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Nutrition Label Use and Sodium Intake in the U.S

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Abstract

Introduction—High sodium intake is a major risk factor for hypertension, but evidence is limited on which interventions are effective in reducing sodium consumption. This study examined the associations between frequent use of nutrition labels and daily sodium intake and the consumption of high-sodium foods in the U.S.

Methods—Using the 2007–2008 and 2009–2010 Flexible Consumer Behavior Survey, this study compared sodium intake measured from the 24-hour dietary recalls, availability of salty snacks at home, and frequencies of eating frozen meals/pizzas between frequent (i.e., always or most of the time) and infrequent nutrition label users. Also, the study examined the association between nutrition label use and sodium-related dietary behaviors across different demographic and socioeconomic groups. Data were analyzed in 2016.

Results—Frequent users of nutrition labels consumed 92.79 mg less sodium per day (95% CI= −160.21, −25.37), were less likely to always or most of the time have salty snacks available at home (OR =0.86, 95% CI=0.76, 0.97), but were just as likely to eat frozen meals or pizzas (incidence rate ratio =0.96, 95% CI=0.84, 1.08) compared with infrequent label users. The

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associations between nutrition label use and sodium intake differed considerably across age, gender, and socioeconomic groups.

Conclusions—Frequent use of nutrition labels appears to be associated with lower consumption of sodium and high-sodium foods in the U.S. Given this small reduction, interventions such as enhancing nutrition label use could be less effective if implemented without other strategies.

INTRODUCTION

High sodium intake is a major risk factor for hypertension—a health condition that affects nearly 30% of adults in the U.S.—and a risk factor for cardiovascular conditions, such as heart failure and stroke.[1,2] Even so, about 90% of adults consume more than the upper limit of sodium intake, which can potentially increase their risk of hypertension.[3] Although recent studies have shown that even modest reductions in sodium intake (i.e., 400–1,200 mg/d) can result in considerable decreases in the incidence of cardiovascular disease and related healthcare costs,[4,5] there is limited evidence so far on which interventions are effective in reducing sodium consumption. High sodium intake across different populations remains a challenging public health concern.[6]

The labeling of nutrient content on packaged foods, a population strategy to inform consumers about facts on nutrition in food products, has been mandatory in the U.S. since the 1990 passage of the Nutrition Labeling and Education Act.[7,8] Studies assessing the impact of this regulation have found that it increases consumer awareness and knowledge of nutrition, but it has had moderate to no impact on consumption behaviors.[9–11] There are urgent and diverse research needs regarding enhancing current understanding of factors that impact consumer awareness and behavior relative to sodium reduction, and nutrition labeling is one lever to be studied and revised as suggested by the National Academy of Medicine in their 2010 report on strategies to reduce sodium intake.[12] In addition, the ability to read and interpret nutrition labels is usually associated with literacy and numeracy as well as sociodemographic status,[13,14] but it is unclear whether frequent nutrition label use will be effective—or equally effective—in decreasing sodium intake across different population groups.

This study used data on dietary habits, attitudes, and behaviors among respondents to the 2007–2008 and 2009–2010 Flexible Consumer Behavior Survey (FCBS) to determine whether frequent nutrition label use is associated with the consumption of sodium and high-sodium foods among U.S. adults. The third round (2011–2012) and fourth round (2013–2014) of FCBS were conducted but were not yet available to the public.[15] The present study used an instrumental variables approach to account for potential biases associated with self-reported nutrition label use and sodium-intake behaviors. This study also investigated how these associations vary across different socioeconomic subgroups. Findings from this study may help inform public health practitioners and policy makers to better use nutrition labels or improve the current nutrition labeling system to decrease high sodium consumption in the U.S.

METHODS

Study Sample

The FCBS is a supplemental module in the National Health and Nutrition Examination Survey (NHANES). Beginning in 2007, the U.S. Department of Agriculture's Economic Research Service started collecting data on dietary habits, attitudes, and behaviors among a subsample of NHANES participants who also completed two 24-hour dietary recalls that reported the foods they consumed during the past 24 hours (N=9,982). After excluding subjects with missing values on food intake (*n*=171), population characteristics (*n*=1,566), and consumers' attitudes about foods (*n*=948), and additionally excluding pregnant women (*n*=77) and those with chronic kidney disease who have to control their sodium intake (*n*=180),[16] 7,040 adult participants aged ≥20 years comprised the analytic sample.

Measures

This study assessed whether label reading was associated with lower sodium consumption. The rationale for this hypothesized relationship might be twofold. First, nutrition labels provide important information for consumers to make healthier choices. Second, Nutrition Facts panels that contain warning signs or recommended levels of intake can be used as tools for health education to improve the health literacy of consumers and therefore reduce overall consumption of unhealthy foods.

The primary predictor in the analysis was self-reported use of nutrition labels when deciding to buy a food product. This predictor was dichotomized into a binary variable, with consumers who always or most of the time used nutrition labels defined as frequent label users, and consumers who sometimes, rarely, or never used nutrition labels defined as infrequent label users. The outcome variables in the analysis included the following: (1) daily sodium intake measured by the amount of mean usual daily sodium intake calculated using the average of the two 24-hour dietary recalls in NHANES, adjusted for use of salt in food preparation[3]; (2) availability of salty snacks at home, defined as always/most of the time available and sometimes/rarely/never available; and (3) frequency of eating frozen meals/pizzas, measured by the question: *During the past 30 days, how often did you eat frozen meals or frozen pizzas?* Outcomes (2) and (3) were included because more than 70% of sodium that Americans consume is in processed foods and restaurant meals[17]; nutrition labels may influence consumers' purchasing decisions of processed foods, such as salty snacks and frozen meals.

Statistical Analysis

Descriptive statistics were used to characterize the study sample and multivariate regression models to estimate the association between nutrition label use and sodium intake and the consumption of high-sodium foods, adjusting for the sampling weights used in NHANES. The association between nutrition label use and daily sodium intake was assessed using ordinary least squares regression and two-stage least squares regression (described later), whereas the association between nutrition label use and the availability of salty snacks was estimated using logistic regression and two-stage residual inclusion regression. Negative binomial regression model and two-stage residual inclusion regression model were employed to analyze the association between nutrition label use and frequency of eating processed foods (i.e., frozen meals or pizzas). All of the regression models adjusted for age, gender, race/ethnicity, income as compared to the federal poverty line (FPL), education, language used in the interview, family size, whether the respondent received food stamps, health conditions, and attitudes and values about diet. The authors also tested for differences in the associations between nutrition label use and dietary behavior across different demographic and socioeconomic groups, and further stratified the sample by age (20–64 vs 65–80 years), gender (male vs female), income (<300% of the FPL vs ≥300% of the FPL) and education levels (less than high school vs high school and above), and performed the same regression analyses.

An instrumental variables approach was also utilized to adjust for potential endogeneity (nutrition label use is correlated with the error term caused by reverse causality or unobserved variable bias) between self-reported label use and related food-consumption behaviors.[18] There might be two sources of endogeneity bias: (1) food-consumption behaviors may affect self-reported label use or the recall of such use (i.e., reverse causality), and (2) unobserved characteristics of consumers may be related to the voluntary use of nutrition labels and food-consumption habits. For example, some consumers may never use labels because of lack of time, inability to understand the information presented in the label, or difficulty seeing the Nutrition Facts panel clearly (i.e., omitted-variable bias).[19,20] An instrumental variables approach, a widely used method in epidemiology and econometrics,[21,22] was used to tease out the effect of a predictor on outcomes, by taking into the consideration the suspected correlation between the predictor and the error term. A valid instrumental variable should meet two requirements: (1) it should be closely related with the predictor, and (2) it must be an exogenous variable that is uncorrelated with the residual in the second stage equation. To address these endogeneity concerns in this analysis, especially the concern about consumers' consciousness of the presence of the food labels, the authors used responses to a question on whether consumers bought any food that was labeled "organic" in the past 30 days as an instrumental variable. As people who will notice the "organic" label are also more likely to read nutrition labels,[23] but they may care only about whether the food is organic. In fact, prior research has shown that purchasing foods with an "organic" label is unlikely to be directly related to sodium intake (as there is no significant difference in sodium content between organic and conventional foods).[24] In implementing the regression model, the authors used the two-stage residual inclusion regression approach, which extends the traditional two-stage least squares regression linear model for instrumental variables to nonlinear outcomes.[25] The Hausman test was used to assess whether it is necessary to use an instrumental variable method rather than a more efficient standard model.[26] Data were analyzed in 2016, and all statistical analyses were conducted using Stata, version 14.2.

RESULTS

Table 1 reports the sample characteristics by frequency of nutrition label use. Among the 7,040 respondents, 41.4% (n=2,913) reported using nutrition labels when buying foods always or most of the time. The frequent nutrition label users and infrequent users differed significantly (p<0.001) in average sodium intake and other measures related to the reported consumption of high-sodium foods. More specifically, frequent nutrition label users consumed on average 3,328 mg of sodium per day, about 10% less than infrequent users. In addition, 58% of frequent nutrition label users reported having salty snacks available at home always or most of the time, and eating frozen meals or pizzas 2.51 times during the past 30 days, whereas these numbers were higher for non-frequent nutrition label users at 66%, and 3.06 times in the last month, respectively.

Significant variations were observed in nutrition label use by age, gender, income, education, family size, and receipt of food stamps. Mid-aged adults (45–64 years) and older adults (aged 65–80 years) were more likely to be frequent nutrition label users than young adults (aged 20–44 years). Women were more likely to be frequent nutrition label users than men. Those in the highest category of income and education were the most likely to be frequent users of nutrition labels. People in small families (i.e., family size less than five people) or who did not receive food stamps were more likely to be frequent nutrition label users, as were adults with hypertension or those on a special diet. In addition, people with different dietary attitudes and values exhibited significant differences in terms of using nutrition labels. For example, those who cared significantly more about food nutrition and how well the food keeps, but less about the importance of taste, were more likely to frequently use nutrition labels.

Table 2 reports the results from standard and instrumental variables regressions assessing the associations between label use and the consumption of sodium and high-sodium foods. The results from the Hausman test suggest that the two-stage least squares regression linear model is the preferred specification (chi-square, 4.99, p=0.03). The findings show that frequent nutrition label users consumed 92.79 mg less sodium per day (95% CI= −160.21, −25.37), were less likely to always or most of the time have salty snacks available at home (coefficient=0.86, 95% CI=0.76, 0.97), but were just as likely to eat frozen meals/pizzas in the past 30 days (incidence rate ratio=0.96, 95% CI=0.84, 1.08), compared with infrequent label users.

Table 3 reports the regression results, with the sample stratified by age group, gender, income, and education levels. The results show that the association between label use and sodium reduction was significant among the young and midlife adults aged 20–64 years, men, those with a family income below 300% of the FPL, but not among the elderly, women, and those whose income was more than 300% above the FPL. By education, the association was only significant among high school graduates or those having some college or above.

DISCUSSION

Using nationally representative survey data on consumer dietary behavior and nutrition, the present study showed that sodium intake was associated with whether consumers frequently use nutrition labels. People who routinely used nutrition labels more frequently consumed less sodium. Also, the associations between nutrition label use and sodium intake differed considerably across different demographic and socioeconomic groups. This is consistent with a previous study showing disparities in nutrition label use across different gender and socioeconomic population groups.[27]

Reducing sodium intake to the recommended amount or adopting a lower-sodium DASH (Dietary Approaches to Stop Hypertension) eating plan, which is rich in fruits, vegetables, and low-fat dairy products, has proved to be an effective way to lower blood pressure in RCTs.[28] However, interventions to change dietary salt consumption in less controlled, real-world settings have not been consistently demonstrated to be effective. Similarly, nutrition labeling, a widely used population-level public health intervention to promote a healthy diet, has not been shown to be efficacious in reducing sodium intake or the consumption of high-sodium foods.[10,11] A few studies based on regional data have shown limited effects of nutrition label use on sodium consumption, however, particularly for people with diabetes or hypertension.[11,27,29] Public health professionals and policymakers are in need of stronger evidence supporting the usefulness of nutrition labels in influencing sodium consumption.

Although this study showed that frequent label use was associated with lower sodium intake, the difference in sodium intake between frequent and infrequent nutrition label users was rather small (i.e., less than 100 mg/d, Table 2). The median sodium intake among U.S. adults was estimated at 3,371 mg/d (95% CI=3,318, 3,424).[30] It is likely that the estimated difference did not imply actual clinical significance. In fact, American College of Cardiology and American Heart Association's recommendations indicated that 1,000 mg/d of sodium reduction can decrease blood pressure.[31] Some studies have suggested that reducing sodium by an average of 400 mg/d could reduce high blood pressure.[5] The U.S. Food and Drug Administration has recently updated and passed regulations on how the Nutrition Facts Label needs to look.[32] Certain information on food labels may be highlighted to increase the impact of nutrition labeling. For example, using an eye-tracking approach, one study has identified several ways—such as locating labels in the front of the package, prominently positioning nutrients with healthy consumption recommendations, and increasing the font size of nutrition labels—that could be implemented to enhance consumer awareness and use of nutrition labels.[20,33] Researchers have also utilized principles from psychology and behavioral economics in their design of innovative nutrition labels.[34] An example of such innovation is the "traffic light" labels that were adopted by some food manufacturers in the United Kingdom and have been shown to be effective in promoting healthy food choices.[35,36] Other sodium reduction strategies in the U.S., such as the National Salt Reduction Initiative and partnerships between health organizations, advocacy groups, and the food industry, have also shown some preliminary promise in reducing sodium consumption.[37] More research is under way to understand the biological, economic, and geographic factors that determine food choices and sodium consumption, which may also shed light on nutrition label designs that can further reduce sodium consumption and differences in such behavior.[38]

Limitations

The present study also has several notable limitations. First, the authors attempted to adjust for the underlying endogeneity bias by applying an instrumental variables approach. However, the instrumental variable may have only controlled for consumers' awareness of the food labels or their ability to understand and read food labels. It is likely that people who consumed less sodium are healthier for reasons that might have little to do with reading labels. The instrumental variable cannot control for the unobserved consumer health consciousness that lead them to avoid excessive sodium intake and read labels, although the value of health was adjusted for as a covariate in the regression. Therefore, the causal link between reading a nutrition label and sodium intake cannot be ascertained in this observational study, and needs to be tested in well-controlled interventional and experimental studies. Second, the data used were collected between 2007 and 2010, which does not reflect more recent policy and dietary patterns. It is possible that consumers have become more health conscious in the most recent years. For example, only 41.4% of the NHANES participants reported always or most of the time using labels, while according to the 2014 Health and Diet Survey, 50% of U.S. adults reported always or most of the time having used nutrition labels to assist in food purchase.[39] Future analysis using the forthcoming FCBS data from the third round (2011–2012) and fourth round (2013–2014) is needed to update the evidence. Finally, the self-reported 2-day dietary recalls were used as an outcome measure, but the gold standard for measuring sodium intake is a 24-hour urine collection.[40,41] However, only one third of respondents provided a urine sample for sodium testing in 2010, and the data are not publicly available.[42] Nevertheless, previous studies have reported that although dietary recall may underestimate the daily sodium intake compared with a 24-hour urine sodium, it is highly associated with urinary sodium over the range of sodium intake amounts.[30,43]

CONCLUSIONS

Although it is difficult to demonstrate the effects of population-wide policies at the level of the individual, these results suggest that nutrition label use is associated with marginally lower dietary sodium consumption. The impact of sodium content labeling might be boosted by other complementary interventions.

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Table 1

Sample Characteristics by Nutrition Label Use, 2007–2010 Flexible Consumer Behavior Survey

Variable	Total (N=7,040)	Frequent nutrition label users[a] (*n*=2,913)	Infrequent nutrition label users[a] (*n*=4,127)	*p*-value[b]
Sodium in daily food (mg),[c] M (SE)	3,519.60 (25.10)	3,327.63 (28.80)	3,653.41 (30.02)	**<0.001**
Salty snacks available at home, %				**<0.001**
Always/most of the time	62.77	58.46	65.78	
Sometimes/rarely/never	37.23	41.54	34.22	
Frequency of eating frozen meals/pizzas,[d] M (SE)	2.84 (0.11)	2.51 (0.11)	3.06 (0.15)	**0.002**
Sociodemographic				
Age, %				**<0.001**
20–44 years	46.35	38.49	51.83	
45–64 years	37.11	39.49	35.44	
65–80 years	16.54	22.01	12.72	
Gender, %				**<0.001**
Male	47.20	39.42	52.62	
Female	52.80	60.58	47.38	
Race/ethnicity, %				**0.048**
Hispanic	11.21	10.48	11.72	
Non-Hispanic white	73.55	74.91	72.61	
Non-Hispanic black	10.24	9.22	10.95	
Others	5.00	5.39	4.73	
Income level, %				**<0.001**
Below FPL	12.43	10.74	13.61	
100%–199% of FPL	19.21	17.9	20.12	
200%–299% of FPL	15.45	15.47	15.44	
300%–399% FPL	13.48	12.57	14.12	
≥400% FPL	39.43	43.32	36.72	
Educational attainment, %				**<0.001**
Less than high school	16.12	14.01	17.59	
High school	23.71	20.31	26.07	
Some college	30.55	29.36	31.37	
College and above	29.63	36.32	24.97	
Language used in interview, %				0.391
English	94.92	95.16	94.76	
Spanish	5.08	4.84	5.24	
Family size, %				**<0.001**
1	21.18	22.54	20.23	
2–4	64.93	66.66	63.73	

Variable	Total (N=7,040)	Frequent nutrition label users[a] (*n*=2,913)	Infrequent nutrition label users[a] (*n*=4,127)	*p*-value[b]
≥5	13.89	10.80	16.04	
Food stamp recipient, %				**0.003**
Yes	11.35	9.97	12.31	
No	88.65	90.03	87.69	
Health, %				
Hypertension				**<0.001**
Yes	30.40	35.77	26.66	
No	69.60	64.23	73.34	
General health				**<0.001**
Excellent/very good	47.09	50.66	44.60	
Good	37.60	35.42	39.11	
Fair/poor	15.31	13.92	16.28	
On a special diet				**<0.001**
Yes	14.89	22.97	9.26	
No	85.11	77.03	90.74	
Diet attitudes/values, %				
Importance of price				0.079
Yes	39.25	40.39	38.46	
No	60.75	59.61	61.54	
Importance of nutrition				**<0.001**
Yes	58.64	79.19	44.32	
No	41.36	20.81	55.68	
Importance of taste				**0.035**
Yes	76.91	75.31	78.03	
No	23.09	24.69	21.97	
Importance of food preparation easiness				0.273
Yes	28.66	29.47	28.1	
No	71.34	70.53	71.9	
Importance of how well the food keeps				**0.016**
Yes	49.21	51.81	47.4	
No	50.79	48.19	52.6	
Instrumental variable, %				
Buy food that was labeled "organic"[e]				**<0.001**
Yes	39.58	49.97	32.34	
No	60.42	50.03	67.66	

Note: Boldface indicates statistical significance ($p<0.05$).

[a]Frequent nutrition label users were defined as those who always or most of the time used nutrition labels to assist in food purchase; infrequent nutrition label users were defined as those who sometimes, rarely, or never used nutrition labels when purchasing a food product.

[b]All statistics were adjusted with sampling weights. The *p*-values were estimated from *t*-test for continuous variables and from chi-square test for categorical variables.

[c]Sodium was calculated as the mean usual intake from the 24-hour dietary recall in NHANES, adjusted for salt use in food preparation.

[d]The respondents were asked, “During the past 30 days, how often did you eat frozen meals or frozen pizzas?”

[e]The respondents were asked, “In the past 30 days, did you buy any food that was labeled ‘organic’”?

FPL, federal poverty line; NHANES, National Health and Nutrition Examination Survey.

Table 2

Association Between Frequent Nutrition Label Use and Sodium Consumption (N=7,040)

Outcomes	Standard regressions	Two-stage regressions with instrumental variables[a]
Sodium in daily food (mg),[b] β (95% CI)	**−84.54**[*](−153.76, −15.32)	**−92.79**[**](−160.21, −25.37)
Salty snacks always/most of the time available at home,[c] OR (95% CI)	**0.84**[**](0.74, 0.96)	**0.86**[**](0.76, 0.97)
Frequency of eating frozen meals/pizzas,[d] IRR (95% CI)	0.95(0.85, 1.07)	0.96(0.84, 1.08)

Note: Boldface indicates statistical significance

[*] $p<0.05$,

[**] $p<0.01$

[a] The variable “Buy food that was labeled ‘organic’” was used as an instrumental variable to adjust for the potential endogenous effect.

[b] Sodium was calculated as the mean usual intake from the 24-hour dietary recall in National Health and Nutrition Examination Survey, adjusted for salt use in food preparation. Ordinary least square and two-stage least squares regressions were used to estimate the association between nutrition label use and daily sodium intake. The regressions adjusted for all covariates listed—age group, gender, race/ethnicity, income level, educational attainment, language used in the interview, family size, food stamp recipients, whether having hypertension, general health, whether on a special diet and dietary attitudes/values.

[c] Sometimes/rarely/never having salty snacks at home was used as the reference group. Logistic regression and two-stage residual inclusion regression were performed to estimate the impact of nutrition label use on purchasing decisions of salty snacks.

[d] Negative binomial regression and two-stage residual inclusion regression were performed to estimate the association between nutrition label use and frequency of eating frozen meals/frozen pizzas. The standard regression adjusted for all aforementioned covariates.

IRR, incidence rate ratio.

Table 3

Association Between Nutrition Label Use and Sodium Consumption, Stratified by Characteristics (N=7,040)[a]

Models	Standard regressions, β (95% CI)	Two-stage regressions with instrumental variables,[b] β (95% CI)
Age group		
20–64 years	**−87.53** * (−173.20, −1.85)	**−95.32** * (−178.34, −12.30)
65–80 years	−93.10 (−226.56, 40.36)	−95.75 (−227.25, 35.74)
Gender		
Male	**−186.80** ** (−314.43, −59.17)	**−193.97** ** (−318.73, −69.22)
Female	−5.80 (−101.57, 89.97)	−11.12 (−108.78, 86.53)
Family Income		
<300% of FPL	**−110.06** * (−215.27, −4.86)	**−125.48** * (−229.60, −21.37)
>300% of FPL	−52.32 (−167.40, 62.76)	−55.37 (−169.28, 58.54)
Education level		
Less than high school	−92.35 (−304.87, 120.17)	−98.11 (−313.91, 117.70)
High school and above	**−83.04** * (−164.76, −1.32)	**−91.17** * (−171.34, −11.00)

Note: Boldface indicates statistical significance

* $p<0.05$,

** $p<0.01$

[a] Sodium was calculated from the first day of the 24-hour dietary recall in National Health and Nutrition Examination Survey, adjusted for salt use in food preparation. Ordinary least square and two-stage least squares regressions were used to estimate the association between nutrition label use and daily sodium intake. The regressions adjusted for all covariates except for the ones used for stratification analysis.

[b] The variable "Buy food that was labeled 'organic'" was used as an instrumental variable to adjust for the potential endogenous effect. FPL, federal poverty line.