

Patient Understanding of Food Labels

The Role of Literacy and Numeracy

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Background: Comprehension of food labels can be important for patients, including those with chronic illness, to help follow dietary recommendations. Patient comprehension of food labels was examined, along with the relationship of comprehension to their underlying literacy and numeracy skills.

Methods: From June 2004 to April 2005, a cross-sectional study of 200 primary care patients was performed. A 24-item measure of food label comprehension was administered. Literacy was measured with the Rapid Estimate of Adult Literacy in Medicine (REALM), and numeracy with the Wide Range Achievement Test, third edition (WRAT-3).

Results: Most patients (89%) reported using food labels. While 75% of patients reported at least a high school education and 77% had 9th-grade literacy skills, only 37% had 9th-grade math skills. On average, patients answered 69% (standard deviation, 21%) of the food-label questions correctly. Common reasons for incorrect responses included misapplication of the serving size, confusion due to extraneous material on the food label, and incorrect calculations. For example, only 37% of patients could calculate the number of carbohydrates consumed from a 20-ounce bottle of soda that contained 2.5 servings. Higher comprehension of food labels was significantly correlated (all *p* values were less than 0.001) with higher income ($\rho=0.39$), education ($\rho=0.49$), literacy ($\rho=0.52$), and numeracy ($\rho=0.67$).

Conclusions: Patients demonstrated deficits in understanding nutrition labels. Poor label comprehension was highly correlated with low-level literacy and numeracy skills, but even patients with higher literacy could have difficulties interpreting labels. Providers need to consider patients' literacy and numeracy when providing dietary recommendations. Opportunities may exist for the U.S. Food and Drug Administration to promote changes to make food labels more comprehensible.

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Introduction

Nutrition labeling is mandatory for most packaged food in the United States, and is regulated by the Food and Drug Administration (FDA) and the U.S. Department of Agriculture. In 1993, the nutrition label format was revised to improve consumer use. The majority of the nutritional information is condensed into a nutrition facts panel located on the product. The nutrition facts panel typically consists of the following components: (1) serving size information,

(2) calorie information, (3) percent daily value (based on a 2000-calorie diet), (4) nutrient information, and (5) a footnote of recommended daily values for standard 2000- and 2500-calorie diets.

Understanding nutrition labels may be important for patients to follow dietary recommendations. This is particularly true for patients with chronic illnesses such as hypertension, heart failure, diabetes, and obesity. Healthcare providers often recommend specific dietary guidelines such as those developed by the National Cholesterol Education Program,¹ or the American Heart Association,² expecting that patients can read and interpret nutrition labels well enough to follow these recommendations. Commercial diet plans, particularly those advocating low-carbohydrate diets, also often require patients to read and understand nutrition labels.^{3,4} Label information pertaining to newer "low-carb" products are not well regulated by the U.S. Food and Drug Administration (FDA) and may be more challenging to understand. To date, limited research

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has been performed to examine patient comprehension of nutrition labels, and no published research has examined patient understanding of new low-carb food labels.^{5–14} Comprehension of current food labels may be difficult for many patients, particularly those with low literacy and numeracy skills, but this has not been examined. This is critical because as many as 90 million Americans have inadequate literacy and numeracy skills to function in today's healthcare environment.^{15–17} Numeracy, the ability to use and understand numbers in daily life, may play a particularly important role in patients' ability to read and interpret nutritional information.

This study examines patients' ability to read and understand nutrition information from food labels. It hypothesized that patients would find food labels difficult to understand, and that poorer patient comprehension of food labels would be significantly associated with worse underlying literacy and numeracy skills. The results of this study may help shape provider practice and inform recent FDA discussions on altering food labels to improve their use.¹⁸

Methods

A cross-sectional study was performed to examine patient understanding of nutrition labels and the relationship between patient characteristics and their nutrition label comprehension. The Institutional Review Board at Vanderbilt University (Nashville TN) approved exemption of study review since no specific patient identifiers were collected. All subjects did provide oral consent to participate after the risks and benefits of the study were explained.

Patients and Study Setting

A convenience sample of patients was recruited from an academic primary care clinic where faculty and residents care for a socioeconomically diverse range of patients. From June 2004 to April 2005, physicians referred patients aged 18 to 80 years for possible participation. Patients were excluded if they had poor vision (>20/50 on Rosenbaum pocket screener), had significant dementia or psychiatric illness, or were non-English speaking.

Measures

All interested patients were administered (1) a questionnaire to assess demographics and behaviors related to nutrition label usage, (2) a validated health-literacy measure (Rapid Estimate of Adult Literacy in Medicine [REALM]),^{19,20} (3) a validated measure of mathematics skills (Wide Range Achievement Test, third edition [WRAT-3]),²¹ and (4) a Nutrition Label Survey (NLS). The NLS was designed with input from registered dietitians, primary care providers, and experts in health literacy/numeracy to evaluate patient understanding of current nutrition labels. Questions were developed based on food label educational materials offered by the Center for Food Safety and Applied Nutrition of the FDA.²² The NLS consisted of 24 questions. All questions

involved patients examining actual food labels that had been collected from a local grocery store. The first 12 items of the survey were open-ended and asked subjects to interpret the food labels, such as determining carbohydrate or caloric content of an amount of food consumed. The second 12 items asked patients to choose which of two foods had more or less of a certain nutrient, giving patients a 50/50 chance to guess the correct food item. Half of the survey questions involved products that were clearly labeled on their package as "reduced carb," "low carb," or designed for "a low-carb diet." These items all used the term "net carbs" to define the carbohydrates thought to have less impact on blood glucose; the amount of net carbs was clearly calculated somewhere on the label as total carbohydrates minus dietary fiber and sugar alcohols (if present).

Data were collected by trained research assistants in the clinic rooms. Patients typically completed the materials right before or after a clinic visit. There was no time limit for completion of the NLS. Survey questions were read to the subject by the research assistant. Subjects were provided paper and pencil to perform calculations as needed. To accommodate subjects who may have answered the latter questions of the test incorrectly due to fatigue with the material, the order of the questions on the NLS was altered with every other patient.

Analyses

Statistical analyses were performed using Stata, version 8.0 (College Park TX, 2003), and R 2.1.0 (www.r-project.org). Descriptive statistics of all variables, including the individual items of the NLS, were performed. Literacy, measured with the REALM, was examined as both a continuous variable (raw score) and a categorical variable (grade level). Numeracy, as measured with the WRAT-3, was also examined as both a continuous variable (standard score) and a categorical variable (grade-level equivalent). Patient characteristics were stratified by literacy and numeracy status using *t*-tests or Wilcoxon rank-sum tests for continuous variables, and Fisher's exact test or chi square tests for categorical variables. For these analyses, a stratification of WRAT-3 and REALM scores at the 9th-grade level was chosen a priori.

Total NLS performance was calculated as percent of questions answered correctly (score 0% to 100%). The Kuder-Richardson coefficient of reliability (KR-20), a variant of the Cronbach's coefficient alpha designed for dichotomous items,²³ was calculated to measure internal reliability of the NLS questions, and was high (KR-20=0.87). Incorrect responses to the first 12 questions of the NLS were coded by two reviewers into three possible categories: (1) did not apply serving size/servings per container appropriately, (2) confused by extraneous or complex information, and (3) calculation or other errors. Agreement on the coding of responses by the two reviewers was high (κ for all items was 0.89). The mean number of errors identified by the reviewers in each category is reported.

The relationship between nutrition label scores and patient characteristics was analyzed using Wilcoxon rank-sum tests or Kruskal-Wallis tests. Correlations between performance on NLS and continuous outcomes, including literacy (REALM raw score) and numeracy (standardized WRAT-3 score) were performed using Spearman's rank correlation coefficients

(rho). Multiple linear regression was used to identify factors that were independently associated with improved performance on the NLS. Literacy skills (REALM raw score) and numeracy skills (standardized WRAT-3 score) were included in the multivariable analysis along with covariates that were chosen a priori, including age, gender, race/ethnicity, income, insurance status, presence of a chronic illness, education level, diet status, and label-reading frequency. All continuous variables on the outcome variable in the model were assessed for nonlinearity effect. Raw scores on the REALM and age were included in the model using restricted cubic splines to allow nonlinear association with the NLS score.²⁴ Residuals analyses of the linear regression were performed graphically to assess normality. Because data on body mass index (BMI) were missing for the first 48 (24%) consecutive patients enrolled, BMI was not included in the main multivariable model. In a sensitivity analysis including BMI in the multivariable model, BMI was not found to have significant impact on the primary findings.

Results

From July 2004 to May 2005, 234 patients were referred, and 200 (85%) of them completed the study. Five patients were not eligible (failed vision screen), 14 patients refused, and 15 patients started but did not finish the survey. Baseline characteristics are presented in Table 1. Sixty-eight percent of patients had at least some college education, and 77% had a minimum of 9th-grade level literacy skills. However, numeracy skills for 63% of patients were less than 9th-grade level. Over 40% had a chronic illness where specific dietary intervention is important (e.g., hypertension, diabetes), and 23% reported being on a specific diet plan. Most patients reported using food labels and found labels easy to understand. Patient characteristics, stratified by literacy and numeracy status, can be seen in Table 2. Patients with lower literacy on the REALM were more likely to be African American, have less education and lower income, lack private insurance, and have worse numeracy skills. Patients with lower numeracy performance on the WRAT-3 were more likely to be older and African American, have lower education and lower income, lack private insurance, report worse math skills, and have worse literacy skills than those with higher numeracy performance.

Overall, patients correctly answered 69% (standard deviation, 21%) of the NLS questions. Figure 1 represents patient response to selected NLS questions. For example, only 32% of patients could correctly calculate the amount of carbohydrates in a 20-oz bottle of soda that had 2.5 servings in the bottle. Only 60% of patients could calculate the number of carbohydrates consumed if they ate half a bagel, when the serving size was a whole bagel. Patients also had significant difficulties determining the net carbohydrates of a product. Only 22% of patients could determine the amount of net carbohydrates in two slices of low-carb bread, and only

Table 1. Patient characteristics and behaviors (*n*=200)

Patient characteristic	<i>n</i> (%)
Mean age (SD), years	43.0 (14.6)
Female	143 (72)
Race/ethnicity	
White	133 (67)
Black	50 (25)
Other	16 (8)
Education	
≤High school	65 (33)
Some college	68 (34)
College or more	67 (34)
Annual family income	
<\$20,000	50 (25)
\$20,000–39,999	48 (24)
\$40,000–59,999	44 (22)
≥\$60,000	56 (28)
Private insurance	145 (73)
Chronic disease^a	82 (41)
Mean BMI (SD)^b	29.8 (7.1)
Literacy status (REALM)	
≤3rd grade	4 (2)
4th–6th grade	12 (6)
7th–8th grade	30 (15)
≥High school	154 (77)
Numeracy skills (WRAT-3)	
≤3rd grade	21 (11)
4th–6th grade	71 (35)
7th–8th grade	34 (17)
≥High school	74 (37)
On specific diet plan^c	46 (23)
Reads food labels	177 (89)
Frequency of food label usage	
Daily	43 (22)
Few times per week	70 (35)
Few times per month	42 (21)
Rarely or never	45 (23)

^aChronic disease requiring dietary restriction. Includes hypertension, coronary artery disease, high cholesterol, diabetes, and heart failure.

^bBMI calculated by kg/m² (*n*=152 for this variable).

^cIncludes calorie-restricted diets, low-carbohydrate diets, vegetarian diets, Weight Watchers, and others.

BMI, body mass index; REALM, Rapid Estimate of Adult Literacy in Medicine; SD, standard deviation; WRAT-3, Wide Range Achievement Test, third edition.

23% could determine the amount of net carbohydrates in a serving of low-carb spaghetti. There were 970 errors identified on the subjects' responses to the first 12 items of the NLS. Common errors included (1) did not attempt to apply serving size/servings per container information or used it inappropriately (*n*=325), (2) confused by extraneous or complex information (*n*=369), and (3) calculation and other errors (*n*=276). Many patients were confused by the complexity of the nutrition label and could not find the proper information on the label, or incorrectly used the information in the percent daily value column or the 2000-calorie recommended daily allowance (RDA) footnote when this information was not relevant. Patients were also more likely to make errors if interpreting the label involved understanding fractions or decimals.

Table 2. Characteristics by literacy and numeracy status

Variable	Literacy level (REALM)			Numeracy level (WRAT-3)		
	<HS ^b (n=46)	≥HS (n=154)	<i>p</i> value ^c	<HS (n=126)	≥HS (n=74)	<i>p</i> value ^c
Mean age (SD), years	44 (17)	43 (14)	0.77	45 (15)	40 (13)	0.02*
Age ≥65 years (%)	13	7	0.21	11	4	0.08
Female (%)	78	69	0.25	76	64	0.06
Race/ethnicity (%)			<0.0001***			<0.0001***
White	36	76		58	81	
Black	58	16		35	8	
Other	7	8		6	11	
≤ High school education (%)	65	23	<0.0001***	45	11	<0.0001***
Income <\$40,000 (%)	80	41	<0.0001***	59	32	<0.0001***
Private insurance	53	79	0.001**	65	86	0.001**
Chronic illness ^a (%)	52	38	0.08	44	35	0.20
Obese (BMI ≥30) (%)	53	43	0.31	48	40	0.30
Reads food labels (%)	87	89	0.71	86	93	0.11
Mean WRAT-3 score (SD)	77 (14)	92 (15)	<0.0001***	—	—	—
<9th grade math on WRAT-3 (%)	91	55	<0.0001***	—	—	—
Mean REALM score (SD)	—	—	—	58 (13)	65 (2)	<0.0001***
<9th grade literacy on REALM (%)	—	—	—	67	95	<0.0001***

^aChronic disease requiring dietary restriction. Includes hypertension, coronary artery disease, high cholesterol, diabetes, and heart failure.

^bHS=high school level (9th grade or above) on the REALM or WRAT-3.

^c*p* values were obtained using Pearson chi-squared test (or Fishers Exact) or Wilcoxon rank sum tests.

**p*<0.05;

***p*<0.01;

****p*<0.0001 (all bolded).

BMI, body mass index; SD, standard deviation; REALM, Rapid Estimate of Adult Literacy in Medicine; WRAT-3, Wide Range Achievement Test, third edition.

T3 Scores on the NLS (Table 3) were lower for patients who were older, female, African American, obese, lacked private insurance, or had lower educational levels or chronic illness. Patients with less than 9th-grade literacy skills performed worse on the NLS than patients with higher literacy skills (51% vs 75% correct responses, *p*<0.0001). Similarly, patients with less than 9th-grade numeracy skills performed worse than those with higher numeracy skills (61% vs 84%, *p*<0.0001). Higher performance on the NLS was significantly correlated (*p*<0.001 for all comparisons) with higher income (*rho*=0.39), higher education (*rho*=0.49), higher literacy skills (*rho*=0.52), and higher numeracy skills (*rho*=0.67). In multivariate regression analysis, lower literacy and numeracy skills remained significantly (*p*<0.001) associated with poorer performance on the NLS, even after adjusting for age, gender, race/ethnicity, income, education, and other factors. Of note, there was a nonlinear relationship between literacy and performance on the nutrition label survey, but a strong linear relationship for numeracy skill and NLS performance (Figure 2).

Discussion and Conclusion

F2 This study is one of the first attempts to systematically characterize how patients comprehend nutrition labels and the relationship between patient comprehension and underlying literacy and numeracy skills. The study

demonstrates that patients can have many difficulties interpreting current food labels, and their performance is highly correlated with their underlying literacy and numeracy skills. Even patients with higher levels of education can struggle to interpret current food labels. Of particular concern are situations that involve interpretation and application of the serving size. This error can lead to both over-estimation and under-estimation of the amount of nutrients consumed. Patients also struggled with understanding the percent daily value information. Some patients inappropriately read the percent daily value information instead of the actual amount of a nutrient, perhaps because the percent daily value is the final column of information on the Nutrition Facts Panel. The footnote of daily values also appears to be a source of confusion. Some patients thought that the footnote of daily values was providing the nutrient information for the product they were consuming rather than providing recommended values for an entire day. This led to a gross over-estimation of the amount of nutrients consumed. Finally, newer low-carb products were particularly difficult for patients to understand—particularly when the net carbs information was located outside of the nutrition facts panel.

A 1996 survey found that food-label use increased after the FDA revised the food label in 1994; however, 70% of subjects still wanted labels to be easier to understand.²⁵ A recent systematic review noted few

Nutrition Facts	
Serving Size 1 bagel (104g)	
Servings Per Container 6	
Amount Per Serving	
Calories 290	Calories from Fat 20
% Daily Value*	
Total Fat 2g	3%
Saturated Fat 0.5g	3%
Cholesterol 0mg	0%
Sodium 540mg	23%
Total Carbohydrate 56g	19%
Dietary Fiber 3g	12%
Sugars 7g	
Protein 11g	
Vitamin A 0%	Vitamin C 0%
Calcium 10%	Iron 20%
* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:	
Calories: 2,000 2,500	
Total Fat	Less than 65g 80g
Sat Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g

Question: How many grams of total carbohydrates are in 1/2 of a bagel?

Correct response: 28 grams

Common errors: Did not apply serving size; incorrect calculation; read % Daily Value column for Total Carbohydrate (19%); used % Daily Value column in calculation.

Percent correct: 60%

Nutrition Facts	
Serving Size 5 pieces (39 g)	
Servings Per Container about 9	
Amount Per Serving	
Calories 210	Calories from Fat 110
% Daily Value*	
Total Fat 12g	18%
Saturated Fat 4.5g	23%
Trans Fat 0g	
Cholesterol < 5mg	1%
Sodium 115mg	5%
Total Carbohydrate 22g	7%
Dietary Fiber 1g	4%
Sugars 19g	
Protein 4g	
Vitamin A 0%	Vitamin C 0%
Calcium 2%	Iron 2%
* Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:	
Calories: 2,000 2,500	
Total Fat	Less than 65g 80g
Sat Fat	Less than 20g 25g
Cholesterol	Less than 300mg 300mg
Sodium	Less than 2,400mg 2,400mg
Total Carbohydrate	300g 375g
Dietary Fiber	25g 30g

Question: How many grams of dietary fiber are in 5 candies?

Correct response: 1 gram

Common errors: Multiplied dietary fiber by 5 (misinterpretation of serving size); multiplied total dietary fiber for a 2000 calorie diet (25g) by 5; multiplied % Daily Value column for Dietary Fiber (4%) by 5.

Percent correct: 66%

Nutrition Facts	
Serving Size 8 fl oz (240 mL)	
Servings Per Container 2.5	
Amount Per Serving	
Calories 100	
% Daily Value*	
Total Fat 0g	0%
Sodium 25mg	1%
Total Carbohydrate 27g	9%
Sugars 27g	
Protein 0g	
* Percent Daily Values are based on a 2,000 calorie diet.	

Question: You drink the whole bottle of soda. How many grams of total carbohydrates does this contain?

Correct response: 67.5 grams

Common errors: Did not apply serving size; incorrect calculation; read % Daily Value column for Total Carb. (9%) or used it in calculation.

Percent correct: 32%

theoretical label formats.^{5-14,26-31} In a study conducted at a shopping mall, 78% of subjects could compare two products, but only 20% could correctly calculate the contribution of a product to a daily diet, a task that required complex math.¹⁰

To the knowledge of the authors, this study is the first to demonstrate that patient understanding of current

Table 3. Patient characteristics and Nutrition Label Survey performance

Variable (n=200)	Mean nutrition score (SD) ^a	p value ^b
Age (years)		0.04*
<65	70 (21)	
≥65	59 (19)	
Gender		0.03*
Female	67 (21)	
Male	74 (20)	
Race/ethnicity		<0.0001***
White	74 (19)	
Black	57 (18)	
Other	77 (18)	
Education		<0.0001***
≤High school	55 (18)	
>High school	76 (19)	
Annual family income		<0.0001***
<\$40,000	63 (21)	
≥\$40,000	76 (18)	
Private insurance		<0.0001***
Yes	73 (20)	
No	59 (19)	
Chronic illness^c		0.03*
Yes	65 (20)	
No	72 (20)	
Body mass index^d		0.04*
<30	73 (21)	
≥30	66 (20)	
Literacy status (REALM)		<0.0001***
<High school	51 (16)	
≥High school	75 (19)	
Numeracy skills (WRAT-3)		<0.0001***
≤High school	61 (19)	
>High school	84 (13)	
On specific diet plan^e		0.07
Yes	74 (19)	
No	68 (21)	
Reads food labels		0.003**
Yes	71 (20)	
No	56 (21)	
Frequency of food label usage		0.002**
Few times per month to daily	72 (20)	
Rarely or never	60 (22)	

^aPercent correct on Nutrition Label Survey.

^bp values were obtained using Wilcoxon rank sum tests or Kruskal-Wallis tests.

^cIncludes hypertension, coronary artery disease, high cholesterol, diabetes, and heart failure.

^dBody mass index calculated by kg/m² (n=151 for this variable).

^eIncludes calorie-restricted diets, low-carbohydrate diets, vegetarian diets, Weight Watchers, and others.

*p<0.05;

**p<0.01;

***p<0.0001 (all bolded).

SD, standard deviation; REALM, Rapid Estimate of Adult Literacy in Medicine; WRAT-3, Wide Range Achievement Test, third edition.

Figure 1. Selected Nutrition Label Survey (NLS) questions.²²

high-quality studies about the comprehension of nutrition labels.⁵ Many previous studies have relied on patient self-report of comprehension without actually testing comprehension, used small focus groups of volunteers, or examined the subjects' understanding of

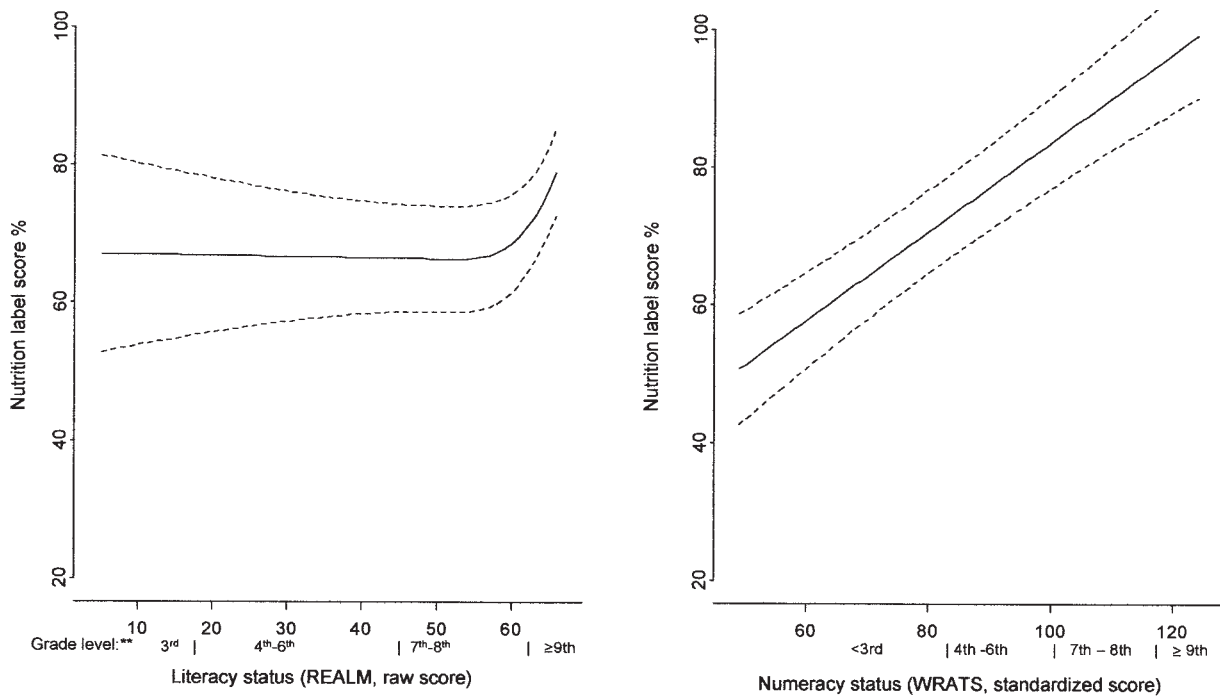


Figure 2. Predicted nutrition label score by literacy or numeracy status. Models were adjusted for age, gender, race/ethnicity, income, insurance status, presence of chronic disease, education level, literacy or numeracy, status of being on a specific diet, and label reading frequency. Dashed lines represent 95% confidence intervals. **Grade levels are approximations based on the REALM and WRAT-3 scores. REALM, Rapid Estimate of Adult Literacy in Medicine; WRAT-3, Wide Range Achievement Test, edition 3.

nutrition labels is highly correlated to their underlying literacy and numeracy skills. In multivariable analyses lower literacy status and numeracy status remained significantly associated with poorer understanding of nutrition labels even after adjusting for income, education, and other factors. Previous studies have demonstrated that patients with poor literacy skills have worse knowledge of their chronic illness and can have worse clinical outcomes.^{15,17,32} Numeracy, the ability to read and interpret numbers in daily life, is an important component of overall literacy that has not been well studied.^{33,34} Numeracy consists of a host of skills that includes basic computation, but also the ability to understand measurement, estimation, and logic, to perform multistep operations, and to infer what mathematical concepts need to be applied when interpreting a situation and then problem solve.^{33,34} In this study, a strong linear relationship was found between a patient's numeracy level and his or her ability to read and interpret nutritional information. Paying special attention to a patient's numeracy ability may be particularly important, since many patients may have adequate literacy skills but still have inadequate numeracy skills. Notably, the sample group was generally well educated and 77% had adequate literacy skills, and yet 63% had less than 9th-grade numeracy skills.

This study demonstrates that even patients with higher education can have difficulty understanding nutrition labels and has important implications for how

to educate patients about nutrition. Opportunities to improve patient nutrition knowledge and subsequent behavior include (1) improving patients underlying literacy and numeracy skills through the education system or adult literacy programs, and (2) providing accommodations, such as improved communication and education techniques, to help patients with poorer skills. Healthcare providers need to consider difficulties that patients may have in interpreting nutrition labels when they provide dietary recommendations—particularly for patients with chronic illness or obesity, for whom reading and processing information on labels may be particularly important. Providers need to be careful, for example, about asking a patient with heart failure or hypertension to limit their sodium intake to 2 g if the patient cannot accurately interpret food labels. Speaking clearly and concisely, avoiding jargon, setting realistic goals, and using low-literacy—oriented materials can aid patient comprehension.^{32,35–42} Asking patients to “teach back” information to confirm understanding may also improve patient understanding.^{40,43} Finally, the use of clinical educators, such as registered dietitians, who have resources and training to educate patients with low literacy or numeracy skills, may be beneficial.

Opportunities may also exist to improve comprehension of nutrition labels by improving their design. The FDA is in the process of considering changes to food labels aimed at improving comprehension. Any im-

provements should consider population literacy and numeracy deficits. Based on this study, five possible changes to the nutrition label to improve patient comprehension are suggested. First, better highlighting of the serving size and servings per container is recommended, perhaps even with written explanation when needed. Second, present nutrient information for the entire container for smaller items (e.g., 20-oz bottle of soda). Third, consider presenting minimum nutrient information for several possible servings of a product. For example, on the side of an ice cream pint, the label could state the following: "If you eat up to a line on the container (one fourth of total), you have consumed this many calories, carbohydrates, fat, and other nutrients," and "If you eat to this line (one half of the container), you have consumed this much," and so on. Fourth, remove extraneous information that few people appear to understand and is a constant source of confusion or misinterpretation (e.g., percent daily value and the footnote of daily values). Finally, indicate more clearly the net carbohydrates of a product and how it is defined, if this is considered an important factor for patients to know. This information should be placed in the carbohydrate section of the nutrition facts panel rather than in other locations on the food label. Making any of these suggested changes would obviously need to be formally tested before implementation.

There are several limitations to this study. As with all cross-sectional studies, the results can demonstrate associations but not causation. Patient performance on the NLS may have been inflated by the survey design (with 12 of the questions designed as dichotomous, giving patients a 50/50 chance on those questions with guessing alone), and the administration to a fairly well-educated population. Greater deficits in nutrition label comprehension may be apparent if this survey was given to a broader population. The study's measure of numeracy, the WRAT-3, is primarily a measure of calculation skills, although it has been shown to correlate with other numeracy skills.²¹ The study's measure of literacy, the REALM, provides a gross estimate of literacy level and may be hampered by ceiling effects, with the highest level of literacy defined as 9th grade or above. This study was not able to examine independent relationships between patient understanding of nutrition labels and specific patient illness. Finally, at this point, the authors of this study do not know if patient misunderstanding of nutrition labels actually translates into poorer dietary habits or worse clinical outcomes.

This study is one of the first to rigorously demonstrate that patient understanding of current nutrition labels can be challenging and is highly correlated to patients' literacy and numeracy skills. The results of this study suggest that there may be important opportunities for healthcare providers and the FDA to improve nutrition education and nutrition labels to improve patient understanding of nutrition information. Future

studies should examine the optimal design of food labels and the role of improved patient-provider communication to enhance patient comprehension and behavior.

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References

1. National Cholesterol Education Program. Detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III), September 1, 2002. Bethesda MD: National Institute of Health, 2002.
2. American Heart Association. An eating plan for healthy Americans. Available at: www.americanheart.org/presenter.jhtml?identifier=1088.
3. Atkins RC. Dr. Atkins' new diet revolution. New York: Avon Books, 2002.
4. Sears B. A week in the zone. New York: Harper Collins, 2000.
5. Cowburn G, Stockley L. Consumer understanding and use of nutrition labeling: a systematic review. *Public Health Nutr* 2005;8:21-8.
6. Food and Drug Administration. Food labeling: prominence of calories. Docket No. 2004N-0463, April 1, 2005, 21 CFR Part 101. Available at <http://www.fda.gov/ohrms/dockets/DOCKETS/04n0463/04n0463.htm>. AQ: 2
7. Food and Drug Administration. Food labeling: serving sizes of products that can reasonably be consumed at one eating occasion. Docket No. 2004N-0456, April 2005, 21 CFR Part 101. Available at <http://www.fda.gov/OHRMS/DOCKETS/dockets/04n0456/04n0456.htm>.
8. Food and Drug Administration. Report of the Obesity Working Group: calories count, March 12, 2004. Available at: www.cfsan.fda.gov/~dms/owg-toc.html.
9. Institute of Medicine. Dietary reference intakes: guiding principles for nutrition labeling and fortification. Washington DC: National Academies Press, 2003.
10. Levy AS, Fein SB. Consumers' ability to perform tasks using nutrition labels. *J Nutr Educ* 1998;30:210-7.
11. Levy L, Patterson RE, Kristal AR, Li SS. How well do consumers understand percentage daily value on food labels? *Am J Health Promotion* 2000;14:157-60.
12. Miller C, Brown J. Knowledge and use of the food label among senior women in the management of type 2 diabetes mellitus. *J Nutr Health Aging* 1999;3:152-7.
13. Miller CK, Probart CK, Achterberg CL. Knowledge and misconceptions about the food label among women with non-insulin-dependent diabetes mellitus. *Diabetes Educ* 1997;23:425-32.
14. Geiger CJ, Wyse BW, Parent CR, Hansen RG. Nutrition labels in bar graph format deemed most useful for consumer purchase decisions using adaptive conjoint analysis. *J Am Diet Assoc* 1991;91:800-7.
15. Ad Hoc Committee on Health Literacy for the Council on Scientific Affairs, American Medical Association. Health literacy: report of the Council on Scientific Affairs. *JAMA* 1999;281:552-7.
16. Kirsch I, Kader B, Jensen GV, Kopher W. Adult literacy in America. NCES 1993-275. Washington DC: National Center for Education Statistics, U.S. Department of Education, 2002.
17. Institute of Medicine Committee on Health Literacy. Health literacy: a prescription to end confusion. Washington DC: the National Academies Press, 2004.
18. Food and Drug Administration. FDA asking for public comment on food label changes, April 2005. Available at: www.fda.gov/bbs/topics/news/2005/NEW01170.html.
19. Davis TC, Crouch MA, Long SW, et al. Rapid assessment of literacy levels of adult primary care patients. *Fam Med* 1991;23:433-5.

20. Davis TC, Long SW, Jackson RH, et al. Rapid estimate of adult literacy in medicine: a shortened screening instrument. *Fam Med* 1993;25:391–5.
21. Wilkinson GS. WRAT-33: Wide Range Achievement Test administration manual. Wilmington DC: Wide Range Inc., 1993.
22. Food and Drug Administration. Food label education tools and general information. Washington DC. Available at: www.cfsan.fda.gov/~dms/lab-gen.html.
23. DeVellis RF. Scale development: theory and applications. Newbury Park CA: Sage, 1991.
24. Harrell FEJ. Regression modeling strategies. New York: Springer, 2001.
25. Kristal AR, Levy L, Patterson RE, Li SS, White E. Trends in food label use associated with new nutrition labeling regulations. *Am J Public Health* 1998;88:1212–5.
26. Barone MJ, Rose RL, Manning KC, Miniard PW. Another look at the impact of reference information on consumer impressions of nutrition information. *J Public Policy Mark* 1996;15:55–62.
27. Levy AS, Mathews O, Stephenson M, Tenney JE, Schucker RE. The impact of a nutrition information program on food purchases. *J Public Policy Mark* 1985;4:1–13.
28. Levy AS, Fein SB, Schucker RE. More effective nutrition label formats are not necessarily preferred. *J Am Diet Assoc* 1992;92:1230–4.
29. Levy AS, Fein SB, Schucker RE. Performance characteristics of seven nutrition label formats. *J Public Policy Mark* 1996;15:1–15.
30. Mitra A, Hastak M, Ford GT, Ringold DJ. Can the educationally disadvantaged interpret the FDA-mandated nutrition facts panel in the presence of an implied health claim? *J Public Policy Mark* 1999;18:106–17.
31. Roe B, Levy AS, Derby BM. The impact of health claims on consumer search and product evaluation outcomes: results from FDA experimental data. *J Public Policy Mark* 1999;18:89–105.
32. Dewalt DA, Berkman ND, Sheridan S, Lohr KN, Pignone MP. Literacy and health outcomes. A systematic review of the literature. *J Gen Intern Med* 2004;19:1228–39.
33. Montori VM, Rothman RL. Weakness in numbers: the challenge of numeracy in health care. *J Gen Intern Med* 2005;20:1071–2.
34. Golbeck AL, Ahlers-Schmidt CR, Paschal AM, Dismuke SE. A definition and operational framework for health numeracy. *Am J Prev Med* 2005;29:375–6.
35. Doak LG, Doak CC. Lowering the silent barriers to compliance for patients with low literacy skills. *Promotion Health* 1987;8:6–8.
36. Doak CC, Doak LG, Friedell GH, Meade CD. Improving comprehension for cancer patients with low literacy skills: strategies for clinicians. *CA Cancer J Clin* 1998;48:151–62.
37. Weiss BD, Coyne C, Michielutte R, et al. Communicating with patients who have limited literacy skills: report of the National Work Group on Literacy and Health. *J Fam Pract* 1998;46:168–76.
38. www.pfizerhealthliteracy.com/improving.html.
39. Rothman R, Malone R, Bryant B, Horlen C, Dewalt D, Pignone M. The relationship between literacy and glycemic control in a diabetes disease-management program. *Diabetes Educ* 2004;30:263–73.
40. Rothman RL, Dewalt DA, Malone R, et al. Influence of patient literacy on the effectiveness of a primary care—based diabetes disease management program. *JAMA* 2004;292:1711–6.
41. Pignone M, Dewalt DA, Sheridan S, Berkman N, Lohr KN. Interventions to improve health outcomes for patients with low literacy. A systematic review. *J Gen Intern Med* 2005;20:185–92.
42. Doak LG, Doak CC, Meade CD. Strategies to improve cancer education materials. *Oncol Nurs Forum* 1996;23:1305–12.
43. Schillinger D, Piette J, Grumbach K, et al. Closing the loop: physician communication with diabetic patients who have low health literacy. *Arch Intern Med* 2003;163:83–90.