# Design and Evaluation of a Training Protocol for a Photographic Method of Visual Estimation of Fruit and Vegetable Intake among Kindergarten Through Second-Grade Students

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## ABSTRACT

**Objective:** To design a replicable training protocol for visual estimation of fruit and vegetable (FV) intake of kindergarten through second-grade students through digital photography of lunch trays that results in reliable data for FV served and consumed.

**Methods:** Protocol development through literature and researcher input was followed by 3 laboratory-based trainings of 3 trainees. Lunchroom data collection sessions were done at 2 elementary schools for kindergarten through second-graders. Intraclass correlation coefficients (ICCs) were used.

**Results:** By training 3, ICC was substantial for amount of FV served and consumed (0.86 and 0.95, respectively; $P < .05$). The ICC was moderate for percentage of fruits consumed (0.67; $P = .06$). In-school estimates for ICCs were all significant for amounts served at school 1 and percentage of FV consumed at both schools.

**Conclusions and Implications:** The protocol resulted in reliable estimation of combined FV served and consumed using digital photography. The ability to estimate FV intake accurately will benefit intervention development and evaluation.

**Key Words:** food intake, digital photography, reliability, fruits and vegetables, school nutrition, dietary assessment (*J Nutr Educ Behav*. 2017;49:346–351.)

## INTRODUCTION

Schools have the ability to impact children's food intake because 80% of children who are enrolled in schools may consume 2 meals and a snack a day while in school.[1] In addition, more than 30 million children consume meals provided from the federally regulated *National School Lunch Program*.[2-4] However, evaluating fruit and vegetable (FV) intake from school lunch data can be challenging and several methods were used to assess child consumption, including both direct and indirect methods. These food intake methods were used in US schools to assess meal acceptance and performance for food service concerns, effectiveness of nutrition programs, and changes in food waste, with programs such as the *National School Lunch Program*, which updated its nutrition standards in 2012.[3-5] The most direct and accurate method of food intake determination is plate weighing, which involves weighing a plate before and after meals. This presents challenges because it can be time disruptive to food services and may delay delivery of lunch trays to children, which consequently may influence a child's intake.[5,6] Other food intake estimation methods have been used as an alternative to direct weighing protocols to mitigate these issues.

Indirect methods include food consumption recalled by children,[7] visual estimation methods,[6,8] and digital photography of food trays.[6,8] Determining food consumption recalled by children relies on children's memory, and children may accurately recall what they consumed, overestimate or underestimate their consumption, or have variation owing to social desirability bias.[9,10] Literature also showed children being able to self-capture food intake with the use of phone applications.[11] Visual estimation methods are conducted by trained observers who visually estimate, in real-time, portions

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of foods served from a child's lunch tray and later determine how much was consumed.[12,13] In addition, visual estimations of food consumption have been evaluated using photographs of children's lunch trays.[14] A study by Williamson et al[12] tested the validity of both visual estimation and digital photography methods for measuring food portions and found that FV, dessert, and beverage portions were highly correlated with the weighed foods method ($r = 0.82–0.98$). Bland-Altman regression used to compare results from the 2 estimation methods also showed that the methods were comparable and had low bias ($P > .30$).[12] These types of indirect methods are well-suited for public eating settings such as cafeterias.[6,12,15] Visual estimates of food intake with and without the use of digital photography were frequently employed because they are less time intensive, costly, and disruptive than weighing foods before and after eating.[12,16] In particular, digital photography is advantageous because it requires less in-school data collection than other methods: one can observe digital images off-site, has a less rushed experience when comparing the image of a consumed meal plate with a reference image, and has a reduced dependency on memory recall.[6,14] This method may include a fiducial marker or standard to help with calculating accurate measurements.[17] Digital photography can allow multiple raters to assess the same images independently. However, to ensure that raters have consistent and reliable estimates, it is important to both create a training protocol to have consistent estimates and assess the reliability of estimates among raters.

Articles assessing various visual estimation techniques using real-time visual estimates and photographic methods did not detail the training techniques involved. One study by Taylor et al[14] described how a 12-hour training program was developed and implemented, and that a final training session had a lunch observation in a controlled laboratory setting. However, that article did not detail what was involved in the training session. Although the effectiveness of training for portion size estimation was discussed previously,[18] current articles did not detail what methods were used in portion size estimation trainings to

collect data in school settings. To the authors' knowledge, no replicable training procedures accurately detailed how to estimate FV portions served and consumed from lunch trays that were photographed in an elementary school lunchroom setting. In addition to creating a training protocol, it is important to conduct reliability measures of the protocol itself, because reliability quantifies how consistently raters observe particular items during data collection.[19]

Therefore, the first objective of the current study was to develop training procedures for visual estimates of FV consumption of elementary school-children through digital photographs of lunch trays. The intent was to develop a training protocol that assessed FV consumption that could be replicated and offered reliable results in various lunch settings. The second objective was to determine whether the training protocol was successful, by using the learned training techniques in 2 elementary schools near Chicago, IL.

## METHODS

The training protocol was created to help guide facilitation of a training on visual estimation of FV consumption. The training sessions and topics (Table 1) were based on past studies that worked to identify methods of visually estimating test meals.[6,12,15,20] Trainee mastery within these topics was graded, with the exception of topic 6, Consistency of Photography. Feedback was given to each trainee, with suggestions for additional practice outside the training session when performance was low. Three sessions allowed topics to be repeated to achieve mastery and allowed new topics to be introduced.

The first 3 training sessions took place in a laboratory that had a kitchen facility, work area, and computers. Stations were set up within the laboratory so the trainees could move through the training at their own pace. Photography methods varied throughout the trainings and trainees practiced using various digital media such as a Panasonic Lumix digital camera (Kadoma, Osaka, Japan) and Apple iPads (Cupertino, CA). Various digital media were employed based on trial and error using the different digital cameras and the input of trainees regarding their ease of use. The Apple iPads were ultimately selected for the images of the third training and last training session at the school. Trainees also practiced taking images of lunch trays using a tripod and then a free-form method in which, rather than a tripod, the camera was held by the trainee.[14] Specific instructions regarding the height at which to hold the camera and the camera angle were provided to trainees. They were told that a 45° angle was appropriate for food depth, as was chosen in another study.[12] Before the trainings, the doctoral student for the project took images of sample lunch trays with various servings of FV that would typically be served in a school setting. Trays were made to represent both what was served and a typical amount that would be consumed by an elementary school student. The researchers did not use fiducial markers in the first 3 training sessions but employed them in the school session by placing a ruler near the lunch trays. Reference plates measuring 1 cup of fruits or vegetables were taken before the training session so that trainees could use them as a reference. In training sessions, trainees visually estimated FV consumption from photographs; these were scheduled individually

**Table 1.** Training Topics for Visual Estimation of Fruit and Vegetable Consumption

| Item | Topic |
|---|---|
| 1 | Familiarization of weights and portions of foods |
| 2 | Food and portion identification of foods served |
| 3 | Food and portion identification of foods consumed |
| 4 | Food and portion identification of photos of foods served |
| 5 | Food and portion identification of photos of foods consumed |
| 6 | Consistency of photography |

Note: Session 1 included topics 1–6; session 2 included topics 1 and 4–6; session 3 included topics 4–6.