

1    **Nutritional quality of packaged foods targeted at children in Brazil: which ones**  
2    **should be eligible to bear nutrient claims?**

3    Vanessa Mello Rodrigues<sup>a,b</sup>; Mike Rayner<sup>b</sup>, Ana Carolina Fernandes<sup>a</sup>; Renata Carvalho de  
4    Oliveira<sup>a</sup>; Rossana Pacheco da Costa Proença<sup>a</sup>, Giovanna Medeiros Rataichesk Fiates<sup>a</sup>.

5    <sup>a</sup>Nutrition Graduate Programme (Programa de Pós-Graduação em Nutrição), Nutrition in Foodservice Research Centre  
6    (NUPPRE), Federal University of Santa Catarina (UFSC), Trindade University Campus, 88040-970, Florianópolis,  
7    Santa Catarina, Brazil.

8    <sup>b</sup>British Heart Foundation Centre on Population Approaches for Non-Communicable Disease Prevention, Nuffield  
9    Department of Population Health, University of Oxford, Old Road Campus, OX1 7LF, Oxford, United Kingdom.

10   **Corresponding author:** G.M.R. Fiates (giovanna.fiates@ufsc.br)

11  
12   **Short running title:** Nutritional quality of products aimed at children

13  
14   **Conflict of interest statement:** We declare we have no conflicts of interest.

15  
16   **Contributor statement:** VMR was responsible for planning the research, collecting, analysing and  
17   interpreting the data, and for drafting the first version of the manuscript. ACF and RCO contributed  
18   towards data collection, analysis and interpretation, and revision of the manuscript. RPCP and MR  
19   contributed to data analysis, interpretation of results and revision of the manuscript. GMRF had  
20   overall responsibility for the study, research coordination, supervision of data collection and  
21   analysis and revision of the final manuscript. All of the authors approved this version for  
22   publication and accepted the conditions established by International Journal of Obesity.

## 23 ABSTRACT

24 **OBJECTIVES:** This study aimed to assess the nutritional quality of food products marketed at  
25 children, with and without nutrient claims, using two different approaches.

26 **METHODS:** Analyses were performed on a dataset with food composition and labelling data from  
27 every packaged food marketed at children sold in a major Brazilian supermarket (n=535). Foods  
28 were classified as 'healthier' and 'less healthy' according to the UK/Ofcom nutrient profile model  
29 and to the NOVA classification based on level of food processing. Pearson's chi-squared test was  
30 used to compare proportions between models. Agreement was assessed using Cohen's kappa  
31 statistic ( $p < 0.05$ ).

32 **RESULTS:** The NOVA model was stricter than the UK/Ofcom model, classifying more products  
33 as 'less healthy' (91.4%) than the nutrient profile based model (75.0%) ( $p < 0.001$ ). Agreement  
34 between models was 79.4% ( $k = 0.30$ ), due to 72.9% (n=390) of products being categorised as 'less  
35 healthy' by both models, and 6.5% (n=35) as 'healthier'. Half of the food products marketed at  
36 children from the database (270; 50.5%) bore nutrient claims. From these products with nutrient  
37 claims, 95.9% (92.8-98.0) were classified as 'less healthy' by the NOVA model, whilst this  
38 percentage was 74.1% (68.4-79.2) according to the UK/Ofcom model ( $p < 0.05$ ).

39 **CONCLUSIONS:** The high number of foods with low nutritional quality being marketed at  
40 children via product packaging and nutrient claims should be of concern to policy makers wanting  
41 to improve children's diets and to tackle childhood obesity. The implementation of nutritional  
42 quality criteria to ensure that foods targeted at children should be eligible to bear nutrient claims on  
43 their labels could avoid a situation where claims mask the overall nutritional status of a food.

44

45 *Keywords:* Children, Claims, Food products, Labelling, Marketing, Nutrient Profiling, Obesity  
46 prevention, Packages, Public policies

## 47 INTRODUCTION

48 The global population is undergoing a pandemic of overweight and obesity.<sup>1</sup> In 2010, both  
49 conditions were estimated to cause 3.4 million deaths and 3.9% of years of life lost worldwide.<sup>2</sup> In  
50 Brazil, an emerging nation, the prevalence of overweight and obesity ranks among the highest in the  
51 world.<sup>3</sup> From 1989 to 2006, the relative prevalence of overweight in Brazilian pre-schoolers  
52 increased by 160.0%.<sup>4</sup> Also, from 1974 to 2009, the prevalence of overweight in children (6-11y)  
53 significantly increased in both males (8.3% to 33.8%) and females (7.2% to 30.0%),<sup>5</sup> whilst obesity  
54 rates among children (5-9y) reached 15.0% by 2009.<sup>3</sup>

55 Evidence linking the occurrence of overweight and obesity in childhood and early development  
56 of diabetes mellitus, cardiovascular disease, dyslipidaemia, and hypertension in adult life is strong.<sup>6</sup>  
57 Therefore, childhood constitutes a crucial period for the prevention of non-communicable diseases.  
58 A poor diet is a cause of excess weight, and food marketing has been identified as an important  
59 driver of poor diets, with high occurrence worldwide.<sup>7</sup> The marketing of foods targeting children is  
60 associated with increased preferences for the advertised products and short-term consumption  
61 behaviour.<sup>8</sup>

62 Nutrient profiling is a scientifically sound method for assessing the nutritional quality of food  
63 and beverage items, and it can be employed by national authorities to promote public health dietary  
64 goals.<sup>9</sup> Different nutrient profile (NP) models have been developed for a number of countries and  
65 regions. Each model consider different nutrients and components and use either thresholds or  
66 scoring, and there is no unanimity as to which one of them is best suited to classify foods according  
67 to their nutritional composition for health-promoting reasons.<sup>10</sup>

68 A NP model developed by the UK Food Standards Agency (FSA) for the UK regulator for  
69 broadcast media (Ofcom) is being used to control the marketing of foods and non-alcoholic  
70 beverages targeted at children in its original version in the UK<sup>11</sup> and Republic of Ireland,<sup>12</sup> and its  
71 adapted version for controlling health claims on food packages in Australia and New Zealand.<sup>13</sup> The  
72 model scores food and drinks as 'healthier' and 'less healthy', using an algorithm based on

73 saturated fats, sodium, total sugars, energy, protein, fibre, and fruit, vegetable, and nut content per  
74 100g or 100ml.<sup>11</sup>

75 In spite of being among the first countries to include mandatory nutrition labelling and product  
76 information on food packages, Brazil does not have a system in place specifically to regulate the  
77 marketing of foods targeted at children. According to a report of a World Health  
78 Organisation/International Association for the Study of Obesity technical meeting on nutrient  
79 profiling, a consensus has not been achieved by the Brazilian National Health Surveillance Agency  
80 (ANVISA) together with the Southern Cone Common Market (MERCOSUR) as to whether it is  
81 necessary to develop a new NP model or adapt an existing one.<sup>9</sup>

82 An alternative to a NP model could be the new Brazilian classification system, nominated  
83 NOVA,<sup>14,15</sup> recently used for the 2014 edition of the Dietary Guidelines for the Brazilian  
84 population.<sup>16</sup> This system is based on the extent and purpose of processing for a food, and divides  
85 foods into three groups: ‘natural or minimally processed foods’, ‘processed foods’, and ‘ultra-  
86 processed foods’. Processed and ultra-processed foods, mainly the latter, typically have properties  
87 that are conducive to overconsumption: they are often hyper-palatable and sold in large portion  
88 sizes; are durable and easy to transport and therefore frequently consumed as snacks. They are often  
89 marketed intensively and persuasively.<sup>14,16</sup> The growing evidence related to the impact of their  
90 consumption on human health, indicate the necessity of halting their increasing consumption.<sup>14,15</sup>

91 Regardless of the model used to evaluate the nutritional quality of foods, the need to regulate the  
92 marketing of ‘less healthy’ food to children is undeniable.<sup>8</sup> As stated by Colby *et al.*, any  
93 advertising of food or beverages using health or nutrition information beyond minimum  
94 requirements can be defined as nutrition marketing.<sup>17</sup> The presence of nutrition claims on food  
95 products has the potential to mislead consumers and boost sales, through the inappropriate emphasis  
96 on attributes considered positive.<sup>18</sup>

This paper aims to investigate how two different models classify foods targeted at children available in a large Brazilian supermarket, and to test which foods would be allowed to bear nutrient claims if either model was applied. The research questions for this paper are:

RQ1: How does the UK Ofcom NP model compares to the NOVA model with respect to strictness, i.e. the percentage of foods classified as ‘less healthy’ by the criteria?

RQ2: What is the level of agreement between the models, i.e. to what extent do the nutritional criteria classify the same foods the same way?

RQ 3: Are foods bearing nutrient claims classified as ‘healthier’ or ‘less healthy’ by the UK/Ofcom model and/or the NOVA model?

RQ4: What proportion of packaged foods marketed at children would be allowed to bear nutrient claims if the UK/Ofcom model or the NOVA model were applied to regulate them?

## **MATERIALS AND METHODS**

### ***Study design***

This cross-sectional study used a dataset with food composition information derived from food labelling collected in-store from all foods aimed at children available in a major Brazilian supermarket ( $n = 535$ ). The supermarket belongs to one of the ten largest Brazilian chains, with 27 stores throughout the country. Therefore, most of the products available are from big food and beverages’ brands, and are similar to those sold in other supermarket chains in Brazil.

Products considered to be targeted at children were those where at least one of the following marketing strategies was identified on the front-of-package label: words and phrases such as "child" or "ideal snack for your child"; cartoons, TV series or film characters; own-brand characters; child celebrities; images of creatures; games or hobbies; colours or shapes that appeal to children; or free gifts.<sup>19-22</sup> Data collection procedures and dataset preparation are described in detail elsewhere.<sup>23</sup>

### ***Nutrient claims***

Information on the presence and type of nutrient claims on labels of all food products targeted at children was obtained from pictures of packages taken in-store and available on the database compiled using food labelling data. Our analysis included all nutrient claims that could be observed on any surface of the packaging visible to the consumer (comprising all different formats, e.g. single words, phrases, sentences, symbols, logos or images). The nutrient claims identified on the food products aimed at children were grouped and registered according to the terms established by the Brazilian regulation #54/2012.<sup>24</sup>

### *Applying the models*

#### *a) The UK Ofcom NP model*

The UK Ofcom NP model scores food and drinks separately, but using the same algorithm as a basis to define products that are ‘healthier’ and ‘less healthy’. The score is based on nutrient and ingredient content per 100 g of a food or drink.<sup>11</sup>

Food composition data on energy, protein, carbohydrates, total fat, saturated fat, fibre, sodium, and total sugars were obtained from the database. Ingredients list photographs were used to calculate fruit, vegetable and nut content of foods, as well as to estimate total sugars content when information was not available on the nutrient declaration tables (displaying data for total sugars content is not mandatory by Brazilian food labelling regulation #360/2003).<sup>25</sup>

Data on sugar content missing from food packages was estimated for 58.1% of the dataset (n=311). For some products (28,9%; n=90), we considered information on the total carbohydrate content as the total sugar content (e.g. soft drinks, chocolates, candies, ice-cream). For other products (11,9%; n=37), we used information on total sugars from a UK database, which was provided by one of our authors. This was done only for identical products, from the same type and brand (e.g. tomato ketchup sauce). For the remaining products (59,2%; n=184), we calculated the total sugar content considering their ingredients list. Some of these products were assigned as 0g of total sugars due to their food groups (i.e. fats, oils, eggs and meat). For a part of these products (n=78), we also used a systematic methodology involving 10 steps<sup>26</sup> to calculate the amounts of

148 **added sugar.** The proportion of fruits, vegetables and nuts content for each food was estimated as  
 149 referred at the guide to apply the model.<sup>27</sup>

150 Points A (0–10) were allocated for each energy (kJ), total sugar (g), saturated fat (g) and sodium  
 151 (mg) content. Points C (0–5) were allocated for each of the fruit, vegetable and nut (%), fibre (g)  
 152 and protein (g) contents. The overall score is calculated by 'total C points' minus 'total A points'.  
 153 Individual scores ranged from -15 (most healthy) to +40 (least healthy). Cut off points used were  
 154 the same as those established by the Office of Communication to regulate marketing to children on  
 155 TV: products were categorised as 'less healthy' (4 points or more for food, and 1 point or more for  
 156 drinks) and 'healthier' (3 points or less for food, and 0 points or less for drinks).<sup>11</sup>

#### 157 ***b) The NOVA model***

158 Food products targeted at children were also classified into one of the three groups established  
 159 by the NOVA classification based on the extent and purpose of industrial processing: 'natural or  
 160 minimally processed foods', 'processed foods', and 'ultra-processed foods'.<sup>14</sup>

161 According to the NOVA model, the first group contains 'natural foods', i.e. foods obtained  
 162 directly from plants or animals, purchased ready for consumption without having undergone any  
 163 alteration after leaving the natural source; and 'minimally processed foods', which are natural foods  
 164 that, prior to their acquisition, underwent minor changes that do not involve adding substances to  
 165 the food. This group includes foods such as vegetables, fresh, dried or juiced fruits with no added  
 166 sugars or additives, nuts, fresh, chilled or frozen meats, pasteurized and UHT milk, plain yoghurt,  
 167 eggs, tea, coffee and water.<sup>14,16</sup>

168 The second group is essentially constituted of manufactured products to which salt, sugar, oil or  
 169 vinegar is added to make them last longer and be more pleasing to the palate. The group includes  
 170 canned vegetables, fruits in syrup, cheeses and breads made with flour, water, salt and yeast.<sup>14,16</sup>

171 The third group is composed of manufactured products that are entirely or mostly made from  
 172 substances extracted from food (oils, fats, sugar, proteins), those that are derived from food  
 173 constituents (hydrogenated fats, modified starch) or from substances synthesised in a laboratory

174 based on organic materials (where colorants, flavourings, flavour enhancers and other additives are  
 175 used to give the products attractive sensory properties). ‘Ultra-processed foods’ include sweet and  
 176 savoury biscuits, chips, granola bars, confectionary in general, fast food dishes, instant noodles,  
 177 various types of ready or semi-ready meals and soft drinks.<sup>14,16</sup>

178 The 2014 edition of the Dietary Guidelines for the Brazilian population recommends that people  
 179 limit their intake of ‘processed products’ to small servings, and to avoid the consumption of ‘ultra-  
 180 processed products’ because they are mostly nutritionally unbalanced.<sup>16</sup> Therefore, after the  
 181 classification according to the NOVA model, food products targeted at children from the  
 182 ‘processed’ and ‘ultra-processed’ groups were designated ‘less healthy’, whilst the ‘natural or  
 183 minimally processed’ group was considered ‘healthier’.

#### 184 *Statistical analysis*

185 Analyses were conducted on the entire dataset and also stratified by presence of nutrient claims  
 186 (food products with nutrient claims and food products without claims). The criteria to classify food  
 187 products as ‘healthier’ and ‘less healthy’ according to both models were applied to the dataset using  
 188 Stata syntax files (available upon request from the first author).

189 For both models, the proportion of ‘healthier’ and ‘less healthy’ products was estimated.  
 190 Standard errors and 95% confidence intervals were estimated assuming a binomial distribution of  
 191 the proportion of foods in the population. Proportions and 95% confidence intervals were calculated  
 192 for the whole dataset, and then stratified by the presence of nutrient claims. Pearson's chi-squared  
 193 test was used to compare proportions and determine positive associations inter and intra-models.

194 Agreement between models was assessed using Cohen’s kappa statistic and classified by the  
 195 rating system devised by Landis and Koch.<sup>28</sup> Cohen’s kappa statistic scores and associated 95%  
 196 confidence intervals were estimated for each pairwise combination of the models. This was also  
 197 done for the whole dataset and stratified by the presence of nutrient claims. The statistical package  
 198 Stata version 11.0 (Stata Corp, College Station, TX, USA) was used for the analyses.

199

## 200    **RESULTS**

201        The NOVA model was stricter than the UK/Ofcom model, classifying more products as ‘less  
202 healthy’ (91.40%) than the NP based model (74.95%), and this difference was statistically  
203 significant.

204        Half of the food products marketed at children from the database (270; 50.5%) bore nutrient  
205 claims, **mainly related to increased amounts or to the presence of vitamins and minerals.** The  
206 NOVA model was also stricter than the UK/Ofcom model when applied to food products with  
207 nutrient claims (95.9%, 92.8-98.0; 74.1%, 68.4-79.2); and without nutrient claims on labels (86.8%,  
208 82.1-90.6; 75.8%, 70.2-80.9) ( $p < 0.05$ ).

209        Foods marketed at children that bore nutrient claims were significantly ‘less healthy’ than foods  
210 that did not bore nutrient claims according to the NOVA model. According to the UK/Ofcom  
211 model, there was no difference in classification between foods bearing and not bearing nutrient  
212 claims (**Table 1**).

213

214

215

**Table 1 is here**

216

217

218        Foods such as sliced white and whole grain bread, sweetened dairy drinks, chicken nuggets and  
219 fish fingers, gelatine powder mix, soy milk-based fruit beverage, diet carbonated drinks, savoury  
220 whole grain biscuits, sugar-free banana granola, pudding and flan powder mixes, and lasagne were  
221 classified as ‘less healthy’ by the NOVA model, but as ‘healthier’ by the UK/Ofcom model. On the  
222 other hand, cocoa milk, butter and honey were classified as ‘healthier’ by the NOVA model and not  
223 by the UK/Ofcom model.

224        Agreement between the models was 79.4% (74.6 – 81.7;  $k = 0.30$ ). From the 535 food products  
225 aimed at children evaluated, 72.9% (64.3 – 81.5) were classified as ‘less healthy’ according to both

models. Only 6.5% (1.8 – 11.2) of food products were considered ‘healthier’ by both models (i.e. rice, dried pasta, fruit juice, fresh fruits and vegetables, eggs, peanuts, and desiccated coconut).

Agreement between models for foods bearing nutrient claims was 74.44% (68.8 – 79.5;  $k = 0.08$ ), whilst the agreement for foods without nutrient claims was 84.23% (79.2 – 88.3;  $k = 0.50$ ).

Overall agreement between models was high, but the kappa score indicated only ‘fair’ agreement. There was a greater agreement between models when categorising foods targeted at children without nutrient claims, achieving ‘moderate’ agreement. As suggested by examining the ‘strictness’ of models when applied to the foods, the least agreement between the models came from foods with nutrient claims. Within the latter category, agreement fell to as low as 0.08 (slight agreement).

## DISCUSSION

Most foods marketed at children from our database were considered ‘less healthy’ by both the UK/Ofcom and the NOVA model. Findings from this study suggest that if either of the models presented here was adopted to indicate which foods marketed at children should not be allowed to bear nutrient claims on labels, around three quarters of the products evaluated would not be considered suitable to do so.

Additionally, it was found that the model based on the level of food processing (the NOVA model) was stricter than the model based on nutrients (the UK/Ofcom model), although both models classified most of food products marketed at children as ‘less healthy’. Only 6.5% of the food products were considered ‘healthier’ by both models. When retailed foods were grouped and analysed by the presence of nutrient claims on labels, similar results were obtained with both models. The NOVA model categorised 95.9% of food products with nutrient claims as “less healthy”, whilst this percentage was 74.1% according to the UK/Ofcom model.

The key feature of a NP model (such as the UK/Ofcom model) is that it uses information about levels of nutrients and/or ingredients from a food in isolation. It does not take account of how often

the food is consumed, in what context or which other foods it is eaten with.<sup>29</sup> The application of criteria considering the whole food rather than just a single nutrient in order to allow the use of nutrient claims on packages could avoid a situation where the claim mask the overall nutritional status of a food product, which could mislead consumers when trying to make healthy choices. Common front-of-package nutrient claims are potentially misleading, especially when placed on products with high levels of nutrients to limit and low levels of nutrients to encourage.<sup>30</sup>

The NOVA model is based on the level of food processing and not on the nutrient composition of foods. However, according to a systematic review, studies in different countries have shown that ready-to-consume, processed and ultra-processed products are more energy dense, have higher sugar, sodium, total and saturated fat content with lower protein and fibre content compared to natural or minimally processed foods.<sup>14</sup> Moreover, ultra-processed products are often served in large portions, are hyper-palatable, have long shelf-lives, can be easily carried around, and are aggressively promoted through persuasive marketing strategies, which encourage excessive energy intake and facilitate the habit of eating between meals and snacking.<sup>14,15</sup>

Results presented here showed that the NOVA system is significantly stricter than the UK/Ofcom model when classifying foods targeted at children as ‘less healthy’. This difference in strictness can be attributed to a number of differences between the models: for example the UK/Ofcom model takes no account of non-caloric sweeteners and other artificial food additives which the NOVA model does albeit indirectly. Therefore, some of the foods targeted at children classified as ‘less healthy’ because of their level of processing, such as some types of sliced bread, chicken nuggets, and diet carbonated drinks, were classified as ‘healthier’ by the UK/Ofcom model but not by NOVA model.

The UK/Ofcom NP model is a recognised method for evaluating the nutritional quality of food products targeted at children, and takes account of nutrients such as saturated fat and sodium which the WHO and other authoritative bodies recommend should be controlled. There is no gold standard for nutrient profiling, but ideally, the nutrients selected for use in a nutrient profile model should be

278 directly linked to desirable health outcomes for the target population.<sup>31</sup> Considering that the  
279 Brazilian population's diet exceeds the recommended intakes for energy density, free sugar, trans  
280 fat and sodium, and is insufficient regarding fibre and potassium,<sup>15</sup> the absence of components such  
281 as trans-fat acids to calculate the score could be something to contemplate if the model were to be  
282 adapted for use in Brazil.

283 However, although the current recommendation from World Health Organisation is no  
284 consumption of industrially produced trans-fat, the current Brazilian legislation on food labelling  
285 from 2003, which is based on portion sizes for different kind of food products, establishes that  
286 foods containing an amount of trans-fat per serving is  $\leq 0.2$  g can declare 'does not contain trans-fat'  
287 or 'not significant amount' on its labels.<sup>24</sup> Hence, the consumption greater than the referred portion  
288 size may lead to significant intake of this type of fat.<sup>32</sup> A study which investigated how trans-fat is  
289 reported on the packaging of food products sold in a Brazilian supermarket found that more than  
290 half of products had components high in trans-fats in the ingredient list. Moreover, a small  
291 percentage of the nutrition facts tables had the trans-fat content, and roughly a quarter of the food  
292 products claimed to contain no trans-fat on the front of the packaging<sup>33</sup> Therefore, it would be  
293 difficult to estimate the amount of trans-fat acids based on what have been reported on the nutrition  
294 facts of Brazilian products, and thus, the trans-fat content would not be a good parameter to  
295 evaluate foods in the current Brazilian scenario of regulations.

296 At least three quarters of the retailed products targeted at children bearing nutrient claims on  
297 labels would not be allowed to do so if either the UK/Ofcom or the NOVA models were adopted for  
298 a Brazilian regulation on claims.<sup>24</sup> This suggests that the majority of products marketed at children  
299 bearing nutrient claims are 'less healthy' than they should be. Similar results have been found in  
300 other countries. A study in Canada that investigated child-oriented marketing in all product  
301 categories, found that 90% of the products were unhealthy and 63% had misleading health or  
302 nutrition claims.<sup>19</sup> An Australian study found that 75.2% of foods marketed to children via product  
303 packaging were high in fat or sugar, and that half of them bore health and nutrition claims.<sup>34</sup> In New

Zealand, most cereals for kids (72%) were categorised as ‘less healthy’, containing significantly higher energy, sugar and sodium content and lower protein and fibre content compared with ‘healthier’ cereals. ‘Less healthy’ cereals for kids bore significantly more nutrition claims compared with the ‘healthy’ ones.<sup>35</sup>

Our results also indicated that most food products targeted at children considered ‘less healthy’ by the NOVA system bore nutrient claims on labels, i.e. the claims were mainly found on processed and ultra-processed foods. These findings are alarming considering that the consumption of ultra-processed foods is associated with higher BMI and greater prevalence of both excess weight and obesity in Brazilian aged >10<sup>15,36</sup>, and that there are also significant associations between ultra-processed food consumption and dyslipidaemias in Brazilian children.<sup>37</sup> Studies from high-income countries that have assessed the influence on obesity of foods that could be classified as ultra-processed also found positive associations between the consumption of such foods and long-term weight gain.<sup>38-40</sup>

Finally, the main characteristic of the 6.5% of foods targeted at children considered ‘healthier’ by both models is that they are fresh and natural. This group was mainly established by the NOVA system, since it was the stricter model. However many studies have shown that most foods which are recommended to be consumed, such as fruits and vegetables, are not typically marketed at children.<sup>19,23</sup> Protective associations between intake of foods such as fruits, vegetables, nuts, and yoghurt and long-term weight gain have been reported.<sup>38</sup>

The difficulties in precisely calculating the fruit, vegetable and nut content of foods from the information in ingredients lists and also of estimating total sugars content for the purpose of applying the UK/Ofcom model are a limitation of this study, but calculations were carefully performed to minimize potential mistakes. Also, it is possible that the thresholds adopted to define ‘less healthy’ and ‘healthier’ products according to the UK/Ofcom model have affected the results. However, we decided to maintain the same limits used to regulate food marketing to children on TV.

The rising burden of obesity and diet-related non-communicable diseases has drawn attention to policy-responsive aspects of the food environment that might influence consumers' food choices and/or influence food manufacturers towards improving when developing or reformulating food products. This is important mainly to avoid manufacturers trying to change aspects in the products which will lead them to include artificial components to rebalance the product palatability, or even to add synthetic components which are not part of these products. Food labelling is a policy area where improvements have potential health benefits.<sup>41</sup> The high percentage of foods with low nutritional quality being marketed at children via product packaging found in this study should be of concern to policy makers wanting to improve children's diet and to tackle childhood obesity. Furthermore, the introduction of nutritional quality criteria to indicate whether foods targeted at children should be eligible to bear nutrient claims on their labels could avoid a situation where claims mask the overall nutritional status of a food.

## ACKNOWLEDGEMENTS

We are grateful to the National Council for Scientific and Technological Development of the Ministry of Science and Technology in Brazil - CNPq, for funding the wider project 'Nutrition labelling in Brazilian foods: thematic analysis of the use by the consumer and influence the choices' (grant number 440040/2014-0) and for the international scholarships conceded to VMR and GMRF. We also thank the Federal Agency for Support and Evaluation of Graduate Education in Brazil – CAPES for the financial support in the form of scholarships to VMR, ACF and RCO.

## CONFLIT OF INTEREST

The authors declare no conflict of interest.

## 353 REFERENCES

- 354 1. Ng M, Fleming T, Robinson M, Thomson B, Graetz N, Margono C *et al.* Global, regional, and  
355 national prevalence of overweight and obesity in children and adults during 1980-2013: a  
356 systematic analysis for the Global Burden of Disease Study 2013. *Lancet* 2014; **384**: 766–781.
- 357 2. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, AlMazroa MA *et al.* A  
358 comparative risk assessment of burden of disease and injury attributable to 67 risk factors and  
359 risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the Global Burden of  
360 Disease Study 2010. *Lancet* 2013; **380**: 2224–2260
- 361 3. Brazilian Institute of Geography and Statistics. IBGE. Brazilian Ministry of Health. *Consumer*  
362 *Expenditure Survey – POF 2008-2009*. Anthropometry and nutritional status of children,  
363 teenagers and adults in Brazil. Rio de Janeiro: IBGE, 2010.
- 364 4. Silveira JAC, Colugnati FAB, Cocetti M, Taddei JAAC. Secular trends and factors associated  
365 with overweight among Brazilian preschool children: PNSN-1989, PNDS-1996, and 2006/07. *J*  
366 *Pediatr* 2014; **90**: 258-266.
- 367 5. Conde WL, Monteiro CA. Nutrition transition and double burden of undernutrition and excess  
368 of weight in Brazil. *Am J Clin Nutr* 2014; **100**: 1617-1622.
- 369 6. Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence  
370 on morbidity and premature mortality in adulthood: systematic review. *Int J Obes* 2011; **35**:  
371 891-898.
- 372 7. Hawkes C. Uneven dietary development: linking the policies and processes of globalization  
373 with the nutrition transition, obesity and diet-related chronic diseases. *Glob Health* 2006; **2**: 4.
- 374 8. Cairns G, Angus K, Hastings G, Caraher M. Systematic reviews of the evidence on the nature,  
375 extent and effects of food marketing to children. A retrospective summary. *Appetite* 2013; **62**:  
376 209–215.
- 377 9. World Health Organization. Nutrient Profiling—Report of a WHO/IASO Technical Meeting,  
378 London, United Kingdom, 4–6 October 2010. WHO: Geneva, Switzerland, 2011. Available at:  
379 [http://www.who.int/nutrition/publications/profiling/WHO\\_IASO\\_report2010.pdf](http://www.who.int/nutrition/publications/profiling/WHO_IASO_report2010.pdf) (accessed on  
380 19 January 2016).
- 381 10. Rayner M, Scarborough P, Kaur A. Nutrient profiling and the regulation of marketing to  
382 children. Possibilities and pitfalls. *Appetite* 2013; **62**: 232–235.
- 383 11. Rayner M, Scarborough P, Lobstein T The UK Ofcom Nutrient Profiling Model—Defining  
384 ‘Healthy’ and ‘Unhealthy’ Food and Drinks for TV Advertising to Children, 2009. Available  
385 at:  
386 [http://www.dph.ox.ac.uk/bhfhprg/publicationsandreports/acadpublications/bhfhprgpublished/nu](http://www.dph.ox.ac.uk/bhfhprg/publicationsandreports/acadpublications/bhfhprgpublished/nutrientprofilemodel)  
387 [trientprofilemodel](http://www.dph.ox.ac.uk/bhfhprg/publicationsandreports/acadpublications/bhfhprgpublished/nutrientprofilemodel). (accessed on 15 December 2015).
- 388 12. Broadcasting Authority of Ireland. Revised General and Children’s Commercial  
389 Communications Codes. Broadcasting Authority of Ireland: Dublin, Ireland, 2013. Available  
390 at: <http://www.bai.ie/en/codes-standards/#al-block-5> (accessed on 15 January 2016).
- 391 13. Food Standards Australia New Zealand. Standard 1.2.7—Nutrition, Health and Related Claims.  
392 Australian Federal Register of Legislative Instruments F2014C01191, 2013. Available at:  
393 <http://www.comlaw.gov.au/Details/F2013L00054> (accessed on 19 December 2015).

- 394 14. Moubarac JC, Parra DC, Cannon G, Monteiro CA. Food Classification Systems Based on Food  
395 Processing: Significance and Implications for Policies and Actions: A Systematic Literature  
396 Review and Assessment. *Curr Obes Rep* 2014; **3**: 256–272.
- 397 15. Louzada MLC, Martins APB, Canella DS, Baraldi LG, Levy RB, Claro RM *et al*. Ultra-  
398 processed foods and the nutritional dietary profile in Brazil. *Rev Saude Publica* 2015; **49**: e-  
399 pub.
- 400 16. Ministry of Health of Brazil. Dietary Guidelines for the Brazilian Population. Ministério da  
401 Saúde: Brasília, 2014. Available at:  
402 [http://189.28.128.100/dab/docs/portaldab/publicacoes/guia\\_alimentar\\_populacao\\_ingles.pdf](http://189.28.128.100/dab/docs/portaldab/publicacoes/guia_alimentar_populacao_ingles.pdf)  
403 (accessed on 12 November 2015).
- 404 17. Colby SE, Johnson L, Scheett A, Hoverson B. Nutrition marketing on food labels. *J Nutr Educ*  
405 *Behav* 2010; **42**: 92-98.
- 406 18. Chandon P. How package design and packaged-based marketing claims lead to overeating.  
407 *Appl Econ Perspect Pol* 2013; **35** 7-31.
- 408 19. Elliott C. Assessing ‘fun foods’: nutritional content and analysis of supermarket foods targeted  
409 at children. *Obes Rev* 2008; **9**: 368–377.
- 410 20. Schwartz MB, Vartanian LR, Wharton CM, Brownell KD. Examining the nutritional quality of  
411 breakfast cereals marketed to children. *J Am Diet Assoc* 2008; **108**: 702–705.
- 412 21. Hawkes C. Food packaging: the medium is the message. *Public Health Nutr* 2010; **13**: 297-  
413 299.
- 414 22. Lythgoe A, Roberts C, Madden AM, Rennie KL. Marketing foods to children: a comparison of  
415 nutrient content between children’s and non-children’s products. *Public Health Nutr* 2013; **16**:  
416 2221-2230.
- 417 23. Rodrigues VM, Rayner M, Fernandes AC, Oliveira RC, Proença RPC, Fiates GMF.  
418 Comparison of the nutritional content of products, with and without nutrient claims, targeted at  
419 children in Brazil. *Br J Nutr* 2016; **115**: 2047-2056.
- 420 24. Brazilian Health Surveillance Agency. Resolution—RDC No. 54, of November 12, 2012.  
421 [Provides the Technical Regulation on Nutrient Claims, 2012]. Federal Employee Gazette of 12  
422 November 2012. Brasília, DF.
- 423 25. Brazilian Health Surveillance Agency. Resolution—RDC No. 360, of December 23, 2003.  
424 [Approves the technical rules for packaged food labelling, and become it mandatory]. Federal  
425 Employee Gazette of 24 dec 2003. Brasilia, DF.
- 426 26. Louie CY, Moshtaghian H, Boylan S, Flood VM, Rangan AM, Barclay AW *et al*. A systematic  
427 methodology to estimate added sugar content of foods. *Eur J Clin Nutr* 2015; **69**: 154–161.
- 428 27. Scarborough P, Rayner M, Boxer A, Stockley L. *Application of the nutrient profiling model:*  
429 *definition of ‘fruit, vegetables and nuts’ and guidance on quantifying the fruit, vegetable and*  
430 *nut content of a processed product.* British Heart Foundation Health Promotion Research  
431 Group. Department of Public Health, University of Oxford, 2005.
- 432 28. Landis J, Koch G. The measurement of observer agreement for categorical data. *Biometrics*  
433 1977; **33**, 159-174.

- 434 29. Scarborough P, Rayner M. When nutrient profiling can (and cannot) be useful. *Public Health*  
435 *Nutr* 2014; **17**: 2637–2640.
- 436 30. Harris JL, Thompson JM, Schwartz MB, Brownell KD. Nutrition-related claims on children's  
437 cereals: what do they mean to parents and do they influence willingness to buy? *Public Health*  
438 *Nutr* 2011; **14**: 2207–2212.
- 439 31. Scarborough P, Payne C, Agu CG, Kaur A, Mizdrak A, Rayner M *et al*. How important is the  
440 choice of the nutrient profile model used to regulate broadcast advertising of foods to children?  
441 A comparison using a targeted data set. *Eur J Clin Nutr* 2013; **67**: 815–820.
- 442 32. Proença RPC, SILVEIRA BM. Intake recommendations and labeling of trans fat in processed  
443 foods in Brazil: analysis of official documents. *Rev. Saúde Pública* 2012; **46**: 923-928.
- 444 33. Silveira BM, Gonzalez-Chica DA, Proença RPC. Reporting of trans-fat on labels of Brazilian  
445 food products. *Public Health Nutr* 2013; **16**: 2146–2153.
- 446 34. Mehta K, Phillips C, Ward P, Coveney J, Handsley E, Carter P. Marketing foods to children  
447 through product packaging: prolific, unhealthy and misleading. *Public Health Nutr* 2012; **15**:  
448 1763-70.
- 449 35. Devi A, Eyles H, Rayner M, Mhurchu CN, Swinburn B, Lonsdale-Cooper E *et al*. Nutritional  
450 quality, labelling and promotion of breakfast cereals on the New Zealand market. *Appetite*  
451 2014; **81**: 253–260.
- 452 36. Canella DS, Levy RB, Martins AP, Claro RM, Moubarac J-C, Baraldi LG *et al*. Ultra-  
453 processed food products and obesity in Brazilian households (2008-2009). *PLoS One* 2014; **9**:  
454 e92752.
- 455 37. Rauber F, Campagnolo PD, Hoffman DJ, Vitolo MR. Consumption of ultra-processed food  
456 products and its effects on children's lipid profiles: a longitudinal study. *Nutr Metab*  
457 *Cardiovasc Dis* 2015; **25**: 116-122.
- 458 38. Mozaffarian D, Hao T, Rimm EB, Willett WC, Hu FB. Changes in diet and lifestyle and long-  
459 term weight gain in women and men. *N Engl J Med* 2011; **364**: 2392–2404.
- 460 39. Woodward-Lopez G, Kao J, Ritchie L. To what extent have sweetened beverages contributed  
461 to the obesity epidemic? *Public Health Nutr* 2010; **14**: 499–509.
- 462 40. Hu FB, Malik VS. Sugar-sweetened beverages and risk of obesity and type 2 diabetes:  
463 epidemiologic evidence. *Physiol Behav* 2010; **100**: 47–54.
- 464 41. Rayner M, Wood A, Lawrence M, Mhurchu CN, Albert J, Barquera S *et al*. Monitoring the  
465 health-related labelling of foods and non-alcoholic beverages in retail settings. *Obes rev* 2013;  
466 **14**: S70-S81.

**Table 1** – Percentage of foods categorised as ‘less healthy’ by the UK/Ofcom nutrient profile model and the NOVA model, overall and by the presence of nutrient claims (95% CI).

	NOVA	UK/Ofcom	Difference between models’ categorisation
<b>Overall (<i>n</i> = 535)</b>	91.4% (88.7-93.6)	75.0% (72.0-79.5)	<i>p</i> < 0.001*
<b>With NC (<i>n</i> = 270)</b>	95.9% (92.8-98.0)	74.1% (68.4-79.2)	<i>p</i> < 0.001*
<b>Without NC (<i>n</i> = 265)</b>	86.8% (82.1-90.6)	75.8% (70.2-80.9)	<i>p</i> = 0.001*
<b>Difference in categorisation by the presence of nutrient claims</b>	<i>p</i> < 0.001*	<i>p</i> = 0.663	

Abbreviations: CI, confidence interval; NC, nutrient claims. \*Statistically significant at *p*<0.05 (Pearson's chi-squared test -  $\chi^2$ ).