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ARTICLE ORIGINAL

Title: Evaluation of short food-frequency questionnaires to assess the dietary pattern associated with atherosclerosis cardiovascular diseases.

Titre : Evaluation de questionnaires nutritionnels pour évaluer le profil alimentaire associé aux maladies cardiovasculaires athéromateuses.

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Summary

Objectives: Cardiovascular diseases are strongly related to dietary habits. Diet can be assessed using dedicated questionnaires that can be self-completed by subjects but with the risk of errors. Aims: To compare the completion error rate of two questionnaires designed to assess dietary pattern linked to cardiovascular diseases and to study the correlation between the two questionnaires. Materials and Methods: Two questionnaires were used to assess dietary patterns of students: the 14-item Food-Frequency-Questionnaire (FFQ) that was validated against biomarkers, and the Cardiovascular-Dietary-Questionnaire 2 (CDQ2), which is a 19-item-FFQ derived from the previous 14-item FFQ. Both questionnaires assessed the intake of various food groups associated with either favourable or unfavourable effects on cardiovascular risk. A global dietary score was calculated for each questionnaire. Results: FFQ and CDQ2 were completed by 150 sport degree students. In the case of FFQ, 111 questionnaires out of 150 (74.0%) were incomplete compared to only 1 CDQ2 out of 150

(0.7%) ($p < 0.001$). The correlation coefficient between the overall CDQ2 score and the FFQ dietary score was 0.53 ($p < 0.01$). Conclusion: The self-completion of CDQ2 compared to FFQ was associated with far less errors. There was a significant correlation between CDQ2 and FFQ. Preference should be given to CDQ2 in clinical practice and in studies where dietary pattern are evaluated without any interviewer.

Key words: cardiovascular disease; questionnaire; diet; atherosclerosis

Résumé

Objectifs : Les maladies cardiovasculaires sont liées aux comportements alimentaires. L'alimentation peut être évaluée par des questionnaires dédiés qui peuvent être remplis seuls mais avec un risque d'erreurs. Les objectifs sont de comparer les erreurs lors du remplissage de deux questionnaires développés pour évaluer l'alimentation liée aux maladies cardiovasculaires athéromateuses et d'étudier la corrélation entre ces deux questionnaires.

Matériels et Méthodes : Deux questionnaires ont été utilisés pour évaluer l'alimentation d'étudiants : un court questionnaire de 14 questions (FFQ) qui a été préalablement validé contre des biomarqueurs et un second questionnaire (CDQ2) de 19 questions dérivées du premier questionnaire (FFQ). Les deux questionnaires évaluent des groupes alimentaires qui ont des effets favorables et défavorables sur le risque cardiovasculaire. Un score global alimentaire était calculé pour chaque questionnaire.

Résultats : Les deux questionnaires ont été remplis par 150 étudiants en faculté de sport. Pour le FFQ, 74 % ($n=111$) des questionnaires étaient incomplets comparativement à 0,7% ($n=1$) pour le CDQ2 ($p < 0.001$). Le coefficient de corrélation entre les scores globaux du CDQ2 et du FFQ était de 0,53 ($p < 0.01$). Conclusion : L'auto-remplissage du CDQ2 est associé à un moindre nombre d'erreurs. Il existe une corrélation significative entre les deux questionnaires. Le CDQ2 devrait être préféré en pratique clinique et dans les études où l'alimentation est évaluée sans interviewer.

Mots clés : Alimentation, athérosclérose, questionnaire, maladies cardiovasculaires

ABBREVIATIONS

14-item FFQ: 14-item Food Frequency Questionnaire

CDQ2: Cardiovascular dietary questionnaire 2

GS: Global score

MUFA: Mono Unsaturated Fatty Acids

PUFA: Poly unsaturated Fatty acids

SFA: Saturated fatty acids

VDS: Vascular dietary score

INTRODUCTION

Several studies have shown that diet is a risk factor in cardiovascular diseases[1–4]. Public policies adopted by high-income countries promoting healthier life styles and healthy eating based on a Mediterranean diet should help to decrease the cardiovascular mortality[5]. Lifestyles are often acquired during the first part of subject's life and the effect of lifestyle is related to exposure time. In this context, questionnaires could be used to assess the subjects' dietary pattern.

Numerous tools with potential application to dietary assessment in clinical settings have been reported[6]. All these tools do not report the same dietary information (fat intake, with or without other nutrients, adherence to the Mediterranean diet, or fruit and vegetable intake). The questionnaires used presented in this study has been developed specifically in France and

reports quality diet[7]. A short questionnaire on foods related to vascular risk, comprising 14 questions (14-item FFQ) was validated against biological markers and a 7-day food survey[7]. A connection between vascular diseases and a risk-related diet had already been highlighted in cases of myocardial infarction, lower limb arterial disease and ischemic stroke[7–12]. Using this questionnaire, the scores for different food groups linked with cardiovascular diseases can be calculated[7,9,13]. In previous studies, the food evaluation was carried out with an interviewer, who ensured that all of the questions were answered. In fact, a missing answer meant that the corresponding food score could not be calculated. The fact that an interviewer was required precluded the widespread use of this questionnaire. Furthermore, this questionnaire included several open questions that could raise issues. A new questionnaire (Cardiovascular Dietary Questionnaire 2; CDQ2) based on the 14-item FFQ was therefore developed to rule out open responses and includes only closed answers. We assume that CDQ2 generates fewer errors than FFQ when self-completed and that there is a satisfactory correlation between the two questionnaires. The primary objective of this study was to compare the number of correctly completed questionnaires and the secondary objective was to study the correlation between these two questionnaires.

MATERIALS AND METHODS

This is a transversal study carried out at the Catholic University of the West (UCO, Angers, France) involving a student cohort studying Sports, Exercise Science and Technology Degree (STAPS).

Study cohort

All students were enrolled at the Institute of Physical Education and Sports Sciences (IFEPSA-UCO, Angers) between 2014 and 2015. Students in the second and third year of their licence studies (BSc/BA), aged 18 years old and over, with or without a disorder were

included. This study was approved by our institutional review board (CHU Angers). All of the subjects signed an informed consent form in order to take part in the study. The study protocol was conformed to the ethical guidelines of the 1975 Declaration of Helsinki.

Study protocol

The study was presented to the students in a lecture theatre. Two visits were then organised: the first to obtain consent and to complete the FFQ and CDQ2 questionnaires, and the second to correct any errors made on completing the questionnaires.

14-item FFQ: this questionnaire was used to assess the consumption of Saturated Fatty Acids (SFA), Mono-Unsaturated Fatty Acids (MUFA), Polyunsaturated Fatty Acids (PUFA) (omega 3 and omega 6), fruits and vegetables[7]. It was also used to calculate a global vascular risk dietary score called the Vascular Dietary Score (VDS). This score was calculated by adding up the beneficial elements (fruits and vegetables, MUFA, PUFA-n3) and subtracting the SFA score. The latter ranged from -17 to +19. The higher the VDS, the higher the cardiovascular protective diet and vice-versa. The FFQ had a good reproducibility amongst the student population [14]. A $VDS \leq -1$ is considered as an unfavourable vascular diet. The optimal dietary score is a $VDS \geq 8$ [11]. For more information about the scoring, readers can refer to previous publications [7,10]

CDQ2 (Supplemental materials): This questionnaire was derived from the 14-item FFQ [7]. The 19 questions, including 2 on alcohol consumption, did not contain any open questions. The CDQ2 was used to calculate a global score (GS). The GS ranges from -36 to +47. The higher the GS, the higher the cardiovascular protective diet and vice-versa. The scoring method is describe in the online supplemental materials.

Error types: different types of errors were considered: no response, double or triple response or confused response indicating the subject's inability to answer the question independently (problem about the type of oil chosen, type of margarine, etc.).

Statistical analyses

A "Shapiro Wilk" normality test was checked to confirm normal data distribution. It showed that variables in the vascular dietary score (VDS), the global score and global score without alcohol followed a normal distribution. The number of errors in the two questionnaires was compared using the "McNemar Test". In order to investigate the relationship between the two questionnaires, correlation tests were carried out between VDS obtained with the 14-item FFQ and the GS obtained with the CDQ2. The level of significance was set at $p < 0.05$.

RESULTS

Study cohort characteristics

Overall, 150 subjects were enrolled in our study (Table 1). The students had a mean VDS of $-0.93 (\pm 3.33)$ and a GS of $0.89 (\pm 5.97)$.

FFQ error types

In Table 2, the types of errors made by the students are presented according to six categories: omitted answers, problems with the type of oil, chips, margarine, responses in duplicate or triplicate and questions about nut consumption. This type of error recurred regularly for the same questions, namely 6, 7, 9, 12, 13 and 14. Frequent errors were made when answering questions 13 and 14 on oil and margarine consumption on the 14-item FFQ.

Results of incorrectly completed questionnaires

Over 70% of the FFQ were incorrectly completed on the first occasion (111/150). Over 99% of CDQ2 were correctly completed except for 1 student who forgot to complete half of the questionnaire.

Relations between the questionnaires

A significant relationship was found between the VDS obtained with the FFQ and the GS obtained with CDQ2 ($r=0.53$) ($p<0.01$). The removal of the 2 questions related to alcohol did not change significantly the correlation: $r=0.54$ ($p<0.01$).

DISCUSSION

This study reports a great improvement in correct answers to questions and exploitable self-completed questionnaires with a rate close to 100% in this student population with the CDQ2. Furthermore, there is a good correlation of this questionnaire with the original 14-item FFQ that generates too much errors or missing answers due to the relative complexity for several subjects to answer correctly the questions related to the choice of fat and oils. However that information is a major one to calculate an informative global dietary score. Indeed the type of fat used for cooking or seasoning is one of the major nutritional determinants to influence the cardiovascular risk. A high intake of saturated and trans fatty acids increases the risk whereas mono and polyunsaturated fatty acids, in particular olive oil and omega-3 fatty acids reduce the risk [15,16].

Fewer errors were made on completing the CDQ2 compared to the 14-item FFQ. The CDQ2 also had several advantages: first, it contained only closed questions – hence the questions were answered more quickly. The time taken to answer the question seemed to facilitate the students' decision [17]. Secondly, although CDQ2 had five additional questions, there were

fewer possible answers (maximum of 19 items). The FFQ contained only 14 questions but 27 items had to be completed [7]. Several partial responses were required for the same question. The results of a meta-analysis of controlled, randomised studies suggest that preference should be given to shorter questionnaires[18]. Shorter questionnaires can be completed more quickly, probably increasing the rate of correct responses[19]. Thirdly, CDQ2 includes alcohol consumption, which was not assessed in the FFQ. The effect of alcohol on cardiovascular disease is debated [20,21]. But numerous epidemiologic studies have shown results in support of a protective effect of a small to moderate alcohol consumption and a deleterious effect of a high consumption and/or binge drinking[22–24]. Many epidemiologic studies have reported that a small to moderate alcohol consumption can be considered as a favourable lifestyle characteristic. Thus the inclusion of alcohol in a dietary questionnaire is important especially for cardiovascular diseases. It could be criticised that alcohol consumption was not considered in the original FFQ and thus the correlation between the 2 questionnaires could be weakened. However this was not the case.

A significant, albeit moderate, correlation ($r=0.53$) was observed between the two global scores derived from the 2 questionnaires. This moderate correlation may be explained by the homogeneity of the population with few extreme dietary scores being recorded. Another sub-study carried out by our team in a more heterogeneous population ($n=56$) of 31 ± 17 years revealed a VDS of 1.04 ± 5.08 and a GS score of 3.59 ± 7.92 with a higher correlation between the two questionnaires: $r=0.78$ ($p<0.001$). Moreover the errors in FFQ answers represent the main explanation for the alteration of the correlation, which is a strong argument in favour of the preferential use of the CDQ2.

Limitations

It may be questioned whether the small number of errors made by this population on completing CDQ2 can be extrapolated to older populations. However, the use of closed answers has facilitated the responses and we can assume this will be the case also for other populations. To date, it has not yet been shown that patients with cardiovascular diseases have an unfavourable GS obtained with CDQ2 whereas it has been reported that a low SDV score (14-item FFQ) is associated with myocardial infarction, PAD and ischemic stroke. There are ongoing studies to check that the CDQ2 global score is as well associated with these diseases.

To conclude, this study shows that CDQ2 is well correlated with the original validated 14-item FFQ and generates far more correctly self-completed questionnaires, which could facilitate its widespread use especially in clinical practice.

CONFLICT OF INTEREST: The authors declare that they have no conflict of interest.

DECLARATIONS:

Ethics approval and consent to participate: This study was approved by our institutional review board (CHU Angers Ethical Committee). All of the subjects signed an informed consent form in order to take part in the study.

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Table 1: Students Cohort Characteristics.

Characteristics	Population (n=150)
Age (years old), m +/- sd	20+/-1
Weight (kg), m +/- sd	67.2+/-8.9
Height (m), m +/- sd	1.76+/-0.08
Men, n (%)	111 (74)
Smokers, n (%)	28 (19)

Legend : m means mean and sd means standard deviation

Table 2: Type of errors found in the 14-item FFQ (n=150 participants)

Questions	Missing answer	Multiple answers	Confusion
Fries consumption	7	22	63
Bread and derived products	1		
Nuts consumption			4
Raw butter or cream consumption		2	
Margarin consumption	12		31
Oil consumption	64		47

Online supplemental material: CARDIOVASCULAR DIETARY QUESTIONNAIRE 2

1. How many portions of cheese do you eat on average? (1 portion = 1/8th of camembert = 30 g)

☐ less than 1 portion per day	SFA score = 0 pt
☐ 1 portion per day	SFA score = 2 pts
☐ 2 portions per day	SFA score = 4 pts
☐ 3 or more portions per day	SFA score = 6 pts

2. Do you eat dairy products?

(1 dairy product = 1 yoghurt or 100 g of white cheese or 1 glass of milk (15 cl) or 1 cream or desserts containing milk)

☐ I only eat skimmed or semi-skimmed dairy products	SFA score = 0 pt
☐ I do not eat dairy products or I eat less than 1 per day	SFA score = 0 pt
☐ I eat 1 to 2 dairy products every day	SFA score = 1 pt
☐ I eat 3 dairy products every day	SFA score = 2 pts
☐ I eat 4 or more dairy products per day	SFA score = 3 pts

3. Do you eat pork, beef, veal, mutton or lamb?

☐ 0 to once a week	SFA score = 0 pt
☐ 2 to 3 times a week	SFA score = 1 pt
☐ 4 to 6 times a week.	SFA score = 2 pts
☐ once a day, or more	SFA score = 3 pts

4. Do you eat fresh, tinned or frozen fish (including tuna, mackerel, sardines and herring)?

☐ at least once a week	UFA Score = 0 pt
☐ once a week	UFA Score = 3 pts
☐ twice a week	UFA Score = 6 pts
☐ 3 times a week	UFA Score = 9 pts
☐ 4 times a week or more	UFA Score = 12 pts

5. Do you eat processed and deli meats (except lean ham) i.e. ham, pâté, salami, rillettes, bacon, sausages (also in stews/casserole dishes, sauerkraut, etc.)?

☐ 0 to once a week	SFA score = 0 pt
☐ 2 to 3 times a week	SFA score = 1 pt
☐ 4 to 6 times a week	SFA score = 2 pts
☐ once a day	SFA score = 3 pts
☐ more than once a day	SFA score = 4 pts

6. Do you eat quiches, tarts and savoury snacks (toasted sandwiches, quiches, tarts, pizza, fried foods, hamburgers, sandwiches with butter, etc.)?

☐ 0 to once a week	SFA score = 0 pt
☐ 2 to 3 times a week	SFA score = 2 pts
☐ 4 to 6 times a week	SFA score = 3 pts
once a day or more	SFA score = 4 pts

7. Do you eat shop cake, gateaux and biscuits made from butter (including “home-made” produce)?

☐ 0 to 1 portion per week	SFA score = 0 pt
☐ 2 to 4 portions per week	SFA score = 2 pts

- ☐ 5 portions or more per week SFA score = 4 pts

8. Do you eat viennoiseries (croissant, brioche, pain au chocolat, pain au lait, etc.)?

- ☐ 0 to 1 per week SFA score = 0 pt
- ☐ 2 to 3 per week SFA score = 1 pt
- ☐ 4 to 6 per week SFA score = 2 pts
- ☐ 1 per day SFA score = 3 pts
- ☐ more than 1 per day SFA score = 4 pts

9. Do you eat fresh fruit?

(1 portion = 1 average-sized fruit, for example 1 apple or 2 clementines or a small dish of berries/small fruit)

- ☐ Never or rarely FV Score = 0 pt
- ☐ 1 to 2 portions per week FV Score = 1 pt
- ☐ 3 to 6 portions per week FV Score = 2 pts
- ☐ 7 to 13 portions per week (at least 1 fruit per day) FV Score = 3 pts
- ☐ 14 portions or more per week (at least 2 pieces of fruit per day) FV Score = 4 pts

10. Do you drink fruit juice every day (pure juice without added sugar)

- ☐ no or less than 1 glass per day FV Score = 0 pt
- ☐ yes, 1 glass per day FV Score = 1 pt
- ☐ yes, 2 glasses or more per day FV Score = 2 pts

11. Do you eat cooked vegetables and vegetable soup (1 portion = 1 plate or 2 bowl)

- ☐ Never or rarely FV Score = 0 pt

☐ 1 to 2 portions per week	FV Score = 1 pt
☐ 3 to 6 portions per week (less than 1 portion per day)	FV Score = 2 pts
☐ 1 portion per day	FV Score = 3 pts
☐ more than 1 portion per day	FV Score = 4 pts

12. Do you eat raw vegetables and salads?

☐ Never or rarely	FV Score = 0 pt
☐ 1 to 2 portions per week	FV Score = 1 pt
☐ 3 to 6 portions per week (less than 1 portion per day)	FV Score = 2 pts
☐ 1 portion per day on average	FV Score = 3 pts
☐ more than 1 portion per day	FV Score = 4 pts

13. Do you usually eat margarine with a high Omega 3 content such as Fruit d'or® or Primevère® or Saint-Hubert oméga 3®?

☐ No	UFA Score = 0 pt
☐ yes, with 1 meal per day	UFA Score = 1 pt
☐ yes, with 2 meals per day	UFA Score = 2 pts
☐ yes, with 3 or more meals per day	UFA Score = 3 pts

14. Do you use butter on your bread or in your food?

(1 portion = 1 individual portion of 10 g)

☐ never or rarely	SFA score = 0 pt
☐ 1 portion per day	SFA score = 2 pts
☐ 2 portions or more per day	SFA score = 4 pts

15. Do you cook with butter or with hard margarine such as Astra® ?

☐ never or rarely	SFA score = 0 pt
☐ yes, 1 meal per day	SFA score = 2 pts
☐ yes, 2 meals per day	SFA score = 4 pts

16. Do you usually use one of the following oils: rapeseed, soybean, nut, or Isio4® ? no

UFA Score = 0 pt

☐ yes, at least 1 soup spoonful per day	UFA Score = 2 pts
☐ yes, 1 soup spoonful per day	UFA Score = 4 pts
☐ yes, 2 soup spoonfuls or more per day	UFA Score = 6 pts

17. Do you usually use olive oil ?

☐ no	UFA Score = 0 pt
☐ yes, at least 1 soup spoonful per day	UFA Score = 1 pt
☐ yes, 1 soup spoonful per day	UFA Score = 2 pts
☐ yes, 2 soup spoonfuls per day	UFA Score = 4 pts
☐ yes, 3 soup spoonfuls per day	UFA Score = 6 pts
☐ yes, 4 or more soup spoonfuls per day	UFA Score = 8 pts

18. How much alcohol do you consume Monday to Friday? – in terms of the number of glasses of alcoholic drinks per day (see the table on the right for equivalents)

☐ never or seldom	OH score=0 pt
☐ at least 1 glass per day	OH score=1 pt
☐ 1 glass per day	OH score=2 pts
☐ 2 glasses per day	OH score=4 pts

<i>1 glass of alcohol</i> = 10 cl of Wine (i.e. 7.5 glasses in a 75 cl bottle) = 10 cl of Champagne = 2 to 3 cl of strong aperitif (Whisky, Pernod, etc.) 7 cl of apéritif – Muscat, Port, Martini 25 ml of Beer (half) or 5° Cider
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- ☐ 3 glasses or more per day OH score=0 pt

19. How much alcohol do you consume at the weekend? – give the overall quantity for

Saturday and Sunday

- ☐ never or seldom OH score=0 pt
- ☐ 1 to 2 glasses OH score=0 pt
- ☐ 3 to 7 glasses OH score=0 pt
- ☐ 8 or more glasses OH score=0 pt ; and a positive answer to this question
cancels all points at qs 18.

CDQ 2 Scores:

- SFA (saturated fatty acid) Score: 0 to 36
- UFA (unsaturated fatty acid) Score: 0 to 29
- FV (fruits and vegetables) Score: 0 to 14
- OH (alcohol) Score: 0 to 4
- Global CDQ2 Score: $UFA + FV + OH - SFA$: -36 to + 47
(the higher, the better = more protective)