Dietary Screener in the 2005 California Health Interview Survey

(CHIS 2005)

November 2019

THE DIETARY SCREENER: CHIS 2005

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THE DIETARY SCREENER: CHIS 2005

1. Background

The dietary screener used in the 2005 California Health Interview Survey (CHIS) was derived from the Five-Factor Screener in the 2005 National Health Interview Survey (NHIS) Cancer Control Supplement (CCS). The 2005 CHIS screener asks respondents for information about how frequently they consume foods in 11 categories. No portion size questions are asked.

This screener does not attempt to assess total diet. The questions allow researchers to gather information about intakes of fruits and vegetables and teaspoons of added sugar. Fruit and vegetable intake is quantified using two different metrics. The Pyramid servings metric is based on the 1992 definitions of servings from the Food Guide Pyramid. The cup equivalents metric is based on the 2005 definitions, derived from Dietary Guidelines for Americans.

You can view or print the CHIS 2005 Fruit, Vegetable & Added Sugars Screener from the National Cancer Institute's (NCI) Register of Validated Short Dietary Assessment Instruments.

The 2005 CHIS Diet Screener is composed of QA05_C14 to QA05_C24 of the 2005 CHIS Adult Questionnaire. The following variables in the 2005 CHIS Adult data were derived by the procedures outlined here: FV, FV_ADJ, FVNB, FVNB_ADJ, FVNF, FVNF_ADJ, FVNFB, FVNFB_AD, FVCE, FVCAD, FVCNB, FVCNBAD, FVCNF, FVCNFAD, FVCNFB, FVCNFBAD, SUG, and SUG_ADJ. Note that the variables SUG, SUG_ADJ, FVNB, and FVNB_ADJ were corrected/modified 2/27/2008.

In CHIS 2005, we applied rules for excluding extreme data responses, described in Definition of Acceptable Dietary Data. The process of scoring the individual response data is described in Scoring Procedures. A description and guidelines for the appropriate uses of the screener-estimated dietary intakes is found in Uses of Screener Estimates. Validation data for the CHIS 2005 screener are presented in Validation Results.
NOTE: The dietary variables on the CHIS dataset are in their natural units. For analyses, however, they must be transformed, first, to approximate normal distributions. For servings of fruits and vegetables and cup equivalents of fruits and vegetables, use the square root transformation; for teaspoons of added sugar, use the cube root transformation. After analyses, the result variables can be back-transformed for easier interpretation.

2. Definition of Acceptable Dietary Data Values

Data collected in the 2005 CHIS Screener are coded by frequency and time unit -- times per day, week, or month. We used the United States Department of Agriculture's (USDA) 1994-

96 Continuing Survey of Food Intakes of Individuals (CSFII) data on reported intakes over two days of 24-hour recall to make judgments about reasonable frequencies of consumption that were reported on a per day basis. This helped us assess values from the CHIS Screener, some of which are highly unlikely.

Maximum daily average frequencies (averaged for each individual across the two days of report) in the CSFII ranged from 1.5 times to 12 times per day for the relevant food groups. We accepted frequency values that were reported in the CHIS on a per day basis up to the maximum average values (rounded to the next whole number).

Table 2- 1 Maximum acceptable daily average frequencies

Food Group	Maximum Daily Acceptable Value
Fruit	12
Salad	5
Fried potatoes	3
Other white potatoes	3
Dried beans	3
Other vegetables	9
100% fruit juice	4
Soda	6
Fruit drinks	6
Ice cream	3
Cookies, cake, pie	5

In addition, we applied judgment to determine the acceptability of frequency reports for the weekly and monthly time periods (see below). For example, a report of 25 times may be most logically associated with a month or year time period, but not so logically associated with a week time period. We applied this judgment to all foods.

Table 2- 2 Acceptable weekly and monthly frequency reports

Time Period	Acceptable Frequency
Week	≤ 14 / week: acceptable > 14: assign a missing value
Month	≤ 60 / month: acceptable > 60: assign a missing value

Depending on the intent of the analysis, a researcher can exclude a person with a missing value for any of the 11 foods, or with missing values only on foods needed to estimate a particular dietary intake variable. In our analyses of CHIS data, we excluded individuals only for the dietary variable for which they had missing food-level data.

3. Scoring Procedures

How analytical scoring procedures were developed

Scoring procedures were developed to convert the individual respondent's screener responses to estimates of individual dietary intake for servings of fruits and vegetables and teaspoons of added sugar using USDA's 1994-96 Continuing Survey of Food Intakes of Individuals (CSFII) dietary recall data.

For servings of fruits and vegetables:

$$E(\text{Fruits and Veg}^{1/2}) = b_0 + b_1(N_{FG1}P_1 + N_{FG2}P_2 + \ldots + N_{FG7}P_7)^{1/2}$$

Servings of fruits and vegetables was square-root-transformed to approximate normality; N_{FGk} is the usual number of times per day an individual consumed food group k; k indexes the 7 fruit and vegetable food groups. Pk is the median portion size of group k. We calculated weighted least-squares estimates of the regression coefficients b0 and b1 on the adults (aged 18 and above) in the CSFII 94-96 sample, stratifying by gender and excluding extreme exposure values.

Estimating intake at the individual level

After excluding extreme and missing values, we performed the following steps with the CHIS dietary data to estimate the individual's intake of servings of fruits and vegetables.

1. **Estimation of N_{FGk}:** All reported frequencies were standardized to a common unit of time by converting them to daily frequencies.

Table 3- 1 Estimation of the usual number of times per day (daily frequency) of intake of food groups

Time Period Reported	N_{FGk}: Daily Frequency
Day	As reported
Week	Reported frequency divided by 7
Month	Reported frequency divided by 30

For Fruit and Vegetable Intake:

2. **Estimation of P_k:** The median age- and gender-specific portion sizes for each food were estimated from CSFII 94-96. The units were in Pyramid servings (Table 3-2).

   A Pyramid serving is defined by the U.S. Department of Agriculture in the 1992 Dietary Guidelines Food Guide Pyramid as:
   - vegetables: 1 cup raw leafy, 1/2 cup of other vegetables, or 3/4 cup vegetable juice; and
   - fruit: 1 whole fruit, 1/2 cup of cut-up fruit, or 3/4 cup fruit juice.

   More recently, the 2005 Dietary Guidelines measure fruits and vegetables in cup equivalents.

   Both metrics are provided for these 2005 data.

Table 3- 2 Median Portion Size (Pk) in Pyramid Servings*per Mention by Gender and Age for Fruits and Vegetables Analyses

Food Group	Age Group						
	18-27	28-37	38-47	48-57	58-67	68-77	78-99
Men							
100% fruit juice (P_1)	2.000000	1.667500	1.335000	1.335000	1.334000	1.001000	1.001000
Fruit (P_2)	1.301000	1.301000	1.229571	1.227333	1.168000	1.168000	1.052333
Salad (P_3)	0.545000	0.708000	0.754500	0.750000	0.833500	0.750000	0.822500
Fried potatoes (P_4)	2.000000	2.000000	1.773000	1.710000	1.400000	1.250000	1.250000

Food Group	Age Group						
	18-27	28-37	38-47	48-57	58-67	68-77	78-99
Other white potatoes (P_5)	2.000000	2.000000	1.999000	1.999000	1.914000	1.544000	1.508000
Dried beans (P_6)	1.374000	1.047000	1.065000	1.227000	1.000000	1.000000	1.114000
Other vegetables (P_7)	0.750000	0.906000	0.974500	1.000000	1.000000	0.880000	0.833333
Women							
100% fruit juice (P_1)	1.500500	1.334000	1.334000	1.251250	1.019500	1.000500	1.000500
Fruit (P_2)	1.168000	1.168000	1.168000	1.168000	1.150500	1.083833	1.000000
Salad (P_3)	0.613500	0.572500	0.833333	1.000000	0.795500	0.625000	0.750000
Fried potatoes (P_4)	1.481000	1.365500	1.272000	1.400000	1.000000	1.026000	1.000000
Other white potatoes (P_5)	1.544000	1.544000	1.528000	1.544000	1.499000	1.516000	1.272000
Dried beans (P_6)	0.964000	0.684000	0.800000	0.687000	0.822000	0.807000	1.000000
Other vegetables (P_7)	0.702200	0.779333	0.792500	0.788500	0.774000	0.833000	0.856750

* Using 1992 Food Guide Pyramid definitions of servings.

Table 3- 3 Median Portion Size (Pk) in Cup Equivalentsper Mention by Gender and Age for Fruits and Vegetables Analyses**

Food Group	Age Group						
	18-27	28-37	38-47	48-57	58-67	68-77	78-99
Men							
100% fruit juice (P_1)	1.499160	1.250580	1.000980	1.000980	1.000176	0.750735	0.750735
Fruit (P_2)	0.999580	0.933450	0.867300	0.867300	0.867300	0.774916	0.657060
Salad (P_3)	0.272700	0.353970	0.377235	0.374963	0.416640	0.375000	0.411323
Fried potatoes (P_4)	0.721125	0.727700	0.641000	0.641000	0.548055	0.480750	0.499980
Other white potatoes (P_5)	1.000400	1.140030	0.999600	0.999600	0.999490	0.833175	0.754400
Dried beans (P_6)	0.717550	0.551540	0.566720	0.612360	0.500250	0.502285	0.575360
Other vegetables (P_7)	0.387675	0.473920	0.499840	0.500240	0.499905	0.460585	0.416899
Women							
100% fruit juice (P_1)	1.124370	1.000960	1.000176	0.938130	0.764776	0.750728	0.750434
Fruit (P_2)	0.749235	0.867300	0.844838	0.789970	0.742350	0.712640	0.620475
Salad (P_3)	0.306788	0.286335	0.416625	0.499950	0.397688	0.312469	0.374963
Fried potatoes (P_4)	0.509595	0.455110	0.448700	0.448700	0.394856	0.444260	0.444260
Other white potatoes (P_5)	0.782020	0.876945	0.771260	0.771260	0.749700	0.771260	0.644235

Food Group	Age Group						
	18-27	28-37	38-47	48-57	58-67	68-77	78-99
Dried beans (P_6)	0.492150	0.341550	0.430530	0.345763	0.430685	0.430530	0.500400
Other vegetables (P_7)	0.364468	0.395882	0.404303	0.408330	0.416913	0.436560	0.452214

** Using 2005 MyPyramid definitions of cups of fruits and vegetables.

3. For Pyramid servings of **fruits and vegetables**, *estimation of b_0 and b_1*:

The model is: $E(\text{Dietary Factor}^{1/2}) = b_0 + b_1(N_{FG1}P_1 + N_{FG2}P_2 + \ldots + N_{FG7}P_7)^{1/2}$

For Pyramid servings of fruits and vegetables, including and excluding French fries and dried beans, for each gender, the estimates of the parameters are:

Table 3- 4 Estimated Regression Coefficients for Sum of Foods Predicting Pyramid Servings*of Different Versions of Daily Servings of Fruits and Vegetables, by Gender

Parameter	Men	Women
Summary Variable with French fries		
Intercept (b_0)	0.906793	0.819559
b_1	0.758560	0.730865
Summary Variable excluding French fries		
Intercept (b_0)	0.940772	0.816265
b_1	0.739056	0.730219
Summary Variable excluding French fries and beans		
Intercept (b_0)	0.950228	0.813568
b_1	0.723395	0.723230
Summary Variable excluding beans		
Intercept (b_0)	0.884786	0.813994
b_1	0.761347	0.726001

* Using 1992 Food Guide Pyramid definitions of servings.

Table 3- 5 Estimated Regression Coefficients for Sum of Foods Predicting Different Versions of Daily Cup Equivalents of Fruits and Vegetables, by Gender**

Parameter	Men	Women
Summary Variable with French fries		
Intercept (b_0)	0.666228	0.611844
b_1	0.770652	0.733890
Summary Variable excluding French fries		
Intercept (b_0)	0.706696	0.616033
b_1	0.742255	0.727761
Summary Variable excluding French fries and beans		
Intercept (b_0)	0.719659	0.618209
b_1	0.723629	0.718681
Summary Variable excluding beans		
Intercept (b_0)	0.671443	0.613051
b_1	0.758684	0.725692

** Using 2005 MyPyramid definitions of cups of fruits and vegetables.

For teaspoons of added sugar:

4. **Estimation of P_k**: The median age- and gender-specific portion sizes in grams for each food were estimated from CSFII 94-96 (Table 3-6).

Table 3- 6 Median Portion Size (Pk) in Teaspoons*per Mention by Gender and Age for Added Sugar Analyses**

Food Group	Age Group						
	18-27	28-37	38-47	48-57	58-67	68-77	78+
Men							
Regular soda (P_1)	11.246397	9.221880	9.221880	9.221880	9.214440	9.125268	9.115360
Fruit drinks (P_2)	10.600000	8.636250	8.565000	8.565000	6.276880	5.700512	5.540320
Cookies, cake, pie (P_3)	5.083032	4.762847	4.582705	4.426306	4.552020	4.216712	3.761836
Ice cream (P_4)	7.046725	5.905380	6.783700	5.858650	5.858650	4.759920	3.478629
Women							
Regular soda (P_1)	9.221880	9.221880	9.184695	9.125268	8.041256	7.684900	9.120314
Fruit drinks (P_2)	8.246250	7.773757	6.276880	6.218740	6.251570	5.353125	5.300000
Cookies, cake, pie (P_3)	3.945000	3.533487	3.649440	3.595380	3.866728	3.315540	3.027309
Ice cream (P_4)	5.858650	5.546760	5.814600	4.933600	4.560570	3.920450	3.920450

*** Using 2005 MyPyramid database.

5. For teaspoons of **added sugar**, *estimation of b_0 and b_1*:

The model is: $E(\text{Dietary Factor}^{1/3}) = b_0 + b_1(N_{FG1}P_1 + N_{FG2}P_2 + \ldots + N_{FG4}P_4)^{1/3}$

For teaspoons of added sugar, estimates of the parameters are:

Table 3- 7 Estimated Regression Coefficients for Sum of Foods Predicting Teaspoons of Added Sugar*, by Gender**

Parameter	Men	Women
Intercept (b_0)	1.566813	1.481876
b_1	0.555082	0.514735

*** Using 2005 MyPyramid database.

4. Uses of Screener Estimates in CHIS

Introduction

Dietary intake estimates from CHIS Diet Screener are rough estimates of usual intake of fruits and vegetables and added sugar. They are not as accurate as more detailed methods (e.g. 24-hour recalls). However, Validation Results suggests that the estimates may be useful to characterize a population's median intakes, to discriminate among individuals or populations with regard to higher vs. lower intakes, to track dietary changes in individuals or populations over time, and to allow examination of interrelationships between diet and other variables. In addition, diet estimates from the CHIS could be used to augment national data using similar methods.

Variance-Adjustment Factor

What is the variance adjustment estimate and why is it needed?

Data from the CHIS Diet Screener are individuals' reports about their intake and, like all self-reports, contain some error. The algorithms we use to estimate servings of fruits and vegetables and added sugar calibrate the data to 24-hour recalls. The screener estimate of intake represents what we expect the person would have reported on his 24-hour recall, given what he reported on the individual items in the screener. As a result, the mean of the screener estimate of intake should equal the mean of the 24-hour recall estimate of intake in the population. (It would also equal the mean of true intake in the population if the 24-

hour recalls were unbiased. However, there are many studies suggesting that recalls underestimate individuals' true intakes).

When describing a population's distribution of dietary intakes, the parameters needed are an estimate of central tendency (i.e., mean or median) and an estimate of spread (i.e., variance). The variance of the screener, however, is expected to be smaller than the variance of true intake because the screener prediction formula estimates the conditional expectation of true intake given the screener responses, and in general, the variance of a conditional expectation of a variable X is smaller than the variance of X itself.

As a result, the screener estimates of intake cannot be used to estimate quantiles (other than median) or prevalence estimates of true intake unless it is first adjusted so that it has approximately the same variance as true intake.

When is it appropriate to use variance adjustment estimates?

The appropriate use of the screener information depends on the analytical objective.

Table 4- 1 Suggested procedures for various analytical objectives

Analytical Objective	Procedure
Estimate mean or median intake in the population or within subpopulations.	Use the unadjusted screener estimate of intake.
Estimate quantiles (other than median) of the distribution of intake in the population; estimate prevalence of attaining certain levels of dietary intake.	Use the variance-adjusted screener estimate.
Classify individuals into exposure categories (e.g., meeting recommended intake vs. not meeting recommended intake) for later use in a regression model.	Use the variance-adjusted screener estimates to determine appropriate classification into categories.
Use the screener estimate as a continuous covariate in a multivariate regression model.	Use the unadjusted screener estimate.

How were the variance adjustment factors estimated?

We developed procedures to estimate the variance of true intake using data from 24-hour recalls, by taking into consideration within-person variability[1, 2]. We extended these procedures to allow estimation of the variance of true intake using data from the screener. The resulting variance adjustment factors adjust the screener variance to approximate the variance of true intake in the population.

We used two external validation datasets available to us to estimate the adjustment factors: the Eating at America's Table Study (EATS)[3] and the Observing Protein and Energy Nutrition Study (OPEN)[4]. The results indicate that the adjustment factors differ by gender for each dietary variable. Under the assumption that the variance adjustment factors appropriate to the California Health Interview Survey are similar to those in these external studies, the variance-adjusted screener estimates of intake should have variances closer to the estimated variance of true intake than would have been obtained from repeat 24-hour recalls.

Table 4- 2 Estimated variance adjustment factors

Dietary Variable		Variance Adjustment Factors	
		Men	**Women**
Total fruits and vegetables (include French fries and dried beans)	**Pyramid servings**	1.3	1.1
	cup equivalents	1.2	1.1
Fruits and vegetables without French fries	**Pyramid servings**	1.3	1.1
	cup equivalents	1.2	1.1
Fruits and vegetables without dried beans	**Pyramid servings**	1.2	1.1
	cup equivalents	1.2	1.1
Fruits and vegetables without French fries and dried beans	**Pyramid servings**	1.3	1.1
	cup equivalents	1.2	1.1
Added sugar (tsp)		1.5	1.3

How are the variance adjustment factors applied?

Adjust the screener estimate of intake by:

Multiplying intake by an adjustment factor (an estimate of the ratio of the standard deviation of true intake to the standard deviation of screener intake); and adding a constant so that the overall mean is unchanged.

The formula for the variance-adjusted screener is:

variance-adjusted screener = (variance adjustment factor)*(unadjusted screener – mean $_{\text{unadj scr.}}$) + mean $_{\text{unadj scr.}}$

This procedure is performed on the normally distributed version of the variable (i.e., Pyramid servings of fruits and vegetables is square-rooted; teaspoons of added sugar is cube-rooted). The results can then be back-transformed to obtain estimates in the original units.
A similar variance adjustment procedure is used to estimate prevalence of intakes for the 2000 NHIS [5].

Attenuation of Regression Parameters Using Screener Estimates

When the screener estimate of dietary intake is used as a continuous covariate in a multivariate regression, the estimated regression coefficient will typically be attenuated (biased toward zero) due to measurement error in the screener. This "attenuation factor"[6] can be estimated in a calibration study and used to deattenuate the estimated regression coefficient (by dividing the estimated regression coefficient by the attenuation factor).

Table 4- 3 Estimated attenuation factors in the EATS and OPEN

Dietary Variable		Attenuation factors for screener-predicted intake	
		Men	Women
(Square-root) Total fruits and vegetables	Pyramid servings	0.81	0.66
	cup equivalents	0.79	0.63
(Square-root) Fruits and vegetables without French fries	Pyramid servings	0.87	0.69
	cup equivalents	0.84	0.65
(Square-root) Fruits and vegetables without dried beans	Pyramid servings	0.78	0.65
	cup equivalents	0.78	0.63
(Square-root) Fruits and vegetables without French fries and dried beans	Pyramid servings	0.85	0.69
	cup equivalents	0.83	0.65
(Cube-root) Added sugar		0.95	0.89

If the screener values are categorized into quantiles and the resulting categorical variable is used in a linear or logistic regression, the bias (due to misclassification) is more complicated because the categorization can lead to differential misclassification in the screener [7]. Although methods may be available to correct for this [8, 9], it is not simple, nor are we comfortable suggesting how to do it at this time.

Even though the estimated regression coefficients are biased (due to measurement error in the screener or misclassification in the categorized screener), tests of whether the regression coefficient is different from zero are still valid. For example, if one used the SUDAAN REGRESS procedure with fruit and vegetable intake (estimated by the screener) as a covariate in the model, one could use the Wald F statistic provided by SUDAAN to test whether the regression coefficients were statistically significantly different from zero. This assumes that only one covariate in the model is measured with error; when multiple covariates are measured with error, the Wald F test that a single regression coefficient is zero may not be valid, although the test that the regression coefficients for all covariates measured with error are zero is still valid

5. Validation Results

Staff in NCI's Risk Factor Assessment Branch (RFAB) assessed the validity of the CHIS Diet Screener in the Eating at America's Table Study (EATS)[3] and the Observing Protein and Energy Nutrition Study (OPEN) [4]. In these studies, multiple 24-hour recalls in conjunction with a measurement error model were used to assess validity. The screeners used in these studies were similar but not identical to that used in CHIS 2005. We have constructed similar questions from the data available and the scoring algorithms developed specifically for CHIS. For added sugar, questions answered on the Diet History Questionnaire administered in both studies were used as proxies for some of the screener items.

Table 5- 1 Estimates of total Pyramid Servings of fruits and vegetables and teaspoons of added sugar in EATS and OPEN

	Men (median intake)		Women (median intake)	
	Recall	Screener	Recall	Screener
Total fruits and vegetables (Pyramid servings)				
EATS	5.8	5.5	4.3	4.6
OPEN	6.2	5.3	5.2	4.7
Total fruits and vegetables (cup equivalents)				
EATS	3.38	3.24	2.43	2.66
OPEN	3.60	3.13	3.09	2.75
Added sugar				
EATS	17.5	18.1	12.3	11.7
OPEN	17.0	17.0	13.0	11.8

These validation results suggest that dietary exposure estimates computed for the CHIS may be useful to compare subgroup means, especially for populations consuming mainstream diets. The estimates may be less useful for populations with ethnic diets, including Asian and possibly Latino populations.

Table 5- 2 Correlations between the screener and estimated true intake for servings of fruits and vegetables and added sugar at the individual level

	Men	**Women**
Total fruits and vegetables (Pyramid servings)		
EATS	0.67	0.49
OPEN	0.58	0.73
Total fruits and vegetables (cup equivalents)		
EATS	0.70	0.52
OPEN	0.62	0.70
Added sugar		
EATS	0.59	0.66
OPEN	0.69	0.66

Overall, about 25 to 50 percent of the variability in the true intake in fruit and vegetable and added sugar will be captured by the screener questions. Thus, although significant error may be associated with these estimates of diet, we believe the exposure estimates still substantially reflect what individuals are actually consuming.

Validation results for the Multifactor Screener, which includes a similar fruit and vegetable component, are reported in detail in Thompson et al., 2004 [10].

National estimates based on the 2000 NHIS Multifactor Screener are presented and compared with other national data in Thompson et al., 2005 [5].

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