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Impact of unstandardized food serving size on consumer behavior

Abstract

This study examines the impact of different food serving sizes on consumer behavior and whether or not standardizing food serving sizes would ease the task of nutritional information comparison. Five hundred nine food product labels of 37 food categories were examined using a web site called Foodfacts.com. In an attempt to explain the impact of standardized and unstandardized serving sizes for consumers, all serving sizes were adjusted to reflect the most commonly used serving sizes. A comparison of the data adjusted (standardized) versus unstandardized was then performed using entropy analysis. Some serving sizes are in grams, some are in ounces, some are in cups, some are in teaspoons, etc. Past research indicates that most consumers read nutritional information on food labels, but different serving sizes make it difficult for consumers to compare nutritional information. Data analysis showed that standardization of serving sizes provides full information and reduces uncertainty. This study has major implications for public policy changes. Standardization of serving sizes will result in reduction of healthcare costs and improved consumer health that justifies a small modification on food labels. This study differs from related studies by examining nutrients of unstandardized and standardized serving sizes. In addition, the statistical technique, entropy, used in this study allows examining which serving size provides more information.

Keywords: nutrition label, food serving size, obesity, standardization, entrophy.
JEL Classification: M37.

Introduction

According to recent news in the popular media, for the first time in two decades, The Food and Drug Administration (FDA) will propose changes to nutrition labels on food packages, having calorie counts in large bold type and adjusting serving sizes to reflect how much people really eat. The reason for this proposal is the fact that nutrition information on current food labels is based on eating habits and nutrition data from the 1970s and 80s. However, food portion sizes have expanded significantly during the last two decades and do not reflect how much average Americans eat. In addition to the large font size of calorie information, a separate line for sugars that are manufactured and added to food will be included.

Public health experts claim that manufactured sugars that are added to foods have contributed to the obesity problem in the U.S. (The New York Times, 2014). While this is a positive move on behalf of the U.S. government, it is only a beginning in having nutrition information on food labels that will help consumers who read nutritional information understand or easily notice the calorie and sugar information. At an anniversary ceremony of the Let's Move campaign, on February 27, 2014 in the White House, First Lady Michelle Obama and the FDA announced changes on food labels. The Let's Move campaign is aimed to reduce obesity, an epidemic that has caused rates of diabetes to rise, and has increased risks for cancer, heart disease and stroke.

In addition to major health risks, obesity has major cost implications both in working environment and in increasing health care cost. For example, costs associated with obesity among full-time employees alone estimated to be $73.1 billion (Finkelstein et al., 2010) and rising obesity rates are predicted to add an additional $200 billion a year in health care costs by 2018 (Thorpe, 2009). Most consumers do not completely understand the nutrition information on food labels and be able to compare nutritional information because of the different serving sizes used by the food industry. The use of different serving sizes is part of clever marketing efforts used by food marketers. Indeed, a major research conducted by Chandon and Wansink (2011) indicates that food marketers have created numerous ways that food marketing impacts the amount of food consumed by consumers and support obesity.

In the U.S., food serving sizes vary in great deal in so much so that they truly confuse consumers and make it very difficult to compare nutritional information. In contrast, in the **European Union** countries, food serving sizes are standardized as 100 grams or 100 millilitres, which makes it easy for consumers to read and compare nutritional information on food labels. Indeed, consumers prefer per 100 grams, European Union label over per serving, U.S. label format (Higginson et al., 2002). Since the nutritional information per serving size is confusing, most consumer who read food labels utilize daily allowance information for the nutrients. In fact, daily allowance/values format provides the most benefits for dietary management (Levy et al., 1996).

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However, since the serving sizes are not equal, consumers can easily be misled even by the use of this format.

A 1995 study indicates that 71 percent of a national sample read nutrition labels (Guthrie et al., 1995) whereas a 1997 study shows that more than 80 percent of the sample use food labels (Kreuter and Brennen, 1997). However, a more recent study, Cooking Light/Roper ASW survey indicates that 51% of the U.S. consumers use nutritional label information when purchasing groceries (Toops, 2006). According to Drichoutis, Lazaridis and Nayga (2006), most empirical research concerning label use have been based on Stigler's (1961) approach of cost and benefit analysis. Specifically, consumers will search for nutrition-related information if the costs (time spent reading labels) do not outweigh the benefits. Ranilović and Barić (2011) indicate that nutrition label design attractiveness and additional information could motivate consumers to read nutrition labels. The reasons for reading nutrition labels vary, but most consumers who believe that there is association between diet and cancer would read nutrition labels to select lower fat foods (Neuhouser et al., 1999). The same reasons mentioned here for reading nutrition labels may also apply to reading serving sizes. Drichoutis et al. (2006) also indicate that nutrition knowledge can affect reading nutrition labels. Unfortunately, there is no scientific evidence that whether or not nutritional information on food labels is beneficial or confusing to consumers. Similarly, there has been no research concerning how the nutritional information on food labels would change if serving sizes were to be uniformed. However, research conducted more than 20 years ago showed that consumers who are concerned about negative eating behavior had lower evaluation of foods that included negative nutrients (Moorman and Matulich 1993). Consumers see fat and calories as negative nutrients while they see fiber and protein as positive nutrients (Balasubramanian and Cole, 2002). Similarly, Drichoutis et al. (2006) consider fat and cholesterol as negative and fiber as positive nutrients.

According to Mohr et al. (2012), despite the extensive use of nutritional information, not all consumers use this information during decision-making. Accordingly, consumers focus their attention to food calories, but ignore serving size. More importantly, as indicated by Block and Peracchio (2006) accurate processing of current nutritional label information frequently requires mathematical computations and numerical conversions tasks (e.g., from grams to ounce, etc.) that consumers tend to perform poorly.

Currently, food producers have some flexibility in setting serving sizes, and they can select serving sizes that may make their products look healthy and more advantageous than competitors' products (e.g., fewer calories, less fat, less sugar or sodium, etc.). Indeed, Balasubramanian and Cole (2002) note that marketers would want to present nutritional information in such a way that would encourage consumer purchase. In fact, manufacturers, can impact consumer purchase intentions and choice if they can influence consumer perception by adjusting nutrition information (Russo et al., 1986). Thus, the goal of this research is to investigate how nutritional information would change when companies utilize standard/uniform serving sizes. While there have been many research studies about the impact of nutrition labeling on consumer behavior, there has been no research focusing on the impact of serving size information on consumer behavior. We try to fill this void by examining the currently unstandardized serving sizes and standardized serving sizes on food labels.

Title 21, Section 101.9 of the Code of Food Regulations provides information on food serving size and defines food serving size as (b) Except as provided in 101.9 (h)(3), all nutrient and food component quantities shall be declared in relation to a serving as defined in this section. The term *serving* or *serving size* means an amount of food customarily consumed per eating occasion by persons 4 years of age or older which is expressed in a common household measure that is appropriate to the food. When the food is specially formulated or processed for use by infants or by toddlers, a serving or serving size means an amount of food customarily consumed per eating occasion by infants up to 12 months of age or by children 1 through 3 years of age, respectively[1]. Despite the given serving size definition here, public policy makers allow variance from reference values in setting serving sizes when consumers actually think that serving sizes are standardized (Mohr et al., 2012). Indeed, FDA rules allow companies to use serving sizes as small as half or as large as double the standard serving, making different packages confusing to consumers who read nutritional information on food labels. Therefore, comparison of nutritional information of different brands and products can be very confusing as well as inaccurate. In an earlier research Mohr et al. (2012) stated that presenting nutritional information on a common metric (e.g., grams, ounces), would make comparisons across product versions much simpler for consumers. However, these researchers lacked empirical data as to how product nutritional information would change if the serving sizes were to be uniformed or standardized for same category of prod-

[1] See http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=101.9.

ucts. With this in mind this research examines the changes in nutritional values if the serving sizes were to be standardized, and compares the computed (adjusted/standardized) nutritional information to the current information on product labels.

1. Methodology

Five hundred nine food product labels of 37 food categories were examined using a web site called Foodfacts.com. Of the 37 food categories 12 had standard serving sizes. Apple juice (8 oz or 240 grams per serving), cane sugar (1 tsp or 4 grams per serving), and tomato sauces (1/2 cup or 120 grams) are some of the products with standardized serving sizes. Similarly, the following products also have standardized serving sizes – Balsamic, Vinegar, Candy Bar, Chocolate Syrup, Lemon Soda, Protein Bar, Sausage, Sliced Packaged American Cheese, and White Sliced Bread. The 25 food categories with varying serving sizes were closely examined (see Table 1).

The five nutritional information including fat, calories, cholesterol, sodium, and sugar, that were listed on product labels were recorded for analysis purposes. The rationale for selecting these five items was the fact that they have been studied as important elements in contributing to people's health (see Aygen, 2012). Indeed, some food manufacturers use reduction in these ingredients as a way to promote their products and create competitive advantage (e.g., reduced calories, reduced fat, reduced salt, reduced or no sugar, no cholesterol, etc.). These five nutritional pieces of information were compared among the actual amounts printed on the food labels and the computed amounts if the serving sizes were to be the same for each product category. For example, we could select serving size for cheese as 28 grams and calculate the amount of sodium, sugar, fat, etc. Accordingly, the same could be done for a brand of cheese with a serving size of 20 grams or 50 grams. Therefore, we computed the nutritional information for 509 food items by selecting the *most commonly used serving size* for each product category. We believe that food manufacturers select food serving sizes in such a way that their products will be seen as having fewer calories, fat, cholesterol, and possibly sugar and sodium. Consumers already recognize calories and fat as bad nutritional items (Balasubramanian and Cole, 2002).

2. Results

A quick observation of same type of product labels marketed under different brand names revealed that they have many different serving sizes. Indeed, serving sizes vary from product to product and even within the same product category. For example three different brands of chocolate syrup, America's Choice, Bosco, and Fifty 50 (used as part of breakfast food) use a common serving size of two tablespoons, but the actual weights are 38, 40, and 60 grams respectively. Similarly, many other products indicate their serving sizes as one-fourth of a full package instead of one-half or one full package showing the serving size much smaller than the actually consumed serving size. This situation while making it confusing for consumers in comparing different brands in terms of product ingredients also misguides consumers in terms of dietary information.

Mohr et al. (2012) kindly call presenting serving sizes smaller than they actually are as health framing and indicate that companies utilize this in packages that are intended to include multiple servings. For example, when we consider a well-liked American snack/desert such as cookies, the most common serving size is one cookie. However, the weight of a single cookie varies from 16 grams to 85 grams with an average cookie size of 27 grams. Naturally, the amount of sugar, carbohydrates, etc., per cookie are also different. Similarly, sliced white bread has the same measure (slice), but the actual weight per slice is different varying from 52 grams to 21.5 minimum with an average of 34.31 grams. Therefore one slice of white bread can be 34% heavier than the average slice of bread. It is also important to note that slices of different brands of white bread contain sodium levels ranging from 360 mg (Pillsbury) to 40 mg (Ener-G) with an average of 191 mg for all white breads (8% of daily-recommended allowance).

An examination of the over 509 food labels in this study showed that there are overall 93 serving sizes (e.g., slice is used for both ham, cheese, bread, etc.) or 134 different serving sizes for the product categories investigated as shown in Table 1. Hot cereal and cookies have the highest number of serving sizes (10) followed by pancakes, and pretzels (8). Interestingly the serving sizes also come in different types of measures, which make it very difficult and sometimes impossible to compare contents of a product by serving size. As seen in Table 1, hot cereal is sold in 10 different serving sizes such as: 1 bowl, 1 packet, 1/2 cup dry, 1/3 cup, 1/4 cup, 1/4 cup dry, 28 g, 3 tbsp, 3 tbsp dry, and 55 grams. Comparison of the contents for these kinds of serving sizes is a difficult task that most consumers ignore. Similar other situations can be seen in Table 1.

Table 1. Most commonly used food serving sizes and serving size varieties

Product category	Most commonly used serving sizes	All serving sizes
Baby food	1 jar	1 jar, 1 pouch, 113 g, 3 cube, 3.5 fl oz, 3.5 oz, 4 tbsp

Table 1 (cont.). Most commonly used food serving sizes and serving size varieties

Product category	Most commonly used serving sizes	All serving sizes
Brownies mix	1/20 package	1 brownie, 1/20 package, 1/20th dry, 1/6 package, 1/9 package, 2 brownie, 3 tbsp.
Canned corn	1/2 cup	0.8 oz, 1/2 can, 1/2 cup, 1/3 cup, 3 piece, 5 oz
Chicken sausage	1 link	1 link, 3 link, 7 link
Cold cereal - rice based	3/4 cup	1 cup, ¾ cup, 5/4 cup
Cooked shrimp	3 oz	11 shrimp, 3 oz, 5 shrimp, 7 shrimp, 9 shrimp
Cookies	1 cookie	1 biscotti, 1 cookie, 1 oz, 1 package, 1 pouch, 15 g, 2 cookie, 3 cookie, 6 cookie, 7 cookie (1 oz)
Egg noodles	2 oz	1/4 cup, 1 cup, 1.5 cup, 2 cup, 2 oz, 3/4 cup
Groats	1/4 cup	1 cup, ¼ cup
Hot cereal	1 packet	1 bowl, 1 packet, 1/2 cup dry, 1/3 cup, 1/4 cup, 1/4 cup dry, 28 g, 3 tbsp, 3 tbsp dry, 55 g
Iced tea	8 oz	1/2 tbsp, 1 cup, 16 oz, 8 oz
Low fat milk	1 cup	1 container, 1 cup
Multigrain bread	1 slice	1 slice, 2 slice
Pancakes (mix)	1/3 cup mix	1/2 cup mix, 1/3 cup dry mix, 1/3 cup mix, 1/4 cup mix, 24 g, 3 pancake, 40 g, 43 g
Pasta sauce	1/2 cup	1 cup, 1.4 oz, ½ cup
Pork sausage	1 link/2 oz	1 link, 2 link, 2 oz
Potato chips (family size)	1 oz	1 oz, 1 package
Pretzels	1 pretzel	1 pretzel, 10 pretzel, 11 pretzel, 13 pretzel, 17 pretzel, 24 pretzel, 3 pretzel, 5 pretzel.
Sliced ham	1 slice	1 slice, 2 slice, 3 slice, 4 slice, 6 slice
Tomato soup	1 9cup	1 cup, 1 envelope, 1 package, 1/2 cup, 1/3 cup, 3 tbsp
Tuna	2 oz	1/4 cup, 2 oz, 3 oz, 4.3 oz, 5 oz
Vanilla iced cream	1/2 cup	1 container, ½ cup, 26 piece, 3 fl oz.
Vanilla yogurt	4 oz	4 oz, 6 oz, 6.6 oz, 8 oz
Waffle	2 waffle	1 dish, 2 piece, 2 waffle, 3 waffle
Whipped cream	1 tbsp	1 tbsp, 2 tbsp

Comparison of the five nutritional information as currently presented on the food labels versus if the serving sizes were to be standardized (i.e. if food manufacturers were to adopt the most commonly used serving sizes within their industry – adjusted serving sizes) showed that all five nutritional pieces of information for the standardized/adjusted serving size would be different from the nutritional information on the current food labels using the current serving size (see Table 2). All five differences calculated are statistically significant and the means for all five nutrients can be seen in Table 2. Interestingly, when the serving sizes are adjusted to reflect the most commonly used serving sizes, the nutrition amounts are smaller for all five items. This means that if consumers were to follow the serving size information in consumption, their intake of the food contents would actually be less than the current food contents using the serving sizes currently present on food packages. However, this would depend on the serving sizes that are agreed by the food industry or the serving sizes mandated by the FDA. Table 3 shows the differences in nutritional information between observed/original and standardized serving sizes for different product groups. There are seven product categories (baby food, groats, multigrain bread, sliced ham, tomato soup, vanilla ice-cream, and vanilla yogurt) that differ when comparing the original and the adjusted nutrients. The amount of Sodium decreased per serving for five of the six product categories with the exception of sliced ham after standardization. All six differences were statistically significant at $p < 0.05$. Interestingly, the amount of sodium for tomato soup decreased from 527.42 milligrams to 188.13 milligrams when the serving size is adjusted (64% decrease). Other statistically significant differences can be seen in the Table.

Table 2. Overall descriptive statistics and paired sample t-tests results of common nutrition information

Nutritional information	Mean	Standard deviation	*t*-values	Significance
Fat information on food labels Fat information for standardized serving size	3.648 3.423	5.722 5.219	2.470	.014
Calorie information on food labels Calorie information for standardized serving size	131.596 124.657	88.536 83.834	2.376	.018
Cholesterol information on food labels Cholesterol information for standardized serving size	18.062 16.922	74.831 73.127	2.073	.039

Table 2 (cont.). Overall descriptive statistics and paired sample t-tests results of common nutrition information

Nutritional information	Mean	Standard deviation	*t*-values	Significance
Sodium information on food labels Sodium information for standardized serving size	219.22 198.424	288.316 278.399	2.474	.014
Sugar information on food labels Sugar information for standardized serving size	7.418 6.529	10.110 8.446	3.081	.002

Table 3. Statistically significant differences in nutrients between original serving sizes and adjusted serving sizes

Product category	Nutrient	Mean		Std. dev.		*t*-value	Sig.
		Original	Adjusted	Original	Adjusted		
Baby food	Sodium	15.15	11.33	13.56	9.61	2.956	0.008
	Sugar	11.10	9.04	4.93	4.68	2.132	0.046
Groats	Fat	2.20	2.38	0.91	0.96	-2.86	0.018
Multigrain bread	Fat	1.27	1.15	0.691	0.696	3.002	0.014
	Sodium	163.50	146.36	49.10	41.66	2.832	0.019
	Sugar	2.85	2.59	1.41	1.42	2.596	0.028
Sliced ham	Fat	1.19	1.42	1.15	1.01	-3.215	0.007
	Cholesterol	11.23	14.40	4.98	2.09	-3.365	0.005
	Sodium	242.76	322.68	89.16	54.01	-3.198	0.007
Tomato soup	Fat	1.07	0.34	1.27	0.62	2.618	0.017
	Sodium	527.42	188.13	301.23	320.19	3.884	0.001
	Sugar	10.84	3.84	5.47	7.67	3.600	0.002
Vanilla ice-cream	Fat	9.37	6.95	10.46	6.81	2.713	0.013
	Cholesterol	23.40	17.33	36.58	24.89	2.166	0.043
	Sodium	67.25	58.82	31.84	26.80	2.693	0.014
Vanilla yogurt	Fat	1.40	0.92	1.07	0.77	2.604	0.028
	Sodium	107.90	73.07	35.39	12.56	3.129	0.012
	Sugar	22.40	15.45	9.03	6.36	2.994	0.015

In support of the analysis for standardizing food-serving sizes, we also utilized information theory, ENTROPY. Entropy measures the uncertainty of a system (Shannon, 1948) as shown in the equation below:

For a random variable X with values in a finite set R, Shannon's entropy $H(x)$ can be defined as:

$$H(x) = -\sum p(x)\log p(x).$$

According to the information theory, having standard serving sizes for food products is better. If there is only one serving size for any food product, then the observed probability will be equal to one. Because the logarithm (for any base) of 1 is equal to zero, the entropy value will then be equal to zero, which means that there is full information. In this case entropy measures the serving size information present on food labels.

Calculated entropy values are shown in Table 4 and presented in Figure 1. As noted in Table 4, the entropy value for potato chips is the lowest, which means that the information for the serving sizes of potato chips is maximized compared to all other products. The reason for this is the fact that the serving sizes for potato chips are reported as two and most of them are sized as one ounce in the database. A sample calculation of entropy for baby foods products is shown in Appendix.

Table 4. Entropy values for unstandardized food serving sizes

Product	Serving size (most observed)	Entropy *H*(x)	Observations
Baby food	1 jar	2.29546	20
Brownies mix	1/20 package	2.64644	10
Canned corn	1/2 cup	1.55678	20
Chicken sausage	1 link	1.0958	11
Cold cereal - rice based	3/4 cup	1.24067	11
Cooked shrimp	3 oz	1.96096	10
Cookies	1 cookie	3.06596	20
Egg noodles	2 oz	2.09893	15
Groats	1/4 cup	0.469	10
Hot cereal	1 packet	3.10869	20

Table 4 (cont.). Entropy values for unstandardized food serving sizes

Product	Serving size (most observed)	Entropy *H*(x)	Observations
Iced tea	8 oz	1.03892	15
Low fat milk	1 cup	0.469	20
Multigrain bread	1 slice	0.469	10
Pancakes (mix)	1/3 cup mix	2.52193	20
Pasta sauce	1/2 cup	1.15678	10
Pork sausage	1 link/2 oz	1.52193	10
Potato chips (family size)	1 oz	0.2864	20
Pretzel's	1 pretzel	2.54644	20
Sliced ham	1 slice	2.07587	13
Tomato soup	1 9cup	1.77095	20
Tuna	2 oz	2.12581	12
Vanilla iced cream	1/2 cup	1.35678	20
Vanilla yogurt	4 oz	1.84644	10
Waffle	2 waffle	1.57095	10
Whipped cream	1 tbsp	0.469	10

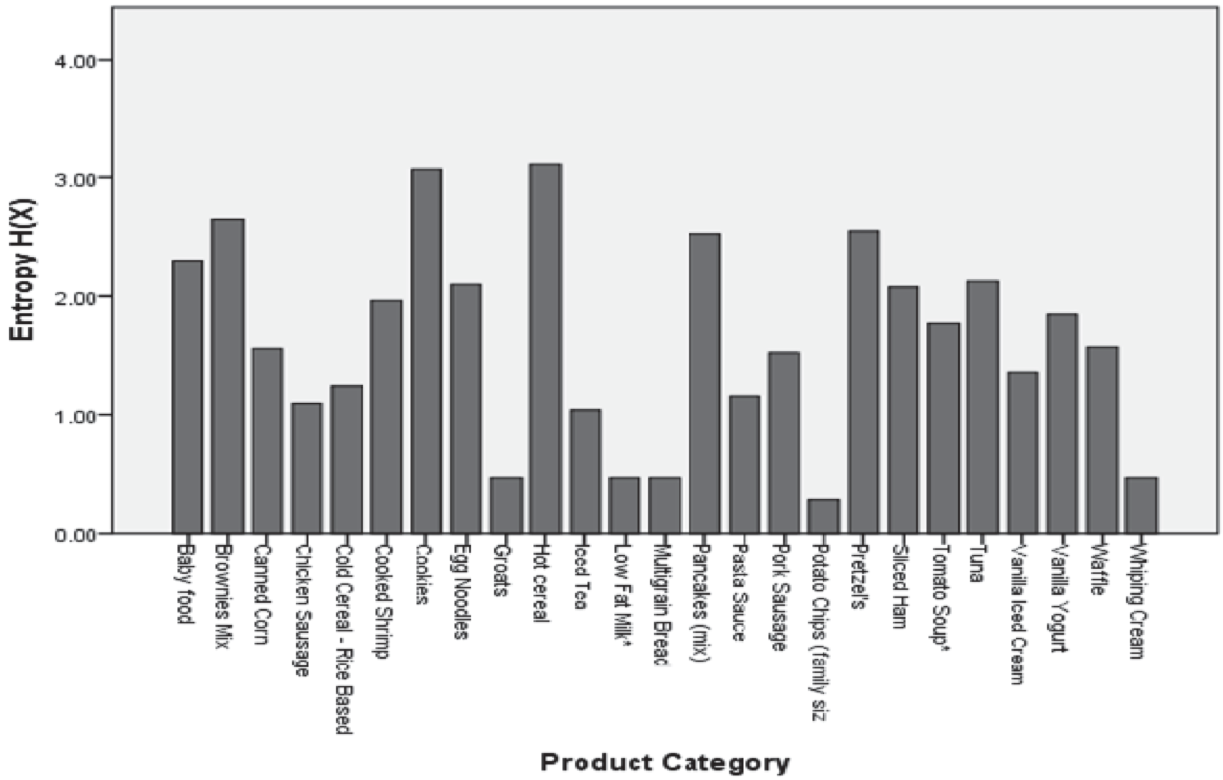

Fig. 1. Graph of entropy values for different product categories

3. Discussion

Consumers think that serving sizes are the identical for the same products. For example serving sizes such as slice for cheese, slice for bread, weight for breakfast cereal or snack foods such as roasted peanuts, and many other food products are perceived to be the same when in reality they are not. Unless consumers are very careful in reading an understanding the food labels before making purchasing decisions, they are highly likely to be misguided by the serving sizes presented on food labels (Mohr et al., 2012). This misguidance can have grave or deadly consequences since a person with an illness such as diabetes or high blood pressure may consume a product that is more than the usual serving size, which can increase blood sugar level or blood pressure. As indicated in the results section, there is a great deal of variance in nutrients among the slices of white bread. A serving of four slices of Pillsbury bread in a single day may actually fulfill 60% of an average consumer's daily allowance of sodium. Since people also obtain sodium from other products, one may easily go over the recommended daily allowance limit of 2,400 mg of sodium per adult. If a consumer has high blood pressure, the four slices Pillsbury bread (1,440 mg sodium) almost fulfills the consumer's daily allowance of 1,500 mg sodium.

This research shows that serving sizes are different from product to product and even among the same products with different brand names. Interestingly, if food manufacturers were to standardize serving sizes applying the most widely used serving sizes in their industries, on average, the nutrients per serving size for all products would actually decrease. This could help those consumers who utilize the serving size information to consume less food. Furthermore, consumers can also compare the nutrients for different products and brands when they shop for food.

Interestingly, manufacturers have discretion in setting the serving size when they produce food products in large units, which encourages increased consumption (Wansink, 1996). For example, potato chip producers examined in this study set serving sizes from 9 to 22 chips per serving size. Of course, the same size package with a smaller serving size will have more servings while having fewer calories, less fat, and less other nutrients per serving size. This may deceive consumers and even reduce the guilt of consumption similar to the low fat labels placed on product packages which increase consumption and reduce consumer guilt (Mccann et al., 2013; Wansink and Chandon, 2006). Research also shows that reduced fat labelled foods are more socially acceptable compared to standard food products and serve as a stimulus for over consumption (McCann et al., 2013). This same principle applies to low cholesterol, sodium, sugar and other food ingredients that consumers are concerned about.

As indicated above, when manufacturers of large size food products such as family size potato chips and other foods set serving sizes smaller than the actual serving sizes or consumption sizes, people may then over consume because of the inaccurate serving sizes which can, in some cases, help lead to obesity. For example, most potato chips labels suggest serving size of 13 chips despite the fact that the serving size is presented as one ounce. Do people count the number of potato chips they eat? Do most people stop eating after one serving? Most consumers exceed one serving size in one sitting – imagine someone watching football and eating potato chips! Furthermore, the sizes of the potato chips are not equal unless one buys Pringles or another brand packed one on top of another in sturdy packages. Having a large number of serving sizes confuses people and creates a level of uncertainty for consumers. As the entrophy analysis showed, fewer number of serving sizes rduces the level of uncertainty by providing comprehendable and clear information.

Public policy implications and future research

Changes in food labeling, while it may result in substantial expense to food manufacturers, it will reduce the healthcare cost and help people live healthier lives. The most recent changes proposed (calorie and sugar information on food labels), while minor, would cost $2 billion to implement. However, the health benefits could eventually be as much as $30 billion as indicated by Michael R. Taylor, the FDA's s deputy commissioner for foods (New York Times, 2014). Having a uniform serving size will cost more than the cost of making a minor change on the food labels, but the health benefits will eventually be enormous, and easily exceed $30 billion.

The current food labels make it very difficult and sometimes impossible for consumers to compare nutrition information because the serving sizes are not equal even for same type of products. The nutrition information on food labels can only be compared accurately if the serving sizes for the same product categories are equal. For example, when a consumer attempts to purchase cheese that has the least amount of sodium, s/he would have a very difficult time because the serving size for cheese varies from 3 to 16 ounces. As if this variation in weights is not enough to create confusion, labels on cheese packages also indicate that many of them have serving sizes such as cubes, grams, pounds, teaspoon, cup, slice, etc. However, if cheese producers and other food companies had a single serving size such as three or six ounces, or 28 grams, etc., then comparison of nutritional information would be easier and meaningful for consumers. The results of this study clearly recommend that food-serving sizes contain information very much like the unit pricing information present on store shelves (e.g., price per pound, per ounce, etc.) in nineteen states and two U.S. territories. If the European Union countries can have standardized serving sizes such as 100 grams or 100 millilitres, then it can be done in the U.S. as well.

Benefits of having uniform serving food sizes are enormous both in terms of improving public health and in lowering healthcare costs in the nation. Here are some simple examples.

1. Consumers will be able to compare calorie amount per serving in different foods and make more informed product choices. In addition, consumers will also know the amount of calories from processed sugar among other things.
2. A person with high blood pressure will be able to select food products with low sodium to help control blood pressure.
3. A person with diabetes will be able to control choose products with different sugar and carbohydrate contents that will help control diabetes.
4. A healthy or unhealthy person will be able to compare fat amount in different foods and control fat intake. In addition to total fat information, a person will also be able to compare different kinds of fats (e.g., saturated fat and trans fat, po-

lyunsaturated fat, and monounsaturated fat).

5. A healthy or unhealthy person will be able to control cholesterol intake from different foods and help reduce or control cholesterol level.
6. Consumers will make better decisions when selecting foods with healthy ingredients such as vitamins, fibers, and other important nutrients.

In addition to the food serving size, there are other issues that FDA and the U.S. Congress must deal with. Many of the food terminologies placed on food packages confuse consumers and influence them to over consume many food products. For example, fat free, reduced fat, reduced calories, low calorie, low fat, low saturated fat, low salt, reduced or low cholesterol, no cholesterol, no sugar, sugar free, no sugar added, no salt added, diet, light, and many other gimmicky words found in the English language create confusion in most cases. Future research is needed in understanding consumer perception of food labels/packages and advertising slogans used to lure consumers to prefer certain foods and brands.

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Appendix

Information on entropy and a sample calculation

Entropy was introduced by Claude E. Shannon (1949), and it measures uncertainty of a system. A maximum entropy (maxent) density can be obtained by maximizing Shannon's information entropy measure subject to known moment constraints. According to Jaynes (1957), the maximum entropy distribution is uniquely determined as the one which is maximally noncommittal with regard to missing information, and that it agrees with what is known, but expresses maximum uncertainty with respect to all other matters. The maxent approach is a flexible and powerful tool for density approximation, which nests a whole family of generalized exponential distributions, including the exponential, Pareto, normal, lognormal, gamma, beta distribution as special cases (Wu, 2003). For a random variable X with values in a finite set *R*, Shannon's entropy *H(x)* can be defined as (1).

$$H\left(x\right)=-\sum_{x\in R}p\left(x\right)\log p\left(x\right), \quad (1)$$

if one considers the restriction as (2).

$$\sum_{i=1}^{n}p_i=1. \quad (2)$$

Then solution of entropy function under this restriction for baby food can be written as:

Serving sizes and their probabilities of the products in the category of baby food.

Serving size	1 jar	1 pouch	113 g	3 cube	3.5 fl oz	3.5 oz	4 tbsp
p(*x*)*	0.45	0.2	0.1	0.05	0.1	0.05	0.05

Notes: *p**: Probability.

H(x) = -[(0.45log20.45)+(0.2log20.2)+(0.1log20.1)+(0.05log20.05)+(0.1log20.1) + (0.05log20.05)+(0.05log20.05)]

H(x) = -[(-0.518)+(-0.464)+(-0.332)+(-0.216)+(-0.332)+(-0.216)+(-0.216)]

H(x) = -[-2.29546]

H(x) = 2.29546