

Research and Professional Briefs

Food and Beverage Environment Analysis and Monitoring System: A Reliability Study in the School Food and Beverage Environment

SALLY LAWRENCE BULLOCK, MPH; LISA CRAYPO, MPH, RD; SARAH E. CLARK; JASON BARRY, MS; SARAH E. SAMUELS, DrPH

ABSTRACT

States and school districts around the country are developing policies that set nutrition standards for competitive foods and beverages sold outside of the US Department of Agriculture's reimbursable school lunch program. However, few tools exist for monitoring the implementation of these new policies. The objective of this research was to develop a computerized assessment tool, the Food and Beverage Environment Analysis and Monitoring System (FoodBEAMS),* to collect data on the competitive school food environment and to test the inter-rater reliability of the tool among research and nonresearch professionals. FoodBEAMS was used to collect data in spring 2007 on the competitive foods and beverages sold in 21 California high schools. Adherence of the foods and beverages to California's competitive food and beverage nutrition policies for schools (Senate Bills 12 and 965) was determined using the data collected by both research and nonresearch professionals. The inter-rater reliability between the data collectors was assessed using the intraclass correlation coefficient. Researcher vs researcher and researcher vs nonresearcher inter-rater reliability was high for both foods and beverages, with intraclass correlation coefficients ranging from .972 to .987. Results of this study provide evidence that FoodBEAMS is a promising tool for assessing and monitoring adherence to nutrition standards for competitive foods sold on school campuses

*FoodBEAMS is a trademark of Samuels & Associates. FoodBEAMS software © 2009.

S. L. Bullock is an associate, L. Craypo is a senior associate, J. Barry is a biostatistician, and S. E. Samuels is President, all at Samuels & Associates, Inc, Oakland CA. S. E. Clark is a graduate student at Tufts University, Medford, MA; at the time of the study, she was a research assistant at Samuels and Associates, Inc, Oakland, CA.

Address correspondence to: Sarah E. Samuels, DrPH, Samuels & Associates, Inc, 1222 Preservation Park Way, Oakland, CA 94612. E-mail: sarah@samuelsandassociates.com

Manuscript accepted: November 24, 2009.

Copyright © 2010 by the American Dietetic Association.

0002-8223/\$36.00

doi: 10.1016/j.jada.2010.04.002

and can be used reliably by both research and nonresearch professionals.

J Am Diet Assoc. 2010;110:1084-1088.

Children's easy access to unhealthy foods at school may be contributing to current rates of childhood obesity in the United States (1). Foods sold outside of the United States Department of Agriculture reimbursable school meal program in vending machines, student stores, and à la carte lines in cafeterias (competitive foods) are, for the most part, unregulated by federal nutrition standards (2). Competitive foods are often high in calories, fat, and sugar (3-7), and may represent a substantial percentage of the foods students purchase on campus (3). Realizing the potential impact that improving school food could have on children's health, states and school districts across the country are developing policies that set nutrition standards for competitive foods (8,9). As of 2006, all school districts with reimbursable lunch programs were also required to establish local wellness policies with nutrition guidelines for all foods available during school hours (10).

Monitoring adherence to school competitive food policies is essential for understanding the degree of implementation and impact policies have on the school food environment (11). Unfortunately, schools with nutrition policies have found it difficult to monitor implementation (12-14). In order to fully understand the extent of policy implementation, schools require a tool to collect data on the types and serving sizes of all competitive foods available on campus, access nutrient information for each item, and compare this nutrient information to nutrition standards in the policy.

The objective of this research was to develop a computerized data collection and analysis tool that efficiently collects information on competitive foods in schools and determines their adherence to California school nutrition policies, and to test the inter-rater reliability of the tool among research and nonresearch professionals.

METHODS

Instrument Development

A computerized competitive food assessment tool, the Food and Beverage Environment Analysis and Monitoring System (FoodBEAMS), was developed based on a paper-and-pencil school Environmental Assessment Tool, which was used in a number of previous studies (15-17). The FoodBEAMS software was designed to be loaded onto touch-screen tablet laptops, allowing for data collec-

tors to enter information into the system while moving about a school campus. The software guides users through the data collection/entry process for all venues where competitive foods are sold on school campuses. For each venue, the data collector enters the brand name, flavor, total size (weight or volume), and price of each item observed. FoodBEAMS uses this information to match the item to its nutrient profile, which is housed in a nutrient database imbedded in the software. The database contains nutrient profiles for >5,500 foods and beverages observed in studies of schools in California and Washington. Sources of information used to generate the nutrient profiles include Nutrition Facts labels on food packaging, US Department of Agriculture nutrient databanks, manufacturers' Web sites, and school cafeteria recipes. Once data are collected from all of the venues selling competitive foods, the data can be exported for analysis with external statistical software or an analysis feature within FoodBEAMS can be used to determine the adherence of the items to the California school nutrition policies (Senate Bills 12 and 965) (18,19).

Study Design and Data Collection

Data were collected as part of a larger study of the implementation of state nutrition standards for competitive foods in a representative sample of 56 public high schools in California (20). Of these 56 schools, a purposive subsample of 21 schools was selected for geographic, ethnic, and economic diversity to participate in FoodBEAMS inter-rater reliability testing. This study did not involve human subjects and was exempt from Institutional Review Board review under federal regulation 45 CFR §46.101(b). Data were collected in spring 2007 by trained project staff on every competitive food and beverage present in the 21 schools. Each school was assessed on the same day by two independent raters in one of two configurations; ie, two researchers, each using FoodBEAMS; and a nonresearcher and a researcher, each using FoodBEAMS. The pool of four researchers was composed of project staff with extensive experience collecting nutrition data in multiple studies and settings. The four nonresearcher data collectors were made up of registered dietitians and nutrition educators who were familiar with school settings, but were not professional researchers regularly conducting observational studies. Prior to data collection, nonresearchers were oriented to FoodBEAMS through telephone and in-person trainings.

For the researcher vs researcher comparison, 11 schools were used as testing grounds, at which a total of 16 food venues and 25 beverage venues were identified and rated. A researcher–researcher dyad was randomly sampled from the pool of four researchers, resulting in four unique dyads rating the food and beverage environments. For the nonresearcher vs researcher comparison, another 10 schools were visited, where 15 food venues and 20 beverage venues were identified and rated. The pool of raters for this testing was six (two researchers and four nonresearchers), with five unique dyads performing the ratings across these school venues. Schools were not visited more than once and venues were not rated by more than one dyad.

Statistical Analysis

Percentage adherence to the California school nutrition policies was determined for each food and beverage item collected by each of the raters. As the method of determining adherence to the food policy differed from the beverage policy, and the same foods and beverages were often found in different venues, the adherence analyses were separated by venue and policy. For each food item a binary adherence (0=does not adhere, 1=adheres) was determined based on food policy criteria limiting the number of calories and amount of fat, saturated fat, and sugar that competitive foods can contain (18). Beverages were classified into categories that are allowed and not allowed under the beverage policy (19). For both foods and beverages, percentage adherence was determined by dividing the number of unique adherent items within each school venue by the total number of unique items within that venue.

The intraclass correlation coefficient (ICC [1,1]) was chosen as the primary measure of concordance, where scores range from 0 (nonconcordance) to 1 (perfect concordance). This statistic takes into account the selection of raters (in the present study, a random pair of raters are selected to rate each target school) and the correlation between raters (21). Other variations of the ICC ([2,1], [3,1]) are relevant to studies where raters are not selected randomly from a larger pool or rate every single target. Furthermore, there is evidence that this statistic is appropriate, given the sample sizes used in this study (numbers range from 15 to 25), where the correct sample size for accurate ICC estimates is defined as the smallest integer that will yield an exact confidence interval width that is less than or equal to the desired width (22). For the purposes of this study, a 99% confidence interval was deemed appropriate in describing the reliability of the sample point estimates.

As a second analytic approach, adherence percentages were transformed from continuous scores to binary scores with 50% as the split point, allowing for binary classification testing. The California nutrition policy for beverages mandated meeting at least 50% adherence by summer 2007. Although this “phase-in” was not required for foods, it was helpful to create binary adherence scores in order to compute sensitivity and specificity. Both sensitivity (the proportion of adherent venues correctly identified) and specificity (the proportion of nonadherent venues correctly identified) were measured for the non-researcher vs researcher comparison, with the researcher's ratings assumed to be “correct” for the purposes of each binary classification test. Data analyses were conducted using SPSS (version 15.0.1, 2006, SPSS Inc, Chicago, IL) to determine percentage adherence, and SAS (version 9.1.3, 2005, SAS Institute, Cary, NC) to determine ICCs, sensitivity, and specificity.

RESULTS AND DISCUSSION

Scatterplots shown in Figures 1 and 2 illustrate high degrees of concordance between the researcher–researcher and researcher–nonresearcher pairs when using FoodBEAMS to assess adherence to nutrition policies. This is also reflected in the ICCs based on continuous adherence scores. The ICC for foods in the researcher–researcher

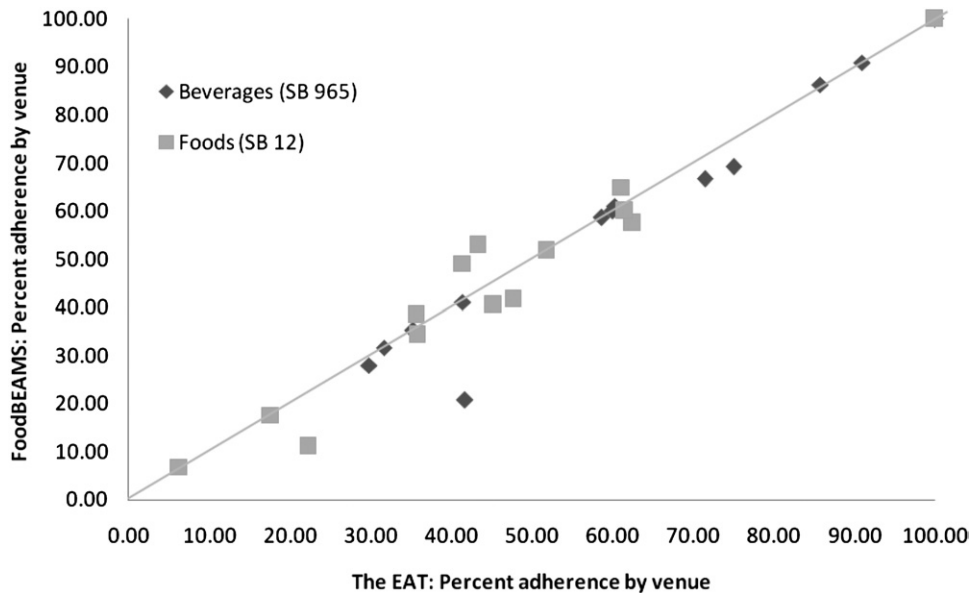


Figure 1. Convergent validity: scatterplot of the Environmental Assessment Tool (EAT) vs Food and Beverage Environment Analysis and Monitoring System (FoodBEAMS) measurements of percent adherence by venue to California state standards for Beverages (SB 965) and Foods (SB 12). The diagonal line represents where the dots would fall for theoretical perfect concordance, and a single dot may represent multiple data points. The paper-and-pencil Environmental Assessment Tool is considered to be the gold standard for collecting such data. The Web-based Food and Beverage Environment Assessment and Monitoring System is under experiment as a valid method for collecting such data.

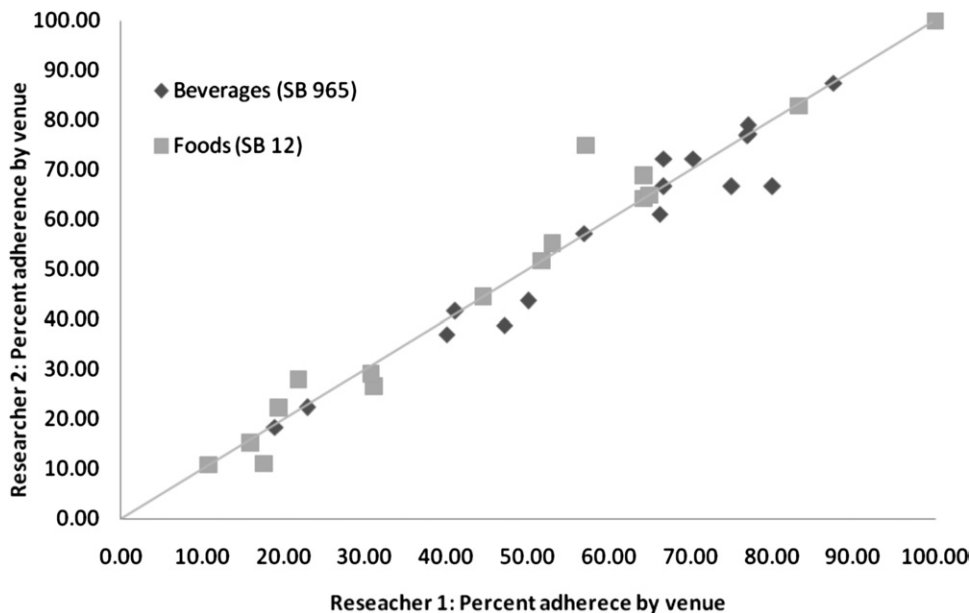


Figure 2. Inter-rater reliability: scatterplot of researcher vs researcher Food and Beverage Environment Analysis and Monitoring System measurements of percent adherence by venue to California state standards for Beverages (SB 965) and Foods (SB 12). The diagonal line represents where the dots would fall for theoretical perfect concordance, and a single dot may represent multiple data points.

comparison was .980 (99% confidence interval [CI]: .934 to .994). The ICC for beverages was .987 (99% CI: .963 to .996). Both ICCs were significantly different from 0 at $P < 0.00001$. The ICC for foods in the researcher–nonresearcher comparison was .972 (99% CI: .903 to .992). The ICC for beverages was .977 (99% CI: .925 to

.993). Both ICCs were significantly different from 0 at $P < 0.00001$.

A perfect score was obtained for specificity of binary adherence to the California school food policy; ie, all non-adherent venues identified by researchers were also identified as such by the nonresearchers. Sensitivity was .83

because of one instance where a researcher found a venue to be adherent but the nonresearcher did not (their respective adherence scores were 53% and 44%). Perfect concordance was obtained for both specificity and sensitivity for the beverage policy when comparing researchers and nonresearchers via a binary classification system of adherence.

A number of research studies have been conducted that include other tools to measure competitive food availability in schools (4,7,12,23-27). Unfortunately, these tools have limitations that make them ineffective for determining adherence to competitive food policies and/or hinder their use by school staff or nonresearch professionals. For example, surveys of school administrators or cafeteria staff have been conducted to determine the prevalence of competitive foods in schools (12,23-25). Although these surveys tend to be less time- and resource-intensive than environmental audits, they are not sensitive enough for determining adherence of competitive foods to policies and results are based on self-report. School environmental audits (4,26-28), while notably more time- and resource-intensive, allow for more detailed information on competitive foods to be collected. However, most audits were designed for researcher use and determining adherence to policies requires access to external nutrient databases and statistical software that are costly and difficult for nonresearchers to use.

Results from this study suggest that FoodBEAMS can be used by both researchers and nonresearchers to reliably measure adherence to nutrition standards for competitive foods sold on school campuses. Because FoodBEAMS guides the user through the data collection process, nonresearchers can use the system with minimal training to accurately record information about each item. FoodBEAMS also increases data collection/entry efficiency as it eliminates the need for entry of a paper form into a database for analysis. The built-in nutrient database and reporting feature allow for easy calculation of food and beverage adherence to California nutrition policies.

There are several limitations to this study and areas for additional research. Testing the validity of FoodBEAMS was not possible because a gold standard does not exist for assessing competitive school food environments. However, validity of FoodBEAMS when compared to the paper-and-pencil school Environmental Assessment Tool was high, with ICCs of .975 (foods) and .982 (beverages) (S. E. Samuels, 2008, unpublished data). Although reliability testing between researchers and nonresearchers (registered dietitians and nutrition educators) showed positive results, additional end-users at the school level must be identified and further reliability testing conducted. In addition, the database housed within FoodBEAMS currently contains foods and beverages observed in California and Washington schools and would need to be expanded for use in other states. The FoodBEAMS reporting feature also analyzes data against California policies only, limiting the features' applicability to other states. Future versions of FoodBEAMS will include an expanded database and will enable users to determine adherence to other nutrition policies.

CONCLUSION

The staggering monetary, physical, and social costs of obesity provide strong incentives for preventing childhood overweight and obesity. Schools play a critical role in reinforcing healthy eating behaviors, but need help creating healthy environments. FoodBEAMS is a tool that could be helpful to registered dietitians and other food and nutrition practitioners working in schools for reliably collecting data on competitive foods and monitoring adherence to nutrition policies. With further expansion, FoodBEAMS has the potential to be used in several other food environments, such as health care institutions and local government agencies that have adopted policies for vending machines (29).

STATEMENT OF POTENTIAL CONFLICT OF INTEREST:

No potential conflict of interest was reported by the authors.

FUNDING/SUPPORT: Development of FoodBEAMS was supported by grant number R43DK078457 from the National Institute of Diabetes and Digestive and Kidney Diseases. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institute of Diabetes and Digestive and Kidney Diseases or the National Institutes of Health. The FoodBEAMS reliability study was conducted in conjunction with a study funded by the Robert Wood Johnson Foundation to assess the implementation of California's competitive food and beverage standards (SB 12 and SB 965) on high school campuses beginning in the spring of 2006.

References

1. Committee on Prevention of Obesity in Children and Youth. *Preventing Childhood Obesity Health in the Balance*. Washington, DC: The Institute of Medicine of the National Academies, National Academies Press; 2005.
2. Government Accountability Office. *School Meals Programs: Competitive Foods Are Widely Available and Generate Substantial Revenues for Schools*. Washington, DC: The United States Government Accountability Office; 2005:GAO-050563.
3. Fox MK, Gordon A, Nogales R, Wilson A. Availability and consumption of competitive foods in US public schools. *J Am Diet Assoc*. 2009;109(suppl 1):S57-S66.
4. French SA, Story M, Fulkerson JA, Gerlach AF. Food environment in secondary schools: A la carte, vending machines, and food policies and practices. *Am J Public Health*. 2003;93:1161-1167.
5. Neumark-Sztainer D, French SA, Hannan PJ, Story M, Fulkerson JA. School lunch and snacking patterns among high school students: Associations with school food environment and policies. *Int J Behav Nutr Phys Act*. 2005;2:14.
6. Kann L, Grunbaum J, McKenna ML, Wechsler H, Galuska DA. Competitive foods and beverages available for purchase in secondary schools—Selected sites, United States, 2004. *J Sch Health*. 2005;75:370-374.
7. Wildey MB, Pampalone SZ, Pelletier RL, Zive MM, Elder JP, Sallis JF. Fat and sugar levels are high in snacks purchased from student stores in middle schools. *J Am Diet Assoc*. 2000;100:319-322.
8. Committee on Nutrition Standards for Foods in Schools. *Nutrition Standards for Foods in Schools: Leading the Way Toward Healthier Youth*. Washington, DC: Institute of Medicine of the National Academies; 2007.
9. Wootan MG, Henry H, Roberts D, Johanson J. *State School Foods Report Card 2007*. Washington, DC: Center for Science in the Public Interest; 2007.
10. Child Nutrition and WIC Reauthorization Act of 2004. P.L. No. 108-265, § 204, 118 Stat. 204; 2004.
11. McGraw SA, Sellers D, Stone E, Resnicow KA, Kuester S, Fridinger F, Wechsler H. Measuring implementation of school programs and pol-

- icies to promote healthy eating and physical activity among youth. *Prev Med.* 2000;31:S86-S97.
12. Greves HM, Rivara FP. Report card on school snack food policies among the United States' largest school districts in 2004-2005: Room for improvement. *Int J Behav Nutr Phys Act.* 2006;3:1.
 13. McDonnell E, Probart C, Weirich JE. School foodservice directors' perceptions and concerns about local wellness policy development, implementation, and enforcement. *J Child Nutr Manage.* 2006;30(1). <http://docs.schoolnutrition.org/newsroom/jcnm/06spring/mcdonnell/index.asp>. Accessed May 17, 2010.
 14. Belansky E, Chriqui J, Schwartz MB. Local school wellness policies: How are schools implementing the congressional mandate? The Robert Wood Johnson Foundation Healthy Eating Research Web site. <http://www.healthyeatingresearch.org/content/blogcategory/8/114/6/0/>. Accessed July 20, 2009.
 15. Craypo L, Purcell A, Samuels SE, Agron P, Bell E, Takada E. Fast food sales on high school campuses: Results from the 2000 California high school fast food survey. *J Sch Health.* 2002;72:78-82.
 16. Samuels & Associates, California Project LEAN, The Partnership for the Public's Health, Center for Weight and Health. *Key Lessons from California Schools Working to Change School Food Environments.* Los Angeles: The California Endowment, Healthy Eating Active Communities Program; 2007.
 17. Samuels SE, Craypo L, Boyle M, Stone-Francisco S, Schwarte L. *Improving School Food Environments Through District Level Policies: Findings from Six California Schools.* Oakland, CA: The California Endowment and Robert Wood Johnson Foundation; 2006.
 18. California Senate Bill No. 12, Education Code (2005).
 19. California Senate Bill No. 965, Education Code (2005).
 20. Samuels S, Bullock SL, Woodward-Lopez G, Clark S, Kao J, Craypo L, Barry J, Crawford PB. To what extent have high schools in California been able to implement state-mandated nutrition standards? *J Adolesc Health.* 2009;45(suppl):S38-S44.
 21. Shrout P, Fleiss J. Intraclass correlations: Uses in assessing rater reliability. *Psychol Bull.* 1979;86:420-428.
 22. Bonett DG. Sample size requirements for estimating intraclass correlations with desired precision. *Stat Med.* 2002;21:1331-1335.
 23. Johnston LD, Delva J, O'Malley PM. Soft drink availability, contracts, and revenues in American secondary schools. *Am J Prev Med.* 2007;33(suppl):S209-S225.
 24. O'Toole TP, Anderson S, Miller C, Guthrie J. Nutrition services and foods and beverages available at school: Results from the School of Health Policies and Programs Study 2006. *J School Health.* 2007;77:500-521.
 25. Probart C, McDonnell E, Weirich JE, Hartman T, Bailey-Davis L, Prabhakher V. Competitive foods available in Pennsylvania public high schools. *J Am Diet Assoc.* 2005;105:1243-1249.
 26. Kubik MY, Lytle LA, Hannan PJ, Perry CL, Story M. The association of the school food environment with dietary behaviors of young adolescents. *Am J Public Health.* 2003;93:1168-1173.
 27. van der Horst K, Timperio A, Crawford D, Roberts R, Brug J, Oenema A. The school food environment associations with adolescent soft drink and snack consumption. *Am J Prev Med.* 2008;35:217-223.
 28. Zive MM, Elder JP, Prochaska JJ, Conway TL, Pelletier RL, Marshall S, Sallis JF. Sources of dietary fat in middle schools. *Prev Med.* 2002;35:376-382.
 29. Lawrence S, Boyle M, Craypo L, Samuels S. The food and beverage vending environment in health care facilities participating in the Healthy Eating, Active Communities Program. *Pediatrics.* 2009;123(suppl 5):S287-S292.