Research Note

Validation of Calorie Smile Vietnam Software for Measuring Food Intake

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ABSTRACT *Background and purpose.* Achieving accuracy and precision in assessing diet is a challenge. Food weighing (FW) is the ″gold standard″ method for dietary estimation. However, this method is time-consuming, costly, and disruptive. Traditional methods such as 24h recall, diet record and food frequency questionnaires are mostly used today but these depend largely on the participants′ memory. A new Vietnamese version of a nutrition support software called ″Calorie Smile Vietnam″ (CSV) has been developed and has a food-measuring intake function. The purpose of this study was to test the validity of CSV software for measuring food intake compared with the weighed food method. *Method.* Actual intake of meals (study 1) and dishes (study 2) as estimated by the CSV method were compared with weighed food. Three dietitians independently estimated portion sizes of each food. *Result.* Estimation of food intake by CSV was highly correlated with FW. CSV showed small overestimates or underestimates (from 0.2% to 4%). Energy and nutrients calculated from CSV had no difference when compared with FW, except for lipid ($p<0.05$). Bland-Altman regression found the CSV yielded results comparable to FW. *Conclusion.* Calorie Smile software is a useful tool for measuring food intake with high accuracy and overcomes the disadvantages of conventional methods.
Keywords: Validation, Calorie Smile Vietnam software, measuring food intake

INTRODUCTION

The accuracy of evaluating nutritional components in dietary surveys is fundamental for assessing nutritional status and analyzing the relationship between diet and a population's health status **(**1**)**. The most accurate method for measuring food intake is the food weighing (FW) method: weighing food before and after eating (2). However, weighing each food item can introduce changes in eating habits, exerts a huge burden on individuals, is very difficult to use with a large sample of people and does not permit assessment of past intakes (3,4). In the context of public health nutrition, self-reporting methods (food records, 24-hour recall, and food frequency questionnaires) are commonly used to collect food intake data but these methods can encounter difficulties. Visual aids used to help subjects remember and describe the food amounts have been created (5). A number of studies have reported the benefits of using photographs to help subjects assess portion sizes (6–13). Food photographs depicting standardized portion sizes organized in an atlas are helpful in improving the accuracy of food quantification (14,15). Therefore, the image-based method is an innovative approach compared with the conventional ones. In addition, in order to measure food intake accurately, we need well-trained personnel such as dietitians.

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However, recently in Vietnam, the number of dietitians is very limited. Therefore, if we continue to follow the traditional food estimating methods, it will take considerable time. In this situation, a nutrition support software has been developed, called ″Calorie Smile Vietnam″ (CSV) (16). This software offers dietitians (or supporters) a new way to conveniently exchange information with their patients (or users) and was designed for both computer and smartphone use. The basic method is that users take photos of their food, send them to the dietitian′s computer, and then the dietitian evaluates their dietary pattern and gives proper advice to users. CSV software has been integrated with the Vietnam Food Composition Table 2007 (17), the nutrient value of 500 common dishes from the Hanoi area (18), and the nutrient value of common street foods from [the] Ho Chi Minh city area (19). When users′ meals are different or they eat items other than those in the data base, adjustments can be made according to the "Photo book to estimate the weight of food" (20), so the dietitians can analyze users′ meals easily and quickly.

There are many potential benefits to be gained by using CSV software in evaluating diet, but there has been no study to validate it. For this reason, we carried out this study with the purpose of testing the validity of CSV software for measuring food intake compared with weighed food.

METHODS

Study design and methods:

The study followed a cross-sectional study. *Study 1:* 50 test meals were prepared in university cafeterias and given to students at lunch. The meals included 5 dishes: starches, a meat dish, 2 vegetable dishes, and soup. *Study 2:* 78 test dishes were prepared in university cafeterias and given to students. The dishes varied from a complete dish like a main dish to a single food like a cup of milk or a bowl of rice or even one piece of fruit.

For both studies, the procedure was the same: Before and after serving, each component was weighed and a trained research staff took all of the photographs of the food to the same standard (study 1: whole meal photo, study 2: dish photo). The food was photographed using a smartphone mounted on a tripod with the lens 2 feet above and 2 feet away from the center of the meal plate with a camera angle of approximately 45°. A placemat with marked regions for placement of the food plates was fixed to the table supporting the camera tripod to ensure optimal visibility of the meal in the digital photographs. All the photos were sent to the CSV software platform for estimation.

Three dietitians involved in this study independently estimated portion size and then calculated the actual food intake using CSV software. The results as estimated by CSV were compared with weighed foods. The comparison focused on energy (kcal), protein (g), lipid (g), and carbohydrate (g).

Statistical Analysis:

Spearman's rank correlation coefficients were calculated to assess the association.

The differences in energy and nutrient intake between CSV and FW were tested using one sample *t*-test.

Agreement between the two methods was evaluated according to Bland−Altman analysis. Statistical analysis was done by SPSS 20.0. The significance level for statistical tests was set at 0.05 for all tests.

RESULTS

Study 1: 50 test meals

Table 1 shows the comparison of energy and nutrient intake between FW and CSV. There was no significant difference between the two dietary assessment methods for intakes of energy, carbohydrate and protein, although the mean difference in lipid/meal was statistically significant ($p<0.05$). The correlation between the two methods was relatively high, ranging from 0.73 (for energy) to 0.79 (for carbohydrate).

Figure 1 shows the differences in estimated energy and nutrients intake from meal between the CSV and FW methods against the FW method with the representation of confidence interval (CI) limits for mean. Most data points are within 95% CI with only one or two outliers.

Table 1: Comparison of estimated energy and nutrients intake from lunch between FW and CSV

Nutrients	Method	Mean intake ± SD	Mean difference ± SD	Difference (%)	Pearson correlation
Energy (kcal)	FW CSV	605.9±69.5 606.9±61.6	1.0±49.2	0.2	0.73**
Protein (g)	FW CSV	33.6±6.7 34.9±7.2	1.28±4.76	3.9	0.77**
Lipid (g)	FW CSV	22.5±4.7 23.4±4.6^{+}	0.97±3.3	4.0	0.74**
Carbohydrates (g)	FW CSV	65.7±11.8 63.7±10.6	-1.9±7.2	3.0	0.79**

\+ *t*-test, $p<0.05$
** $p<0.001$

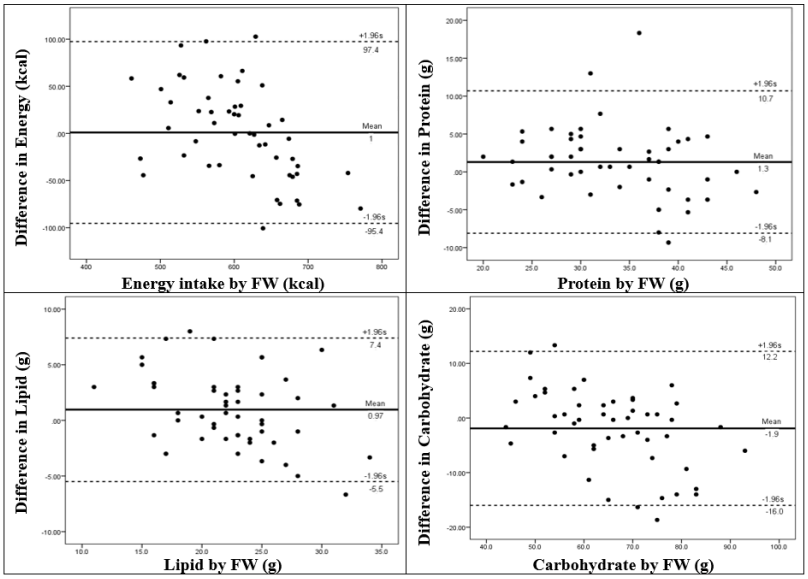

Figure 1: Plot of differences between CSV and FW methods against the FW method in estimating energy and nutrient intakes from meal

Study 2: 78 test dishes

Figure 2 presents the differences of estimated energy and nutrient intake from dishes between CSV and FW method against the FW method with the representation of confidence interval (CI) limits for mean. The 95% CI were relatively narrow and most data points are within the limits of agreement with only a few outliers. In addition, the scatter around the bias line tends to get larger as the intake estimated by FW increases.

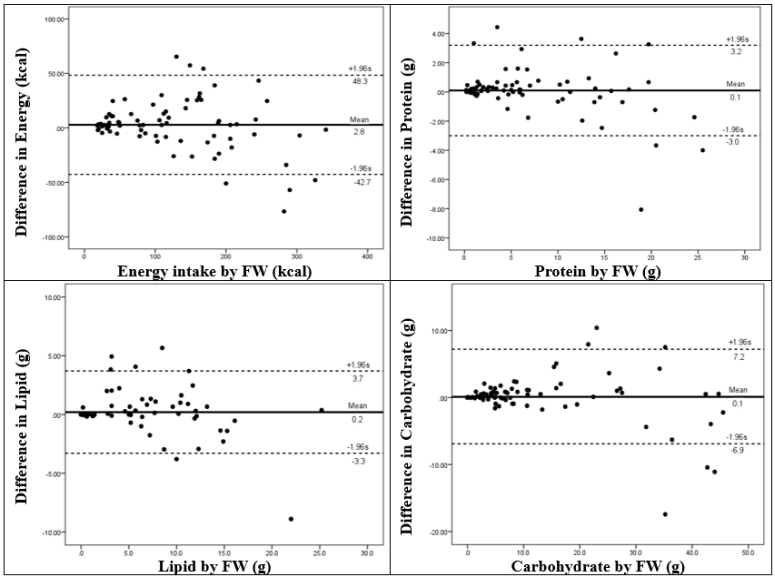

Figure 2: Plot of differences between CSV and FW methods against the FW method in estimating energy and nutrient intakes from dishes

DISCUSSION

The results of this study support the validity of the CSV for measuring food intake. Overall, CSV was highly correlated with foods that were carefully weighed and measured. There was no significant difference between the two dietary assessment methods for intakes of energy, carbohydrate and protein intakes, although the mean difference of lipid/meal was statistically significant. It could be understood that lipid is a component that creates difficulties in assessing diet via the CSV platform because CSV operates in visual items. Moreover, energy and the three nutrients estimated from CSV indicated a high level of association with FW with correlation coefficients ranging from 0.73 (energy) to 0.79 (carbohydrate), which also strongly supports the validity/accuracy of this method. The average differences between the two methods were also small, ranging from 0.2% (energy) to 4.0% (lipid) overestimated and 3% underestimated (carbohydrate). The percentage difference in energy was only 0.2% overestimated compared with the actual FW which was more accurate than the novel food frequency questionnaires with 11% underestimated (21) and the Remote Food Photography Method with an error range of −8.8% to 6.8% (22). Lipid is the component that has the highest percentage of difference comparing the CSV and FW methods but the difference is still small (4.0%). As previously mentioned, lipid was estimated mostly on the basis of experience, so needless to say these experiences vary from individual to individual. From the comparison with previous studies, CSV has provided positive results in terms of assessing diet with less than 5 % estimated food difference.

An acceptable level of agreement between CSV with FW was demonstrated by the Bland−Altman plots. According to figure 1 and 2, the two methods were found to be comparable in estimating energy and nutrient intakes for both meals and single dishes. The approach involves linearly regressing the difference depending on the average. Almost all of the points are in a band of plus or minus double the standard deviation of the straight equality of means. Bland−Altman analysis shows that most measures of energy and nutrients are scattered on either side of the mean differences and all along the line of equality (difference=0). Our data analyses of energy and nutrient intakes show that the Calorie Smile software method was able to adequately estimate the weights of food portions and gave results that are comparable to the actually consumed amounts (FW).

To sum up, from the results of the study, the appearance of CSV software is actually an innovation in the nutritional field which can be considered a useful method in assessing dietary intakes in a free-living environment as well as for clinical purposes, given its high level of accuracy.

ACKNOWLEDGEMENTS

I would like to extend my great appreciation to US-Japan Medical Science Program, Jumonji University for giving the best condition to complete the study; and to Prof. Andrew Durkin, emeritus professor of Indiana University, for careful proof-reading of the paper.

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