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Factorial Validity and Reliability of a Food Behavior Checklist for Japanese Pregnant and Postpartum Women

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ABSTRACT

Background: Dietary education programs for pregnant and postpartum Japanese women are conducted during health check-ups and in childbirth education classes, but there is no tool to evaluate their food behavior. Therefore, this study examined the factorial validity, test–retest reliability, and internal consistency of the food behavior checklist (FBC) for pregnant and postpartum Japanese women.
Subjects and Method: This was a longitudinal study. We screened 4,000 women aged 18–45 years who were either pregnant or nursing an infant aged <1 years and enrolled in Freeasy, a platform with 4.5 million panels. Data were collected from 97 pregnant women and 203 postpartum women through an online survey. They completed the 21-item FBC on a web survey twice at an interval of 3 weeks. After performing principal component analyses, internal consistency was calculated using Cronbach's α. The intraclass correlation coefficient (ICC) and kappa (κ) coefficient were calculated to assess the test–retest reliability.
Results: There were 21 items loaded on six factors (fruit and vegetable quantity, vegetable variety, balanced fish and meat intake, sweetened beverages, eating habits, and food consciousness). Cronbach's α for the total scale was 0.77. ICC for the test–retest reliability of individual items ranged from 0.35 to 0.62, and ICC for the total scale was 0.62. The κ coefficient values ranged from 0.26 to 0.52, indicating fair-to-moderate strength of agreement between the test and retest.
Conclusion: The FBC demonstrated factorial validity, test–retest reliability, and internal consistency, indicating its potential application in evaluating the effects of the dietary education programs on pregnant and postpartum women, which include taking a staple meal, folic acid, and avoiding raw food consumption. This compact tool can be conveniently used by midwives and provide practical guidance during maternal health check-ups.

Keywords: pregnant, postpartum, dietary, checklist, reproducibility.

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BACKGROUND

The Japanese Ministry of Health, Labour, and Welfare (MHLW) issued "Dietary Guidelines for Pregnant and Lactating Women" in 2006 (Ministry of Health Labour and Welfare of Japan, 2006). This guideline instructs on how to have a balanced diet and recommends weight gain during pregnancy, while a midwife or dietitian provides individual advice to the women. The dietary education programs for pregnant and postpartum women, which include taking a staple meal, folic acid, and avoiding raw food consumption are conducted in health check-ups and childbirth education classes at each institute.

The percentage of Japanese women with a body mass index of less than 18.5 was 20.7% for women aged 20–29 years and 16.4% for women aged 30–39 years in 2021, which highlights the problem of many women being underweight (Ministry of Health Labour and Welfare, 2021). Previous studies concluded that low prepregnancy body mass index in Japanese women has a detrimental effect on birthweight and increases the proportion of low-birth-weight (LBW) infants (Takimoto et al., 2003; Okubo et al., 2011). In addition, Japan has had the highest proportion of LBW infants among Organisation for Economic Co-operation and Development (OECD) countries for over 20 years. In 2019, the proportion of low-birth-weight infants in Japan was 9.4%, whereas the average proportion for OECD countries was only 6.6% (Organization for Economic Co-operation and Development, 2022). LBW infants have been shown to be predisposed to infant mortality and morbidity in the short term (Friedman et al., 2000; Kusuda et al., 2012) and noninflammatory chronic diseases in the long term (Gluckman et al., 2004). Hence, nutrition education during pregnancy is critical.

A review of the literature in Japan revealed the nonutilization of the guideline among midwives (Takimoto et al., 2013; Omizu et al., 2010). One of the reasons for this observation is that they are not sure how to use the dietary guideline or how to count one serving. A well-balanced diet can be evaluated using the Dietary Reference Intake for Japanese published by the MHLW. However, the targeted population for health education should be monitored using various. Therefore, a simple tool to assess guideline-based nutrition education that can be used by midwives and the targeted population is needed.

The United States Department of Agriculture runs several programs, such as the Supplemental Nutrition Assistance Program Education and the Expanded Food and Nutrition Education Program, in the U.S (Hersey et al., 2014). One of the tools used to evaluate the impact of nutrition education on dietary intake is a food behavior checklist (FBC) (Marilyn et al., 2006).

This tool, a brief questionnaire containing items on food security and overall diet quality, has a photo that helps its users to visually perceive the information it contains. Previous studies have demonstrated the validity and reliability of the Spanish (Banna et al., 2010) and Tagalog (Suzuki et al., 2017) versions of the FBC and found it to evaluate nutrition education on dietary intake. This simple tool may also be used in Japan to evaluate the impact of guideline-based nutrition education in pregnant and postpartum women; hence, we have developed the Japanese FBC in 2022, and evaluated face validity (Fujita et al., 2022). To match the Japanese food culture, the Japanese FBC removed inadequate questions, added some items from the dietary guidelines for pregnant and postpartum women, and changed the pictures used in the previous FBC. Firstly, the food insecurity question was removed since this

tool is targeted for people with middle-income and above. Secondly, we added sentences, such as “excluding soda water” and “excluding folic acid supplements” to make the questions more meaningful. In particular, the images had to be matched with the Japanese food culture, and “images of eating snacks,” “serving dishes,” and “food menus” were replaced. The Japanese version of the FBC consists of 21 items (Fig. 1), adding three new items was recommended in the maternal and child health handbook, namely staple food intake, folic acid, and heating raw food (Ministry of Health Labour and Welfare of Japan, 2023). As with the Spanish and Tagalog versions of the FBC (Banna et al., 2010, 2015), this tool was a brief questionnaire containing items on the intake of fruits and vegetables, sweetened beverages, dairy products, staple food, and fried food, as well as food preparation and diet quality.

This study aimed to examine the factorial validity, test–retest reliability, and internal consistency of the FBC for Japanese pregnant and postpartum women.

SUBJECTS AND METHOD

1. Study Design

This study had a longitudinal design and was conducted through a market research provider (Freeasy; iBRIDGE Corporation, Tokyo, Japan), September and October 2022 in Japan.

2. Population and Sample

A two-stage sampling approach was used to ensure representativeness. First, we screened 4,000 women between the ages of 18 and 45 years who were either pregnant or nursing an infant aged <1 year registered on Freeasy, a platform with 4.5 million panels. The tolerance error and the confidence level were set at 5% and 95%, respectively, and sample size was estimated to be 400 respondents (Israel, 1992), who were asked the Japanese FBC questions online. The collection ended when 400 responses were received, and the Japanese FBC questionnaire was provided for a second time three weeks later. The ρ coefficient was set to 0.5 to analyze test–retest reliability (Bonett, 2002), and the final sample was 300 respondents.

3. Study Variables

Dependent variables are the Japanese version of the FBC consist of 21 items (Figure 1). Sociodemographic information included age, pregnancy, level of education, and household income.

4. Study Instruments

Participants completed the 21-item FBC for Japanese pregnant and postpartum women on two occasions that were three weeks apart. Sociodemographic information were obtained from participants’ Freeasy database. The responses on the FBC were recorded on a 4-point scale ranging from 1 to 4 or a 5-point scale ranging from 1 to 5, with higher scores indicating more desirable behavior. Dichotomous items were recorded with a score of 2 for "yes" and 1 for "no" after replacing responses to reversal items. Diet quality was rated on a 10-point scale, and higher scores indicated better diet quality. The behavior change stage was based on the transtheoretical portion of the health behavior change model by Prochaska (Prochaska et al., 1997). Hence, these were asked on a 6-point scale as to whether they would like to improve their eating habits.

5. Data analysis

The researchers performed data analysis using JMP v16.1.0® software (SAS Institute, Cary, NC, USA).

Continuous variables were presented as mean values with standard deviations for normally distributed data or median values with interquartile ranges for skewedly distributed data, while categorical variables were presented as frequencies and percentages.

Figure 1. The Japanese version of the FBC consists of 21 items

5. Data analysis

Regarding factor validity, the researchers first segregated items according to predetermined categories: fruits and vegetables, milk and dairy, diet quality, and the remaining items. Factor validity was examined using the principal component analysis (PCA) with varimax rotation for each category having at least two items at the first point. To assess the number of factors, the Kaiser criterion (eigenvalues >1.0) and scree plot analysis were initially used. Same as in the previous study (Tonan et al., 1995), any item with a factor loading of >0.40 was considered to load on the given factor, in conjunction with the review of the content of the individual items.

Internal consistency was calculated using Cronbach α with each subscale and total scale at the first time point. We considered α > 0.70 to be acceptable (Tonan et al., 1995). Test–retest reliability was assessed using the most commonly used intraclass correlation coefficient (ICC), with scores for each item, each subscale, and the total scale calculated between scores at both time points (Koo and Li, 2016; Putz et al., 2019). Categorical data were calculated using Kappa (κ) coefficients with scores for each subscale. The following strength of agreement standards for κ coefficients was used: ≤0 = poor; 0.01–0.20 = slight, 0.21–0.40 = fair, 0.41–0.60 = moderate; 0.61–0.80 = substantial; and 0.80–1.0 = almost perfect (Landis et al., 1977). Items referring to the previous day or the past week were excluded from test–retest reliability analyses due to reference to a specific period.

7. Research Ethics

The study used the Freeasy database and participants' anonymity was preserved. The research ethics was ascertained by the institutional review board of Yamagata University Japan under protocol number 2022-109.

RESULTS

1. Sample Characteristics

Table 1 shows the demographic characteristics of the study participants. Of the 300 participants, 97 (32.3%) were pregnant women and 203 (67.7%) were postpartum women. The mean (SD) age was 33.7 (5.4) years, and 249 (83.0%) participants were married. A total of 263 (63%) participants had occupation, and the group with a median household income of 4–6 million yen accounted for 31.7%.

2. Results of the factorial validity

Results of the PCA with varimax rotation are displayed in Table 2, as well as the mean and SD of each item. Six factors were identified: (1) fruit and vegetable quantity, (2) vegetable variety, (3) balanced fish and meat intake, (4) sweetened beverages, (5) eating habits, and (6) food consciousness. There were 15 items loaded on a factor, except for the item on citrus fruit juice and fried food. The predetermined milk and dairy subscale and diet quality items were not included in the PCA because they consisted of two items.

3. Results of test–retest reliability and internal consistency

Table 3 shows internal consistency and test–retest reliability. Cronbach α for internal consistency of subscales among the respondents of this study ranged from 0.21 (milk/dairy subscale) to 0.77 (vegetable variety subscale), and Cronbach α for the total scale was 0.77. The intraclass correlation coefficient for the test–retest reliability of individual items ranged from 0.35 to 0.62, whereas the correlation coefficients of individual subscales ranged from 0.49 to 0.65. The correlation for the test–retest reliability of the total scale was 0.62. The κ coefficient values ranged from 0.26 to 0.52, indicating fair-to-moderate strength of agreement between the test and retest.

Table 1. Demographic Characteristics of Pregnant and Postpartum Japanese Women (n = 300)

Characteristics	n (%)
Age (year) Mean ± SD [range]	33.7 ± 5.4 [21–45]
Pregnant women (over 20 weeks of gestation)	97 (32.3)
Postpartum women (within 1 year after birth)	203 (67.7)
Marital status	
Married	249 (83.0)
Single	51 (17.0)
Occupation	
Yes	207 (69.0)
No	86 (28.7)
Other	7 (2.3)
Household income (JPY)	
< 4,000,000	81 (27.0)
4,000,000–<6,000,000	95 (31.7)
6,000,000–<8,000,000	65 (21.7)
8,000,000–<12,000,000	37 (12.3)
12,000,001≦	22 (7.3)

Table 2. Factor Validity and Item Analysis 21 Items on the Food Behavior Checklist for Japanese pregnant and postpartum women (n = 300)

Food Behavior Item	Factor Loading	Mean	SD
Fruit and vegetable quantity subscale	**Factor 1**		
1. How many cups of vegetable do you eat each day?	0.55	2.57	0.94
2. How many cups of fruit do you eat each day?	0.93	2.09	0.85
3. Do you eat more than one type of fruits each day?	0.54	2.37	0.97
Vegetable variety subscale	**Factor 2**		
4. Do you eat more than one type of vegetable each day?	0.81	3.24	0.97
5. Do you eat 2 or more vegetables at your main meal?	0.67	3.05	1.04
Does not load on any factor >0.40:			
6. Did you have citrus fruit or citrus juice during week?		1.38	0.49
Balanced fish and meat intake subscale	**Factor 3**		
7. Did you eat fish during the past week?	0.52	1.90	0.30
8. Did you eat red meat or pork during the past week?	0.73	1.93	0.26
Sweetened beverage subscale	**Factor 4**		
9. Do you drink fruit drinks or sport drinks?	0.76	2.96	0.87
10.Do you drink regular soda?	0.68	2.97	0.85
Eating habits subscale	**Factor 5**		
11. Do you eat meat and fish well heated?	0.54	3.32	1.01
12. How many times do you eat staple foods each day?	0.51	3.38	0.83
Food consciousness subscale	**Factor 6**		
13. Do you eat fruits or vegetable as snacks?	0.40	2.31	0.97
14. Do you take the skin off chicken?	0.56	2.17	1.14
15. Do you eat folic acid containing foods each day? (excluding supplements)	0.43	2.34	0.99
16. Do you see the nutrients and the production area when food shopping?	0.48	2.44	1.04
Does not load on any factor >0.40:			
17. Did you eat fried food yesterday?		1.55	0.5

Food Behavior Item	Factor Loading	Mean	SD
Milk/dairy subscale			
18. Do you drink milk?	N/A	2.77	1.06
19. Did you drink milk or eat dairy during the past week?	N/A	1.90	0.30
Diet quality subscale			
20. How would you rate your eating habits?	N/A	5.34	1.58
21. Would you like to improve your eating habits?	N/A	2.09	0.93

N/A indicates Not applicable.
Notes: Factor structures were not examined for factors with ≤2 items. Analyses were performed using responses to the food behavior checklist at the first time point.

Table 3. Internal consistency and test–retest reliability of the Food Behavior Checklist for Japanese Pregnant and Postpartum Women (n = 300)

Food behavior item	Internal consistency	Test–Retest Reliability	
	α	Intraclass Correlation Coefficient	Weighted Kappa (95% CI)
Fruit and vegetable quantity subscale	0.67	0.49	
1. Cups of vegetable each day		0.42	0.35 (0.27-0.44)
2. Cups of fruit each day		0.36	0.37 (0.28-0.46)
3. >1 type of fruit each day		0.53	0.36 (0.28-0.44)
Vegetable variety subscale	0.77	0.65	
4. >1 types of vegetable each day		0.36	0.40 (0.32-0.48)
5. ≥2 vegetables at main meal		0.58	0.43 (0.36-0.51)
Does not load on any factor >0.40:			
6. Citrus fruits or citrus juice during past week		N/A	N/A
Balanced fish and meat intake subscale	0.54		
7. Fish during past week		N/A	N/A
8. Red meat during past week		N/A	N/A
Sweetened beverage subscale	0.69	0.54	
9. Drink fruit drinks, sport drinks		0.40	0.39 (0.30-0.47)
10. Drink regular soda		0.58	0.52 (0.44-0.60)
Eating habits subscale	0.44	0.51	
11. Heat cooking		0.45	0.35 (0.26-0.43)
12. Staple food each day		0.48	0.46 (0.38-0.54)
Food consciousness subscale	0.54	0.54	
13. Fruits or vegetable as snacks		0.40	0.37 (0.29-0.45)
14. Take skin off chicken		0.62	0.49 (0.41-0.56)
15. Folic acid each day		0.35	0.26 (0.19-0.34)
16. Use label when food shopping		0.51	0.36 (0.28-0.44)
Does not load on any factor >0.40:			
17. Fride food yesterday		N/A	N/A
Milk/dairy subscale	0.21		
18. Drink milk		0.57	0.46 (0.38-0.54)
19. Dairy during past week		N/A	N/A

Food behavior item	Internal consistency	Test–Retest Reliability	
	α	Intraclass Correlation Coefficient	Weighted Kappa (95% CI)
Diet quality subscale	N/A		
20. Rate eating habits past week		N/A	N/A
21. Stage of behavior		N/A	N/A
Total scale[a]	0.77	0.62	

[a]Total scale excludes no.6, no.17 and diet quality subscale.

DISCUSSION

In the present study, we examined the factorial validity, test–retest reliability, and internal consistency of the FBC for Japanese pregnant and postpartum women.

Factor validity revealed that all but 2 of the 17 items loaded on the six factors. The citrus item and fried food did not load on any factor. The fried food item unloaded was the remarkable result of the Japanese version of the FBC. This item had a high mean value; that is, many respondents did not eat fried food the previous day, a specific finding of the Japanese version of the FBC. There were pregnant women among the participants of this study; so, they may have been more cautious while consuming fatty foods (Fujita et al., 2015). The photos of citrus fruits and beverages were of common citrus fruits, but it may have been difficult to answer owing to the large variety of citrus fruits available in Japan depending on the region and season. If it does not correlate with nutrient intake in future studies, these items may either be modified and tested further or considered for deletion.

With regard to internal consistency, Cronbach α coefficient of the total scale was 0.77, which was considered to be acceptable. However, internal consistency was low for the fish and meat balance, eating habits, and milk/ dairy subscale containing 2 items. Since internal consistency is affected by the number of subitems (Streiner, 2003), this was expected given the small number of items these subscales contained. Similar results were found in a previous study evaluating the Spanish and Tagalog versions of the FBC (Banna et al., 2010; Suzuki et al., 2017), in which the correlation coefficient for the low number of items involved was also low. The low value indicated that items in the subscales may have reflected independent food behaviors. However, these items are based on the Dietary Guidelines for Pregnant and Lactating Women (Ministry of Health Labour and Welfare of Japan, 2006) and are considered as useful items.

Regarding test–retest, the ICC values and the strength of the Kappa coefficient were lower than those obtained for the Tagalog version of the FBC. The reason for this is that data were collected using an anonymized web-based survey method. Alternatively, the web surveys have a response bias because the researcher is not directly involved (Hirao et al., 2012). Therefore, all items in these subscales may be used in the final tool.

During pregnancy, a variety of factors, including changes in food preferences and meal frequency, influence dietary behavior due to morning sickness. Further testing of the questionnaire revealed that it may be possible to consider featuring other relevant behaviors. Previous studies evaluating the validity of the English and Spanish versions of the FBC involved the collection of 24-hour dietary recalls to evaluate convergent validity and serum carotenoids as a fruit and vege-

table intake marker to assess criterion validity (Murphy et al., 2001; Banna et al., 2011). Further, additional testing of this tool is needed to assess convergence and criterion validity. The dietary guidelines for pregnant and lactating women issued by MHLW indicate that they should eat well at least twice daily, with a staple food, a main dish, and a side dish. Therefore, there could be an item that asks about the balance of one meal and the number of fruits and vegetables. In Japan, the Meal-based Diet History Questionnaire has been developed to estimate food and nutrient intake by adults' diet type (Murakami et al., 2021a). and a web-based feedback system has been established (Murakami et al., 2021b). In addition, practical evaluation methods have been developed, such as the dish-based dietary patterns questionnaire (Shinozaki et al., 2020), which evaluates the combination of foods at each meal. In assessing the reliability and validity of the FBC for Japanese pregnant women, it may be possible to compare these tools with questionnaire responses. In addition, it may be possible to clarify items that should be deleted from the FBC. After testing is completed, it is expected that the FBC may be used to assess the food behavior for pregnant and postpartum women.

However, this study had certain limitations. First, health conditions during pregnancy were not considered, and responses may have been affected by factors such as weight gain and health guidance when having perinatal complications. Second, the participants were not asked about breastfeeding. Lactating mothers had additional nutritional requirements that nonlactating mothers did not have, which may have affected their responses. However, the FBC for Japanese pregnant and postpartum women is a brief tool with eight subscales that health education providers and their women may easily use.

After a future study to examine the convergence and criterion validity of the tool, this tool may be used to evaluate the effects of the dietary education programs for pregnant and postpartum women, which include taking a staple meal, folic acid, and avoiding raw food consumption. This brief tool would also be easy for midwives to use and would provide effective guidance during maternal health check-ups.

In conclusion, the FBC demonstrated factorial validity, test–retest reliability, and internal consistency; therefore, it could be used to evaluate the effects of the dietary education programs for pregnant and postpartum women, which include taking a staple meal, folic acid, and avoiding raw food consumption.

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CONFLICT OF INTEREST

The authors have not stated any conflicts of interest.

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