

Assessing the Impact of Eating Behavior on Weight Gain During Pregnancy: Validation of a Dietary Behavior Questionnaire

Runa Sato, Megumi Fujita*, Mihar Suzuki and Mihar Tezuka

Department of Clinical Nursing, Graduate School of Medical Science, Yamagata University, Yamagata, Japan

Abstract

Pre-pregnancy obesity and excessive weight gain during pregnancy raised the risk of pregnancy-related hypertension, gestational diabetes, having an overly large baby, and the likelihood of cesarean delivery. Hence, managing weight during pregnancy is critical.

This study aimed to assess the factorial validity of a questionnaire on eating behavior related to weight gain during pregnancy in Japan. The study included 238 postpartum mothers who delivered singleton, full-term babies between February 2023 and June 2023. The factorial validity of the original 46-item dietary behavior questionnaire (DBQ) with excessive weight gain during pregnancy was examined using the principal component analysis with promax rotation. Internal consistency was calculated using Cronbach α with each subscale and total scale at the first time point. Results of the principal component analysis with promax rotation, 24-items in six factors were identified: misperceptions and regrets over weight gain, tendency to eat fast without chewing well, unbalanced taste preferences in eating out and replacement home meals, anxiety about food scarcity, inclination toward eye-catching fruits and sweets, and aversion to leftover food. The Cronbach's alpha for the overall scale was 0.83 and there was a correlation coefficient between pre-pregnancy body mass index, pregnancy weight gain category, and the total score on the DBQ. There was a significant positive correlation between pre-pregnancy body mass index and all total scores on the DBQ ($r = 0.32$, $p < 0.0001$). Regarding pregnancy weight gain categories, the above-standard and below-standard weight gain groups had higher DBQ scores than the below-standard group, with p -values of 0.004 and 0.002, respectively. The 24-item DBQ showed factorial validity and internal consistency, thus it could be used to assess the impact of eating behavior on weight gain during pregnancy.

Introduction

Pre-pregnancy obesity and excessive weight gain during pregnancy raise the risk of pregnancy-related hypertensive disorders, gestational diabetes, overly large babies, and cesarean deliveries [1]. Meanwhile, Japan has had the highest rate of LBW infants among OECD countries for over 20 years. In 2019, Japan had a low-birth weight rate of 9.4% among new-borns, higher than the OECD average of 6.6% [2], indicating a new perinatal challenge to address. Previous studies have determined that a low pre-pregnancy body mass index in Japanese women adversely affects birth weight and increases the incidence of low-birth weight infants [3,4]. For this reason, weight management during pregnancy is very important.

In 2021, the Japan Society of Obstetrics and Gynaecology updated the recommended pregnancy in 2021. According to the pre-pregnancy body mass index: recommended weight gain is body mass index <18.5 : 12–15 kg, $18.5 \leq$ body mass index <25 : 10–13 kg, $25 \leq$ body mass index <30 : 7–10 kg, body mass index ≥ 30 : personalized [5,6]. Proper weight gain during pregnancy is crucial to prevent perinatal complications, yet pregnant women who gain excessive weight require careful medical guidance. The Japanese Ministry of Health, Labour and Welfare published the Dietary Guidelines for Pregnant and Lactating Women in 2006 [7]. This guideline provides instructions for maintaining a balanced diet and recommends weight gain during pregnancy, with a midwife or dietitian offering personalized advice to women. A balanced diet can be assessed using these guidelines; however, the target population for health education should be monitored considering factors such as eating behaviors, food preferences, and dietary discrepancies. The variations in eating behavior are known as perception discrepancies “I gain weight even if I only drink water,” satiety discrepancies “I can eat whatever I want even when full,” and intake discrepancies “I eat a lot, but the amount is not really that much [8].” It is speculated that nutritional balance, as well

as discrepancies and habits in eating behavior, may be at the root of excessive weight gain during pregnancy. A 55-item questionnaire assessing discrepancies and eating behavior habits for weight control in Japanese obesity was administered, which examined the eating behaviors associated with obesity and led to behavioral changes in obese individuals [9]. Although the questionnaire on obese eating behavior was intended for adults, an analysis revealed that certain items were not suitable for pregnant women, such as “frequent feasting and parties with alcohol.” Consequently, this questionnaire hampers the assessment of pregnant women's eating behavior. If the eating habits of pregnant women with excessive weight gain could be monitored, midwives could tailor their care to meet individual needs.

This study aimed to assess the factorial validity of the questionnaire on eating behavior related to weight gain during pregnancy in Japan.

Materials & Method

Step 1: Item pool selection and scaling

The 55-item obesity eating behavior questionnaire served as a reference to develop the eating behavior questionnaire for pregnant women with excessive weight gain. The content's validity was assessed by four obstetrics researchers with experience in obstetric practice.

***Corresponding Author:** Prof. Megumi Fujita, Department of Clinical Nursing, Yamagata University Graduate School of Medical Science, Yamagata, Japan, Tel: +81-23-628-5443; E-mail: f.megumi@med.id.yamagata-u.ac.jp

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First, the obesity-related eating behavior questionnaire contained several items unsuitable for pregnant women, such as “frequent banquets and parties with drinks,” hence those 13 items were removed. Since a diet high in carbohydrates and fats leads to weight gain, the terms “high carbohydrate intake” and “high fat intake” have been added, and a 44-item questionnaire has been developed. We then revised the wording of the 15 items to make it easier for pregnant women to answer the questions. The response format was multiple-choice: “not at all,” “not very often,” “a little,” “quite,” and “a lot.”

Step 2: Face validity and item editing

The 44-item questionnaire underwent facial validity assessment. Six mothers were asked to provide open-ended responses to the following questions within two years postpartum: response time, questionnaire clarity, ease of answering, and reasons for weight gain during pregnancy. As reasons for excessive weight gain during pregnancy, respondents stated: “Others encourage me to eat a lot, so I overeat” and “I finish the entire meal because not eating any offered food would be wasteful.”

The Dietary Behavior Questionnaire for cases of excessive weight gain during pregnancy consisted of a total of 46 items.

Step 3: Factor validity and internal consistency

Sample

The study was conducted at the Ishinomaki Red Cross Hospital in Japan. The participants were 238 postpartum mothers who had given birth to a single, full-term baby between February 2023 and June 2023. Inclusion criteria included postpartum mothers who had difficulty understanding Japanese. The sample size was determined based on the construct validity requirement of 6–10 times the number of question items [10].

The lead researcher, or a collaborating ward midwife, distributed the questionnaire and consent form to the women on the first postpartum day. The surveys were collected by the ward staff during health orientation on the third or fourth day postpartum.

The sociodemographic data encompassed age, height, pre-pregnancy weight, pre-pregnancy body mass index, weight gain during pregnancy, parity, gestational week, new-born’s weight, obstetric complications, occupation, family type, and returning to the parental home for childbirth. The Japanese cultural practice of “Satogaeri bunben” involves pregnant women spending roughly their third trimester and the first month postpartum at their parents’ home for childbirth and recovery. Weight gain during pregnancy was categorized into three groups (below-standard, within standard and above-standard) based on the criteria recommended by the Japan Society of Obstetrics and Gynaecology [6]. The dependent variables were the dietary behavior questionnaire consisting of 46 items, for pregnant women.

Statistical Analysis

The researchers conducted data analysis using JMP v17.0.0® software (SAS Institute, Cary, NC, USA).

Continuous variables were reported as mean values with standard deviations for normally distributed data and interquartile ranges, whereas categorical variables were presented as frequencies and percentages. The dietary behavior questionnaire responses were recorded on a five-point scale ranging from 1 to 5, with higher

scores indicating more undesirable behavior. For the inverted items, the values have been reversed and converted. Before conducting exploratory factor analysis, the distribution of responses, and missing values were checked, and the mean and standard deviation for each item were calculated to assess ceiling and floor effects.

The validity of the factors was assessed using principal component analysis with promax rotation and the maximum likelihood method for each category with at least two items at the first time point. To assess the number of factors, the Kaiser criterion (eigenvalues > 1.0) and scree plot analysis were initially used. As in the previous study [11], items with a factor loading >0.40 were deemed associated with a specific factor, along with a review of the content of individual items. Items with factor loadings below 0.4 were removed, and the sequential factor analysis continued. Internal consistency was assessed using Cronbach’s alpha for each subscale, and the overall scale at the initial time point. We considered $\alpha > 0.70$ to be acceptable [12]. The validity associated with the criteria was assessed by examining the correlation coefficient with pre-pregnancy body mass index and the total dietary behavior questionnaire scores, and by employing Tukey’s multiple comparison test with the categories of weight gain during pregnancy.

Results

Out of the 238 postpartum women, 220 (92.4%) were surveyed, with 218 (99.0%) providing valid responses, excluding any missing data.

Table 1 displays the demographic characteristics of the study participants. The mean age standard deviation was 31.5 (5.7) years,

Table 1: Demographic characteristics of post-partum Japanese women (n = 218).

Characteristics	Mean \pm standard deviation [range], n (%)
Age, (y)	31.5 \pm 5.7 [19–44]
Parity	
Primipara	99 (45.4)
Multipara	119 (54.6)
Pre-pregnancy BMI (kg/m²)	
<18.5	21 (9.6)
18.5–24.9	147 (67.4)
25.0–29.9	33 (15.1)
30 \leq	17 (7.8)
Maternal weight gain during pregnancy (kg)	11.3 \pm 2.6 [3.8–14.6]
Recommended weight gain during pregnancy based on body mass index	
Less than recommended	86 (39.5)
Recommended	77 (35.3)
More than recommended	55 (25.2)
Birth weight (g)	3,074.4 \pm 348.1 [2178–4254]
Occupation	
Yes	64 (29.4)
No	154 (70.6)
Family type	
Immediate family	170 (78.0)
Extended family	48 (22.0)
Returning to her parents’ home for childbirth.	
Yes	31 (14.2)
No	187 (85.8)

and 119 (54.6%) participants were multiparous. A total of 154 participants (71.0%) were employed, and the group returning to their parents' home for childbirth accounted for 14.2%. The average birth weight was 3,074.4 g (standard deviation = 348.1 g), ranging from 2,178 to 4,254 g. Pre-pregnancy body mass index categories were 25 to 29.9 for 33 individuals (15.1%) and 30 or above for 17 individuals (7.8%). Regarding the recommended weight gain during pregnancy by body mass index, 55 participants (25.2%) gained more than advised.

The principal component analysis results with promax rotation are displayed in Table 2, along with the mean and standard deviation for each item. Six factors were identified: (1) Misconceptions and regret about weight gain, (2) habit of eating quickly without proper chewing, (3) imbalanced taste preferences when dining out and

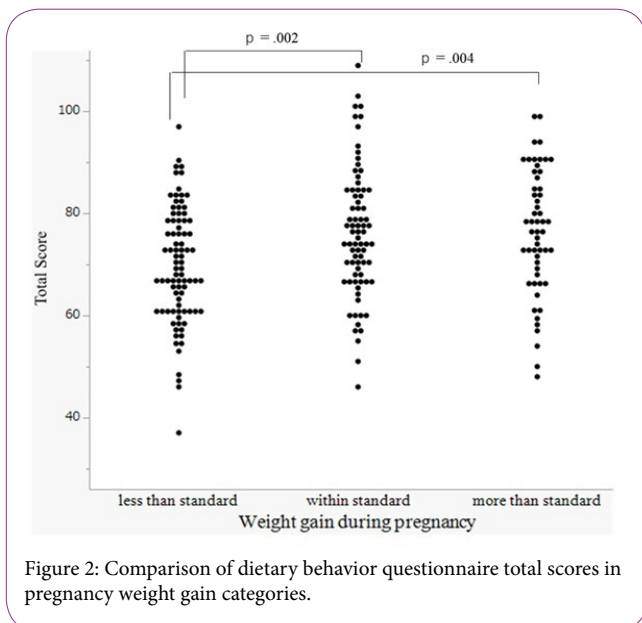
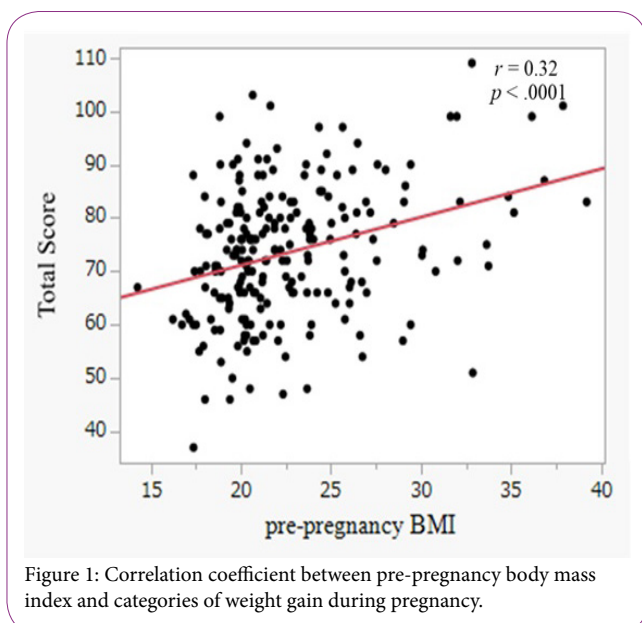
during home meal replacements, (4) concern over food scarcity, (5) inclination toward eye-catching fruits and sweets and (6) aversion to leftover food. Twenty-four items were loaded onto a factor with a cumulative contribution rate of 66.5% and a Kaiser–Meyer–Olkin sample adequacy measure of 0.77. The Cronbach's alpha for internal consistency of the subscales among respondents in this study ranged from 0.65 (subscale for the tendency to eat eye-catching fruits and sweets) to 0.83 (subscale for the tendency to eat quickly without chewing well), with the Cronbach's alpha for the overall scale being 0.83.

Figure 1 displays the correlation coefficient among pre-pregnancy body mass index, the category of weight gain during pregnancy and the total score of the dietary behavior questionnaire. A significant

Table 2: The 24-item Dietary Behavior Questionnaire on excessive weight gain during pregnancy: the principal component analysis

Items	Factor Loading	Mean	standard deviation	Cronbach α
Misconceptions and regrets about weight gain	Factor 1			0.72
Weight gain despite not supposed to be eating much.	0.69	2.61	1.10	
I always gain weight during the holidays, Christmas and New Year's.	0.63	3.13	1.32	
I regret eating too much.	0.58	3.48	1.22	
I think my sweet tooth is what's causing me to gain weight.	0.46	3.55	1.22	
I do eat when people around me encourage me to eat a lot.	0.42	2.61	1.21	
Tendency to eat quickly without chewing properly.	Factor 2			0.83
I am a fast eater.	0.81	3.00	1.28	
As if not chewing properly.	0.77	2.72	1.22	
I put the food in my mouth one after another.	0.72	2.61	1.21	
Imbalanced taste preferences in meals eaten out and in homemade substitute meals.	Factor 3			0.69
I am a fan of fatty foods.	0.62	2.01	1.05	
I often eat out, get delivery, or takeout.	0.53	2.84	0.86	
I use fast food.	0.49	3.04	0.81	
I prefer salty flavors.	0.47	3.28	1.25	
My meal has a high fat content.	0.45	2.97	0.90	
When I see something that looks delicious at the supermarket, I end up buying it. Even if I do not intend to.	0.44	3.55	1.10	
I use the deli.	0.41	3.12	0.87	
Concern about running out of food.	Factor 4			0.69
When I shop for groceries, I feel compelled to buy more than I need.	0.83	2.67	1.22	
I am not comfortable with less food in my fridge.	0.57	2.32	1.11	
I need to cook more to distract myself.	0.56	2.56	1.19	
Inclination toward eating eye-catching fruits and sweets.	Factor 5			0.65
If it is after dinner and I like it, I can eat it.	0.69	3.63	1.20	
When I have fruit and sweets in front of me, I tend to eat them.	0.50	3.58	1.07	
I eat a lot of snacks and sweets.	0.48	3.65	1.01	
I usually have sweets after dinner.	0.48	3.08	1.00	
Resistance to leftover food	Factor 6			0.82
I ate all the food served to me because I thought wasting it would be a shame.	0.99	3.31	1.28	
I eat all the food to avoid waste.	0.63	3.21	1.21	
			Total	0.83

positive correlation was found between pre-pregnancy body mass index and all total dietary behavior questionnaire scores ($r = 0.32$, $p < 0.0001$). In the category of weight gain during pregnancy, the groups with above-standard and standard weight gain had higher scores on the dietary behavior questionnaire compared to the below-standard group ($p = 0.004$, $p = 0.002$, respectively) (Figure 2). Finally, the initial version of the Dietary Behavior Questionnaire for Pregnant Women (dietary behavior questionnaire), comprising 24 items, was developed to assess excessive weight gain during pregnancy (Table 3).



Discussion

In the present study, we examined the factorial validity of the dietary behavior questionnaire in relation to weight gain during pregnancy.

Pre-pregnancy body mass index data suggest that these pregnant women were a noteworthy target. In the Japan Environment and Children's Study, which enrolled 103,099 pregnant women, 10.7% had

a pre-pregnancy body mass index of 25 or higher [13], and the present results indicate that a significant proportion were obese compared with these data. The participant community was marked by Japan's second-highest rate of lifestyle-related diseases and a high prevalence of childhood obesity. These features may be associated with the high prevalence of obesity among pregnant women.

The dietary behavior questionnaire was compared to the categories of the obese eating behavior questionnaire [9] and several similar categories were identified: misconceptions and regret about excessive weight gain, a tendency to eat quickly without proper chewing, imbalanced flavor preferences for meals eaten out and replacement meals at home, concern over food scarcity, and a propensity for consuming eye-catching fruits and sweets. Thus, we regard the dietary behavior questionnaire as a tool to assess dietary behaviors leading to excessive weight gain during pregnancy. Conversely, "resistance to food remnants" was identified as a distinct category in the dietary behavior questionnaire. Proper nutrition during pregnancy is essential for fetal growth, preventing perinatal complications and postpartum recovery. The dietary behavior of pregnant women is influenced not by their own cravings, but by their desire for the baby's growth [13,14]. We start from the assumption that it is the same people surrounding the pregnant woman family and friends who also recommend nutrient-rich foods to her [15]. Consequently, if this subscale's score is high, it is essential to assess the impact of environmental factors such as family type, returning home, social relationships, etc. Regarding internal consistency, the Cronbach's alpha coefficient for the overall scale was 0.83, which was deemed acceptable. However, the internal consistency was below 0.70 for the subscale with three items, which included imbalanced flavor preferences in dining out, concerns about food scarcity and the tendency to eat eye-catching fruits and sweets. These can be made more reliable by removing items with low correlation coefficients. However, we did not remove the items as they contained elements initially intended for measurement. In the future, the matters and content of custody should be discussed.

A higher dietary behavior questionnaire total score was associated with pre-pregnancy body mass index and weight gain during pregnancy. It was found that pregnant women with a pre-pregnancy body mass index of 25 or higher exhibited discrepancies in eating behavior. It has been reported that pre-conceptional eating behaviors persist throughout pregnancy [16,17]. Consequently, the dietary behavior questionnaire can serve as an educational tool to identify discrepancies and eating behavior patterns during the initial medical examination. The group with above-normal weight gain during pregnancy exhibits misaligned and habitual eating behaviors. Currently, undernutrition in pregnant women is an issue in Japan, regardless of weight gain during pregnancy [18,19]. Previous studies have reported variations in the balance of protein, fat and carbohydrate intake in relation to weight gain during pregnancy [20] and among the main macronutrients, multiparous women consumed significantly more fats than nulliparous women [21]. We believe that nutritional counseling for pregnant women should encompass an assessment of their dietary intake and eating habits to achieve appropriate weight gain.

This study has several limitations. First, the data were collected from a single region, and regional characteristics may have influenced the findings on dietary behavior. Second, the current study did not sufficiently examine the retest of the questionnaire on pregnant women's eating behavior. On the contrary, the strength of this study

Table 3: Version 1 of the Dietary Behavior Questionnaire for Pregnant Women.

Select an answer for each question.		Not at all	Not very often	a little	quite	a lot
Q1	I am a fast eater.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q2	I think my sweet tooth is what is causing me to gain weight.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q3	I use the deli.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q4	I usually have sweets after dinner.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q5	I am not comfortable with less food in my fridge.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q6	I eat a lot of snacks and sweets.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q7	I eat all the food to avoid waste.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q8	If it is after dinner and I like it, I can eat it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q9	I prefer salty flavors.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q10	I always gain weight during the holidays, Christmas and New Year's..	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q11	As if not chewing properly.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q12	I often eat out, get delivery, or takeout.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q13	I use fast food.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q14	I regret eating too much.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q15	I am a fan of fatty foods.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q16	When I have fruit and sweets in front of me, I tend to eat them.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q17	When I shop for groceries, I feel compelled to buy more than I need.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q18	I need to cook more to distract myself.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q19	When I see something that looks delicious at the supermarket, I end up buying it. Even if I do not intend to do it.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q20	Weight gain despite not supposed to be eating much.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q21	My meal has a high fat content.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q22	I put the food in my mouth one after another.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q23	I do eat when people around me encourage me to eat a lot.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Q24	I ate all the food served to me because I thought wasting it would be a shame.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

lies in its ability to capture the characteristics of pregnant women's eating behaviors, including discrepancies and habits. In the future, we aim to assess the validity and reliability of this questionnaire and consider its use in weight management during pregnancy in clinical practice.

Conclusions

The 24-item dietary behavior questionnaire showed factorial validity and internal consistency; therefore, it can be used to evaluate the effects of the dietary behavior concerning weight gain during pregnancy.

Competing Interests

The authors declare that they have no competing interests. The funding group had no role in the study design, data collection, statistical analysis, data interpretation, manuscript writing or the decision to publish the results.

Author's Contributions

Conceptualization, R.S., M.F.; methodology, R.S., M.F., M.T., M.S.; formal analysis, R.S.; investigation, R.S.; data curation, R.S., M.F., M.T., M.S.; writing—original draft preparation, R.S.; writing—review and editing, M.F., M.T., M.S.; supervision, M.F.; project administration, M.F.; funding acquisition, M.F. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of the University of Yamagata (No. 2022-245).

Informed Consent Statement

Informed consent was obtained from all participants involved in the study.

Availability Statement

The data presented in this study are available on request from the corresponding author. The data is not publicly accessible.

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