Interactions between traditional regional determinants and socio-economic status on dietary patterns in a sample of French men

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The aim of the present study was to assess the respective contributions of regional and socio-economic factors to dietary pattern. We used the data from the final MONICA (MONItoring of trends and determinants in Cardiovascular disease) population survey conducted in the three French centres in 1995–7 among a representative sample of 976 men aged 45–64 years. Dietary intake was assessed using a 3-d record method. Dietary patterns were identified by a factor analysis, based on fifteen food items. An analysis of variance was then used to study their relationship with regional and socio-economic determinants. Two major dietary patterns were identified: a 'Western diet', characterized by high intakes of sugar and sweets, grains, butter, added fats, eggs, potatoes and cheese; a 'prudent diet', mainly distinguished by high intakes of fruit, vegetables, olive oil and fish and low intakes of alcohol, high-fat meat and potatoes. Strong associations were mostly observed with the 'prudent diet' pattern, with a significant relationship with region, educational and income-tax levels, leisure-time physical activity and smoking status. There was also a statistically significant interaction between region and educational level ($P=0.05$), and between region and income-tax level ($P=0.03$), indicating that the influence of socio-economic factors is different among regions. In conclusion, these results indicate large regional and socio-economic differences in the dietary patterns of this French male population. When considering the 'prudent diet' pattern, they also suggest that traditional regional influences may now be overcome by socio-economic determinants.

Dietary patterns: Geographical determinants: Socio-economic status

The effects of dietary factors on the development of chronic diseases, especially CVD and cancer, but also obesity, have been investigated in many experimental, clinical and epidemiological studies. The traditional analytical approach in nutritional epidemiology has largely focused on individual nutrient- or food-based analyses. However, it is often difficult to separate the specific effects of nutrients or foods because of the complexity of dietary intake and the multiple potential interactions between the components of a diet (Jacques & Tucker, 2001). The combined effects of various nutrients and foods can be observed only when the entire eating pattern is considered. In recent years another approach, based on the identification of overall dietary patterns, has been proposed (Hu, 2002). The interests of such an analysis have been underlined in many recent publications focused on the role of overall dietary patterns in chronic diseases (Jacques & Tucker, 2001; Schulze & Hu, 2002; Kant, 2004). Analysing food consumption in terms of dietary patterns is not only interesting to examine the relationship between diet and disease risk but may also have implications from a public health perspective. Identification of such patterns provides useful information to set up health and nutrition policies and guidelines for healthy food consumption.

Geographical factors are usually considered as strong determinants of dietary patterns; one of the most obvious examples of that influence is the 'Mediterranean diet', adopted by the different populations around the Mediterranean Sea (Keys *et al.* 1986). Regional differences have also been found in France, as shown in the first French MONICA (MONItoring of trends and determinants in Cardiovascular disease) population survey (Jost *et al.* 1990). People living in the south of France adopted the 'Mediterranean diet' rich in fruit and vegetables, fish, olive oil and wine, whereas in the northern regions, the traditional diet was characterized by high intakes of sausages and ham, butter, eggs, potatoes and beer.

However, some studies have suggested an attenuation of geographical differences in dietary behaviours (Huijbregts *et al.* 1997) and the strong contribution of socio-economic factors (Marmot *et al.* 1991; Roos *et al.* 1996; Margetts *et al.* 1998; Johansson *et al.* 1999) that may modulate geographical influences. Although many studies have explored dietary patterns

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Abbreviations: HF, high-fat; LF, low-fat; LPA, leisure-time physical activity.
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in relation to their determinants, very few investigations have focused on the extent to which these different determinants interact. Using the data from the final French MONICA population survey, we attempted to identify dietary patterns in a random sample of nearly 1000 middle-aged men living in France, in three distinct regions characterized by traditionally different dietary habits, and to evaluate the relative contribution of the regional and socio-economic factors to the main dietary patterns.

Methods

Study design and sample

The study is based on data from the final MONICA population survey, conducted in 1995–7 in three French centres: the Urban Community of Lille in the north (N), the department of Bas-Rhin in the north-east (NE) and the department of Haute-Garonne in the south-west (SW) of France. Study design and data collection have been described elsewhere (WHO MONICA Project Principal Investigators, 1988). The random sample, stratified by town size, was obtained from the electoral rolls. It included 3508 men and women aged 35–64 years (1195 in N, 1131 in NE and 1182 in SW). The mean participation was 58 %.

A standard questionnaire was submitted to the participants in order to identify their socio-demographic, lifestyle and health characteristics. This questionnaire included questions on socio-economic factors, health, physical activity, smoking and drinking habits, attitudes and knowledge concerning several diseases. Physical measurements and a venous blood sample were also performed by a specially trained nurse, following the recommendations of the WHO *MONICA Manual* (World Health Organization, 1986).

According to the MONICA–France study design, the nutritional study was carried out only in a subsample of men, comprising 976 subjects (376 in N, 264 in NE and 336 in SW), aged 45–64 years. Food intake data were collected by trained dietitians, using a prospective 3-d food intake record. The data were carefully checked and portions were estimated with a validated set of photographs.

Study variables

The statistical analyses were carried out using the following dietary, regional, socio-economic and lifestyle variables.

Indicators of dietary habits.   Fifteen foods or food groups collected by the 3-d food intake record were included in the analysis to describe eating patterns. These were: (1) grains: bread and cereal; (2) low-fat (LF) dairy products: milk and yoghurt; (3) cheese; (4) eggs; (5) LF meat, with less than 10 % fat (including poultry, beef, veal); (6) high-fat (HF) meat, with more than 10 % fat (including sausages, fat pork meat, lamb); (7) fish; (8) fruit; (9) vegetables; (10) potatoes; (11) sugar and sweets; (12) butter; (13) alcohol (including beer, wine and liquor); (14) added fats; (15) olive oil. All food items were expressed as mean intake in g/d.

Geographical variable.   The geographical variable was the MONICA centre, in three categories: N; NE; SW.

Socio-economic variables.   Socio-economic variables were the educational and income-tax levels. Educational level was divided into three groups: primary school; secondary school; technical training/university. Income-tax level was classified in three categories as: no and low income tax (<750 euros/year); medium income tax (750–2300 euros/year); high income tax (>2300 euros/year).

Lifestyle indicators.   Lifestyle indicators were smoking status and level of leisure-time physical activity (LPA). Smoking status was classified as no current smoking or current smoking. LPA was categorized as no LPA, moderate LPA almost every week, intensive LPA for at least 20 min once or twice a week, intensive LPA for at least 20 min three times or more per week.

Statistical analyses

Statistical analyses were performed with the Statistical Analysis Systems statistical software package version 8.2 (SAS Institute, Cary, NC, USA). Dietary patterns were identified by a factor analysis, a multivariate statistical technique that uses dietary information (from food frequency questionnaires or dietary records) to identify common underlying dimensions (factor or patterns) of food consumption. This technique aggregates specific food items on the basis of their degree of correlation (Hu, 2002). We conducted the analyses with the SAS System PROC FACTOR procedure: we used a principal component analysis to extract the initial factors and an orthogonal transformation (Varimax rotation function in SAS) to make it simpler and easier to interpret factors. To identify the number of factors to be retained, we considered eigenvalue >1·0, the scree test and the interpretability of the factors. A diagram of Cronbach's coefficient α was also used to test the pattern structure and to determine the food items contributing to the factor. Food items with absolute factor loadings >0·25 were considered as significantly contributing to the pattern. Factor scores (i.e. the individual values of the factor) for each pattern were then derived by summing observed intakes of the component food items weighted by factor loadings. These scores were subsequently used in an ANOVA to characterize the dietary patterns across the regional, socio-economic and lifestyle determinants. Furthermore, ANOVA was used to test the effects on dietary patterns of region × educational level and of region × income-tax level interactions. Results were expressed as means with their standard errors and differences in dietary patterns were regarded as significant when the P value was <0·05.

In order to minimize reporting errors, the analyses were done with and without taking into account underreporters. We identified underreporters from the ratio of daily energy intake to theoretical BMR, estimated using the Schofield equations based upon weight, age and sex (Schofield *et al.* 1985). The underreporting cut-off value was based on estimation of the lowest physically plausible energy intake for weight maintenance; in this study based on a 3-d record, the cut-off value was 1·05, as proposed by Goldberg (Goldberg *et al.* 1991).

Results

Socio-economic and lifestyle characteristics

Table 1 shows the regional, socio-economic and lifestyle characteristics of the population under study. The average age of the 976 participants was 55·1 (SD 6·1) years with 488 men aged 45–54 years and 488 men aged 55–64 years. The subjects had predominantly received secondary or technical education and the majority paid a medium or high income tax 21% were current smokers. A moderate LPA was reported by the majority of the subjects (49·3 %). About 21 % were obese (BMI ≥ 30 kg/m^2) and almost 50 % were overweight (BMI 25–29·9 kg/m^2).

Table 1. Regional, socio-economic and lifestyle characteristics of the 976 participants

	n	%
Age in years		
mean	55·1	
SD	6·1	
Region (MONICA centre)		
North	376	38·5
North-east	264	27·0
South-west	336	34·4
Educational level		
Primary	225	23·1
Secondary or technical	529	54·2
University	222	22·7
Income-tax level		
None and low	309	32·3
Medium	329	34·3
High	320	33·4
Smoking status		
No current smoking	766	78·5
Current smoking	210	21·5
Physical activity		
No LPA	178	18·3
Moderate LPA	480	49·3
Intensive LPA 1–2 times per week	179	18·4
Intensive LPA ≥3 times per week	137	14·1
BMI		
< 25 kg/m²	286	29·5
25–30 kg/m²	484	49·9
≥ 30 kg/m²	199	20·6

LPA, leisure-time physical activity.

Dietary patterns

Factor analysis extracted two major factors from the fifteen foods or food groups collected by the 3-d record. These factors accounted for 26·7 % of the total variance in food intake. The factor loading matrix is shown in Table 2. Factor 1 (termed 'Western diet') explained 13·6 % of the total variance. It was positively and heavily associated with the following foods or food groups: sugar and sweets, grains, butter, added fats, eggs, dairy products, potatoes, cheese and fruit. Factor 2 (termed 'prudent diet'), accounting for

Table 2. Factor loading matrix for the major factors (diet patterns) in the final French MONICA survey (976 men)*

	Factor 1	Factor 2
Sugar and sweets	0·70	–
Grains	0·54	–
Butter	0·50	–
Added fats	0·44	–
Eggs	0·43	–
Dairy products	0·37	0·34
Cheese	0·26	–
Fruit	0·26	0·56
Vegetables	–	0·54
Olive oil	–	0·48
Fish	–	0·32
Alcohol	–	− 0·44
High-fat meat	–	− 0·50
Potatoes	0·33	− 0·55

* Food items with absolute factor loadings >0·25 were considered as significantly contributing to a pattern and are represented in the table. A positive loading indicates a positive association with the factor, whereas a negative loading indicates an inverse association. High loadings indicate strong associations between the corresponding observed variables and patterns.

13·1 % of the variance, was positively associated with fruit, vegetables, olive oil, dairy products and fish, and negatively associated with alcohol, HF meat and potatoes. The variable LF meat, which had a very low loading, was not assigned to any factor. However, as we considered that LF meat could not be ignored, its z-score was included as a separate 'factor' in the subsequent analysis.

Geographical, socio-economic and lifestyle factors associated with the dietary patterns

The univariate associations of the two major dietary patterns and of LF meat with regional, socio-economic and lifestyle determinants were examined by ANOVA. The results, summarized by the factor score for factor 1 and factor 2 and the z-score for LF meat, are presented in Table 3.

The first dietary pattern was significantly associated with the region ($P<0.01$), men living in NE being more likely to adhere to this pattern, but not with socio-economic factors. The only significant association with lifestyle factors was found for physical activity ($P=0.04$).

All the studied regional, socio-economic and lifestyle variables were associated with the second dietary pattern. A strong association was observed with the region ($P<10^{-4}$): the 'prudent diet' was mostly favoured by men living in SW. Educational level ($P<10^{-4}$) and income-tax level ($P<10^{-3}$) also had a significant effect on this pattern, with a better adherence from people with a higher educational level and with medium or high income-tax levels. There was a significant and positive association with physical activity ($P<10^{-4}$): men who had regular physical activity favoured the 'prudent diet'. Conversely, a negative association was observed with smoking status ($P<10^{-4}$): smokers were less likely to follow that pattern.

The only significant association for LF meat was observed with the region ($P<0.01$), men from SW reporting the highest LF meat intake.

Relative contribution of regional and educational factors to the dietary patterns

In order to evaluate the relative influence of regional and socio-economic factors on the dietary patterns, the ANOVA was repeated with an interaction factor: region × educational level. We found no significant interaction either for the 'Western diet' pattern ($P=0.75$) or for LF meat ($P=0.63$). Region × educational level interaction was, however, significant ($P=0.05$) for the 'prudent diet' pattern, indicating that the contribution of these two determinants was not independent. Results are detailed in Table 4. A significant effect of the region was observed for each educational level, but was stronger for the primary and the secondary educational levels ($P<10^{-4}$) than for the university educational level ($P=0.03$). The effect of the educational level determinant was significant in the NE and N ($P<10^{-4}$), but not in the SW. A significant interaction was also observed for the 'prudent diet' ($P=0.03$), when the interaction factor region × income-tax level was considered in the ANOVA (Table 5). Seen alternatively, the prudent diet score was high in the SW, even among those with little education or low income; this was not the case in the N and NE.

None of these results was modified by the exclusion of (1) underreporters or (2) subjects reporting being on a diet for medical reason.

Table 3. Mean factor score and significance values from analysis of variance of food factors by region, educational level, income-tax level, smoking status and physical activity level

	Factor 1 'Western diet'			Factor 2 'prudent diet'			Low-fat meat (*z*-score)		
	Mean	SE	P value	Mean	SE	P value	Mean	SE	P value
Region									
North	−0.097	0.051		−0.298	0.049		−0.138	0.051	
North-east	0.178	0.061		−0.097	0.058		0.041	0.061	
South-west	−0.031	0.054	<0.01	0.409	0.052	<10^{-4}	0.122	0.054	<0.01
Educational level									
Primary	0.107	0.067		−0.249	0.065		−0.070	0.066	
Secondary or technical	−0.007	0.043		−0.056	0.042		0.023	0.043	
University	−0.093	0.067	0.10	0.383	0.066	<10^{-4}	0.015	0.067	0.49
Income-tax level									
No and low income-tax level	0.009	0.056		−0.195	0.056		−0.026	0.057	
Medium income-tax level	−0.025	0.054		0.077	0.055		0.095	0.055	
High income-tax level	−0.008	0.055	0.91	0.108	0.055	<10^{-3}	−0.052	0.056	0.14
Smoking status									
No current smoking	0.001	0.036		0.122	0.035		0.009	0.036	
Current smoking	−0.001	0.069	0.90	−0.447	0.067	<10^{-4}	−0.034	0.069	0.58
Physical activity (LPA)									
No LPA	−0.133	0.075		−0.217	0.074		−0.108	0.075	
Moderate LPA	−0.009	0.046		−0.093	0.045		0.012	0.045	
Intensive LPA 1−2 times per week	0.167	0.075		0.157	0.073		0.021	0.075	
Intensive LPA ≥3 times per week	−0.016	0.085	0.04	0.406	0.084	<10^{-4}	0.052	0.085	0.46

LPA, leisure-time physical activity.

Table 4. Mean factor score and significance values from analysis of variance of factor 2 ('prudent diet') by region for the three educational levels and by educational level in the three regions

	Region						
	North		North-east		South-west		
Educational levels	Mean	SE	Mean	SE	Mean	SE	P
Primary	−0.497	0.082	−0.517	0.170	0.344	0.114	<10^{-4}
Secondary	−0.372	0.071	−0.166	0.071	0.357	0.069	<10^{-4}
University	0.221	0.108	0.315	0.120	0.567	0.099	0.03
P value	<10^{-4}		<10^{-4}		0.20		

Table 5. Mean factor score and significance values from analysis of variance of factor 2 ('prudent diet') by region for the three income-tax levels and by income-tax level in the three regions

	Region						
	North		North-east		South-west		
Income-tax levels	Mean	SE	Mean	SE	Mean	SE	P
None or low	−0.501	0.074	−0.219	0.103	0.352	0.104	<10^{-4}
Medium	−0.314	0.086	−0.057	0.109	0.503	0.086	<10^{-4}
High	−0.017	0.09	−0.005	0.096	0.335	0.09	0.01
P value	<10^{-3}		0.28		0.33		

Discussion

In the present study, we identified two main dietary patterns in a large representative sample of French men and evaluated their association with regional, socio-economic and lifestyle determinants. The first dietary pattern, named 'Western diet', was characterized by a higher intake of sugar and sweets, grains, butter, added fats, eggs, dairy products, potatoes, cheese and fruit. The second pattern, qualified as 'prudent diet', was rich in fruit, vegetables, olive oil, dairy products and fish, and poor in alcohol, HF meat and potatoes. Some food groups (dairy products, fruit and potatoes) loaded on different patterns simultaneously. However, although dairy products loaded comparably on both patterns and cannot therefore be assigned to a particular pattern, the loading of fruit indicates a greater contribution to the 'prudent diet' pattern. For potatoes, a positive association was observed with the 'Western diet' pattern, whereas it was negative with the 'prudent diet' pattern.

The 'Western diet' pattern was influenced by regional but not by socio-economic factors, and no interaction between region and educational level and between region and income-tax level was found for this pattern. By contrast, both regional and socio-economic factors contributed to the 'prudent diet' pattern with, moreover, a positive interaction between region and educational level and between region and income-tax level, suggesting that regional influences are modulated by socio-economic influences in the N and NE.

In this sample of French men, the 'Western diet' and 'prudent diet' patterns derived from factor analysis were much like those observed in several previous studies using the same analysis. The terms 'prudent' and 'Western' dietary patterns were first used by Slattery in 1998, in a case–control study examining associations between dietary eating patterns and the risk of colon cancer. Six dietary patterns were generated by the factor analysis, among which were a 'Western pattern', characterized by a higher intake of red meat, processed meat, fast food, refined grains and sugar-containing foods, and a 'prudent pattern', characterized by a higher intake of fruit, vegetables, fish and poultry (Slattery et al. 1998). Using the data from two large cohort studies, the Nurses' Health Study and the Health Professionals' Follow-up Study, Hu also derived prudent and Western patterns, and then examined the relationship between these major eating patterns and the risk of CHD (Hu et al. 2000; Fung et al. 2001a), type 2 diabetes (van Dam et al. 2002) and biochemical markers of obesity and CVD risk (Fung et al. 2001b). A protective effect of the 'prudent diet' was demonstrated in all these studies.

Although similarities might exist between the present study and these studies of US populations, as well as some studies of European populations (Osler et al. 2001, 2002; Schulze et al. 2001), some differences can be evidenced. However, factor analysis is always data-driven, thus defining population-specific patterns. The results are likely to represent patterns that are in some aspects unique to the French population and the current study findings may therefore be limited to this population.

Geographical variations across Europe have been investigated in many studies comparing dietary patterns between northern and southern European populations (Evans et al. 1995; Holdsworth et al. 2000). A north–south gradient in diet quality has been described, with a higher intake of energy-dense foods by northern European populations, whereas southern populations are more likely to adhere to a Mediterranean-style diet, mainly characterized by a large intake of fruit and vegetables, fish and olive oil. This north–south gradient was also observed in France in the first MONICA population survey, conducted in 1985–7, which underlined the major effect of region (Jost et al. 1990; Perrin et al. 2002). Results from this earlier study showed important variations in eating habits between the three centres, which persist in the final study. The main differences in the 1985–7 study concerned the consumption of LF meat, fruit and vegetables, bread, olive oil and wine, privileged by the inhabitants of the south-west. Most of these foods were components of the 'prudent diet', still favoured in this southern region. Moreover, in this first MONICA study, the influence of the socio-economic status appeared less important than the effect of the region. Only slight differences were noted between the educational levels, with a significant higher consumption of fruit among highly educated people, and of potatoes, bread and added fats among lower-educated people.

As documented in several previous studies (Smith & Baghurst, 1992; Roos et al. 1996; Hjartaker & Lund, 1998; Margetts et al.

1998; Johansson et al. 1999), we found that dietary habits differed between low and high social status groups. Studies on the influence of socio-economic differences on dietary patterns usually report a higher intake of fruit and vegetables in people with a higher socio-economic status, which is in accordance with our results. These socio-economic differences also concerned other behaviours, like smoking or LPA. Indeed, healthy dietary habits were mainly associated with other healthy lifestyle factors. Thus, the concept of 'prudent diet' could be extended to a 'prudent profile' that includes no smoking, low alcohol consumption and LPA, which are more frequently observed in high-status groups. For several authors, the distribution of this healthy behaviour, including dietary habits, may explain differences in mortality and morbidity between social classes (Marmot et al. 1991; Lynch et al. 1996).

The main finding of the present study was the demonstration that relationships between diet and regional determinants differed according to socio-economic influences (and conversely). The influence of region was mainly observed among people of low and medium socio-economic levels, who seemed to favour their traditional region's diet. This influence was less significant among the subjects of university and high income-tax levels, who are more likely to adhere to the 'prudent diet', whatever their region of origin. Yet, in south-west France, where a Mediterranean-style diet is favoured, the effect of educational level and of income-tax level was not significant. Tradition and lower cost of healthy foods (especially of fruit and vegetables) seemed, working together, to counteract the relevance of socio-economic status in the SW region.

There are some limitations to the present study. The first one concerns the food data collection. Dietary surveys were based on a record method, which appears well adapted to evaluate total energy and macronutrient intake but is less likely to be representative of long-term dietary habits. However, the survey was carried out over a whole year, so that all seasons were equally represented. Moreover, in the MONICA centre of NE, where a food frequency questionnaire was also used to determine dietary intake, we showed that data obtained by the 3-d record and the food frequency questionnaire correlate well with regard to individual food items (unpublished results).

The second limitation could apply to all studies using a factor analysis to identify dietary patterns and has already been discussed (Martinez et al. 1998; Hu et al. 2000; Schulze et al. 2001). Results of factor analysis are strongly affected by subjective analytic but important decisions, including the assignment of food items into food groups, the number of factors to extract, the method of rotation and even the labelling of components. Finally, the two major patterns accounted for only 26 % of the total variance, which is in agreement with most previous studies using factor analysis. As the extracted patterns account only for a moderate part of the total variance, the potential existence of other patterns may be discussed. However, the percentage of variance explained by the factors should be interpreted with caution, because it largely depends on the total number of variables included in the analysis and on the degree to which these variables are reduced.

In conclusion, this study identified in a French population two main dietary patterns, opposed in terms of nutritional quality, and indicate large regional and socio-economic differences in these patterns. Our main finding was the demonstration that the contribution of regional and socio-economic factors was not

independent. Our results suggest that a low socio-economic status population is at relatively higher risk of diet-related health problems in regions where the traditional diet is of low quality, thus identifying a population potentially in special need of attention from public health agencies.

Acknowledgements

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