Reports

Regional Nutritional Pattern and Cancer Mortality in the Federal Republic of Germany

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Abstract

Regional age-adjusted mortality rates of the Federal Republic of Germany from 1976 to 1980 were correlated with regional nutritional data from a national survey on income and consumption. This survey was conducted in 1973 and covered a sample of 50,000 households. The mortality rates due to carcinomas of the stomach, colon, rectum, liver, gallbladder, pancreas, breast, and prostate and the consumption data of 15 nutrients and other compounds are shown for the 11 Federal States. For alcohol, vitamin C and calcium variations range about 20%, whereas deviations in the consumption of protein, fat, and most carbohydrates appear of minor importance. Some of the 45 correlation coefficients significant at the 5% level (out of 210) may have etiologic importance. The associations that coincide in both sexes are alcohol and disaccharide consumption with stomach cancer and protein intake with pancreatic cancer.

Because previous habits and consumption may have a stronger etiologic influence than do present ones in the induction of chronic diseases, the utilization of existing information from the 1930s (e.g., Atlas of Ethnic Studies*) and the assessment of habits in previous decades by means of case-control studies are emphasized.*

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Environmental factors are believed to play a significant role in the pathogenesis of malignant neoplasms (1). One of them, nutrition, may be considered not only for the gastrointestinal tract but also for other sites (2).

Under the hypothesis of specific etiologic relationships between nutrition and cancer, a distinct pattern of cancer incidence should result from different nutritional patterns in special populations. Such patterns have been demonstrated in several studies of nutritional habits and cancer (3–9). However, the generalization of these results requires that they not only be reproducible on a worldwide scale but also must prevail in regionally defined areas and even in individual cases. Indeed, some of these associations were confirmed in studies at the regional level (10–17). To examine the validity of certain associations, regional data on nutritional patterns for 1973 in the Federal Republic of Germany were correlated with the average mortality rates of the same regions from 1976 to 1980.

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Although correlational studies are considered unsatisfactory for etiologic research, they do establish previously recognized associations and are part of the epidemiological reasoning. Positive correlation results have often led to more detailed research and precipitated the initiation of special studies, such as case-control studies or experimental work. On the other hand, a lack of good correlation on an ecological level does not exclude a risk factor at the individual level.

Materials and Methods

Regional mortality rates were obtained from the statistical offices of the Federal States, where data are uniformly collected and computerized from 1968 on. For this study, only a five-year period (1976 to 1980) could be used for obvious reasons, such as those published (18). We used the age-adjusted mortality rate (AMR), which is a summary statistic, standardized on the World population, as a reference base for all correlations.

Regional nutritional data were derived from a national income and consumption survey. This survey was carried out in 1973 and covered a representative sample of 50,000 households. It was part of the official data sampling procedures in the Federal Republic of Germany. On it, each selected household was asked to record (in amount and cost) the consumed food items during one month. Participation was compulsory. Data were converted into individual figures by regression procedures, which are described in detail by the official report (19). This analysis does not take into account meals consumed outside the home. Calculations of the association between the mortality and nutritional data were performed by using the Pearson's correlation coefficient. The coefficients are presented in the tables by several significance levels.

Results

For 1973, Table 1 shows the regional food consumption of energy, proteins, fats of animal and vegetable origins, carbohydrates (by poly- and disaccharides), and alcohol. Data on alcohol consumption were calculated on the basis of per capita figures multiplied by average alcohol content. The percent food consumption figures for all nutrients do not differ considerably within the regions. Deviations for proteins, fats, and carbohydrates range about 6–8% in each direction and appear unimportant, whereas some contents show variability of up to 18% for vegetable fat and 14% for disaccharide. An even greater range was seen for alchohol consumption, which tends to be related to ethnicity (e.g., Bavaria's lead over Berlin is attributable to beer drinking).

The regional figures for micronutrients and other nutrient contents showed similar distributions in that the variability again was minimal except for vitamin C and calcium, which had 20% variation (Table 2). Although chance variation, bias, and assessment errors are conceivable, it may well be that these figures closely reflect the dietary patterns (e.g., alcohol consumption) which prevail in the defined regions. Several empirical studies have emphasized the regional factor in the nutritional pattern and have demonstrated that certain geographical patterns can be reliably described (20,21). We believe that today the regional variation reflects sharper regional differences that prevailed decades ago. During the last few years, more and more of these special regional nutritional behavior patterns were obscured, mostly because of peoples' mobility and the worldwide acting food industry. Nevertheless, verification of the above-mentioned summary figures and regional deviations require further study.

Tables 3 and 4 show regional AMRs by state from 1976 to 1980. The detailed nationwide cancer mortality pattern, broken down into 328 administrative districts, has been visualized in the *Atlas of Cancer Mortality in the Federal Republic of Germany* (18). In broad terms, strong regional clustering of districts was seen for stomach cancer, with decreasing frequency, and for breast cancer, with increasing trends. Regions with higher mortality rates from gastric cancer are found in Eastern Bavaria; breast cancer shows a falling trend from North to South.

Table 1. Regional Consumption of Selected Nutrients and Other Compounds as Percentage of the Average Consumption in the Federal Republic of Germany in 1973.

				Sources of Fat			Sources of Carbohydrates, g		Alcohol, g	
	Energy, kcal	Protein, g	Lipids, g	Animal, g	Vegetable, g	Carbohydrates, g	Polysaccharides	Disaccharides	Males	Females
Schleswig-Holstein	99	98	100	103	94	98	95	105	96	99
Hamburg	100	101	101	104	97	97	96	99	91	94
Lower-Saxony	98	96	100	100	101	96	95	98	98	99
Bremen	99	99	101	102	100	96	95	98	98	99
Northrhine-Westphalia	101	101	103	102	108	98	101	96	95	95
Hessen	97	97	98	98	99	96	96	98	94	94
Rhineland-Palatinate	99	98	99	98	103	100	102	97	96	98
Baden-Württemberg	102	101	98	96	102	103	103	103	98	99
Bavaria	101	102	96	99	90	104	103	107	117	113
Saarland	97	96	96	97	95	99	104	93	94	93
Berlin	101	102	100	105	93	97	98	98	110	116
Range	5%	6%	7%	9%	18%	8%	9%	14%	26%	20%
				Consumption FRG, absolute figures						
Males	3,107	87	142	93	49	278	168	110	41	
Females	2,609	73	121	79	42	247	142	105		21

Table 2. Regional Consumption of Selected Micronutrients and Other Compounds as Percentage of the Average Consumption in the Federal Republic of Germany in 1973

	Retinol equivalent, mg	Vitamin B_1, mg	Vitamin C, mg	Raw Fiber, g	Iron, mg	Calcium, mg	Cholesterol, mg
Schleswig-Holstein	102	96	97	95	93	110	100
Hamburg	102	94	105	99	97	109	102
Lower-Saxony	100	96	98	97	95	98	96
Bremen	105	96	105	100	97	104	103
Northrine-Westphalia	106	102	108	104	100	103	102
Hessen	97	98	96	97	99	97	96
Rhineland-Palatinate	100	101	99	99	102	92	99
Baden-Württemberg	99	100	98	100	103	101	102
Bavaria	94	102	88	98	102	95	99
Saarland	92	99	99	103	100	90	93
Berlin	100	100	108	104	102	107	104
Range	14%	8%	20%	9%	10%	20%	10%
			Consumption FRG, absolute figures				
Males	1.05	1.54	96	25.1	19.2	776	522
Females	0.93	1.31	91	22.4	16.1	700	454

Table 3. Regional Mortality Rates (Age-Adjusted) as Percentage of the FRG Rate (for men from 1976 to 1980)

	Stomach ICD 151	Colon ICD 153	Rectum ICD 154	Liver ICD 155	Gallbladder ICD 156	Pancreas ICD 157	Prostate ICD 185
Schleswig-Holstein	100	86	82	84	71	88	99
Hamburg	90	95	90	146	92	107	100
Lower-Saxony	94	94	98	74	114	88	93
Bremen	92	98	100	117	80	88	118
Northrhine-Westfalia	100	105	102	108	102	102	110
Hessen	85	104	102	97	98	101	93
Rhineland-Palatine	92	100	107	149	111	97	102
Baden-Württemberg	92	99	96	86	105	98	98
Bavaria	123	102	108	90	88	108	96
Saarland	77	91	111	66	90	85	83
Berlin	88	101	95	160	113	113	117
Age-adjusted mortality rate in FRG	23.46 (= 100)	13.60	9.30	2.36	2.69	7.52	15.55

Table 4. Regional Mortality Rates (Age-Adjusted) as Percentage of the FRG Rate (for women from 1976 to 1980)

	Stomach ICD 151	Colon ICD 153	Rectum ICD 154	Liver ICD 155	Gallbladder ICD 156	Pancreas ICD 157	Breast ICD 174
Schleswig-Holstein	99	93	94	86	74	102	96
Hamburg	88	101	91	133	81	108	105
Lower-Saxony	95	102	100	76	103	99	94
Bremen	90	116	108	151	74	86	104
Northrhine-Westfalia	98	109	105	117	106	100	109
Hessen	83	103	103	106	108	103	97
Rhineland-Palatine	94	108	104	170	129	95	103
Baden-Württemberg	95	88	88	79	107	101	95
Bavaria	131	90	99	68	78	99	93
Saarland	74	93	112	110	97	80	98
Berlin	90	105	105	122	116	114	111
Age-adjusted mortality rate in FRG	11.96 (= 100)	11.89	5.55	1.29	4.86	4.65	20.82

The results of a direct correlation between regional cancer mortality rates and food consumption figures are shown in Tables 5 and 6. In addition, we calculated partial correlation coefficients. Significant values at the 5% level of this partial correlation analysis were expressed by an underline in Tables 5 and 6. These calculations were done to control for possible systematic bias in deriving the regional consumption figures. The energy intake that has the lowest variation and that coincides with most of the nutrients with respect to the regional tendency was used as the control variable for calculating the partial correlation coefficients. The results of the partial correlation analysis give supplemental information about direct correlation coefficients found to be significant and may be helpful in interpretation, because with this procedure there is an impression of the influence of possible measurement errors.

We compared the correlation coefficients for stomach cancer (in males and females) with those for colon and rectal cancer. Hypothetically, dietary constituents would be suspected as factors for all three tumor sites. The correlation coefficients reflect associations of stomach cancer mortality with carbohydrates; there is an especially strong association for disaccharide

Table 5. Correlation Coefficients for Regional Consumption of Selected Nutrients in 1973 and Regional Cancer Mortality Rates from 1976 to 1980

	Stomach ICD 151		Colon ICD 153		Rectum ICD 154	
	Male	Female	Male	Female	Male	Female
Protein	0.49	0.45	0.47	−0.06	−0.13	−0.44
Lipids	−0.09	−0.19	0.11	0.64*	−0.39	−0.09
Animal fat	0.12	0.01	−0.16	0.35	−0.57*	−0.11
Vegetable fat	−0.24	−0.30	0.36	0.49	0.11	0.01
Carbohydrates	0.57*	0.69†	0.16	−0.71†	0.40	−0.39
Polysaccharides	0.12	0.36	0.27	−0.56*	0.74†	−0.05
Disaccharides	0.77†	0.81†	−0.10	−0.58*	−0.35	−0.67*
Alcohol	0.64*	0.59*	0.32	−0.14	0.24	0.00
Retinol equivalent	0.04	−0.10	0.06	0.59*	−0.50	−0.20
Vitamin B_1	0.33	0.51	0.62*	−0.25	0.52*	−0.18
Vitamin C	−0.50	−0.41	0.09	0.58*	−0.24	0.05
Crude fiber	−0.31	−0.09	0.35	0.14	0.44	0.25
Iron	0.09	0.24	0.70†	−0.09	0.64*	0.01
Calcium	0.07	−0.02	−0.22	0.19	−0.85†	−0.44
Cholesterol	0.26	0.20	0.31	0.34	−0.38	−0.32

*Denotes $0.01 < p < 0.05$.
†Denotes $p < 0.01$.
Underlining indicates significant ($p < 0.05$) partial correlations (see text).

Table 6. Correlation Coefficients for Regional Consumption of Selected Nutrients in 1973 and Regional Cancer Mortality Rates from 1976 to 1980

	Liver ICD 155		Gallbladder ICD 156		Pancreas ICD 157		Breast ICD 174	Prostate ICD 184
	Male	Female	Male	Female	Male	Female	Female	Male
Protein	0.50	−0.05	0.11	−0.09	0.83†	0.62*	0.42	0.56*
Lipids	−0.50	0.43	0.14	−0.03	0.12	0.33	0.69†	0.66*
Animal fat	0.56*	0.22	−0.20	−0.39	0.35	0.48	0.58*	0.62*
Vegetable fat	0.07	0.34	0.41	0.45	−0.18	−0.13	0.25	0.22
Carbohydrates	−0.23	−0.48	−0.03	−0.05	0.24	−0.01	−0.49	−0.28
Polysaccharides	−0.16	−0.23	0.23	0.26	0.10	−0.23	−0.27	−0.31
Disaccharides	−0.16	−0.60*	−0.36	−0.46	0.26	0.31	−0.57*	−0.03
Alcohol	0.08	−0.23	0.14	0.06	0.56*	0.48	0.14	0.13
Retinol equivalent	0.44	0.41	−0.05	−0.11	0.04	0.30	0.58*	0.77†
Vitamin B_1	0.28	−0.08	0.34	0.20	0.66*	0.29	0.25	0.02
Vitamin C	0.57*	0.48	0.19	0.05	0.13	0.29	0.81†	0.68*
Crude fiber	0.31	0.19	0.38	0.25	0.27	0.07	0.64*	0.35
Iron	0.29	0.08	0.50	0.42	0.56*	0.15	0.27	0.12
Calcium	0.37	0.05	−0.29	−0.40	0.26	0.59*	0.42	0.59*
Cholesterol	0.68*	0.32	−0.02	−0.13	0.55*	0.50	0.61*	0.87†

*Denotes $0.01 < p < 0.05$.
†Denotes $p < 0.01$.
Underlining indicates significant ($p < 0.05$) partial correlations (see text).

consumption and alcohol for both sexes. With respect to colon and rectum cancer, there was no unique pattern of association between the sexes. For colon cancer among females, several significant associations were found: lipids, vitamin C, and retinol equivalent were positively related and all sources of carbohydrates were negatively related. In men, the table shows two positive associations: one with vitamin B_1 and the other with iron. In rectum cancer, more significant results were found in males than in females. In females, there is a negative association with disaccharides, whereas in males it is with animal fat and calcium. In males, positive associations were also found with polysaccharides, vitamin B_1, and iron.

Liver cancer does not appear to be associated with alcohol consumption in either sex. But, there are other associations with nutrient intake: positive with animal fat, vitamin C, and cholesterol in males and negative with disaccharides for females. The regional variation of gallbladder cancer could not be explained by any variation of the regional consumption of nutrients without excluding chance.

Cancer of the pancreas was associated with protein intake in both sexes. Positive associations were also found with alcohol, retinol equivalent, iron, and cholesterol in males and with calcium in females.

The endocrinological cancers of the breast and prostate are positively associated with lipids, especially animal fat, retinol equivalent, vitamin C, and cholesterol. In addition, positive associations were found in breast cancer with crude fiber and negative associations with disaccharides; in prostate, positive associations were found with protein and calcium.

Discussion

The findings resulting from the correlation of aggregate data on a regional (and more or less administratively determined) level deserve attention for several reasons, despite the limitations of this type of study (22–25). First, correlations of this kind have been done in other parts of the world. It is one of the principles of epidemiology that real associations should show up under different conditions and settings repeatedly to be acceptable in a causal argument. Second, the routine data collection in a European country such as Germany, which has a long tradition of medical and vital statistics documentation, has the advantage that data contents are fairly close to reality with respect to cancer as a cause of death. Third, the regional cancer mortality patterns have shown some striking and long-lasting patterns of differential mortality from specific types of malignant neoplasms. This justifies the search for possible reasons for these regional differences. Fourth, the results of the evaluation based on comparatively large populations may well contribute to present knowledge and may reveal previously unknown associations, in addition to reconfirming already-known facts. The above objectives prompted the present study and, not surprisingly, the results are in agreement with the expected outcome.

The significant correlation coefficients, which supply consistent results for both sexes and are also consistent with the results of other studies, deserve special attention. In the case of strong etiologic associations, a similar regional distribution of malignant diseases in both sexes should be recognizable, because regional patterns of nutrition have the same quantitative distribution (Tables 1 and 2). In this study, consistent results for both sexes were only observed for cancer of the stomach and pancreas. Stomach cancer was positively related to the consumption of carbohydrates, in particular disaccharides and alcohol and pancreatic cancer to protein intake.

The possible contribution of different carbohydrates in the etiopathogenesis of stomach cancer is reported in several studies (13,26–28). However, when the consumption of sugar, a main carrier of disaccharides, was associated with stomach cancer, negative or neutral results were found (4,5,7,8,27,28). With regard to the possible contribution of alcohol consumption to the genesis of the stomach carcinoma, there is a good agreement with other studies (14,29–32).

The nonsignificant negative association between stomach cancer and vitamin C intake shows a good agreement for both sexes. This is mentioned in regard to the hypothesis of the contribution of vitamin C as an inhibitor of the formation of carcinogenic *N*-nitroso compounds (33).

The positive relation in both sexes between pancreas carcinoma and protein intake is consistent with the results of other correlation studies, which report positive asssociations with protein carriers, in particular meat, milk, and eggs (4,5,8). But, in cohort studies performed in Japan (34), an increased relative risk with more meat consumption was reported. The positive correlations of cholesterol and pancreas carcinoma, which agree very well in both sexes (although only with men significant at a level of 5%), confirm the trend of an association with animal foods. In the same way, the positive correlation of the pancreas carcinoma with alcohol consumption (again, only significant for males) was confirmed by other studies (35). However, it is uncèrtain if there is a real biological mechanism (36).

The carcinoma of the breast and the prostate have a number of significant associations with nutrients, which (for easily intelligible reasons) cannot be controlled by a corresponding differentiation of sexes as can other forms of carcinoma. If we consider the significant association individually, it is striking that they often agree for both forms of carcinoma. This points to an equal operating mechanism of the nutrients in contributing to the genesis of these tumors.

Some of the significant associations correspond to findings from other studies based on a contribution of fats and/or proteins in the pathogenesis of each tumor site (5,37–41). However, positive association with retinol equivalent and vitamin C are hard to interpret. There is definitely no causal association, but rather there are effects of a nutritional pattern specific for these areas. Furthermore, the associations between calcium and the prostate carcinoma, which correspond to findings of a positive association between prostate carcinoma and milk and cheese, should be briefly mentioned (37).

All other significant correlation coefficients are not further commented on. Because of differences in both sexes, there is only minimal evidence of actual associations. Out of a total of 210 correlation coefficients, 45 are found to be significant at the 5% level. This indicates that some of the significant correlation coefficient are not produced by change, but others could be.

Taking these limits and pointers and considering the consistency of the results with previous findings and the often strong statistical association, the weakness of correlational analysis can only be surmounted by true epidemiological studies. The strength of the case-control study and its power to identify etiologic inferences have been demonstrated (42).

Conclusion

The analysis presented here is considered a step towards the investigation of dietary habits as related to life-style and the importance of these habits in the cause or prevention of cancer. It also strengthens the case for systematic data collection and improvement of efforts to study regional food consumption patterns in the Federal Republic of Germany. The result of such an undertaking is manifold; one of the advantages will be the availability of a data source for future epidemiological research.

The regional analysis of cancer mortality, as related to regional food consumption figures, is but one of the possible uses of such data. Besides chronic disease epidemiology focusing on public health problems, much emphasis has to be centered around theoretical models and approaches to the investigation of behavioral aspects of diet and food consumption. Secular changes, such as those frequently observed in disease patterns, have also occurred in the behavior and traditions, because an increasing mobility of populations or subgroups has also brought about sweeping changes in cooking and methods of preparation of food. Thus, dif-

ferences shown in the regional analysis probably reflect earlier dietary patterns that disappeared in recent times, with almost "equal distribution" of food-related industries. The *Atlas of Ethnic Studies* (43), which was prepared in Germany before World War II, however, indicates that there were strongly pronounced regional patterns of dietary traditions in Germany in the past. Previous habits and food consumption have a stronger etiologic influence than do the present ones in the induction of chronic diseases.

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