Food intake patterns, self rated health and mortality in Danish men and women. A prospective observational study

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Abstract

***Objective*—To examine whether self rated health confounds or modifies the relation between a prudent food intake pattern and mortality and to study whether the prudent food intake pattern predicts subsequent changes in self rated health.**

***Design*—A prospective cohort study with follow up of total mortality and changes in self rated health. Food intake patterns were identified by principal component analysis from a 28 item food frequency questionnaire, collected at baseline.**

***Setting*—MONICA surveys, Copenhagen County, Denmark.**

***Participants*—A random sample of 3698 men and 3618 women aged 30–70 years were followed up from 1982 to 1998 (median 15 years).**

***Main results*—Among participants with complete information on all variables 18% had rated their health as poor (average or bad) at the baseline examination. Poor self rated health was related to a low score on the prudent food intake pattern, which was characterised by a frequent intake of wholemeal bread, fruit and vegetables. Three hundred and seventy six men and 210 women died during follow up. Poor self rated health and a low prudent food score were associated with increased mortality in both men and women. Self rated health did not modify the relation between diet and mortality. Of the 1098 men and 1048 women with good self rated health at baseline, 243 men and 297 women reported poor health during follow up. Low prudent food score, smoking, and high BMI increased the risk of developing poor health in both men and women, but in multivariate analysis the associations attenuated and were only significant for BMI.**

***Conclusion*—Both prudent food intake pattern and self reported health are independent predictors of mortality. Self rated health does not seem to modify the relation between diet and mortality.**

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During the past 40 years a large number of studies have shown that a prudent diet and good self rated health are related to longevity.[1 2] In addition, a few cross sectional studies have shown a relation between diet and health perceptions.[3 4] For instance, in the British Health and Lifestyle Survey a healthy diet, mainly reflecting frequent intakes of whole meal bread fresh fruit and vegetables, was associated with less illness and psychosocial malaise.[3] In Swedish adults, infrequent vegetable consumption was associated with poorer self rated health, while the consumption of dietary fat was not related to self rated health.[4] Although, self rated health seems to be related to diet, this variable has not been considered in previous follow up studies. The aims of this population based cohort study were (1) to assess whether self rated health confounded or modified the relation between a prudent food intake pattern and mortality. Additionally, in a subgroup of the cohort (2) to study whether the prudent dietary pattern predicted changes in self rated health, for example, if self rated health was an intermediate factor in the diet-mortality relations.

Methods

SUBJECTS

The study is based on data from the Danish WHO MONICA surveys, previously described in detail.[5] Briefly, random equal sized samples of 30 year, 40 year, 50 year, and 60 year old men and women living in the south western part of Copenhagen County, were drawn from the National Central Person Registry and invited to participate in surveys conducted in 1982–84 (DAN-MONICA I), 1987 (DAN MONICA II), and 1991–92 (DAN-MONICA III). The MONICA III survey also included men and women aged 70 years. The response rates were 79%, 75%, and 73%, respectively, and the total population comprised 3698 men (1940 +748 + 1010) and 3618 women (1845+756+1017) (table 1). After 10 years, 4130 subjects from the MONICA I sample, were still alive and lived in Denmark. They were invited to a follow up examination. Of these 2254 men and women attended both examinations.

All cohort members were followed up until 31 October 1998 for all cause mortality obtained from official death certificates at the National Board of Health.

DATA COLLECTION

Data on well established biological and behavioural cardiovascular risk factors were collected by clinical examinations and questionnaires, respectively. Comparable survey methods, which followed the WHO-MONICA protocol, were used in all three surveys. These methods are described in earlier reports.[5 6] Data on the biological variables, smoking, drinking, and

Table 1 Overview of study participants

Study	Men (n)	Women (n)	Deaths		Person years	
			Men (n)	Women (n)	Men	Women
MONICA I	1940	1845	333	185	27282	27341
MONICA II	748	756	76	40	8496	8861
MONICA III	1010	1017	94	69	7017	7187
Total	3698	3618	503	294	42795	43389
Participants with complete data						
MONICA I	1793	1713	295	161	25824	25470
MONICA II	311	300	22	11	3589	3557
MONICA III	751	742	59	38	5320	5340
Total	2855	2755	376	210	34733	34367

physical activity, were missing from less than 1% of the participants, whereas 19% of the participants had missing data for one or more of the variables in the questionnaire on dietary habits. Subjects with incomplete data were more often women, lower educated and from the MONICA II survey. All analyses were conducted on the subgroup of 2855 men and 2755 women, with complete information on all variables.

VARIABLES

In all three studies, an extensive questionnaire on sociodemographic variables, lifestyle, and health was completed before a general health examination. The subjects were questioned about their *present state of health* and asked to describe their health as: (1) very good, (2) good, (3) average, (4) bad, or (5) very bad. Average, bad or very bad self rated health was considered to be poor health. The questionnaire also included a question on *food intake* in which respondents were asked: "How often do you, on average, eat the following food items ?" followed by a list with the 26 items specified in table 2, which gives the exact answer categories. The alternatives used in the frequency scale were as follows: never, once a month or less, twice a month, once a week, 2 to 3 times a week, once a day, 2 to 3 times a day, and 4 times or more daily. Participants were also asked about their average daily number of cups of tea or coffee. The food frequency questionnaire has been compared with a diet history interview as a part of this study.[6] This cross comparison showed that the mean food intake measured by a diet history interview increased with increasing frequency category of the food frequency questionnaire indicating that this questionnaire was able to identify levels of food intake correctly. Data were aggregated using principal component analysis (factor analysis) described in detail elsewhere.[2] The frequency of intakes of the 28 food items aggregated in two factors (components) with eigenvalues over 2. The first component (termed "prudent food intake pattern") that positively associated with frequent intakes of wholemeal breads (and inversely with other types), pasta, rice, oatmeal products, fruit, vegetables, and fish (table 2). The second component (termed "western food intake pattern") was positively associated with frequent intakes of meat, sausages, potatoes, butter and white bread (data not shown). The prudent food intake pattern was inversely associated with all cause mortality, while the western food intake pattern was not associated with

Table 2 Horizontal rotated factor loadings for dietary variables in prudent food components derived from principal components analysis

	Prudent food component
Wholemeal bread	0.61
Wholemeal ryebread	0.56
Vegetables, raw	0.53
Fruit	0.51
Rice	0.41
Vegetables, boiled	0.39
Juice	0.36
Cakes, cookies	0.36
Tea	0.36
Pasta	0.35
Jam, honey	0.33
Candy, chocolate	0.31
Porridge, groats	0.30
Fish	0.27
Milk, yougurt	0.24
Low fat margarine	0.22
Cheese	—*
Ice cream	—*
Egg	—*
Meat	—*
Sausages	—*
Meat for sandwich	—*
Butter, lard,	—*
Vegetable margarine	—*
Coffee	−0.26
White bread	−0.38
White ryebread	−0.46

*—Low factor loadings (between 0.20 and −0.20).

mortality (2). The following known predictors of mortality were chosen as covariates for the analyses: *Smoking*: Questions on smoking concerned current habits (yes, occasionally, no/never), and the kinds and average daily quantities of tobacco consumed (cigarettes, cheroots, cigars, pipe). In the analyses of the data, only subjects who smoked daily were considered smokers. Participants were also asked about their weekly intake of beer (bottles), wine (glasses), or spirits (units). *Alcohol consumption* was assessed by the average number of beers, glasses of wine and units of spirits having been consumed per week during the last year. These data were classified according to weekly alcohol intake: <1 drink per week, 1–14 drinks per week for women and 1–21 drinks per week for men, and a consumption of more than 14 or 21 drinks per week, respectively. Data on *leisure time physical activity* were based on answers to a question for which the participants had to mark one of four alternatives: A, mostly sedentary; B, walking, bicycling or otherwise active at a corresponding level at least four hours per week; C, going jogging or demanding sports, or doing heavy activity during leisure for at least three hours per week; D, long distance running or competitive sports several times per week. We defined people in group A as being inactive the rest were considered active. *Educational attainment* was assessed with questions about whether participants had any vocational education. Anthropometric measures were collected by the same trained nurse in all studies. *Body mass index (BMI)* was calculated as weight in kilograms divided, by the square of height in metres and divided to four categories: under weight (BMI<20), normal weight (BMI 20–24.9), overweight (BMI 25–29.9) and obesity (BMI $\geqslant$ 30).

Table 3 Odds ratio estimates (95% confidence intervals) of poor self rated health from bivariate analyses in relation to prudent dietary pattern, smoking, physical activity, BMI and education

	Men		*Women*	
	Number	*Odds ratio*	*Number*	*Odds ratio*
Self rated health				
good				
very good	867		867	
good	1469		1390	
poor				
average	415		365	
bad	84		105	
very bad	20		28	
Prudent dietary pattern				
lowest quartile	901	1	502	1
second quartile	739	0.74 (0.58, 0.97)	663	0.78 (0.58, 1.04)
third quartile	661	0.82 (0.63, 1.06)	742	0.83 (0.63, 1.10)
highest quartile	554	0.62 (0.46, 0.82)	848	0.59 (0.44, 0.78)
Current smoking				
no	1298	1	1456	1
yes	1557	1.64 (1.35, 2.00)	1299	1.37 (1.13, 1.67)
Physical activity				
active	2211	1	1906	1
inactive	644	1.92 (1.56, 2.38)	849	2.13 (1.75, 2.63)
BMI (kg/m^2)				
20–24.9	1334	1	1520	1
25–29.9	1129	1.23 (1.00, 1.51)	638	1.30 (1.03, 1.65)
>30	295	1.64 (1.20, 2.23)	243	2.43 (1.73, 3.18)
<20	97	2.52 (1.60, 3.97)	354	0.92 (0.67, 1.28)
Vocational education				
yes	2281	1	1797	1
no	574	1.46 (1.17, 1.83)	958	1.50 (1.23, 1.83)

STATISTICAL ANALYSIS

Bivariate associations between the prudent food intake pattern, self rated health and other covariates were evaluated by logistic regression. Association between risk factors and mortality was analysed using Cox's proportional hazards regression models with age as underlying time scale and delayed entry accordingly. A Cox model was developed that included the prudent dietary pattern (in quartiles), smoking status (0=non-smoker,1=smoker) , physical activity (0=active, 1=inactive), vocational education (0=yes, 1=no), BMI (in four categories), weekly alcohol intake (<1 drinks, 1–14 drinks for women and 1–21 drinks for men and over 14 or 21 drinks, respectively), and self rated health (in five categories) as predictors of death. In the model we analysed for potential interactions between the prudent dietary pattern and self rated health. The proportional hazards assumption was evaluated for all variables by comparing estimated log-log surviour curves over the different categories of the variables being investigated and by a test based on the generalisation of Grambsch and Therneau.[7] This showed that the assumption held for the models. Tests for the individual covariates indicated that the assumption was not valid for physical activity in women. Thus, the risk estimates must be interpreted with caution for this variable. The initial data analyses showed that self rated health could be collapsed into three categories: very good and good, average, bad and very bad, because the risks were very similar in the adjacent categories. Furthermore, moderate alcohol consumption was associated with good self rated health (data not shown), but alcohol did not predict mortality and was excluded from the analyses. In the MONICA I population the association between risk factors (including age) and impaired or improved self rated health were also analysed using multiple logistic regression. Impaired self rated health was defined as those with very good or good health at baseline, who reported their health as average, bad or very bad at the re-examination. Improved health was defined as those with average or bad health at baseline, who reported of very good or good health at the re-examination.

Results

DIET, SELF RATED HEALTH AND MORTALITY

After exclusion of subjects with incomplete data, the study population comprised 2855 men and 2755 women, who were followed up for a median of 15.0 years (range 0.1–16 years). During follow up, 376 men and 210 women had died (table 1).

In total, 519 (18%) men and 498 (18%) women had poor self rated health at the baseline examination (table 3). Self rated health was related to diet. Thus, men and women in the lowest quartile of the diet score had more often poor health than those in the highest quartile. Poor self rated health was also related to smoking, physical inactivity and low education. In men, BMI both showed J shaped associations with self rated health with best health among those with normal weight. In women, BMI was positively associated with self rated health, with best health among those with normal and low weight (table 3). Table 4 shows that both a low prudent diet score and poor self rated health were associated with increased mortality in men and women. Smoking, physical inactivity, low BMI and education were also significantly related to mortality. In both men and women, the association between diet and mortality was attenuated but remained significant after adjustment for other risk factors in the multivariate model (table 4). The risk estimates changed most when smoking, self rated health and physical activity was entered in the model, but was nearly unaffected by the inclusion of education and BMI (data not shown). Tests for potential interactions between diet and self rated health displayed evidence that self rated health did not modify the association between diet and mortality (data not shown).

DIET AND IMPAIRED SELF RATED HEALTH

Of the 1497 men and 1417 women from MONICA 1, who rated their health as very good or good in 1982–84, 1018 men and 1043 women participated in the follow up 10 years later, while 131 men and 69 women had died. In total, 243 men and 297 women reported poor health during follow up. Two hundred and ninety six men and 296 women with poor health at baseline participated in the follow up and 47 (16%) and 66 (22%) of these men and women rated their health as very good or good at the re-examination. In both sexes impaired health was associated with eating a less prudent diet and high BMI at baseline. In women, impaired health was also related to low physical activity, while it was related to smoking and low education in men (table 5). In multiple logistic

Table 4 Hazard rate ratio estimates (95% confidence intervals) of all cause mortality in bivariate and multivariate models with age as underlying time scale

	Men		*Women*	
	Bivariate	*Multivariate**	*Bivariate*	*Multivariate**
Self rated health				
good and very good	1	1	1	1
average	2.03 (1.54, 2.54)	1.84 (1.44, 2.36)	1.62 (1.13, 2.32)	1.50 (1.04, 2.16)
bad and very bad	2.24 (1.52, 3.31)	2.08 (1.40, 3.09)	3.30 (2.21, 4.92)	2.22 (1.45, 3.41)
Prudent dietary pattern				
lowest quartile	1	1	1	1
second quartile	0.78 (0.69, 0.99)	0.91 (0.71, 1.17)	0.56 (0.40, 0.78)	0.67 (0.48, 0.95)
third quartile	0.59 (0.44, 0.78)	0.72 (0.54, 0.97)	0.45 (0.31, 0.64)	0.59 (0.40, 0.86)
highest quartile	0.48 (0.38, 0.69)	0.65 (0.44, 0.95)	0.29 (0.18, 0.45)	0.45 (0.28, 0.72)
Current smoking				
no	1	1	1	1
yes	2.04 (1.03, 2.56)	1.76 (1.40, 2.22)	2.38 (1.79, 3.18)	1.87 (1.39, 2.53)
Physical activity				
active	1	1	1	1
inactive	1.69 (1.35, 2.12)	1.43 (1.14, 1.81)	1.78 (1.35, 2.32)	1.22 (0.91, 1.63)
BMI (kg/m²)				
20–24.9	1	1	1	1
25–29.9	0.89 (0.71, 1.12)	0.91 (0.72, 1.14)	1.02 (0.72, 1.42)	1.07 (0.76, 1.50)
>30	1.13 (0.82, 1.54)	1.14 (0.83, 1.57)	1.69 (1.15, 2.49)	1.52 (1.01, 1.26)
<20	2.17 (1.36, 3.42)	1.67 (1.04, 2.67)	1.75 (1.13, 2.71)	1.40 (0.90, 2.17)
Vocational education				
yes	1	1	1	1
no	1.36 (1.01, 1.58)	1.08 (0.84, 1.36)	1.46 (1.11, 1.93)	1.16 (0.87, 1.53)

*Model with prudent diet score, self rated health, physical activity, smoking, and vocational education as covariates.

regression analysis the association between diet an subsequent impaired health attenuated and became non-significant. Among subjects with good self rated health at baseline, prudent food intake, smoking and low education were associated with increased mortality after control for other risk factors (data not shown). In women, improved self rated health was associated with prudent diet (4.08 (1.64, 10.17)), smoking (0.49 (0.28, 0.90)), low education (0.51 (0.28, 0.41)), and low BMI (0.10 (0.01, 0.80)). However, only the associations with diet and BMI remained significant in the multivariate analysis. In men, improved self reported health was associated with smoking (0.45 (0.24, 0.86)), prudent diet (6.57 (2.58, 16.73)) and low education (0.37 (0.15, 0.92)).

Table 5 Odds ratios (95% confidence intervals) of subsequent poor self rated health among 1018 men and 1043 women with very good or good self rated health at baseline examination

	Men		*Women*	
	Bivariate	*Multivariate**	*Bivariate*	*Multivariate**
Prudent dietary pattern				
lowest quartile	1	1	1	1
second quartile	0.88 (0.61, 1.24)	0.95 (0.65, 1.47)	0.89 (0.60, 1.30)	0.92 (0.63, 1.37)
third quartile	0.68 (0.46, 1.00)	0.85 (0.56, 1.28)	0.65 (0.43, 0.97)	0.72 (0.48, 1.09)
highest quartile	0.51 (0.32, 0.82)	0.68 (0.44, 1.12)	0.60 (0.40, 0.90)	0.72 (0.46, 1.11)
Current smoking				
no	1	1	1	1
yes	1.43 (1.07, 1.92)	1.38 (1.01, 1.89)	1.26 (0.97, 1.66)	1.21 (0.90, 1.62)
Physical activity				
active	1	1	1	1
inactive	1.35 (0.90, 1.89)	1.13 (0.78, 1.69)	1.58 (1.28, 2.12)	1.36 (1.01, 1.85)
BMI (kg/m²)				
20–24.9	1	1	1	1
25–29.9	1.38 (0.94, 1.75)	1.32 (0.95, 1.83)	1.52 (1.08, 2.13)	1.43 (1.01, 2.04)
>30	2.08 (1.28, 3.41)	2.02 (1.22, 3.61)	3.30 (1.88, 5.78)	3.92 (1.63, 5.21)
<20	1.41 (0.65, 3.11)	1.28 (0.56, 2.88)	1.15 (0.76, 1.72)	1.17 (0.76, 1.79)
Vocational education				
yes	1	1	1	1
no	2.31 (1.63, 3.27)	2.06 (1.43, 2.97)	1.27 (0.96, 1.69)	1.03 (0.76, 1.41)

*Model with age, prudent diet score, physical activity, smoking,and vocational education as covariates.

KEY POINTS

- In total, 18% of men and women aged 30–70 years had poor self rated health, and 20% of those with good self rated health reported of poor health 10 years later.
- Poor self rated health was related with smoking, physical inactivity, low education, body mass index and a low score on a prudent diet patten reflecting frequent intakes of wholemeal bread, fruit and vegetables.
- Poor self rated health and a low prudent food score predicted increased mortality after control for potenial confounders.
- Low prudent food score, smoking, and high BMI increased the risk of developing poor health in both men and women, but in multivariate analysis the associations attenuated and were only significant for BMI.

Only, the two latter remained significant after control for other factors.

Discussion

The present population-based cohort study confirms the association between eating a less prudent diet and the prevalence of poor self rated health, described in Sweden and in the UK.[3 4] We expanded these findings by demonstrating independent associations between mortality and both poor self rated health and a low prudent food intake score in men and women that persisted after adjustment for other risk factors in the multivariate models.

CONFOUNDING, EFFECT MODIFICATION AND MEDIATION

In contrast with the suggestions by others[4] this study found that the association between self rated health and mortality was not a result of confounding from other behavioural factors such as food intake, smoking, and physical activity, also known to affect mortality. Previous studies have shown that smoking,[3 4 8–10] low alcohol intake,[10–12] physical inactivity and low intakes of vegetables[3 4] are associated with poor self rated health. However, these studies have all been cross sectional, and hence have not concluded whether self rated health influences behaviour or is the effect of certain behaviours. A recent study, among approximately 3000 Swedish adults showed that those who increased their physical activity during 1980–1988 also reported better health.[13] In our study a prudent diet, and other behavioural factors, were not associated with changes in self rated health. We did not study the so called "intervening hypothesis", which suggests that suboptimal health leads to poorer dietary behaviours.[14] However, in a previous study we showed that among women good self rated health was associated with increased intake of vegetables and stopping smoking.[15]

In this study, poor self rated health was associated with low prudent food intake pattern at baseline, but food intake did not seem to influence changes in self rated health. However, we

did not know whether the food intake pattern changed during the period where self rated health changed. Thus, if food intake patterns are established before the development of suboptimal health, then self rated health may be considered as a mediator of the relation between diet and mortality. Consequently, suboptimal health is an important variable in the pathogenic pathway, and should not be controlled for in the statistical analyses. On the other hand, suboptimal health may also influence food intake, and hence should also be taken into account when considering the relation between diet and mortality. Furthermore, if diet promotes wellbeing, it is an important aspect to consider for interventions early in the disease chain.

METHODOLOGY

A number of study limitation should be noted. We did not have information on psychosocial factors or biological markers of psychosocial strain, which may have improved our model, as these factors are associated with self rated health. Furthermore, we cannot exclude that the cross sectional relations between self rated health and prudent food intake reflect, that those with good self rated health overstate the favour of their food habits. In addition, the lack of statistical significant associations between prudent diet and changes in self rated health might reflect low power given the relatively small sample size in this analysis. We used a logistic regression analysis to predict changes in self rated health. However, when the data were analysed using a Cox model with age at second examination as censoring time, results were similar. However, the time of examination may not be the correct point of time for when the change in health occurred, therefore we chose to report the results from the logistic regression analysis.

In conclusion, both food intake patterns and self reported health seem to be independent predictors of all cause mortality. Self rated health does not modify the relation between diet and mortality.

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