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

Dietary guidelines have been a recent battleground in nutrition, driven by the drivel from the low-carb/high-fat [LCHF] diet camp. In 2016, a report published by a LCHF foghorn advocacy group stated that the UK dietary guidelines had driven *"people away from highly nourishing, wholesome, and health promoting foods"* [(1)].

A year before, Zoe Harcombe had published a paper in the journal BMJ Open Heart, which is also a platform for publishing pseudoscientific nutritional revisionism, where she contended that dietary guidelines introduced in the US in 1977 and the UK in 1983 were flawed because they were not based on randomised controlled trials [(2)].

But we also know that Zoe Harcombe is utterly insane, her papers reading like an incoherent stream of consciousness which, to paraphrase Kurt Vonnegut, makes you picture an armless, legless author smashing their face against the keyboard and calling the output "science".

Why have dietary guidelines become such a focal point of nonsensical arguments? The LCHF movement contends that "low-fat" messages in dietary guidelines were responsible for a fundamental shift in the composition of population diets, moving people away from "nourishing" animal foods toward a diet high in refined carbohydrates and sugars [(1)]. Yet this has always been entirely unsupported by the data. Yes, shift in the composition of population diets occurred, but increased food supply energy availability and greater dietary energy density, have been driven by a complex web of social, environmental, political, and economic factors [(3)].

But this argument also rests on a rebuttal presumption: that people *actually followed* the dietary guidelines. Which begs the question, what would happen if they *actually* did? The present study investigated just that.

The Study

The present study was an analysis from the Copenhagen General Population Study [CGPS], a prospective cohort study in Denmark. The study was initiated in 2003, and included Danes living around Copenhagen from both densely populated and more rural areas, and high and low socioeconomic status.

Diet was assessed using a food-frequency questionnaire tailored to the Danish food-based* dietary guidelines, which included the following key recommendations:

- Eat less saturated fat;
- Eat plenty of vegetables and fruit;
- Eat more fish;
- Eat less sugar;
- Eat lower salt foods.

The FFQ also focused on dietary fat quality, based on the source of dietary fat, e.g., saturated fats from butter vs. unsaturated fats from vegetable oils and soft margarines.

The exposure of interest was adherence to the dietary guidelines, divided into 5 levels of adherence from highest to lowest. The outcomes of interest were cardiovascular disease mortality, non-cardiovascular mortality, and all-cause mortality.

For the analysis, the highest level of adherence to the dietary guidelines was the reference category against which other levels of adherence were compared.

Results: 100,191 participants provided complete dietary data for the present study. Up to 14yrs follow-up was available [average of 9.2yrs], in which 9,273 deaths occurred.

- ***Cardiovascular Mortality:*** Compared to the highest level of adherence, the lowest level was associated with 35% [HR 1.35, 95% CI 1.11 - 1.64] higher risk of death from CVD. Excluding deaths in the first 1-5yrs of follow-up did not change this association.
- ***Non-cardiovascular Mortality:*** Compared to the highest level of adherence, the lowest level was associated with 56% [HR 1.56, 95% CI 1.34 - 1.82] higher risk of death from non-CVD causes. Excluding deaths in the first 1-5yrs of follow-up did not change this association.
- ***All-Cause Mortality:*** Compared to the highest level of adherence, the lowest level was associated with 46% [HR 1.46, 95% CI 1.32 - 1.62] higher risk of death from all causes. Excluding deaths in the first 1-5yrs of follow-up did not change this association.

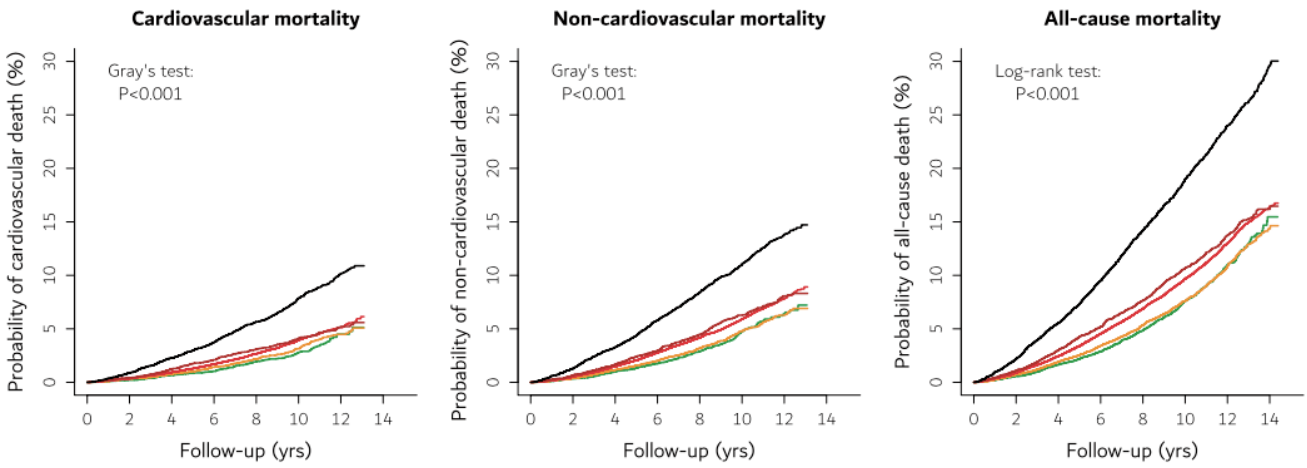


Figure *from the paper illustrating, from left to right, the increase in CVD, non-CVD, and all-cause mortality over 14yrs follow-up associated with different levels of adherence to certain key recommendations in the Danish dietary guidelines. The green line is the reference group of very high adherence; orange is high adherence; red is intermediate; maroon is low adherence; black is very low adherence. As is clear from this, the very and high adherence lines tend to overlap, as does the intermediate and low adherence, both of which exhibit higher risk than the very high/high adherence levels. However, low adherence is by orders of magnitude greater in risk compared to the other categories.*

The Critical Breakdown

Pros: The study had an enormous sample of ~100,000 participants, and a substantial number of deaths [~15,000]. The analysis adjusted for multiple socioeconomic factors, in addition to cardio-metabolic risk factors like blood pressure and LDL-cholesterol. A mediation analysis was also conducted, which explored the extent to which the associations between the exposure [adherence to dietary guidelines] and outcomes [disease] could be explained by factors like diabetes, BMI, blood pressure, and LDL-C. The researchers also conducted a sensitivity analysis excluding the first 1-5yrs of the follow-up period, which is helpful to eliminate the potential for undiagnosed disease to influence the associations [i.e., reverse causation].

Cons: For reasons not explained, the FFQ did not cover other recommendations in the Danish dietary guidelines, in particular eating more whole-grain foods and opting for low-fat dairy products. The scoring system for the dietary guidelines does leave a few questions. In effect, the key recommendations were divided into three levels of priority, but it isn't clear why. For example, dietary fat and fibre were the 'Class A' priority for adherence, but low salt was 'Class C'; the justifications for this are unclear. Arguably, the investigators would have been better to include all recommendations - including whole-grains and low-fat dairy - in a points-based dietary pattern score. This could have provided a more nuanced analysis than the relatively dichotomised system used in the present analysis.

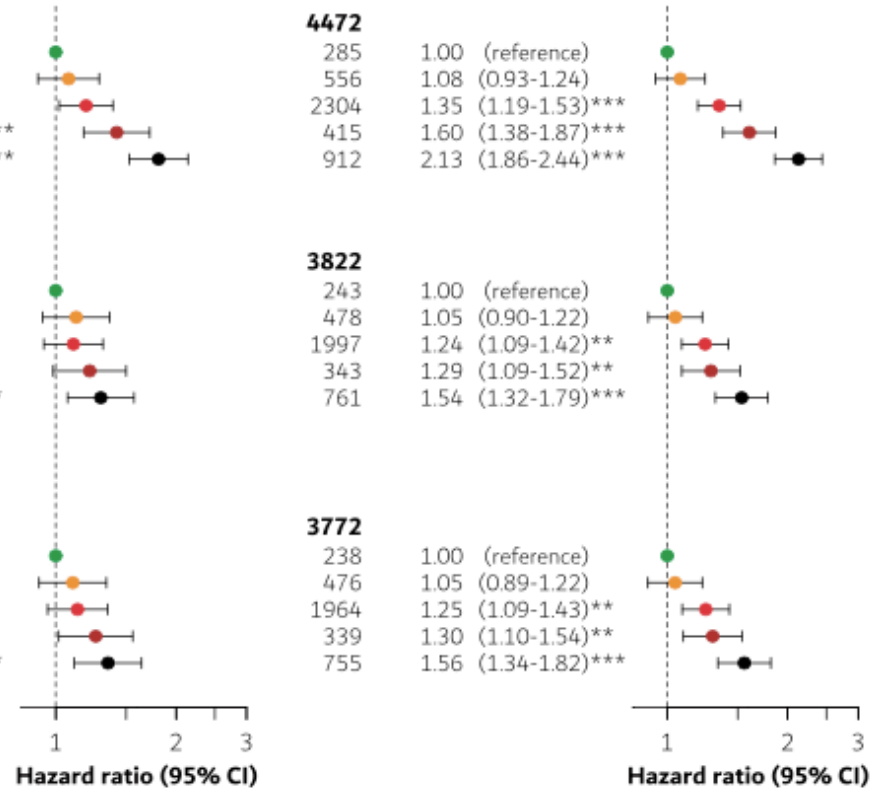
Key Characteristic

Given the numerous factors that are associated with diet quality at the population, this study is an example of the importance of using sophisticated adjustment models to account for potential confounding factors and mediating factors. In this study, the potential confounders were factors like income, education level, smoking, alcohol, and physical activity. The potential mediating factors, i.e., risk factors which mediate the relationship between diet and disease processes, included LDL-C, systolic blood pressure, and BMI.

The **figure** on page 7, illustrates this step-wise process of adjustment nicely. You can see '**A**', which is the basic model adjusted only for age and sex; then '**B**' adds in the potential confounders; finally '**C**' adds in the potential mediating factors. What you can see is that the magnitude of the increase in risk is highest in the basic model '**A**'; this is normal. Adding in additional factors attenuates the magnitude of the association, however, importantly it does not abolish the significance of the increase in risk [shown here for CVD and non-CVD mortality], nor the graded, linear nature of the association [continued under ***Interesting Finding***].

Key Characteristic - Figure

		Cardiovascular mortality			Non-cardiovascular mortality	
Adherence to dietary guidelines	No. of individuals	No. of events	Hazard ratio (95% CI)	Forest plot	No. of events	Hazard ratio (95% CI)	Forest plot
A Adjusted for age and sex	**100191**	**2982**			**4472**		
Very high (reference)	10030	183	1.00 (reference)		285	1.00 (reference)	
High	17375	384	1.08 (0.90-1.28)		556	1.08 (0.93-1.24)	
Intermediate	54541	1502	1.19 (1.02-1.39)*		2304	1.35 (1.19-1.53)***	
Low	8302	273	1.42 (1.17-1.72)***		415	1.60 (1.38-1.87)***	
Very low	9943	640	1.81 (1.53-2.14)***		912	2.13 (1.86-2.44)***	
B Adjusted for age, sex, education, income, smoking, leisure time physical activity, and alcohol	**90286**	**2550**			**3822**		
Very high (reference)	9152	152	1.00 (reference)		243	1.00 (reference)	
High	15836	340	1.12 (0.93-1.36)		478	1.05 (0.90-1.22)	
Intermediate	49303	1289	1.11 (0.93-1.31)		1997	1.24 (1.09-1.42)**	
Low	7311	237	1.22 (0.99-1.50).		343	1.29 (1.09-1.52)**	
Very low	8684	532	1.30 (1.07-1.57)**		761	1.54 (1.32-1.79)***	
C Adjusted for age, sex, education, income, smoking, leisure time physical activity, alcohol, diabetes, body mass index, systolic blood pressure, and LDL cholesterol	**88818**	**2522**			**3772**		
Very high (reference)	8981	150	1.00 (reference)		238	1.00 (reference)	
High	15596	335	1.10 (0.91-1.34)		476	1.05 (0.89-1.22)	
Intermediate	48477	1278	1.13 (0.95-1.35)		1964	1.25 (1.09-1.43)**	
Low	7215	233	1.26 (1.02-1.56)*		339	1.30 (1.10-1.54)**	
Very low	8549	526	1.35 (1.11-1.64)**		755	1.56 (1.34-1.82)***	



Interesting Finding

The fact that the risk was linear [as is evident in the figure under ***Key Characteristic***, above] is striking once we consider what the characteristics of the dietary pattern, within the definition of adherence to the Danish dietary guidelines applied for this analysis, would mean. Because of the inclusion of certain key recommendations, adherence reflects a diet with primarily unsaturated fats, >3 weekly servings of vegetables, >3 weekly servings of fruit, >3 weekly servings of fish, <500ml sugar-sweetened beverages per week, <5 weekly servings of cold meat cuts, and <1 weekly serving of fast food.

If we think about the positive scored foods here; unsaturated cooking oils and spreads, and weekly servings of fruits and vegetables in particular, these are not particularly onerous targets for dietary intake. This is an important consideration when we come to factor in socioeconomic barriers to a healthy dietary pattern. In fact, these levels of "very high" or "high" adherence would fall far short in comparison to public health campaigns like "5-a-Day".

The findings in the present study are interesting because of the implicit message in the results: that relatively small changes in diet quality can produce meaningful shifts in the burden of disease across the population. There is much low-hanging fruit, excuse the pun, to be picked at the population level.

Relevance

Ah, you hear the sophists say, but this is observational research! You hear mutterings of "association isn't causation" and other lowly critiques. So let's start with this, because unbeknownst to the LCHF talking heads there is evidence from RCTs that corroborate the efficacy of dietary guidelines in reducing disease risk.

In the CRESSIDA study, the intervention group were counselled according to the UK dietary guidelines, emphasizing low saturated fats, use of soft polyunsaturated-enriched margarine, added monounsaturated oils, wholegrains, and oily fish, and compared to a control group consuming a typical British diet pattern with butter spreads, refined grains and cereals [(4)]. At baseline, all subjects had dietary characteristics that reflected population averages for total fat, saturated fat, and salt.

Over 12-weeks, the dietary guideline intervention group reduced body weight, blood pressure and cholesterol, reflecting an increase in fibre, reduction in added sugars and sodium, increase in omega-3's, and reduction in saturated fat (Ibid). The reductions in blood pressure and cholesterol observed with adherence to the dietary guidelines would be predicted to reduce risk of fatal CVD by 15% and nonfatal CVD by 30% [(4)].

It's also important to make clear that *no* one really ever started following the dietary guidelines. This is evident both in dietary analysis at the population level, and at the individual, going back to the start. For example, a study in the UK which included analysis 3yrs after the introduction of the UK guidelines showed that only 8.3% met recommendations for fruit and vegetable intake [(5)].

I do think that the socioeconomic elephant in the room does need to be discussed, as always. The thresholds to be met in the present study to be deemed adherent to the Danish dietary recommendations were quite low [as discussed above under ***Interesting Finding***]. The fact that the associations survived adjustment for income and education may reflect these relatively low thresholds. Put this way; if "5-a-Day" was the exposure, would any positive associations with fruit and and vegetable intake still be associated with the outcome? I would argue that the higher the threshold for adherence, the less an association would be observed once socioeconomic status was factored in.

For example, an analysis of disposable income based on the Living Cost and Food Survey (LCFS) in the UK is [an ongoing national study of living costs and food that is updated annually], demonstrated that households in the lowest 10% of income would have to spend 73.6% of disposable income just to comply with Eatwell Guide. Households in the top 10% would only have to spend 6%. On average, the poorest half of the UK population would have to spend ~30% of disposable income to meet Eatwell Guide targets, while the top 50% would have to spend 12%.

The present study is an important addition to the literature in providing more evidence that adherence to broad, general population-wide dietary guidelines is beneficial for lowering the burden of disease. However, I would have reservations that the findings are truly a reflection of socioeconomic parity given the relatively low thresholds of intake used to define adherence. Conversely, this may also be seen as encouraging given it indicates that small changes may add up to meaningful shifts in the burden of disease across the whole population into a lower risk category.

Application to Practice

The contention that adherence to national dietary guidelines is somehow responsible for, or associated with, the rise in obesity and chronic cardio-metabolic disease, is a fantastical narrative divorced from both reality and evidence. Lack of adherence to broad, general population dietary recommendations also has little to do with a failure on the part of the guidelines, and speaks more to the powerful role of the food industry, its relationship with the prevailing sociopolitical models, and the resulting socioeconomic challenges and barriers to achieving health-promoting diets.

In a nutritional landscape where there is pressure on practitioners and coaches to be up on "hacks", "tailored plans", and a fancy label on whatever "approach" is declared, it may pay to remember that perhaps the best thing a individual needs is simple changes along general best-practice dietary advice. You are not a lesser nutritionist because you help someone achieve the Eatwell Guide recommendations over the latest macro-split-intuitive-eating-intermittent-fasting bastardisation festering the Internet. You're actually better for it.

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