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Health Disparities in Calorie Knowledge and Confidence Among the U.S. Adult Population

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Abstract

Purpose: Obesity prevalence has reached an all-time high in the US, affecting >40% of the population. This study's objective was to evaluate associations between demographics and self-reported calorie knowledge and self-perceived confidence in calorie knowledge ("calorie confidence"). The relationships between body mass index (BMI) and calorie knowledge and confidence were also explored. **Methods:** We analyzed data from participants (n = 2171) in the crosssectional, nationally representative 2019 FDA Food Safety and Nutrition Survey using logistic regression to estimate adjusted odds ratios (AORs) and confidence intervals (95% CIs) for associations between BMI and calorie knowledge (correct/incorrect), calorie confidence (confident/not confident), and demographic characteristics, and the Wald chi square test to evaluate relationships between BMI and both calorie knowledge and confidence. **Results:** Many of the same subgroups were more likely than others to report lack of calorie knowledge and lack of confidence in knowing the typical daily calorie intake needed to maintain a healthy weight [respective AORs (95% CIs): age (years), >60 vs 51-60, 1.7 (1.1-2.5), and 1.4 (1.0-2.0); sex, male vs female, 1.7 (1.3-2.3), and 1.7 (1.3-2.1); race/ethnicity, non-Hispanic Black vs non-Hispanic white, 3.4 (2.1-5.5), and 2.4 (1.6-3.8); education, ≤high school vs college grad, 1.5 (1.0- 2.3), and 1.9 (1.3-2.7)]. BMI was significantly correlated with calorie confidence ($P = .047$), such that those reporting less confidence were more likely overweight or obese [underweight/healthy (BMI < 25): 29%, overweight (25 ≤ BMI < 30): 34%, obese (BMI ≥ 30): 37%]. **Conclusion:** In certain demographic subgroups associations between calorie knowledge and confidence differed. Tailored education and outreach for these groups may help to address these disparities.

Keywords

obesity, calorie knowledge, calorie confidence, disparities, consumer survey

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Introduction

The prevalence of obesity in the United States has risen dramatically in the past 2 decades. Between 1999 to 2000 and 2017 to 2018 the percent of the U.S. population aged 20 and over considered obese increased 39%, from 30.5% to 42.4%.[1] Disparities in obesity prevalence vary across racial/ethnic groups and socio-economic status, with the highest prevalence among non-Hispanic Blacks (49.6%), Hispanics (44.8%), and non-Hispanic whites (42.2%), and those of low socio-economic status (SES) and education levels.[2] Some sociodemographic groups are at higher risk of obesity-related complications including heart disease, stroke, type 2 diabetes, and premature death,[3] highlighting the need to study obesity at a more granular level.

Knowledge of recommended daily calorie intake can be helpful for maintaining a healthy weight.[4] The 2015 to 2020 Dietary Guidelines for Americans (DGA), estimates that based on an individual's age and physical activity level, the average healthy adult woman and man need to consume 1600 to 2400 and 2000 to 3000 calories per day, respectively, to maintain current weight.[5]

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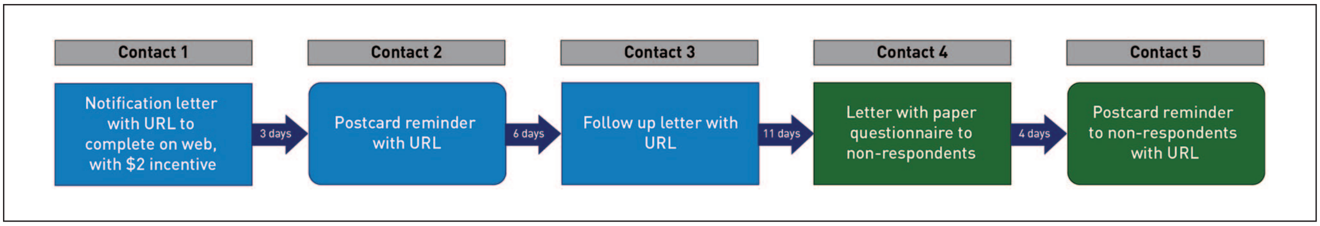

Figure 1. FDA Food Safety and Nutrition Survey data collection flow.

Individuals may more easily achieve and maintain a healthy weight when they have accurate and accessible information about calories. Changes to the U.S. Food and Drug Administration's (FDA) Nutrition Facts label and to the menu labeling provisions of the Federal Food, Drug, and Cosmetic Act (FD&C Act), aim to increase visibility and transparency of nutrition information, including caloric content on food packages and restaurant menus.[6-10] The Nutrition Facts label changes to calorie information include (1) enlarging the text size of calories and serving size to increase distinction; (2) providing an updated and more accurate estimate of calories in a "serving" based on current food consumption; (3) providing calculations of calorie amounts of the entire package for products with <2 servings; (4) providing calorie amounts for both a single serving, as well as the entire contents, on packages for products that can be consumed in 1 or more sittings, that is, between 2 and 3 servings; and (5) replacing the footnote with language that includes information stating that the general nutritional advice is based on a 2000 calorie-per-day diet and defining the use of Percent Daily Value (%DV).[8,9] The requirements for chain restaurants and similar retail food establishments that are subject to the regulation include, but are not limited to, disclosing calorie information on menus and menu boards for standard menu items, and on food displays for self-service items.[10]

This study builds on and adds to prior research about consumer knowledge of daily calorie needs. Previous research has consistently found that at least one-third of respondents estimate their daily needs between 1500 and 3000 calories per day.[4,11-14] A Canadian study also assessed this question and reported similar results.[15] A few of these studies evaluated calorie knowledge by sociodemographic characteristics, finding that men,[4,12,15] non-Hispanic Blacks, and Hispanics,[4,11,13] as well as those with lower income and education[4,11,13,15]—many of the same groups with a greater obesity prevalence—were most likely to incorrectly estimate daily calorie needs. None of these studies has looked at other aspects of calorie consumption, such as calorie confidence.

We expand upon the existing literature by presenting recent findings from the FDA's nationally representative 2019 Food Safety and Nutrition Survey (FSANS) on self-reported calorie knowledge with a focus on sociodemographic characteristics. We simultaneously look at the sociodemographic correlates of confidence in calorie knowledge, and the relationship between calorie knowledge, calorie confidence, and body mass index (BMI).

Methods

Survey Sample

A total of 4398 respondents participated in the 2019 FSANS. Of those, 2171 were assigned to the Nutrition Version.

The respondents for this survey were English- or Spanish-speaking noninstitutionalized adults ($\geq$18 years old) living in the 50 US states and the District of Columbia. Address-based sampling was used to draw a nationally representative sample of households. Respondents within the household were randomly selected using the Hagen-Collier within household sampling scheme to identify 1 random adult.[16]

Each selected household received up to 5 mailings requesting participation in the study.[17] As shown in Figure 1, the first was a notification letter on FDA letterhead introducing the study and providing the information necessary (the URL and a unique personal identification number [PIN] assigned to each selected household) to complete the study by visiting a now defunct FDA website (http://www.fda.gov/foodsurvey/). That first mailing contained 2 $1 bills as a gesture to encourage response and maintain data quality. The second mailing, a thank you/reminder postcard, was sent 3 days after the initial letter, and was followed 6 days later by the third mailing, a second reminder letter. The fourth mailing, sent 20 days after the initial mailing to those who had not yet responded, contained a letter, a survey booklet, and a pre-paid return envelope for respondents to use. Four days after the fourth mailing, researchers sent the fifth and final contact, a mail survey reminder postcard that also included instructions on how to access the web version of the survey. Addresses in zip codes with high density Hispanic populations according to the US Census (20% Hispanic or higher) received 2-sided letters in Contacts 1, 3, and 4 with information in English and Spanish. The American Association for Public Opinion Research (AAPOR) response rate 3 (RR3) was 28.1%.[18]

The FDA survey webpage provided commonly asked questions about the study in both English and Spanish, and a link that routed each participant to the survey host site. (Once on the host site, the respondents entered their assigned PIN to begin the survey.

Each respondent was randomly assigned to 1 of the 2 versions of the survey: Food Safety or Nutrition. Some overlapping questions were asked on both versions. This analysis only used selected questions from the Nutrition version of the survey.

Survey data were weighted to account for sampling design and non-response.[18] Because all the US addresses had the same chance of being selected, the base weights are the same for all the sampled addresses. Base weights were adjusted with data from the sample frame (Census region, single or multi-unit housing), the number of adults per household, and finally with demographic controls from the latest release of the 5-year American Community Survey (ACS) data (2014-2018) for sex, age, race, Hispanic origin, education, Census region, and residence in a metropolitan area.

The study protocol was determined exempt and approved by the institutional review board of the FDA. Data were collected from October 1, 2019 through November 20, 2019.

Survey Design

Prior to the administration of the survey, 3 rounds of 9 cognitive interviews were conducted with potential survey respondents to test and enhance the survey's understandability and to evaluate the survey administration. Additionally, a pilot test was conducted to pretest FSANS data collection procedures. Pretest frequencies were reviewed to asses any items with high item non-response, and responses to "other specify" questions were reviewed to ensure completeness of response item lists.

Survey Variables

Dependent variables. Two dependent response variables were analyzed. The first addressed knowledge of daily calorie needs (hereafter called "calorie knowledge"): "Thinking about yourself, about how many calories do you need to consume in a day to maintain your current weight?" Respondents could choose "Less than 500 calories," "500 to 1000 calories," "1001 to 1500 calories," "1501 to 2000 calories," "2001 to 2500 calories," "2501 to 3000 calories," "More than 3000 calories," or "Don't know." These responses were coded following the convention used in McKinnon et al[4] Correct [1001-3000+ (female), 1501-3000+ calories (male)] or Incorrect [Don't know, ≤1000 calories (female), ≤1500 calories (male)].

The second question addressed self-perceived confidence in calorie knowledge (hereafter called "calorie confidence"): "How confident are you that you know how many calories you should eat each day?" Respondents could choose from "Not at all confident," "Slightly confident," "Somewhat confident," "Very confident," and "Extremely confident." The responses were operationalized into a dichotomous calorie confidence variable, with "Not at all confident" or "Slightly confident" aggregated into the "Not confident" category, and "Somewhat confident," "Very confident," or "Extremely confident" aggregated into the "Confident" category.

Independent variables. Because this study focused on disparities in knowledge and confidence related to calories among demographic subgroups, we systematically explored the effects of demographics on calorie knowledge and calorie confidence. The candidate sociodemographic predictors were sex (Male or Female), age group in years (18-30, 31-50, 51-60, or 60+), race [Hispanic; non-Hispanic White; non-Hispanic Black; or non-Hispanic Other, including multi-racial and Asian), income (<$25 000, $25 000-$34 999, $35 000-$49 999, $50 000-$74 999, $75 000-$99 999, $100 000-$149 999, $150 000+, or Don't know), education [less than high school (HS)/HS graduate, Some college, or College graduate], Supplemental Nutrition Assistance Program (SNAP) benefits recipient (Yes or No/Don't know), and zip code (Urban or Rural).

Statistical Analysis

Sampling weight adjustment. Survey sample weights were developed to sum to the US adult population. However, for this analysis, sampling weights were scaled to sum to the sample size:

$$wt\_sd_i = \frac{wt_i}{\sum wt_i / n}$$

where n is the sample size, and wt_sd_i is the scaled weight of the ith respondent.

Income imputation. Preliminary analyses revealed yearly household income as a strong predictor of calorie knowledge and attitudes. Income had, however, a relatively high non-response rate and was therefore imputed under Missing-At-Random (MAR) and non-monotone missing data pattern assumptions. The multiple imputation procedure was utilized to multiply impute income (nimpute = 5) using fully conditional specification methods (FCS) from household size, number of adults in household aged 18 to 59 years, education level, sex, age (in continuous years), race, rural or urban zip code, SNAP benefits recipient, and home ownership (own/rent/other). The quality of the imputations was checked via cross-validation (20% randomly set to missing). The Pearson correlation of .46 ($P = .014$) indicated a statistically significant positive correlation between imputed and non-imputed values, that is the imputed values correspond well to the non-imputed values. Some of the imputed income categories were aggregated for the analyses into 4 income groups: <\$25 000; \$25 000-\$49 999; \$50 000-\$99 999, and \$100 000+.

Models. Because this study aimed to explore the sociodemographic correlates of calorie knowledge and confidence, after reviewing the literature to ensure that all theoretically important sociodemographic variables were included, several steps were taken to determine the best logistic regression model specification. These steps included evaluating the concordance statistic (*C*-statistic) for each independent variable to make sure it was contributing to the model, and testing and removing independent variables that had small sample sizes or high levels of multicollinearity.

The sociodemographic independent variables were ranked in terms of predictive ability by running bivariate logistic regressions separately between the dependent variables and each predictor. The *C*-statistic, an estimate of the ability of each independent variable to contribute predictive power to the model,[19] was also used for the purpose of assessing predictor importance. Predictors with a *C*-statistic of .50 or less are not good predictors and may be excluded. The *C*-statistic was used to rank potential predictors with a *C*-statistic greater than .50 with higher values indicating greater predictor importance.

Associations between the dependent variables and the joint effects of the candidate predictors, including 2-way multiplicative interactions, were assessed via logistic regression. To filter out predictors with high variability because of the small number of respondents in each considered category, cross tabulations of calorie knowledge and calorie confidence by each predictor and each 2-way multiplicative interaction were examined. The standard error of each cell percentage was calculated and scaled [coefficient of variation (CV) by the percentage (p) $CV = 100\% * \frac{stderr}{p}$]. Predictors and 2-way interactions with CVs > 15% were excluded from further modeling.

The retained predictors were then assessed for multicollinearity using variance inflation factors (VIFs) [calculated with the blr_vif_tol function in the R package "blorr"[20]]. Data from complete cases with non-imputed income values were included in the assessment, which used a "delete-one" strategy to identify large decreases in VIFs upon removing a predictor from the model. As a rule of thumb, a large VIF (>10) is a cause for concern[21]; therefore, predictors contributing to VIFs > 10 were removed.

Lastly, to improve prediction accuracy and interpretability by improving the choice of predictors and selecting fewer for inclusion in a resulting reduced model, the procedure for group least absolute shrinkage and selection operator (group LASSO)-regularized regression was performed.[12] LASSO, which tackles the bias-variance tradeoff, was cross-validated using 100 separate 30 to 70 data splits (30% validation data, 70% training data), and the fit was evaluated via the average squared error criterion computed from the validation data. Predictors common to at least 50% of the iterations were kept in the final sparse model.

Post-LASSO, the following variables were selected for inclusion in the final reduced model for calorie knowledge: age, education, sex, race, and income, as well as sex by education interaction.

Adjusted odds ratios were computed from the reduced (sparse) models using weighted logistic regression, grouped by imputation number (1, 2, . . ., 5), and the results of the 5 imputations were pooled. The odds of "being Incorrect" were modeled for calorie knowledge and the odds of "Not being confident" were modeled for calorie confidence. All pairwise odds ratios were compared for each predictor, and 95% confidence intervals on the differences of the log odds ratios were computed.

Body mass index (BMI), not included in the logistic regression models but used for assessing the relationship between it and both calorie knowledge and calorie confidence, was calculated from self-reported height and weight, and respondents were categorized as underweight or normal (BMI < 25), overweight ($25 \leq BMI < 30$) or obese ($BMI \geq 30$). The correlations between BMI and calorie knowledge and calorie confidence were assessed using Wald Chi-square tests. The data analysis for this paper was generated using SAS/STAT software, Version 9.4 (SAS Institute).

Results

Of 2171 respondents who participated in the FSANS Nutrition version, 1980 (91.2%) were complete cases with data across all the variables, excluding income. About a third of respondents either did not know or appeared to have incorrect information about how many calories they should consume each day to maintain their weight. About half of respondents were not confident about the number of calories they should eat each day to maintain their weight. The weighted sociodemographic characteristics of study participants generally matched the U.S. population aged 18 years and older (Table 1).

Table 2 summarizes the bivariate relationships between each dependent variable (calorie knowledge and calorie confidence) and the independent sociodemographic variables. Bivariate *C*-statistics identified income, education, and sex as the strongest candidate predictors for calorie knowledge ($C_{income} = .64$, $C_{education} = .62$ $C_{gender} = .58$). Education, income, and race were the strongest predictors for calorie confidence ($C_{education} = .59$, $C_{income} = .58$, $C_{race} = .57$). All *C*-statistic values were greater than .50, but some values were low across both models, namely for urbanicity ($C_{rural} = .51$) and SNAP ($C_{SNAP} = .53$), making these poor predictors. Expected *C*-statistic values were all

Table 1. Descriptive Statistics for Calorie Confidence, Calorie Knowledge, and Socio-Demographic Variables (National US Population Estimates FSANS 2019).

Variable	Category	n	% (weighted)
Calorie knowledge[a]	Correct	1543	68
	Incorrect	585	32
	Total	2128	100
Calorie confidence[b]	Confident	1412	59
	Not confident	750	41
	Total	2162	100
Sex	Female	1334	51
	Male	796	49
	Total	2130	100
Age	18-30	183	20
	31-50	567	36
	51-60	391	18
	>60	931	27
	Total	2072	100
Race	Non-Hispanic White	1573	65
	Non-Hispanic Black	171	11
	Non-Hispanic other	198	8
	Hispanic	161	16
	Total	2103	100
Income (unimputed)	<$25K	265	17
	$25K-$49 999	398	25
	$50K-$99 999	610	31
	$100K+	560	27
	Total	1833	100
Education	HS or less than HS	503	40
	Some college	619	31
	College graduate	1017	29
	Total	2139	100
SNAP	No/don't know	1980	89
	Yes	166	11
	Total	2146	100
Urban or rural	Urban	1828	83
	Rural	340	17
	Total	2168	100
BMI[c]	Underweight/normal (BMI < 25)	736	33
	Overweight (25 ≤ BMI < 30)	688	34
	Obese (BMI ≥ 30)	579	34
	Total	2003	100

The number of missing cases for each variable was: calorie knowledge (nmiss = 43), calorie confidence (nmiss = 8), gender (nmiss = 41), age (nmiss = 99), race (nmiss = 68), education (nmiss = 32), rural (nmiss = 3), SNAP (nmiss = 25), BMI (nmiss-168). Income presented the highest number of missing values, including "don't know," with nmiss = 338 and was imputed.

[a]Thinking about yourself, about how many calories do you need to consume in a day to maintain your current weight? (Incorrect: don't know, >3000 calories, ≤1000 calories [female], ≤1500 calories [male]).

[b]How confident are you that you know how many calories you should eat each day? (Not confident, not at all or slightly confident; confident, somewhat or very or extremely confident).

[c]BMI, body mass index; calculated as kg/m^2.

between .5 and .6 since the predictors were all categorical in nature. From the CV-step (ie, CV ≤ 15%), all main effects and the 2-way interactions gender × education and gender × rural were retained for the Calorie knowledge and Calorie confidence models, and gender × age was further retained for the Calorie confidence model. No VIF's were greater than 10 for the Calorie knowledge model and all main effects, gender × education, and gender × rural were retained for the LASSO step. For the Calorie confidence model gender × age was removed as

Table 2. Bi-Variate Relationships Between Calorie Knowledge, Calorie Confidence, and Socio-Demographic Variables (National US Population Estimates FSANS 2019).

		Calorie knowledge					Calorie confidence				
		Incorrect		Correct			Not confident		Confident		
Characteristic	Category	n	% (weighted)	n	% (weighted)	*C*-statistic	n	% (weighted)	n	% (weighted)	*C*-statistic
Gender	Male	279	35	513	65	0.58	314	46	479	54	0.54
	Female	295	27	1030	73		426	37	902	63	
Race	Non-Hispanic White	373	26	1181	74	0.56	489	37	1077	63	0.57
	Non-Hispanic Black	83	55	87	45		96	59	74	41	
	Non-Hispanic other	59	32	136	68		83	48	114	52	
	Hispanic	48	34	113	66		63	44	98	56	
Income	<$25K	112	44	147	56	0.64	121	47	143	53	0.58
	$25K-$49 999	139	41	251	59		158	46	240	54	
	$75K-$99 999	128	25	475	75		197	42	411	58	
	$100K+	86	15	463	85		140	27	415	73	
Age	18-30	45	28	138	72	0.58	69	44	113	56	0.53
	31-50	108	25	454	75		188	40	378	60	
	51-60	91	28	297	72		120	36	268	64	
	>60	310	42	612	58		341	46	586	54	
Education	HS or less than HS	200	41	293	59	0.62	235	50	268	50	0.59
	Some college	185	30	428	70		225	40	392	60	
	College graduate	191	21	804	79		279	31	732	69	
Rural or urban	Urban	487	31	1307	69	0.51	624	40	1196	60	0.51
	Rural	98	38	233	62		125	47	214	53	
SNAP	No/don't know	508	30	1443	70	0.53	662	40	1309	60	0.53
	Yes	69	43	96	57		83	53	83	47	

the VIF dropped from 16.6 to 6.1 upon its removal from the model. As such all main effects, gender × education, and gender × rural were retained for the LASSO step.

The logistic regression showed that age, education, sex, income, and race predict calorie knowledge and calorie confidence (Table 3). Older respondents (>60 years) had poorer calorie knowledge and lower levels of calorie confidence. They were 1.9 times more likely as respondents aged 18 to 30 years old, and 1.7 times more likely than respondents aged 31 to 50 and 51 to 60 years old, to lack calorie knowledge. They were also 1.5 times more likely than respondents 51 to 60 years old to lack calorie confidence. Respondents with lower levels of education (HS education or less) were 1.5 times more likely than college graduates to lack calorie knowledge and 1.9 times more likely to lack calorie confidence. Males were 1.7 times more likely than females to lack calorie knowledge and calorie confidence. Non-Hispanic Black respondents were, respectively, 3.4 and 2.4 times more likely than non-Hispanic white respondents to lack calorie knowledge or confidence. Non-Hispanic-other race respondents were, respectively, 1.8 and 1.9 times more likely than non-Hispanic white respondents to lack calorie knowledge or confidence. Significant differences were also found by annual income, with low income (<$25 000) and lower middle-income ($25 000-$49 999 annually) respondents 2.9 and 2.6 times more likely, respectively, than high-income respondents ($100 000+) to lack calorie knowledge.

In addition to the main effects of education and sex, there is also a significant interaction between education and sex for both calorie knowledge and calorie confidence. The effects of lower levels of education were more pronounced in males than females. Males with a HS education or less were 2.5 and 2.2 times more likely, respectively, than females of similar education to lack calorie knowledge or confidence.

The analytical sample included relatively few Hispanic non-English speakers, however, Hispanics who indicated speaking only Spanish at home (N = 36) were less likely to have calorie knowledge than Hispanics who reported speaking English at home (40% vs 72%, $P < .05$).

We compared 3 categories of BMI (Underweight/Normal, Overweight, and Obese) with Calorie knowledge and Calorie confidence (Table 4). While calorie knowledge was not correlated with BMI (Wald Chi-square $P = .18$), Calorie confidence was significantly correlated with BMI (Wald Chi-square $P = .047$). Percentages of those not calorie confident increase with each increase in BMI category (29%, 34%, and 37%, respectively.

Discussion

This study examined sociodemographic differences in knowledge among US adults of calories required to maintain current weight, as well as confidence in knowing the

Table 3. Associations Between Demographic Characteristics of Adults Aged 18 Years and Older and Lack of Calorie Knowledge and Low Levels of Calorie Confidence (National US Population Estimates FSANS 2019).

				Lack of calorie knowledge[a]	Low calorie confidence[b]
Characteristic	Category vs reference	Effect modifier		Adjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Age	31-50 vs 18-30			1 (0.6-1.7)	0.9 (0.6-1.3)
	51-60 vs 18-30			1.2 (0.7-1.9)	0.7 (0.4-1.1)
	>60 vs 18-30			1.9 (1.2-3)**	1 (0.6-1.4)
	51-60 vs 31-50			1.1 (0.7-1.7)	0.8 (0.5-1.1)
	>60 vs 31-50			1.9 (1.3-2.7)**	1.1 (0.8-1.5)
	>60 vs 51-60			1.7 (1.1-2.5)*	1.4 (1-2)*
Education	HS or less than HS vs some college			1.3 (0.9-1.9)	1.4 (1-2)*
	HS or less than HS vs college graduate			1.5 (1-2.3)*	1.9 (1.3-2.7)***
	Some college vs college graduate			1.1 (0.8-1.6)	1.3 (1-1.8)
Gender	Male vs female			1.7 (1.3-2.3)***	1.7 (1.3-2.1)***
Race	Non-Hispanic Black vs non-Hispanic White			3.4 (2.1-5.5)***	2.4 (1.6-3.8)***
	Non-Hispanic other vs non-Hispanic White			1.8 (1.1-2.9)*	1.9 (1.2-3)**
	Hispanic vs non-Hispanic White			1.5 (0.9-2.4)	1.4 (0.9-2.1)
	Non-Hispanic Black vs non-Hispanic other			1.9 (1-3.7)	1.3 (0.7-2.4)
	Non-Hispanic Black vs Hispanic			2.2 (1.2-4.2)*	1.8 (1-3.2)
	Non-Hispanic other vs Hispanic			1.2 (0.6-2.2)	1.4 (0.8-2.5)
Income	<$25K vs $25K-$49 999			1.1 (0.6-1.9)	0.9 (0.5-1.4)
	<$25K vs $50K-$99 999			1.9 (1.1-3.3)*	0.9 (0.6-1.5)
	<$25K vs $100K+			2.9 (1.4-5.9)**	1.4 (0.8-2.3)
	$25K-$49 999 vs $50K-$99 999			1.7 (1.2-2.6)**	1.1 (0.8-1.6)
	$25K-$49 999 vs $100K+			2.6 (1.5-4.6)**	1.5 (1-2.4)
	$50K-$99 999 vs $100K+			1.5 (0.9-2.4)	1.4 (1-2.1)
Education	HS or less than HS vs some college	Gender	Male	2 (1.2-3.4)*	1.7 (1-2.9)*
	HS or less than HS vs college graduate		Male	1.8 (1-3.3)*	2.4 (1.4-4.1)**
	Some college vs college graduate		Male	0.9 (0.5-1.5)	1.4 (0.9-2.2)
Gender	Male vs female	Education	HS or Less than HS	2.5 (1.5-4.2)***	2.2 (1.4-3.5)**
	Male vs female		Some college	1.1 (0.7-1.8)	1.5 (1-2.4)
	Male vs female		College graduate	1.7 (1.1-2.8)*	1.4 (0.9-2.1)

Abbreviation: N.S., not significant.
[a]% Concordance = 71%.
[b]% Concordance = 65%.
*$P < .05$. **$P < .01$. ***$P < .001$.

number of calories to eat each day. We found that about a third of US adults lack knowledge of the number of calories needed to consume each day to maintain their weight and about half of US adults are not confident about their daily calorie needs. We also found that calorie knowledge and confidence are not equally distributed in the population. Many of the same subgroups who lack objective calorie knowledge self-identify as lacking confidence in knowing the number of calories they should consume in a day.

We believe our study is the first to simultaneously assess calorie knowledge and confidence in knowledge of daily calorie needs and show how these 2 concepts relate to BMI. Our results confirm findings from previous studies on calorie knowledge and the disparities between different sociodemographic groups, although we found somewhat higher levels of correct calorie knowledge than some studies.[4,12,14,15] Like McKinnon et al[4] who used a nationally representative US sample collected in 2007 to 2010, we found similar disparities in calorie knowledge among sociodemographic groups, with men, non-Hispanic Blacks, those with lower levels of education and income, and those over age 60 less likely to know the number of calories they needed to maintain their weight. In our study, these same groups also reported having lower confidence in knowing the number of calories needed to consume each day to maintain their weight. However, unlike results from McKinnon et al[4] which indicated lower levels of calorie knowledge among Hispanics, and results from Acheampong and Haldeman[22] and Robles et al[23] who found that Hispanics had lower levels of confidence in preparing and selecting

Table 4. *B*-Variate Relationship Bewteen BMI and Calorie Knowledge and Calorie Confidence.

	Underweight/normal (BMI < 25)		Overweight (25 ≤ BMI < 30)		Obese (BMI ≥ 30)		Total	
	n	% (weighted)	n	% (weighted)	n	% (weighted)	n	*P* value
BMI total	736	33	688	34	579	34	2003	
Calorie knowledge								
Incorrect	182	31	187	33	154	36	523	.46
Correct	540	33	493	34	413	32	1446	
Total							1969	
Calorie confidence								
Not confident	240	29	228	34	212	37	680	.047
Confident	489	35	459	33	367	31	1315	
Total							1995	

healthy foods, we did not find differences between Hispanics and other racial/ethnic groups on either calorie knowledge or calorie confidence. However, we found limited evidence that language may be a barrier to calorie knowledge suggesting the need for future research with non-English speakers to explore the role of language spoken at home in calorie knowledge and confidence.

Finally, like McKinnon et al[4] and Oh et al[24] we found no relationship between BMI and calorie knowledge. We found that BMI is significantly correlated with calorie confidence, such that those lacking confidence are more likely overweight and obese. The constructs Social Cognitive Theory (SCT) help explain this finding. Social cognitive theory suggests that self-efficacy, "beliefs in one's ability to succeed in specific situations or accomplish a task," of which confidence is 1 factor, are better predictors of behavior change than knowledge and certain kinds of social support.[25] Therefore, while nutrition knowledge may contribute positively to healthy diet practices, strategies to increase self-efficacy and confidence in health knowledge would appear to have an impact in the successful promotion of health behaviors related to calorie consumption. Other health behavior theories, such as those employing ecological or social models of health behavior, suggest that positive health behaviors rely not only on individual factors but also on environmental, community, organizational, and societal-level influences.[26,27] Therefore, while increasing calorie confidence might be a strong facilitator for weight maintenance, efforts focusing on promoting positive health behaviors on other levels may also be warranted.

This study has some strengths and limitations. The major strengths include the FSANS' robust sampling and weighting methodology, including its relatively large sample size, allowing findings to be representative of the US adult population. Among our study's main limitations, the self-reported nature of the data may not have perfectly captured calorie knowledge, confidence, or BMI. Also, for the calorie knowledge question respondents were asked to select among preset calorie ranges. While a "don't know" response was offered, some respondents may have chosen to guess a correct calorie range rather than admitting they did not know the answer. Finally, conducting the survey in English and Spanish may have precluded participation of some non-English and non-Spanish speakers.

In conclusion, this study finds that many of the same sociodemographic factors that have been historically correlated with calorie knowledge continue to be correlated with both calorie knowledge and calorie confidence. The study also presents evidence indicating that only calorie confidence significantly correlates with BMI. In addition to assessing calorie knowledge and confidence by sociodemographic characteristics, this study helps identify opportunities to address knowledge and confidence disparities that can be addressed through education and motivational programs. The FDA has developed nutrition educational materials about the Nutrition Facts label and menu labeling to meet the needs of a wide range of consumers in a way that is easily accessible (https://www.fda.gov/food/food-labeling-nutrition/nutrition-education-resources-materials; https://www.fda.gov/food/nutrition-education-resources-materials/new-nutrition-facts-label), including older adults (https://www.fda.gov/food/new-nutrition-facts-label/using-nutrition-facts-label-older-adults), Spanish speakers (https://www.fda.gov/food/nutrition-education-resources-materials/cantidad-de-calorias-en-el-menu; https://www.fda.gov/food/new-nutrition-facts-label/la-nueva-etiqueta-de-informacion-nutricional), and health educators including physicians and health care professionals (https://www.fda.gov/food/healthcare-professionals/nutrition-facts-label-continuing-medical-education-program-physicians). These materials provide the background information that nutrition health professionals can use to boost their clients' confidence in their ability to use them.

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