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Association between nutrition knowledge and nutritional intake in middle-aged men from Northern France

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Abstract

Objective: The way in which nutrition knowledge transforms into dietary behaviour and nutrient intake may vary among populations. Therefore, the goal of the study was to examine whether nutrition knowledge is associated with nutritional intake in middle-aged men who are at major risk of cardiovascular disease.
Design: Cross-sectional population study aimed at comparing the response to a nutrition quiz with food habits and nutrient intake determined by a 3-day food record.
Setting: Men of the Urban Community of Lille (France) examined at home.
Subjects: 361 men aged 45–64 y, randomly selected from the electoral rolls.
Results: Subjects were separated in a high-score ($n = 59$) and a low-score ($n = 41$) group according to their responses to the nutrition quiz. Subjects in the high-score group had better educational and higher income levels than those from the low-score group. Multivariate analysis, adjusting on educational and socio-economic levels and other confounding variables – such as age, body mass index, cigarette smoking, physical activity and energy intake underreporting – showed that subjects in the high-score group were more often consumers of olive oil (36 vs. 12%; $p = 0.06$), cheese (85 vs. 76%; $p < 0.01$) or cereals (27 vs. 15%; $p < 0.04$) and less often consumers of sunflower oil (51 vs. 68%; $p < 0.02$) or dry vegetables (12 vs. 22%; $p < 0.05$) than those in the low-score group. Subjects in the high-score group had lower intakes of fat (89 ± 24 vs. 104 ± 38 g/d; $p = 0.04$) and especially of monounsaturated fat of animal origin (23 ± 9 vs. 29 ± 13 g/d; $p = 0.01$) than individuals in the low-score group.
Conclusion: Nutrition quiz score is associated with specific patterns of food choices and nutrient intake suggesting that nutrition knowledge influences dietary behaviour in middle-aged men from Northern France.

Keywords
Nutrition
Knowledge
Food choices
Epidemiology
Cardiovascular prevention

Introduction

Among different regions of France, the Northern area shows regularly the worse health indicators[1]. Among these indicators, coronary mortality rates are higher in the North of France than in the South[2]. Other studies have shown that middle-aged men from Northern France, who are at a great risk for coronary heart disease, have higher intakes of saturated fat and lower intakes of fruits and vegetables than those of Southern regions of France[3]. These observations indicate that middle-aged men from Northern France are targets for nutrition intervention, in order to improve their general health status.

Understanding the reasons that influence food choices is essential for establishing effective ways to improve nutritional habits. These habits depend on various factors including socio-economic status[4–6], level of education[7], personal beliefs[7,8], food availability and nutrition knowledge. The latter factors differ widely among geographical areas which may contribute to the important variability in food choices among populations or within populations with different cultural backgrounds[9].

Nutrition knowledge is not necessarily related to dietary behaviour[10–12]. In most studies in which the association between nutrition knowledge and dietary behaviour has been analysed, the association was found positive and generally weak[13] most probably because cultural, educational, economic factors as well as food availability have an important influence on dietary behaviour and food choices.

Since the way in which nutrition knowledge transforms into dietary behaviour and nutrient intake may vary

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Table 1 Results of the nutrition knowledge quiz

		Correct/random	p^*
Part 1: Biochemistry			
Protein	Does fish contain as much protein as meat?		
	yes/no	89%/50%	$p < 0.0001$
	Are proteins of animal origin only?		
	yes/no	66%/50%	$p < 0.0001$
Lipids	Does peanut oil contain as much fat as sunflower oil?		
	yes/no	45%/50%	ns
	What is a 'polyunsaturated fatty acid'?		
	a nutrient that increases blood cholesterol level/a drug/a componant of oil and fish	51%/33%	$p < 0.0001$
Cholesterol	Among the following items, which one contains cholesterol?		
	200 g of French fries cooked in vegetable oil/3 rings of dried sausage/1 avocado	22%/33%	$p < 0.001$
	How much cholesterol does a glass of peanut oil contain?		
	0 mg/10 mg/10 mg	10%/33%	$p < 0.0001$
	Do eggs contain a lot of cholesterol?		
	yes/no	81%/50%	$p < 0.0001$
Part 2: Health			
	It is necessary to eat meat twice a day?		
	yes/no	96%/50%	$p < 0.0001$
	Is cooking with butter healthier than with vegetable oil?		
	yes/no	84%/50%	$p < 0.0001$
	Are dry vegetables nutritive?		
	yes/no	73%/50%	$p < 0.0001$

n = 361. *Chi-square analysis was used to assess the difference from random response. ns = not statistically significant.
Correct answers are underlined.

among populations, it appears important to assess whether nutrition knowledge is associated with particular food choices and nutrient intake before any nutrition intervention is initiated in a given population. Therefore, the goal of the present study was to examine whether nutrition knowledge is associated with food consumption and nutritional intake in middle-aged men from Northern France.

Material and methods

Population

The participants were recruited in the framework of the third WHO-MONICA population survey, between May 1995 and November 1996, in the Urban Community of Lille, in Northern France (MONICA centre number 59). The sample included 361 men, aged 45–64 y, randomly selected from the electoral rolls of the Urban Community of Lille. The participation rate was 77.2%. The protocol was approved by the appropriate Ethical Committees according to the regulations in France. Participants were examined at home. After signing an informed consent, they were administered a standard questionnaire, including about 300 questions, and physical measurements were made by a specially trained nurse, as explained in the MONICA manual (MONICA manual, memo 214, March 1992). The questionnaire covered questions on health, socio-economic factors, physical activity, smoking,

Table 2 Nutrition score and % of correct answers according to previous medical history

	Controls	Hyperchol†	Diab‡
Number of subjects	265	94	35
Score (mean ± SD)	6.1±1.4	6.4±1.3	6.3±1.1
Questions (% of correct answers)			
Does fish contain as much protein as meat?	87%	94%	88%
Are proteins of animal origin only?	68%	60%	65%
Does peanut oil contain as much fat as sunflower oil?	46%	44%	38%
What is a 'polyunsaturated fatty acid'?	48%	61%	56%
Among the following items, which one contains cholesterol?	26%	13%*	18%
How much cholesterol does a glass of peanut oil contain?	9%	15%*	15%*
Do eggs contain a lot of cholesterol?	77%	88%**	91%*
Is it necessary to eat meat twice a day?	95%	98%	100%
Is cooking with butter healthier than with vegetable oil?	83%	88%	82%
Are dry vegetables nutritive?	71%	77%	82%

Controls = individuals without previous history of hypercholesterolemia and diabetes. Hyperchol = hypercholesterolemia. Diab = diabetes.
Multivariate analysis of variance (for mean value comparison) and logistic regression analysis (for percentage comparison) were used adjusting for age, bmi, educational level, housing, physical activity and smoking. †comparison between controls and hyperchol. ‡comparison between controls and diab. *$p \leq 0.05$. **:$p \leq 0.01$.

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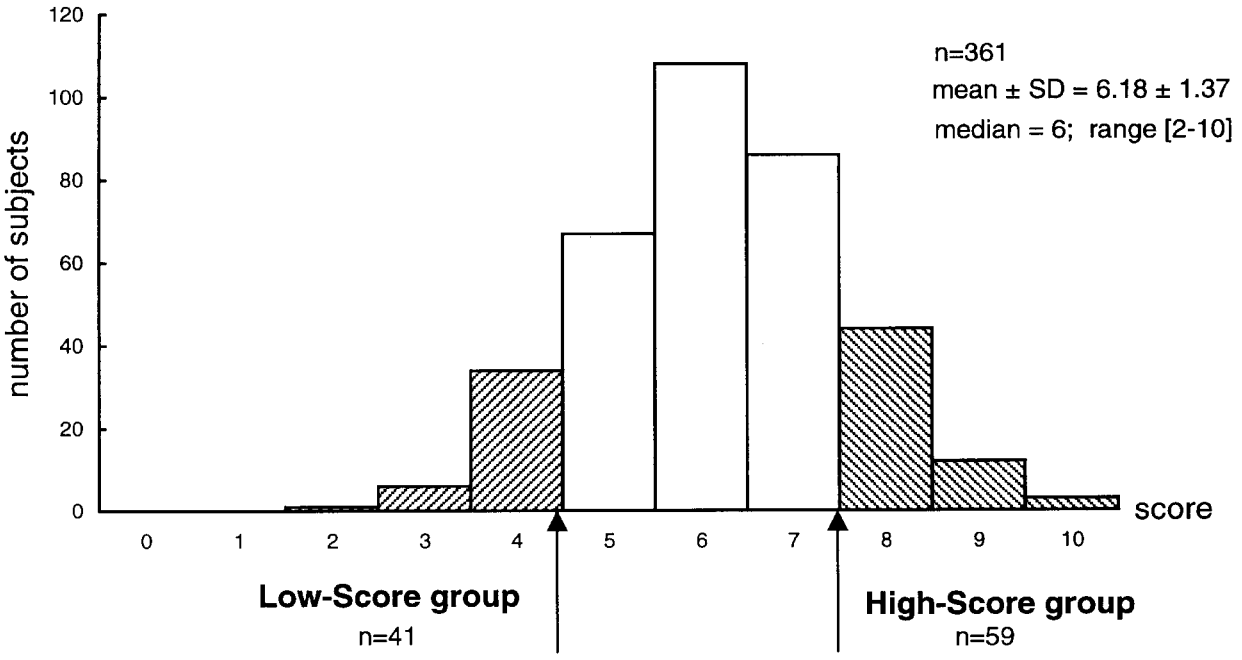

Fig. 1. Nutrition knowledge score distribution in the sample of 361 middle-aged men from Northern France.

alcohol consumption, personal medical history, family history and current drug therapy. Anthropometric measurements were taken on subjects in light clothing without shoes. Physical activity was assessed by means of 8 questions related to activities during work and leisure times, on working days and weekends. Subjects were declared active if they performed more than 2 hours of sports per week, and/or walked or rode a bicycle to work for more than 15 min per day, and/or manipulated heavy loads (>25 kg) during their working hours. Smoking status was determined by questions on present and past habits, number and type of cigarettes, cigars or pipe smoked per day. Smokers were defined as individuals currently smoking at least one cigarette per day. Educational level was classified into 3 categories (primary school, secondary school or technical training, and university). Data on levels of income tax and occupation categories were also recorded.

Nutrition

Each subject was interviewed at home by a registered dietician. Food intake was assessed by means of a 3-day food record. In this record, participants were asked to report in detail their daily food and drink intake as well as portion sizes in usual household measures during three consecutive days. They also had to explain their cooking methods, the type of fat they used, including shortening and dressings. The questionnaire was reviewed and corrected by the dietician, quantified using photographic models and standard weights. Food quantities were computed and translated into energy and nutrient values using the Renaud's[14] and McCance's[15] food composition tables, completed by data obtained from food manufacturers. Each food was classified into 26 categories. The 'consumers' were defined as those who declared consuming more than 1/3 of an arbitrary daily portion of a food item. The cut-off points are presented in Table 4. The 'daily serving size' was calculated exclusively in the group of 'consumers'.

Two strategies were used to account for underreporting. First, subjects were defined as underreporters if they declared a total energy intake lower than 1.05 their basic meabolic rate[16] which was estimated from weight, height, age and gender as reported previously[17]. Underreporting was then included in the multivariate analysis as a confounding variable (see results). Second, underreporters were defined as people with a reported ratio of energy intake to basal metabolic rate lower than 1.20. Analyses were performed in this sample after excluding underreporters. Both strategies gave similar results. For the sake of clarity, only the first strategy is presented in this paper.

Nutrition knowledge

Nutrition knowledge was evaluated with a 10-question form concerning food composition and nutrition practices. This quiz was added to the 300-question standard MONICA questionnaire and to the 3-day food record and had to be concise for practical reasons and time constraints. The aim of the questionnaire was to assess nutrition knowledge related to food and nutrients involved in coronary heart disease risk control. This quiz was adapted from a questionnaire that was used in the Preventive Medicine Centre at the Pasteur Institute of

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Table 3 Clinical and socio-economic characteristics according to nutrition score

		Low-score	High-score	*p*
n		41	59	
Age (years)		53±6	54±7	ns
Body mass index (kg/m^2)		26.6±4.3	27.3±3.8	ns
Waist-to-hip ratio		0.95±0.07	0.96±0.06	ns
Hypercholesterolemia (%)		17	29	ns
Diabetes (%)		2	10	ns
Current smokers (%)		37	24	ns
Physical activity (% active)		37	32	ns
Underreporters (%)		22	25	ns
Educational level (%)	Primary	56	31	<0.01
	Secondary and technical	32	32	
	University	12	37	
Schooling duration (years)		9.4±2.5	11.5±4.7	<0.01
Occupational category (%)	High	17	36	<0.01
	Middle	15	27	
	Low	68	37	
Income tax level (%)	None	17	12	0.07
	Low	35	17	
	Medium	28	30	
	High	20	41	
Housing (%)	<4 rooms	27	15	<0.02
	4 rooms	39	20	
	5 rooms	19	29	
	>5 rooms	15	36	
Home owners (%)		61	86	<0.01

Values are mean ± SD or %. Chi-square analysis and Fisher exact test when necessary were used for qualitative data and Student's T-test for quantitative data. Active people have a physical activity greater than #15 min waling per day. Underreporters declared energy intake < 1.05 × BMR. Occupation categories: High = farmers, craft workers, shop owners, managers, senior executives, professors and engineers; Middle = middle rank executives and technicians; Low = employees in private or public companies, personal service workers military, police, skilled and unskilled workers. Income tax levels: Low < 5000FF/y; Medium 5000 to 15000ff/y; High > 15000ff/y. ns: not statistically significant. Low-score: score ≤ 4; High-score: score > 7.

Lille and was tested for understanding and difficulty in a sample of 30 middle-aged men. The goal of the pre-test was to avoid ceiling and floor effects in scoring. Successful answer was quoted 1 point (see Table 1).

Statistical analysis

The SAS software release 6.12 was used (SAS Institute Inc, Comp, NC, USA). Univariate analyses for qualitative data were performed using Chi-square test, Fisher's exact test when necessary and multivariate logistic regression. Because of the non-Gaussian distribution of food intakes, the Wilcoxon's test was preferred to compare quantitative variables. Student's T-test and general linear model were used for univariate and multivariate analyses of normally distributed data.

Results

The results of individual responses to the nutritional quiz differed from chance in nine out of ten questions (Table 1). The mean (±SD) and median score values equalled 6.18 (±1.37) and 6 (range [2–10]) respectively (Fig. 1). Univariate analysis indicates that the nutrition score was positively associated with the level of education ($p < 0.02$), duration of schooling ($p < 0.01$), occupation category ($p < 0.006$), income tax level ($p < 0.04$), estate properties ($p < 0.005$) and size of house ($p = 0.05$), but not with age, body mass index, waist-to-hip ratio, cigarette smoking, physical activity and energy intake underreporting.

Since individuals with a medical history of metabolic disease such as hypercholesterolemia and diabetes are more likely to be informed about diet, nutrients and foods, we compared the answers of affected subjects with those of healthy controls. There were a number of differences in clinical variables between hypercholesterolemic subjects and controls such as body mass index (28.8 ± 4.7 vs. 26.5 ± 3.9 kg/m^2 respectively; $p = 0.0001$) and waist-to-hip ratio (0.98 ± 0.07 vs. 0.95 ± 0.07; $p = 0.0001$). Similarly, there were differences in body mass index (29.4 ± 4.2 vs. 26.5 ± 3.9 kg/m^2; $p = 0.0001$) and waist-to-hip ratio (0.98 ± 0.06 vs. 0.95 ± 0.07; $p = 0.008$) between diabetics subjects and controls respectively. Importantly, the educational level and occupational category were not different among groups. The mean score was not statistically different between subjects with a personal history of hypercholesterolemia (mean ± SD : 6.39 ± 1.33 vs. 6.10 ± 1.38; ns) or diabetes (6.35 ± 1.12 vs. 6.10 ± 1.38; ns) and healthy controls (Table 2). However, subjects with hypercholesterolemia or diabetes had significantly better responses to two out of three questions related to 'cholesterol' than the healthy control group. However, to the one question related to the cholesterol content of French fries, dried sausage and avocado, subjects with hypercholesterolemia did not perform as well as healthy controls did.

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Table 4 Food items' consumers and size of serving according to nutrition score

	Consumption cut-off (g/day)	Low-score consumers	High-score in percent	p†	p‡	Low-Score consumer's serving size (g/day)		High-Score		p§
Low fat meat	>40	58%	58%			67	[40–225]	73	[40–283]	
High fat meat	>40	95%	83%	0.07		138	[40–400]	107	[43–337]	0.03
Fish and seafood	>30	39%	53%			81	[33–133]	67	[33–370]	
Eggs	>20	51%	53%			48	[24–135]	46	[20–127]	
Cheese	>15	76%	85%		<0.01	53	[15–177]	47	[17–160]	
Green vegetables	>70	85%	93%			167	[70–431]	187	[75–521]	
Dry vegetables	>30	22%	12%		<0.05	40	[30–60]	37	[30–50]	
Fruit and juices	>50	61%	75%			183	[65–1191]	200	[53–549]	
Cereals	>70	15%	27%		<0.04	101	[73–152]	88	[72–145]	
Bread	>20	95%	95%			113	[27–280]	112	[22–280]	
Butter	>5	78%	75%			23	[5–70]	22	[7–50]	
Margarines	>5	66%	58%			12	[5–40]	8	[5–40]	
Vegetable oils	>1	93%	93%			12	[1–65]	12	[1–30]	
Sunflower oil	>1	68%	51%	0.08	<0.02	7	[1–18]	6	[1–20]	
Peanut oil	>1	58%	39%	0.05		8	[3–53]	6	[1–20]	
Olive oil	>1	12%	36%	<0.01	0.06	1.5	[1–3]	5	[1.5–27]	<0.002
Sugar	>5	93%	85%			37	[8–182]	34	[5–85]	
Beer	>80	51%	56%			717	[83–1567]	267	[83–1000]	0.007

The consumers were defined as individuals who declared consuming more than 1/3 of an arbitrary daily serving of a food item. †chi-square, ‡logistic regression adjusted for age, BMI, educational level, housing, physical activity, tobacco consumption, previous history of diabetes, hypercholesterolemia or high blood pressure and underreporting.
Portions are expressed as median and range [in brackets], §Wilcoxon's test was used to compare size of serving. P values in blank spaces are ns (no significant).
Values for milk, dairy produce, potatoes, animal fats, other vegetable oils, coffee, wine and spirits consumption are not presented (ns).

In order to avoid the confounding influence of random responses, we compared subjects who succeeded in answering the questions (score >7) to those who failed (score ≤4), excluding individuals with a score between 5 and 7. It was assumed that individuals with score >7 (high-score) had an 'appropriate' nutrition knowledge, whereas those with score ≤4 (low-score) had an 'incorrect' nutrition knowledge. Both groups differed with respect to the level of education ($p < 0.01$), duration of schooling ($p < 0.01$), occupation category ($p < 0.01$), income tax level ($p = 0.07$), size of house ($p < 0.02$) and estate properties ($p < 0.01$) (Table 3). On average, subjects in the high-score group were more educated and had a better socio-economic status than those from the low-score group. There was, however, no statistically significant difference between groups for age, body mass index, waist-to-hip ratio, smoking status, physical activity, energy intake underreporting and previous medical history of hypercholesterolemia and diabetes.

In order to test whether nutrition knowledge is associated with both food consumption and serving size, we compared the food items and serving portions between the high- and low-score groups (Table 4). There were more consumers of olive oil ($p < 0.01$) and less of fatty meat ($p = 0.07$), sunflower oil ($p = 0.08$) or peanut oil ($p = 0.05$) in the high-score group compared to the low-score group. Multivariate analysis, adjusting on educational and socio-economic levels and other confounding variables such as age, body mass index, physical activity, tobacco consumption, previous histories of diabetes, hypercholesterolemia or high blood pressure and underreporting, showed that subjects in the high-score group were more often consumers of olive oil (36 vs. 12%; $p = 0.06$), cheese (85 vs. 76%; $p < 0.01$) or cereals (27 vs. 15%; $p < 0.04$), and less often consumers of sunflower oil (51 vs. 68%; $p < 0.02$) or dry vegetables (12 vs. 22%; $p < 0.05$) than individuals in the low-score group. Similarly, the serving sizes were larger for olive oil ($p < 0.002$) and lower for fatty meat ($p = 0.03$) or beer ($p = 0.007$) in the high-score than in the low-score group.

Finally, we tested whether nutrition score was associated with nutritional intake (Table 5). In the high-score group, intakes of lipid (as percent of non-alcoholic energy; $p = 0.05$), total fat ($p = 0.01$), saturated fat ($p = 0.04$) and monounsaturated fat of animal origin ($p = 0.005$) were significantly lower than in the low-score group. After adjustment on educational and socio-economic variables and confounding factors such as age, body mass index, underreporting or previous medical histories, total fat ($p = 0.04$) and monounsaturated fat of animal origin ($p = 0.01$) intakes remained significantly lower in the high- than in the low-score group.

Discussion

The results of the present study showed that middle-aged men from Northern France who succeeded in answering a nutrition quiz have a specific dietary behaviour characterised by a greater consumption of olive oil and a lower intake of fatty meat. This resulted in a lower dietary fat of animal origin consumption. The differences in food and nutrient patterns between those who succeeded and those who failed at the nutrition quiz remained significant

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Table 5 Daily caloric and nutrient intake according to nutrition score

	Low-score	High-score	*p*†	*p*‡
Total energy intake (kj/d) (cal/d)energy	10.4±3.4 (2484±826)	9.3±2.0 (2237±487)	ns	ns
Non-alcoholic energy (kj/d) (cal/d)	9.4±3.2 (2551±772)	8.4±1.9 (2016±456)	ns	ns
% of non-alcoholic energy				
Protein %	18±4	18±4	ns	ns
Lipid %	42±6	40±5	0.05	ns
Carbohydrate %	40±7	40±5	ns	ns
Alcohol (g/d)	33±27	32±30	ns	ns
Total carbohydrate (g/d)	223±97	208±59	ns	ns
Total protein (g/d)	93±29	87±23	ns	ns
Total fat (g/d)	104±38	89±24	0.01	0.04
Saturated (g/d)	44±18	37±14	0.04	ns
Monounsaturated (g/d)	37±15	31±9	0.007	0.02
MUFA of animal origin (g/d)	29±13	23±9	0.005	0.01
MUFA of vegetable origin (g/d)	8±6	8±5	ns	ns
Polyunsaturated (g/d)	14±7	13±6	ns	ns
Linoleic acid (g/d)	12±6	11±6	ns	ns
P/S ratio	0.36±0.18	0.40±0.27	ns	ns
Cholesterol (mg/d)	534±314	461±167	ns	ns
Dietary fibre (g/d)	14±8	15±6	ns	ns

Values are means ± SD. Analysis of variance was used to compare mean values. †non adjusted data. ‡data adjusted for age, BMI, educational level, housing, physical activity, tobacco consumption, previous history of diabetes, hypercholesterolemia or high blood pressure and underreporting.
MUFA = monounsaturated fatty acid. P/S ratio = polyunsaturated/saturated fatty acids. ns: not significant.

after adjustment on educational and socio-economic factors. This suggests that nutrition knowledge influences food consumption and nutrient intake in French men aged 45 to 64 years.

There was 3 and 2 times more consumers of olive oil and cereals, respectively, in the high-score group than in the low-score group. The increase in olive oil corresponded to a substitution of olive oil for peanut and sunflower oil. Therefore, vegetal fat intake was not quantitatively but qualitatively modified. In the last decade, the Mediterranean diet and olive oil consumption have been favourably considered in the medical community[18,19]. As such, olive oil received great advertisement and promotion in the media, which could have influenced individuals who cared about nutrition. The greater consumption of cereals and cheese in the high-score group may be related to an attitude of nutritionally educated subjects who have more structured meals with: entrée, main course, salad, cheese and dessert. For instance, in young French students, the daily pattern of meal intake is close to the traditional three-meals-a-day model[20]. Accordingly, breakfast consumption is more frequent in French university students with positive beliefs about nutrition than in others[20].

Subjects from the high-score group consumed less total fat, saturated fat and monounsaturated fat of animal origin than those of the low-score group. After adjusting for confounding variables, the intake of total fat and monounsaturated fat of animal origin remained significantly lower in the high- than in the low-score group suggesting that nutrition knowledge influences nutrient intake. Therefore as a general rule, it appears that nutrient intake is more favourable in individuals with a better nutrition knowledge. However, despite this better nutrient profile for middle-aged men, the absolute intake of fat was still above the recommended guidelines[21] for the vast majority of subjects, suggesting that nutrition knowledge *per se* is not sufficient to implement appropriate nutrient intake[22]. This hypothesis is in agreement with previous studies[13] which demonstrated that the relationship between nutrition knowledge and healthy food behaviour is weak in the general population. One possible explanation for such a modest association could be related to the selective group of subjects, since both men and elderly subjects are less likely to be informed on nutrition than women and young adults[20,23].

Not surprisingly, individuals with better education and higher income levels had a better score on nutrition quiz[7,24]. The reasons for these associations are quite self-evident for educational level. More intriguing, however, is the lack of association between nutrition knowledge and dyslipidemia or diabetes. In the present study, we expected that subjects with metabolic diseases would be more aware of the relationship between nutrients and health problems than healthy controls. A number of reasons may explain this lack of association. First, the nutrition questionnaire may have been particularly difficult or too general for these patients. In agreement with the latter hypothesis, dyslipidemic patients tend to perform better the questions related to lipid metabolism. Second, these patients may not be properly advised on healthy nutritional attitudes[25,26] resulting in confusion over dietary recommendations[5,27,28].

In conclusion, in middle-aged men from Northern France, a better nutrition knowledge is associated with specific patterns of nutritional intake. This association

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remained after adjustment on educational level, socio-economic factors and other confounding variables. These data have potential implications in public health education and chronic disease prevention, since they demonstrated that nutritionally informed or educated people can modify their attitudes towards food choice and nutrient intake. These findings suggest that public health interventions designed to promote healthy nutritional habits in the population at large or in patients with metabolic diseases, should be given with comprehensible explanations. The understanding of the association between nutrition and health should help people to choose healthy diets.

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