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The Nordic diet – possible health effects and approaches to the different food indexes

A Literature Study

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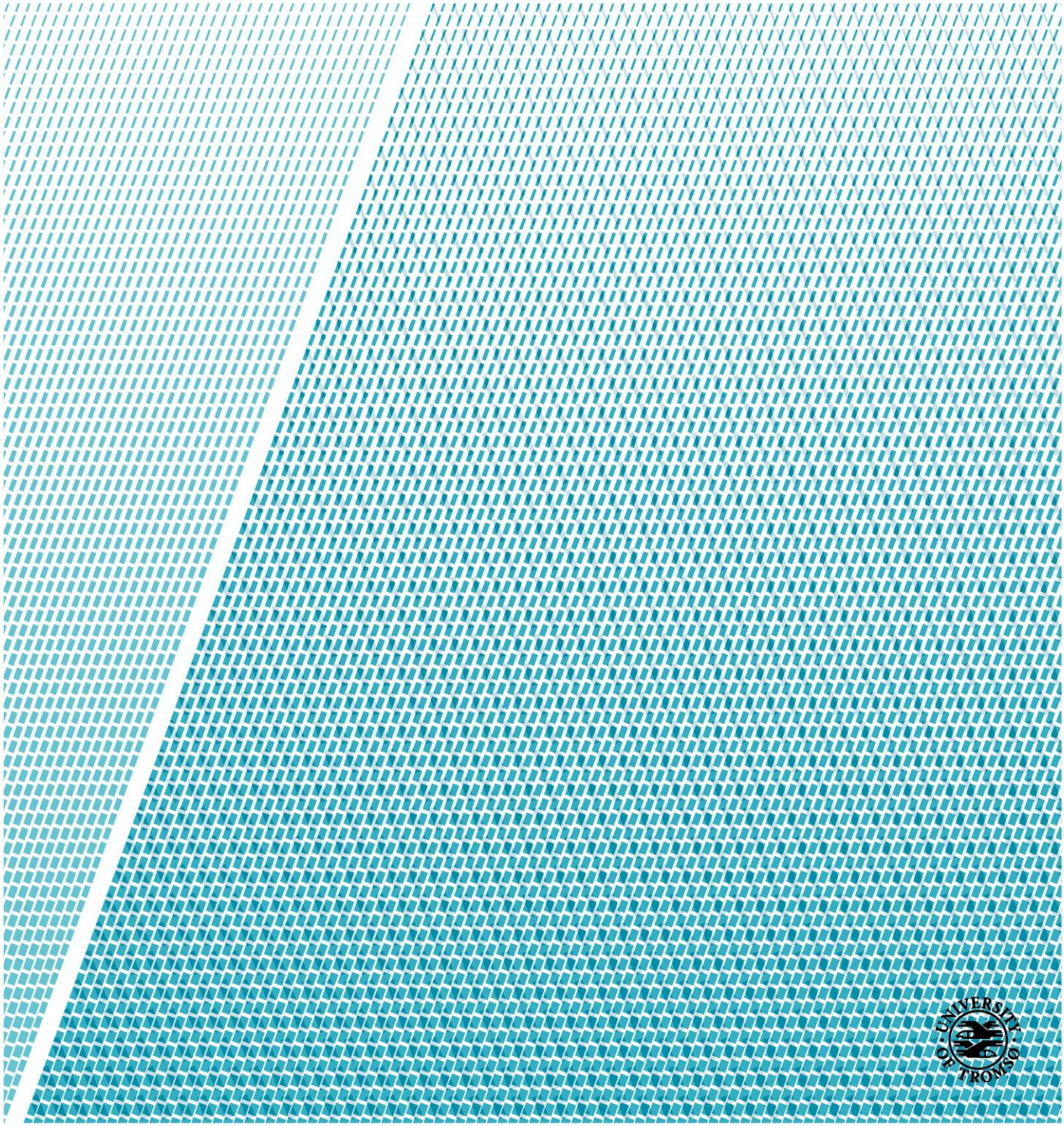

Preface

I was given the opportunity to write a master's thesis on the Nordic diets and its relation to health. This topic resonated well with me because of my background as a dietician, and it also spurred an interest to get an in-depth knowledge of the possible health effects of the Nordic diet, and understand how the Nordic diet relates to the different food indexes.

The creation of the first of the Nordic food indexes, the healthy Nordic food index, was published in 2012 and a number of evidence based research have in the following years been published looking at various aspects of the Nordic diet in relation to health. This research have as a result spurred the creation of several other food indexes with origin in the Nordic countries and with Nordic food items as a basis.

I believe that focusing on our daily diet and examining our dietary pattern, the food we eat, for prevention or treatment potential is crucial if we are to stop the increase in deaths from non-communicable diseases. This burden of disease is costing our society, both in terms of health-care costs and costs of premature deaths caused by preventable morbidities.

Knowledge is important and knowing how nutrition influences risks of disease is of vital importance to improve public health.

Acknowledgements

I must thank my supervisors Runa Borgund Barnung and Torill Miriam Enget for their guidance, kind support, insight and knowledge over this past year. They have helped me navigate through this interesting and educational project and their valuable feedback and numerous points on structure have been highly appreciated. Their patience and consideration have made me persist and complete this project.

Last, but not least, I owe my family thanks. Without their help and support this thesis would not have been possible.

Ann-Merethe Nilsen

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Abstract

The World Health Organization has stated that annually 38 million people dies from non-communicable disease, and this number is estimates to rise to 52 million deaths in 2030.

Four non-communicable diseases are responsible for the majority of deaths: cardiovascular disease, cancer, chronic respiratory disease and diabetes.

One possible way to overcome this increasing and preventable challenge to public health is to facilitate a healthy diet with sufficient nutritional value. In the Nordic region efforts have been made to focus on the health impacts of the dietary pattern, issuing guidelines for dietary composition and recommended intake of nutrients which forms the basis for the national dietary recommendations for the Nordic countries. The Nordic nutrition recommendations (NNR) has instigated the creation of food indexes based on local produce of Nordic origin with possible beneficial health effects.

The aim of this thesis is to explore different approaches to the Nordic diet, and the possible health effects of the Nordic diet. To that effect, a literature study was performed with the goal to identify and describe potential health effects of a Nordic diet, and whether comparing results and conclusions on health outcomes based on different food indexes is possible.

Abbreviations

ADD	Average Danish diet
ALA	Alfa-linoleic acid
AMPK	AMP-activated protein kinase
AR	Alkylresorcinol
BSDP	Baltic sea Diet pyramid
BSDS	Baltic sea Diet score
BMI	Body mass index
BMJ	British Medical Journal
BNP	Brutto nasjonalprodukt
CD	Communicable disease
CTS	Cathepsin S
CVD	Cardiovascular disease
CI	Confidence Interval
DALY	Disability-adjusted life years
DASH	Dietary approach to stop hypertension
FFQ	Food frequency questionnaire
FTO	Fat mass and obesity associated protein
GDP	Gross domestic product
GP	General Practitioner
HDL	High density lipoprotein
HNFI	Healthy Nordic Food index
HOMA-IR	Homeostasis model assessment-insulin resistance
ICD	Statistical classification of diseases
LDL	Low density lipoprotein
MDS	Mediterranean diet score
MMR	Mortality rate ratio
MNOK	Million Norwegian kroner
MUFA	Mono-unsaturated fatty acid
NOK	Norwegian kroner
NCD	Non-communicable disease
ND	Nordic diet
NDS	Nordic diet score
NND	New Nordic diet
NNR	Nordic Nutrition Recommendations
OPUS	Optimal well-being, development and health for Danish children through a healthy New Nordic Diet
SCAT	Subcutaneous abdominal adipose tissue
SNP	Single nucleotide polymorphism
SFA	Saturated fatty acids
SFT	Senior Fitness Test
TCF7L2	Transcription factor 7 like 2 gene
TG	Triglycerides
VLDL	Very low density lipoprotein
WHO	World Health Organization

LIST OF CONTENTS

1. Introduction

1.1 Purpose / Rationale

Health, diet and nutrition are closely connected. In order to maintain good health over the course of one's life, a healthy, balanced and nutritious diet is a key factor.

How can nutrition better public health and disease status, possibly on a global level?

In the following, I will underline some of the health issues we are facing today; and outline how global health may possibly improve with better nutrition.

According to the World Health Organization (WHO) report "Global Health Risks" (1), the leading cause of death today in high-income countries is heart disease, stroke, lung cancer, pneumonia and asthma, or bronchitis. In fact, WHO state that 57% of cardiovascular deaths can be linked back to one of the following risk factors: alcohol use, high blood pressure, high body mass index (BMI), high cholesterol, high blood glucose, low fruit and vegetable intake and low physical activity. High blood pressure, which itself is influenced by high BMI, and physical inactivity, is the leading risk factor causing cardiovascular disease (CVD) (1).
Over this last decade there has been a shift in the burden of disease, a shift from the infectious, communicable diseases (CD) over to the chronic, non-communicable diseases (NDC) (2). Four main types of NCDs are causing 82% of deaths from NCDs: CVD (heart attack and stroke), cancer, chronic respiratory disease (chronic obstructed pulmonary disease and asthma) and diabetes (1).

WHO estimates the number of deaths from non-communicable diseases to increase from 38 million in 2012 to 52 million in 2030 (3-4).

Dr. Oleg Chestnov, Assistant Director-General of non-communicable diseases and mental health of the WHO states:

> Non-communicable diseases (NCDs) are one of the major health- and development challenges of the 21st century, in terms of both the human suffering they cause and the harm they inflict on the socio-economic fabric of countries, particularly low- and middle-income countries. No Government can afford to ignore the rising burden of NCDs. In the absence of evidence-based actions, the human, social and economic costs of NCDs will continue to grow and overwhelm the capacity of countries to address them (2).

One way to overcome this growing and preventable public health challenge is to provide and facilitate a nutritious and healthy diet, as an appropriate diet may provide beneficial health outcomes.

Facing this challenge, great efforts are being made in the Nordic regions to create and facilitate a healthy way of eating, which is sustainable, economic and makes use of locally grown produce. To that effect, the Nordic council of ministers have since 1980 issued Nordic nutrition recommendations (NNR); which are guidelines for dietary composition and recommended intake of nutrients forming the national dietary recommendations for the Nordic countries (5).

The NNR dietary guidelines, with its emphasis on dietary patterns, have spurred the creation of several new food indexes with local and healthy produce, which are also sustainable and palatable. Dietary research have in the past focused on single nutrients and their individual health benefit, as several single nutrients have shown to be associated with beneficial health

effects. However, it is a fact that people eat diets consisting of foods, not macronutrients. Therefore, dietary recommendations has a better chance of success if it based on foods and is presented to the public as a dietary pattern [2].

1.2 Research question / objective

The objective of the study is to explore different approaches to the Nordic diet, as well as possible health effects of a Nordic diet pattern. A literature study was conducted aiming to identify and describe potential health effects of a Nordic diet, and to see if it is possible to compare results and conclusions on health outcomes in relevant studies based on different food indexes.

1.3 Thesis composition and structure

This thesis in structured in six chapters, Chapter 1 introduces the reader to the topic and presents the purpose and objective. Chapter 2 gives the theoretical framework with definitions and clarifications, also introducing the idea behind NNR and Nordic diets. Chapter 3 deals with methodology, the search process and selection criteria. Chapter 4 supplies methodological considerations, outlining strengths and limitations of the articles and the project itself. Chapter 5 provides analysis and discusses the results from the articles and Chapter 6 concludes, outlines and recommends further studies on this topic.

2. Theoretical framework

2.1 Definitions and clarifications

In the following passage, I will supply some frequently used definitions of "health", "healthy diet", "New Nordic Diet" (NND), "Healthy Nordic food index" (HNFI) and "Baltic Sea Diet score" (BSDS).

The term "health" give room for many different and subjective interpretations. WHO defined health in 1948: "Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (6).

The definition of health and how to define this concept have been issue of debate and a new definition is proposed in British Medical Journal (BMJ) as; "the ability to adapt and self-manage in the face of social, physical, and emotional challenges". This is of interest because health is the goal of healthcare and health research and we need to know what it looks like and how to measure it (7).

The term "healthy diet" can have many interpretations. WHO's definition of a healthy diet is: fruits, vegetables, legumes (e.g. lentils, beans), nuts and whole grains (e.g. unprocessed maize, millet, oats, wheat, brown rice). WHO also recommends reduced intake of salt, sugar and fat (8).

"Healthy Nordic food index" (HNFI) is based on foods from Nordic nature which were commonly consumed in the Nordic region [9]. This index was created by Olsen et al. [9] in

2011 and consisted of 6 different food groups: rye bread, oatmeal, apples/pears, root vegetables, cabbages and fish/shellfish.

"New Nordic diet" (NND) was introduced by Mithrill et al. (9) in 2012 and was a diet characterized by a high content of fruits and vegetables, all from the Nordic nature. This Nordic diet consisted of 15 food groups: berries, cabbages, root vegetables and legumes, fresh herbs, potatoes, plants and mushrooms, whole grains, nuts, fish, shellfish, seaweed, free-range livestock, pigs, poultry and game.

"The Baltic Sea Diet score" (BSDS) was created by Kanerva et al. [11] in 2013 by using the Baltic Sea Diet pyramid (BSDP), which was a tool made by the Finnish Heart Association and the Finnish Diabetes Association in collaboration with the SYSDIET study of the University of Eastern Finland. This diet score was meant to illustrate the healthy dietary choices available in the Nordic region.

The Baltic Sea Diet score consist of 9 variables: 6 food groups and 3 nutrients. The 6 food groups include fruit and berries (apples, pears, bilberries and lingonberries), vegetables (lettuce, tomatoes, cucumber, cabbages, legumes and roots – not potatoes), cereals (rye, oats and barley), low fat milk (fat-free and with fat content below 2%), fish (Baltic herring, mackerel and salmon) and meat (pork, beef, processed meats and sausages) [11]. Meat is considered as a negative component of the diet.

2.2 Health promotion and costs

There has been a global and dramatic increase in the incidence of obesity and overweight over the last 60 years (1). Today, the fact is that the major determinants of the burden of disease are related to our diet (1). Upholding an unhealthy diet is a serious health risk, and an

inappropriate diet also proves to be a burden on the environment (10), I will elaborate on both issues in the following.

The overall burden of disease is measurement of years lost by disability, ill health or early death and is called disability-adjusted life years (DALY). In Jensen et al.'s Danish study (10) it is calculated that the shift from an average Danish diet (ADD) to the New Nordic diet (NND) has an effect on the burden of disease by saving 18.000 (DALY) per year in Denmark from the non-communicable diseases; CVD, diabetes, stroke, stomach- breast- and lung cancers.

I will use Norway and Norwegian statistics as an example to illustrate what this health challenge is costing a typical developed, high-income country: In 2015, the annual expenditure on health In Norway was 9.9% of the gross domestic product (GDP) (11). The total expenditure on health was 311 MNOK, and amounted to NOK 60.000 per capita, up NOK 3.000 from 2014. Medical treatment and rehabilitation services consumed 50% of the total expenditures on health. In Norway, the health care system is funded mainly through public sources, central and local government and the National Insurance Scheme, who accounted for 85% of the total health expenditures (12). The remaining 15% is privately financed and are household's out-of-pocket payment for pharmaceuticals and co-payment for visits to the General Practitioner (GP).

According to the health statistics from Statistics Norway from 2012 (13), 22% of the adult Norwegian population aged between 45 and 66, approximately 600.000 men and women, reported having health-related issues stemming from CVD. CVD is linked to smoking habits, obesity and inactivity and affects the population above the age of 40 (13). This increase in

cardiovascular disease and other life-style related diseases is burdening our health care system, and at the same time taking years away from the adult population. Implementation of the Nordic diets has the potential of saving costs by addressing the life style related expenditures burdening our health care system, thereby contributing to a healthier population. Other beneficial effects of implementing a regional diet are that Nordic diets contributes to upholding a Nordic identity, is sustainable and environmental friendly.

2.3 NNR

NNR are the overall national nutrition recommendations, jointly developed by the Nordic Council of Ministers. According to NNR: "New Nordic Food stresses the importance of using locally grown food stuff, preferably while it is in season, and puts an emphasis on organically grown and none-genetically manipulated foods" (14-15).

To that effect, the New Nordic food manifesto was formulated, summarizing a 10-point goal focusing on health, ethical production and the use of traditional foods. http://www.norden.org/en/theme/ny-nordisk-mad/the-new-nordic-food-manifesto. However, keep in mind that this new Nordic kitchen and the Nordic Council of Minister's use of the term "new Nordic food" must not be confused with the scientific term used in the following; the healthy Nordic food index, though they both have the same grounds of origin.
NNR gives recommendations for total intake of nutrients and they are the guideline for dietary composition and recommendations in the Nordic countries. In this current 2012-edition of NNR, the features of a healthy dietary pattern is set out as; plenty of vegetables, fruit, berries, pulses, fish, vegetable oils, wholegrain, low-fat alternatives of dairy and meat; little red and processed meat, sugar, salt and alcohol, guidelines true to the Nordic perspective (16-17).

Recognizing that it is not just a matter of limiting and recommending the intake of nutrients: fat, carbohydrates, dietary fibre, protein and added sugar, NNR also sets guidelines for physical activity in order to prevent lifestyle related diseases (16-17).

These recommendations have been published every 8th year since 1980. The current NNR 2012 is the 5th updated edition. It is noteworthy that this edition of NNR is available also in English, whereas the previous editions prior to 1996 have only been published in Swedish. This change in accessibility is a reflection recognizing that scientific recommendations for nutrition should not only be limited to the Nordic region, but could and should impact decision makers and experts in other parts of the wold (16-17).

2.4 Nordic Diets

The idea of the healthy Nordic food index (HNFI) [9] was developed and published in an article in 2011 by Olsen et al. [9], as an attempt to promote and improve public health by creating a food index based on traditional Nordic food items with expected health-promoting effects. The components of this diet is previously stated in section 2.1.

The health promoting effects of the Mediterranean diet had been known for decades, and the idea of Olsen et al. [9] was to develop an index consisting of traditional Nordic food items with possible health-promoting effects to see if a diet with traditional Nordic foods could have similar beneficial health effects. It is a well-known fact, as stated in the article; "that knowledge about a healthy lifestyle is not necessarily followed by appropriate dietary changes" [9]. The hope of the authors was that if a healthy Nordic food index was invented and implemented, several barriers preventing a healthy diet could be overcome – barriers like: cultural differences in taste and difficulties in fundamentally changing one's diet.

The dietary concept New Nordic Diet (NND) grew out of a collaboration between the OPUS project and the gourmet restaurant NOMA in Copenhagen in 2012 [4] (9). NND is based on regional and seasonal foods, stressing the importance of palatability (9), sustainability and health and aims to implement a diet that are in keeping with regional food culture and dietary habits. All dietary components included have health promoting properties, are of Nordic origin, are environmentally sustainable and have gastronomic potential (9). It is underlined by Mithrill et al. (9) that NND is a regular diet for normal weight people, and is not designed to be a weight loss diet (9). The dietary components of the NND are listed in section 2.1.

Working along the same lines, to promote better health in the Baltic regions, the Finnish Heart association, the University of Eastern Finland and the Finnish Diabetes association collaborated on creating a Baltic Sea Diet Pyramid in 2011 [11]. This pyramid acted as template for the new Baltic Sea diet score issued in 2012. The components of this diet are listed in section 2.1.

As mentioned above, the Nordic governments summarised the 10-point kitchen manifesto to emphasize; purity, season, ethics, health, sustainability, to put Nordic food on the gastronomic map and to raise awareness of the Nordic cuisine worldwide (15). With this in mind, it could be argued that the NNR and philosophy behind it has served as a direct inspiration behind the scientific work of Olsen et al. and others in the creation of the healthy Nordic food index (HNFI), the new Nordic diet (NND) and the Baltic Sea Diet score (BSDS).

2.5 Use of dietary indexes and patterns in Nordic diet research

The use of dietary indexes in diet research has introduced parameters that has made it possible to compare results between studies on diet. As mentioned in the introduction, people eat meals consisting of a variety of foods, not single nutrients. In order to capture the variety, pattern, quality and quantity of a person's diet the dietary index is a measurement of behaviour, as a dietary index measures the overall diet quality. As stated by Kanerva et al. (18), the value of eaten foods can be summed up in a dietary score and a predefined, healthy diet can then be measured by the score. The score of the diet indicates how healthy the diet is; i.e. high score equals healthy diet, low score equals less healthy diet. The dietary score has the ability of assessing multiple effects and interactions within the diet, making the effects on health more detectable, which is an advantage.

Nordic diet research uses both dietary indexes and dietary patterns; dietary patterns like the NNR and NND are based on recommending single nutrients, as a matter of fact the NND was developed based on the recommendations of the NNR 2004 [4]. The HNFI and BSDS are indexes created and designed to assess a dietary pattern and possibly detect the relationship between the diet and the risk of developing chronic diseases, diseases like NCDs.

3. Methodology

This thesis will be a literature study aiming to identify the health effects of a Nordic dietary pattern, and to see if it is possible to compare results and conclusions on health outcomes in relevant studies based on different food indexes.

3.1 Literature search

3.1.1 Search words

MEDLINE, EMBASE and PUBMED bases were searched between September 28 and September 30, with the following key words; Nordic diet, food habits, diet* pattern, diet* score*, healthy eating index, food index, healthy Nordic food index, Nordic diet, new Nordic diet, healthy Nordic diet, Nordic diet* score.

EMBASE	26 results	(nordic diet OR food habits OR diet* pattern* OR diet* score* OR healthy eating index OR food index OR healthy nordic food index) AND (nordic diet OR new nordic diet OR healthy nordic diet OR nordic diet* score)
MEDLINE	28 results	(nordic diet OR food habits OR diet* pattern* OR diet* score* OR healthy eating index OR food index OR healthy nordic food index) AND (nordic diet OR new nordic diet OR healthy nordic diet OR nordic diet* score)
PUBMED	37 results	(nordic diet OR food habits OR diet* pattern* OR diet* score* OR healthy eating index OR food index OR healthy nordic food index) AND (nordic diet OR new nordic diet OR healthy nordic diet OR nordic diet* score)

3.1.2 Selection criteria

I used different selection criteria. Several limits were put in place, removing duplicates, conference notes and articles reviewing children, pregnant or breastfeeding women, or study subjects with diabetes, metabolic syndrome or hyper-cholesterolaemi. The main subject or this thesis were to look at possible health outcomes for healthy adult and middle-aged population, and as the health outcomes has a slow onset, studies with children were excluded. The articles had to be available in full-text to be included. Further, no reviews or meta-analysis were included, as the objective is to compare results and conclusions from individual studies. Studies included had an age range of; 19-45+ years (MEDLINE) or 18-65+ years (EMBASE) and 19+ years (PUBMED). Articles without a specific health outcome were excluded. Health outcome being hypertension, increased body weight or obesity, diabetes 2, cancers, cardiovascular disease, cognition and physical performance.

The search in EMBASE yielded 26 results. The MEDLINE search yielded 28 results. When putting into effect with the same filters, limits and inclusion/exclusion factors as above, 15 articles were left to review. Searching PUBMED yielded 37 results, the same exclusion factors as mentioned above were put into place, and this left 4 articles to review. The EMBASE and PUBMED articles were also found in MEDLINE, and the list of articles will therefore identify the searched database as MEDLINE. All 15 articles are discussed further in chapter 5.

3.2 Materials

Articles, notes and supporting or disproving evidence were obtained from a number of sources: web-sites, MEDLINE database or from public reports.

All articles used are current and from 2011-2016.

4. Methodological considerations

4.1 Strengths and limitations

4.1.1 Strengths and limitations of the included articles

Roswall et al.: Adherence to the healthy Nordic food index and total and cause-specific mortality among Swedish women [1]

Strengths	Limitations
Random sampling of cohort Large number of incident deaths Near complete follow-up Long follow-up of 21.3 y Detailed information on intake of dietary items and confounding variables	Assessment of dietary intake at only one time-point FFQ not developed at the time to capture the HNFI Low participation rate

Roswall et al.: Association between Mediterranean and Nordic diet scores and changes in weight and waist circumference; influence of FTO and TCF7L2 loci [2]

Strengths	Limitations
Country-specific, standardized FFQ at baseline Written informed consent Follow-up of 6.8 y The use of random-effects model meta-analysis across cohorts Prospective design eliminates risk of recall bias Long follow up minimized risk of selective drop-outs	Assessment of dietary intake at only one time-point which excluded changes in dietary habits during follow-up MDS incl. 9 components characteristics, whereas NDS incl. 5 components, difference hampers the comparability of the two Possible information bias, due to self-reporting of anthropometric measures

Jobs et al.: Influence of a prudent diet on circulating cathepsin S in humans [3]

Strengths	Limitations
Randomized controlled design Recruitment by advertisement Written, informed consent by all Controlled diet to participants, High compliance and low drop-out rate	Measuring methods different between studies, possible bias Small study sample with possible lack of statistical power Possible differences between study group and control group, physical activity and smoking not assessed Study subjects from only one ethnic group, and generalizability to other ethnic groups unclear

Poulsen et al.: Health effect of the new Nordic diet in adults with increased waist circumference: a 6-month randomized controlled trial [4]

Strengths	Limitations
Block randomization stratified from BMI Free living situation, cookbook and menu plan provided to participants Highly controlled dietary intake Close verification of food intakes by biological markers, shop database food entry and 3 d weighted dietary records High degree of satisfaction and compliance to the NND	Costly diet Availability of food items Time consuming preparation of food

Lacoppidan et al.: Adherence to a Healthy Nordic food index is associated with a lower risk of type-2 diabetes – The Danish diet, cancer and Health cohort study [5]

Strengths	Limitations
Prospective design Large number of cases Detailed information on confounding factors Validated FFQ Long follow-up of 15 y median	Measurement errors possible Individuals only assessed at baseline Limited FFQ, not allowing for alternative food items Possible residual confounding

Roswall et al.: No association between adherence to the healthy Nordic food index and cardiovascular disease among Swedish women: a cohort study [6]

Strengths	Limitations
Large number of cases Almost complete follow-up Detailed information on intake of dietary items Detailed information on potentially confounding variables	Assessment of dietary intake at one point only Limitations in the FFQ, deficient estimation of some categories Possible residual confounding Findings may not be applicable to men, as the pathophysiology of the heart differs between men and women

Roswall et al.: No association between adherence to a healthy Nordic food index and colorectal cancer: Results from a Swedish cohort study [7]

Strengths	Limitations
Almost complete follow-up Detailed information on intake of dietary items Adjustments for possible confounding factors	Modest statistical power Assessment of dietary intake at one point only

Li et al.: Adherence to a healthy Nordic food index and breast cancer risk: results from a Swedish cohort study [8]

Strengths	Limitations
Prospective design Detailed information on intake of dietary items Adjustment for potential confounding variables Almost complete follow-up	Assessment of diet only at baseline Limitations in the FFQ used, not allowing for alternative food items

Olsen et al.: Healthy aspects of the Nordic diet are related to lower total mortality [9]

Strengths	Limitations
Prospective design Large number of cases Detailed information on confounding factors Near complete follow-up	Exposure assessment due to limitations in the FFQ and long follow-up, diet was only assessed once and may have changed during the trial period Residual confounding caused by participants with a generally healthy lifestyle providing a high index score Even though the cohort is population based, results may not be applicable to the entire population as participants may have a higher socioeconomic status than non-responders

Kyrø et al.: Adherence to a healthy Nordic food index is associated with a lower incidence of colorectal cancer in women: The diet, cancer and health cohort study [10]

Strengths	Limitations
Prospective design Large number of cases Long follow-up, 13 y median, with a minimal loss Detailed information on potential confounding factors	Assessment of diet from a single FFQ at baseline only Limitations in the FFQ, not capturing intake of traditional Nordic food items, such as berries and rape seed oil

Kanerva et al.: Adherence to the Baltic sea diet consumed in the Nordic countries is associated with lower abdominal obesity [11]

Strengths	Limitations
Validated FFQ Large and representative sample Participation rate at acceptable level	The FFQ may have influenced the exposure assessment as diet was measured over the last 12 months, while obesity is accumulated over longer time Cross-sectional design do not allow for information on prior weight and eating pattern Possible under-reporting Possible nutritional confounding due to correlations with the intake of various dietary factors and existing nutrients The health conscious are more likely to participate in health surveys, which may have influenced the result

Poulsen et al.: Long-term adherence to the New Nordic diet and the effects on body weight, anthropometry and blood pressure: a 12-month follow-up study [12]

Strengths	Limitations
52 week follow-up Very high dietary compliance and satisfaction with the NND Food items provided free of charge in intervention Controlled setting	Unvalidated FFQ scores rated by the participants and therefore affected by their perception FFQ asked twice during follow-up, not showing possible changes in compliance Costly diet, participants had to buy their own food during follow-up Low accessibility of food items

Fritzen et al.: New Nordic diet-induced weight loss is accompanied by changes in metabolism and AMPK signalling in adipose tissue [13]

Strengths	Limitations
No mention	No mention

Männikkö et al.: The Nordic diet and cognition – the DR's EXTRA study [14]

Strengths	Limitations
Large study sample Food record filled in when food is consumed Low drop-out rate Follow-up of 4 y	Underreporting in food record Adjustment for possible confounding factors only done at baseline Cognitive function assessed only at end of intervention Impossible to assess the impact of contents of food groups, as they were estimated by a software

Perälä et al.: A healthy Nordic diet and physical performance in old age: findings from the longitudinal Helsinki birth cohort study [15]

Strengths	Limitations
Large study population Long follow-up of 10 y Measure of overall physical performance by SFT (Senior Fitness Test)	Diet assessed by FFQ and overestimation of healthy food consumption and under-reporting of intake of unhealthy food cannot be ruled out Residual confounding factors cannot be excluded, higher adherence to the NDS is connected to higher socio economic status and higher physical activity Study subjects from ethnically and culturally homogeneous population which limits the generalisability of results Possible lack in statistical power – more women than men in the study

4.1.2 Strengths and limitations of this project

This literature review with its synthesis of scientific articles has proven to be an interesting project on a current topic. The healthy Nordic diet was published 5 years ago and in the years following the publication of the article by Olsen et al. [9], a number of scientific articles have emerged, examining the effects of Nordic diets or Nordic dietary patterns on health.

Since health is best measured over time, and due to the slow onset of chronic diseases, the study design most suited to measure health effects is the longitudinal cohort. Hence, the longitudinal, prospective cohort is represented with the majority of studies in this project. Furthermore, a number of prospective and longitudinal cohort designs examining various health effects and Nordic diet have been published, which is a strength to this project. Projects may be limited by the quality of and number of published articles. However, in this project both the quality and the scope of published articles on the subject were deemed sufficient by the author and acted as a strength, not as a limitation. However, a possible limitation in this project are the food frequency questionnaires (FFQs) used in the different studies. It is pointed out in a majority of the studies that the FFQs may have caused limitations; by not capturing the exact intake of food items, not allowing for alternative food items or allowing for deficient estimation of food items. These limitations must be addressed before replicating findings in future articles.

5. Analysis and discussion of results

5.1 Introduction to study designs

A total of 15 articles have been selected for review. The studies have different designs: prospective cohort studies, case-cohorts, cross-sectional studies and randomized control trials (RCT's). The ranking order of the evidence is illustrated in Figure 1. below, which is a model of the evidence hierarchy. Section 5 will give a brief summary of the different designs, starting with the highest level of evidence. In section 5.1.1, I will proceed with a list of the selected articles. In section 5.2, I will outline the different approaches to Nordic diet, and section 5.3 provides a discussion of the various health outcomes.

4 of the 15 articles were RCT's [3],[4],[12],[13]. This study design is considered to be the gold standard in clinical research. The study subjects were randomly allocated to either treatment or no-treatment group. Treatment group followed different types of Nordic diets and no-treatment group adhered to a regular diet. Since the diets consisted of different foods, blinding was not possible.

A majority of the studies used in this thesis were prospective cohort studies, 8 of the 15 studies [1],[5],[6],[7],[8],[9],[10] and [15]. This design is used in research of disease and disorders, where a large and healthy study population is followed over time, to determine if and when disease occur and whether exposure has any outcomes - as in this instance – exposure to the Nordic diet and a wide range of health outcomes.

There was one case/control study [2], which is an observational study where a group with disease is compared to a healthy group. In this article the cohort consisted of the group with the greatest amount of unexplained weight gain, compared with non-cases.

Two cross-sectional studies analysed data at a specific point in time for a given selection of the population [11] and [14]. The studies in question looked at Nordic diet and cognition and Nordic diet and abdominal obesity. One [14] of the two studies had a longitudinal design.

The possible health effects and ways of comparing results and conclusions between the different studies are questions that can best be answered through the design of the prospective cohort study. Cohorts have a large study population and longitudinal design, which leaves multiple outcomes to be considered on the basis of one cohort. Thus, this design is represented with the 8 studies in this thesis, which represents the majority of included studies.

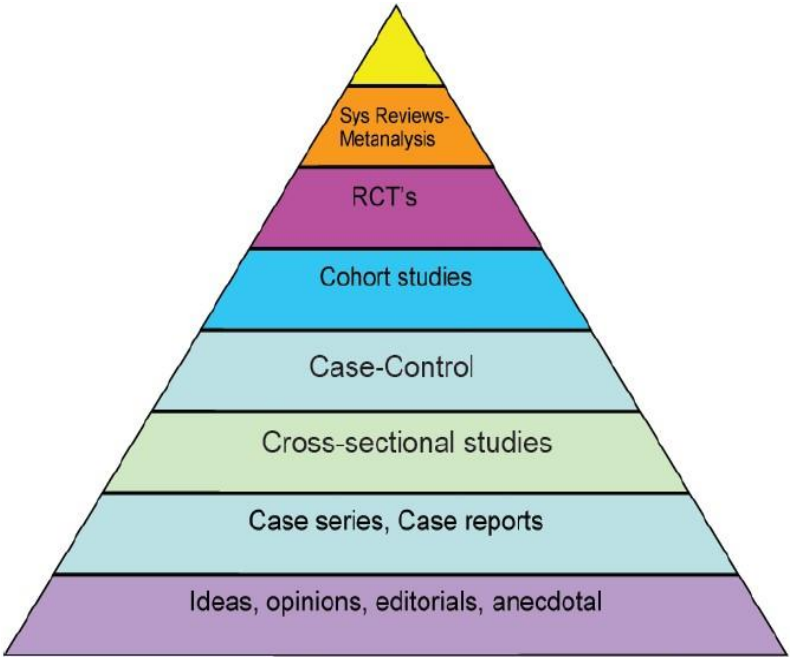

Figure 1. The hierachy of evidence.

Source:http://clinicalstudiestoday.blogspot.no/2010/09/hierarchy-evidence-clinical-studies.ht

5.1.1 Summary of the selected articles

Database	Study	Study design	Participants	Outcome and Result
Medline	Adherence to the healthy Nordic food index and total and cause-specific mortality among Swedish women. Roswall N et al. [1]	Prospective cohort study	44,961 women aged 29-49 years, participants of the Swedish Women's Lifestyle and Health (WLH) cohort	Adherence to a healthy Nordic food index and association to overall mortality and death by CVD, cancer, injuries/suicide and other causes. Found a lower overall mortality with higher adherence to a healthy Nordic food index.
Medline	Association between Mediterranean and Nordic diet scores and changes in weight and waist circumference: influence of FTO and TCF7L2 loci. Roswall N et al. [2]	Case-control study	11,048 men and women from 5 European countries From the EPIC cohort	Whether adherence to the Nordic diet hold similar beneficial effect as the Mediterranean diet score, considering both diet and genetics. A high MDS diet score is associated with a lower waist circumference and BMI, regardless of risk alleles FTO and TCF7L2. Adherence to the NDS was not associated with anthropometric changes during follow-up.
Medline	Influence of a prudent diet on circulating cathepsin S in humans. Jobs et al. [3]	Exploratory analysis of a randomized study (RCT)	88 men and women aged 25-65 years from Sweden Part of the NORDIET-trial	The aim is to investigate the effect of a prudent Nordic diet *ad libitum* on plasma cathepsin S in healthy individuals and whether changes in concentrations of cathepsin S are linked to cardiometabolic risk factors. Compared with a habitual control diet, a healthy Nordic diet decreased the cathepsin S levels in healthy individuals, possibly mediated by weight loss and/or lowered LDL-C.
Medline	Health effect of the New Nordic Diet in adults with increased waist circumference: a 6-mo randomized controlled trial. Poulsen et al. [4]	Randomized control study (RCT)	181 obese men and women aged 20-66 years	To test the health effect of the new Nordic diet in a controlled but free living setting. An *ad libitum* NND produces weight loss and blood pressure reduction in centrally obese individuals.
Medline	Adherence to a Healthy Nordic food index is associated with a lower risk of type-2 diabetes – the Danish diet, cancer and health cohort study Lacoppidan et al. [5]	Prospective cohort study	55,060 Danish men and women aged 50-64 years participating in the DCH cohort	To investigate the association between a healthy regional Nordic diet and the risk of type 2 diabetes. When adjusted for potential confounders, it was found that greater adherence to the healthy Nordic food index was significantly associated with a lower risk of type 2 diabetes for both men and women.

Medline	No association between adherence to the healthy Nordic food index and cardiovascular disease amongst Swedish women: a cohort study. Roswall et al. [6]	Prospective cohort study	43,310 women aged 29-49 years from the Swedish Women's Lifestyle and Health WLH cohort	To investigate the association between a healthy Nordic diet and clinical diagnosis of CVD. No association was found between the healthy Nordic food index and overall risk of developing CVD.
Medline	No association between adherence to a healthy Nordic food index and colorectal cancer: Results from a Swedish cohort study. Roswall et al. [7]	Prospective cohort study	45,222 women aged 29-49 at baseline from the WLH cohort	To investigate whether there is an association between the HNFI and colorectal cancer. No association found between adhering to a healthy Nordic food index and colorectal cancer.
Medline	Adherence to a healthy Nordic food index and breast cancer risk: Results from a Swedish cohort study Li et al. [8]	Prospective cohort study	44,296 women aged 29-49 years in the WLH cohort	To assess the association between HNFI and risk of breast cancer; overall; by menopausal- and hormone receptor status. No association found between adherence to HNFI and breast cancer risk, or any association with breast cancer incidence found regardless of menopausal status or hormone receptor status.
Medline	Healthy aspects of the Nordic diet are related to a lower total mortality. Olsen et al. [9]	Prospective cohort study	57,053 Danish men and women aged 50-64 at baseline in the Danish The Diet, cancer and health (DCH) cohort	To develop a food index based on traditional Nordic food items with expected health promoting effects, and evaluate the possible effect on all-cause mortality. When the 6 components of the food index were evaluated separately, whole grain rye bread was associated with lower mortality in men. Among middle-aged Danes an index of traditional healthy Nordic foods relates to lower mortality, among men in particular.
Medline	Adherence to a healthy Nordic food index is associated with a lower incidence of colorectal cancer in women: the Diet, Cancer and health cohort study. Kyrø et al. [10]	Prospective cohort study	57,053 Danish men and women aged 50-64 at baseline in the Danish The Diet, cancer and health (DCH) cohort	To determine whether a healthy Nordic food index could be related to the incidence of colorectal cancer. A strong adherence to this Nordic food index was associated with a 35% lower incidence of colorectal cancer in women, compared to women with poor adherence. For men a similar tendency was found.

Medline	Adherence to the Baltic sea diet consumed in the Nordic countries is associated with lower abdominal obesity. Kanerva et al. [11]	Population based cross-sectional study	4,720 Finnish men and women aged 25-74 years at baseline	To assess whether the Baltic sea diet score based on the Baltic sea diet pyramid is associated with a decrease in risk of obesity and abdominal obesity. The study suggests an inverse association with abdominal obesity and Nordic foods, in particular cereals and alcohol, with a stronger association in younger age groups, compared with older age groups.
Medline	Long-term adherence to the New Nordic diet and the effects on body weight, anthropometry and blood pressure: a 12 mo follow-up study. Poulsen et al. [12]	26-week controlled intervention study with a 52-week follow-up (RCT)	147 Danish participants with a mean age of 43 years of which 110 completed the follow-up study (75%)	To assess whether the health effects, high compliance and satisfaction to the New Nordic Diet can be maintained after the active intervention has ended. The study shows that high satisfaction is associated with the New Nordic diet. High compliance and increased physical activity is associated with reduced body weigh regain.
Medline	New Nordic diet – induced weight loss is accompanied by changes in metabolism and AMPK signalling in adipose tissue. Fritzen et al. [13]	26 week controlled intervention study (RCT)	64 moderately obese men and women aged 20-66 at baseline	Whether expression of proteins in skeletal muscles or adipose tissue could explain improvements in glucose and lipid homeostasis following the weight loss. An improvement of metabolic capacity in adipose tissue after weight loss, possibly caused by AMPK.
Medline	The Nordic diet and cognition – the DR's extra study. Männikkö et al. [14]	Population based cross sectional study	1,140 men and women aged 57-78 at baseline	The association between the Nordic diet and cognitive function at baseline and after a 4-year random, population based follow-up. The Nordic diet might be associated with a positive cognitive effect in individuals with normal cognition.
Medline	A healthy Nordic diet and physical performance in old age: findings from the longitudinal Helsinki Birth cohort study. Perälä et al. [15]	Prospective cohort study	1,072 participants from the Helsinki Birth Cohort study at the mean age of 61 years and follow-up at 71 years	To assess whether adherence to a healthy Nordic diet could be associated with better physical performance, and follow-up 10 years later. A healthy Nordic diet was among women associated with a better overall physical performance, no association was observed in men.

5.2 Different approaches to the Nordic diet in the articles

The 15 included articles used 4 different approaches to Nordic diet; NNR, HNFI, NND and BSDS.

5.2.1 Nordic Nutrition Recommendations (NNR)

Nordic Nutrition Recommendations (NNR) are referred to in 2 articles: [3] and [14].

Jobs et al. [3] refers to the Nordic diet consisting of foods originating from and commonly used in the Nordic countries; NNR 2004 consisting of fruits (apples), berries (blueberries), legumes, vegetables, low fat dairy products, fatty fish (salmon) and barley, almonds and psyllium seeds.

Männikkö et al. [14] took use of NNR 2012, based on a traditional Nordic diet on a high consumption of vegetables, fruit and berries, fish and wholegrain products, (rye, oats and barley). This diet allows for low-to-moderate consumption of meat and alcohol. Rapeseed oil is the recommended fat source. Männikkö et al. [14] notes that their Nordic diet score is a modification of the diet score used by Kanerva et al. [11].

While Kanerva et al. used a (BSDS) diet with 9 components, Männikkö et al. was, due to limitations in data, availability of produce or as an attempt to redefine the score quality, only able to measure 8 variables; excluding milk products and excluding the total fat intake. Further, the data for rapeseed oil was unavailable, and data for alfa-linoleic acid (ALA) acted as a surrogate. Although Männikkö et al. used an adjusted BSDS, the initial reference was the NNR 2012, and thus, the article is referred to under sections 5.2.1 and 5.2.4.

5.2.2 Healthy Nordic Food index (HNFI)

The healthy Nordic food index is referenced in 8 articles: [1], [2], [5], [6], [7], [8], [9] and [10].

I will start with Olsen et al.'s [9] original index, since this article is the reference for the HNFI: Olsen et al.'s [9] original index with 6 food items: whole grain rye (as rye bread), whole grain oats (oatmeal), apples/pears, root vegetables and fish.

Roswall et al. [1] included 6 food items: rye bread, oatmeal, apples/pears, cabbages, root vegetable and fish/shellfish. The following adjustment was made: wholegrain bread substituted rye bread.

Roswall et al. [2] included 5 food items: rye bread, apples/pears, cabbages, root vegetables and fish/shellfish. The following adjustment was made: oatmeal was excluded.

Lacoppidan et al. [5] included 6 food items: rye bread, oatmeal, apples/pears, cabbages, root vegetables and fish.

Roswall et al. [6] included 6 food items: rye bread, oatmeal, apples/pears, cabbages, root vegetables and fish/shellfish. The following adjustment was made: wholegrain bread substituted rye bread.

Roswall et al. [7] included 6 food items: whole grain bread, oatmeal, apples/pears, cabbages, root vegetables and fish.

Li et al. [8] included 6 food items: whole grain bread, oatmeal, apples/pears, cabbages, root vegetables and fish/shellfish.

Kyrø et al. [10] included 6 food items: rye bread, oatmeal, apples/pears, cabbages, root vegetables and fish.

The original HNFI was referenced in 5 articles, [5], [7], [8], [9] and [10]. In 3 articles minor adjustments were made regarding wholegrain. 2 articles used wholegrain bread instead of rye bread [1] and [6], and 1 article excluded oatmeal [2].

5.2.3 New Nordic Diet (NND)

The New Nordic diet (NND) is referenced in 3 articles: [4], [12] and [13].

All 3 studies uses the exact same NND based on 15 food groups: fruit and vegetables (berries, cabbages, root vegetables and legumes), potatoes, fresh herbs, plants and mushrooms from the wild, nuts, whole grains, meat from livestock and game, fish and shellfish and seaweed.

5.2.4 Baltic Sea Diet score (BSDS)

The Baltic Sea diet score is referred to in 3 articles: [11], [14] and [15].

Kanerva et al.'s [11] BSDS consist of 9 components – 6 food groups and 3 nutrients; apples, berries, roots and cabbages, rye, oats and barley, low fat milk products, rapeseed oil and fatty fish; the diet is also low in red and processed meats and alcohol.

Männikkö et al. [14] adjusted Kanerva et al.'s score and used a modified 8-component diet based on the BSDS; fish, vegetables, fruit and berries, whole grain bread, meat, alcohol and

alfa-linoleic acid. The original BSDS score here modifies for the following; no milk products were included, total fat intake excluded and the intake of alfa-linoleic acid (ALA) substituted rapeseed oil. [14]

Perälä et al. [15] used a 9-component Baltic Sea Diet score. Article [11] and [15] refers to identical Baltic Sea Diet score, while article [14] modifies the original BSDS score.

5.3 Mortality and Nordic Diet

Mortality as a health outcome was investigated in articles [1] and [9].

Roswall et al. [1] found a lower overall mortality with higher adherence to a healthy Nordic food index. The diet components were examined individually; Roswall et al. [1] found that only wholegrain bread and apples/pears were significantly inversely associated with all-cause mortality. Wholegrain bread above vs below median intake; Mortality rate ratio (MRR) 0.83 (0.76-0.92) and apples/pears above vs below median intake MRR 0.88 (0.79-0.97). MRR meaning the ratio of observed deaths below median in the cohort.

Roswall et al. [1] categorised in 3 groups according to HNFI index score: 0-1 points, 2-3 points and 4-6 points. A 1-point increment in the Healthy Nordic food index was significantly associated with a 6% lower risk of all-cause mortality. The study found a significant, inverse association with “other causes of death”. Available literature suggests an association between wholegrain intake and non-cancer, non-cardiovascular deaths and an inverse association with death due to respiratory diseases (19). According to Roswall et al. [1], wholegrain is the component showing the strongest individual association with mortality, suggesting that the HNFI is effective through a diet-mediated pathway on mortality from other causes, rather than

an effect not mediated by diet. This study found no association with death due to injury/suicide, inversely linked to status and not to dietary factors. Roswall et al. [1] points to the fact that the similar magnitude of effect of the Nordic and Mediterranean diets indicates that the Nordic diet may be adopted to other regions. The components of the HNFI are part of diets all over Europe and improved intake should be encouraged.

Olsen et al. [9] found a lower mortality among middle-aged scoring high on the HNFI index. A 1-point higher score was associated with a 4% significant lower mortality rate among both men and women. When applied fully adjusted and categorically into the model, scoring >1 index point was significantly associated with lower mortality in men, not in women. The diet components were examined individually and Olsen et al. [9] found that the association for men was most related to whole-grain. The association for women was most related to root vegetables, whereas the intake of cabbages related to both men and women.

5.4 Cardiovascular disease and Nordic Diet

This health outcome was investigated in articles [1], [3], [4], [6] and [12].

Roswall et al. [1] found no association with Nordic diet and cardiovascular mortality. However, it is pointed out by Roswall et al. [1], that available literature indicates beneficial effect for a range of cardiovascular markers; decrease in Cathepsin S levels [1], [3], decrease in body weight and cholesterol (20), mean arterial pressure and diastolic blood pressure (21), improvement of lipid profile and reduction of low grade inflammation (22), reduced blood pressure and weight loss [4].

Roswall et al. [1] points to the fact that not finding an association with cardiovascular mortality and Nordic diet is surprising, given that beneficial effect on cardiovascular

incidence and mortality has been linked to individual components of the HNFI. Roswall et al. [1] explains this lack of association with lack of statistical power caused by a young median age at baseline, leading to few cardiovascular deaths in the cohort. The study subjects was from the Swedish Woman's and Health cohort (WLH) including women aged 29-49, randomly selected from the Central Population Registry.

Jobs et al. [3] investigated whether a diet based on NNR has an effect on plasma levels of cathepsin S, and the association between changes in cathepsin S levels and changes in cardiometabolic risk factors; weight, insulin sensitivity, triglyceride (TG), high density lipoprotein (HDL) and low density lipoprotein (LDL)-levels, and systolic- and diastolic blood pressures. Cathepsin S is linked to an increased risk of cardiometabolic diseases.

Jobs et al. [3] investigated whether a diet based on NNR has an effect on plasma levels of cathepsin S, and the association between changes in cathepsin S levels and changes in the cardiometabolic risk factors; weight, insulin sensitivity, triglyceride (TG), high density lipoprotein (HDL) and low density lipoprotein (LDL)-levels, and systolic- and diastolic blood pressures. Cathepsin S is linked to an increased risk of cardiometabolic diseases.

Jobs et al. [3] found that adhering to a prudent healthy Nordic diet may moderately decrease cathepsin S levels in normal weight men and women. A result that may be mediated by weight loss due to healthy diet and/or reduced concentrations of LDL-C. The levels of cathepsin S and changes in cathepsin S level correlates significantly with changes in weight ($p=0.05$), when adjusting for sex the value remains significant ($p=0.04$). Change in LDL-C and total cholesterol correlates with changes in cathepsin S, also after adjusting for sex,

(p=0.03 and p=0.01) respectively. Cathepsin S and changes in insulin sensitivity, HDL-C, triglycerides, systolic- or diastolic blood pressure did not correlate.

Poulsen et al. [4] found reductions in cardiovascular disease risk factors. The participants of the NND diet had reductions in blood pressure (BP) – both systolic and diastolic, plasma triglyceride, total cholesterol, very low density lipoproteins (VLDL) and fasting glucose decreased [4].

Poulsen et al. [4] suggests a preventive potential for the NND, as well as a treatment potential. On population level, a small long-term reduction of BP (1-4 mm Hg) has in another study (23) been predicted to reduce cardiovascular mortality by 5-20%. The increased intake of fibres, fruits, vegetables and nuts, along with the reduced sodium intake, could account for the reduction in BP. The fasting glucose was reduced by 0.1 mmol/L between the NND and average Danish diet (ADD), the effect on insulin was significantly different and effects remained after adjustments for body weight. This result may stem from the reduced energy intake, lowering the intake of saturated fatty acids and added sugars, and the increase of intake of vegetables, fruit, wholegrain and fibres, all dietary factors inversely associated with cardiovascular risk factors (24).

Roswall et al.'s [6**]** observational study found that a higher adherence to the healthy Nordic food index was not associated with cardiovascular disease, neither did overall or specific subtypes. A statistical and significant beneficial lower risk of 4% of CVD per 1-point increment was found among former smokers, the only statistical association found in this study [6]. The authors note that this finding could be an effect of smoking cessation often being linked to dietary lifestyle changes with an increase in fruit and vegetable intake.

Roswall et al. [6] points to the fact that the results of this study agree with the only other study investigating the effect of a healthy Nordic food index (HNFI) on cardiovascular disease. This other study was cross-sectional and did not find a clear association, questioning the reproduction of the effects in an everyday setting **(**25). The authors note that this lack of association may be caused by the fact that these previous studies used a designed Nordic diet, including only Nordic produce. An adherence to the healthy Nordic food index in this present study was additional to, and did not preclude, produce not included in the index. Roswall et al. [6] also found that high adherers to the HNFI had a high intake of sodium and red / processed meats. A beneficial effect of the HNFI on CVD might be expected, since several components of the HNFI have been linked to effect. The HNFI is not a total diet, allowing other dietary items to the total energy intake, which may explain the lack of effect along with the fact that this diet only includes six food items and has no negative scoring for items with adverse health effects. Strict adherence to the HNFI, precluding all other dietary items, may be necessary to produce results that are significant. This is supported by findings in a recent intervention trial indicating that the beneficial effects of the HNFI were not maintained after the intervention period when adherence to the diet declined (26).

Roswall et al. [6] points to the fact that the effects may vary from each high-risk population, depending on the baseline risk of CVD. The differences in study populations and the many variations on the Nordic diet used makes it difficult to compare effects and results.

Poulsen et al. [12] looked for outcome in systolic and diastolic blood pressure. Both intervention groups, NND and ADD, decreased their blood pressure during the intervention.

During follow-up, an increase of systolic blood pressure of 4.4 mmHg (SE 0.9, p<0.0001) and an increase in diastolic blood pressure of 2.8 mmHg (SE0.9, p=0.0018) appeared for the NND group. No interaction between diet and a priori changes in systolic and diastolic blood pressure was seen (p=0.72 and p=78, respectively) [12]. Regain of bodyweight during follow-up and changes in blood pressure, both systolic and diastolic, was significantly associated with each other. For every 1 kg of regained body weight, the systolic and diastolic blood pressure went up 0.69 mmHg (p=0.001) and 0.43 mmHg (p=0.007) [12].

5.5 Cancer and Nordic diet

This health outcome was investigated in articles [1], [7], [8] and [10].

Roswall et al. [1] found an association with cancer. Roswall et al. [1] categorised the women in 3 groups according to HNFI index score; 0-1 points, 2-3 points and 4-6 points. When comparing between groups, a 1-point increment in the HNFI was significantly associated with a 5% lower risk of cancer mortality. Cancer deaths were mainly caused by breast cancer deaths (22%), lung cancer (20%), Ovarian (10%) and colorectal cancer (9%).

Roswall et al.'s. [7] prospective study among Swedish women did not find that a higher adherence to the HNFI was associated with colorectal cancer risk. Estimates were adjusted for age, smoking status, education level, body mass index (BMI), oral contraceptive use, consumption of alcohol and red/processed meat, and energy intake. When adjusted for confounding factors, a high adherence had an incidence risk ratio of 1.09 compared to those with low adherence [7]. No difference in the effect was shown in the two sub-groups when stratified for cancer type, colon/ rectum. Roswall et al.'s [7] lack of association might be caused from relatively few cases of colorectal cancer, and the study is limited by modest

statistical power. Residual confounding may also be the case; the dietary components most associated with an increase in colorectal cancer was also a large part of the diet of the high adherers to the HNFI, namely on the intake of red/processed meats. In addition, the median age of the women in this study was 39 years at baseline, which could affect the result. Colorectal cancer with a genetic component have a debut at a younger age and no proof has previously been published that supports the fact that dietary factors decrease the risk of hereditary colorectal cancer, which could account for the lack of association [7].

Li et al. [8] found that adherence to the HNFI was not associated with a lower risk of breast cancer in any groups of women. The association between adherence to the healthy Nordic food index (HNFI) and the risk of breast cancer was assessed both overall, by menopausal status and by hormone receptor status. The association was examined between adherence to the HNFI and breast cancer in all women, and in postmenopausal and premenopausal women separately. This study shows a slightly higher intake of cabbages, root vegetables and fish/shellfish in cases with breast cancer than with non-cases. No statistical significant association was found when examining the 6 individual components of the HNFI and breast cancer risk in pre- and postmenopausal and all women [8].

Li et al. [8] points to the fact that epidemiological evidence is inconsistent in regards to diet and breast cancer. The only dietary item affecting risk of breast cancer with repeated finding is alcohol consumption. A high intake of whole-grain products, whole-grain bread and oatmeal is hypothesized to be instrumental in cancer treatment prevention, this alleged beneficial effect has also been ascribed to fruit and vegetables, such as apples/pears, cabbages and root vegetables due to their content of fibre and polyphenols [8]. However, no such evidence exists and Li et al. [8] can draw no conclusion with regards to breast cancer

prevention and the consumption of fruits, vegetables and whole-grain products. This conclusion was supported by examinations of the Mediterranean dietary pattern and breast cancer incidence, where no association was observed between the components of the diet and risk of breast cancer [8]. However, a meta-analysis (27) found that a higher consumption of the omega-3 fatty acid is associated with a 14% reduction in risk of breast cancer, no association observed for fish intake.

Kyrø et al. [10] found that adherence to the HNFI was associated with a lower incidence of colorectal cancer for women, when adjusting for possible confounders, the same tendency became un-significant for men. A score of 5-6 points, showing best adherence to the HNFI, was associated with a 35% lower incidence of colorectal cancer for women, this same tendency became un-significant when adjusting for possible confounders.

Kyrø et al. [10] found that those scoring high on the HNFI were likely to be longer schooled, had smaller waist circumference and were less likely to be smokers, had higher energy intake, and did sports compared to lower scorers. Measured individually, none of the food items of the HNFI was found to be responsible solely for the protective effect on colorectal cancer of the food index [10]. A statistical significant association between intake of cabbage above or equal to the median and lower incidence of colorectal cancer for women disappeared when other dietary items were included in the model [10].

5.6 Type-2 diabetes and Nordic diet

This health outcome was investigated in articles [3], [4] and [5].

Jobs et al. [3] found no correlation between changes in serum cathepsin S and Homeostatic Model Assessment of Insulin resistance (HOMA-IR). However, it is noted that the Nordic diet (NNR) did produce moderate, statistically significant changes in the insulin sensitivity in this study. The authors note that this discrepancy could be caused by the fact that two different measuring methods for insulin sensitivity have been used in this study and in the observational NORDIET study supplying the data.

Poulsen et al. [4] found an association with diabetes risk factors. Fasting glucose decreased with adherence to the New Nordic diet.

Lacoppidan et al. [5] found a lower risk of type-2 diabetes among individuals adhering to a healthy Nordic food index. Lacoppidan et al.'s [5] study shows that both men and women can benefit from adhering to the healthy Nordic food index. When adjusted for confounding factors; alcohol, smoking, level of schooling, activity level, intake of red and processed meat; a 1-point higher score was associated with a 6% lower risk for women and a 9% lower risk for men of type-2 diabetes. Lacoppidan et al. [5] also found significant inverse associations; women with the highest adherence had a 25% lower risk of type-2 diabetes compared to women scoring in the lowest range. Among the men, the association was clearer; the highest scoring group had a 38% lower risk of type-2 diabetes than the lowest scoring group. Adjusting for the mediators; BMI and waist circumference, gave insignificant results for women. Assessing the single index food items and the risk of type-2 diabetes, intake of root vegetables and oatmeal above the cut-off values was associated with a lower risk of diabetes for both sexes, and intake of rye bread and cabbage was significantly associated for men [5].

Even though each of the food items included in this study have proven health effects, it cannot be concluded that any one of the items in this index is solely responsible for the associations that is found. It seems to be more the effect of a dietary pattern, than the effect of a single, individual food item. The beneficial effects from oatmeal, rye bread, root vegetables and cabbages might be due to the high dietary fibre content in the produce. Dietary fibre has many beneficial effects; slowing absorption and digestion and affects the insulin sensitivity and glucose level [5].

Lacoppidan et al. [5] points to the fact that this study cohort looked at a population aged 50-64. This age range may represent a population with a higher risk of type-2 diabetes than the population as a whole, thus making the associations of this study stronger and not entirely generalizable.

5.7 Weight change / obesity, anthropometry and Nordic diet

This health outcome was found in articles [2], [3], [4], [11], [12] and [13].

Roswall et al. [2] found that a adhering to the Nordic diet score (NDS) was not significantly associated with lower waist circumference, and lower waist circumference adjusted for BMI, regardless of the risk alleles.

The fat-mass and obesity-associated protein (FTO) and transcription factor 7 like 2 (TCF7L2) loci are genes that have shown to be the most important susceptibility genes for obesity and diabetes, respectively. Findings from recent studies indicate that the genetic variation in the mentioned genes could modify the association between the NDS and changes in anthropometrics [2]. For changes in waist circumference adjusted for BMI, Roswall et al. [2]

observed a significant 3-factor interaction between the NDS, FTO and sex (p=0.02). The interaction between FTO and NDS were significant in women (p=0.015), not in men (p=0346). For NDS there were no observed significant interactions with FTO/TCF7L2 with regards to any of the outcomes.

Roswall et al. [2] found that a high NDS adherence did not show any changes in anthropometric measures during the follow-up phase of this study. Other studies have produced results both in line with the findings of Roswall et al. [2], and findings that are in contrast. The studies that produced contrasting results were intervention studies, targeting obese or subjects with a condition, who were obliged to follow a strict and constructed diet (22) [4]. This makes direct comparison between the studies difficult, because the intake distributions do not match. Finding from other studies, both observational and experimental (28-32) suggest that there is an inverse association with both the current anthropometric status and anthropometric changes, which supports of the findings of Roswall et al. [2] suggesting there is an inverse association between MDS and anthropometry. This observed associations could be explained through biological mechanisms; a diet with high satiety and low energy intake due to intake of dietary fibre, legumes, fruit and vegetables. The intake of fish and olive oil are sources of unsaturated fats replacing saturated fat in the diet and entails loss of total weight and fat mass. Further, a combined dietary profile which are plant-based, with few meats and dairy products may give a lower energy-dense diet. It is pointed out by the researchers that many of these mechanisms may play the same part in the NDS, because the NDS is a diet with similar characteristics; fish, dietary fibre and is plant based.

Roswall et al. [2] found no significant association, which may be caused by the fact that NDS contains fewer dietary items than the MDS and is therefore not able to make a sizable, dietary

variation. The differences in scales and in valuation between the NDS and MDS makes comparability difficult. Rowall et al.'s [2] recommends that the study is replicated in another cohort.

Jobs et al. [3] found that changes in weight and changes in Cathepsin S levels correlates. When compared to the control group, Jobs et al found that the serum levels of cathepsin S (CTS) were reduced, to some level, in both men and women with normal weight to slight overweight when adhering to an *ad libitum* Nordic diet (ND). When the body weight changed, the circulating CTS level changed, suggesting that the body weight, low-density lipoprotein (LDL-C) and total cholesterol have effect on the CTS level. Reduced levels of serum- and adipose tissue levels of CTS was the result from previous studies on obese women (33-34) (20). Jobs et al. [3] shows a near significant correlation between the change in body weight and the change in CTS levels.

Cathepsin S is strongly associated with elevated triglycerides and LDL-C, the cardiovascular risk factors (35-36). The participants in the study of Jobs et al. [3] who adhered to the ND did improve their risk profile, both lowering the level of LDL-C, insulin resistance and blood pressure. These beneficial changes may have affected the levels of CTS. The findings of Jobs et al. [3] supports this idea, as the difference between the groups at baseline was abolished when adjusting for change in LDL-C, total cholesterol and change in body weight. However, Jobs et al. [3] points to the fact that the baseline level of CTS ($p=0.06$) may indicate a lack in statistical power.

Poulsen et al. [4] found association with weight loss and anthropometric changes. Weight loss was followed by reduction in waist- and hip circumference, sagittal diameter and body fat

mass. The change in body weight correlates strongly with improvement of health. Weight loss were measured in both groups, but at the end of the trial the mean weight loss was 3.22 kg more in the New Nordic diet (NND) group, who also had reductions in waist- and hip circumference, sagittal diameter and body fat mass. There were no difference in changes in physical fitness between the groups. The study by Poulsen et al. [4] shows that the NND group consumed a less energy dense diet than the average Danish diet (ADD) group. The proportions of energy from saturated fatty acids (SFAs), total fat and also added sugars was lower, and the dietary fibres content was higher. The proportion of Nordic foods and seaweed consumed was 80.2% and 0.7g/d, which is considered low compared to the principles of NND. Otherwise, the diet was in accordance with the principles of the NND.

Poulsen et al. [4] notes factors for weight loss in the NND group; the NND group consumed significantly less energy than the ADD group (-1776 kJ/d); the NND causes enhanced or higher early satiation, possibly due to the energy density being lower (-88 kJ/d) compared to the ADD, and the higher dietary fibre content of the diet (37). The NND reduced the systolic pressure by 5.1 mm Hg and the diastolic pressure by 3.2 mm Hg, an effect also produced in other studies using the other diets; the Dietary Approaches to Stop Hypertension (DASH) and Mediterranean diet (MDS) diets scores (38-39).

The findings by Poulsen et al. [4] suggests that adhering to the NND produced greater health improvements and weight loss. However, the diet was not designed to be a weight-loss diet, but was presented to participants as a study into the NND's broad health effects and culinary properties and Poulsen et al. [4] suggests that the weight-loss achieved by both groups is could come from counselling on how to regulate appetite. Poulsen et al. [4] notes that this

particular NND was created by restaurant chefs, presenting the participants with new recipes with unfamiliar foods, which may challenge the use and distribution of the NND.

Kanerva et al. [11] found that adhering to a Nordic diet is likely to be inversely associated with abdominal obesity. Suffering from an elevated waist circumference encumbers more health risks than overall obesity. The major determinant of obesity is diet. Specific nutrients as fats and carbohydrates are controversial, as the regular diet entails a large number of components in inter-correlation and looking at an entire, healthy dietary pattern may be more effective and useful than examining individual foods or nutrients. Comparing low and high adherence to the diet, subjects with high adherence to the Baltic Sea Diet score (BSDS) were less likely to have a waist circumference in excess, independent of BMI. This statistical association remained significant for men, not women after adjusting for confounders. The younger were more likely than the older to benefit from adhering to the BSDS. Further, there was no association between BSDS and BMI.

This is a diet high in fibre content, which may explain the effects on abdominal adiposity. In addition, moderate consume of alcohol could have beneficial effect on abdominal fat distribution. Research suggests that excess abdominal fat is more pathogenic than subcutaneous fat and insulin resistance and CVD is associated with excess abdominal fat (30), which is in support of Kanerva et al. [11], an entire dietary pattern described by a dietary score, is a predictor of risk of abdominal obesity. Even though individual components may have greater effect on abdominal obesity, the importance is the overall quality of the diet, not individual nutrients [11].

Poulsen et al. [12] found that initial weight loss was followed by weight regain during follow-up. Increased physical activity and higher compliance with NND reduces regain of body weight. Weight-loss is the first and initial step treating lifestyle diseases associated with obesity and reduces metabolic risk factors.

In Poulsen et al.'s [12] controlled dietary intervention the NND participants underwent significant decrease in body weight during intervention (-6.2 kg) ($p<0.0001$), followed by weight regain during follow-up of (4.6 kg.) ($p<0.0001$). For the NND group waist- and hip circumference, and sagittal diameter followed the same pattern, they decreased during intervention and increased during follow-up. When adjusted for confounders, every 1 kg. of body weight lost was followed by a regain of body weight of 0.46 kg. ($p<0.0001$) during intervention. The group adhering to average Danish diet (ADD) gained 2.2 kg. less than the NND group, ($p=0.007$). For high-scorers on adherence, regain of body weight was associated with 0.90 kg smaller increase, ($p=0.026$). Further, if physical activity was increased participants gained 3.4 kg less than participants who did not increase physical activity during follow-up.

Poulsen et al. [12] notes that the indications on weigh-regain is in line with other studies. The actual weight-regain in the study is due to lack of active intervention. This study was not designed as a weight-loss study and participants received little instruction how to maintain decrease in weight during intervention. Pointing to the challenge; maintaining the weight loss. Overall, the NND is a diet with high satisfaction, is healthy and can provide potential health benefits for the general population [12].

Fritzen et al. [13] found that adhering to a NND induced greater fat-mass reduction than ADD, along with upregulation of proteins regulating glucose and lipid-handling. Prior dietary research has targeted single nutrients. This article investigates the health benefits on specific dietary regimes [13]. Adherence to NND induced weight loss and both improved homeostasis model of assessment-insulin resistance (HOMA-IR) index and the plasma level of triglyceride (TG), this coincided with an upregulation of proteins regulating glucose and lipid-handling in subcutaneous abdominal adipose tissue (SCAT), but not in skeletal muscle. The increased AMP-activated protein kinase activity (AMPK) might have resulted in an up-regulation of the key metabolic proteins, which in turn results in lowering of HOMA-IR and plasma TG. Suggesting that the change in HOMA-IR is a direct result of adaptations in SCAT. Weight loss induced changes in fatty tissue, not in skeletal muscle [13].

5.8 Cognition and Nordic diet

Männikkö et al. [14] found that adherence to a Nordic diet is positively associated with cognition in individuals with normal levels of cognition. The Nordic diet has previously shown to have beneficial effect on cardiovascular risk factors. [11], (22), and elevated cardiovascular risk factors have been linked to vascular dementia (40).

Männikkö et al. [14] found a statistical significant association for participants with normal cognition who kept a baseline Nordic diet. They scored higher in memory, language and global cognition after adjusting for lifestyle- and demographic factors. When adjusting for energy intake this significant association disappeared. The authors note that this find may be a reflection on the importance of variation of diet, i.e. consuming a nutritious and balanced diet to reduce the cognitive decline symptomatic with aging. The improvement in cognitive function over the course of this study was small, but not expected in this population. One

possible explanation is that the participation itself improved lifestyle-factors and provided social- and mental stimulation. Dementia is a slow-onset affliction and progression from normal cognitive state to dementia often progresses over time. (41). To that effect, linking the effect of the diet with minor changes in cognition is an important and clinically relevant association [14].

5.9 Physical performance and Nordic diet

Perälä et al. [15**]** found that for women adhering to a healthy Nordic diet was associated with better overall physical performance 10 years later, and adhering to the diet may lower the risk of old-age disability. Poor physical performance is a predisposition to morbidity, disability and mortality in old-age. (42). The European population is aging rapidly, this fact makes it paramount to understand factors that impacts on physical performance to prevent adverse health outcomes. The relation between a dietary pattern and overall physical performance warrants investigation [15].

Women scoring high on NDS had higher education, were older, physically active and less likely to smoke. Men scoring high were more active physically and less likely to smoke. Both men and women scoring high had higher intake of carbohydrate, fibre and total energy and lower intakes of saturated fatty acids (SFA), mono-unsaturated fatty acids (MUFA) and total fat. High scorers had higher intake of beta-carotene and vitamins C and E. An observed association between the overall Senior Fitness Test (SFT) and the Nordic diet was statistically significant for women, not for men. After adjusting for confounders, the observation remained [15].

The authors offers explanations for the observed differences; the study included more women than men; women live longer and tend to make healthier food choices than men. In addition to providing beneficial health outcomes, adherence to the Nordic diet promotes physical performance in the older age-groups of the population. Promoting a better health through improvement of physical performance can have major impacts on the individual independence and may as a result contribute to lower healthcare costs [15].

5.10 Comparing results between the different approaches to Nordic diet

The 15 articles used 4 different dietary patterns or dietary indexes ; NNR, HNFI, NND and BDSD.

NNR; Nordic Nutrition recommendations – a standard setting national dietary recommendations in the Nordic region. Articles [3] and [14] used NNR as approach to Nordic diet. However, there were differences making it difficult to compare results; Article [3] provided an *ad libitum* diet (20), ready cooked, weighed and packed. Participants were allowed to eat one meal per week outside this menu, warranting registration in menu checklist. The initial reference in study [3] was to NNR 2012.

Article [14] used a modification of the score issued by Kanerva et al. [11], using 8 variables; excluding milk products and total fat intake, also substituting ALA for rapeseed oil. Although article [14] is a modified BSDS, the initial reference was to NNR 2004, I have therefore allowed this article to be included in both sections.

HNFI; Healthy Nordic food index – a food index with 6 components. Articles [1], [2], [5], [6], [7], [8], [9] and [10] used the HNFI as approach to Nordic diet. The original HNFI as

developed by Olsen et al. was referenced in five of the articles [5], [7], [8], [9] and [10]. In the remaining three articles, minor adjustments were made regarding whole-grain, 2 of the articles used whole-grain bread instead of rye bread [1] and [6] and one article [2] excluded oatmeal. When taking this into consideration, the articles have comparable results.

NND; New Nordic diet – a food index with 15 food groups. Articles [4], [12] and [13] used this approach, all three articles used the exact same NND and produced comparable results.

BSDS; Baltic Sea Diet score – a food index with 6 components and 3 nutrients
Articles [11], [14] and [15]. Articles [11] and [15] used 9 components, article [14] used a modified score with 8 components, excluding milk products, excluding total fat intake and substituting alfa-linoleic acid (ALA) for rapeseed oil. Articles [11] and [15] have produced comparable results, to some extent also article [14] can compare results to articles [11] and [15].

The four different dietary indexes or dietary patterns all have different approaches to Nordic diet, which makes it hard to compare results between the different studies. However, results may be comparable if studies using the same approach is compared separately, i.e. in this instance studies using the HNFI may produce comparable results with only minor adjustments inflicting on the result. The articles using the NND produced comparable results, and the BSDS can compare results between two of the three included studies, the third study used a modified score making comparison difficult. Articles using the NND did not produce comparable results.

6. Conclusions and future recommendations

6.1 Conclusions

I will start with the conclusions of the included studies, then proceed with summing up the effect of the diet or dietary pattern on specific health outcomes.

6.1.1. Conclusion of the included studies

The 15 included studies found a range of effects linked to adherence to the Nordic dietary pattern:

Roswall et al. [1] found a lower overall mortality with higher adherence to a healthy Nordic food index. Other advantages in adhering to this food index is ecological sustainability, easy implementation and adaptation due to cultural familiarity. The findings in this study requires further investigations.

Roswall et al. [2] examined if men and women have different associations when looking at a genetic 2-factor interaction between sex and diet scores and found no significant interaction between any of the factors and any of the measured outcomes. However, an un-significant tendency towards between the diet and weight change and waist circumference adjusted for BMI was found. The authors encourages reproduction of findings.

In the article by Jobs et al. [3] it is suggested that the levels of cathepsin S in non-obese men and women may be reduced as a result of a prudent diet of healthy Nordic foods. As pointed out by Jobs et al.[3], this seems to be a partly and mediated diet-induced weight loss

association – also involving reduced LDL-C concentration. These findings warrants further studies on this subject.

In the article by Poulsen et al. [4] it is indicates that the new Nordic diet holds a considerable preventive and treatment potential. The diet produced blood pressure reduction and weight loss in the study group. The NND is supported and accepted by participants and the result could be transferred to the Danish population. However, participants were provided with food items, this warrants for future studies with a more diverse group of participants without provision of food to be able to validate the findings.

Lacoppidan et al. [5] found an inverse association for both men and women between a healthy Nordic food index and the risk of developing diabetes type 2. This indicates that the prevention of diabetes type-2 and the healthy aspects of the Nordic diet may interact with each other. The use of a local, healthy diet may both enhance compliance, support cultural diversity and be friendly to the environment.

Roswall et al. [6] found no association in the entire cohort between adherence to the healthy Nordic food index and the risk of incident CVD and no effect-modification was found by alcohol, BMI or age. A beneficial interaction, statistically, was found between former smokers and HNFI, this association was not found with current or former smokers. This finding requires replication, as result could be due to bias.

Roswall et al.'s [7] study found no association between hereditary colorectal cancer among adult Swedish women and the HNFI. The authors note that they were unable to confirm findings of a previous cohort.

Li et al. [8] found that when taking into account menopausal status and hormonal status, no association between breast cancer incidence was found. The authors note that this is the first study to look at this association, which warrants reproduction of the findings.

Olsen et al. [9] found lower mortality among middle aged male Danes scoring high on the index, and when dealing with the public health message; a recommendation of traditional and familiar foods will be more effective when trying to implement major healthy changes.

Kyrø et al. [10] found a reduced incidence of colorectal cancer in women, for the men only a tendence towards lower incidence was found. Compliance to a diet is easier if the food is familiar, this is favourable towards the local, healthy Nordic diet, ensuring cultural diversity, is friendly to the environment and has respect for heritage.

Kanerva et al. [11] suggests that a dietary score is a more useful tool to evaluate the overall health impact of dietary components, and Nordic foods have a beneficial effect on abdominal fat distribution. However, further studies are needed to confirm the results.

Poulsen et al. [12] underlines the potential of the NND, as both healthy and satisfying, though the effects on body weight, anthropometry and blood pressure decreased during follow-up.

Fritzen et al. [13] found that when losing weight as a result of change of diet, the key proteins taking part in glucose uptake, insulin signalling, fatty acid metabolism and increased AMPK phospho-regulation in adipose tissue is accompanied with improvements in HOMA-IR index and a lowering of plasma triglyceride, however not in skeletal muscle. These changes may have overall health benefits.

The article by Männikkö et al. [14] found that consumption of this Nordic diet had beneficial effect on cognition in individuals with normal levels of cognition. This article stresses the importance of local, health promoting food items.

Perälä et al. [15] found that high adherence at baseline to a healthy Nordic diet was associated with a higher level of physical performance 10 years later. This study suggests that the effect of the diet is reduced oxidative stress and inflammation, which is beneficial to the overall physical performance. Adhering to a heathy diet decreases health care costs, decreases the risk of disability and aids the ability to remain independent in older age by improving physical health.

6.1.2 The effects of the diet or dietary pattern on specific health outcomes

Summing up the effects of the diets or dietary patterns on specific health outcomes:

Mortality	A lower mortality was found with adherence to the HNFI [1] and [9]. Both studies used the same food index and produced significant and comparable results.
Cardio vascular disease	Adhering to the NNR [3] and NND [4] and [12] had effect on this health outcome. Studies [1] and [6] did not find a significant effect, both the latter studies used the HNFI. The six studies used 3 different food indexes or patterns and results cannot be compared between the studies. Studies [4] and [12] used the NND and can compare results between studies.
Cancer	Adhering to the HNFI had effect on cancer in studies [1] and [10]. The HNFI was also used in studies [7] and [8], but did not produce

	significant results. The same index was applied for all studies, and results are comparable.
Weigh change / obesity / anthropometry	Adhering to NNR [3], NND [4], [12] and [13] as well as BSDS [11] had significant effect on this health outcome. Study [2] used the HNFI, and produced no significant result. Studies using the same index (NND) produced comparable results.
Diabetes-2	3 different indexes used. Study [3] used NNR, study [4] used NND, and study [5] used HNFI. The latter study produced significant results, the other two studies did not. Results are not comparable.
Cognition	Adhering to the NNR produced significant results in study [14]. Only one study looked at this health outcome.
Physical performance	Adhering to the BSDS in study [15] had beneficial effect on physical performance in women. Again, only one study looked at this health outcome.

Adhering to a healthy diet has effect on health. Though the effect is not found to be beneficial for all health outcomes studied in this thesis, significant health outcomes were found, suggesting that adherence to a healthy diet is beneficial for health.

Comparing results from studies using different indexes may prove difficult due to the differences in the scoring and variety of the food items included in the food indexes.

6.2. Further studies / Future recommendations

Though each study came to their own individual conclusions based on their analysis of available data, some factors are shared among all 15 studies:

- The idea to view the overall diet and the associated health effects, and not health effects by each individual dietary component or macronutrient.
- People eat food and not nutrients, warranting the recommendation of a complete healthy dietary pattern.
- Adherence to a diet of well-known, traditional foods has a better chance of implementation than an unfamiliar dietary pattern.
- A diet-based approach seems to have beneficial effect on health.
- Promoting healthy regional diets in any part of the world may effectively improve public health, is ecologically sustainable, easy to implement and is culturally acceptable.

The above factors point to nutrition as an important role in chronic disease prevention, making the diet a major contributor to health policy on a global level. In order to better fight the burden of disease, the dietary index must be shaped to accurately assess a dietary pattern, being able to identify correlation between dietary components and also being able to identify specific health outcomes (43). In addition, the shared factors are crucial guidelines to successful implementation of a healthy diet in any part or region of the world, which should be reflected in future article and research on the Nordic diet.

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