International Journal of Scientific and Management Research
Volume 4 Issue 8 (Dec) 2021
ISSN: 2581-6888
Page: 9-8

Questionnaire to Identify FOOD BELIEVES: Evidence of Validity and Reliability

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DOI - http://doi.org/10.37502/IJSMR.2021.4802

Abstract

Objectives: to develop a health measurement instrument, in which food beliefs represent the construct, and to assess evidence of its reliability and validity. Methodology: Participants: Facebook, You Tube, WhatsAPP users. Factor Analysis: Exploratory, Exploratory/Confirmatory and Confirmatory. Dornik-Hanzen and KMO test. Factorial validity: convergent and discriminant. Reliability: Cronbach's alpha and composite reliability-CC. Goodness of Fit-GOF: Root Mean Square Error of Approximation-RMSE, Comparative Fit Index-CFI and Tucker-Lewis Index-TLI. Change parameters: Modification Index-MI and Expected Parameter Changes-EPC. Results: Prototype Responders (P)/items P1/52, P2/31 and P3/28 (n=215) and P4/12 (n=280). Doornick-Hansen and KMO test: multivariate normality and sample adequacy. Principal Factor Analysis, Promax rotation, P1: two-dimensional structure: Factor1: 85.32% and Factor2: 85.11% of construct latency. P1 reached convergent factorial validity (Factor1=0.771 and Factor2=0.7362) and discriminant (Factor1=0.8782 and Factor2=0.8580/correlation between factors=0.3461). Cronbach's alpha for both factors: 0.9931. Re-specified model, E/AFC, P3: CC Factor1=0.7972 and CC Factor2=0.9622. GOF showed RMSEA=0.22; CFI=0.82 and TLI=0.84. MI and EPC values indicated the removal of three items and re-specification of the model for AFC, P4. The values of RMSEA=0.08, CFI=0.88 and TLI=0.77 indicated poor fit and the MI and EPC values for i3x, i4x, i31y and i33y: semantic redundancy. The residual variance indicated to removal i3x and i33y. GOF values were recalculated: RMSEA=0.067, CFI=0.86 and TLI=0.82, indicating plausible fit. Conclusion: The final questionnaire has eight items with two dimensions: "Food disease prevention" and "Foods with therapeutic value", five in each.

Keywords: Questionnaire, Food belief, Social media, Validity, Reliability, Factor analysis.

1. Introduction

The food industries are making very much advertisement to its products with the aim of conquering more and more consumers. Currently, digital marketing has reached a large number of Internet users with information from social media, which can to be considered an

important tool to determine the behavior of individuals regarding their consumption. On the other hand, we have advice from health professionals whose prescription and prohibition discourses that are not always by consensus with media influencers, creating a “food cacophony” [1].

In this scenario, both the media and the food industry can take advantage of consumers' lack of knowledge in relation to food and, at the same time, give them a seductive role of certain benefits that scientifically may not correspond to the truth.

On the other hand, it cannot be denied that the common census, that is, popular theories, play an important role in determining the prohibition or recommendation of consumption of certain foods. Remember that popular theories are based on observation and experimentation, in a way that they differ from scientific models, and should not be considered irrational or illogical, as it can be, in certain cases, the best of the common census [2], but they must be analyzed since their contents can contribute to nutritional problems.

In contemporary society, individuals interact daily with a set of information, which enable them to create beliefs about food. Food beliefs are difficult to eliminate, as they are linked to people's emotional and history, however, it is important that they become known to those who intend to trigger any type of intervention in this area [3].

Beliefs can be defined as the relationship between two things or between something and one of its characteristics [4]. When it is said that "duck meat is harmful to health", it can be believed that duck meat is difficult to digest regardless of whether it is a false or true statement. A belief can be seen as the individual's understanding of himself or his environment, in the present case, in the context of his food consumption.

The individual only perceives their beliefs when questioned. The individual’s behavior can be used as a guide to infer about their beliefs and attitudes. Bem [4] warns that the circumstances also must be taken into account, since both beliefs and context seem to be responsible for the behavior of individuals.

Extending the considerations of Bem [4], circumstances seem to be responsible for beliefs, so it is also necessary to know aspects of Social Communication Theory.

Festinger [5] formulated the Theory of Informal Social Communication, that is, spontaneous communication between people in a group. According to the author, the individuals of a group formed when communicating, seek uniformity and there is a need to establish a social reality focused on their goals. The members of a group need to standardize actions to achieve their goals and then establish communication between them, which results from the pressure for uniformity.

In relation to social reality, the beliefs that individuals hold must have some basis on which they rest for their validity [5] in the context of food consumption, a person may think that a food is considered healthy but it cannot be. Thus, the individual can seek scientific evidence and ensure the veracity of the information.

On what does the subjective validity of this belief depend? It largely depends on whether or not other people share your opinion. If there are other people around you who believe the same thing, then your opinion is for cognition (information) to be valid. A belief is "correct", "valid" and "adequate" insofar as it is anchored in a group of people with similar beliefs. It is not necessary for everyone to share the same belief. It is only necessary for the members of the group to which the individual belongs to think alike. The person who does not agree is seen as different and not an adequate reference for their opinion. For example, a person who believes that lemons have slimming properties, can compare themselves with others who appear in the media and have a thin and slender body, especially if she is a woman. Likewise, men may compare athletic bodies to their bodies and believe that eating lots of egg whites will help build muscle mass.

The advent of Food Technology, using a series of technical-scientific discoveries, has helped consumers to adjust to the frenetic pace of modern life, leading to inappropriate eating behavior that can result in pathologies such as obesity and other non-communicable chronic diseases [6].

In the post-modern world, advertising and consumer ideology gain importance, favoring the formation of new eating habits and replacing old food beliefs with new ones, now influenced by the media. It can be believed that new beliefs are being built in the imagination of modern man. Thus, health professionals must know them for the intervention that is needed.

1. 1. Purpose of the study

In a previous research study conducted by Lanzillotti [3] on food beliefs, this construct was evaluated according to the Classical Test Theory (TCT), which is based on the theory of measurement in Psychometrics to explain the meaning of the responses given by the subjects for a series of tasks and even propose techniques for measuring mental processes [7]. The TCT prevailed until the mid-1980s, using simple mathematical models and its objective was to have statistical techniques to predict the error in the application of tests [7].

According to Pasquali [7], the current problem is not to discover the construct from an existing representation (test), but to discover whether the representation (test) constitutes a legitimate, adequate representation of the construct. In this sense, Factor Analysis and Structural Equation models are able to test whether the construct representation operationalizes the theory with the ability to represent latent constructs, that is, models with measurable variables that explain concepts that cannot be measured directly [8] in the present case, dietary beliefs.

The present study identified a current model of food beliefs according to a psychometric approach with two objectives: to develop a health measurement instrument, in which food beliefs represent the construct, and to assess evidence of its reliability and validity.

2. Methods

2.1. Subjects

Participated adults of the social media and that are seeking a relationship between their food beliefs and the fundamentals of healthy eating.

2.2 Study design

The study deals with the development of a questionnaire focused on the area of Food and Nutrition, as an instrument for measuring health. The construction of the questionnaire was based on two strategies. The first was to seek the theoretical foundation of the belief construct, more strictly in food beliefs. Therefore, a bibliographic search was carried out in the following Health Sciences databases: SCIELO, MEDLINE, Pub Med. National and international publications available in Portuguese and English were included, from 2010 to 2021, which addressed theoretical plausibility in the identification of food beliefs. The keywords were: food, beliefs, food beliefs, food taboos, taboos. Likewise, the second strategy was to build a database with items created with sentences extracted from texts available on Instagram from social influencers.

The sentences operationalized the latent trait of the construct [9] "food belief". Assertions (items) with negative words were avoided in order not to reduce the validity of the questionnaire [10]. Assertions were organized into 52 items, which formed the “Food Beliefs” questionnaire, named Prototype 1 (Table 1). Items were presented on a Likert scale with five levels of agreement (5=strongly agree, 4=agree, 3=neither disagree nor agree 2=disagree, 1=strongly disagree). Then the questionnaire was configured in "Google Forms", edited, formatted and sent to users of social networks Facebook and WhatApp, in the period from 2020 to 2021. Internet users were asked to answer the questionnaire "FOOD BELIEFS" giving their agreement or disagreement on the items, alerting them to the non-existence of right or wrong answers. The purpose was only to obtain the opinion of internet users about the assertions. Demographic data such as age and gender and academic background also were requested. The Informed Consent Form accompanied the questionnaire.

Table 1: Questionnaire "FOOD BELIEVES", Prototype1 (n=52 items), addressed to users of the social network Facebook and WhatsApp. Period 2020-2021.

Item	Assertive	Item	Assertive
i1	Margarine is bad fat.	i27	Instant noodles irritate the stomach.
i2	Egg white helps to gain muscle mass.	i28	Extra virgin olive oil is good fat.
i3	Lemon water slims.	i29	Avocado causes diarrhea.
i4	Lemon cleanses the liver.	i30	Soy oil is bad fat.
i5	Coffee makes the migraine worse.	i31	Sardines are a good source of fat.
i6	Soy prevents breast cancer.	i32	Coconut water slows down aging.
i7	Sweet potatoes help to gain muscle mass.	i33	Cassava does not contain gluten.
i8	Banana prevents cramps.	i34	Vegan diet causes nutritional deficiency.
i9	Sunflower oil is bad fat.	i35	Banana causes constipation.
i10	Dark chocolate protects the heart.	i36	Hibiscus tea has a diuretic effect.
i11	Chicken helps to gain muscle mass.	i37	Flaxseed is a source of good fat.
i12	Olive oil protects the heart.	i38	Coconut oil is good fat.
i13	Bold tea cleanses the liver.	i39	Green tea prevents cardiovascular disease.
i14	Carbohydrate raises blood sugar.	i40	Salmon is a source of good fat.
i15	Grilled meat favors the appearance of cancer.	i41	Cabbage prevents anemia.
i16	Black tea helps with weight loss.	i42	Milk prevents bone disease.
i17	Coconut oil eliminates belly fat.	i43	Orange loosens the intestine.
i18	Chia is a good source of fat.	i44	Mortadella, smoked salami and ham cause migraines.
i19	Papaya causes diarrhea.	i45	Dark chocolate improves the feeling of well-being.
i20	Lard is good fat.	i46	Fruits and vegetables reduce the risk of cancer.
i21	Cheese makes migraine worse.	i47	Guava causes constipation.
i22	Ginger gets thin.	i48	Mint improves digestion.
i23	Wine makes migraine worse.	i49	Grape juice is good for the heart.
i24	Cinnamon reduces fat accumulation.	i50	Passion fruit is a great natural tranquilizer.
i25	Watermelon is a diuretic.	i51	Honey with warm milk fights insomnia.
i26	Cabbage has more calcium than milk.	i52	Pineapple prevents fluid retention.

i=item

Based on the responses from Prototype 1, in "Google Forms", a database with scores was created in Excel, and then data mining was carried out.

The theoretical hypothesis of the modeling that supports the questionnaire on food beliefs is the existence of a proliferation of information, often without theoretical nutritional plausibility, that bombards the users of social influencers' media.

2.3. Endorsement Index (EI)

The frequency of item endorsement used the proportion of people who chose the score alternative and closely indicates the behavior of the interest group in relation to food beliefs. The endorsement is intended to identify the "ground" items (proportion <0.05) and the "ceiling" items (proportion >0.95). Items with endorsement rates between 0.20 and 0.80 should be included in the questionnaire. The endorsement index reveals the discrimination capacity of item (di) [10], given by the following formula:

$$EI = \frac{Ui - Li}{ni} \quad (1)$$

Where,

Ui is the number of people above the median who obtain a positive result (agreement) in item i

Li is the number of people below the median who obtain a positive result (agreement) in item i

ni is the number of people above (or below) the median.

The total number of items in the questionnaire followed the guidance of Selltiz et al. [11], based on the Thurstone scale, which suggests a final questionnaire with approximately 20 items or smaller.

2.4. Exploratory Factor Analysis (EFA)

The exploratory factorial model started after the analysis of the "ceilings" and "floor" items, in which the multivariate normality of the scores was tested using the Dornik-Hanzen test [12]. The Kaiser-Meyer-Olkin (KMO) test verified whether the sample size was adequate for a factor analysis model, using ≥0.50 as a cutoff point [13]. Brown [14] considers values greater than 0.80 to be excellent.

The exploratory factor structure of the "food belief" construct was verified by Principal Component Analysis (PCA) and the number of components was evaluated by the Kaiser-Guttman rule, which recommends eigenvalues greater than one. Once the number of factors was defined, the Principal Factor Analysis (PFA), using the likelihood ratio (LR) as an estimator, was performed. The Kaiser-Guttman rule identified the number of dimensions of the construct. The Promax oblique rotation method was applied to the model restricted to n factors. According to Field [13], in the areas of Humanities and Social Sciences, the variables are almost always correlated, which indicates the use of oblique rotation. Satisfactory items were inferred as those with factor loadings (λ) greater than .50, since they are considered significant (σ= .05) for samples with a size equal or greater than 120 subjects [15]. Items with similar factor loadings in two or more factors and whose difference between the loads was less than λ=.10 [16] were considered items with cross loading and, therefore, likely to be eliminated from the questionnaire, unless they had theoretical plausibility for their permanence. The error variance (uniqueness: Ɛ) was considered adequate when Ɛ≤.70 [14, 15] and indicated the permanence of the item.

Commonality is an index that assesses how much of the variance in each item is explained by the factor solution. Expressive commonality values indicate that a large amount of variance in an item was extracted by the factorial solution [14]. Items with commonalities lower than 0.50 do not sufficiently explain the latency of the construct [15].

Two factorial validities were presented, the convergent, given by the Average Variance Extracted (AVE) and the discriminant, by comparing the square root of the factor's AVE and the values of the correlations with other factors in the system. The first ranges from 0 to 1 and values equal to or greater than 0.50 suggest that the items share a common variance [17] and the second is corroborated if the square root of the AVE of a factor is greater than the correlations between this and the other factors [14, 16]. The internal consistency of the questionnaire was assessed using Cronbach's alpha. The minimum acceptable value for alpha is α= .70 and the maximum value, α= .90, above this value it can be considered that there is redundancy of the semantic content of the item. Alpha values between .80 and .90 are recommended [10] The Cronbach's alpha error measurement index was calculated by (Streiner, [10] :

$1-\alpha^2$, where α is Cronbach's alpha (2)

2.5. Confirmatory Factor Analysis (CFA)

Anticipating a possible misfit of the model and predicting plausible alternative dimensional structures, the next step was to re-explore the dimensional structure of the questionnaire, according to an E/CFA (Exploratory/Confirmatory Factor Analysis) model, since this approach represents an intermediate step between the EFA and CFA which provide important substantial information in developing confirmatory solutions. The evaluation of the adequacy of the model for the continuation of the CFA was evaluated by goodness of fit - Goodness of Fit (GOF), in which three indices were used [14]: a) Root Mean Square Error of Approximation (RMSEA), which incorporates a penalty function for poor parsimony of the model [14,18,19]. Browne and Cudeck [18] consider it an adequate fit if the lower limit of the 90% is below 0.05, inadequate if the upper limit is above 0.10, and the model must be rejected or re-specified [14]; b) Comparative Fit Index (CFI) and c) Tucker-Lewis Index (TLI) which represent incremental fit indices [9, 14] contrasting the hypothesized model with a more restricted nested baseline model, named “null model”. Both range from zero to one and values greater than 0.9 are indicative of adequate adjustment [14, 20].

In order to assess the robustness of the E/CFA model, in addition to the goodness-of-fit parameters, the Modification Index (MI) was used. An MI reflects how much a general Chi-square model decreases if a constrained parameter is freely estimated. The MI is approximately equivalent to the difference in Chi-square between two models, where in one model the parameter is fixed or constrained and in the other the parameter is freely estimated. Possible correlations between measurement errors of items involving MI values equal to or greater than 10 require a more detailed analysis in parallel with the magnitude of the Expected Parameter Changes (EPC), which reflects the parameter changes when freely estimated [14].

The possible E/CFA model should be applied to the remaining items of the questionnaire in its Prototype 1 version, after the EFA has been performed. The E/CFA model, now Prototype2, requires a Structural Equation Model procedure, as proposed by Brown [14]

Subsequently, it may still be necessary to apply a re-specified CFA model coming from the E/CFA, now called Prototype 3. This Prototype 3 should be sent to Internet users in "Google Form", with a procedure similar to that of Prototype 1. Another database should be created with responses from another sample of similar participants, not included in the first sample, since there is the possibility of identifying, by e-mail, the subjects who participated in the first sample. Analogously to Prototype 1, the Kaiser-Meyer-Olkin test [13] and the Doornik-Hansen test [12] must be applied. Then, a Structural Equation Model procedure [21] also must be used for CFA in the model of the final instrument, in which the Goodness of Fit, Modification Index and Expected Parameter Changes (EPC) are verified. As a last analysis, the standardized residuals covariance matrix must be inspected. Values greater than 2.58 for the items are considered large and, consequently, inadequate [22].

At this time, this is a final confirmatory study, so Composite Reliability (CR) must be calculated, since Brown [14] reports that Cronbach's alpha coefficient does not indicate “true” reliability. CR is given by:

$$CR = \frac{(\sum_{i=1}^{i=k} \lambda i)}{(\sum_{i=1}^{i=k} \lambda i)+(\sum_{i=1}^{i=k} \delta i)} \quad (3)$$

Where:

λi factor loadings (standardized coefficient of the observed information matrix)

δi error variance for k items.

The CR varies from 0 to 1, being considered satisfactory when ≥ 0.70 [14].

In all models, the theoretical plausibility of the “food belief” construct, which permeates the items to assess the dimensionality of the questionnaire, must be considered.

The STATA application, version 12, was used to calculate descriptive statistics and conduct the EFA, E/CFA and CFA.

2.6. Consent and Ethical Approval

The research project that originated the present study was “Knowledge acquisition by the Nutri-Fuzzy-ORIXAS system" approved by the Research Ethics Committee of the Pedro Ernesto Hospital of the State Rio of Janeiro University, Protocol 794 CEP/HUPE/2003 accord to Resolution 252 of the Health National Council. Participants who agreed to collaborate with the research signed the Informed Consent Form.

3. Results

The questionnaire, Prototype 1, was answered by 215 users of social networks, predominantly female (67.91%). The mean age was 31.46 years (SD=12.88), the most

expressive level of education was bachelor's degree (incomplete=41.86% and complete=46.98). Among the declared courses, those in the health area represented 49.76% of the participants.

The Endorsement Index (EI) of the 52 initial assertions (items) allowed the identification of four items "ceiling" and six "floor". Items with EI between 0.20 and 0.80 formed the Prototype 1 of the questionnaire, which included 31 items (Table 2), with 11 items that did not belong to the EI limits for inclusion in the questionnaire being excluded.

Table 2: Endorsement Index (EI) "ceiling", "floor" and items between the recommended limits for inclusion in Prototype 1 of the "FOOD BELIEVES" questionnaire (n=31 items) answered by users of social networks Facebook and WhatsApp (n= 215). Period 2020-2021.

Item	EI		Item	EI	Item	EI	Item	EI
	>0.95	<0.05			≥0.20 e ≤0.80			
i1	1.00		i3	0.26	i20	0.32	i33	0.47
						0.48		0.22
i2		0.04	i4	0.75	i21		i34	
						0.27		0.20
i14	1.00		i7	0.29	i22		i35	
i32		0.03	i8	0.44	i23	0.26	i36	0.33
i37		0.00	i9	0.62	i24	0.39	i39	0.44
i40	1.00		i12	0.56	i25	0.28	i41	0.34
i44		0.01	i13	0.51	i26	0.52	i42	0.32
i45		0.03	i15	0.20	i28	0.44	i43	0.37
i50	1.00		i16	0.53	i30	0.46	i46	0.28
i51		0.02	i18	0.67	i31	0.36	i47	0.29
							i49	0.23

EI: Endorsement Index. Items 5;6;10;11;17;19;27;29;38;48 e 52, they did not present EI within the limits for inclusion in Prototype 1 of the questionnaire.

The Doornick-Hansen test showed multivariate normality in the distribution of scores given to Prototype 1 items (*chi2 (62) =1087.540 Prob>chi2= .0000*), allowing the construction of the factor analysis model.

The PCA (Principal Component Analysis) indicated two components for the structure of the questionnaire with auto values of 28.00 and 1.08, component 1 and component 2, respectively. Component 1 explains 93.84% of the latency of the "food belief" construct, while component 2 only explains 3.52%, which allows us to infer, at first, a one-dimensional structure.

The KMO values for the items ranged between 0.91 and 0.98 for each item per se and with the total value for the questionnaire of 0.96, which denotes adequacy of the sample size for a factorial model.

PFA (Principal Factor Analysis) confirmed the possible one-dimensionality of Prototype 1, with eigenvalues of 27.97 and 1.06 for factors 1 and 2, respectively. Analogously to the PCA results, Factor 1 explained 92.33% of the latency of the "food belief" construct and Factor 2 only 3.53% (*LR test: independent vs. saturated: chi2(465) = 2.0e+04 Prob>chi2 = .0000*). However, when applying Promax rotation to the model, the one-dimensional structure was rejected and the two-factor structure for the fit was subscribed. The results showed that the factors explained 85.32% and 85.11% of the latency of the "food belief" construct, respectively for Factor 1 and Factor 2.

The model constrained to two factors with Promax rotation presented in its structure 13 items in Factor 1 and 15 items in Factor 2. Three items showed cross load, namely: i12 ("Olive oil protects the heart"), i23 ("Wine makes migraine worse") and i43 ("Orange loosens the intestines"). These findings suggested the removal of the items from the questionnaire. Most of the error variances for the items of both factors did not exceed the value 0.10, with the exception of item i39 (Green tea prevents cardiovascular diseases) which presented a value of 0.12 (Tables 1 and 3).

Table 3: Exploratory Factor Analysis Model: factor loadings, error variance, convergent factor validity, discriminant factor validity, reliability-Cronbach's alpha and Exploratory/Confirmatory Factor Analysis Model: Composite Reliability, Goodness of Fit, Modification Index and Expected Parameter Changes of the model, Prototype 2 (31 items), of the "FOOD BELIEVES" questionnaire answered by users of social networks Facebook and WhatsApp (n=215). Period 2020-2021.

Exploratory Factor Analysis Model					
Factor 1			Factor 2		
Item	Factor loadings λ	Error variance δ	Item	Factor loadings λ	Error variance δ
i3	.9052	.0725	i7	.7405	.0759
i4	.8323	.0916	i8	.9594	.0448
i9	.8390	.0559	i13	.6404	.0415
i15	.8330	.0983	i18	.6058	.0716
i16	.8270	.0511	i25	.7106	.0657
i20	.7626	.0428	i26	.5685	.0753
i21	.8793	.0415	i28	.9000	.0506
i22	.7247	.0522	i30	.6508	.0414
i24	.7503	.0851	i31	.8461	.0636
i34	.8391	.0671	i33	.6673	.0454
i35	.7009	.0531	i36	.6288	.0873
i39	.5882	.1242	i41	.9212	.0451

i47	.5459	.0756	i42	.7099	.0632
			i46	.8348	.0675
			i49	.6586	.0940

Cross loading

	λ		λ	δ
i12	.4906		.5417	.0629
i23	.5559		.4738	.0597
i43	.5267		.5026	.0686

Convergent factor validity,

AVE Factor 1: 0.77 Factor 2: 0.73

Discriminant factor validity

Square root AVE Factor 1: 0.87 Factor 2: 0.85

Factor rotation matrix

	Factor 1	Factor 2
Factor 1	0.9382	0.9370
Factor 2	0.3461	-0.3493

Reliability Factor 1: .9931 Factor 2: .9931

α Cronbach CI 95%: .9920-.9942 CI 95%: .9934-.9953

Error index: 0.0137 Error index: 0.0137

Exploratory/Confirmatory Factor Analysis Model

Composite Reliability Factor 1: 0,79 Factor 2: 0,96

Goodness of Fit

RMSEA=0.227 (90%CI lower:0.215) CFI=0.87 TLI=0.84

Modification Index and Expected Parameter Changes of the model

Item	MI	*P*>MI	EPC	Item	MI	*P*>MI	EPC
i21x	10.59	.00	-0.14	i18y	24.09	.00	0.27
i24x	9.52	.00	0.17	i28y	15.87	.00	-0.23
i39x	41.81	.00	0.50	i31y	5.22	.02	-0.13
				i33y	8.53	.00	0.14
				i46y	6.81	.01	-0.14

I: item, λ: Factor loadings, Ɛ: Error variance, AVE: Average Variance Extracted, x:" Food disease prevention, y: ""Foods with therapeutic value", RMSEA: Root Mean Square Error of Approximation, CFI: Comparative Fit Index, TLI: Tucker-Lewis Index, MI: Modification Index, EPC: Expected Parameter Changes. P>MI *chi-square significance, degree of freedom: 1.LR test: independent vs. saturated: chi2 (465) = 2.0e+04 Prob>chi2 = .0000*

With regard to commonality, in Factor 1, three items: i35 (Banana causes constipation), i39 (Green tea prevents cardiovascular disease.) and i47 (Guava causes constipation) that had values below 0.50 and when calculating its error, none of them was greater than 0.70. In Factor 2, seven items were below the cut-off point: i13 (Bold tea cleanses the liver), i18 (Chia is a good source of fat), i26 (Cabbage has more calcium than milk), i30 (Soy oil is bad fat.), i33 (Cassava does not contain gluten), i36 (Hibiscus tea has a diuretic effect) and i49 (Grape juice is good for the heart). Analogously to the items in Factor 1, none showed expressive error (data not shown in table).

Convergent factor validity was achieved for both factors (Factor 1: 0.77and Factor 2: 0.73), suggesting that the items share a common variance. Likewise, the discriminant validity, since the square root of the AVE for both factors (Factor 1: 0.87 and Factor 2: 0.85) was greater than the correlations between these and the other factors (correlation:0.34) (Table 3).

Cronbach's alpha was calculated by removing the items that presented a cross load (i12, i23 and i43). In both factors, α= .99 with values greater than .90, which indicates redundancy of the item's semantic content. The index error alpha was 0.01. The results were more parsimonious for Factor 1, but not for Factor 2 (Table 3).

The semantic analysis of the items for both factors shows that in Factor 1 there are seven items with theoretical plausibility in Dietetics and Diet Therapy that support food belief cognition (i3, i4, i15, i16, i21, i24 and i39) and six that do not present this assumption (i9, i20, i22, i34, i35 and i47). Similarly, in Factor 2, there are eight with theoretical support (i18, i25, i28, i31, i33, i36, i46 and i49) and seven without (i7, i8, i13, i26, i30, i41 and i42) (Table 4). The cross-loaded items were eliminated and a new model was re-specified, including only items with theoretical plausibility, for both Factor 1 and Factor 2, named Prototype 3. In an attempt to name the factors created from the cognitions of the participants was suggested: Factor 1: "Food disease prevention" and Factor 2: "Foods with therapeutic value".

Table 4.Theoretical plausibility for assertions (items) of the "FOOD BELIEVES" questionnaire, according to scientific studies, Prototype 3 (n=28 items).

Theoretical plausibility			
Item	Yes	Item	No
i3	Lemon water slims. [23]	i7	Sweet potatoes help to gain muscle mass. [38]
i4	Lemon cleanses the liver. [24]	i8	Banana prevents cramps. [39]
i15	Grilled meat favors the appearance of cancer. [25]	i9	Sunflower oil is bad fat. [40]
i16	Black tea helps with weight loss. [26]	i13	Bold tea cleanses the liver. [41]
i18	Chia is a good source of fat. [27]	i20	Lard is good fat. [42]
i21	Cheese makes migraine worse.[28]	i22	Ginger gets thin. [43]
i24	Cinnamon reduces fat accumulation. [29]	i26	Cabbage has more calcium than milk.[44]
i25	Watermelon is a diuretic. [30]	i30	Soy oil is bad fat. [45]
i28	Extra virgin olive oil is good fat. [31]	i34	Vegan diet causes nutritional deficiency. [46]
i31	Sardines are a good source of fat. [32]	i35	Banana causes constipation. [47]
i33	Cassava does not contain gluten.[33]	i41	Cabbage prevents anemia. [48]
i36	Hibiscus tea has a diuretic effect. [34]	i42	Milk prevents bone disease.[49]
i39	Green tea prevents cardiovascular disease. [35]	i47	Guava causes constipation. [50]
i46	Fruits and vegetables reduce the risk of cancer.[36]		
i49	Grape juice is good for the heart.[37]		

YES: proven theoretical plausibility according to referenced authors. NO: unproven theoretical plausibility according to referenced authors.

In the E/AFC model, Prototype 3, the reliability of the model, given by Composite Reliability, reached 0.79 and 0.96 for Factors 1 and 2, respectively (Table 3). Regarding Factor 2, redundancy of the semantic content of items persisted.

Regarding the quality of the adjustment, analyzing the values of RMSEA=0.22 (IL/IC90%:0.215), CFI=0.82 and TLI=0.84, an inadequate adjustment was identified, which incorporated a penalty function with poor parsimony, suggesting that the questionnaire should be re-specified and applied to an interest group of similar subjects. Before the model of the questionnaire has been re-specified, Modification Index (MI) and Expected Parameter Changes (EPC) were evaluated.

The modification indices showed that freely estimating the factor loadings of the dimension “Food disease prevention”, MI i39x=41.81 (*chi2 ms (89) 1073.659 model vs saturated*), would decrease the chi-square of the model with one EPC of 0.50. Similarly for the dimension "Foods with therapeutic value", MI i18y=24.09 and MI i28y=15.87 (*chi2 ms(89) 1073.659 model vs saturated*), produced an EPC of 0.27 and -0.23, respectively (Table 3). Then, the re-specified model, Prototype 4, was tested without the i39x, i18y, and i28y items.

At this stage, Prototype 4, 280 users of social networks answered the questionnaire, predominantly female (72.86%). The mean age was 39.29 years (SD=15.46), the most expressive level of education was bachelor's degree (incomplete=23.21% and complete=56.08). Among the declared courses, those in the area of health and applied social sciences represented 26.07% and 22.86% of the participants, respectively.

The Doornick-Hansen test showed multivariate normality in the distribution of scores given to Prototype 4 items (*chi2(24)=623.480 Prob>chi2= .0000*) and KMO values between 0.6724 and 0.8576 allowed the model to be carried out of re-specified Confirmatory Factor Analysis.

The squared multiple correlations (R^2) for the items showed values ranging from 0.11 to 0.60 in the dimension “Food disease prevention” and for the dimension “Foods with therapeutic value”, from 0.17 to 0.42. The coefficient of determination reached 0.9194 (Table 5).

Analyzing the RMSEA, CFI and TLI values, that is, 0.08, 0.88 and 0.77, there are persistence of a not parsimonious fit of the model to the sample data, indicating that the model should be re-specified once again. However, the residual explained variance of the items did not show values greater than 2.58 (Table5).

Items i3x, i21x and i36y had higher MI (>10) indicating a cross-load. The EPC for item i3x assumed a value of -0.24. So, it is possible to infer that this item is not capable of capturing the construct of the dimension “Food disease prevention”. Although with MI of 7.79, item i31y had an EPC of -0.20, that is, it did not capture the dimension “Foods with therapeutic value”. These findings recommend the removal of these items from the questionnaire (Table5).

Semantically analyzing the items i3x (“Lemon water slims”), i21x (Cheese makes migraine worse”) and i36y (Hibiscus tea has a diuretic effect.) it is possible to imagine that they are not items capable of operationalizing the difference between the latencies of dimensions, although there is theoretical plausibility for them.

The standardized residuals covariance matrix was verified and no value exceeded 2.58 (Table 5) which demonstrates an indication of consistency between the data and the hypothetical model.

The covariance between items i25y and i33y (MI=7.91 and EPC= 0.22); i33y and i49y (MI=9.93 and EPC= -0.25) and i46y and i15x (MI=7.20 and EPC=0.18) indicate the removal of item i33y (Table 5).

Table 5: Confirmatory Factor Analysis Model re-specified: Explained variance (adjusted, predicted and residual), Coefficient of determination, Goodness of Fit, Modification Index and Expected Parameter Changes, Prototype 3 (12 items), of the "FOOD BELIEVES" questionnaire answered by users of social networks Facebook and WhatsApp (n=215). Period 2020-2021.

Confirmatory Factor Analysis Model re-specified									
	Factor 1					Factor 2			
	Explained variance					Explained variance			
item	Adjusted	Predicted	Residual	R^2	Item	Adjusted	Predicted	Residual	R^2
i3x	1.93	1.03	0.89	0.53	i25y	0.79	0.26	0.53	0.33
i4x	1.57	0.69	0.88	0.43	i31y	1.81	0.35	1.46	0.19
i15x	1.74	0.19	1.54	0.11	i33y	1.25	0.46	0.78	0.37
i16x	1.70	0.46	1.24	0.27	i36y	1.47	0.25	1.22	0.17
i21x	1.85	0.11	1.74	0.60	i.46y	1.22	0,51	0.70	0.42
i.24x	2.03	0.10	1.93	0.53	i.49y	1.27	0.43	0.83	0.34
Coefficient of determination				0,9194					
Goodness of Fit									
RMSEA=0.08 90%CI: 0.06-0.09			CFI=0.81		TLI=0.77				
Modification Index and Expected Parameter Changes									
Item	MI	*P*>MI	EPC	Item	MI	*P*>MI	EPC		
i3x	10.13	0.00	-0.24						
i15x	5.05	0.02	0.17	i31y	7.79	.01	-0.20		
i16x	5.50	0.02	0.17						
i21x	13.12	0.00	0.28	i36y	22.54	.00	0.35		
				i49y	9.70	.00	0.22		
Covariance									
	MI	*P*>MI	EPC						
i25y e i33y	7.91	.00	0.22						
I33y e i49y	9.93	.00	-0.25						
I46y e i15x	7.20	.01	0.18						

i: item, F1: "Food disease prevention", F2: ""Foods with therapeutic value". R2: Coefficient of determination, x:" Food disease prevention, y: "Foods with therapeutic value" RMSEA: Root Mean Square Error of Approximation, CFI: Comparative Fit Index, TLI: Tucker-Lewis Index, MI: Modification Index, EPC: Expected Parameter Changes.*P>MI chi-square significance, degree of freedom: 1.

LR test of model vs. saturated: chi2 (53) = 150.45, Prob > chi2 = 0.0000

Recalculating the GOF for the final model, excluding items i3x, i21x, i31y and i33y, the values were: RMSEA=0.06 (90%CI, lower bound=0.03 and upper bound 0.09), CFI=0.91 and TLI=0.87. These parameters are indicative of adequate adjustment

The questionnaire now has eight items in its final model, namely F1: "Food disease prevention", F2: "Food disease prevention" includes items i4x i15x i16x and i24x and, "Foods with therapeutic value", i25y i36y i46y and i49y.

4. Discussion

The present study presented a robust statistical modeling to assess the validity and reliability of a questionnaire to identify dietary beliefs.

According to Brown [14], when the item score distribution does not present a Gaussian profile, this can result in a biased standard error and the Chi-square test having a poor behavior adjusted for the model. If the non-normality of the item scores is extreme, that is, the presence of items with a significant "floor effect", the likelihood ratio estimator will produce incorrect parameter estimates. Trying to avoid this problem, this study started with the use of the Endorsement Index (EI) which indicated the removal of four items "ceiling" and six, "floor". Then, 31 of the 52 items initially constructed were included in the questionnaire. This strategy followed the recommendation of Streiner [10], that is, to include only those with EI between 0.20 and 0.80.

The questionnaire was validated using three factor analysis models: AFE, E/AFC and AFC.

Initially, the EFA indicated a possible of one dimension for the questionnaire; however, the results of the application of Promax rotation to the factorial model rejected such structure, subscribing to a solution with two factors. According to Raykov, [51], in some studies, get only one dimension for an original questionnaire can reduce its validity. Brown [14 relates that the consequences of over factoring are less harmful than those of under factoring. These were the reasons why, in the present study, a two-factor model was chosen and more theoretical justifications were made to adopt the two-dimensional structure of the questionnaire.

It is emphasized that this article did not suggest or advocate abandoning any requirements for one dimensionality of the scales used and developed in research on eating behavior. Rather, the concern was to provide an approach to estimating the validity and reliability of a dimensional structure that, for important substantive reasons, may involve more than a single source of latent variability.

With regard to the validity of a measurement instrument, it is necessary that the variables (items) be correlated with the theoretical assumptions, thus reaching the evidence of convergent validity. Regarding discriminant validity, the variables should not be correlated [7].

In the present study, it can be inferred that the measurement error did not affect the validation of the instrument, as it was possible to capture the latency of the construct [8].

The convergent validity in both factors (dimensions) reached values above 0.70 [8]. On the other hand, discriminant validity (inter correlation between factors) was reached, which implies a parsimonious factorial solution. These findings reflect correlations between the variables (items) that theoretically converge and others that diverge in the explanation of the latency of the construct.

It is important to emphasize the consideration of Pasquali [57] that the analysis of internal consistency does not constitute complete proof of the test's construct validity, since high correlations between items do not necessarily indicate that they are measuring the same construct. In the present study, in both factors, Cronbach's alpha reached values greater than

0.90, that is, high correlations, which indicate the redundancy of items [10] and which, therefore, need to be inspected. In this sense, in evaluating the internal consistency of the dimensions of the questionnaire in Prototype 2, E/AFC model, the composite reliability suggested by Brown [14] was chosen and which reached adequate levels for both factors.

The EFA results indicated implausible for the fit parameters. In this case, going directly to a CFA model could run the risk of a poor fit solution. So, we opted for an E/CFA study (Prototype 2) and, in sequence, the GOF (RMSEA, CFI and TLI) and the MI and EPC statistics. This statistics were analyzed to assist in the selection of those items that could remain or should be removed from the model to improve the fit [14]. The use of the E/CFA model in continuation of the EFA model was a useful precursor of the CFA, as it allowed exploring the more complete measurement frameworks before moving to a confirmation framework [14]. The strategy used was structural equation modeling (SEM).

Many measurement procedures in behavioral and social research are based on multi-component instruments, such as tests or test batteries, scales, questionnaires, inventories. In recent years, however, interest in Structural Equation Modeling approaches has increased [51]. The application of this modeling allowed the identification of accentuated values related to the residual explained variance for the items i5x, i16x, i21x, i24x, i31y and i36y (Prototype 4), showing that there were elements to be improved, as can be seen in the values of RMSEA=0 .08, CFI=0.88 and TLI=0.77. A semantic analysis in parallel with the statistical data indicated the removal of items i3x and i33y, leading to a better adjustment of the RMSEA, CFI and TLI indices. These indices were relatively plausible, but not expressive. However, it is noteworthy that Brown [14] warns that the sample size affects the model and that the analysis of covariance is based on theories with large samples. Thus, getting well-adjusted hypothetical models is very rare in most empirical research. In the present study, the sample for modeling structural equations consisted of 280 users of social networks, which may have affected the quality of the adjustment. However, the study sample size is in line with what is recommended in simulation surveys based on AFE, E/AFC and AFC analysis [14] and it was similar to other validation studies in the health area [52, 53, 54].

According to Brown [14], an inadequate fit in the model is more likely to have originated from a bad specification than from its dimensional structure. In order to improve the modeling in the course of this study, several re-specifications of the initial model (Prototype 1) were carried out.

It is possible to believe that the dimensional structure of the "FOOD BELIEVES" questionnaire allows us to seek clues of the evidence of a cultural and contemporary representation of people's concern with health.

A study carried out by Godin and Sahakian [1] in Switzerland draws attention to the websites of prescribers of food consumption in the media. The authors warn that they are an important mechanism for the diffusion and, eventually, the adoption of new prescriptions by the people. They adopting what are perceived as healthy eating habits or do not. The onus of conflicting prescriptions is, therefore, on people's daily lives, involving what to buy.

The approach of this study deviates from more conventional explanatory patterns about food beliefs in the sense of taboos, when people avoid eating food for religious reasons or other historically constructed reasons [55].

This study can be considered a pioneer to investigate the validity and reliability of an instrument for measuring food beliefs; however, future validation tests are needed to examine it in other contexts.

Reichenheim et al. [56]) comments: the answer to whether a factor structure will be repeatable in different cultural situations requires more research and new evidence replicating and extending the proposed models. It could be argued that the process of developing the food beliefs questionnaire has come full circle here. However, results from culturally diverse interest groups may differ.

5. Conclusion

The results showed that the factor analysis allowed the identification of two factors, which should not be used empirically as separate subscales.

The final form of the questionnaire has eight items, four in each of the two dimensions, “Food disease prevention” and “Foods with therapeutic value”, with evidence of reliability and validity.

The "FOOD BELIEVES" questionnaire, although still pending corroboration from further studies to be carried out in different contexts, seems to be well suited as an empirical representation of this construct. Its use in nutritional practice and applied research should be encouraged.

The limitation of this study includes the composition of the sample restricted to internet users of social networks, for reasons of non-pharmacological sanitary measures imposed by the COVID-19 pandemic.

This instrument can provide health professionals with brief but culturally relevant knowledge about current food beliefs in nutrition education intervention sites.

Acknowledgements

This study was funded by the Scientific Initiation Program of the Department of Training and Support for Human Resources Education at the State University of Rio de Janeiro, Brazil.

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Competing Interests

"Authors have declared that no competing interests exist".

AUTHORS' CONTRIBUTIONS

Maria Luiza Barreto Medeiros da Silva: carried out bibliographic reference research; researched belief food assertions on social media; transformed the questionnaires into Google format for sending to respondents; created the databases and did the data mining; participated in data analysis and translated the manuscript.

Haydée Serrão Lanzillotti: designed the study, managed and performed the statistical analysis, wrote the first draft of the manuscript and elaborated its final version.

Roseane Moreira Sampaio Barbosa: The author carried out the critical reading of the final manuscript.

Maria Elisa Barros: wrote the first draft of the manuscript and analyzed its final version.

All authors read and approved the final manuscript.