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Are fish eaters healthier and do they consume less health-care resources?

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Abstract

Objective: Regular dietary intake of fish is associated with reduced risk of developing cardiovascular and other chronic diseases, and may improve general well-being. If fish eaters are healthier, they may use fewer health-care resources. The present study aimed to describe the reported intake of fish and fish products in a Danish general population, and to investigate whether fish consumption is associated with generic measures of self-reported health and consumption of health-care resources.

Design: Data on eating patterns and health status for 3422 Danish adults were obtained by telephone interview in the Funen County Health Survey. These data were merged with individual-level register data on health-care utilisation. Survey respondents were categorised into those consuming fish at least once weekly (fish eaters) and those consuming fish less frequently (non-fish eaters).

Results: People who reported eating fish twice monthly or once weekly had significantly better overall self-reported health than those who rarely eat fish, even after adjustment for age, gender, social characteristics and lifestyle factors. Fish eaters did not have significantly lower aggregated health-care costs, although their hospital utilisation was significantly lower than that for non-fish eaters.

Conclusions: Moderate fish consumption was associated with better self-reported general health even after controlling for possible confounding variables. Overall, fish eaters appeared to use the same amount of health-care resources as non-eaters, although fish eaters used more medicine but were less likely to be admitted to a hospital.

Keywords
Fish consumption
Self-reported general health status
Resource utilisation
Health-care costs
Denmark

The observation of low CVD rates in Eskimo and other fish-eating populations has directed large research efforts into the health effects of dietary fish and fish constituents[1,2]. Several epidemiological studies and randomised controlled clinical trials have identified an inverse relationship between fish or fish-oil consumption and cardiac or sudden death for patients with established heart disease in secondary and tertiary prevention programmes[3,4]. Laboratory tissue and animal studies have shed further light on the underlying biochemical mechanisms and have reported anti-arrhythmic, anti-atherosclerotic, anti-thrombotic and anti-inflammatory effects of various fish components[5]. Although most studies involving high-risk individuals suggest a cardio-protective effect of fish consumption for patients with documented heart disease[6–8], the evidence from prospective cohort studies involving healthy individuals is less conclusive[9]. While some suggest lower risks of developing CVD also for the general population[6,10], others – including a Danish study – failed to find a protective effect of fish intake on CVD[11–13].

There is, however, also substantial evidence in other disease areas (including diabetes, rheumatoid arthritis and other inflammatory diseases, as well as neuronal development, cognitive functioning and mental health) that increased fish intake could have a positive health impact[14].

The multiple evidence of potential positive health benefits from fish consumption has led several countries, including Denmark, the UK and the USA, to issue formal dietary recommendations for the general population on minimum fish intake to maintain good health[15–18].

Fish, especially oily fish such as salmon, mackerel or herring, is the best natural dietary source of the *n*-3 PUFA, EPA and DHA[19]. In addition, a seafood-rich diet provides lean protein and other essential minerals and vitamins such as Zn, Fe, iodine, Se and vitamins A, B and D[5,20]. The inclusion of these essential nutrients suggests

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that fish consumption may be more beneficial than fish-oil supplementation alone[9]. According to a study by the Danish Veterinary and Food Administration conducted in 2000–1, the average intake of fish and fish products for Danish adults is about 120 g/week, with a median of 100 g/week[21,22]. However, the recommendation in Denmark is to eat at least 200–300 g fish/week, corresponding to two main dishes per week. In addition, it is recommended to eat a variety of fish types in order to minimise any potentially adverse health effects from environmental contaminants such as dioxins or methylmercury. With the recommended volumes the benefits outweigh the potential risks[15].

Although increased fish intake may have multiple favourable health effects on specific target groups with defined diseases, it is questionable whether these health effects are identifiable in a general population survey using preference-based generic measures of self-reported health. The literature on the effect of fish intake as a single food item on overall health status of the general population is rather scarce. The study reported here can be seen in the context to two Danish studies, both based on data from the MONICA (Monitoring Trends and Determinants in Cardiovascular Disease) study, and one study from New Zealand. The first Danish study showed that a prudent food intake pattern (including fish consumption) was associated with better overall health and had an independent effect on mortality[23]. The second Danish study investigated whether fish consumption was associated with lower CVD and total mortality, and found no effect for the general population[13]. Methodologically our study is most similar to a study performed in New Zealand, which examined the association between fish consumption and generic summary measures of self-reported physical and mental health in the New Zealand general population[19].

The objective of the present paper is to describe the relationship between fish consumption and two generic summary measures of health utility in the general population in Denmark. In addition, the paper extends the knowledge base by exploring the association of fish consumption with measures of health-care utilisation and costs.

Materials and methods

Telephone interview data

Data on health status, health behaviour, eating patterns and socio-economic background were obtained from the Funen County Health Survey (FCHS), which was conducted in winter 2000–1[24]. In this survey a random sample of 5000 people living in Funen County, Denmark, aged 16–80 years, was drawn from the centralised civil register and invited to participate in the survey. The sample was stratified with respect to municipality. Telephone interviews were conducted by trained interviewers. A total of 3422 individuals participated, corresponding to a weighted response rate of 69·2 %. The demographic characteristics of the sample were similar to those of the Danish adult population aged 16–80 years; the average age of the survey population was 45 years and 48 % of the respondents were men. Approval by an ethics committee was not required and it is assumed that people who answer the questions accept to participate in the survey. The study has been registered with the Danish Data Protection Agency.

Register-based data

The FCHS data were merged with data from individual-level computerised registers that provided data on all hospital contacts, use of primary health-care services and prescription drug use one year prior and one year after the date of interview. Using registers to extract information on health-care utilisation makes it possible to obtain detailed information on health-care utilisation over a long period of time and to distinguish between different types of health care. Resource consumption in the health-care sector was measured as the long-run cost of services and approximated by pharmaceutical retail prices, hospital charges and reimbursed fees as recorded in the registry data[24]. All costs are presented in Euros and adjusted to 2003 price levels.

Variable description

The FCHS telephone survey included the official Danish versions of the Short-Form Health Survey with thirty-six questions (SF-36)[25,26] and the five questions for the EuroQol EQ-5D instrument[27,28]. Both instruments attempt to assess overall health status by including various aspects of health, such as mental health status and functional limitations. The answers to the health questions are self-reported, but include objective measures (e.g. problems to walk a certain distance) and subjective measures (such as health perceptions). The resulting health profiles consequently cannot be used to directly compare respondents' overall health states with each other. We therefore employed methods that use preference-based valuations to transform a health profile into a single measure of health utility, which we borrowed from previous studies. The responses to the SF-36 were converted to an overall measure of health utility using the Short-Form 6 Standard Gamble (SF6-SG)[29], whereas for the five-dimensional profile of the EQ-5D a summary index was estimated using time trade-off (TTO) valuations. Danish weights were used to calculate the summary index scores for both instruments[30–32]. The two methods are well established to compare overall health states across different diseases and populations and to measure the benefits of public health programmes. In our study the SF6-SG measure ranges from 0·488 to 0·995 with a mean of 0·953 (SD 0·066). The EQ-5D TTO ranges from −0·226 to 1 with a mean of 0·892 (SD 0·161).

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The average dietary food intake of survey participants was assessed using an FFQ including twenty-six food categories. Frequency of fish consumption was measured on an ordinal 8-point scale ranging from 1 = 'never' to 8 = 'four or more servings daily'. The percentage distribution across frequency categories was 6·4 % for eating no fish at all, 15·3 % for once monthly, 25·6 % for twice monthly, 35·0 % for once weekly, 14·0 % for twice weekly, 4·0 % for daily, 2·0 % for two or three times daily and 0 % for four or more times daily. The same FFQ had been used in previous studies, such as MONICA I[13]. Respondents eating fish more than once weekly and respondents eating fish once monthly or less were grouped into two separate categories, due to a small frequency of occurrence, leaving four categories for statistical analyses. Just as in the MONICA I study, no attempt was made to convert consumption into grams per day; however, a validation study for the MONICA I study had shown that the mean intake of fish in grams increased in higher food frequency categories[33]. In addition, we created a dummy variable 'fish eaters' = 1 for consuming fish at least once weekly in order to test whether a recommendation to increase fish consumption to this level for the average population is beneficial in terms of health or health-care utilisation.

In all analyses we controlled for a set of demographic, social and lifestyle characteristics. Demographic confounding factors included dummies for age groups (16–30, 31–49, 50–64 and 65+ years) and gender (coded 1 for males). Social characteristics included dummies for formal tertiary education and a dummy for living with a partner.

Personal and household income was not included in the analysis as it was found to be insignificant in all preliminary regression models and many respondents had refused to answer these questions. However, a number of lifestyle factors were included: dummies for smoking status (equal to 1 for smokers and ex-smokers), drinking alcohol over the recommended limit (21 standard units per week for men and 14 for women) and a dummy termed 'physical inactivity' for leisure-time physical activity (with value of 1 indicating little or no physical activity). In addition, we controlled for general healthy dietary habits by including a dummy for eating more fruit and vegetables than the population average and a dummy for the experience of health deterioration (equal to 1 if respondents reported health deterioration within the previous year).

Statistical analysis

The data were analysed using the STATA® statistical software package version 9·2 (StataCorp., College Station, TX, USA). Descriptive statistics were used to assess whether there were systematic differences in population characteristics between groups that ate fish at least once weekly and those who ate less fish.

In addition we used multivariate logistic regression to analyse which characteristics were associated with eating fish at least once weekly. Ordinary least-squares (OLS) regression was used to test whether there was a significant difference between fish eaters and non-eaters in health-related quality-of-life scores and whether there was a dose-dependent relationship, while controlling for other characteristics. Finally, we used OLS and logistic regression to examine whether frequency of fish consumption was associated with consumption of health-care resources after controlling for other characteristics. In all analyses P values of $\leq 0{\cdot}05$ were considered statistically significant.

Results

Demographic, educational and lifestyle characteristics differed between groups defined by frequency of fish consumption, as summarised in Table 1. Fish eaters were on average older, had longer education, ate more fruit and vegetables and were more likely to live with a partner and to have active leisure pursuits than non-fish eaters. Their unadjusted mean health status was similar to that of non-fish eaters, but they had higher average health-care costs and were more likely to drink alcohol over the limit.

Table 2 reports the probability of eating fish at least once weekly according to various characteristics. There appeared to be a clear relationship with age. Older and male respondents and those with longer education, living with a partner, active leisure activities, eating more fruit and vegetables and drinking above the recommended level were significantly more likely to eat fish.

Results for the association between fish consumption and measures of health-related quality of life as measured by the EQ-5D TTO and SF6-SG index scores are presented in Table 3. A preliminary analysis that included a single dummy variable for fish eating at least once weekly did not provide a significant parameter, which may imply that already lower levels of fish consumption are associated with better self-rated health compared with non-fish eaters. When a more detailed description of fish consumption was included in the model, a significant pattern could be observed. The results suggest that individuals who ate fish regularly had higher health-related quality of life as opposed to individuals who rarely ate fish or did not eat fish at all. However, eating fish more than once weekly was not associated with better health, either. So the model did not provide evidence for an increasing dose–response relationship. As expected, old age, smoking status, physical inactivity and the experience of health deterioration were significantly associated with lower health-related quality of life, while men and individuals with longer education tended to be significantly healthier. All of the variables that were significantly associated with the EQ-5D index score were also significantly associated with the SF6-SG index score. The estimated

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Table 1 Characteristics of the study sample by frequency of fish consumption: Danish adults, aged 16–80 years, participating in the Funen County Health Survey, 2000–1

Characteristic	Eating fish at least once weekly (*n* 1798) Mean or %	Eating fish less than once weekly (*n* 1624) Mean or %
Demographic		
Age (years), mean	48·9	41·1
Age 16–30 years (%)	16·1	29·7*
Age 31–49 years (%)	33·3	40·1*
Age 50–64 years (%)	30·6	20·2*
Age 65+ years (%)	19·8	9·1*
Male (%)	48·7	46·7
Tertiary education (%)		
None	20·9	23·3
Short	45·6	43·3
Middle	16·3	11·2*
Long	6·4	3·8*
Other or in education (%)	10·9	18·4*
Lifestyle		
Current smoker (%)	34·2	37·1
Current or former smoker (%)	59·6	56·6
Drinks alcohol over limit (%)	14·6	10·7*
Physically inactive (%)	10·0	14·4*
Fruit and vegetables (%)	56·4	39·0*
Living with a partner (%)	75·3	66·0*
Health		
EQ-5D TTO index, mean	0·893	0·891
SF6-SG index, mean	0·953	0·952
Full health (EQ-5D) (%)	59·0	57·9
Health deterioration (%)	10·1	11·2
Two-year health-care costs (€, 2003 prices)		
Hospital costs	1873	1423
Primary care	614	542*
Pharmaceutical costs	409	266*
Total health-care costs	2896	2231*

EQ-5D TTO, EuroQuol 5-Dimensional time trade-off index score of health utility; SF6-SG, Short Form 6 Standard Gamble index score of health utility.
Fish eaters are defined as individuals who report eating fish at least once weekly.
*Value was significantly different compared with fish eaters: $P < 0{\cdot}05$.

Table 2 Factors affecting the probability of weekly fish consumption (logistic regression): Danish adults, aged 16–80 years, participating in the Funen County Health Survey, 2000–1

Variable	OR	*P* value
Demographic		
Age 31–49 years	1·243	0·028
Age 50–64 years	2·169	0·000
Age 65+ years	3·861	0·000
Male	1·250	0·003
Tertiary education		
Short	1·119	0·256
Middle	1·471	0·003
Long	1·515	0·032
In education	0·852	0·208
Lifestyle		
Living with a partner	1·273	0·003
Ever smoker	1·039	0·664
Drinks alcohol over limit	1·468	0·001
Physically inactive	0·667	0·001
Fruit and vegetables	2·066	0·000
Health		
Health deterioration	0·909	0·419
	n 3422	
	Log likelihood = −2186·8	
	Pseudo R^2 = 0·076	

The reference group is below 30 years old, female, without tertiary education, does not live with a partner, does not smoke, drinks no or only little alcohol, is physically active in leisure time, eats the average amount of fruit and vegetables and eats no or only little fish.

parameters had the same sign but their size was about double for the EQ-5D. The overall fit of the models was similar.

Table 4 reports the determinants of different measures of health-care consumption using OLS and logistic regressions. Model 1 describes the association between weekly fish intake and log-transformed aggregate health-care costs, whereas the other models concentrate on disaggregated hospital, primary care and pharmaceutical costs. The reported coefficients can be interpreted as the percentage change in the costs associated with a marginal change in the variable. Health-care utilisation as a dependent variable is modelled by logistic regression in columns two, four and six. The odd ratios indicate the association between a variable and the probability of using a particular type of health care.

The results from Model 1 indicate that fish consumption at least once weekly was not associated with lower total health-care costs, but fish eaters tended to have lower hospital costs compared with those eating less fish. However, this was almost entirely due to the fact that fish eaters used hospital services less frequently (Model 2). Conditional on hospital utilisation, fish eaters did not appear to have lower hospital costs (Model 3).

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Table 3 Determinants of health-related quality of life as measured by the EQ-5D TTO and SF6-SG indices (ordinary least-squares regression): Danish adults, aged 16–80 years, participating in the Funen County Health Survey, 2000–1

	EQ-5D TTO		SF6-SG	
Variable	Model 1	Model 2	Model 1	Model 2
Fish consumption				
Dummy ≥once weekly		0·002		0·0006
Once to twice monthly	0·026*		0·011*	
Once weekly	0·027*		0·010*	
>Once weekly	0·018		0·009*	
Demographic				
Age 31–49 years	−0·028*	−0·031*	−0·008*	−0·012*
Age 50–64 years	−0·049*	−0·056*	−0·018*	−0·022*
Age 65+ years	−0·055*	−0·064*	−0·021*	−0·026*
Male	0·028*	0·029*	0·011*	0·012*
Tertiary education				
Short	0·020*	0·021*	0·009*	0·009*
Middle	0·029*	0·029*	0·013*	0·013*
Long	0·043*	0·044*	0·016*	0·017*
In education	0·018	0·018	0·005	0·003
Lifestyle				
Living with a partner	0·011	0·012	0·004	0·005
Ever smoker	−0·021*	0·022*	−0·009*	−0·009*
Drinks over limit	0·006	0·004	0·003	0·002
Physically inactive	−0·095*	−0·097*	−0·041*	−0·042*
Fruit and vegetables	0·004	0·03	0·002	0·002
Health				
Health deterioration	−0·140*	−0·140*	−0·064*	−0·064*
Constant	0·895*	0·092*	0·954*	0·966*
	n 3415	*n* 3415	*n* 3400	*n* 3400
	Adj. $R^2 = 0·179$	Adj. $R^2 = 0·179$	Adj. $R^2 = 0·204$	Adj. $R^2 = 0·203$

EQ-5D TTO, EuroQuol 5-Dimensional time trade-off index score of health utility; SF6-SG, Short Form 6 Standard Gamble index score of health utility; Model 1, using categorical fish consumption variable; Model 2, using dichotomous fish consumption variable (=1 for eating fish ≥ once weekly).
The reference group is below 30 years old, female, without tertiary education, does not live with a partner, does not smoke, drinks no or only little alcohol, is physically active in leisure time, eats the average amount of fruit and vegetables and eats no or only little fish.
*Coefficient was statistically significant: $P < 0·05$.

Weekly fish consumption was associated with higher primary care and pharmaceutical costs, but was not significant. However, pharmaceutical costs conditional on use were higher for weekly fish eaters. In general, inactive leisure pursuits, smoking status and having experienced health deterioration in the last year were associated with higher health-care costs. But also living with a partner and eating more fruit and vegetables were associated with higher total health-care costs. Only primary health-care costs appeared to be slightly higher for individuals with tertiary education. Age had a U-shaped effect on total health-care costs, driven primarily by decreasing hospital costs for the group aged between 30 and 50 years and increasing thereafter. This also reflects the dominant effect of hospital costs on total costs, as primary care and pharmaceutical costs both increased with age. In all models besides hospital cost conditional on utilisation, men had lower health-care costs than women.

Discussion

The present study, in which cross-sectional survey data of the Danish adult population were linked to health service register data, is the first to identify a significant relationship between regular fish intake and overall health status and hospital costs. The results support findings from several prospective cohort studies that habitual fish intake is correlated with better health outcomes for CVD and other diseases.

The study results suggest that consuming fish between twice monthly and once weekly is associated with better self-reported health utility as measured by the EQ-5D TTO and SF6-SG index scores in the Danish general population. Since higher frequencies of fish consumption were not associated with better overall health, we found no evidence to support a recommendation to increase fish intake to more than once weekly. While a New Zealand study[19] identified a positive relationship between fish consumption and the SF-36 mental health score, but not the physical score, the present analysis found a significant association between moderate fish consumption and overall health utility. This finding – that some fish consumption is fine but more is not better – has been reported in previous studies and might be associated with a potentially negative effect of environmental contaminants that can accumulate in fatty fish[20,34–36].

At this point it should be noted that fish eaters were shown to have longer education, eat more fruit and vegetables and be physically more active. All of these factors are related to better health and might explain why it is so difficult to find solid results for fish alone. Another

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Table 4 Determinants of health-care resource consumption within a two-year period (ordinary least-squares and logistic regression): Danish adults, aged 16–80 years, participating in the Funen County Health Survey, 2000–1

Model	1	2	3	4	5	6	7
	Total health-care costs	Dummy hospital costs	Hospital costs conditional on use	Dummy primary care use	Primary care costs conditional on use	Dummy medicine use	Medicine costs conditional on use
Variable	Coefficient	OR	Coefficient	OR	Coefficient	OR	Coefficient
Fish consumption	0·082	0·860*	0·0315	1·493	0·042	1·184	0·141*
Demographic							
Age 30–49 years	−0·077	0·568*	−0·140	0·784	0·131*	1·012	0·445*
Age 50–64 years	0·391*	0·716*	0·348*	0·715	0·280*	1·445*	1·499*
Age 65+ years	0·845*	1·353*	0·742*	0·745	0·341*	2·819*	1·987*
Male	−0·525*	0·808*	−0·088	0·353*	−0·380*	0·404*	−0·266*
Tertiary education							
Short	0·011	1·019	−0·145	1·104	0·119*	0·953	−0·251*
Middle	−0·002	0·985	−0·161	1·029	0·138*	0·787	−0·260*
Long	−0·057	0·990	−0·017	0·444	0·123	0·757	−0·070
In education	−0·149	0·887	−0·380*	0·903	0·022	0·857	−0·406*
Lifestyle							
Living with a partner	0·218*	1·166*	0·052	2·375*	0·124*	1·306*	−0·190*
Ever smoker	0·168*	1·276*	0·316*	0·683	0·056	1·228*	0·124*
Drinks over limit	−0·087	0·985	−0·292*	0·9168	−0·080	0·967	0·006
Physically inactive	0·283*	1·209	0·371*	0·797	0·182*	1·185	0·500*
Fruit and vegetables	0·174*	1·111	0·140	1·732	0·056	1·055	0·040
Health							
Health deterioration	0·827*	2·707*	0·331*	4·503*	0·320*	2·427*	0·403*
Constant	8·266*		8·584*		7·766*		5·895*
	n 3422	*n* 3422	*n* 1520	*n* 3422	*n* 3345	*n* 3422	*n* 2646
	Adj. $R^2 = 0·100$	$R^2 = 0·037$	Adj. $R^2 = 0·085$	$R^2 = 0·075$	Adj. $R^2 = 0·105$	$R^2 = 0·069$	Adj. $R^2 = 0·229$

The reference group is below 30 years old, female, without tertiary education, does not live with a partner, does not smoke, drinks no or only little alcohol, is physically active in leisure time, eats the average amount of fruit and vegetables and eats no or only little fish.
*Coefficient or odds ratio was statistically significant: $P < 0·05$.

explanation for the weak association between fish consumption and health could be due to increased fish consumption in response to poor health. Owing to the cross-sectional study design we cannot identify any causal effects but can only describe the observed correlations. It cannot be determined, therefore, whether self-reported health influences eating patterns or whether better health is a result of certain behaviours, including higher fish intake.

Another possible limitation of the current study relates to the size of the estimated coefficients. Although we could identify a statistical difference between fish eaters and non-fish eaters in self-reported health as measured by the EQ-5D TTO and SF6-SG index scores, the estimated coefficients for fish intake were rather small – and in fact just under the threshold for a minimal clinically important difference in generic health measures as defined by Kaplan[37]. So it is questionable whether this can be considered an important public health issue. On the other hand, the identified correlation between fish intake and health status was larger than the difference between genders or between smokers and non-smokers, which are typically considered to be important public health issues.

Moreover, it could not be shown that long-term total health-care costs may be lower for people who eat fish at least once weekly, although the costs for hospital care, which are the main drivers of total costs, were lower for weekly fish eaters due to a reduced probability of hospital utilisations for weekly fish eaters. It could be that weekly fish eaters are going sooner to their primary physician and thus getting medical care earlier than people consuming less fish. The data did not provide the possibility to differentiate between different types of medication or hospital service and therefore did not permit us to analyse the effect of fish intake on specific diseases.

The measurement of fish intake may be associated with a substantial amount of uncertainty. A cross-checked dietary history interview may have been a better method to assess fish intake. Although a previous validation study showed that measures of mean daily intake of fish were similar for the two methods[23], we cannot exclude that random misclassification of fish intake has affected our results. In addition, we were unable to test whether the association between fish intake and health status was mediated by *n*-3 PUFA (DHA and EPA), which were shown to have positive health effects in experimental and observational studies and which are found in relatively high concentrations in fatty fish[4].

Ours is the first descriptive study to explore the pattern of fish consumption in Denmark and the associated potential benefits in terms of overall health status and associated health-care expenditures. More detailed analysis is needed to determine whether the relationships between fish intake and self-reported health and

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health-care utilisation are causal. An interesting extension to the current study could be to analyse the effect of fish intake on subsequent mortality, including an analysis on specific causes of death by matching with register-based mortality data. A recent Danish study found a significant effect of a healthy dietary pattern (including fish consumption) on all-cause mortality[23]. However, dietary patterns that comprise a combination of foods are studied more frequently and it would be interesting to see whether fish has a significant effect as a single food item.

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