± 1.7	5.4 ± 1.6	0.034
Alcohol[d] ***(%)***				0.293				0.164
None	12.0	9.1	7.1		23.3	19.7	15.3	
Low-moderate	76.3	79.7	84.9		65.3	67.2	70.9	
Moderate	7.4	7.5	4.7		8.8	10.9	11.5	
High	4.3	3.7	3.3		2.6	2.2	2.3	
Supplement use ***(%)***								
Fish oil use	4.6	8.3	11.3	0.008	5.2	8.3	11.0	0.010
Cod liver oil use	33.0	41.4	45.8	0.004	27.6	32.3	43.5	<0.001

Food intake *(g/1000 kcal)*								
Fish/shellfish	30 ± 18	38 ± 20	47 ± 19		30 ± 18	40 ± 21	49 ± 22	
Meat	58 ± 24	55 ± 22	55 ± 19	0.113	59 ± 25	56 ± 23	51 ± 21	<0.001
Vegetables	57 ± 50	85 ± 66	106 ± 55	0.000	84 ± 54	128 ± 81	160 ± 74	0.000
Root vegetables	10 ± 13	20 ± 21	26 ± 18		17 ± 16	31 ± 28	39 ± 25	
Cabbages	10 ± 17	22 ± 37	27 ± 28		16 ± 23	34 ± 45	46 ± 38	
Fruit/berries	80 ± 58	100 ± 62	120 ± 66	<0.001	117 ± 86	139 ± 81	159 ± 77	0.000
Apples/pears	12 ± 23	20 ± 26	26 ± 24		18 ± 28	27 ± 30	34 ± 30	
Milk/dairy products	157 ± 117	154 ± 94	149 ± 91	0.724	137 ± 112	138 ± 100	134 ± 84	0.479
Bread	93 ± 34	92 ± 29	89 ± 24	0.735	91 ± 33	86 ± 29	81 ± 22	<0.001
Whole grain bread	36 ± 24	56 ± 44	70 ± 32		41 ± 49	60 ± 41	64 ± 27	
Breakfast cereals	3 ± 8	5 ± 8	7 ± 10		2 ± 8	5 ± 10	8 ± 11	

Values are presented as percentages and means ± SD. Missing data: supplement use (n=1).

P values for differences between men and women categorized in the three adherence groups were calculated using the Kruskal-Wallis test or Chi-square test for continuous and categorical variables, respectively.

E%, percent of total energy intake; PUFA, polyunsaturated fatty acid; LCPUFA, long-chain polyunsaturated fatty acid; n-3, omega-3; n-6, omega-6

[a] Sum of α-linolenic acid (ALA), eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA), and docosahexaenoic acid (DHA)

[b] Sum of eicosapentaenoic acid (EPA), docosapentaenoic acid (DPA), and docosahexaenoic acid (DHA)

[c] Sum of linoleic acid (LA) and arachidonic acid (ARA)

[d] None: 0 g/day; Low-moderate: women 0.1-10 g/day, men 0.1-20 g/day; Moderate: women 10-20 g/day, men 20-30 g/day; High: women >20 g/day, men >30 g/day

3.4 Differences between adherence to the Healthy Nordic Food Index and the metabolic syndrome

Significant differences between adherence to HNFI and MetS and its components were seen neither in men nor in women (Table 8). Contrary to the expectations, men with high adherence to HNFI corresponded to a higher prevalence of MetS (39.6%) compared to medium- and low-adherence, with a MetS prevalence of 36.4% and 35.5%, respectively. Whereas for women, high adherence to HNFI corresponded to a lower prevalence of MetS (20.5%) compared to the other adherence groups. Compared with low adherence, men with high adherence had a higher prevalence of elevated TG, blood pressure, serum glucose levels, and decreased levels of HDL-C. In contrast, women with high adherence had a higher prevalence of increased WC and elevated blood pressure.

Table 7 Diagnosis of metabolic syndrome and its components in the study population of 1087 men and 1446 women in the Healthy Nordic Food Index in the low-, medium-, and high-adherence categories in the Hordaland Health Study

	Healthy Nordic Food Index Score ***Men****, n = 1087*				***Healthy Nordic Food Index Score*** ***Women****, n = 1446*			
	0-2 (low) n = 392	*3-4 (medium) n = 483*	*5-6 (high) n = 212*	*p*	*0-2 (low) n = 464*	*3-4 (medium) n = 635*	*5-6 (high) n = 347*	*p*
Metabolic syndrome	35.5	36.4	39.6	0.591	23.1	23.8	20.5	0.486
WC[a]	45.9	42.7	41.0	0.450	41.4	45.7	44.1	0.366
Triglycerides[b]	51.5	52.4	51.9	0.969	23.1	21.1	20.2	0.580
HDL-C[c]	29.3	32.9	31.6	0.523	35.1	34.2	29.1	0.160
Blood pressure[d]	48.0	53.0	57.1	0.084	30.6	32.1	31.7	0.863
Serum glucose[e]	29.1	29.0	30.2	0.946	22.4	19.8	19.9	0.534

Values are presented as percentages.

P values for differences between men and women categorized in the three adherence groups were calculated using the Chi-square test for categorical variables.

Blood sampling in the Hordaland Health Study was non-fasting. HDL-C, high-density lipoprotein cholesterol; WC, waist circumference

[a] Men ≥ 94 cm, women ≥ 80 cm

[b] ≥1.7 mmol/L

[c] Men <1.0 mmol/L, women <1.3 mmol/L

[d] Systolic: ≥130 mmHg and/or diastolic: ≥85 mmHg

[e] ≥5.5 mmol/L

3.5 Associations between adherence to the Healthy Nordic Food Index and the metabolic syndrome

The multinomial regression analysis is presented in Table 9. In the energy-adjusted model for men, medium adherence is associated with increased serum glucose levels, and high adherence is associated with elevated SBP. After further adjustment for potential confounders, including BMI, smoking, hard physical activity, and education, only the association of SBP with high adherence remained statistically significant (RRR 1.01, 95% CI 1.00-1.03). In addition, in men, an association between high adherence and reduced WC was observed (RRR 0.96, 95% CI 0.92-0.99).

In the energy-adjusted model for women, SBP is associated with medium adherence, and serum HDL-C is associated with high adherence. In the mutually adjusted model, only the association of serum HDL-C in high adherers remained statistically significant (RRR 1.70, 95% CI 1.05-2.74).

No statistical significance was observed for the association between adherence to HNFI and MetS for either men or women. However, in the mutually adjusted model, a non-significant lower risk of MetS was observed in men with medium adherence and in women with medium- and high-adherence.

Table 8 Relative risk ratios for medium-, and high Healthy Nordic Food Index adherence category (with low adherence category as reference) according to metabolic syndrome and its components in the Hordaland Health Study

	Men, *n = 1087*				**Women**, *n = 1446*			
	Medium adherence		**High adherence**		**Medium adherence**		**High adherence**	
	Energy adjusted	Mutually adjusted*	Energy adjusted	Mutually adjusted*	Energy adjusted	Mutually adjusted*	Energy adjusted	Mutually adjusted*
	RRR** (95% CI)	RRR** (95% CI)	RRR** (95% CI)	RRR** (95% CI)	RRR** (95% CI)	RRR** (95% CI)	RRR** (95% CI)	RRR** (95% CI)
Metabolic syndrome	1.05 (0.79-1.40)	0.98 (0.69-1.37)	1.19 0.83-1.72)	1.06 (0.69-1.63)	1.04 (0.77-1.39)	0.87 (0.62-1.23)	0.83 (0.57-1.20)	0.74 (0.48-1.14)
Waist circumference	1.00 (0.99-1.02)	0.98 (0.95-1.01)	1.00 (0.98-1.02)	**0.96 (0.92-0.99)**	1.01 (0.99-1.03)	0.99 (0.97-1.02)	1.01 (0.99-1.02)	0.97 (0.94-1.00)
Serum triglycerides	0.96 (0.86-1.08)	0.95 (0.83-1.07)	1.01 (0.88-1.16)	1.00 (0.86-1.17)	0.96 (0.83-1.11)	0.93 (0.79-1.09)	0.92 (0.77-1.11)	0.93 (0.76-1.15)
Serum HDL-C	0.82 (0.52-1.30)	0.85 (0.51-1.41)	0.86 (0.48-1.53)	0.89 (0.47-1.72)	1.16 (0.82-1.65)	1.22 (0.82-1.82)	**1.71 (1.12-2.62)**	**1.70 (1.05-2.74)**
Serum glucose	**1.15 (1.00-1.32)**	1.14 (0.99-1.31)	1.09 (0.91-1.29)	1.06 (0.88-1.28)	0.92 (0.80-1.05)	0.89 (0.77-1.03)	0.93 (0.78-1.11)	0.88 (0.73-1.07)
DBP	1.00 (0.99-1.02)	1.00 (0.98-1.01)	1.01 (0.99-1.03)	1.00 (0.99-1.02)	1.01 (0.99-1.02)	1.00 (0.99-1.02)	1.01 (0.99-1.03)	1.01 (0.99-1.03
SBP	1.01 (0.99-1.02)	1.00 (0.99-1.01)	**1.02 (1.01-1.03)**	**1.01 (1.00-1.03)**	**1.01 (1.00-1.02)**	1.01 (0.99-1.02)	1.01 (0.99-1.02)	1.01 (0.99-1.02)

*Mutually adjusted for energy intake, body mass index, smoking, physical activity, and education

**Relative risk ratios from multinomial logistic regression

RRR, relative risk ratios; CI, confidence intervals; HDL-C, high-density lipoprotein cholesterol; DBP, diastolic blood pressure; SBP, systolic blood pressure

4.0 Discussion

4.1 Main findings

The thesis aimed to investigate the association between adherence to HNFI and the risk of MetS and its components, following the hypothesis that high adherence to HNFI is associated with a reduced risk of MetS and its components in a middle-aged population from Western Norway. However, our results did not find an association between adherence to HNFI and the risk of MetS.

4.2 Discussion of results

There is inconsistent evidence on whether high adherence to HNFI is associated with a reduced risk of diet-related chronic diseases (45, 47-50, 70). HNFI was developed as a local Nordic opposition to the Mediterranean diet, a dietary pattern associated with reduced risk of MetS (58, 59). However, no such association with the HNFI was detected in this cross-sectional study. In the mutually adjusted regression model, a non-significantly lower risk of MetS was seen for both sexes with medium adherence and women with high adherence. On the other hand, there was an increased risk of MetS in men with high adherence, although this was not statistically significant. These results are reflected when looking at the prevalence of MetS in the various adherence categories. Men with high adherence had the highest prevalence of MetS (39.6%), whereas women with high adherence had the lowest prevalence of MetS (20.5%).

In contrast to the HNFI, the Mediterranean diet is characterized by various food groups and nutrients with either positively or negatively associated health effects (59). Some of the food groups typically consumed in Southern Europe, such as legumes and olive oil, may be uncommon to consume in the Nordic countries. Similar to the Mediterranean diet, other dietary indices, such as the DASH diet (65) and the HEI (60), consist of an eating pattern with food groups known to have positive or negative health effects. The three dietary patterns mentioned have all been significantly associated with reduced risk of MetS (58, 59, 61, 66). The HNFI may not capture the total essence of a Healthy Nordic diet as it reflects only a minor part of the energy consumed, as major food groups providing energy are not included in the index (but they may be related to the food groups included). In addition, the food groups included in the HNFI mainly reflect dietary fiber. This might contribute to why we did

not observe any association between HNFI adherence and MetS. Indeed, associations may also be hidden in cross-sectional analyses and become more visible in longitudinal analyses.

In men, high adherence to HNFI is statistically significantly associated with decreased WC. Our result is supported by findings in studies investigating the Nordic dietary pattern, where high adherers were less likely to have elevated WC, mainly driven by the effect of high dietary fiber intake and moderate alcohol consumption (74). Similar findings have also been observed with high adherence to the DASH diet (66), as well as adherence to the Mediterranean diet (58). The relative risk of elevated serum HDL-C in women with high adherence is in accordance with findings from the SYSDIET study (52), which found a trend towards elevated HDL-C in a healthy Nordic diet in subjects with MetS. A dietary pattern containing foods with a low glycemic index, such as fruits, vegetables, and whole-grains, may result in elevated serum HDL-C (75, 76). Elevated SBP was associated with high adherence in men; these findings are inconsistent with other studies on the healthy Nordic diet, which found a reduction in SBP (51). High adherence to the Mediterranean and DASH diets has been shown to be protective of higher blood pressure (58, 66).

Indeed, several mechanisms relate to the HNFI and its potential effects on metabolic disorders, even though there was no association observed in the present study. The food groups comprising the index have positive health effects, providing plausibility for its potential protective role against MetS, which might have been expected. Whole-grains have been demonstrated to protect against metabolic disorders due to their high content of fiber, vitamins, minerals, antioxidants, and other plant compounds (for example, phytochemicals) (77). Diets rich in whole grain have been linked to a lower prevalence of MetS (78-80). One of the cross-sectional studies (79) found favorable associations between intake of whole-grains and BMI, waist-to-hip ratio, total cholesterol, low-density lipoprotein cholesterol (LDL-C), and fasting insulin concentrations. A large cross-sectional study from Norway (30) reported an association between fish intake and reduced risk of MetS. Those consuming fish at least once a week had a lower risk of MetS than those consuming fish less than once a week. Higher lean and fatty fish consumption reduces serum TG and increases HDL-C levels (30, 81-83). Evidence suggests that a high intake of fruits and vegetables is associated with a lower risk of hypertension, hyperlipidemia, and obesity, which all of these are associated with increased risk of MetS. Results from different meta-analyses (84, 85) indicates that fruit and vegetable consumption, both separately and combined, are associated with a significantly decreased risk of MetS.

The association between the intake of various types of fruit and vegetables with the risk of MetS has been investigated in several studies; however, the available data remains inconsistent. For example, a recent prospective study (86) found no association between root vegetables and the risk of MetS. In contrast, a higher intake of green leafy vegetables (some of them included in the index food category, "cabbages") has shown to be beneficial in reducing the risk of MetS (86), CVD (87), and T2DM (88, 89). In addition, a meta-analysis of RCTs (90) investigated the effect of apples on metabolic and cardiovascular markers. They observed that intake of apples could improve blood cholesterol levels by reducing total cholesterol and LDL-C.

High adherence to HNFI corresponds to higher energy intake, as seen in other studies on the HNFI (38, 45, 46, 70). In accordance with our findings, high adherers had higher education, were more physically active, and were less likely to be current smokers than those with low adherence (38, 46). Men with high adherence to HNFI had a BMI similar to those with low adherence. A similar finding has been reported by Puaschitz et al. (70) and Olsen et al. (38). The reported level of physical activity may explain why men with high adherence (and higher energy intake) had similar BMI to men with low adherence (and lower energy intake). This result highlights the importance of physical activity in preventing MetS and other NCDs (91-94). An association between higher adherence to HNFI and higher BMI in women has been seen in different studies (45, 46), which supports our findings that women with high adherence have a higher prevalence of obesity. The Norwegian Women and Cancer (NOWAC) Study (95) has reported BMI as a predominant factor in weight loss attempts, where over 90% of the women with BMI $\geq$30 kg/m^2 were trying to lose weight. Those women reported a diet with less fat and more dietary fiber, fruits, and vegetables compared to women not trying to lose weight. This may also contribute to our findings why a higher proportion of obese women had higher adherence to the HNFI.

A significant association was observed between the HNFI adherence groups and other dietary factors. High adherers had a significantly higher consumption of dietary fiber and a lower percentage of total fat and added sugar compared to the low adherers. The lower intake of SFA in high adherers may correspond to a slightly lower intake of SFA-containing foods such as meat/processed meat and milk/dairy products. However, no significant differences between adherence and the dietary intake of the latter food groups were observed, except for meat consumption in women. Participants with high adherence to HNFI had a higher consumption of vegetables, fruits and berries, whole-grain bread, and breakfast cereals, contributing to the

high fiber intake. These results show that high adherence is associated with better dietary quality and that the index not only measures a higher intake of all foods. This is in accordance with Bjørnaråa et al. (96), who found an association between high adherence to a healthy Nordic diet and higher consumption of healthy foods, without a higher intake of meat, sweets, and energy intake. The distribution of macronutrients was relatively similar across the adherence groups, and the percentage intake of total fat, carbohydrates, and proteins was in accordance with recommendations by NNR5 (21). Similar observations have been found in other studies on the HNFI (45, 46, 70). However, none of the adherence groups had a mean fiber intake fulfilling the recommended consumption of dietary fiber (21), except for women with high adherence. In addition, the percentage intake of SFA was higher than the recommendations for all adherence groups. Similar findings were reported by Roswall et al. (45) among Swedish women. However, a suggestion to avoid any possible misleading results based on the impact of energy intake could be to use energy adjusted cut-offs (g/1000 kcal) of the median for the index in future research.

4.3 Discussion of methods

A cross-sectional study design cannot provide evidence of a causal relationship between HNFI and MetS. Sometimes, associations between diet and health outcomes are not visible in cross-sectional analyses, as known from, for example, the association between sugar intake and obesity (97, 98). The too high error rate in dietary assessment and measurements may be an explanation for a non-significant association. However, RCTs are considered the gold standard for examining the cause-effect relationship between an intervention and outcome (99).

The participants in HUSK2 are a community-dwelling population from Hordaland County in Norway. A limitation in population-based epidemiological studies is that participants selected for inclusion do not always participate in such studies. In addition, people with lower socioeconomic status and lower education are known to have a lower participation rate (100, 101), and thus impairs the generalization. The same trends are observed in HUSK2.

Data collection from HUSK2 was gathered in 1997-1999, which may indicate that the overall dietary intake is not entirely consistent with the current diet of the population in Western Norway (or Norway in general), as dietary habits have changed over time. Indeed, differences in food consumption were observed when comparing Norwegian dietary data from 1999 with

2020 (93). Compared to 2020, the Norwegian population had a lower intake of dietary fiber, vegetables, fruits, berries, and meat in 1999. On the other hand, the Norwegian population in 1999 had a higher consumption of milk (particularly whole milk), sugar-sweetened beverages, and added sugar compared to 2020. No significant differences in fish consumption were observed (102). However, data from the National Dietary Survey among men and women in 1997 was comparable to the dietary intake in our study population, supporting the validity of our dietary data (103).

In our study population, individuals with extreme values for energy intake were excluded, thus reducing the risk of reporting bias (104). Although several covariates in the regression models that examined associations between HNFI and MetS were included, the potential for residual confounding remains.

Dietary pattern analyses provide a comprehensive and complementary method to investigate diet quality and diet-related diseases and are more applicable to clinical and public health interventions than individual food and nutrient approaches. A dietary pattern is more comparable to what people eat, like meals with complex combinations of nutrients, as we do not eat single food items. Analysis of dietary patterns using the *a priori* approach, the same method used in this study, showed more varied and healthy diets. Those diets are associated with higher energy intake, higher income, higher education, higher bone mineral density, and reduced all-cause and CVD mortality (27). Some of the outcomes have been observed in this study. Another strength of using dietary indices is that they are based on previous knowledge of a healthy diet, as they generally use dietary recommendations as guiding principles, making them objective (26, 28).

Furthermore, dietary patterns derived from dietary indices are easy to understand for the general population and can be helpful in the further investigation between diet and chronic diseases. Dietary indices may also be particularly useful for defining FBDG (28), as habitual food intake tends to change over time. The construction of the HNFI is based on the median of the food items incorporated in the index, the same method used in the MED (39). Other dietary indices use recommended values or quintiles (105). Using a median cut-off seems reasonable due to its resistance to misclassification of extreme values.

However, the validity and reproducibility of dietary patterns have been discussed. A critical review of 20 indices of overall diet quality (106) found that the different predefined scores varied considerably, such as the items included, the cut-off values used, and the exact method

of scoring, indicating that many arbitrary choices have been made in the development of an index. This may explain why some of the results related to dietary quality and health outcomes are inconsistent. However, the Dietary Patterns Methods Project (105) developed a standardized approach to index-based dietary analysis to evaluate dietary indices in different cohorts and compare their ability to capture a healthy diet and their association with mortality. All the dietary indices captured the essence of a healthy diet and showed a similar strength of an inverse association with mortality. However, none of the dietary patterns were recommended over the other, and no recommendations regarding the scoring system used in developing an index were mentioned.

The FFQ used in the present thesis is a cost-efficient dietary assessment method, and it evaluates the habitual dietary intake in many individuals (107, 108). However, the use of FFQ will introduce errors. The FFQ is a self-reported assessment method, where some limitations, such as underreporting (109), detailed information about food preparation, and the consumption of specific foods and beverages, are lacking (107). However, self-reported dietary data could be valuable in answering questions regarding differences in habitual dietary intake in the same population, such as characterizing the type of foods consumed by older vs. younger adults or by individuals with normal weight vs. obesity (109). It should also be considered which time of the year the FFQ was administered due to seasonal reporting bias (110), of which the reported intake of some foods is influenced by the different seasons. This may suggest a higher reported intake of root vegetables, cabbages, and apples/pears during autumn, as these foods are in season in Norway at that time of the year.

Although the FFQ was semi-quantitative, we used quantitative cut-offs in the index (even though the cut-off was based on ranking, 50^{th} percentile), which may lead to errors in classification. Unfortunately, the FFQ was not initially designed to assess compliance with a healthy Nordic diet and thus does not capture all relevant food groups incorporated in the original HNFI, such as rye bread and oatmeal. Some adjustments to the HNFIs in the present study were therefore necessary. Whole grain bread and breakfast cereals are food groups based on a single question from the FFQ. A more precise assessment of the consumed types and amount of whole grain in the diet could have been achieved by an FFQ with a more detailed evaluation of the kinds of whole grain bread and whole grain products in the breakfast cereals category. However, a study conducted around the same time as HUSK2 (111) observed that approximately 80% of the grains in the cereal category were whole-grains in the Norwegian and Danish populations. Differences in commonly consumed foods in the

Nordic countries may affect the comparability of the index between countries. This might be particularly relevant for the food items that include whole grains as there are differences in habitual intake between the commonly consumed grains in the Nordic countries. For example, the Norwegian population commonly consumes wheat, whereas rye is the most consumed grain in Denmark and Sweden (111).

It can be argued whether it is advantageous or disadvantageous to exclude all people with CRP > 5 mg/L. As previously mentioned, participants with a CRP above 5 mg/L were excluded as we wanted the most homogeneous study population possible where inflammation should not be a disturbing factor. Different studies have found an association between CRP levels and fasting glucose (112, 113). Elevated CRP could lead to falsely elevated glucose values and thus affect the diagnosis of MetS for the participants in the present study. However, over 500 participants were excluded due to high CRP values and thus leaving out information that may have altered the findings in this study and reduced statistical power. A CRP value above 5 mg/L may indicate an increased cardiovascular risk, or it could be a CRP returning to normal after infection (114). Several studies have observed higher CRP levels in obese individuals with MetS compared to those without (115-118); however, the mean levels of CRP were all under 5 mg/L. This is in accordance with our findings, although we did not look exclusively at obese individuals.

Moreover, the blood sampling in HUSK2 was non-fasting, which may affect the actual prevalence of MetS in the present study. Over 80% of the subjects in another HUSK2 study (81) reported that the time since the last meal was less than 4 hours. However, minimal changes in lipids and lipoproteins in response to normal food intake have been observed (119). Karlsson et al. (81) reported serum glucose and TG levels with an inverse association between time since the last meal, whereas no such association was seen for HDL-C. Using a higher cut-off for defining elevated glucose levels (≥6.0 mmol/L instead of ≥5.5 mmol/L), the prevalence of high serum glucose was 12.9% compared to 24.4%, whereas the prevalence of MetS was 25.3% compared to 28.7%.

4.4 Strength and limitations

The main strengths of this community-based study are the large sample size with the inclusion of both men and women of the same age and the available data on clinical and sociodemographic characteristics of the study population. Blood variables were measured with the same methods and in certified laboratories. In addition, the dietary intake was obtained from a validated semi-quantitative FFQ, which captured a long-time dietary food intake and dietary patterns over time (68). Another strength is the use of dietary pattern analyses which assess the overall diet quality.

There are several limitations in the present study that needs to be highlighted. A major limitation of this study is the use of a cross-sectional study design which does not allow for drawing conclusions on causality. The FFQ was not initially designed to assess compliance with a healthy Nordic diet. The blood sampling in HUSK2 was non-fasting, which may have affected the actual prevalence of MetS. In addition, a large number of participants with CRP > 5mg/L were excluded and may therefore reduce statistic power.

4.5 Conclusion

The present results do not support an association between adherence to HNFI and a reduced risk of MetS in a middle-aged population from Western Norway. Participants with high adherence to HNFI had a higher energy intake and followed a healthier lifestyle. However, this did not translate into a lower prevalence of the MetS. Obviously, the HNFI is not covering the dietary quality and intake to the extent that it could explain the presence of the MetS.

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6.0 Appendix

Appendix 1: The FFQ from the Hordaland Health Study

HVA SPISER DU?

I dette skjemaet spør vi om dine spisevaner slik de **vanligvis** er. Vi er klar over at kostholdet varierer fra dag til dag. Prøv derfor så godt du kan å gi et **"gjennomsnitt"** av dine spisevaner. Ha det siste året i tankene når du fyller ut skjemaet. Der du er usikker, anslå svaret.

Skjemaet skal leses av en maskin, og derfor er det viktig at du setter et tydelig kryss i avmerket rute.

Riktig markering er slik: ☒

Bruk helst bløt blyant. Feil kan da rettes med viskelær.
Kulepenn og svart tusjpenn kan også brukes.

Av hensyn til den maskinelle lesingen pass på at arkene ikke blir brettet.

Alle svar vil bli behandlet strengt fortrolig.

EKSEMPEL PÅ UTFYLLING AV SPØRSMÅL 1.

Kari Nordmann spiser daglig 5 skiver brød og ett knekkebrød. Hun spiser vanligvis kneippbrød, men i helgene blir det en del loff. I tillegg spiser hun ett knekkebrød hver dag. Hun fyller ut første spørsmål slik:

1. HVOR MYE BRØD PLEIER DU Å SPISE?

Legg sammen det du bruker til alle måltider i løpet av en dag.

(1/2 rundstykke = 1 skive, 1 baguett = 5 skiver, 1 ciabatta = 4 skiver)

	Antall skiver pr. dag												
	0	1/2	1	2	3	4	5	6	7	8	9	10	11	12+
Fint brød (loff, baguetter, fine rundstykker o.l.)	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mellomgrovt brød (lys helkorn, lys kneipp, lyst hj.bakt o.l.)	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐
Grovt brød (fiberkneipp, mørk kneipp, mørkt hj.bakt o.l.)	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knekkebrød (kavring, grov skonrok o.l.)	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Sum skiver pr. dag = 6

Antall skiver pr. uke: 6 x 7 = 42 Tallet brukes i spørsmål 5.

1. HVOR MYE BRØD PLEIER DU Å SPISE?

Legg sammen det du bruker til alle måltider i løpet av en dag.

(1/2 rundstykke = 1 skive, 1 baguett = 5 skiver, 1 ciabatta = 4 skiver)

	Antall skiver pr. dag												
	0	1/2	1	2	3	4	5	6	7	8	9	10	11	12+
Fint brød (loff, baguetter, fine rundstykker o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Mellomgrovt brød (lys helkorn, lys kneipp, lyst hj.bakt o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Grovt brød (fiberkneipp, mørk kneipp, mørkt hj.bakt o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Knekkebrød (kavring, grov skonrok o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Sum skiver pr. dag = _____

Antall skiver pr. uke: _____ x 7 = _____. Tallet brukes i spørsmål 5.

2. HVA PLEIER DU Å SMØRE PÅ BRØDET?

Merk av både for hverdag og helg, selv om du bruker det samme.

Hverdager		Lørdager, søndager
☐	Bruker ikke	☐
☐	Smør (meierismør)	☐
☐	Bremykt, Smøregod	☐
☐	Brelett	☐
☐	Soft, soyamargarin (pakke, beger)	☐
☐	Solsikke	☐
☐	Oliven	☐
☐	Vita	☐
☐	Olivero	☐
☐	Omega	☐
☐	Soft light	☐
☐	Vita lett	☐
☐	Annen margarin	☐

3. OM DU BRUKER FETT PÅ BRØD, HVOR MYE BRUKER DU?

En porsjonspakning på 12 g rekker til antall skiver

1 ☐

2 ☐

3 ☐

4 ☐

5 ☐

4. MELK SOM DRIKK

(1 glass = 1,5 dl)

	Drikker sjelden/ ikke	Antall glass pr. dag							
		1/2	1	2	3	4	5	6	7	8+
Helmelk, søt, sur	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lettmelk, søt, sur	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lettmelk, ekstra lett	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Skummet melk, søt, sur	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

5. PÅLEGGSSORTER

Bruk sum skiver pr. uke fra spørsmål 1.

Til antall skiver pr. uke

	0	1/2	1	2-3	4-5	6-7	8-14	15-21	22-28	29-35	36+
Brun ost, prim	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hvit ost, helfet, 27% fett (Jarlsberg, Norvegia o.l., smøreost; eske, tube)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Hvit ost, halvfet, 16% fett (Jarlsberg, Norvegia o.l., smøreost; eske, tube)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Ost med mer enn 27% fett (kremoster, Normanna, Ridderost)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	0	1/2	1	2-3	4-5	6-7	8-14	15-21	22-28	29-35	36+
Leverpostei, vanlig	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Leverpostei, mager	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Servelat, vanlig	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lett servelat, kalverull, kokt skinke, okserull o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Salt pølse, spekepølse (fårepølse, salami o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	0	1/2	1	2-3	4-5	6-7	8-14	15-21	22-28	29-35	36+
Kaviar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Makrell i tomat, røkt makrell	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Sardiner, sursild, ansjos o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Laks, ørret	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Reker, krabbe	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	0	1/2	1	2-3	4-5	6-7	8-14	15-21	22-28	29-35	36+
Syltetøy, marmelade, frysetøy	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Honning, sirup, sjokolade-, nøttepålegg	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

	0	1/2	1	2-3	4-5	6-7	8-14	15-21	22-28	29-35	36+
Grønnsaker som pålegg (agurk, tomat o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Frukt som pålegg (banan, eple o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Salater med majones	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Majones på smørbrød	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. EGG

Antall pr. uke

	0	Mindre enn 1	1	2	3-4	5-6	7	8+
(kokt, stekt, eggerøre, omelett)	☐	☐	☐	☐	☐	☐	☐	☐

7. FROKOSTGRYN, GRØT OG YOGHURT

Svar enten pr. måned **eller** pr. uke. <1 betyr sjeldnere enn 1 gang.

	Gang pr. måned					Gang pr. uke						Mengde pr. gang				
	0	<1	1	2	3	1	2-3	4-5	6-7	8+		1	1 1/2	2	3+
Havregryn, kornblandinger (4-korn, usøtet müsli o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐
Cornflakes, puffet ris, havrenøtter o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐
												1-2	3-4	5-6	7+
Havregrøt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐
												1	2	3-4	5+
Sukker til frokostgryn, grøt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ts)	☐	☐	☐	☐
												1/2	1	1 1/2	2+
Yoghurt, naturell, frukt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(beger)	☐	☐	☐	☐
												1/2	1	1 1/2	2+
Lettyoghurt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(beger)	☐	☐	☐	☐
Go´morgen yoghurt inkl. müsli	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(beger)	1/2 ☐	1 ☐	1 1/2 ☐	2+ ☐
												3/4	1	2	3+
Melk søt, sur på gryn, grøt og dessert	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐

8. KAFFE OG TE

(1 kopp kaffe = 1,2 dl 1 kopp te = 2 dl)

	Drikker ikke/ikke daglig	Antall kopper pr. dag: 1/2	1	2	3-4	5-6	7-8	9-10	11+
Kaffe, kokt	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kaffe, traktet, filter	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kaffe, pulver (instant)	☐	☐	☐	☐	☐	☐	☐	☐	☐
Kaffe, koffeinfri	☐	☐	☐	☐	☐	☐	☐	☐	☐
Te	☐	☐	☐	☐	☐	☐	☐	☐	☐
Nypete, urtete	☐	☐	☐	☐	☐	☐	☐	☐	☐

	Antall teskjeer eller biter pr. kopp: 0	1/2	1	2	3	4+
Sukker til kaffe	☐	☐	☐	☐	☐	☐
Sukker til te	☐	☐	☐	☐	☐	☐
Kunstig søtstoff til kaffe eller te	☐	☐	☐	☐	☐	☐
Fløte til kaffe	☐	☐	☐	☐	☐	☐

9. ANDRE DRIKKER?

Svar enten pr. måned **eller** pr. uke. < 1 betyr sjeldnere enn 1 gang.
Merk at porsjonsenhetene er forskjellige. 1/3 liter tilsvarer en halvflaske øl og 2/3 liter tilsvarer en helflaske.

	Gang pr. måned					Gang pr. uke						Mengde pr. gang					
	0	<1	1	2	3	1	2-3	4-5	6-7	8+		1/2	1	2	3	4	5+
Vann	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(glass)	☐	☐	☐	☐	☐	☐
Appelsinjuice	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(glass)	☐	☐	☐	☐	☐	☐
Annen juice, most, nektar	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(glass)	☐	☐	☐	☐	☐	☐
Saft, solbærsirup m. sukker	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(glass)	☐	☐	☐	☐	☐	☐
Saft, kunstig søtet	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(glass)	☐	☐	☐	☐	☐	☐
Brus, Cola, Solo o.l., med sukker	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(liter)	☐	☐	☐	☐	☐	☐
Brus, Cola, Solo o.l., kunstig søtet	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(liter)	☐	☐	☐	☐	☐	☐
Farris, Selters, Soda o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(liter)	☐	☐	☐	☐	☐	☐
Alkoholfritt øl, vørterøl, lettøl	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(liter)	☐	☐	☐	☐	☐	☐
Pilsnerøl	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(liter)	☐	☐	☐	☐	☐	☐
Vin	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(glass)	☐	☐	☐	☐	☐	☐
Brennevin, likør	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(1 dram = 4 cl)	☐	☐	☐	☐	☐	☐

	1/2	1	2	3	4	5+
Vann	☐	☐	☐	☐	☐	☐
Appelsinjuice	☐	☐	☐	☐	☐	☐
Annen juice, most, nektar	☐	☐	☐	☐	☐	☐
Saft, solbærsirup m. sukker	☐	☐	☐	☐	☐	☐
Saft, kunstig søtet	☐	☐	☐	☐	☐	☐
Brus, Cola, Solo o.l., med sukker	☐	☐	☐	☐	☐	☐
Brus, Cola, Solo o.l., kunstig søtet	☐	☐	☐	☐	☐	☐
Farris, Selters, Soda o.l.	☐	☐	☐	☐	☐	☐
Alkoholfritt øl, vørterøl, lettøl	☐	☐	☐	☐	☐	☐
Pilsnerøl	☐	☐	☐	☐	☐	☐
Vin	☐	☐	☐	☐	☐	☐
Brennevin, likør	☐	☐	☐	☐	☐	☐

	1/4	1/3	1/2	2/3	1	11/2+
Vann	☐	☐	☐	☐	☐	☐
Appelsinjuice	☐	☐	☐	☐	☐	☐
Annen juice, most, nektar	☐	☐	☐	☐	☐	☐
Saft, solbærsirup m. sukker	☐	☐	☐	☐	☐	☐
Saft, kunstig søtet	☐	☐	☐	☐	☐	☐
Brus, Cola, Solo o.l., med sukker	☐	☐	☐	☐	☐	☐
Brus, Cola, Solo o.l., kunstig søtet	☐	☐	☐	☐	☐	☐
Farris, Selters, Soda o.l.	☐	☐	☐	☐	☐	☐
Alkoholfritt øl, vørterøl, lettøl	☐	☐	☐	☐	☐	☐
Pilsnerøl	☐	☐	☐	☐	☐	☐

	1	2	3	4	5	6+
Vin	☐	☐	☐	☐	☐	☐
Brennevin, likør	☐	☐	☐	☐	☐	☐

10. MIDDAGSRETTER

Vi spør både om middagsmåltidene og det du spiser til andre måltider. Tell til slutt sammen antall retter du har merket for og se om summen virker sannsynlig.
En "dl" tilsvarer omtrent mengden i en suppeøse. Med "ss" menes en spiseskje.

	Gang pr. måned										Mengde pr. gang					
	0	<1	1	2	3	4	5-6	7-8	9+		1/2	2/3	1	11/2	2+	
Kjøttpølse, medisterpølse	☐	☐	☐	☐	☐	☐	☐	☐	☐	(kjøttpølse)	☐	☐	☐	☐	☐	
Hamburger, karbonader o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐	
Grill- og wienerpølse	☐	☐	☐	☐	☐	☐	☐	☐	☐	(pølse)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐	
Hamburger-, pølsebrød, lomper	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐	
Kjøttkaker, medisterkaker, kjøttpudding	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐	
Kjøttdeigretter (saus eller gryte med kjøttdeig, lasagne o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐	
Taco (med kjøtt og salat)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐	
Pastaretter	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐	

	Gang pr. måned										Mengde pr. gang				
	0	<1	1	2	3	4	5-6	7-8	9+		1/8	1/4	1/2	3/4	1+
Pizza (500-600 g)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(pizza)	☐	☐	☐	☐	☐
											1/2	1	1 1/2	2	2 1/2+
Biff (alle typer kjøtt)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
											1/2	1	1 1/2	2	2 1/2+
Koteletter (lam, okse, svin)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
											1-2	3-4	5-6	7-8	9+
Stek (lam, okse, svin)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(skive)	☐	☐	☐	☐	☐
											1-2	3-4	5-6	7-8	9+
Stek (elg, hjort, reinsdyr o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(skive)	☐	☐	☐	☐	☐
Gryterett med helt kjøtt, frikassé, fårikål o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Lapskaus, suppelapskaus, betasuppe	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
											1-2	3-4	5-6	7-8	9+
Bacon, stekt flesk	☐	☐	☐	☐	☐	☐	☐	☐	☐	(skive)	☐	☐	☐	☐	☐
											1/4	1/3	1/2	3/4	1+
Kylling, høne	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
											1-2	3-4	5-6	7-8	9+
Leverretter	☐	☐	☐	☐	☐	☐	☐	☐	☐	(skive)	☐	☐	☐	☐	☐
	0	<1	1	2	3	4	5-6	7-8	9+		1	2	3	4	5+
Fiskekaker, fiskepudding, fiskeboller	☐	☐	☐	☐	☐	☐	☐	☐	☐	(kake)	☐	☐	☐	☐	☐
											1-2	3-4	5-6	7-9	10+
Fiskepinner	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
											1	2	3	4	5+
Torsk, sei, hyse (kokt)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
											1	2	3	4	5+
Torsk, sei, hyse (stekt, panert)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
											1	2	3	4	5+
Sild (fersk, speket, røkt)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(filet)	☐	☐	☐	☐	☐
											1/2	1	1 1/2	2	3+
Makrell (fersk, røkt)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(filet)	☐	☐	☐	☐	☐
											1	2	3	4	5+
Laks, ørret (sjø, oppdrett)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(skive)	☐	☐	☐	☐	☐
Fiskegryte, -grateng, suppe med fisk	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
											1	2	3	4	5+
Reker, krabbe	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl, renset)	☐	☐	☐	☐	☐
	0	<1	1	2	3	4	5-6	7-8	9+		1-2	3-4	5-6	7-8	9+
Risgrøt, annen melkegrøt	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐	☐
											1-2	3-4	5-6	7-8	9+
Pannekaker	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
Suppe (tomat, blomkål, ertesuppe o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Vegetarrett, vegetarpizza grønnsakgrateng, -pai	☐	☐	☐	☐	☐	☐	☐	☐	☐	(bit/dl)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
	0	<1	1	2	3	4	5-6	7-8	9+		1/2	1	1 1/2	2	2 1/2+
Brun/hvit saus	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐	☐
Smeltet margarin, smør til fisk	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
											1	2	3	4	5+
Bearnaisesaus o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	☐	☐	☐	☐	☐
											1	2	3	4	5+
Majones, remulade	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	☐	☐	☐	☐	☐
											1	2	3	4	5+
Ketchup	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	☐	☐	☐	☐	☐

11. POTETER, RIS, SPAGHETTI, GRØNNSAKER

Svar enten pr. måned **eller** pr. uke. <1 betyr sjeldnere enn 1 gang.
Disse spørsmålene dreier seg først og fremst om tilbehør til middagsretter, men spiser du for eksempel en rå gulrot eller salat til lunsj, skal det tas med her.

	Gang pr. måned					Gang pr. uke						Mengde pr. gang				
	0	<1	1	2	3	1	2-3	4-5	6-7	8+		1	2	3	4	5+
Poteter, kokte	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐	☐
Pommes frites, stekte poteter	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐	☐
Potetmos, -stuing, gratinerte poteter	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐	☐
Ris	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Spaghetti, makaroni, pasta	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Gulrot	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1/2 ☐	1 ☐	1 1/2 ☐	2 ☐	3+ ☐
Hodekål	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(skalk)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Kålrot	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(skive)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Blomkål	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(bukett)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Brokkoli	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(bukett)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Rosenkål	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Grønnkål	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Løk	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Spinat, andre bladgrønns.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Sopp	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Avocado	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1/4 ☐	1/2 ☐	3/4 ☐	1 ☐	1 1/4 + ☐
Paprika	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(strimmel)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Tomat	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1/2 ☐	1 ☐	1 1/2 ☐	2 ☐	3+ ☐
Tomatbønner, bønner/linser	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Mais	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	1-2 ☐	3-4 ☐	5-6 ☐	7-8 ☐	9+ ☐
Erter, frosne grønnsak-blandinger	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Salatblandinger	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4 ☐	5+ ☐
Dressing	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	1/2 ☐	1 ☐	2 ☐	3 ☐	4+ ☐
Rømme	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(ss)	1/2 ☐	1 ☐	2 ☐	3 ☐	4+ ☐

Hvor mange ganger om dagen spiser du vanligvis grønnsaker utenom grønnsakene du spiser til middag?

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5+ ☐

12. TYPE FETT TIL MATLAGING

Smør/margarin	Oljer
☐ Smør (meierismør)	☐ Olivenolje
☐ Bremykt	☐ Soyaolje
☐ Melange, Per	☐ Maisolje
☐ Soft-, soyamargarin (pakke, beger)	☐ Solsikkeolje
☐ Solsikke	☐ Valnøttolje
☐ Oliven	☐ Andre oljer
☐ Annen margarin	

13. FRUKT

Svar enten pr. måned **eller** pr. uke. < 1 betyr sjeldnere enn 1 gang.

	Gang pr. måned					Gang pr. uke						Mengde pr. gang			
	0	<1	1	2	3	1	2-3	4-5	6-7	8+		1/2	1	2	3+
Eple	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐
Appelsin, mandarin, grapefrukt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐
Banan	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐
Druer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(klase)	☐	☐	☐	☐
Eksotisk frukt (kiwi, mango)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐
Annen frukt (fersken, pære m.v.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	☐	☐	☐	☐
Jordbær, bringebær (friske, frosne)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐
Blåbær	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐
Multer	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐

Hvor mange frukter spiser du vanligvis pr. dag?

0	1	2	3	4	5	6	7	8	9+
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

14. DESSERT, KAKER, GODTERI

Svar enten pr. måned **eller** pr. uke. < 1 betyr sjeldnere enn 1 gang.

	Gang pr. måned					Gang pr. uke						Mengde pr. gang			
	0	<1	1	2	3	1	2-3	4-5	6-7	8+		1/2	1	2	3+
Hermetisk frukt, fruktgrøt	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	☐	☐	☐	☐
Puddinger (sjokolade, karamell o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4+ ☐
Is (1 dl = 1 pinne = 1 kremmerhus)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1 ☐	2 ☐	3 ☐	4+ ☐
Boller, julekake, kringle	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4+ ☐
Skolebrød, skillingsbolle	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4+ ☐
Wienerbrød, -kringle o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4+ ☐
Smultring, formkake	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1 ☐	2 ☐	3 ☐	4+ ☐
Vafler	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(plate)	1/2 ☐	1 ☐	2 ☐	3+ ☐
Sjokoladekake, bløtkake, annen fylt kake	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1/2 ☐	1 ☐	2 ☐	3+ ☐
Søt kjeks, kakekjeks (Cookies, Bixit, Hob Nobs)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1-2 ☐	3-4 ☐	5-6 ☐	7+ ☐
Sjokolade (60 g)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(plate)	1/2 ☐	1 ☐	2 ☐	3+ ☐
Drops, lakris, seigmenn o.l.	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(stk)	1-2 ☐	3-4 ☐	5-6 ☐	7+ ☐
Smågodt (1 hg = 100g)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(hg)	1/2 ☐	3/4 ☐	1 ☐	1 1/2+ ☐
Potetgull (1 pose 100g = 7 dl)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7+ ☐
Annen snacks (skruer, crisp, saltstenger, lettsnacks o.l.)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(dl)	1-2 ☐	3-4 ☐	5-6 ☐	7+ ☐
Peanøtter, andre nøtter (1 pose 100g = 4 never)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	(neve)	1 ☐	2 ☐	3 ☐	4+ ☐

15. KOSTTILSKUDD (bs = barneskje, ts = teskje)

	Hele året	Bare vinter-halvåret	Gang pr. uke: 0	<1	1	2-3	4-5	6-7		Mengde pr. gang			
										1 ts	1 bs	1 ss	
Tran	☐	☐	☐	☐	☐	☐	☐	☐		☐	☐	☐	
										1	2+		
Trankapsler	☐	☐	☐	☐	☐	☐	☐	☐	kapsler	☐	☐		
										1-2	3-4	5-6	7+
Fiskeoljekapsler	☐	☐	☐	☐	☐	☐	☐	☐	kapsler	☐	☐	☐	☐
Multipreparater													
			0	<1	1	2-3	4-5	6-7		1	2	3	4+
Sanasol	☐	☐	☐	☐	☐	☐	☐	☐	bs	☐	☐	☐	☐
Biovit	☐	☐	☐	☐	☐	☐	☐	☐	bs	☐	☐	☐	☐
Vitaplex	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Kostpluss	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Vitamineral	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Annet	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐

Hvis annet, hvilket? .....

Jernpreparater													
			0	<1	1	2-3	4-5	6-7		1	2	3	4+
Ferro C	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Hemofer	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Duroferon Duretter	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Annet	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐

Hvis annet, hvilket? .....

			0	<1	1	2-3	4-5	6-7		1	2	3	4+
B-vitaminer	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
C-vitamin	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
D-vitamin	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
E-vitamin	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Folat (folsyre)	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
			0	<1	1	2-3	4-5	6-7		1	2	3	4+
Kalktabletter	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Fluortabletter	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐
Annet	☐	☐	☐	☐	☐	☐	☐	☐	tablett	☐	☐	☐	☐

Hvis annet, hvilket? .....

16. NÅR SPISER DU PÅ HVERDAGER?

HOVEDMÅLTIDER som frokost, formiddagsmat, middag, kvelds.

Omtrent klokken

6		8		10		12		14		16		18		20		22		24		2		4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

MELLOMMÅLTIDER som kaffe, frukt, godteri, snacks m.v.

Omtrent klokken

6		8		10		12		14		16		18		20		22		24		2		4
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

17. MENER DU SVARENE I SPØRRESKJEMAET GIR ET BRUKBART BILDE AV KOSTHOLDET DITT?

Ja ☐ Nei ☐

Er det matvarer/produkter du regelmessig bruker, og som ikke er nevnt i skjemaet?

.....

.....

18. ER DU FORNØYD MED KROPPSVEKTEN DIN SLIK DEN ER NÅ?

- ☐ Ja
- ☐ Nei, jeg ønsker å slanke meg
- ☐ Nei, jeg ønsker å legge på meg

19. KJØNN

Mann ☐ Kvinne ☐

Vennligst se etter at du har svart på alle spørsmål.

Takk for innsatsen!