The Brazilian population consumes larger serving sizes than those informed on labels

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Abstract

Purpose – The purpose of this paper is to relate average serving size intake by the Brazilian population and declared serving size, the presence of trans fat and household measure fractioning declared on labels of processed, and ultra-processed food products.

Design/methodology/approach – Cross-sectional study that analyzed the food labelling of all processed and ultra-processed food products sold in a supermarket in southern Brazil.

Findings – A total of 1,071 processed and ultra-processed food products were analyzed. In 88 per cent of food groups, the average serving size consumed was larger than what was declared on labels. Consumed serving size was up to 9.2 times larger than the declared ones in food products with trans fat among their ingredients list and in false negatives and up to 9.9 times larger in foods with fractioned household measure ($p < 0.001$). The Brazilian population consumes, on average, larger serving sizes than those declared on labels, which may represent a significant intake of trans fats without the consumers' noticing.

Originality/value – This study has been performed with the use of a national database on food consumption, as well as the information from a large number of processed and ultra-processed food labels marketed in Brazil. This study is also proven to be important and novel, contributing with information as to the manner in which nutrition labelling has been presented to Brazilian consumers, discussing its possible consequences for food choices, intake, and the guarantee of consumer rights.

Keywords Food consumption, Food labelling, Nutritional information, Trans fatty acids, Ultra-processed food

Paper type Research paper

Introduction

A nutritional transition, characterized by changing in life styles and eating patterns, has been observed in the last decades, in several countries as well as Brazil. Among eating patterns changes, an increase in the consumption of animal, processed, and ultra-processed food products has been replacing consumption of grains and cereals (World Health Organization, 2004; Popkin, 2006; Popkin *et al.*, 2012; Malik *et al.*, 2013).

Processed food products are derived from *in natura* foods and converted into less perishable food products, as well as more palatable and more attractive through the addition of salt, sugar, and/or fat, or submitting food to techniques such as roasting and smoking. Ultra-processed food products are ready or semi-ready to consume, obtained total, or partially from industrial ingredients. They have low nutritional value, low

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amount of fibre, and high amounts of energy, simple carbohydrates, sodium, trans fats, and/or saturated fat (Monteiro *et al.*, 2012).

Studies performed in Brazil demonstrate the availability and consumption of foods with trans fat content. Castro *et al.* (2009) have shown that the average intake of trans fats in the city of São Paulo was of 5.0 g/day, and up to 7.8 g/day among adolescents. In addition, Silveira *et al.* (2013) have found that processed and ultra-processed food products with trans fats can be up to 69.5 per cent less expensive than foods without this type of fat.

The intake of industrial trans fats is associated to the development of several diseases, such as cancer, diabetes, and heart disease (World Health Organization, 2004; Mozaffarian *et al.*, 2009). To that end, the World Health Organization (WHO) recommends the elimination of this type of fat since 2004, through the Global Strategy on Diet, Physical Activity and Health, with a reinforced recommendation in 2013 (World Health Organization, 2013). Furthermore, nutrition labelling can be a strategy to inform and educate consumers (Bosman *et al.*, 2014) in order to reduce trans fat intake (World Health Organization, 2004, 2013).

However, Brazilian laws regulating nutrition labelling in the country allow food companies to claim "zero trans fat" or "trans fat free" on food packaging if the amount of trans fat per serving is under 0.2 g, which is considered negligible by the legislation (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003a). Moreover, the lack of standards in potentially including trans fat nomenclature of components within ingredients list in food products may induce misinterpreting, such as "vegetable fat" or "margarine" (Silveira *et al.*, 2013; Hissanaga *et al.*, 2012; Proença and Silveira, 2012). In consequence, consumers may have difficulty in controlling trans fat intake by compromising understanding of nutritional information, which must be clear and precise (Bryant and Dundes, 2005).

Brazilian legislation also sets recommended serving sizes in grams or millilitres to be declared on labels for most foods, and requires information about respective household measurements (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). As a result of this public policy, it is expected that such information will become standardized, allowing for comparisons of similar foods, facilitating food choices and promoting the intake of appropriate quantities. Nevertheless, Brazilian law allows serving sizes declared on nutrition labels to vary in relation to the recommended value (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). Studies performed in Brazil (Castro *et al.*, 2009), the USA (Bryant and Dundes, 2005; Remig *et al.*, 2010), and Europe (Steenhuis and Vermeer, 2009; Ueland *et al.*, 2009; Reeves *et al.*, 2011) have presented a discrepancy among serving sizes usually consumed by the population and what is declared on food labels.

It can be suggested that, due to the Brazilian law for nutrition labelling, the intake of trans fat can occur unknowingly and in quantities larger than recommended. Upon the light of such issues, this study aims to relate average serving size intake by the Brazilian population with declared serving sizes, presence of trans fat and household measure fractioning declared on labels of processed and ultra-processed food products.

Methods

Data collection

This was a cross-sectional study that analyzed the food labelling of processed and ultra-processed food products sold in a randomly chosen supermarket in the city of Florianópolis, a capital located in southern Brazil. This supermarket belongs to a large supermarket chain with 21 stores in the southern region of Brazil, six of which located

in Florianópolis. Most products sold in these stores are similar to those sold in other large supermarket chains throughout the country. Data were collected in May 2010 by trained dieticians. The research was allowed by the supermarket manager.

A previously tested form was used to collect information reported on packaging, such as product identity (product, commercial name, flavour, brand) and information on trans fat (presence of components containing trans fat in the ingredient list, presence of the item "trans fat" on the nutrition facts label, amount of trans fat per serving on the nutrition labelling, and claims of "no trans fat" on the packaging).

The information on the packaging of identical products with different sizes was registered separately, as their list of ingredients also differed.

Processed and ultra-processed food products

In order to select processed and ultra-processed food products, a list of foods was chosen from the Analysis of Personal Food Consumption in Brazil of the Consumer Expenditure Survey 2008-2009 (*Pesquisa de Orçamentos Familiares* – POF) (Instituto Brasileiro de Geografia e Estatística (IBGE), 2011) performed by the Brazilian Institute of Geography and Statistics (*Instituto Brasileiro de Geografia e Estatística* - IBGE).

From the eligible processed and ultra-processed food products available in the market, foods which did not apply to the Brazilian law of nutrition labelling, such as food additives and products fractioned at retail and marketed as pre-measured by the supermarket, have been ignored (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003a). Concentrated, powdered, and dehydrated products have also been excluded, as well as mixtures with no yield information and foods which followed the Brazilian legislation (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b) and presented serving size by household measurement and not by amounts in grams or millilitres, or foods which did not present information on household measurement.

Data analysis

The collected data were entered into two separate databases and was subsequently checked for errors and validated in EpiData® versão 3.1 (EpiData Association, Odense, Denmark).

Processed and ultra-processed food products were divided into 17 groups, following the Brazilian legislation (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b): processed nuts, *farofas* (a Brazilian mixture of grilled manioc flour and condiments, commonly used as side dish), breakfast cereals, dry pastas, whole-wheat breads, cakes, salted crackers, cookies, filled biscuits, yogurt, chocolates, ice cream and ice lolly, pizzas, sandwiches, industrialized snacks, and meat pastries. These categories also take into consideration the food groups proposed by the Consumer Expenditure Survey 2008-2009 in the Personal Food Consumption in Brazil, in order to evaluate average serving size of foods consumed by the Brazilian population (IBGE, 2011).

As regards to serving size in terms of household measurements, the "non-fractioned" category referred to foods with entire household measurements values, and "fractioned" referred to foods with fractioned household measurements (1/2, 1/3, 1/4, and so on).

In total, two indicators were used to determine the presence of trans fat in products: ingredient lists, and the amount of trans fat reported on the nutrition labelling. With regard to ingredient lists, trans fat was considered present when the list contained any type of hydrogenated fat/oil or any ingredient that chemically corresponds to hydrogenated fat, such as margarine or vegetable fat/cream (Danish Nutrition Council, 2003). "Vegetable cream" and "vegetable fat" probably contain trans fat, as they are

commonly present in products with trans fat (Danish Nutrition Council, 2003). Also, the nutrition labelling was analyzed with the consumer in mind, since consumers may not know whether the fats listed in ingredient lists are hydrogenated if incomplete terms are used; for example, when "vegetable fat" is reported instead of "hydrogenated vegetable fat". The use of full ingredient names by the food industry should be mandatory, such as "hydrogenated vegetable fat", which contains trans fat, or "palm vegetable fat", which does not contain trans fat. Food companies should also be required to report and highlight the presence of trans fat on labels.

For each group of foods, the median and amplitude of declared serving sizes on labels were calculated. In addition, the ratio between the average serving size consumed by the Brazilian population (according to POF 2008-2009) (IBGE, 2011) and the declared serving size on labels was also calculated, with additional presentation of their respective percentile 2 and 98 (p2-p98). However, food products which do not have serving sizes recommended by Brazilian law, in grams or millilitres, were excluded from these analyses (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). Moreover, the prevalence of foods with trans fat in ingredient lists or on nutrition labelling, and the prevalence of false negatives (products that reported zero trans fat on the nutrition labelling or made claims of no trans fat on the packaging but contained items with trans fat in the ingredient list) were also calculated.

The association among the presence of trans fat and household measurement fractioning declared on labels with the average serving size consumed by the Brazilian population and the declared serving size was evaluated through the Mann-Whitney test. The software Stata 11.0 (StataCorp, College Station, TX, USA) was used for data analysis, considering $p < 0.05$ as an indication of statistical significance.

Results

Information was collected from the labels of 1,071 processed and ultra-processed food products. It was observed that 15 out of 17 groups presented recommended serving size in grams or millilitres (median of 73 foods per group; amplitude from 7 to 152 foods) and two groups presented recommended serving size in calories (up to 500 kcal per serving).

According to Table I, 13 out of 15 food groups analyzed have presented reference serving size values equal to the declared value median. Declared serving medians were smaller than the reference values for meat pastries and yogurts (40 and 20 per cent, respectively). However, when observing the amplitude of declared serving size, only three food groups (*farofa*, crackers, ice cream, and ice lolly) obeyed the Brazilian regulation in all of the analyzed products, with declared serving sizes within the range of 30 per cent over or under reference values. In the case of dry pastas, meat pastries, cheese, yogurt, and chocolate, some products have declared serving sizes on labels at least two times smaller than the reference values.

Table I also shows that for 88 per cent of the analyzed groups, the average serving size consumed by the Brazilian population (IBGE, 2011) was larger than the declared serving size (ratio > 1.0), with special mention to dry pasta, filled biscuits, chocolate, industrialized snacks, pizza, and processed nuts – which presented consumed serving sizes of at least two times larger than declared serving sizes. Only two groups of foods (whole-wheat breads and sandwiches) presented average serving sizes consumed smaller than the declared serving sizes.

Some of the food groups with largest ratios between consumed and declared serving sizes (dry pasta, filled biscuits, chocolate, and industrialized snacks) also presented elevated numbers of foods with trans fat in their ingredient lists (from 37.7 to 97.3 per cent

Food groups	*n*	Reference serving size[a]	Declared serving size		Ratio: consumed[b]/declared average serving size		Presence of trans fat		
			Median	Amplitude	Median	p2-p98	Ingredient list (%)	Nutritional information (%)	False negatives[c] (%)
Processed nuts	32	15	15	(15-25)	2.8	(1.6-2.8)	71.9	6.2	95.7
Farofa[d]	7	35	35	(35-35)	1.4	(1.4-1.4)	0.0	0.0	0.0
Breakfast cereal	16	30	30	(30-40)	1.2	(0.8-1.2)	0.0	0.0	0.0
Dry pasta	68	80	80	(30-100)	3.8	(3.0-10.1)	91.2	1.5	98.4
Whole-wheat bread	33	50	50	(40-72)	0.8	(0.5-0.9)	42.4	0.0	100.0
Cakes	45	60	60	(40-60)	1.4	(1.4-2.1)	100.0	17.8	82.2
Salted crackers	73	30	30	(21-30)	1.2	(1.2-1.7)	79.5	17.8	77.6
Cookies	144	30	30	(17-40)	1.4	(1.1-2.4)	59.7	26.6	62.8
Filled biscuits	110	30	30	(20-40)	3.5	(2.6-4.4)	97.3	20.9	78.5
Meat pastries	8	130	91	(30-130)	1.4	(0.9-4.2)	25.0	50.0	50.0
Cheese	100	30	30	(10-50)	1.4	(0.8-4.2)	0.0	29.0	0.0
Yogurt	73	200	170	(90-200)	1.3	(1.1-2.4)	0.0	0.0	0.0
Chocolate	152	25	25	(10-40)	3.4	(2.2-6.8)	74.3	4.6	93.8
Ice cream and ice lolly	86	60	60	(60-70)	1.9	(1.6-1.9)	94.2	36.1	61.7
Industrialized snacks	77	25	25	(15-25)	3.4	(3.4-4.2)	37.7	0.0	100.0
Frozen pizzas[e]	37	Up to 500 kcal/serving	77	(40-125)	2.9	(1.7-5.4)	2.7	48.6	100.0
Frozen sandwiches[e]	10	Up to 500 kcal/serving	147	(145-180)	0.8	(0.7-0.8)	50.0	100.0	0.0

Notes: $n = 1{,}071$. [a]Reference serving size, according to Brazilian law (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b); [b]Average serving size consumed by the Brazilian population, according to POF data (IBGE, 2011); [c]Products that reported zero trans fat on the nutrition labelling or made claims of no trans fat on the packaging but contained items with trans fat in the ingredient list; [d]*Farofa* is a mixture of toasted manioc or maize flour with condiments; favor may vary; [e]Reference serving size in kcal, according to Brazilian law (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b)

Table I. Reference serving size, declared serving size, ratio of average serving size consumed/declared, and percentage of foods with trans fat and false negatives

of foods) and false negatives (from 78.5 to 100 per cent of foods). It was also observed that 12 out of 17 groups presented false negatives above 50 per cent, with special mention to whole-wheat bread, pizza, and industrialized snacks – with 100 per cent false negatives.

Table II presents the relation between average serving size consumed and declared on labels, according to the presence of trans fat and household measure fractioning declared on labels. Ratio median was twice as large in foods with trans fat within their ingredient lists or in false negatives, when compared with reference categories. When considering such median as to the presence of trans fat within its nutritional information on labels, values were larger among products claiming to not have such fat. In relation to household measurements, the ratio median between the consumed serving size and the declared serving size on labels was larger among foods with fractioned household measurements (up to 9.9 times as large).

When ranking ratios between consumed and label-declared serving sizes according to the presence of trans fat and household measurement fractioning, it can be observed that among foods with no household measurement fractioning, there was a larger ratio on trans fat foods within ingredients list, informing no trans fat in nutritional information, and among false negatives. Foods with fractioned household measurements presented similar medians to this ratio in different sets of comparison (see Table III).

Discussion

In the present study, the average serving size intake by the Brazilian population was larger than serving sizes declared on labels among products with trans fat within their ingredient lists that were false negatives, particularly among foods with fractioned household measurements.

Most food groups analyzed presented a median of label-declared serving sizes equal to the reference serving size regulated by Brazilian law (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). However, data presented amplitude with great variability in serving size statements. Similar data were found in another Brazilian study (Kliemann, 2013), in which serving size declared varied within 82.3 per cent of

Table II.
Association between the presence of trans fat and false negatives with household measurements fractioning, as well as between consumed average serving size[a] and serving size declared on labels

Variables	Ratio: consumed/declared average serving size Median	p2-p98	*p*-value[b]
Trans fat within ingredients list			
Yes	2.8	(0.8; 9.2)	< 0.001
No	1.4	(0.8; 4.3)	
Trans fat within nutritional information			
Yes	1.4	(0.8; 4.7)	< 0.001
No	2.2	(0.8; 7.5)	
False negative[c]			
Yes	3.4	(0.8; 9.2)	< 0.001
No	1.7	(0.9; 4.7)	
Household measurement fractioning			
Yes	3.4	(0.8; 9.9)	< 0.001
No	1.9	(0.8; 4.7)	

Notes: $n = 1{,}071$. [a]Average serving size consumed by the Brazilian population, according to POF data (IBGE, 2011); [b]Mann-Whitney test; [c]Products that reported zero trans fat on the nutrition labelling or made claims of no trans fat on the packaging but contained items with trans fat in the ingredient list

groups. This study also demonstrated that declared serving sizes varied from 10 to 525 per cent in relation to the serving size recommended by Brazilian regulation (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). In the USA, label-declared serving sizes may vary between 50 and 200 per cent in relation to reference serving sizes regulated by the North American government (Bryant and Dundes, 2005).

Authors argue that presenting serving sizes on labels discrepant from the previously established by law may induce consumers to make erroneous food choices (Bryant and Dundes, 2005; Steenhuis and Vermeer, 2009; Tample and Fraser, 2013). In an example cited by Kliemann *et al.* two peanut spreads (A and B) found with serving sizes adequate to Brazilian law. Spread A had a 15 g serving size and 78 kcal per serving; spread B had a 20 g serving size and 84 kcal per serving. Although a quick reading may indicate that spread A presents lower energy per serving, it actually presents greater energy values (520 kcal/100g when compared to 420 kcal/100g of spread B). If spreads A and B had used the 20 g reference serving size, it would have been possible to compare their energy appropriately, with no need for calculations. This situation is breaking consumer laws, according to Article 31 of the Brazilian Consumer Rights Code, as well as *Codex Alimentarius* guidelines (Código de defesa do consumidor, 1990; World Health Organization, 2007).

Several authors have notified the intake of serving sizes larger than what is declared on nutrition labelling in countries such as Brazil, England, and USA. (Schwartz and Byrd-Bredbenner, 2006; Castro *et al.*, 2009; Steenhuis and Vermeer, 2009; Ueland *et al.*, 2009; Remig *et al.*, 2010; Reeves *et al.*, 2011). The findings in the present study agree with them, in the sense that the average serving size consumed by the Brazilian population was found to be larger than what is declared on labels of most analyzed foods, as well as larger than reference (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). It is important to highlight that the average serving size consumed of filled biscuits, chocolate, snacks, processed nuts, and pizza was at least twice as large as the serving size declared on labels; for dry pasta, serving sizes were up to ten times larger.

Table III. Association between the presence of trans fat and false negatives with household measurement fractioning, as well as between consumed average serving size[a] and serving size declared on labels, according to household measurement fractioning

Presence of trans fat	Fractioned household measurement Ratio: consumed/declared average serving size Median	p2-p98	*p*-value*	Non-fractioned household measurement Ratio: consumed/declared average serving size Median	p2-p98	*p*-value[b]
Within ingredient list						
Yes	3.4	(0.8; 10.1)	0.01	1.9	(0.9; 5.7)	< 0.001
No	3.4	(0.8; 4.0)		1.4	(0.8; 4.3)	
Within nutritional information						
Yes	1.9	(1.2; 10.1)	0.71	1.4	(0.8; 4.5)	< 0.001
No	3.4	(0.8; 9.8)		1.9	(0.8; 5.3)	
Within false negatives[c]						
Yes	3.4	(0.8; 9.8)	0.74	2.6	(1.2; 6.3)	< 0.001
No	3.5	(1.2; 10.1)		1.7	(0.9; 4.7)	

Notes: $n = 1{,}071$. [a]Average serving size consumed by the Brazilian population, according to POF data (IBGM, 2011); [b]Mann-Whitney test; [c]Products that reported zero trans fat on the nutrition labelling or made claims of no trans fat on the packaging but contained items with trans fat in the ingredient list

This phenomenon can be a consequence of consumer response to the increasing serving sizes consumed outside of their households, as shown in a survey conducted by Young and Nestle (2007) in the USA. According to European research, this phenomenon can also be related to the increase in foods available for sale in packages of high net weight and very small serving sizes declared on their nutrition labelling, which can compromise consumer understanding of the several serving sizes that foods contain (EUFIC, 2011). Furthermore, it can hinder consumer perception that the average serving size consumed is larger than the offered serving size (Schwartz and Byrd-Bredbenner, 2006; Steenhuis and Vermeer, 2009; Ueland *et al.*, 2009). The implicit fitness on food packaging, such as "low fat or reduced calorie", can also influence both the perceived serving size and the actual food consumption (Koenigstorfer *et al.*, 2013; McCann *et al.*, 2013). This situation indicates the possibility of underestimating calorie consumption, as well as of other nutrients informed within nutrition labelling (Schwartz and Byrd-Bredbenner, 2006; Lando and Labiner-Wolfe, 2007; Remig *et al.*, 2010; Reeves *et al.*, 2011; Campos *et al.*, 2011; Vanderlee *et al.*, 2012), such as trans fat.

It is also important to note that most analyzed foods presented high percentages of trans fat presence in ingredient lists, as well as false negatives. Such situation has been reported in the scientific literature in relation to filled biscuits. A study performed with 2,298 individuals in São Paulo, Brazil, indicated that filled biscuits are the greatest source of trans fat in the diet of adolescents (Castro *et al.*, 2009). In addition, it is indicated that their intake is usually larger than the suggested serving sizes (Galdino *et al.*, 2010). It is important to highlight that the intake of industrial trans fats is associated to the consumption of large portion sizes (Kelly *et al.*, 2009), which can implicate in the increasing prevalence of obesity in the population (Faulkner *et al.*, 2012).

In situations similar to the present study, the intake of trans fat may occur without the consumer's noticing, considering that Brazilian regulation (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003a, b) allows foods with up to 0.2 g trans fat per serving to claim "zero trans". In November 2012, a legislation adjustment decreased to 0.1 g per serving the amount trans fat considered insignificant (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2012). Although the analyses were not repeated with the new parameters, considering the results of this study, it is believed that the problem remains with fractioned use of household measurements, and consumption of larger serving sizes than recommended. Therefore, individuals can unknowingly ingest significant amounts of trans fat when consuming more than one serving size of foods categorized as false negatives (Mozaffarian *et al.*, 2009; Remig *et al.*, 2010).

It can be added that serving sizes on labels of the analyzed foods may not be serving their purpose. According to Brazilian legislation, serving sizes were calculated based on a 2,000 kcal/day diet, in order to represent a recommended intake for the population (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). However, the results presented above indicate that the average serving sizes consumed by the population are larger than those declared on labels for most analyzed food products, as well as larger than the reference servings regulated by Brazilian law (Ministério da Saúde. Agência Nacional de Vigilância Sanitária, 2003b). Therefore, providing information about serving sizes on labels may not be enough to promote adequate food consumption (Ueland *et al.*, 2009; Marchiori and Papies, 2013), since the population may not understand what this information means (Faulkner *et al.*, 2012; Vartanian and Sokol, 2012). It seems that there is a need for educational campaigns to address this issue.

Household measurements referent to serving sizes also seems to be failing to achieve their goals. Household measurements indicating the fractioning of foods usually consumed with no fractioning was found (e.g. meat balls and filled biscuits). Similar results have been found in an Australian survey, which has collected information from 3,344 food products and found only 701 products with household measurements declared on labels, often inconsistent with the characteristic of the studied food products (Vartanian and Sokol, 2012). These findings may compromise consumption recommendations, enabling the intake of serving sizes larger than those declared on labels (Lando and Labiner-Wolfe, 2007). According to Campos *et al.* (2011), fractioned nutritional information that requires calculations during their reading are considered to be confusing to consumers, which can compromise the understanding of nutritional information (Schwartz and Byrd-Bredbenner, 2006).

Similarly to the Australian law, the law in Brazil leaves household measurements up to manufacturers, which decide the most appropriate measure for each type of processed food. The Brazilian and Australian practices strongly contrast with nutrition labelling practices in the USA (US Food and Drug Administration (FDA), 2014), where government determines the household measures to be declared on labels. The standardization of household measurements by legislation might be an alternative to improve the clarity and usability of this information by consumers.

One possible limitation of the present study is the use of ingredient lists to determine the presence of trans fat in food products without chemical analyses. However, the study considers consumers to only have access to what is reported on the packaging, so its accuracy should be ensured by the manufacturer and tested for compliance with the legislation. Another possible limitation of the study was the inclusion of products sold in only one store; however, since the supermarket surveyed belongs to a large chain, most products sold by this store are sold by other stores of the same chain throughout the country, so this does not affect the external validity of the study. The list of ingredients was interpreted by taking into account the different names of possible trans fat ingredients listed in the scientific literature; however, since vegetable fat has been automatically considered hydrogenated, false positives may have occurred. Nevertheless, the use of this categorization, which is more sensitive than specific, would introduce a bias in direction to its nullity. Therefore, stringer associations would be expected in the analysis.

Conclusions

This study has been performed with the use of a national database on food consumption, as well as the information in 1,071 processed and ultra-processed food labels marketed in Brazil. Results obtained in this study show that the Brazilian population is consuming serving sizes larger than recommended and larger than what is declared on labels of processed and ultra-processed foods. In addition, such consumption has been found to be larger in foods that may contain trans fat. Furthermore, the presence of trans fat may be not clearly and visibly shown on food labels. Among factors which may be contributing to underestimate trans fat, increasing its intake by consumers, the following can be highlighted: the variability in declared serving sizes and the presentation of serving sizes with non-applicable fractioning. Considering the risks that consuming this type of lipids can cause on human health, this study indicates that declared serving sizes should be standardized, as well as clearer and with more feasible household measurements. In this sense, nutritional information calculated per 100 g of product can be a proper strategy to inform the real

content of trans fat on labels. The need to review Brazilian nutrition labelling laws is evident as regards to serving size variability, household measure fractioning, and declaring trans fat within nutritional information. It is expected that the aforementioned suggestions make consumer understanding of nutrition labelling easier, as well as the use of such information to make food choices and determine intake. Considering that the intake of serving sizes has been larger than what is stated on labels, it is important for nutritionists, dieticians, and healthcare professionals to educate patients with regards to controlling serving sizes consumed. Public health campaigns involving the use of mass media should also be helpful to increase knowledge on ways to control trans fat consumption using nutrition labelling. This study is also proven to be important and novel, contributing with information as to the manner in which nutrition labelling has been presented to Brazilian consumers, discussing its possible consequences for food choices, intake, and the guarantee of consumer rights.

References

Bosman, M.J.C., Van der Merwe, D., Elli, S.M., Jerling, J.C. and Badham, J. (2014), "South African adult metropolitan consumers' opinions and use of health information on food labels", *British Food Journal*, Vol. 114 No. 1, pp. 30-43.

Bryant, R. and Dundes, L. (2005), "Portion distortion: a study of college students", *Journal of Consumer Affairs*, Vol. 39 No. 2, pp. 399-408.

Campos, S., Doxey, J. and Hammond, D. (2011), "Nutrition labels on pre-packaged foods: a systematic review", *Public Health Nutrition*, Vol. 14 No. 8, pp. 1496-1506.

Castro, M.A., Barros, R.R., Bueno, M.B., César, C.L.G. and Fisberg, R.M. (2009), "Trans fatty acids intake among the population of the city of São Paulo, Southeasthern Brazil", *Revista de Saúde Pública*, Vol. 43 No. 6, pp. 991-997.

Código de defesa do consumidor (1990) Lei n 8.078, De 11 De Setembro De 1990: dispõe sobre a proteção do consumidor e dá outras providências, Diário Oficial [da] República Federativa do Brasil, Poder Executivo, Brasília.

Danish Nutrition Council (2003), "Trans fatty acid levels in the Danish diet", Chapter 2, *The Influence of Trans Fatty Acids on Health*, available at: www.meraadet.dk/gfx/uploads/Rapporter_pdf/Trans fatty acids_4.th ed._UK_www.pdf (accessed 15 July 2013).

EUFIC (2011), *Consumer Response to Portion Size on Food and Drink Packaging: A Pan-European Study*, European Food Information Council, Brussels.

Faulkner, G.P., Pourshahidi, L.K., Wallace, J.M.W., Kerr, M.A., McCrorie, T.A. and Livingstone, M.B.E. (2012), "Serving size guidance for consumers: is it effective?", *Proceedings of the Nutrition Society*, Vol. 71 No. 4, pp. 610-621.

Galdino, T.P., Antunes, A.R., Lamas, R.C., Zingano, M.A., Cruzat, V.F., Coutinho, V.F. and Chagas, P. (2010), "Filled cookies: the cheaper the higher trans fat content?", *Scientia Medica*, Vol. 20 No. 4, pp. 270-276.

Hissanaga, V.M., Proença, R.P.C. and Block, J.M. (2012), "Trans fatty acids in Brazilian food products: a review of aspects related to health and nutrition labeling", *Revista de Nutrição*, Vol. 25 No. 4, pp. 517-530.

Instituto Brasileiro de Geografia e Estatística (IBGE) (2011), *Pesquisa de Orçamentos Familiares 2008-2009: Análise do Consumo Alimentar Pessoal no Brasil*, IBGE, Rio de Janeiro.

Kelly, M.T., Wallace, J.M., Robson, P.J., Rennie, K.L., Welch, L.W., Hannon-Fletcher, M.P., Brennan, S., Fletcher, A. and Livingstone, M.B. (2009), "Increased portion size leads to a sustained increase in energy intake over 4 d in normal-weight and overweight men and women", *British Journal of Nutrition*, Vol. 102 No. 3, pp. 470-477.

Kliemann, N. (2013), "Analysis of the domestic measurements and portions in ultra-processed food labels", unpublished dissertation, Universidade Federal de Santa Catarina, Florianópolis.

Koenigstorfer, J., Groeppel-Klein, A., Kettenbaum, M. and Klicker, K. (2013), "Eat fit. Get big? How fitness cues influence food consumption volumes", *Appetite*, Vol. 65, pp. 165-169.

Lando, A.M. and Labiner-Wolfe, J. (2007), "Helping consumers make more healthful food choices: consumer views on modifying food labels and providing point-of-purchase nutrition information at quick-service restaurants", *Journal of Nutrition Education and Behaviour*, Vol. 39 No. 3, pp. 157-163.

McCann, M.T., Wallace, J.M.W., Robson, P.J., Rennie, K.L., McCaffrey, T.A., Welch, R.W. and Livingstone, M.B.E. (2013), "Eat fit. Get big? How fitness cues influence food consumption volumes", *Appetite*, Vol. 65, pp. 153-158.

Malik, V.S., Willett, W.C. and Hu, F.B. (2013), "Global obesity: trends, risk factors and policy implications", *Nature Reviews Endocrinology*, Vol. 9 No. 1, pp. 13-27.

Marchiori, D. and Papies, E.K. (2013), "A brief mindfulness intervention reduces unhealthy eating when hungry, but not the portion size effect", *Appetite*, Vol. 75, pp. 40-45, doi: http://dx.doi.org/10.1016/j.appet.2013.12.009.

Ministério da Saúde. Agência Nacional de Vigilância Sanitária (2003a), Resolução RDC n 360, de 23 de dezembro de 2003. A Diretoria Colegiada da ANVISA/MS aprova o regulamento técnico sobre rotulagem nutricional de alimentos embalados. Diário Oficial da União. 2003, 26 dez. (251):33; Seção 1a.

Ministério da Saúde. Agência Nacional de Vigilância Sanitária (2003b), Resolução RDC n 359, de 23 de dezembro de 2003. A Diretoria Colegiada da ANVISA/MS aprova regulamento técnico de porções de alimentos embalados para fins de rotulagem nutricional. Diário Oficial União. 26 dez; (251):28; Seção 1b.

Ministério da Saúde. Agência Nacional de Vigilância Sanitária (2012), Resolução RDC n 54, de 12 de novembro de 2012. Dispõe sobre o regulamento técnico sobre Informação Nutricional Complementar. Diário Oficial União. 13 nov; (219); Seção 1.

Monteiro, C.A., Cannon, G., Levy, R.B., Claro, R. and Moubarac, J.C. (2012), "The food system. Ultraprocessing. The big issue for nutrition, disease, health, well-being", *Journal of the World Public Health Nutrition Association*, Vol. 3 No. 12, pp. 527-569.

Mozaffarian, D., Aro, A. and Willett, W.C. (2009), "Health effects of trans-fatty acids: experimental and observational evidence", *European Journal of Clinical Nutrition*, Vol. 63, pp. 5-21.

Popkin, B.M. (2006), "Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases", *American Journal of Clinical Nutrition*, Vol. 84 No. 2, pp. 289-298.

Popkin, B.M., Adair, L.S. and Ng, S.W. (2012), "Global nutrition transition and the pandemic of obesity in developing countries", *Nutrition Reviews*, Vol. 70 No. 1, pp. 3-21.

Proença, R.P.C. and Silveira, B.M. (2012), "Intake recommendations and labeling of trans fat in processed foods in Brazil: analysis of official documents", *Revista de Saúde Pública*, Vol. 46 No. 5, pp. 923-928.

Reeves, S., Wake, Y. and Zick, A. (2011), "Nutrition labeling and portion size information on children's menus in fast-food and table-service chain restaurants in London, UK", *Journal of Nutrition Education and Behaviour*, Vol. 43 No. 6, pp. 543-547.

Remig, V., Franklin, B.S.M., Kostas, G., Nece, T. and Street, J.C. (2010), "Trans fats in America: a review of their use, consumption, health implications, and regulation", *Journal of American Dietetic Association*, Vol. 110 No. 4, pp. 585-592.

Schwartz, J. and Byrd-Bredbenner, C. (2006), "Portion distortion: typical portion sizes selected by young adults", *Journal of American Dietetic Association*, Vol. 106 No. 9, pp. 1412-1418.

Silveira, B.M., Gonzalez-Chica, D.A. and Proença, R.P.C. (2013), "Reporting of trans-fat on labels of Brazilian food products", *Public Health Nutrition*, Vol. 16 No. 12, pp. 2146-2153.

Steenhuis, I.H.M. and Vermeer, W.M. (2009), "Portion size: review and framework for interventions", *International Journal of Behavioral Nutrition and Physical Activity*, Vol. 58 No. 6, pp. 6-58.

Tample, N.J. and Fraser, J. (2013), "Food labels: a critical assessment", *Nutrition*, Vol. 30 No. 10, pp. 257-260.

Ueland, O., Cardello, A.V., Merrill, E.P. and Lesher, L.L. (2009), "Effect of portion size information on food intake", *Journal of American Dietetic Association*, Vol. 109 No. 1, pp. 124-127.

US Food and Drug Administration (FDA) (2014), "Chapter 1: food and drug administration, department of health and human services (continued). Part 101.9 – nutrition labelling of food",in US Food and Drug Administration (Ed.), *Code of Federal Regulations – Title 21 – Food and Drug*, US Government Printing Office, Washington, DC, (2008 cited 2012 Febraury 2013), available at: www.access.gpo.gov/nara/cfr/; www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfcfr/cfrsearch.cfm?fr=101.9 (accessed 19 January 2014).

Vanderlee, L., Goodman, S., Yang, W.S. and Hammond, D. (2012), "Consumer understanding of calorie amounts and serving size: implications for nutritional labelling", *Canadian Journal of Public Health*, Vol. 103 No. 5, pp. 327-331.

Vartanian, L.R. and Sokol, N. (2012), "Serving-size information on nutrition labels in Australia", *Australian and New Zealand Journal of Public Health*, Vol. 36 No. 5, pp. 494-494.

World Health Organization (2004) "United Nations. Global strategy on diet, physical activity and health: list of all documents and publications", Fifty-seventh World Health Assembly, A57/9, 17 abr. 2004a.

World Health Organization (2013) "Follow-up to the political declaration of the high-level meeting of the general assembly on the prevention and control of non-communicable diseases", Sixty-sixth World Health Assembly.

World Health Organization and Food and Agriculture Organization of the United Nations (2007) *Codex Alimentarius: Food Labelling*, 5th ed., Codex Alimentarius Comission, Rome.

Young, L.R. and Nestle, M. (2007), "Portion sizes and obesity: responses of fast-food companies", *Journal of Public Health Policy*, Vol. 28 No. 2, pp. 238-248.

Further reading

Marchiori, D., Corneille, O. and Klein, O. (2012), "Container size influences snack food intake independently of portion size", *Appetite*, Vol. 58 No. 3, pp. 814-817.

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