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Short Communication

Relative validity of a food frequency questionnaire in patients coinfected with hepatitis C virus and human immunodeficiency virus

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Abstract

Introduction: Validation of food frequency questionnaires (FFQs) is recommended for accurate measurement of habitual food consumption. We assessed the relative validity of a FFQ in patients coinfected with hepatitis C virus and human immunodeficiency virus. **Methods:** Each patient responded to a FFQ and three 24-hour food recalls. Pearson's correlation and weighted Kappa index analyses were performed to identify the FFQ relative validity and concordance. **Results:** De-attenuated correlation coefficients ranged from 0.35 (vitamin B1) to 0.81 (selenium). The concordance index ranged from 0.07 (vitamin C) to 0.51 (calcium). **Conclusions:** The FFQ showed satisfactory relative validity for most nutrients.

Keywords: Food consumption. Validation studies. Infectious diseases.

Hepatitis C virus (HCV) and human immunodeficiency virus (HIV) coinfection is a global public health problem, with a prevalence of about 10 million coinfected individuals worldwide[1]. These patients may present alterations in food intake, protein-energy malnutrition, and consequently, micronutrient deficiency. Alternatively, with the advent of highly active antiretroviral therapy (HAART), patients often present metabolic disorders such as obesity, insulin resistance, and dyslipidemia[2]. Both protein-energy malnutrition and metabolic alterations can be minimized with nutritional care. The adequate intake of energy, macronutrients, and certain micronutrients is associated with the prevention or treatment of nutritional outcomes related to coinfection.

Given these observations, the investigation of food intake of individuals with coinfection is crucial in order to understand the ways in which diet can affect coinfection-induced nutritional alterations. An instrument that assesses patients' habitual food consumption is needed to accomplish this goal, and the food frequency questionnaire (FFQ) has been used for this purpose[3]. Different populations or patient groups require FFQs that consider the unique features of their specific diets. FFQ validity is considered relative because a FFQ is validated by comparing it to a reference method, usually a food record or a 24-hour food recall (24hR). The validation procedure evaluates the similarity of the data collected by the different methods for evaluating dietary intake[4].

To the best of our knowledge, we are unaware of studies published to date on the validation of this instrument in individuals with HCV/HIV coinfection. Moreover, given the importance of evaluating habitual food intake in this patient group with a reliable instrument, the present study aimed to measure the relative validity of a FFQ in patients with HCV/HIV-coinfection who were treated in a public hospital in Southern Brazil.

The present study was conducted with a convenience sample of consecutive patients with HCV/HIV-coinfection who visited the infectious diseases outpatient clinic in a reference hospital for HIV treatment in southern Brazil between August 2013 and August 2014. The patients were invited to participate in the study during a routine medical examination. Of the 65 patients initially enrolled, we excluded 4 (6.1%) patients who did not respond to all 24hRs and 3 (4.6%) patients who did not complete the FFQ, resulting in a final sample of 58 patients. The inclusion criteria were as follows: HCV/HIV coinfection, both sexes, ≥18 years of age, and current use of antiretroviral therapy. Pregnant women, patients with cirrhosis, and patients

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on an oriented diet were excluded from the study because of alterations of habitual food intake.

The instruments used for the assessment of food intake were the FFQ and the 24hR. The FFQ was developed on the basis of information from 118 24hRs from a sample of 55 patients with HCV/HIV-coinfection who were treated at the infectious diseases outpatient clinic of a public hospital in southern Brazil between December 2011 and December 2012. In accordance with the methodology proposed by Block et al.[5], we selected the FFQ food list on the basis of the most representative food items, which comprised >95% of total food consumption, for measurement of energy and macronutrient intake by patients.

The FFQ consisted of a list of 75 food items. The consumption frequencies were classified into eight categories, including daily, weekly, and monthly . Patients were asked about their eating habits during the last month. This was a quantitative questionnaire, and the participant used a photo album to provide responses about the amount of food and portion size consumed[6]. The FFQ was applied by trained interviewers during patients' personal interviews.

For the 24hR, we quantitatively assessed food and drink intake in the 24 hours prior to the interview. Using a photo album[6], participants reported, in detail, the portion size consumed, product brands, and how food was prepared. The 24hRs were applied in three interviews: the first personal interview, along with the FFQ, and the other two telephonic interviews, with an average interval of 20 days between all three interviews. One of the 24hRs was applied a day after a weekend or holiday, which characterized an unusual day.

The information acquired through the 24hR and FFQ was analyzed using Avanutri® software (Avanutri and Nutrition Computer Services, RJ, Brazil). The 24hR data were entered directly into Avanutri®, and for the FFQ, food intake was converted into grams/day. The monthly and weekly frequencies were divided by 30 and 7, respectively. This result was multiplied by the number of portions and individual portion size in grams. Intakes of energy, protein, carbohydrate, lipid, fiber, vitamins A, B1, B2, B6, folic acid, B12, C, D, E, zinc, selenium, sodium, calcium, potassium, and iron were estimated for each of the three 24hRs and FFQs.

Means, standard deviations, and difference between means were calculated for absolute values of energy and the consumed nutrients in the FFQ and 24hR (**Table 1**). For analyses, energy and nutrient intakes measured by both methods were log-

TABLE 1

Daily energy and nutrient intake as assessed using the food frequency questionnaire and 24-hour food recalls in 58 patients with HCV/HIV coinfection.

Nutrients	FFQ Mean (SD)	24hR Mean (SD)	FFQ –24hR Difference (SD)
Energy*	2,036.6 (830.3)	1,770.1 (628.8)	266.5 (628.9)
Protein (g)	77.6 (43.6)	72.0 (29.5)	5.6 (32.0)
Carbohydrate (g)	286.6 (116.7)	244.3 (89.3)	42.3 (93.3)
Lipid (g)	63.2 (30.4)	56.0 (26.0)	7.2 (26.2)
Fiber (g)*	17.6 (10.1)	14.2 (8.3)	3.4 (8.2)
Vitamin A (mcg)	681.5 (577.7)	626.4 (594.6)	55.1 (731.0)
Vitamin B1 (mg)*	2.8 (3.4)	1.7 (1.2)	1.1 (3.5)
Vitamin B2 (mg)*	1.9 (1.2)	1.4 (0.7)	0.5 (1.1)
Vitamin B6 (mg)	1.4 (0.8)	1.3 (0.8)	0.1 (0.7)
Folic acid (mcg)*	194.6 (107.8)	136.0 (77.6)	58.6 (96.4)
Vitamin B12 (mcg)*	3.3 (2.2)	2.3 (1.4)	1.0 (2.3)
Vitamin C (mg)*	107.1 (81.3)	62.9 (47.9)	44.2 (90.4)
Vitamin D (mcg)	3.1 (2.1)	3.1 (3.1)	0.0 (2.4)
Vitamin E (mg)*	12.9 (6.7)	10.6 (7.6)	2.3 (7.7)
Zinc (mg)	8.6 (5.8)	8.0 (4.4)	0.6 (5.3)
Selenium (mcg)*	90.5 (51.2)	58.7 (25.9)	31,8 (53,7)
Sodium (mg)	2,224.5 (1043.3)	2,003.6 (850.4)	220.9 (1,008.0)
Calcium (mg)*	686.0 (364.2)	563.7 (341.6)	122.3 (345.0)
Potassium (mg)*	2,665.4 (1,389.0)	2,122.9 (1,058.5)	542.5 (1,006.2)
Iron (mg)*	14.0 (7.0)	12.0 (5.5)	2.0 (5.4)

HCV/HIV: hepatitis C virus/human immunodeficiency virus; **FFQ:** food frequency questionnaire; **24hR:** 24-hour food recall; **SD:** standard deviation. *$p < 0.05$ for the paired t-test for differences between the FFQ and the mean of the three 24hRs.

transformed to normal distributions. We performed adjustments for energy by computing the residuals of regression models, with energy intake as the independent variable and nutrient intake as the dependent variable[7].

Owing to the attenuation caused by daily intra-individual variations in food intake, the correlation coefficients were corrected using the ratio of the intra- and inter-individuals variances in the three 24hRs, by applying the following equation: $rv = ro\ (1+\lambda/n)^{1/2}$, where *rv* is the true correlation, *ro* is the observed correlation between the FFQ and the mean of the 24hR, λ is ratio of the intra- and inter-individual variances in the 24hR, and *n* is the number of replicates, which in this case was three 24hRs[8]. The relative validity was assessed using Pearson's correlation coefficient. The concordance between the FFQ and the mean of the three 24hRs was also assessed using the weighted Kappa index, taking into consideration the adjusted and de-attenuated data. For the analyses of Pearson's correlation, we used Statistical Package for the Social Sciences (SPSS) for Windows, version 22.0 (SPSS Corp, Chicago, US). Concordance analyses were performed in WinPepi, version 11.43.

This study was approved by the local Research Ethics Committee (Protocol Number 11-226), and was performed in accordance with the Helsinki Declaration of 1964, as revised in 1975, 1983, 1989, 1996, and 2000. Patients were included after they read and signed the informed consent form.

In this study, 58 patients with HCV/HIV-coinfection were evaluated. Their mean age was 46 ± 11.2 years, educational level was 8 ± 3.8 years, and they had been receiving HAART for over 3 months. The sample consisted mostly of women (60.4%), and 41.4% of participants were married.

With regard to the validity of the FFQ data relative to the average intake measured via the three 24hRs, the crude data had the lowest values for vitamin B1 and the highest values for vitamin D: 0.20mg and 0.68mcg, respectively. After adjustment for energy, there was a reduction in the coefficients for all nutrients except lipid, vitamins B1 and B12, and sodium. In contrast, after adjustment, de-attenuated coefficients increased for most nutrients with correlations greater than 0.4, except for vitamin B1. As shown in **Table 2**, the weighted Kappa index values ranged from 0.07 for vitamin C (95% confidence interval = -0.12–0.26) to 0.51 for calcium (95% confidence interval = 0.35–0.68)**.**

Our results suggest that the FFQ used in the present study has adequate validity for measurement of intake of energy as well as most nutrients assessed, and that it can be used to estimate the habitual food consumption of patients with HCV/HIV-coinfection in southern Brazil. The FFQ can be applied in different geographical areas by using adaptation procedures[3].

Many FFQs were developed and tested in different populations. The relative validity of macronutrient intake

TABLE 2

Pearson's correlation coefficients and concordance analysis by weighted Kappa between the mean of the values from the three 24-hour food recalls and the food frequency questionnaire in 58 patients with HCV/HIV-coinfection.

	Correlation coefficients			
Nutrient*	**crude**	**adjusted****	**de-attenuated*****	**Concordance (CI95%)**
Energy	0.65	-	-	0.37 (0.20–0.53)
Protein (g)	0.67	0.59	0.62	0.43 (0.27–0.59)
Carbohydrate (g)	0.61	0.59	0.61	0.27 (0.09–0.46)
Lipid (g)	0.59	0.65	0.66	0.48 (0.31–0.64)
Fiber (g)	0.64	0.52	0.57	0.41 (0.26–0.56)
Vitamin A (mcg)	0.32	0.30	0.53	0.24 (0.05–0.44)
Vitamin B1 (mg)	0.20	0.30	0.35	0.14 (-0.04–0.33)
Vitamin B2 (mg)	0.52	0.51	0.55	0.41 (0.24–0.58)
Vitamin B6 (mg)	0.53	0.52	0.59	0.36 (0.18–0.53)
Folic acid (mcg)	0.56	0.48	0.53	0.31 (0.15–0.48)
Vitamin B12 (mcg)	0.31	0.45	0.67	0.26 (0.08–0.44)
Vitamin C (mg)	0.27	0.14	0.44	0.07 (-0.12–0.26)
Vitamin D (mcg)	0.68	0.28	0.40	0.48 (0.30–0.66)
Vitamin E (mg)	0.55	0.53	0.57	0.31 (0.13–0.49)
Zinc (mg)	0.52	0.49	0.54	0.37 (0.19–0.54)
Selenium (mcg)	0.65	0.57	0.81	0.22 (0.03–0.40)
Sodium (mg)	0.50	0.52	0.55	0.39 (0.22–0.57)
Calcium (mg)	0.62	0.46	0.51	0.51 (0.35–0.68)
Potassium (mg)	0.62	0.46	0.50	0.37 (0.20–0.53)
Iron (mg)	0.61	0.57	0.60	0.42 (0.26–0.58)

24hR: 24-hour food recall; **HCV/HIV:** hepatitis C virus/human immunodeficiency virus; **CI95%:** 95% confidence interval. *Nutrients transformed by natural logarithm. **Nutrients adjusted to energy using the residual method. ***Correlations corrected for intra-individual variation in the three 24hRs (de-attenuated and adjusted).

measurement using an FFQ was tested in men infected with human papilloma virus[9] and in healthy adults in Southern Brazil[10-11]. The de-attenuated correlation coefficients in these studies were both lower and higher than those found in the present FFQ validation study in patients with HCV/HIV-coinfection.

With regard to micronutrients, a weak correlation was observed for vitamin B1 (r = 0.35). The instrument was valid for measurement of the habitual intake of antioxidant vitamins (A, E), in addition to the minerals selenium (r = 0.81) and zinc (r = 0.54). Zinc and selenium deficiency has been linked to the severity of liver disease, insulin resistance, and the decrease of sustained virological response in patients with HCV infection[12-13]. The validity of the FFQ for the measurement of other assessed micronutrients was adequate.

Methodologies employed in FFQ validation studies suggest that the crude coefficients should be corrected, that is, they should be adjusted for energy and de-attenuated. Correlations above 0.4 indicate adequate validity of the method used[4]. In the present study, the de-attenuated correlation coefficients increased for most nutrients. The finding that the de-attenuated value for vitamin B1 was below 0.4 can be explained by inter-individual variability in dietary intake, which points to the need for more replicates of the reference method in order to measure the consumption of this nutrient more accurately[14]. After investigating the concordance between methods, the weighted Kappa indexes showed reasonable agreement, greater than 0.21[15], for most nutrients assessed. Vitamins B1 and C showed poor concordance: 0.14 and 0.07, respectively.

In conclusion, the FFQ has a satisfactory relative validity for most nutrients, indicating that the instrument is capable of accurately measuring habitual dietary intake. Weak correlations observed for vitamin B1 and poor concordance for vitamins B1 and C compromised the relative validity of the FFQ for the measurement of these nutrients. We suggest using the validated FFQ for further investigations of dietary factors and associations with metabolic alterations or liver disease progression in individuals with HCV/HIV-coinfection.

Conflicts of interest

The authors declare no conflicts of interest

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