Consumer confusion about wholegrain content and healthfulness in product labels: a discrete choice experiment and comprehension assessment

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Abstract

Objective: Using a legal standard for scrutinising the regulation of food label claims, this study assessed whether consumers are misled about wholegrain (WG) content and product healthfulness based on common product labels.
Design: First, a discrete choice experiment used pairs of hypothetical products with different amounts of WG, sugar and salt to measure effects on assessment of healthfulness; and second, a WG content comprehension assessment used actual product labels to assess respondent understanding.
Setting: Online national panel survey.
Participants: For a representative sample of US adults (*n* 1030), survey responses were collected in 2018 and analysed in 2019.
Results: First, 29–47 % of respondents incorrectly identified the healthier product from paired options, and respondents who self-identified as having difficulty in understanding labels were more likely to err. Second, for actual products composed primarily of refined grains, 43–51 % of respondents overstated the WG content, whereas for one product composed primarily of WG, 17 % of respondents understated the WG content.
Conclusions: The frequency of consumer misunderstanding of grain product labels was high in both study components. Potential policies to address consumer confusion include requiring disclosure of WG content as a percentage of total grain content or requiring disclosure of the grams of WG *v.* refined grains per serving.

Epidemiological evidence suggests that high consumption of whole grains (WG) protects against CVD[1–3], type 2 diabetes[4,5], cancer[1–3,6] and total mortality[1–3]. In 1999, the Food and Drug Administration (FDA) recognised the health benefits of WG by authorising a health claim linking WG intake with reduced risk of heart disease and cancer[7]. The 2015–2020 Dietary Guidelines for Americans (DGA) recommend that consumers 'make at least half of grains whole grains'[8], which is stronger than the 2000 DGA recommendation to consume 'a variety of grains daily, especially whole grains'[9]. Likewise, the American Cancer Society recommends choosing 'whole grains in preference to refined grain products'[10].

Food manufacturers have developed and marketed many new products with increased WG content, but they also use WG claims on less healthful products. In addition, the terms 'wheat,' 'multigrain' or 'made with whole grain'

may appear on products whose grain content comes primarily from refined grains. Previous research found that subsets of consumers have difficulty assessing WG content from food labels[11,12]. In light of the foregoing, the Center for Science in the Public Interest petitioned FDA to require disclosure of the refined grain and WG content on any product whose label makes a WG content claim[13]. Moreover, members of Congress proposed a bill that, if enacted, would require disclosure of WG content as a percentage of total grain content[14].

Policymakers seeking to enhance labelling requirements for WG claims must ensure that a proposed regulation does not violate the First Amendment of the Constitution, which protects commercial speech, including labelling[15]. Courts use two separate legal tests to determine if a regulation of commercial speech violates the First Amendment depending on whether the government

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seeks to require disclosure of factual information[16] or restrict commercial speech[15]. The government may require the disclosure of purely factual and 'uncontroversial' information about the product itself under the *Zauderer* test, as long as it is reasonably related to a governmental interest and is not unjustified or unduly burdensome[17,18]. Valid government interests include preventing consumer deception and promoting health[19]. Conversely, the government may ostensibly restrict commercial speech under the *Central Hudson* test if the restriction directly advances a substantial governmental interest and is not more extensive than necessary to serve that interest[20]. However, the Supreme Court has not upheld a commercial speech restriction under *Central Hudson* since 1995. Nonetheless, the Court has consistently maintained that the government may regulate misleading or deceptive commercial speech[19].

The Supreme Court has distinguished among three types of misleading or deceptive commercial speech: inherently misleading, actually misleading and potentially misleading. WG labels are not likely to be considered 'inherently' misleading because this has been found when terms have no inherent meaning[21]. For labels that are merely 'potentially' misleading (meaning that the information can be presented in a way that is not misleading), the government may order correction, revision or increased factual disclosures, but it cannot prohibit the claims[22]. The Supreme Court has stated that 'actually' misleading speech occurs when empirical evidence proves that the speech is 'misleading in practice,' and the government therefore may restrict such speech[22,23].

To assess the legal feasibility of proposals to regulate WG labels, it is essential to have better empirical information[19]. Thus, to measure the extent of consumer understanding and misunderstanding of grain product labels and their impact on consumer assessment of product healthfulness for a representative sample of US adults, this study uses an online discrete choice experiment with hypothetical products and survey questions about labels for actual products.

Subjects and methods

The study had two main components. First, in a discrete choice experiment, respondents were shown paired hypothetical products, with and without WG labels, and were asked, 'Which product is healthier?' In each pair, one product was nutritionally superior or inferior based on the disclosed nutrition information. Second, in a WG content comprehension assessment, respondents were shown real products with various WG content claims and were asked to identify the relative amount of WG. In addition, we asked five questions with Likert scale options for agreement/disagreement with statements about familiarity with or difficulty using WG labels (e.g. 'I find it difficult to determine which products contain whole grain').

Sample

The sample was recruited from US adult members of a large international panel from Survey Sampling International in 2018. The target sample size for this study was 1000, with sub-targets by race and ethnicity to match the US adult population. Members of the ongoing customer research panel were contacted by Survey Sampling International and offered the opportunity to respond to our online survey, for which they were compensated by Survey Sampling International. From the commercial survey panel, the recruited sample was chosen to match demographic characteristics of the US adult population by age, sex, race, Hispanic ethnicity, education attained and household income in seven broad categories.

Discrete choice experiment

Each respondent was asked about one pair of hypothetical products in each of the three product categories (cereal, crackers and bread). The respondent was shown the mocked up front-of-pack (the principal display panel) and a Nutrition Facts Panel and ingredient list identical to those required by the FDA for a side-by-side pair of hypothetical products (see online supplementary material, Supplemental Figures 1–3). The left or right position was assigned at random. The 'no WG label' product had no claim on the front of pack but had higher WG content according to the ingredients list and higher fibre content according to the Nutrition Facts Panel. The 'WG label' product had a WG content claim on the front of pack but lower WG content than the other option and had other nutritional disadvantages (e.g. higher sugar) according to the ingredients list and Nutrition Facts Panel, as noted below. From each pair, respondents were asked to choose which product was 'healthier,' with three multiple choice options ('A', 'equally healthy', or 'B'). By design, the 'no WG label' option was the healthier option, while the equal and WG label options were less healthy and thus incorrect. Similar to the large discrete choice literature in which respondents face a trade-off between a favourable characteristic and higher price[24], this experiment assessed how respondents balanced the appeal of the WG label on the front of pack against the information from the ingredients list and Nutrition Facts Panel.

Within each of the three product categories, there were three variations for the front-of-pack WG label (the cereal and cracker categories had 'made with whole grains,' 'multigrain' and a WG stamp; the bread category had 'multigrain,' 'wheat' and a WG stamp). Each respondent was shown just one randomly selected variation. For example, for the cereal category, the 'no WG label' had WG maize as the third ingredient, while the 'WG label'

Table 1 Characteristics of study sample and US adult population

	Frequencies (%)	
	Sample	USA (2017)*
n	1030	3 190 040
Age (years)		
18–24	9·5	12·2
25–34	19·8	17·8
35–44	20·3	16·4
45–54	17·7	16·8
55–64	16·1	16·7
65 or more	16·6	20·1
Sex		
Male	47·2	48·7
Female	52·8	51·3
Race		
White/Caucasian	77·3	74·0
Black/African American	14·0	12·3
Asian/Pacific Islander	4·6	6·0
American Indian/Alaska Native	0·8	0·8
Other race	3·2	6·9
Prefer not to say	0·2	n/a
Ethnicity		
Non-Hispanic/Latino	88·2	84·0
Hispanic/Latino	11·1	11·9
Prefer not to say	0·8	4·1
Education		
High school degree or less	29·5	45·0
Some college	25·9	24·3
College degree	30·0	18·6
Graduate school/professional degree	14·6	10·9
Household income		
<$25 000	20·7	20·3
$25 001–50 000	20·7	21·5
$50 001–75 000	23·5	16·5
$75 001–100 000	13·8	12·5
$100 001–150 000	14·9	14·5
More than $150 000	5·5	14·7
Prefer not to say	0·97	n/a

*US data from Census, 2018 (income variables) and Integrated Public Use Microdata Series (IPUMS), 2018 (all other variables).

products had more sugar and WG maize as the sixth ingredient.

We conducted a balance analysis to confirm no significant differences in demographic variables across the randomly assigned label variations and left/right position of the label. For descriptive analysis, we estimated frequencies for the choice of healthier label and cross-tabulations with the categorical question about self-reported difficulty determining which products contain WG. For multivariate analysis, we used an ordered logit model to test hypotheses and to estimate associations between explanatory variables and the propensity to select an incorrect label. The outcome variable was coded 1 (unlabelled), 2 (equally healthy), 3 (labelled), ordered from most correct to most incorrect. Coefficients in the ordered logit model represent the effect of explanatory variables on a latent variable, which determines the log-odds of choosing the next highest value of the outcome variable (e.g. choosing the equally healthy option over the unlabelled option or choosing the labelled option over the equally healthy option). The ordered logit model was also used to test whether respondent choices were associated with randomly assigned left/right position (which should be irrelevant), with the three product label variations, and with the questions about familiarity with or difficulty using WG labels. Control variables in an initial extended multivariate model were age, sex, race, Hispanic ethnicity, education and income; after excluding variables that were statistically insignificant for all three product categories, we retained age, race and education category in the main analysis.

Wholegrain content comprehension

For the four real grain products, each respondent was shown an image of the actual product packages from the manufacturers' websites, with the accompanying Nutrition Facts Panel and ingredient list. The respondents were asked to choose the best option on a four-point Likert scale ranging from 'All the grain is whole grain' to 'There is little or no whole grain', with a fifth option indicating 'other' responses. The four products were the following: (a) a 'honey wheat' bread that had 'unbleached enriched flour' as first ingredient and <1 g fibre, (b) a 'multigrain' cracker with 'enriched flour' as the first ingredient and <1 g fibre, (c) an apple cinnamon oat cereal whose package noted 'first ingredient whole grain oats' and 'simply made gluten free', with 'wholegrain oats' as first ingredient and 2 g fibre and (d) a '12 grain' bread with 'enriched wheat flour' as the first ingredient and 3 g fibre.

Analyses were conducted in 2018 and 2019 using Stata v14 (Stata Corp). The survey was reviewed and approved by the Tufts University Institutional Review Board (IRB). Each respondent gave informed consent on the first screen of the online survey.

Results

Sample characteristics

The survey respondents (*n* 1030) had a similar distribution in age, sex, race and Hispanic ethnicity as the US adult population in 2017 (Table 1). The survey respondents were more likely than the general US adult population to have a college or graduate degree (44·6 % *v.* 29·5 %), and slightly more likely to have mid-level household annual income ($50–75k) and less likely to have very high household annual income (above $150k). The balance analysis confirmed that sample characteristics were not significantly different across the randomly assigned left/right label position and the three randomly assigned label variations in the discrete choice experiment (see online supplementary material, Supplemental Table 1).

Discrete choice experiment

Although by design, the 'no WG label' option had more actual WG content, substantial fractions of respondents
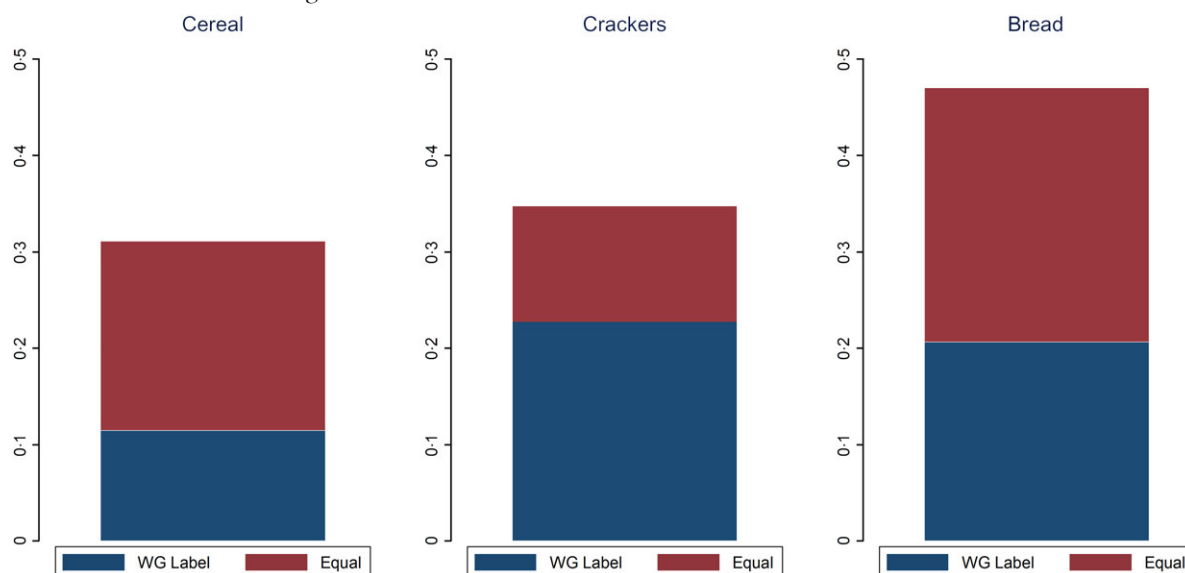
Fig. 1 (colour online) Relative frequency of incorrect responses (stating that the whole grain (WG) labelled option was healthier or both options were equally healthy, in trials of hypothetical product pairs for which the unlabelled option was healthier). Online supplementary material, Supplemental Table 1 provides standard errors, and Supplemental Figure 1 provides disaggregated results for three randomly assigned variations of the product labels

incorrectly identified the 'WG label' option as healthier or chose the 'equally healthy' option (Fig. 1). Disaggregated results and standard errors are in online supplementary material, Supplemental Table 2 and Supplemental Figure 1. For the cereal category, 31·1 % of respondents incorrectly chose the 'equally healthy' or 'WG label' options, with no significant difference across the three variations on WG labels (made with WG, multigrain and the WG stamp). For the crackers category, a substantial percentage also incorrectly answered and there were modest but statistically significant differences across the three variations: the frequency of incorrectly choosing the 'equally healthy' or 'WG label' options was 36·5 % for the made with WG label, 38·2 % for the multigrain label and 29·2 % for the WG stamp. For the bread category, 47·0 % of respondents incorrectly chose the 'equally healthy' or 'WG label' options, and, as with the cereal category, there was no significant difference across the three variations (multigrain, wheat and WG stamp).

There was wide variation in self-reported familiarity with or difficulty using WG labels (Table 2). More than 60 % strongly or somewhat agreed with a statement that they purposefully choose WG products. One-third strongly or somewhat agreed with a statement that they find it difficult to determine which products contain WG. Higher agreement with this latter statement about 'difficulty' was associated with higher frequency of choosing the incorrect 'equally healthy' or 'WG label' options in the discrete choice experiment (Table 3). For example, for the cereal category, among those who strongly agreed that they had difficulty, just 47·7 % correctly chose the 'no WG label' option; among those who strongly disagreed that they had difficulty, 72·8 % correctly chose the 'no WG label' option (Table 3).

In the multivariate analysis, for all three product categories, ordered logit estimates showed that the propensity to choose an incorrect unlabelled option was higher for younger respondents with high school or less

Table 2 Response frequencies for agreement with behaviour and attitude statements (%) (*n* 1036)

Statement	Strongly agree	Somewhat agree	Neither agree nor disagree	Somewhat disagree	Strongly disagree
'I find it difficult to determine which products contain whole grain.'	11·2	22·6	27·4	26·6	12·2
'I rely on statements made on the front of food packages to find healthy food.'	18·2	30·8	18·8	19·3	12·9
'I rely on the nutrition and ingredient information on food packages to find healthy food.'	39·6	44·8	10·9	2·9	1·8
'When buying certain foods, I purposefully choose whole grain products.'	23·5	38·8	23·2	9·8	4·8
'Eating more whole grains and less refined grains can help reduce the risk of heart disease and some cancers.'	36·3	40·2	19·1	2·7	1·7

Table 3 Relative frequency of correct responses and incorrect responses, disaggregated by agreement with a statement that 'I find it difficult to determine which products contain whole grain'*

Agreement with statement that 'I find it difficult to determine which products contain whole grain':	Cereal (*n* 1030)						Cracker (*n* 1016)						Bread (*n* 1022)					
	Which product is healthier?						Which product is healthier?						Which product is healthier?					
	No WG label claim		Equal		WG label claim		No WG label claim		Equal		WG label claim		No WG label claim		Equal		WG label claim	
	Correct		Incorrect		Incorrect		Correct		Incorrect		Incorrect		Correct		Incorrect		Incorrect	
	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE	%	SE
Strongly agree	47·7	4·8	27·9	4·3	24·3	4·1	41·1	4·7	34·8	4·5	24·1	4·1	36·3	4·5	25·7	4·1	38·1	4·6
Somewhat agree	62·8	3·2	26·0	2·9	11·3	2·1	61·2	3·2	26·9	2·9	11·9	2·2	49·6	3·3	24·3	2·8	26·1	2·9
Neither agree nor disagree	66·2	2·8	22·1	2·5	11·7	1·9	64·9	2·9	23·3	2·5	11·8	1·9	50·0	3·0	19·4	2·4	30·6	2·8
Somewhat disagree	84·0	2·2	11·3	1·9	4·7	1·3	77·2	2·5	16·5	2·3	6·3	1·5	63·3	2·9	18·5	2·3	18·2	2·3
Strongly disagree	72·8	4·0	12·8	3·0	14·4	3·2	68·8	4·2	16·8	3·4	14·4	3·2	59·2	4·4	16·8	3·4	24·0	3·8

*Images for the hypothetical product comparison are in online supplementary material, Supplemental Figure 2, and results for 4 more attitude statements are available on request.

education, who were Black or African American, and who self-reported more difficulty determining the WG content of foods (Table 4). In the cereal category, for example, the ordered logit coefficient of –0·449 indicates that older adults (aged 65+ years) were approximately 45 % less likely than younger adults (aged 18–24 years) to choose a more incorrect outcome category (i.e. choosing the equally healthy option over the correct unlabelled option

Table 4 Ordered logit estimates for propensity to respond incorrectly (stating that both options were equally healthy or the whole grain (WG) labelled option was healthier) when comparing hypothetical product pairs for which the unlabelled option was healthier*

Explanatory variables†	Cereal		Crackers		Bread	
	Coefficient‡	SE	Coefficient‡	SE	Coefficient‡	SE
Label variation 1§	(Comparison)		(Comparison)		(Comparison)	
Label variation 2	0·135	0·173	0·022	0·161	0·008	0·152
Label variation 3	–0·102	0·179	–0·351	0·170	0·087	0·153
'Difficult to determine' which products contain WG						
Strong disagreement	(Comparison)		(Comparison)		(Comparison)	
Some disagreement	–0·603	0·266	–0·297	0·246	–0·021	0·221
Neither	0·321	0·242	0·210	0·235	0·457	0·218
Some agreement	0·310	0·247	0·256	0·239	0·268	0·221
Strong agreement	0·936	0·275	0·963	0·267	0·687	0·254
18–24-year-olds	(Comparison)		(Comparison)		(Comparison)	
25–34-year-olds	0·442	0·264	0·513	0·259	0·105	0·244
35–44-year-olds	0·355	0·264	0·339	0·259	–0·013	0·242
45–54-year-olds	–0·153	0·278	–0·228	0·270	–0·479	0·249
55–64-year-olds	–0·411	0·296	–0·122	0·276	–0·511	0·258
Age 65 or more	–0·449	0·298	–0·815	0·303	–0·715	0·261
Black/African American	(Comparison)		(Comparison)		(Comparison)	
Asian/Pacific Islander and other	0·164	0·271	–0·339	0·277	–0·009	0·256
White/Caucasian	–0·368	0·193	–0·430	0·185	–0·598	0·181
College degree	(Comparison)		(Comparison)		(Comparison)	
Graduate/professional degree	0·088	0·233	0·110	0·224	0·342	0·205
HS or less	0·496	0·181	0·421	0·178	0·739	0·164
Some college	0·169	0·191	0·214	0·184	0·367	0·171
Cut point 1 (equal *v.* unlabelled)	0·929	0·364	0·550	0·351	0·061	0·335
Cut point 2 (labelled *v.* equal)	2·273	0·372	2·036	0·359	1·045	0·336
Obs	1015		1008		1013	

*Outcome variable coded 1 (unlabelled), 2 (equally healthy) and 3 (WG labelled).
†For simple comparisons across the three label variations, a reduced model without the 'difficult to determine' question is presented in online supplementary material, Supplemental Table 3. An extended model is presented in online supplementary material, Supplemental Table 4 (the additional variables were statistically insignificant for all three product categories).
‡Coefficient shows effect of each explanatory variable on the log-odds of having the next higher value of the outcome variable (i.e. choosing equally healthy over unlabelled).
§WG label variations for the cereal and cracker categories: (1) 'made with whole grains,' (2) 'multigrain,' and (3) a WG stamp; and for the bread category: (1) 'multigrain,' (2) 'wheat' and (3) a WG stamp.

Table 5 Wholegrain (WG) content comprehension questions for actual products with varying amounts of WG content*

Product description	Actual WG content	Frequency of respondent choices (%)				
		'All the grain is whole grain'	'Half or more than half the grain is whole grain'	'Less than half the grain is whole grain'	'There is little or no whole grain'	'Other'
Honey wheat bread	Less than half. Whole wheat flour (sixth ingredient) is less than unbleached enriched wheat flour (first ingredient).	17·89	24·95	22·44	30·46	4·26
Multigrain cracker	Less than half. Whole wheat flour (fifth ingredient) is less than enriched wheat flour (first ingredient).	14·33	26·62	30·40	25·56	3·10
Farmhouse twelve-grain bread	Less than half. Whole wheat flour (third ingredient) is less than enriched wheat flour (first ingredient).	22·14	29·13	27·86	18·16	2·72
Apple cinnamon oat cereal	Half or more. WG oats (first ingredient) is more than maize starch (third ingredient).	45·05	36·60	11·84	4·85	1·65

*Product images are in online supplementary material, Supplemental Figure 4.

Wholegrain content comprehension

Respondents showed substantial difficulty in identifying the WG content of four actual products found in the marketplace (Table 4). For three products (the honey wheat bread, multigrain cracker and farmhouse twelve-grain bread), the correct answers are 'less than half' or 'little or none' of the grain is WG because non-WG flour was the first ingredient and whole wheat flour was a lesser ingredient. Yet, the frequency of incorrectly stating that 'all the grain is whole grain' or 'half or more than half is whole grain' was 43 % for the honey wheat, 41 % for the multigrain cracker and 51 % for the farmhouse twelve-grain bread. For the fourth product, an apple cinnamon oat cereal, the correct answer was 'half or more than half the grain is whole grain' because it did have WG oats as the first ingredient and non-WG maize starch was a lesser ingredient. For this product, 37 % responded correctly and another 45 % responded that 'all the grain is whole grain' (which may be because maize starch is more difficult to identify as relevant to grain content from the ingredients list), while 17 % of respondents underreported the WG content (Table 5).

Discussion

For a survey sample of US adults, this study investigated consumer understanding of WG labels using, first, a discrete choice experiment with assigned pairs of hypothetical products and, second, a WG content analysis of consumer understanding of WG labels for actual products. The first analysis found that, depending on the product and label, 29–47 % of respondents incorrectly identified the healthiest product from paired options. The second analysis found that 17–51 % of respondents had difficulty identifying the WG content of actual grain products.

In the discrete choice analysis, respondents faced a trade-off between the appeal of WG content marketing (as indicated by front-of-pack labels) and the actual WG content and other nutritional advantages (as indicated by the ingredients list and Nutrition Facts Panel). For the cereal and crackers category, 31 % and 35 % of respondents, respectively, appeared to be misled by the front-of-pack label, incorrectly stating that both options were 'equally healthy' or that the 'WG label' option was healthier. For the bread category, the fraction of respondents that appeared to be misled was higher; 47 % chose the incorrect options. The tendency to choose the incorrect response was greater for respondents with less education or who reported having difficulty determining the WG content of products. In this sense, the consumers who are most likely to be misled by WG labels are themselves aware of the problem.

In the WG content analysis, consumers were shown images of the front of pack, ingredients list and Nutrition Facts Panel for actual products. For three products that really had less than half the grains as WG, but which had potentially confusing references to 'wheat' or 'multigrain', 43–51 % of respondents overstated the WG content. Conversely, for the fourth product, a WG oat cereal that really did have WG as the first grain ingredient (ordered by weight), 17 % of respondents erred in the opposite

direction and understated the WG content (they stated that less than half the grain was WG, when actually more than half the grain was WG).

This study corroborates previous research. An in-depth small sample study of eighty-nine older adults found that 37 % and 34 %, respectively, incorrectly identified a WG cereal and a cracker product[11]. For a bread product that was not WG, only 19 % correctly identified it as a refined grain product. Similar to our discrete choice analysis, subjects in that study appeared to be misled by the claims on the front of the package. A different study of 387 socio-economically diverse subjects in California used side-by-side comparisons of products in which 1 choice had less Na, fewer energies or more fibre[25]. That study found poor accuracy in using label information to compare nutritional qualities of cereal products, and analysis of eye tracking showed lower accuracy associated with more attention to front-of-pack information about energies, fat and Na, and higher accuracy associated with more attention to fibre and sugar information. Higher accuracy was also associated with greater nutrition knowledge. As in the present study, there was evidence that subjects can be misled by marketing information on the front of food labels.

The current study has potential policy implications for Federal Trade Commission oversight over false, unfair, and deceptive advertising, FDA oversight over food labelling, and for the DGA, which are the basis for government food programmes. The Federal Trade Commission is responsible for identifying deceptive advertising, which includes representations or omissions that are likely to mislead consumers and affect consumers' decisions about a product[26]. The Federal Trade Commission often relies on survey evidence to determine if 'at least a significant minority of reasonable consumers' were misled by a representation or omission[27]. Courts have upheld the Federal Trade Commission's finding of deception when far fewer respondents (10·5–17·3 %) were found to be misled than in the current study[28]. In one case comparable to the WG findings here, survey evidence revealed 20–36 % of the respondents were misled by the term 'biodegradable' on plastic containers[29]. The Sixth Circuit found that a significant minority of consumers were misled. Similarly, in the case of WG labelling, survey evidence of consumer misunderstanding may indicate that labels are deceptive.

Courts are increasingly sceptical of WG-related claims. In one case, a court found that even if the name of Subway's breads, Nine-Grain Wheat and Honey Oat, is 'literally true,' it is a question for the fact-finder (e.g. the jury) whether 'the manner in which Subway markets its . . . breads could have a tendency to mislead a reasonable consumer' about the breads' WG content[30]. Likewise, the Second Circuit found that a reasonable consumer could be misled by Kellogg Company's Cheez-It crackers, labelled 'whole grain' or 'made with whole grain,' to 'believe that the grain in whole grain Cheez-Its was predominantly whole grain'[31].

The FDA is responsible for regulating the labels of the majority of food products in the US, including WG products. Claims similar to those studied here may be considered 'actually misleading' and thus amenable to prohibition in the contexts in which they were tested[32]. Short of such prohibition, potential policy options include prescribing the ingredients for WG products as the FDA has done for whole wheat macaroni products[33]; requiring disclosure of WG content as a percentage of total grain content[14]; or requiring disclosure of the grams of WG *v.* refined grains per serving[13]. These options would be in line with FDA's current regulatory scheme and consistent with potential planned changes under its proposed Nutrition Innovation Strategy[34]. The present study may inform the policy merits and legality of such proposals.

The 2015–2020 DGA noted that distinguishing WG from refined grains is especially important because Americans are currently consuming enough grains daily; however, over 40 % are not consuming enough WG[8]. Future DGA may consider providing practical information to Americans on how to identify WG or guide them to easy-to-identify WG such as WG rice or oats, to support informed decisions when purchasing grain products. The DGA influence nutrition policy beyond just consumer education, including nutrition standards in federal nutrition assistance programmes and the Nutrition Facts Panel design, so the next DGA may contribute to greater clarity in food labelling policy for WG.

This study had strengths and limitations. Our analysis used a large national US sample (*n* 1030) with targets for race, Hispanic ethnicity and sex that matched the US adult population. However, high-education respondents were moderately over-represented. Participants in ongoing consumer panels had to volunteer to respond to an invitation to complete our survey, so it is not possible to estimate the denominator for a formal response rate, which is a threat to external validity. This sample offered reasonable cost and low implementation burden. In our discrete choice experiment, we randomly assigned three variations of WG product labels, but our product pairs had just one labelled and one unlabelled product within each product category. We randomly assigned left/right position, which had no significant effect, but we did not randomly assign other differences in the product pairs (colour and hypothetical brand name). Future research might fully randomise all product differences. For the WG content analysis, our results apply to these four actual products, but these products reflect commonly found product characteristics in the marketplace.

Conclusion

This study confirms, through two distinct analyses, consumers have difficulty identifying the healthfulness and WG content of grain products. The high percentage of

consumers misled by the front-of-package marketing indicates government could regulate WG claims and product names consistent with the First Amendment.

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Supplementary material

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