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What We Know, Think We Know, or Are Starting to Know

Since developing as a modern science, nutrition research has faced a dilemma between a more reductionist approach which focuses on specific macronutrients and micronutrients, or a more holistic approach that focuses on the total dietary pattern [1,2].

In reality, these approaches are not mutually exclusive, but complementary; nutrients are provided by the foods and food groups which comprise a total dietary pattern, and investigating the health effects of diet and nutrition requires coming at the question from both angles [1,3]. And even some of nutrition science's staunchest critics agree that whole-diet approaches may be a preferable approach to nutrition research [4].

In 2003, Mark Messina *et al*. [2] published a critique of the emphasis on reductionism in nutrition research, describing it as "narrowing" the perspectives on diet, nutrition, and health. It is ironic, therefore, that the same narrowing of perspective has occurred for dietary patterns since the publication of that paper; you would be forgiven for thinking that the Mediterranean diet is where nutrition starts and ends.

But there are other dietary patterns that warrant consideration. Examining other dietary patterns allows us to compare and contrast similarities and, importantly, differences. This is particularly insightful where there may be similar nutritional characteristics of diets, but potentially different compositions of foods.

The Nordic and Baltic Sea dietary pattern [see Baltic Sea Diet Pyramid, below] characterises diets common to Norway, Sweden, Denmark, Iceland, and Finland [5,6]. The dietary pattern exhibits certain foods that others may not emphasise; berries, cereals such as oats, rye and barley, cabbage and root vegetables, rapeseed oil as a primary oil, fish and seafood, and low-fat dairy. The present study assessed the evidence for the Nordic dietary pattern from both epidemiology and intervention trials.

The Study

The present study was a systematic review and meta-analysis of studies investigating the Nordic dietary pattern in adults with type-2 diabetes [T2D] or elevated T2D risk factors. To be included, studies were required to meet the following criteria:

- **Design**: Both prospective cohort studies and randomised controlled trials [RCTs].
- **Population**:
  - **Cohorts**: Adults with T2D but free of cardiovascular disease [CVD], or free of T2D if a cohort had T2D incidence as an outcome.
  - **RCTs**: Participants with elevated levels of T2D risk factors [overweight/obese, metabolic syndrome, or dyslipidaemia].
- **Exposure/Intervention**:
  - **Cohorts**: The Nordic dietary pattern assessed using a diet quality index or diet pattern score in cohort studies.
  - **RCTs**: An intervention group based on Nordic diet recommendations.
- **Comparator/Control:**
  - **Cohorts**: The analysis compared highest to lowest Nordic diet scores, and also conducted a dose-response analysis for each score increase in Nordic diet scores.
  - **RCTs:** A control group consuming similar energy as the intervention and a contrasting diet to the intervention group.
- **Duration**:
  - **Cohorts**: Cohort studies were required to have a minimum of ≥1-year follow-up.
  - **RCTs**: ≥3-weeks.
- **Outcomes**:
  - **Cohorts**: The primary outcome was total CVD incidence. Secondary outcomes in the cohorts' analysis included CVD mortality, coronary heart disease [CHD] incidence, stroke incidence, and T2D incidence.
  - **RCTs**: The primary outcome was LDL-cholesterol. Secondary outcomes in RCTs included other CVD and T2D risk factors.

The outcomes were presented as relative risks [RR] and 95% confidence intervals [CI] for the cohorts' analysis; the outcomes for the RCTs were presented in the unit of measurement [e.g., LDL-C in mmol/L].

Results: The systematic review resulted in 15 cohort studies and six RCTs which met the inclusion criteria being identified and included in the study. The cohort studies totalled 1,057,176 total participants, including 41,078 total CVD events and 13,121 cases of T2D. The RCTs totalled 717 participants. Follow-up duration in the cohort studies was between 13–17-years on average, while the RCTs duration were between 12–48-weeks.

***Prospective Cohort Studies Outcomes*:**

CVD Incidence: For the primary outcome of total CVD incidence, the highest dietary pattern adherence was associated with a 7% [95% CI, 1% to 12%] lower risk of CVD compared to the lowest. Each 1-point increase in Nordic diet adherence [diet score range of 0–6] was associated with a 2% [95% CI, 1% to 3%] lower risk of CVD. The global dose-response analysis [which analyses the associations with the highest level of population adherence over the full dose-response range, rather than comparing high scores vs. low scores] mirrored the high vs. low scores comparison.

CVD Mortality: In the high vs. low analysis, there was a 19% [95% CI, 10% to 27%] lower risk of CVD mortality. Each 1-point higher score was associated with a 6% [95% CI, 4% to 7%] lower risk, while the highest level of population adherence within the dose-response range was associated with a 26% [95% CI, 20% to 31%] lower risk of CVD mortality.

Other Secondary Outcomes: The highest level of population adherence in the dose-response range was associated with a 12% [95% CI, 4% to 21%] lower risk of CHD incidence, a 13% [95% CI, 3% to 22%] lower risk of stroke, and an 8% [95% CI, 1% to 16%] lower risk of T2D incidence.

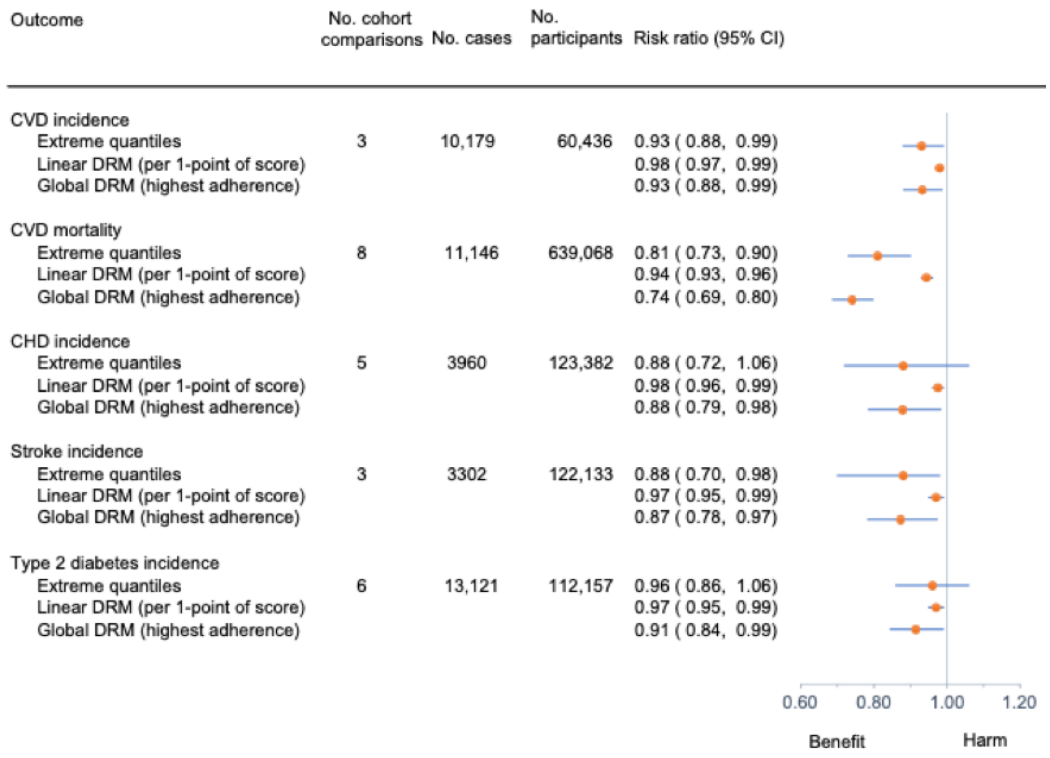


***Figure** from the paper illustrating the outcomes from the meta-analyses of prospective cohort studies. Each association was analysed in three ways; 1) comparing extreme quantiles of diet pattern scores [i.e., "highest vs. lowest", where the RR and 95% CI reflects the association relative to that lowest score]; 2) per 1-point increase in diet pattern score from 0 to 6, and; 3) the association at the highest level of adherence over the full 0 to 6 range, rather than per 1-point increase or against a specified "low" comparison.*

***RCTs Outcomes*:**

LDL-C: For the primary outcome of LDL-C, Nordic dietary pattern interventions were associated with a 0.26mmol/L [~10mg/dL] lower LDL-C compared to control diets.

Secondary Outcomes: Nordic dietary interventions were associated with a 0.69mmol/L [~26mg/dL] lower non-HDL-C, and 0.15g/L [~15mg/dL] lower ApoB [apolipoprotein-B, a marker for all atherogenic lipoproteins in circulation, as each particle expresses ApoB].

Nordic dietary interventions were also associated significant, albeit modest magnitudes of effect, reductions in fasting insulin, blood pressure, bodyweight and BMI, and waist circumference.

The Critical Breakdown

Pros: The systematic review searched relevant databases up to 2021, making this the most current synthesis of evidence on this dietary pattern. The inclusion criteria were clearly stated, and the studies included higher risk participants with either T2D or elevated T2D risk factors, a population with high CVD co-morbidity. The included cohort studies were ranked as high quality, while the RCTs were mostly graded as low risk of bias. The statistical analysis was thorough and included a dose-response analysis, which better describe risk at different levels of an exposure than a "high vs. low" comparison alone. Several sensitivity analyses were conducted to test the robustness of the associations in the main analysis. The sample sizes in the cohort studies were very large and included a substantial number of cases for the outcomes of interest, with long durations of follow-up, which increases the robustness of the risk estimates.

Cons: There was a limited number of RCTs included with a small total sample size. There was evidence of high heterogeneity in several analyses, indicating substantial variance in effect size estimates between studies. For the primary outcome of incident CVD, this heterogeneity appears to have been driven by two studies in particular, nevertheless it reduces confidence in what the true population effect of the Nordic dietary pattern may be for this particular outcome [and others with high heterogeneity]. The Nordic dietary pattern in cohort studies was assessed using six difference scales, while the RCTs were the usual hodgepodge of intervention and control diets; both factors that reduce the precision in characterising the exposure and may have contributed to the high heterogeneity observed.

Key Characteristic

This study stands out for its concurrent inclusion of the two major research designs on which nutrition science relies: prospective cohorts and intervention trials. One of the major criticisms of nutrition science is that cohort studies are unreliable and produce results that are not replicated in RCTs [4,7]. This contention against nutrition science primarily relies on comparisons between epidemiological research on diets and intervention trials of dietary supplements using isolated nutrients [4].

However, where the source of intake is diet in cohort studies and this is compared to dietary intake in RCTs, there is a strong level of agreement in the results from both nutritional epidemiology and intervention trials [8]. The present meta-analysis, by combining studies from both cohort and RCT designs, allowed for congruence between these respective lines of evidence to be considered.

For example, the RCTs demonstrated that Nordic dietary patterns lowered ApoB by ~15mg/dL, and wider research from lipid-lowering drug trials has demonstrated that each 10mg/dL lower ApoB is associated with an 8% lower risk of major CVD events [9].

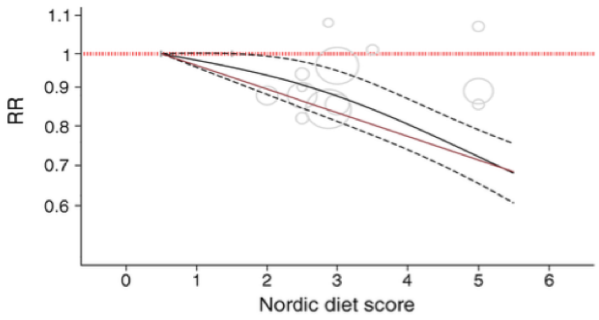
The largest effect sizes in the RCTs in the present meta-analysis were for effects of the Nordic diet on blood lipids, and this provides a biologically plausible explanation for the associations of lower CVD risk, particularly CVD mortality.

Interesting Finding

The inclusion of the dose-response analysis adds strength to the analysis of cohort studies. The most common method of analysis in nutritional epidemiology is to divide an exposure according to levels of intake and compare the highest vs. lowest levels of intake. While this is a useful approach, it is also often arbitrary in how the dietary exposure is divided, and is influenced by the magnitude of difference between levels of intake in either category [10].

Dose-response analyses allow for the associations between an exposure and outcome to be characterised across the full range of exposure levels. Because we are interested in diet, the exposure is typically intakes of a nutrient, but in the case of the present study was dietary pattern scores. In the present analysis, this allowed for risk over the full range of Nordic diet adherence scores to be determined, which demonstrated that the associations were substantially stronger for CVD mortality compared to incidence.

Although a secondary outcome, arguably it is more robust; the finding is based on a large sample and number of events, and did not exhibit high heterogeneity. The finding of a 6% lower risk per 1-point increase in Nordic dietary pattern scores was reflected in the ~26% lower risk across the entire scoring range. The figure below demonstrates this; the red line is the analysis per 1-point increase; the black line is the global analysis across the full range.



Relevance

Arguably the concept of a Nordic or Baltic Sea dietary pattern didn't get off to a good start in the nutrition research world; the Finns had the highest rates of coronary heart disease mortality globally in the 1950's and 1960's, and their butter consumption was a whopping annual average of 15kg per capita [11].

However, the characteristics of the local food environments in this region have been described with several foods and food groups associated with healthy dietary patterns [5,6]. While dietary pattern scores are useful, however, this does not infer homogeneity across all Nordic and Baltic countries; there are differences in food habits and particular emphases for meals across these countries [12].

Nevertheless, dietary pattern scores are inherently designed to capture characteristics of overall diets, of which there are several in the Nordic dietary pattern of note: the emphasis on berries, rather than a general class of "fruit", on grains such as rye, root vegetables, and rapeseed oil [5,6].

In the SYSDIET trial, adherence to certain characteristics of this dietary pattern – fatty fish, rapeseed oil, and grains – were verified by biomarker status, the highest levels of which were associated with a ~2-fold greater improvement in CVD risk factors [13]. Cumulatively, the evidence to date supports the benefits to the particular characteristics of the Nordic/Baltic Sea dietary pattern.

Application to Practice

In relation to generalisability [i.e., to what extent do the characteristics of the study sample reflect the population in which an intervention will be applied], it is important to bear in mind that dietary patterns are inherently population-specific.

Of the 15 cohort studies included in this analysis, 13 were conducted in either Norway, Sweden, Denmark, or Finland. And this generally means we should be cautious against extrapolating a dietary pattern consumed in a certain cultural and regional context to an assumption of applying in any other context.

Yet an inherent advantage of dietary pattern research is identifying nutritional characteristic similarities, while recognising that the precise food-based means of achieving those characteristics differ. In the case of the Nordic dietary pattern, the emphasis on unsaturated fat-rich oils [bear in mind rapeseed oil has significantly more omega-3's than olive oil], on fibre-rich grains, and (poly)phenol-rich fruits, is consistent with benefits related to several dietary patterns.

Thus, while food sources may differ, the Nordic dietary pattern also confirms that the broad contours of a health-promoting diet are relatively universal.

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