Resolution No. 06-2001-148

RESOLUTION OF THE
WHITE MOUNTAIN APACHE TRIBE OF THE
FORT APACHE INDIAN RESERVATION

WHEREAS, Becky Ethelbah on behalf of Johns Hopkins University, Pathways, has approached the Tribal Council this date with a request that the Tribal Council approve the Pathways manuscript for publication: *"How Closely do School Menus and Recipes Reflect Nutrient Intakes of Children at School Lunch? Results from the Pathways Study";* and

WHEREAS, this manuscript compares estimates of nutrients intake at school lunch from menu/recipes analysis with those obtained from direct observation of second-grade children eating school lunch; and

WHEREAS, the Tribal Council concludes that it should grant approve to have this manuscript published.

BE IT RESOLVED by the Tribal Council of the White Mountain Apache Tribe that it hereby approves for publication of Pathways Manuscript, *"How Closely do School Menus and Recipes Reflect Nutrient Intakes of Children at School Lunch? Results from the Pathways study."*

The foregoing resolution was on June 7, 2001, duly adopted by a vote of EIGHT for and ZERO against by the Tribal Council of the White Mountain Apache Tribe, pursuant to authority vested in it by Article IV, Section 1 (a), (g), (s), (t) and (u) of the Constitution of the Tribe, ratified by the Tribe on September 30, 1993, and approved by the Secretary of the Interior on November 12, 1993, pursuant to Section 16 of the Act of June 18, 1934 (48 Stat. 984).

Dallas Massey, Sr.
Chairman of the Tribal Council

Cyndy Harvey-Burnette
Secretary of the Tribal Council

How closely do school menus and recipes reflect nutrient intakes of children at school lunch? Results from the Pathways study.

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Running head: Nutrient Intakes at Lunch

Abstract

Objectives.
This study compared estimates of nutrient intake at school lunch from menu/recipe analysis with those obtained from direct observation of second-grade children eating school lunch.

Methods.
Menus, recipes, and labels from vendor products were collected from 41 schools on seven American Indian reservations. Random samples of 15-18 second-grade children drawn from each school were observed eating school lunch and plate waste was recorded. Matched menu/recipe data and meal observation data were available for 632 children. Nutrient analyses were done using the Nutrition Data System for Research (NDS-R) software. Mixed models were developed to estimate the validity and reliability of the menu/recipe data to represent actual nutrient intakes at the school level and the child level.

Results.
Menu/recipe analysis significantly over estimates mean nutrient intakes from observation for all the nutrients examined, except macronutrients expressed relative to energy intake. Intraclass correlation coefficients (R) between menu/recipe analysis and observation at the child level are low to moderate, ranging from 0.52 for saturated fat to 0.71 for folate. At the school level, values of R are higher and range from 0.70 for saturated fat to 0.96 for folate.

Conclusions.
The estimates of mean nutrient intake of American Indian children in the second grade using menu/recipe analyses were found to significantly overestimate their actual nutrient intakes for almost all nutrients studied. The results indicate that it may be inappropriate to make child-level inferences of actual intakes of children from menu/recipe analyses. It may be appropriate, however, to make school-level inferences of actual intakes of children from menu/recipe analyses, with a consideration of some likely biases in mean levels.

Introduction

School meals are a crucial part of the regular nutrition of over 25 million students who participate in school lunch programs.[1] Also, the analysis of school menus and recipes has become important in public health research and practice. Researchers have used careful analyses of the vendor products, menus, recipes, and standard portion sizes used by school food services to evaluate school-based interventions,[2,3] and to evaluate the content and nutrient composition of school meals.[4] For example, Osganian et al.[2] found a reduction of 4.1% calories from fat in school lunches associated with the CATCH Eat Smart Food Service intervention, based on menu/recipe analyses. The US Department of Agriculture (USDA) has issued regulations requiring all schools in the United States that participate in the National School Lunch Program to certify that they are meeting nutrient standards, based on analyses of school menus and recipes over a five-day period.[1]

Using menus and recipes is attractive because it requires less effort and expense than conventional approaches to estimate dietary intake of individual children, e.g., 24-hour dietary recalls, food records, etc. Nevertheless, a tacit assumption in most applications of menu/recipe analysis is that it represents a reasonable proxy for the nutrient consumption of children who eat the meals associated with the menus and recipes. Obviously, if children do not eat everything that is served, menu/recipe analysis may over estimate actual nutrient intakes. Food brought from home, however, would not be included in most analyses of menus and recipes. We are not aware of any studies that have directly compared nutrient estimates from menu/recipe analysis with objective measures of dietary intake in children. Clearly, the results of such a comparison have important implications for the uses and interpretation of menu/recipe analysis in schools and other institutional settings.

The purpose of this study was to compare estimates of nutrient intake from menu/recipe analysis with corresponding estimates obtained from direct observation of children eating school lunch. Direct observation was chosen as the criterion method because it has been shown to be objective and reliable.[5,6] In the present communication we report results obtained from the Pathways study, a multi-site intervention for primary prevention of obesity in American Indian children.[7]

Methods

The analyses are based on data collected at baseline for the Pathways study.[8] The sample includes second-grade children, attending 41 schools on seven American Indian reservations. Because the data are from baseline observations, none of the schools or children had received any intervention at the time of data collection. All research procedures were approved by Institutional Review Boards at each participating University, and by each appropriate tribal or school authority dealing with human subjects.

For each school, labels for vendor products, menus, and recipes were collected for a five-day period, following a protocol similar to that used in the CATCH study.[2] Local food service staff underwent training in how to gather the menu/recipe data. Specific vendor products allowed calculation of nutrients based on that particular product. Recipes included food preparation practices, such as rinsing and draining ground beef, as well as specific ingredients, amounts and yields. Standard serving sizes for each food were collected from the food service staff. A Pathways nutritionist at each site provided review and quality control for the data gathered before sending it to the Nutrition Coordinating Center (NCC) at the University of Minnesota.

The menus, recipes, and vendor products were entered into the Nutrition Data System for Research (NDS-R 4.02, database version 30), a software program developed at NCC. The NDS-R program was used to generate the nutrient composition of the foods served according to how they were prepared at each school. Food items in menus with multiple choices were weighted and averaged according to the actual number of items served, e.g., 2% milk and whole milk. The nutrient composition of the foods served at each school was then used to analyze the nutrient intakes of the children who were observed eating lunch during one of the five days when menus and recipes were collected.

The protocol for direct observation of children eating lunch was similar to that of Gittelsohn et al.[5] Pathways school lunch observers were trained and certified centrally. Certification involved passing a visual portion-size estimation test (total mean absolute error not to exceed 20%), and a "real-life" test. For the latter test, the trainees observed 2-3 children eat a school lunch (in non-study schools), and their data were compared with a "gold-standard" observer. Lunch observations were conducted on at least two days in each school. A standard tray was used at each lunch, as a basis of expected food choices and serving sizes. Each observer observed 1-3 children at lunch as inconspicuously as possible and visually estimated the types and amounts of food served and eaten by the child. Observers recorded any modifications (food sharing, second helpings, spillage, etc.), and then measured plate waste using standardized measurement utensils. After every 20-25 observations, each observer co-observed a child with a gold-standard observer. Significant variation from the gold standard required the observer to undergo additional training and to be recertified. Data were checked by a field supervisor and then sent to NCC for coding and analysis.

For lunch observation, 15-18 children were selected randomly in each school from among those whose parents had provided consent. To be included in the analyses, children needed to have a lunch observation on a day for which there were corresponding school menu/recipe data. This criterion yielded data for 632 children, with 304 girls and 328 boys; schools and genders were pooled for the analyses.

Thirteen nutrients and nutrient ratios were selected for analysis as examples of macronutrients, minerals, and vitamins. Most of the nutrient intakes had frequency distributions that were approximately Gaussian. Intakes of vitamin A, vitamin C, and folate, however, required transformation into natural logarithms to approximate normality for calculation of the intraclass correlations and for tests between means.

The data were analyzed using a mixed model: $\mathbf{y}_{ij} = {}_{ij} + {}_{1}\mathbf{x}_{1ij} + \mathbf{b}_{j\,(i)} + \mathbf{e}_{ij}$, where **y** is the nutrient of interest, **x** is the fixed effect, type of data (observation or menu/recipe), **b** is the random effect of school within type, and **e** is the random error. It was assumed that $\mathbf{e}_{ij}$~$\mathbf{N(O, e^2)}$ and $\mathbf{b}_{j(i)}$ ~$\mathbf{N(O, b^2)}$. Analyses were conducted using PROCMIXED in the Statistical Analysis System.[9] We assume that the intraclass correlations between observation and menu/recipe analyses did not differ across schools.

The data were analyzed two ways. First, we analyzed mean nutrient intakes from lunch observations and mean menu nutrients within schools. This school-level analysis is important for answering questions regarding the validity of using menu/recipe data to represent child intakes aggregated to a school level. Secondly, we analyzed the data with student as an additional random variable so that the results represent child-level comparisons. The child-level analyses address the question of validity of using menu/recipe data to represent the intakes of individual children. For final tests between means, the most appropriate models for each nutrient were used, either assuming equal variance or unequal variance, based on comparisons using –2 log likelihoods from separate logistic models. The intraclass correlations comparing menu/recipe and observed data were calculated for both the school-level and child-level models.

Results

The unadjusted means and standard deviations for 13 nutrients and nutrient ratios from the menu/recipe analysis and the direct observations are presented in Table 1. Generally, the unadjusted

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means from the menu/recipe analyses are greater than those obtained from direct observation. The exception to this pattern are mean percent calories from fat and saturated fat, where the means are very similar between methods.

With the appropriate data transformations and full analytic models applied, the resultant mean differences and statistical significance of differences for school-level results are presented in Table 2. Analysis using child-level models and other micronutrients yielded similar results (data not shown). The mean differences in Table 2 are estimates of the average bias in using menu/recipe data to represent actual intakes of children, and the standard errors of the differences are estimates of the associated random error. It is clear from Table 2 that the menu/recipe analysis significantly overestimates mean nutrient intakes for almost all nutrients examined when compared with the data from direct observations, except for the total fat and saturated fat ratios expressed relative to energy. Similar lack of significant differences were observed for percent calories from carbohydrates and protein (data not shown). This lack of significant differences between menu/recipe analysis and direct observations for percent of calories from fat and other macronutrient ratios indicate that the differences between the results of the two methods are fairly uniform relative to the macronutrient density of the food served. .

A summary measure of the validity and reliability of menu/recipe data relative to direct observation is the intraclass correlation coefficient (R). This measure takes account of both systematic and random errors. Intraclass correlations are presented at the child level and school level in Table 3. At the

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child level, values of R are low to moderate, ranging from 0.52 for saturated fat to 0.71 for folate. These coefficients mean, for example, that about 52% of the variation between children in directly observed saturated fat intake can be captured using menu/recipe analysis. The child-level coefficients indicate that, in general, menu/recipe analyses are not satisfactory for child-level inference of actual nutrient intakes at school lunch. The relatively low values of child-level R for percent fat calories and percent saturated fat calories (0.57, 0.62), even though there is no significant bias relative to observation (Table 2), indicate that the lesser validity results from additional random error rather than bias.

At the school-level, menu/recipe data provide quite good representations of actual nutrient intakes based on direct observation. Values of R range from 0.70 for saturated fat to 0.96 for folate. These levels of validity and reliability of menu/recipe data indicate that they may be used appropriately for school-level inferences, as long as the systematic biases (Table 2) are taken into consideration in the interpretation of results. School-level inferences about intakes of saturated fat and dietary energy are the least valid in this population.

Discussion

The current sample and analyses indicate that there is significant bias in menu/recipe data, such that they systematically over estimate the absolute intakes of nutrients at school lunch. The most obvious and probable reason for the bias is that children eat less than they were served. To the degree that this is so, the lack of significant differences in the nutrient ratios relative to energy suggest that the children do not systematically exclude high-fat or low-fat foods. Possible alternative explanations are that children routinely refused items offered, that they traded away foods unobserved, or that average servings to children were systematically less than the recipe yields and the standard tray. Differences between menu/recipe data and meal observation should not be due to children systematically choosing items with less nutrient density because the menu data were weighted for choice items according to actual items served. We cannot determine the exact sources of bias from the current analyses.

While it is not surprising that children's intakes, on the average, are less than standard servings offered, the exact differences from observed intakes have not been documented previously. Clearly, the relative importance of the observed bias relative to intakes depends on the particular population studied and how estimated intakes from menu/recipe analyses are used.

The USDA regulations for certification of school lunch programs[1] stipulate that lunches should provide 33% of the RDA[10] for eight nutrients, and that they do not exceed 30% of calories from total fat and 10% of calories from saturated fat. If the unadjusted means in Table 1 were used to certify, collectively, the Pathways schools according to the USDA criteria, one would obtain the results in Figure 1, expressed as percentage of the USDA standards for school lunch .

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Based on the results from the menu/recipe analyses, the USDA criteria for the six nutrients, excluding total and saturated fat and their energy ratios, were easily met. Based on the menu/recipe data, fat, saturated fat, and their energy ratios, however, exceeded the USDA criteria for limiting fat intake. If the observed nutrient intakes were the basis of judging compliance with the USDA standards, energy intake would be considered inadequate and the absolute amount of total fat would be within the established USDA standard limits. The current data are an example of how the systematic differences in results from the two methodologies may yield different conclusions.

This study had several features that enhanced the quality of data. Lunch observers had a high level of centralized training and certification, and food service personnel were trained using standardized protocols. Any reporting bias of menu/recipe data by food service workers would not have affected the current results because nutrients were calculated for direct observations using the same information. Direct observation of the children is a strong method for comparison with menu/recipe analysis because it is unbiased by children's recall or recording.[5] By using the actual menus, recipes, and vendor products at each school and the NDS-R software, we believe our estimates of nutrients and nutrient ratios are objective and valid.[11]

The Pathways study was carried out in American Indian children in the second grade. The participating schools were almost all public schools. We have no reason to believe that these American Indian children and the participating school food services are predictably different than others elsewhere. Nevertheless, because of the lack of comparable data for other children, it is unknown to what degree these results are generalizable to other ethnic groups, to older children, or to other settings. For example, it may be that older children eat relatively more or less of what they are served at school lunch. Certainly, other studies should be carried out in older children and in other institutional settings.

In summary, the estimates of mean nutrient intake of American Indian children in the second grade using menu/recipe analyses were found to significantly overestimate their actual nutrient intakes for almost all nutrients studied. These results indicate that it may be inappropriate to make child-level inferences of actual intakes of children from menu/recipe analyses. It may be appropriate, however, to make school-level inferences of actual intakes of children from menu/recipe analyses, with a consideration of some likely biases in mean levels. These results should be considered by researchers and institutions when interpretations of menu/recipe analysis are made relative to actual nutrient intakes.

Acknowledgements

Appreciation is extended to the many Pathways field staff who helped to collect the data. Special thanks are extended to tribal authorities and school staff who were partners in the Pathways study. This study was supported by grants from the National, Heart, Lung and Blood Institute of the National Institutes of Health in Bethesda, Maryland.

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Table 1. Unadjusted means for nutrient intakes from menu/recipe and direct observation.

	Menu/recipe		Observed	
Nutrient	**Mean**	**SD**	**Mean**	**SD**
Energy (kcal)	698	151	535	150
Carbohydrate (gm)	86.1	20.9	64	18.9
Protein (gm)	32.6	25.8	26.6	7.9
Fat (gm)	25.9	10.6	20.2	8.1
Fat calories (%)	32.7	8.1	32.9	7.4
Saturated fat (gm)	9.5	3.5	7.6	3.3
Saturated fat calories (%)	12.2	3.4	12.3	3.5
Vitamin A (mcg RE)	379	245	261	137
Vitamin C (mg)	34.9	27.3	23.8	18.8
Folate (mcg)	90.9	53.9	62.8	39.6
Calcium (mg)	471	126	346	137
Iron (mg)	4.6	1.3	3.5	1.3
Zinc (mg)	4.3	1.5	3.4	1.4

Table 2. Mean differences between direct observations and menu/recipe analysis for nutrient intakes, modeled for study design to indicate school-level intakes, and using transformed variables

Nutrient	Mean difference	SE difference	t
Energy (kcal)	160	25.8	6.16 ***
Carbohydrate (gm)	21.6	3.31	6.53 ***
Protein (gm)	6.62	1.22	5.42 ***
Fat (gm)	5.61	1.53	3.64 ***
Fat calories (%)	- 0.17	1.23	- 0.13
Saturated fat (gm)	1.90	0.61	3.13 **
Saturated fat calories (%)	-0.13	0.55	-0.24
Vitamin A (ln mcg RE)	0.41	0.09	4.61 ***
Vitamin C (ln mg)	0.39	0.11	3.62 ***
Folate (ln mcg)	0.38	0.07	5.54 ***
Calcium (mg)	122	21.4	5.75 ***
Iron (mg)	1.02	0.22	4.72 ***
Zinc (mg)	0.96	0.22	4.26 ***

** $p \leq 0.01$

*** $p \leq 0.001$

Table 3. Intraclass correlation coefficients (R) between nutrient intakes from direct observations and menu/recipe analyses, calculated for child-level and school-level inference.

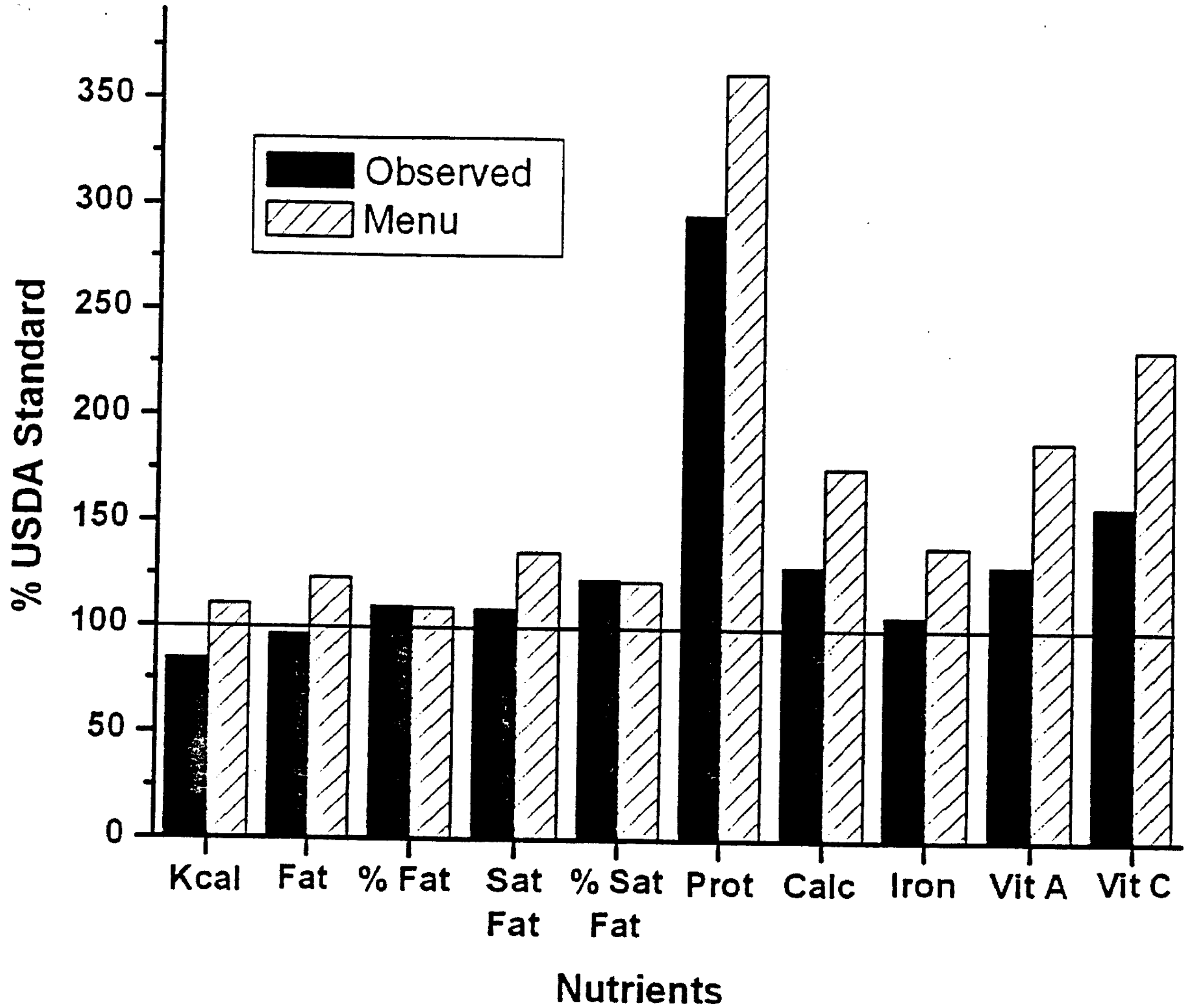
Nutrient	Child-level R *	School-level R **
Energy (kcal)	0.62	0.77
Carbohydrate (gm)	0.62	0.84
Protein (gm)	0.70	0.83
Fat (gm)	0.55	0.88
Fat calories (%)	0.57	0.93
Saturated fat (gm)	0.52	0.70
Saturated fat calories (%)	0.62	0.91
Vitamin A (mcg RE)	0.58	0.80
Vitamin C (mg)	0.60	0.92
Folate (mcg)	0.71	0.96
Calcium (mg)	0.69	0.88
Iron (mg)	0.63	0.83
Zinc (mg)	0.64	0.93

* 95% CI ≈ ± 0.08

** Calculations of 95 % CI for the school-level model were unstable because of the study design, but CI≈ ± 0.17, except for the upper limits when R > 0.83.

Figure legend

Figure 1: Percentage of USDA (1995) standard (grades K-3 option), based on unadjusted means of nutrient intakes from menu/recipe data and from direct observation of children eating school lunch.



350
300
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200
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50
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% USDA Standard
Observed
Menu
Kcal
Fat
% Fat
Sat Fat
% Sat Fat
Prot
Calc
Iron
Vit A
Vit C
Nutrients