RESEARCH
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Validity and Interrater Reliability of the Visual Quarter-Waste Method for Assessing Food Waste in Middle School and High School Cafeteria Settings

Katherine M. Getts, MPH, RD; Emilee L. Quinn, MPH; Donna B. Johnson, PhD, RD; Jennifer J. Otten, PhD, RD

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ABSTRACT

Background Measuring food waste (ie, plate waste) in school cafeterias is an important tool to evaluate the effectiveness of school nutrition policies and interventions aimed at increasing consumption of healthier meals. Visual assessment methods are frequently applied in plate waste studies because they are more convenient than weighing. The visual quarter-waste method has become a common tool in studies of school meal waste and consumption, but previous studies of its validity and reliability have used correlation coefficients, which measure association but not necessarily agreement.

Objective The aims of this study were to determine, using a statistic measuring interrater agreement, whether the visual quarter-waste method is valid and reliable for assessing food waste in a school cafeteria setting when compared with the gold standard of weighed plate waste.

Methods To evaluate validity, researchers used the visual quarter-waste method and weighed food waste from 748 trays at four middle schools and five high schools in one school district in Washington State during May 2014. To assess interrater reliability, researcher pairs independently assessed 59 of the same trays using the visual quarter-waste method. Both validity and reliability were assessed using a weighted κ coefficient.

Results For validity, as compared with the measured weight, 45% of foods assessed using the visual quarter-waste method were in almost perfect agreement, 42% of foods were in substantial agreement, 10% were in moderate agreement, and 3% were in slight agreement. For interrater reliability between pairs of visual assessors, 46% of foods were in perfect agreement, 31% were in almost perfect agreement, 15% were in substantial agreement, and 8% were in moderate agreement.

Conclusions These results suggest that the visual quarter-waste method is a valid and reliable tool for measuring plate waste in school cafeteria settings.
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POLICIES TO IMPROVE SCHOOL NUTRITION, SUCH AS the Healthy Hunger-Free Kids Act of 2010, may result in more students selecting healthy options at breakfast and lunch, including fruits, vegetables, and low-fat unflavored milk,[1] but it is not clear whether students consume these foods.[2,3] Measuring food waste in school cafeterias is an important part of a comprehensive evaluation of the effectiveness of school policies and interventions designed to increase consumption of healthier meals[4] and to reduce food waste in schools.[5]

Weighing food waste (ie, plate waste) from individual plates or trays with a scale, considered the gold standard method,[6] can be time-intensive, costly, and impractical in a busy cafeteria setting.[7] Therefore, indirect forms of measuring waste have been developed,[8] including aggregate selective plate waste,[9] student self-report of consumption,[10] visual estimation on-site,[10,11] and, more recently, visual estimation using digital photography.[12,13] Of these indirect methods, visual estimation by trained observers is relatively unobtrusive, efficient, and it safeguards against self-report bias, but may be subject to potential measurement bias.

Visual estimation is an assessment process in which trained observers estimate food waste using one of several developed scales.[10-11,13-15] The visual quarter-waste method, which estimates food waste as 0% remaining, 25% remaining, 50% remaining, 75% remaining, or 100% remaining, has been used with increasing frequency.[15] Studies that have assessed the validity of visual estimation have used intermethod comparisons and discussed situations where one method may be preferable.[10,13,15-17] To do so, they have assessed the correlation between visual estimation and the weight of waste. By evaluating linear trends, correlation coefficients measure

association but not necessarily agreement[17] and should be interpreted with caution. Thus, the aims of this study were to assess the validity of the visual quarter-waste method in comparison to weighing plate waste, and the interrater reliability of the visual quarter-waste method, using a statistic that measures interrater agreement rather than correlation.

METHODS

Study Design

This study was conducted by trained research staff at the University of Washington Center for Public Health Nutrition as part of a larger study evaluating the influence of a school cafeteria intervention.[18] In the intervention, cafeteria staff implemented low-cost strategies to improve students' selection and intake of fruits, vegetables, and white milk within the National School Lunch Program. Study protocols were approved by the University of Washington Institutional Review Board. Data collection took place during May 2014 at four middle schools and five high schools in one school district in Washington State. Each school was visited once. In preparation for data collection, 10 graduate and undergraduate students received 2 hours of training in the visual quarter-waste method from the study's project coordinator. Training included instruction regarding the tool and protocol as well as time to practice using the protocol with sample lunches until the team could accurately assess the food waste compared with test amounts.

Data Collection

At each school, the research team reviewed the day's food options before the cafeteria opened to familiarize themselves with the size and shape of whole entrées. Some foods, such as whole fruits, vegetable side dishes, and low-fat white and chocolate milk, were the same at all nine schools, whereas entrées and specialty fruit items varied between schools. Beverages and most fruits and vegetables were prepackaged with the exception of whole apples and oranges. Cafeteria staff served hot entrées, and one school had a staff-operated made-to-order entrée salad bar on the day of data collection. Items were in standardized sizes due to being prepackaged or served by cafeteria staff. No foods included in the study were self-serve. In some cases, the team retained whole entrées or side dishes as references and agreed upon measurement standards such as the number of baby carrots in a prepackaged bag. Foods sold outside of the National School Lunch Program, called competitive foods, were not included in the study.

Researchers selected cafeteria tables during each lunch period based on a random cluster sample design. Once students were seated with their lunches, students at those tables were recruited to participate in the evaluation study.[18] Each student provided verbal consent to participate. Research staff completed a card for each tray by marking the foods present, and taped it to the bottom of the student's tray. Students were instructed to return their trays with all waste and wrappers to a marked rack in one section of the cafeteria when they finished eating. These trays were randomly distributed to members of the research team for visual assessment and then passed to another researcher who weighed the food waste.

Visual Quarter-Waste Method. Each food on the tray was assigned a visual assessment estimate using the quarter-waste method, marking the amount of food waste as either 0% (none left), 25%, 50%, 75%, or 100% remaining (all left). Visual assessors noted on the data card any foods for which there was no evidence of expected waste such as an empty container or peel, as well as those that were added after the data card was filled. Entrées served with a side dish in the same container, such as chicken fingers and roasted potatoes, were visually assessed as separate foods. Visual assessors poured milk and juice into a measuring cup and measured the remaining fluid to the closest quarter-cup. A full milk carton is 8 oz and a full juice carton is 4 oz. Using simple calculations, the visual assessor determined the appropriate category for percent remaining. This approach for beverages differed from the standard visual quarter-waste method used because milk was served in cardboard cartons that were open in one corner and difficult to visually assess. For consistency, the pouring method was used for all beverages.

Interrater reliability testing was conducted at three schools with smaller student populations and/or fewer lunch periods, which allowed the team time to assess the same trays more than once. At these schools, the team tested a total of 59 trays for interrater reliability. After one visual assessor assessed a tray, she stapled the completed data card underneath a blank data card and marked on that card which foods were present on the tray before passing the tray at random to a second visual assessor for assessment. All members of the team were included in interrater reliability testing.

Weighed Method. After visually assessing a tray, the researcher passed it to another researcher who weighed the food waste for each individual food on a scale (E Series E-160 Digital Portion Scale; Edlund) and noted the gram weight in the appropriate row on the data card. All scales were calibrated before data collection according to manufacturer directions. Beverages were weighed in their containers. For an entrée served in a cardboard boat that included more than one type of food item, such as chicken nuggets and french fries, each food was weighed separately and staff noted the presence or absence of the container for each weight. Once a tray's food items had been weighed and recorded, they were discarded.

Throughout the data collection period, researchers weighed each item offered in its whole and/or uneaten state at least once. Foods accessible to the researchers at multiple schools before lunch service—all beverages and most side dishes—were able to be weighed multiple times. Multiple weights obtained for the same food or beverage were averaged together to provide a baseline, uneaten weight for each food. Foods weighed in containers or packaging were noted as such. Researchers also collected and retained at least one type of container or packaging for all food items, which were washed, dried, and cleaned before being weighed and recorded.

For foods served in a boat, container, carton, or plastic bag, the packaging weight was subtracted from the recorded weight of the food waste to provide a final weight of the food