Original article

Differences in characteristics of raters who use the visual estimation method in hospitals based on their training experiences

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S U M M A R Y

Background & aims: Despite a clinical need, only a few studies have provided information concerning visual estimation training for raters to improve the validity of their evaluations. This study aims to describe the differences in the characteristics of raters who evaluated patients' dietary intake in hospitals using the visual estimation method based on their training experiences.
Methods: We collected data from three hospitals in Tokyo from August to September 2016. The participants were 199 nursing staff members, and they completed a self-administered questionnaire on demographic data; working career; training in the visual estimation method; knowledge, attitude, and practice associated with nutritional care; and self-evaluation of method validity of and skills of visual estimation. We classified participants into two groups, experienced and inexperienced, based on whether they had received training. Square test, Mann-Whitney U test, and univariable and multivariable logistic regression analysis were used to describe the differences between these two groups in terms of their characteristics; knowledge, attitude, and practice associated with nutritional care; and self-evaluation of method validity and tips used in the visual estimation method.
Results: Of the 158 staff members (79.4%) (118 nurses and 40 nursing assistants) who agreed to participate in the analysis, thirty-three participants (20.9%) were trained in the visual estimation method. Participants who had received training had better knowledge (2.70 ± 0.81, score range was 1—5) than those who had not received any training (2.34 ± 0.74, p = 0.03). Score of self-evaluation of method validity of the visual estimation method was higher in the experienced group (3.78 ± 0.61, score range was 1—5) than the inexperienced group (3.40 ± 0.66, p < 0.01). Mean total scores of using tips in the visual estimation method in the experienced and inexperienced groups were 19.6 ± 1.76 and 17.9 ± 2.28, respectively (score range was 6—24), differing significantly between the two groups (p < 0.01). Multivariable logistic regression revealed that participants who had been trained had adequate knowledge (OR: 2.78, 95% CI: 1.05—7.35) and frequently used tips in visual estimation (OR: 1.85, 95% CI: 1.26—2.73).
Conclusion: Trained participants had more required knowledge and they used visual estimation tips more frequently than participants who had not been trained in the visual estimation method. This study provides new evidence for the importance of training clinical staff members to use the visual estimation method appropriately and makes suggestions to improve the validity of the visual estimation method.

1. Introduction

Accurately measuring patients' dietary intake is important to provide appropriate nutritional care in many hospitals. Visual estimation method is the most common approach of measuring dietary intake, and it is used many hospitals and large-scale research [1—3]. In this approach, raters observe food-consumption behavior to visually estimate food intake and evaluate plate waste to measure the patients' meal intake. Nurses and nursing assistants check daily dietary consumption primarily using the visual estimation method as a routine task in clinical settings [4].

Accurate evaluation by trained staff using the visual estimation method is very important because many clinical staff members

utilize the results of evaluation including monitoring nutritional status and tube and intravenous feeding based on nutrient intake calculation by dietary intake data [4]. Several researchers have noted the importance of training for accurately measuring patients' dietary intake using the visual estimation method [5–8]. High validity were reported by several previous studies that trained raters in the visual estimation method prior to the study period [6,9–11]. These results contradicted that of the other previous study that collected data from untrained raters and reported low validity [7]. Raters who work in actual clinical settings are expected to obtain better knowledge, attitudes, and skills in relation to the visual estimation method and nutritional care and increase the validity of the method they use by undergoing training. Raters' knowledge and attitude toward nutritional care may be important for visual estimation because these were found to be associated with several nutritional care practices [12,13].

However, only few studies have examined the effects of visual estimation training for raters, and we have little knowledge about effective training programs. Several previous studies reported that research or clinical staff conducted raters' training as preparation for validation studies [6,11]. In these studies, raters were trained in the visual estimation method through training sessions or educated about nutritional care in clinical practice before research days. We do not know whether these trainings were effective or if they reflected actual clinical practice. Additionally, the actual number of raters who have undergone visual estimation training and the differences in the behaviors exhibited by raters who are trained in the visual estimation method are unclear in previous studies. Our previous qualitative study revealed that many raters were trained by their colleagues and that some raters used tips to accurately measure patients' dietary intake using the visual estimation method [4]. We should indicate the differences in usage conditions of these tips to establish that they are useful as a first step towards including them in visual estimation training.

Therefore, this study aims to describe the differences in the characteristics of the raters who evaluated patients' dietary intake using the visual estimation method in hospitals based on their training experiences.

2. Materials and methods

2.1. Study design and subjects

We collected data using a questionnaire from three hospitals in Tokyo from August to September 2016. We used convenience sampling for this study. We used data from two of the three community hospitals from our previous study (hospital 1 and 2) [12]. Additionally, we collected data from another hospital for this study (hospital 3). Hospital 1 has about 50 general beds, hospital 2 has 180 general, rehabilitation, and tuberculosis beds, and hospital 3 has 90 general and long-term care beds. The participants from the final three hospitals were 199 nursing staff members (151 nurses and 48 nursing assistants). Nurses or nursing assistants who worked in the hospital wards during the study period were included, while those who worked in ambulatory service were excluded. The head nurses of each ward distributed an anonymous self-administered questionnaire to the participants.

2.2. Sample size of calculation

A power analysis calculation indicated that for an effect size of 0.15 and power of 0.8, at least 135 participants would be required for a multiple regression [14].

2.3. Research instruments

The 43-item self-administered questionnaire that we used in this study was developed by the first author and validity scales were used to measure reliability. We used 38 items in this study. The questionnaire sought information about participants' demographic data; working career; training in the visual estimation method; knowledge, attitude, and practice associated with nutritional care; and self-evaluation of method validity and skills of the visual estimation method.

2.3.1. Demographic data and working career

Demographic data and working career included details about the age, gender, education, job category (nurses or nursing assistants), and years of experience. The total number of items in this section was five.

2.3.2. Training in the visual estimation method

Data about training in the visual estimation method was obtained through two questions. First, participants responded to the question, "Have you received training in the visual estimation method?" If the participants responded "yes," we sought information about the approach by which they received training based on our previous qualitative research: verbal explanation, on-the-job training, validation by weighing method, training session, and others (free description) [4].

2.3.3. Knowledge, attitude, and practice associated with nutritional care

There is currently no appropriate, reliable, and valid scale to evaluate clinical staff's nutritional care knowledge in Japan. Therefore, participants' knowledge of nutritional care was evaluated on a five-point scale using their responses to the following question: "Do you possess the knowledge necessary to provide appropriate nutritional care to patients? (responses ranged from "1: completely disagree" to "5: completely agree.")"

Participants' attitudes toward nutritional care were investigated using the Staff Attitudes to Nutritional Nursing Geriatric Care (SANN-G) scale developed by Christensson et al. [15]. This reliable, valid, and widely-used scale consists of 18 items, and uses a five-point scale (1: completely agree - 5: completely disagree). We modified the questionnaire for use by Japanese nursing staff members and used 17 of the 18 items. We removed one item through factor analysis. Further information about applying this scale has been reported in our previous study. The Cronbach's α of the 17 items on the SANN-G scale was 0.84.

To obtain data about the practice associated with nutrition, we asked participants about whether they shared nutrition information with colleagues. Sharing patient information is one of the practices used to directly describe the participant's state of achievement of nutritional care practice, regardless of the wards where participants work. We used three questions from a subscale titled "collaboration with other health professionals [16]." This subscale was part of the Japanese Self–evaluation Scale for Nurses in Nutritional Management questionnaire. The responses were assessed using a five-point scale (1: seldom, 5: always.) The Cronbach's α of these questions was 0.89.

2.3.4. Self-evaluation of method validity and skills of the visual estimation method

We asked the participants 3-item questions on how they use the visual estimation method based on our previous study [4]. For example, we attempted to find out whether they considered tray division as an evaluating unit (whole, grains/other, food items and other), scale type used for food intake evaluation (3-, 4-, 5-, 6-, 11-

point scale and other), and how they dealt with supplied food items (evaluating as either distinct from or part of a meal and not evaluating). The participants were asked about the self-evaluation of method validity of the visual estimation method: "Do you think you can correctly evaluate patients' dietary intake using the visual estimation method? (five-point scale from 1: completely disagree to 5: completely agree.)" We think these self-evaluation questions accurately represent the validity of participants' visual estimation.

Our previous qualitative studies revealed that some raters who employed the visual estimation method used several skill-related tips to accurately measure patients' dietary intake [4]. Therefore, skills of visual estimation were evaluated using six questions based on tips that we obtained in the previous qualitative study: lifting packages of beverages or supplementary foods to estimate weight, taking the cover off dishes, gathering information about food items that have not been not cleared, calorie counting, consulting raters' colleagues for evaluation, and understanding serving sizes. Each item was evaluated on a four-point scale (1: seldom, 4: always). Detailed questionnaire sentences are described in Table 1.

2.4. Ethical approval

The study was approved by Ochanomizu University's Research Ethics Board [17]. All the participants (nurse and nursing assistants) were informed about the aim of the study, and they voluntarily signed the consent form.

2.5. Statistical analysis

All statistical analyses were performed using the Statistical Package for the Social Science (SPSS) for Windows (version 20, SPSS Inc.). The mean and S.D. of the responses for the questionnaires were used to describe the data. Among the 199 nursing staff members, 158 staff members (response rate: 79.4%) (118 nurses and 40 nursing assistants) agreed to participate in our research and were included in the analysis. The total score of knowledge, attitude, and practice associated with nutritional care was converted into mean score per item because it is crucial to provide equal weighting to these three indices. Therefore, the scores of knowledge, attitude, and practice associated with nutritional care, and self-evaluation of method validity ranged from 1 to 5. The scores of tips used in the visual estimation method ranged from 1 to 4. We calculated the total score, and the range of the score was 6–24.

We divided participants into two groups, experienced and inexperienced, based on their responses about whether they had any training experience. Chi-square test, Mann–Whitney U test, and univariable and multivariable logistic regression analysis (the stepwise method) were used to describe the differences between these two groups in terms of characteristics; knowledge, attitude, and practice associated with nutritional care; and self-evaluation of method validity and tips used in the visual estimation method. We

used the data of the female participants (n = 150) for the logistic regression analysis because the male participants were small-group and the odds ratio in the univariable and multivariable analysis could not be calculated. For the logistic regression analysis, job category; education; years of experience; knowledge, attitude, and practice associated with nutritional care; self-evaluation of method validity; and total score of tips (6–24 points) were used as independent variables. We used the total score of tips instead of the mean score because of these importance that the tips might directly reflect the validity of the visual estimation method and it is necessary to interpret the data. Forced entry method was used in the univariable analysis, and stepwise method was used in the multivariable analysis. Multivariable regression analysis was conducted using three models, adjusted for the hospitals where the participants worked. Model 1 consisted of the demographic data (job category, education, and years of experience). Model 2 consisted of demographic data and knowledge, attitude, and practice associated with nutritional care. Model 3 consisted of the demographic data; knowledge, attitude, practice associated with nutritional care; self-evaluation of method validity; and tips used in the visual estimation method. The results were considered statistically significant if p-values were less than 0.05.

3. Results

3.1. Participants' evaluation method and training experiences in the visual estimation method

Many participants responded that they used grains/other divisions (n = 131, 82.4%) and an 11-point scale (n = 77, 48.4%). Half of them evaluate supplied food items along with meal trays (n = 81, 50.9%). Mean score of the self-evaluation of method validity of the visual estimation method was 3.5 ± 0.7. Many participants thought they could moderately evaluate patients' dietary intake using the visual estimation method (n = 71, 44.7%).

Thirty-three participants (20.9%) had received training in the visual estimation method through verbal explanation (n = 27, 81.8%), on-the-job training (n = 8, 24.2%), and training session (n = 6, 18.2%) respectively.

3.2. Difference in participants' characteristics based on whether they had training in the visual estimation method

Participants' characteristics and the difference between the two groups (experienced and inexperienced) are presented in Table 2. Most of the participants were females (n = 150, 94.9%), and their mean years of experience were 12.5 ± 8.7. Nurses constituted 74.7% (n = 118) of the participants, and they constituted a greater share of the inexperienced group (83.9%) than did the nursing assistants (65.0%, p = 0.02). Many of the participants graduated from a technical college (66.4%) and participants' educational level was

Table 1
Questionnaire items on tips used by raters while employing the visual estimation method to accurately measure patients' dietary intake.

No.	Tips	Questionnaire queries
1	Lifting packages of beverages or supplementary foods to estimate weight	How often do you lift cartons of beverages or supplementary foods whose leftovers cannot be easily seen to estimate weight?
2	Taking the cover off dishes	How often do you take the cover off dishes when you evaluate covered dishes?
3	Gathering information about food items that have not been cleared	How often do you confirm the details of food items that were not returned on trays with the patients?
4	Calorie counting	How often do you evaluate patients' dietary intake based on energy intake instead of the weight of leftovers?
5	Consulting raters' colleagues for evaluation	How often do you consult your colleagues when you think it is difficult to determine patients' dietary intake?
6	Understanding serving sizes	How often do you determine serving sizes of individual patients' sizes when you evaluate their dietary intake?

Each item was evaluated on a four-point scale (1: seldom; 4: always).

Table 2
Difference in participants' characteristics based on whether they had training in the visual estimation method.

	Total n	Experienced n = 33		Inexperienced n = 125		p value[a]
		n/Mean	%/S.D.	n/Mean	%/S.D.	
Characteristics						
Job category						
Nurse	118	19	16.1	99	83.9	0.02
Nursing assistant	40	14	35.0	26	65.0	
Gender						
Male	7	0	0.0	7	100.0	–
Female	150	33	22.0	117	78.0	
Non-respondent	1	–		–		
Education						
College/University/Graduate school	13	3	23.1	10	76.9	0.50
Junior college	11	2	18.2	9	81.8	
Technical college	105	19	18.1	86	81.9	
Other	29	9	31.0	20	69.0	
Years of experience (year)	150	11.0	6.7	12.9	9.2	0.49
Knowledge, attitude, and practice associated with nutritional care[b]						
Knowledge (1—5)	157	2.70	0.81	2.34	0.74	0.03
Attitude (1—5)	148	3.79	0.43	3.83	0.50	0.72
Practice (1—5)	149	3.12	1.28	2.74	1.07	0.11
Self-evaluation of method validity and skills of the visual estimation method[c]						
Self-evaluation of method validity	156	3.78	0.61	3.40	0.66	<0.01
Tip 1 Lifting packages of beverages or supplementary foods to estimate weight (1—4)	157	3.85	0.44	3.52	0.86	0.03
Tip 2 Taking the cover off dishes (1—4)	158	4.00	0.00	3.86	0.53	0.09
Tip 3 Gathering information about food items that have not been cleared (1—4)	153	3.45	0.68	2.91	0.95	<0.01
Tip 4 Calorie counting (1—4)	155	1.65	0.76	1.25	0.54	<0.01
Tip 5 Consulting raters' colleagues for evaluation (1—4)	158	3.00	0.66	2.93	0.75	0.77
Tip 6 Understanding serving sizes (1—4)	153	3.72	0.58	3.43	0.77	0.047

S.D. Standard deviation.
[a] Chi-square and Mann Whitney U test.
[b] Score range was 1—5. Participants who had a higher score had more adequate knowledge and a more appropriate attitude toward nutritional care and more frequently shared patients' nutritional information with their colleagues.
[c] Score range was 1—4. Participants who scored high frequently used each tip.

not different in the two groups (p = 0.50). Years of experience were not significantly different in the two groups (experienced: 11.0 ± 6.7, inexperienced: 12.9 ± 9.2, p = 0.49).

Knowledge of nutrition care was different in the two groups. Participants who had training experience had better knowledge (2.70 ± 0.81, p = 0.03) than those in the inexperienced training group (2.34 ± 0.74). Attitude and practice associated with nutrition care were not significantly different between the two groups.

Score of self-evaluation of method validity of the visual estimation method was higher in the experienced group (3.78 ± 0.61, p < 0.01) than in the inexperienced group (3.40 ± 0.66). Frequency of using tips in the visual estimation was significantly higher in the experienced group, except for Tips 2 and 5. Mean total scores of using tips in experienced and inexperienced groups were 19.6 ± 1.76, 17.9 ± 2.28, respectively, differing significantly between the two groups (p < 0.01, not listed in the table).

3.3. Relationship between participants' training in the visual estimation method and their characteristics; knowledge, attitude, and practice associated with nutritional care; and self-evaluation of method validity of and skills of the visual estimation method

We described the relationship between training in the visual estimation method with the characteristics; knowledge, attitude, and practice associated with nutritional care; self-evaluation of method validity and skills of the visual estimation method in Table 3. In univariable analysis, job category, knowledge of nutritional care, self-evaluation of method validity, and tips of visual estimation were found to be significantly associated with training in the visual estimation method. Participants who were nursing assistants (OR: 2.58, 95% CI: 1.14—5.84), evaluated themselves as having adequate knowledge of nutritional care (OR: 1.97, 95% CI:

1.14—3.42), indicated high self-evaluation of method validity (OR: 2.47, 95% CI: 1.29—4.74), and frequently used visual estimation tips (OR: 1.54, 95% CI: 1.20—2.00) had higher odds ratio of training. Additionally, in Model 1 in multivariable analysis, we plugged all the participants' characteristics into the logistic regression expression. Job category (OR: 2.86, 95% CI: 1.19—6.89) was found to be significantly associated with training in the visual estimation method. In Model 2, nutritional care knowledge (OR: 2.24, 95% CI: 1.02—4.93) was significantly associated with training, and results of participants' knowledge, attitude, and practice associated with nutritional care were added into the regression expression. In the final model, we plugged all the factors into the regression expression. Participants who had adequate knowledge (OR: 2.78, 95% CI: 1.05—7.35) and frequently used visual estimation tips (OR: 1.85, 95% CI: 1.26—2.73) had higher odds ratios of training.

4. Discussion

The present study attempted to describe the differences in the characteristics of the raters who evaluated patients' dietary intake using the visual estimation method in hospitals by their training experiences. Multivariable analysis revealed that participants who had received training possessed more than the required knowledge and more frequently used visual estimation tips than participants who had not been trained in the visual estimation method.

We indicated that effective data would become the first step to verify that validity of the visual estimation method can improve on using easy visual estimation tips such as the ones in this study. Previously, visual estimation tips were not widely known by clinical staff and many used a discretionary approach to evaluate patients' dietary intake [4]. Participants who had received more training used many visual estimation tips. For example, lifting packages of

Table 3
Odds ratio of training experiences of the visual estimation method (n = 150[a]).

| | n | Univariable[b] | | Multivariable[c] | | | | | |
| | | | | Model 1 | | Model 2 | | Model 3 | |
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Model 1: Characteristics									
Job category									
Nurse	117	ref		ref		–			
Nursing assistant	33	2.58	1.14–5.84	2.86	1.19–6.89	–			
Education									
College/University/Graduate school	13	ref		–		–		–	
Junior college	11	0.74	0.10–5.49	–		–		–	
technical college	97	0.81	0.20–3.24	–		–		–	
Other	29	1.50	0.33–6.80	–		–		–	
Years of experience	142	0.97	0.93–1.02	–		–		–	
Model 2: Knowledge, attitude, and practice associated with nutritional care[d]									
Knowledge (1–5)	149	1.97	1.14–3.42			2.24	1.02–4.93	2.78	1.05–7.35
Attitude (1–5)	140	0.93	0.39–2.19			–		–	
Practice (1–5)	141	1.38	0.94–2.03			1.75	0.988–3.11	1.88	0.97–3.67
Model 3: Validity and skills of the visual estimation method[d]									
Self-evaluation of method validity (1–5)	148	2.47	1.29–4.74					–	
Tips (6–24)	137	1.54	1.20–2.00					1.85	1.26–2.73

[a] Data of male participants were excluded because the category of "gender" could not be used to calculate odds ratio in the univariable and multivariable analysis.
[b] Forced entry method was used for the univariable analysis.
[c] Stepwise method was used for the multivariable analysis, adjusted for the hospitals where the participants worked.
[d] High scores indicate a high level of knowledge, attitude, practice, self-evaluation validity, and tips. Odds ratios were calculated by setting 1 as reference.

beverages or supplementary foods to estimate weight is important because leftovers are not visible in carton food items such as beverage and supplied food items. Furthermore, understanding serving sizes is also important because raters compare a serving portion with plate waste in the visual estimation method. In our previous qualitative study, we had reported that nurses had lower understanding about serving sizes of hospital meals than dietitians when they checked patients' dietary intake using the visual estimation method [4]. These tips that qualitatively emerged in our previous may help in accurately measuring patients' dietary intake using the visual estimation method. However, we have not quantitatively examined the associations of using these tips with the criterion validity of the visual estimation method.

Our results can help in developing a training program for clinical staff members who evaluate the visual estimation. The previous study reported that meetings were conducted and discusses the importance of providing nutritional care in hospital settings prior to training raters before the validation study [6]. However, most previous studies did not provide details about the training programs for raters [9–11]. We should develop reliable and valid training programs based on this study and several validation studies [5–7,9–11,18]. For example, percent consumption, modified texture meals, and adding supplied food items were associated with the low validity of the visual estimation method [5,18]. Participants who had been trained did not have a higher score on attitude and practice associated with nutritional care and self-evaluation of method validity of the visual estimation method. According to the previous studies, knowledge, attitude, practice, and self-efficacy are closely related with nursing practices [19,20]. Therefore, we can expect that enhancing these factors will lead to improvement in the validity of the visual estimation method. On the other hand, raters tend to make careless mistakes with the passage of time since training completion [7,11]. Raters require periodical training. To more accurately measure patients' dietary intake using visual the estimation method, a diversified approach is necessary to increase the validity of the visual estimation method.

Participants who had received visual estimation training evaluated themselves as having high-level knowledge of nutritional care. Nutritional knowledge, such as calorie counting and understanding serving sizes, is important because without this knowledge clinical staff could not use some of the visual estimation tips. Moreover, the relationship between nutritional care practice and nutritional knowledge was pointed out in several previous studies [12,13,21]. Previous research has reported that training nurses in nutritional care improved their knowledge, attitude, and practice associated with nutritional care [22]. We could similarly expect to improve the validity of the visual estimation method by training raters. Therefore, the study results might support the importance of training raters to increase the validity of the visual estimation method.

One of the study limitations is that the all the participants were females. However, many nursing staff members were female in general. Our results reflect the current status of actual clinical setting. Additionally, all data were based on self-evaluation. The objectivity of the data collected could not be confirmed. The strength of the present study is that it is the first to evaluate clinical staff members' training experiences to increase the validity of the visual estimation method. This study provides new evidence about the training of the visual estimation method for clinical staff members and makes suggestions for improving the validity of the visual estimation method. We recommend that future research focus on developing a training program for clinical staff members who evaluate the visual estimation method.

5. Conclusion

The study results revealed that participants who had been trained in the visual estimation method had more knowledge and more frequently used visual estimation tips than those who had not been trained. This study provides new evidence supporting the training of the visual estimation method for clinical staff members and helps improve the validity of the visual estimation method.

Statement of authorship

YK, YT, RA, MS, and KF designed the project. YK carried out the data collection, performed the data analysis, and drafted the manuscript. All authors critically read and approved the final manuscript.

Conflict of interest

The authors have no conflicts of interest to declare.

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