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A new food frequency questionnaire to assess chocolate and cocoa consumption

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ABSTRACT

Objective: Cocoa has been highlighted as a food with potential benefits to human health because of its polyphenol content. However, few studies show the contribution of cocoa and chocolate products in polyphenol intake. The aim of this work was to develop a food frequency questionnaire (FFQ) for evaluating the intake of food products containing cocoa (C-FFQ).
Methods: A sample of 50 university students was recruited to complete the 90-item questionnaire, a validated questionnaire (called here European Food Safety Authority [EFSA]-Q) as well as a 24-hour dietary recall (24 HDR). Spearman correlation test, Bland-Altman plots, and quintile classification analysis were conducted together with the Wilcoxon test and descriptive statistics.
Results: Significant correlations between the C-FFQ and the EFSA-Q for the most common cocoa/chocolate products were observed ($P < 0.05$), as well as between data from the C-FFQ and 24 HDR ($P < 0.05$). However, a number of cocoa/chocolate products frequently consumed by the participants were detected by the C-FFQ and 24 HDR which were not included in the EFSA-Q. According to the C-FFQ, chocolate bars were the main source of cocoa in university students, but dairy products also provided an important amount of cocoa.
Conclusion: The developed C-FFQ questionnaire can be considered as a valid option for assessing the consumption frequency of cocoa/chocolate-derived products, thereby allowing the evaluation of cocoa polyphenol intake in further studies.

Introduction

Chocolate products are commonly consumed in the human diet and, depending on their cocoa content, can represent an important source of polyphenols, mainly flavonoids [1]. In fact, cocoa contains more phenolic antioxidant compounds than tea or red wine [2]. These antioxidant effects have led to cocoa being extensively investigated for its potential benefits to human health [3].

Clinical studies have associated cocoa consumption with the reduction of several cardiovascular risk factors because cocoa improves vascular functions [4], shows antihypertensive effects [5] and reduces body weight/body fat [6], among other effects. Overall, a positive scientific opinion has existed regarding the substantiation of a health claim related to cocoa flavanols and vasodilation [7]. Cocoa consumption also has beneficial effects on cancer prevention [8] and inflammatory diseases [9]. In light of all these data, cocoa consumption has gained importance in human dietary habits, and a growing interest in studying its further benefits to human health is emerging.

F.V., S.S., M.R., P.P., F.P. and M.C. conceived and designed the questionnaire and global study design; F.V. and S.S. processed the initial data and conducted initial results analysis; F.V., S.S., M.J., F.P. and M.C. were involved in the interpretation of the data; all authors contributed to the critical revision of the manuscript; F.P. and M.C. had primary responsibility for the final content. We would like to thank Eulalia Roure and Jaume Serra from the "Servei Educació Sanitària i Programes de Salut" in the "Generalitat de Catalunya" for their help in the construction of the FFQ. The study was supported by AGL2011-24279. The authors declare no conflict of interest. None of the funders had a role in the design or analysis of the study or in the writing of this article.

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Polyphenols, present in cocoa as well as in fruits, vegetables, and beverages such as tea, seem to be the main elements in cocoa's protective actions. In spite of being a great source of polyphenols—and chocolate, as a natural source of cocoa, is a widely consumed food—cocoa is not among the top polyphenol sources consumed [10,11]. In fact, some data reveal that cocoa accounts for less than 10% of polyphenol intake [12]. This could be due to the different methodologies employed and the focus of the food frequency questionnaires (FFQs) used in these consumption studies. In this context, most of the validated FFQs poorly identify the several cocoa sources other than chocolate bars and snacks. As an example, a validated FFQ, used in the GINIplus and LISAplus Studies, groups chocolate, chocolate bars, and soft sweets as confectionery food [13], and the validation of an FFQ to be applied to young people also classifies chocolate products in just one category [14]. Moreover, a study aimed at determining the association between chocolate consumption and body weight in adolescents did not differentiate between white, milk, and dark chocolate [15], while an FFQ applied to undergraduate university students from Greece and Scotland asked for snack preferences including chocolate products, without distinguishing the type of chocolate [16]. These facts support the need for an assessment of cocoa product consumption to evaluate the actual cocoa intake, especially in the young population, who frequently consume chocolate without being aware of its benefits [17,18].

Thus, the aim of the present study was to develop an FFQ designed to assess the consumption of cocoa in the diet of a young and healthy population (i.e., university students). This would constitute the first phase of a bigger study focused on associating cocoa/chocolate consumption with healthy habits and lifestyle in university students studying health sciences.

Materials and methods

Participants

The study population was recruited from among students from several Health Science graduation and postgraduation programs in the Faculty of Pharmacy at the University of Barcelona.

Procedure

The present study was conducted according to the guidelines laid down in the Declaration of Helsinki and the study protocol was approved by the Ethical Committee of the University of Barcelona (IRB 00003099). Written informed consent was obtained from all participants after the aims and procedure of the study were described.

The participants were required to respond to a 24 h dietary recall (24 HDR), the developed C-FFQ, and an European Food Safety Authority (EFSA) questionnaire (EFSA-Q) (gathering consumption data on specific consumer groups of energy drinks in adults aged 18–65 y) [19] that was used as the gold standard [20]. The EFSA-Q enquires about the frequency of consumption of hot chocolate, chocolate bars, and snacks, and also has a question asking which kind of chocolate (white, milk, and dark) the subject prefers. It also enquires about the intake of coffee and tea. Since the EFSA-Q enquired about the frequency of consumption over the last year, participants were given instructions to answer the C-FFQ by also considering their average consumption frequency over the same period. The 24 HDR is an open questionnaire asking for the intake of products the day before. Taking into account the possible weekend effect on cocoa/chocolate consumption in the 24 HDR [21], the questionnaires were conducted between Thursday and Friday. The questionnaires were answered during the period from May to October in 2014.

Food frequency questionnaire to assess cocoa consumption (C-FFQ)

The C-FFQ was developed based on a previous FFQ designed to evaluate the changes in the nutritional habits and nutritional status of the Catalan population [22]. It was written in Spanish and included 90 food items that potentially contain polyphenols. A full version of the C-FFQ can be downloaded (http://diposit.ub.edu/dspace/handle/2445/60475). The FFQ inquired about the consumption of fruits and vegetables, as wells as cereals, dairy products, and confectionery food (pastries and snacks), which can include chocolate. The range of cocoa/chocolate products is much wider than that included in the EFSA-Q. In particular, information about the consumption of chocolate with cereals was required; the FFQ also included questions about dairy products that can contain chocolate (milk, flan, custard, yogurt, and ice cream). There were also items related to confectionery that can include chocolate, such as pastries and snacks. Six items were devoted to asking which kind of chocolate bars the participant consumes (white, with milk, or with <60%, 60–70%, 70–85%, and >85% cocoa). Next, there were items related to cocoa/chocolate beverages (including hot chocolate and milk with cocoa) and spreads. Finally, information relating to the intake of coffee and tea was requested and these answers have been used to compare the C-FFQ with the EFSA-Q. The frequency of consumption of the 90 food items was assessed using 12 categories ranging from 1 (never) to 12 (three or more times per day). The quantity of food items was specified as one portion or a piece.

Estimation of cocoa intake

To estimate the cocoa intake of each participant, the amount of cocoa per portion within each listed item in the C-FFQ was calculated. For that, established portions were considered [23]. Moreover, due to the lack of information for some sources, food labels were analyzed in 5 to 7 products in each food category, and from this, the amount of cocoa per portion was calculated. The amount of each one was converted into cocoa amount per portion (Table A1).

Statistical analysis

Data from cocoa/chocolate-derived products, tea, and coffee consumption were converted into the number of portions ingested per day. To study the agreement between the new FFQ, the EFSA-Q, and the 24 HDR, the correlation among data was calculated by both Spearman test and Bland-Altman plots. In addition, the consumption frequency data were compared using the non-parametric paired Wilcoxon test. Study participants were classified into quintile categories of either cocoa, tea, or coffee consumers based on the distribution of data obtained from these assessments. Proportions of subjects misclassified were derived. Results were considered statistically significant at a two-tailed α level of 0.05. Statistical analysis was performed using software package SPSS 22.0 (IBM SPSS Statistics, IBM Corp, Armonk, NY, USA).

Results

Sociodemographic and anthropometric characteristics

A total of 50 individuals completed the three questionnaires. The participants comprised eight males and 42 females, 54% were undergraduate students, and 46% were enrolled in one of the master's or postdoctorate studies within the several University of Barcelona programs. Mean age was 24.10 y (SD = 3.29), and the mean body mass index was 21.42 kg/m^2 (SD = 2.27), ranging between 17.69 and 27.68 kg/m^2.

Consumption frequency

The consumption frequency of tea, coffee, hot chocolate, chocolate snacks, and chocolate bars were assessed by the three questionnaires (Table 1). No differences were found between the C-FFQ and the EFSA-Q for tea consumption, but the 24 HDR revealed a lower intake ($P < 0.05$). With regard to coffee, the C-FFQ provided a lower consumption frequency than the EFSA-Q ($P < 0.05$), but higher than the 24 HDR ($P < 0.05$).

Focusing on cocoa/chocolate-derived products, the C-FFQ detected a consumption frequency of hot chocolate lower than that of the EFSA-Q but higher than the 24 HDR ($P < 0.05$). The intake frequency of chocolate snacks according to the C-FFQ was higher than that in the EFSA-Q ($P < 0.05$) and similar to the 24 HDR. When considering chocolate bars, a similar consumption frequency between the C-FFQ and EFSA-Q was found, although the EFSA-Q showed a lower intake of white and dark chocolate bars ($P < 0.05$). The C-FFQ also revealed a higher chocolate bar consumption frequency than the 24 HDR ($P < 0.05$), which was mainly due to the intake of dark chocolate bars.