RESEARCH
Review

Food Waste in the National School Lunch Program 1978-2015: A Systematic Review

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ABSTRACT

Background Food waste studies have been used for more than 40 years to assess nutrient intake, dietary quality, menu performance, food acceptability, cost, and effectiveness of nutrition education in the National School Lunch Program (NSLP).

Objective Describe methods used to measure food waste and respective results in the NSLP across time.

Methods A systematic review using PubMed, Science Direct, Informaworld, and Institute of Scientific Information Web of Knowledge was conducted using the following search terms: *waste, school lunch, plate waste, food waste, kitchen, half method, quarter method, weight,* and *photography*. Studies published through June 2015 were included. The systematic review followed preferred reporting items for systematic reviews and meta-analyses recommendations.

Results The final review included 53 articles. Food waste methodologies included in-person visual estimation (n=11), digital photography (n=11), direct weighing (n=23), and a combination of in-person visual estimation, digital photography, and/or direct weighing (n=8). A majority of studies used a pre−post intervention or cross-sectional design. Fruits and vegetables were the most researched dietary component on the lunch tray and yielded the greatest amount of waste across studies.

Conclusions Food waste is commonly assessed in the NSLP, but the methods are diverse and reporting metrics are variable. Future research should focus on establishing more uniform metrics to measure and report on food waste in the NSLP. Consistent food waste measurement methods will allow for better comparisons between studies. Such measures may facilitate better decision making about NSLP practices, programs, and policies that influence student consumption patterns across settings and interventions.
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THE NATIONAL SCHOOL LUNCH PROGRAM (NSLP) serves more than 31 million children in more than 100,000 schools each school day.[1,2] The NSLP aims to offer balanced meals to schoolchildren, provided at free or reduced costs for low-income populations and subsidized by the federal government.[2] The Healthy Hunger Free Kids Act of 2010 required updated nutrition standards for schools based on the most recent Dietary Guidelines for Americans and Institute of Medicine recommendations.[3] The requirements consist of five meal components: fruits, vegetables, whole grains, low-fat dairy, protein, and sodium content in a specified range. The serving size and caloric limits for each meal for children enrolled in grades kindergarten through 12 are based on age group. A lunch provided to a student must consist of three out of the five components offered to be considered a reimbursable meal, with one of the components being a fruit or vegetable.[3]

The NSLP setting provides an important opportunity for researchers and practitioners to study how much and what types of nutrients children consume and waste. The lunchroom is experimental in nature because menus are designed (and can be changed) by local school food authorities per national nutrition standards, food portions are standardized, and many students dine in the cafeteria every school day. Study results with high external validity have far reaching implications for the NSLP nationwide.

Since the 1970s,[4] researchers have used plate and food waste studies to observe nutrient intake, dietary quality, menu performance, food acceptability, cost, and effectiveness of nutrition education in the NSLP. Plate and food waste are used synonymously throughout most of the school foods research literature and will herein be referred to as food waste. Food waste studies measure the uneaten edible portion of food served to an individual.[5] Food waste methodology can measure several important food and nutrition outcomes,[6] including the amount of a specific nutrient available, consumed, and wasted, the types of food groups most likely being eaten or thrown away, compliance with nutrition practices and policies, the effect of nutrition education on food choice and consumption, acceptability of menu items, and the influence of waste on an institution's budget and on natural resources. The resulting data can be used to drive important changes in practices, programs, and policies in a school lunch program. In addition, in recent

years, global and national food waste campaigns have further amplified the importance of reducing food waste.[7,8]

The purpose of this systematic review was to provide a summary of the literature describing the measurement and results of food waste studies in the NSLP across time.

METHODS

Search Strategy

Articles included in this systematic literature review were extracted from PubMed, Science Direct, Informaworld, and ISI Web of Knowledge using the preferred reporting items for systematic reviews and meta-analyses (PRISMA) format published through June 2015.[9] When testing key words, these databases yielded relevant articles. The authors tested potential key words related to NSLP and food waste through mock searches to ensure that the final list of terms captured relevant articles that met inclusion and exclusion criteria. Keywords entered with Boolean operators included *waste, school lunch, plate waste, food waste, kitchen, half method, quarter method, weight,* and *photography*. The following are two search strategies used in Science Direct: waste OR "food waste" OR "plate waste" OR "kitchen waste" AND school AND lunch; waste OR "food waste" OR "plate waste" AND school AND lunch AND "quarter method" OR "half method" OR weight OR photography. No limits or filters were used in the search. The search strategy was modified for individual databases.

Study Selection

The main criterion for inclusion was the explicit use and description of a method to measure food waste in the NSLP. Articles included were peer-reviewed, written in the English language, and based on studies conducted in the United States covering the NSLP. Journal articles that collected primary data were considered. Articles were excluded in cases where they did not focus on the NSLP, were conducted outside of the United States, did not measure food waste, or presented a review of literature. Meeting abstracts were excluded due to limited information about methodology conducted. Cross-sectional, intervention, quasiexperimental, randomized controlled trial, and mixed-methods study designs and methods were considered.

Data Extraction

Two reviewers first evaluated articles by titles, abstracts, and key words. In cases where food waste and kindergarten through 12th-grade schools were discussed in the title of an article, abstract, or key words, the full article was reviewed to determine relevance. Titles and abstracts that met the inclusion criteria were recorded for full text review. The references in each article included were reviewed to determine whether any other additional studies were relevant, although no additional articles were found that were not already captured in the search. The authors reviewed each article independently and met to determine inclusion or exclusion; disagreements were resolved via discussion.

For each article included in the review, one coder collected and entered data into an extraction template. Information recorded included: first author and year published, purpose, study design and specific data collection method, school type, number of schools involved, location of school, number of students, free and reduced NSLP eligibility, race/ethnicity, grade level or age, dietary component measures, duration and frequency of the data collected, food waste results, other relevant findings to food waste, and whether conducted before or after implementation of the NSLP standards updated by the Healthy Hunger Free Kids Act of 2010. The categories for data extraction were determined based on factors that may inform a researcher's decision to select a particular food waste measurement method. For example, it may be useful for researchers to understand the various ways results are reported when using a particular method (ie, waste of nutrients, specific foods, or food groups). The data collected, along with the publication, were reviewed by at least two additional coders to ensure accuracy; all disagreements were resolved by discussing inclusion and exclusion criteria to reach consensus.

Quality Appraisal of Individual Studies

Study quality was assessed using the Effective Public Health Policy Project (EPHPP) Quality Assessment Tool.[10] The EPHPP Quality Assessment Tool provides researchers with criteria to evaluate studies on the basis of selection bias, study design, confounders, blinding, data collection methods, withdraws and dropouts, intervention integrity, and analysis. Each criteria is scored numerically according to provided guidelines by the EPHPP Quality Assessment Tool as strong (score=1), moderate (score=2), or weak (score=3). Subsequently, the entire article is rated as strong (no weak ratings), moderate (one weak rating), or weak (two or more weak ratings).

This study was exempt from institutional review board review because there was no interaction with human subjects.

RESULTS

A total of 10,892 articles were retrieved using the database search. After eliminating duplicates and articles that did not meet inclusion criteria based on title and abstract screening, 66 articles remained for content review. After reviewing the full articles, 13 studies were excluded due to the following reasons: four were conducted outside of the United States; four did not involve the NSLP; three were in preschools; and two were conference abstracts, not full articles (see the Figure).

The 53 studies included in this review used four major types of food waste measurement methodologies: in-person visual estimation (n=11) (Table 1), digital photography (n=11) (Table 2), direct weighing (n=23) (Table 3), and a combination of in-person visual estimation, digital photography, and/or direct weighing (n=8) (Table 4). With regard to study design and methods, most studies identified interventions with a pre–post or pre–post-follow-up design (n=20) or cross-sectional (n=23), two were quasiexperimental, two were mixed methods, one study was longitudinal, and five were randomized controlled trials. Fourteen studies were rated as strong, 20 studies were rated as moderate, and 19 studies were rated as weak according to the EPHPP Quality Assessment Tool. Studies labeled as moderate were likely to have a weak rating for study design, whereas studies labeled as weak were likely to have weak ratings for selection bias or confounders and study design. See Tables 1 through 4 for quality assessment ratings.

In-Person Visual Estimation of Food Waste through Observation

In-person visual estimation through observation of food waste occurred in 11 studies (Table 1).[11-21] Researchers