Research Brief

Development and Validation of a Technology-Based System for Tracking and Reporting Dietary Intake at School Meals

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ABSTRACT

Objective: This report describes the development and validation of a technology-based system that integrates data on food choice, nutrition, and plate waste to generate feedback reports summarizing students' dietary intake at school meals.

Methods: Cafeteria staff used the system to document the school lunch choices of seventh-graders (n = 37) in an urban charter school for 5 months. Plate waste was assessed by research staff using a visual estimation method that was validated against directly weighed plate waste.

Results: Most food choices (97.1%) were correctly recorded through the system. Visual estimates of plate waste had excellent interrater reliability (r's ≥ .94) and agreement with direct measurements (ρ's ≥ .75). Plate waste assessment required approximately 10 s/tray. Fifty-four percent of parents received feedback reports consistently.

Conclusions and Implications: The technology-based system enabled staff to monitor dietary intake accurately at school meals. The system could potentially inform lunch menu modifications aimed at reducing plate waste.

Key Words: technology, school nutrition, plate waste, prevention, *National School Lunch Program* (*J Nutr Educ Behav*. 2016; ■:1-5.)

Accepted September 15, 2016.

INTRODUCTION

Schools are an important setting in which to address children's dietary intake, particularly in low-income communities where poor diet quality and childhood obesity are most prevalent.[1-3] The US Department of Agriculture aims to affect children's dietary intake by implementing nutrition standards for meals provided through the *National School Lunch Program* (NSLP), which subsidizes free or reduced-cost school meals for over 30 million low-income students annually.[4] The Healthy Hunger-Free Kids Act of 2010 stipulates that lunches include only fat-free and 1% milk, increases the amount of fruits and vegetables served, requires gradual reductions in sodium content over a 10-year period, and specifies grade-appropriate calorie ranges for meals. The Act also requires that students select a fruit or vegetable for a meal to be reimbursable.

Parents, school food service providers, and teachers might be more effective in their efforts to promote children's nutritional health if they had timely access to information regarding what students eat at school meals and what they discard as plate waste. These data could be used to inform waste-reducing changes to lunch menus, provide parents with tailored feedback about the nutrition their child obtained through school meals, and enhance classroom-based nutrition education by helping students understand the nutritional impact of their actual food choices. Researchers developed methods to estimate dietary intake at school meals across school- or grade-level populations during finite time periods.[5-8] However, to the authors' knowledge, methods have not been developed that would allow schools to collect, synthesize, and report dietary intake data for individual students over prolonged periods.

Any attempt to estimate school meal intake accurately must account for plate waste, which is substantial (40% to 45% overall) and affects both nutritional health and program costs.[5,6] Plate waste did not increase after the recent passage of more stringent nutrition standards,[7,8]

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Conflict of Interest Disclosure: The authors' conflict of interest disclosures can be found online with this article on www.jneb.org.

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http://dx.doi.org/10.1016/j.jneb.2016.09.008

but this may change as the standards continue to evolve. The reference standard method of assessing plate waste is to weigh portions of uneaten food directly,[5] but this practice is impractical for sustained use in most settings. Visual plate waste estimation methods, with or without the aid of photography, greatly reduce assessment burden and have been found to be valid.[9-11]

This report describes the development and validation of a technology-based system that facilitates accurate documentation of food choice at school meals and provides a means with which to share this information with parents, teachers, and stakeholders. The *Healthy School Meals Realized through Technology* (SMART) system includes touchscreen and barcode scanning technology that enables cafeteria staff to record food choices efficiently as students proceed through the cafeteria lunch line. Plate waste is assessed by research staff using an efficient visual estimation method. The system integrates food choice and plate waste data with nutrition information for each food item and automatically generates reports that provide parents with nutritional feedback and individually tailored health messaging. The validity and reliability of the *Healthy SMART* system were examined during a 5-month proof-of-concept study conducted with middle school students in a low-income, urban charter school network with high NSLP participation. The study aims were to (1) assess the accuracy of food choices recorded using the system; (2) test the validity and interrater reliability of the visual plate waste estimation method; and (3) evaluate 2 key aspects of program implementation, the time required to assess plate waste, and the frequency with which parents received and reviewed feedback reports.

METHODS

Study Sites and Participants

The target population (n = 37) consisted of middle-school students within a kindergarten through grade 12 charter school network in Chicago, IL (2013–2015). The charter school network almost exclusively served low-income, ethnic minority families, and the vast majority of students received free or reduced-cost lunch through the NSLP (n = 37; 100% of the current sample). Because the network serves predominantly Spanish-speaking households (n = 25; 68% of the current sample), study materials were developed in English and Spanish. Students were generally offered between 3 and 6 food items at lunch, plus a choice of skim white, 1% milk fat white, or skim chocolate milk. Charter school network administrators selected 2 schools to participate in this project. Families were informed about the project through flyers and announcements at school functions and during telephone conversations with a parent liaison employed by the charter school network. Interested parents returned signed consent forms and surveys to the research team. Study procedures were approved by the Institutional Review Boards of Rush University Medical Center and Chicago Public Schools, and all parents and children signed consent/assent forms before participation.

Healthy SMART System Development Process

The first step in the development process was to conduct in-depth formative research with the study population of charter school families, staff, and administrators at both study sites to inform the design of the food choice tracking system and the feedback reports. Main findings from the formative research were that (1) healthy foods served at school lunches were somewhat unpalatable and had high levels of plate waste, and (2) few parents had reliable Internet access and preferred paper-based feedback reports. A detailed report summarizing this formative research is available from the authors by request. The second step was to contract with a school food service software development company (K-12 Plus, Inc, Tulsa, OK) to build the technology-based food choice tracking system. The third step was to test the functionality of the food choice tracking system prototype during a 3-month pilot study with a sixth-grade class (n = 18) at 1 school. No technical problems arose with the system during pilot-testing. The fourth step was to examine the validity, reliability, and implementation of the system in a proof-of-concept study with seventh-grade families (n = 37) at the second school, which is described in this report.

Description of the *Healthy SMART* System

Many schools that provide meals through the NSLP use software to track program participation for reimbursement purposes. For this project, existing software (A-Plus Café, version 3.1.0.43; K-12 Plus, Inc) was adapted to allow recording of individual food choices. At school lunches, students' school identification cards were scanned with a barcode scanner as they passed through the cafeteria line. Doing so created a new record in a relational database. Cafeteria staff then used a touchscreen monitor (Model 15B2; Elo Touch Solutions, Inc, Menlo Park, CA) displaying that day's lunch menu to document food choices. Research staff assessed plate waste for each student every day using a validated visual estimation method (described subsequently). Plate waste data were appended to the food choice database.

Each week, researchers downloaded food choice and plate waste data from the database. Queries were run after the last lunch period in each week so that data for the entire week were available. Nutrition information and portion sizes for all foods served were obtained from the school's contracted foodservice provider on a monthly basis. The system calculated students' intake of each food item by subtracting the amount of each food discarded (plate waste) from the amount served. Because the tracking system documented all food choices, it was possible to identify foods that were consumed in their entirety and left no residual plate waste. Students' energy and nutrient intake were derived by multiplying the nutritional content of each food by the amount consumed, and summing these values within each meal.

Report generation software (Crystal Reports 2011; SAP America, Newtown Square, PA) was used to create feedback reports automatically for parents that listed all foods chosen and summarized the total calorie intake, vegetable choices, and milk choices at each meal during the week. To enhance their relevance for individual families, reports included tailored suggestions based on students' food choices and health messages promoting family engagement in activities linked to weight control (eg, reducing screen time, engaging in physical activity as a family, eating healthy meals at home). To provide value to the school,