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Association between a dietary quality index based on the food standard agency nutrient profiling system and cardiovascular disease risk among French adults

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ABSTRACT

Background: In France, the implementation of a front-of-pack (FOP) nutrition label–the 5-Colour Nutrition Label (5-CNL) is currently under consideration as a strategic tool to allow consumers making healthier food choices. This FOP label is based on the British Food Standards Agency Nutrient Profiling System (FSA-NPS), reflecting the overall nutritional quality of foods. At the individual level, an energy-weighted mean of all FSA-NPS scores of foods usually consumed has been elaborated (FSA-NPS DI). Our objective was to investigate the prospective association between the FSA-NPS DI and cardiovascular disease (CVD) risk.

Methods: 75,801 participants to the NutriNet-Santé cohort, who completed at least three 24 h dietary records during the first 2 y of the follow-up, were followed between 2009 and 2016. Multivariable Cox proportional hazards models were used to characterize the associations between FSA-NPS DI and the incidence of CVDs.

Results: 509 major cardiovascular events were diagnosed (262 coronary heart diseases and 247 strokes). A higher FSA-NPS DI, characterizing lower dietary quality, was associated with increased CVD risk ($HR_{\text{for a 1-point increment}} = 1.08$ (1.03–1.13); $HR_{Q4vs.Q1} = 1.40$ (1.06–1.84), $P_{\text{trend Q4-Q1}} = 0.01$). This association tended to be stronger in overweight subjects ($HR_{\text{for a 1-point increment}} = 1.12$ (1.04–1.19); $P_{\text{interaction}} = 0.003$).

Conclusions: These results suggest that lower dietary quality, as reflected by a higher FSA-NPS DI, may be associated with a significant increase in cardiovascular risk, especially in at-risk individuals (overweight population). They support the public health relevance of developing a front-of-pack nutrition label based on this score.

1. Introduction

Cardiovascular diseases (CVDs) account for almost one third of all deaths worldwide, and also present a large burden in terms of loss of quality of life among the affected patients [1]. Among the modifiable environmental factors involved in the aetiology of CVDs, diet and physical activity play a decisive role [2]. Currently, there is a growing consensus that overall dietary patterns rather than individual nutrients should be targeted in the context of effective prevention strategies [3–5].

Therefore, nutrition-labelling schemes have emerged as potentially useful tools to guide consumers towards healthier food choices. Some of the labels are based on scores attributed to each food according to its nutritional quality, using a nutrient profiling system (NPS) [6–8]. Such strategies aim to help consumers make well-informed and empowering them in choosing healthier products, as prescribed by the WHO [9] and Organization for Economic Co-operation and Development [10]. In France, public policy makers are currently considering the implementation of a nutrition label on the front-of-pack of food products. The Five-Colors Nutrition label (5-CNL) has been suggested on the basis of several scientific studies as a strategic tool to allow consumers making healthier food choices. It focuses on the overall nutritional quality of food items, and has been evaluated as the easiest to identify and to understand (in comparison to other nutrition labels) [11,12]. The 5-CNL is based on the British Food Standards Agency NPS (FSA-NPS), one of the most scientifically validated system in the European Union [8,9]. This index permits the account for nutritional variability across food groups, but also within food groups [13,14]. In order to investigate the validity and usability of nutrition-labelling schemes [15], a dietary index based on the FSA-NPS (the FSA-NPS DI), reflecting the overall quality of the diet at the individual level, has recently been validated in France (16;17). Previously published investigations

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have shown that a higher FSA-NPS DI (reflecting choices of foods of lower nutritional quality) was associated with an increased risk of long-term weight gain [18], incidence of the metabolic syndrome [19], cancer [20] and CVDs [21] in the French SU·VI.MAX cohort (1994–2002).

Therefore, the aim of the present prospective study was to provide up-to-date information on the association between the FSA-NPS DI score and the risk of incident CVDs in the ongoing large-scale French NutriNet-Santé cohort, using detailed dietary data reflecting today's reality of dietary habits and the range of food products on the market. In addition, to assess whether diet quality had the same potential impact on CVD risk in subjects who were more or less at risk of cardio-metabolic disorders, we also explored whether these associations were modulated by known modifiable CVD risk factors.

2. Methods

2.1. Study population

Participants were a sample of volunteers from the NutriNet-Santé study, a prospective observational cohort study launched in May 2009 in order to evaluate the determinants of eating behaviours and the relationships between nutrition and chronic disease risk. Inclusion criteria were residence in France, age above 18 years and access to the Internet. Registration and participation took place online using a dedicated web site (www.etude-NutriNet-sante.fr). The NutriNet-Santé study's aims and methods have been described in details elsewhere [22]. Informed consent is obtained electronically from all participants. All procedures were approved by the International Research Board of the French Institute for Health and Medical Research (IRB Inserm no. 0000388FWA00005831) and the French National Information and Citizen Freedom Commission "CNIL" (no. 908450 and 909216).

2.2. Cases ascertainment

Participants self-declared health events through the yearly health status questionnaire, through a specific check-up questionnaire for health events (every three months) or at any time through a specific interface on the study website. Following this declaration, participants were invited to send their medical records (diagnosis, hospitalization, radiological reports, electrocardiograms, etc.) and, if necessary, the study physicians contacted the participants' treating physician or the medical structures to collect additional information. Then, medical data were reviewed for the validation of major health events. Vital status and causes of death were identified via the national death registry (CepiDC Inserm). The present study focused on all first incident stroke, myocardial infarctions, acute coronorary syndromes and angioplasty diagnosed between the inclusion and March 2016.

2.3. Data collection

2.3.1. Sociodemographic, lifestyle and anthropometric data

Baseline validated [23] self-administered questionnaires were administered to collect data on sociodemographic, lifestyle and behavioral characteristics, including sex, age, geographical region, marital status, number of children, educational level, smoking status, weight and height and leisure-time physical activity (international physical activity questionnaire [24]).

2.3.2. Dietary data

At baseline, participants were invited to complete three non-consecutive validated [25–27] web-based 24-h dietary records, randomly distributed between week and weekend days to account for intra-individual variability. The questionnaires were completed via a secured user-friendly interface that was designed for self-administration on the Internet. Participants reported all foods and beverages (type and quantity) consumed at each meal (breakfast, lunch, dinner) or any other eating occasion. Portion sizes were assessed using photographs directly included in the computerised interface. These photographs, from a validated picture booklet [28], represent more than 250 foods (corresponding to 1000 generic foods) proposed in three different portion sizes. Along with the two intermediate and two extreme quantities, there are seven choices of amounts. Instead of using the photographs, the participant can directly enter the quantity consumed in grams or volume, if known. Values for energy, macronutrients and main micronutrients came from a published ad hoc food composition database [29]. We excluded energy under-reporting participants using the method proposed by Black [30].

2.4. FSA-NPS DI construction

As previously described (13;16) the FSA-NPS score for foods and beverages was calculated taking into account nutrient content for 100 g. FSA-NPS scores for foods and non-alcoholic beverages are based on a discrete continuous scale ranging theoretically from −15 (most healthy) to +40 (less healthy). Points (0−10) are allocated for content in energy (KJ), total sugar (g), saturated fatty acids (g) and sodium (mg). Points (0–5) are subtracted from the previous sum, according to the content in fruits, vegetables (%), fibers (g) and proteins (g). An increase of this score therefore reflects decreasing nutritional quality of the food or beverage item. Modifications of the original score were applied for cheese, added fats and beverages, to comply with French nutritional recommendations, as advised by the French High Council for Public Health [31] (Supplementary material 1).

In a second step, the FSA-NPS DI was calculated at the individual level using arithmetic energy-weighted means with the following equation [16], in which i represents a food or beverage consumed by the subject, FSi represents the food (or beverage) score, Ei represents the mean daily energy intake from this food or beverage and n represents the number of different food/beverage items consumed by the individual across his/her dietary records:

$$\mathrm{FSA-NPS\ DI} = \frac{\sum_{i=1}^{n} \mathrm{FS_i E_i}}{\sum_{i=1}^{n} \mathrm{E_i}}$$

Increasing FSA-NPS DI therefore reflects decreasing quality of the overall diet.

2.5. Statistical analyses

Baseline characteristics are reported as mean (SD) or N (%), according to sex-specific quartiles of the FSA-NPS DI. Body mass index (BMI) was computed as weight (in kg) divided by square height (in m^2). Reported *P*-values refer to ordinal polytomous logistic regressions.

Hazard ratios (HRs) and 95% confidence intervals (CIs) obtained from Cox proportional hazards models with age as the primary time variable were used to estimate the association between FSA-NPS DI (coded as a continuous variable and as sex-specific quartiles) and CVDs risk. Participants contributed person-time to the Cox models until the date of cardiovascular event, the date of the last completed questionnaire, the date of death, or March 31st 2016, whichever occurred first. We confirmed that the assumptions of proportionality were satisfied through examination of the log–log (survival) versus log–time plots. Tests for linear trends were performed using the ordinal score on quartiles of FSA-NPS DI. Multivariable models were adjusted for age (time-scale in the Cox model), sex, number of dietary records, BMI (kg/m^2, continuous), physical activity (high, moderate, low, computed following IPAQ recommendations [24]), smoking status (never/former/occasional/current smokers), educational level (<high-school degree/≥ high-school degree and <2 y after high school degree/<2 y after high school degree), family history of CVD (yes/no), energy intake (kcal), alcohol intake (sex-specific quintiles) and season of completion

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