

# A framework to regulate the marketing of foods and beverages to children in South Africa

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## ABSTRACT

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### *Background*

Globally the childhood obesity prevalence has increased dramatically and appears to be rapidly increasing in low-income and middle-income countries as well. In South Africa the rates of childhood obesity have increased by 7% during the last decade. The 'obesogenic' food-environment which promotes the consumption of foods and non-alcoholic beverages high in fat, sugar and/or salt (HFSS) has been recognized as a key driver in this global pandemic. The World Health Organization has called for governments to improve children's food environment by implementing restrictions on the marketing of HFSS foods and non-alcoholic beverages to children. Nutrient profiling is defined as the science of categorizing foods according to their nutritional composition for the purpose of preventing disease and promoting health. Internationally, nutrient profiling has recently proliferated, specifically in the context of restricting the marketing of HFSS foods and non-alcoholic beverages to children.

### *Aim*

This study aimed to develop a framework for regulating the marketing of HFSS foods and non-alcoholic beverages to children in South Africa with the support of an appropriate nutrient profiling model. The framework will be submitted to the South African Department of Health for consideration to be implemented into the child-directed food marketing regulations.

### *Methods*

The appropriateness and validity of the South African nutrient profiling model (SANPM), originally designed to screen food for the eligibility of a nutrient and/or health claim, for regulating the marketing of foods to children was established. The SANPM was compared to four global non-industry developed models for the purpose of regulating the marketing of HFSS foods to children. Comparisons between the models were done by classifying the 'healthiness' of 197 individual foods according to each of the nutrient profiling models' classification criteria. Then, registered dietitians in South Africa were requested to categorize 120 foods on a 6-point Likert scale in one of six positions on the basis of their 'healthiness' via an online survey. The classification of the 120 foods by the included nutrient profiling models was then compared to the views of the dietitians. Finally, the scientific evidence supporting the absolute exclusion criteria used by the nutrient profiling models were evaluated for inclusion into the suggested framework.

## *Results*

The percentage of foods permitted for child-directed food marketing according to the different models ranged from 6% to 45 %. The majority of the pairwise comparisons between the models yielded kappa statistics greater than 0.4 indicating a moderate agreement between the models. An almost perfect pairwise agreement (kappa = 0.948) existed between the SANPM and a model extensively tested and validated for such regulations, the United Kingdom Food Standards Agency model (Ofcom).

Four of the included nutrient profiling models displayed a medium correlation with the views of dietitians (Spearman's correlation = 0.38-0.68,  $p = 0.001$ ). The SANPM was the only model displaying a strong correlation with the views of dietitians (Spearman's correlation = 0.71,  $p = 0.001$ ).

The SANPM was included as the first step in the suggested framework and the inclusion of an absolute exclusion criterion for non-nutritive sweeteners was found to be scientifically sound.

## *Conclusion*

This study provided valuable information regarding the use of a nutrient profiling model for child-directed food marketing regulations. The appropriateness and construct validity of the SANPM for regulating the marketing of foods to children in South Africa was established. A suggested framework for regulating the marketing of foods to children in South Africa was developed by including a non-nutritive sweetener absolute exclusion criterion. We recommend that this framework is legislated to regulate the marketing of foods to children in South Africa to support the Strategy for the Prevention and Control of Obesity in South Africa.

*Key terms:* marketing of foods, food marketing regulations, childhood obesity, nutrient profiling, obesity prevention strategies

## OPSOMMING

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### *Agtergrond*

Die voorkoms van kinderobesiteit het wêreldwyd drasties toegeneem en blyk ook in lae-inkomste en middel-inkomste lande toe te neem. In Suid-Afrika het die voorkoms van kinderobesiteit met 7% gedurende die laaste dekade toegeneem. Die 'obesogeniese' voedselomgewing wat die inname van voedsels en nie-alkoholiese drankte hoog in vet, suiker en/of sout (HVSS) bevorder, is erken as 'n sleuteldrywer in hierdie globale pandemie. Die Wêreld Gesondheid Organisasie het 'n beroep op regerings gedoen om die voedselomgewing van kinders te verbeter deur beperkings op die bemarking van HVSS-voedsels aan kinders te implementeer. Nutriëntprofilering word omskryf as die wetenskap van kategorisering van voedsels volgens hul nutriëntsamestelling met die doel om siektes te voorkom en gesondheid te bevorder. Internasionaal het nutriëntprofilering onlangs veld gewen, spesifiek in die konteks van beperking op die bemarking van HVSS-voedsels aan kinders.

### *Doel*

Die oogmerk van hierdie studie was om 'n raamwerk te ontwikkel vir die regulering van die bemarking van HVSS-voedsels aan kinders in Suid-Afrika met die ondersteuning van 'n gepaste nutriëntprofielmodel. Die raamwerk sal aan die Suid-Afrikaanse Departement van Gesondheid voorgelê word vir oorweging om te implementeer in die voedselbemarkings-regulasies gerig op kinders.

### *Metodes*

Die geskiktheid en geldigheid van die Suid-Afrikaanse nutriëntprofielmodel (SANPM), oorspronklik ontwerp om voedsel te sif vir geskiktheid vir 'n nutriënt- en/of gesondheidsaanspraak, is vasgestel vir die regulering van bemarking van voedsels aan kinders. Die SANPM is met vier globale nie-industrieël-ontwikkelde modelle vergelyk met die doel om bemarking van HVSS-voedsels aan kinders te reguleer. Die modelle is met mekaar vergelyk deur die 'gesondheid' van 197 individuele voedsels te klassifiseer volgens elk van die nutriëntprofielmodelle se klassifikasie kriteria. Daarna is geregistreerde dieetkundiges in Suid-Afrika versoek om 120 voedsels op 'n 6-punt Likertskaal te kategoriseer in een van ses posisies op die basis van hul 'gesondheid' in 'n aanlynopname. Die klassifikasie van die 120 voedsels deur die ingeslote nutriëntprofielmodelle is daarna met die opinies van die dieetkundiges vergelyk. Ten slotte is die wetenskaplike bewyse wat die absolute uitsluitingskriteria gebruik deur die nutriëntprofielmodelle ondersteun, geëvalueer vir insluiting al dan nie in die voorgestelde raamwerk.

## *Resultate*

Die persentasie voedsels vir bemarking gerig op kinders toegelaat volgens die verskillende modelle het van 6% tot 45% gewissel. Die meerderheid van die gepaarde vergelykings tussen die modelle het kappa-statistiek groter as 0.4 gelewer, wat op 'n matige ooreenstemming tussen die modelle dui. 'n Feitlik perfekte gepaarde ooreenstemming (kappa = 0.948) het bestaan tussen die SANPM en 'n model wat ekstensief getoets en gevalideer is vir sulke regulasies, die '*United Kingdom Food Standards Agency*' model (Ofcom).

Vier van die ingeslote nutriëntprofielmodelle het 'n medium korrelasie met die opinies van dieetkundiges getoon (Spearman korrelasie = 0.38-0.68,  $p = 0.001$ ). Die SANPM was die enigste model wat 'n sterk korrelasie met die opinies van dieetkundiges vertoon het (Spearman korrelasie = 0.71,  $p = 0.001$ ).

Die SANPM is as die eerste stap in die voorgestelde raamwerk ingesluit en die insluiting van 'n absolute uitsluitingskriterium vir die teenwoordigheid van nie-nutriënt versoeters in 'n voedselprodukt is wetenskaplik begrond gevind.

## *Gevolgtrekking*

Hierdie studie het waardevolle inligting verskaf wat betref die gebruik van 'n nutriëntprofielmodel vir voedselbemarkingsregulasies gerig op kinders. Die geskiktheid en geldigheid van die SANPM vir regulering van die bemarking van voedsels aan kinders in Suid-Afrika is vasgestel. 'n Voorgestelde raamwerk vir die regulering van die bemarking van voedsels aan kinders in Suid-Afrika is ontwikkel deur die insluiting van 'n nie-nutriënt versoeter absolute uitsluitingskriterium. Ons beveel aan dat hierdie raamwerk in wetgewing opgeneem word om die bemarking van voedsels aan kinders in Suid-Afrika te reguleer om die Strategie vir die Voorkoming en Beheer van Obesiteit in Suid-Afrika te ondersteun.

*Sleuteltermes:* bemarking van voedsels, voedselbemarkingsregulasies, kinderobesiteit, nutriëntprofilering, obesiteitvoorkomingstrategieë

## DEFINITIONS

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Added sugar: refers to any sugar added to food by manufacturers, cooks or consumer during processing or preparation (SADoH, 2014; WHO, 2015a).

Advergame: a digital game that features branded content and is used to advertise a brand.

Advertising: one type of marketing activity.

Child: people under 18 years of age, in line with the United Nations Convention on the Rights of the Child and the World Health Organizations Commission on Ending Childhood Obesity.

Food additive: means any substance, regardless of its nutritive value, that is not normally consumed as a food by itself and not normally used as a typical ingredient of the food, which is added intentionally to a food for technological (including organoleptic) purposes in the manufacturing, processing, preparation, treatment, packing, packaging, transport or storage of the food, and result, or may reasonably be expected to result (directly or indirectly) in such a substance, or its by-products, becoming a component of, or otherwise affecting the characteristics of such foods and excludes any substance added to foods for maintaining or improving nutritional qualities or any contaminants and sodium chloride, but excludes processing aids (SADoH, 2014).

Free sugars: include monosaccharides and disaccharides added to foods and beverages by the manufacturer, cook or consumer, and sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates (WHO, 2015a).

Intervention: action taken to improve a situation.

Marketing: any activity in which an organization engages to facilitate exchanges between itself and its customers.

Non-nutritive sweetener: is a food additive (other than a mono-saccharide or disaccharide sugar), of which one serving of 5 g provides  $\leq 8$  kJ (1.9 kcal) and a sweet taste equivalent to 5 g of sucrose (DOH, 2014; WHO, 2015b).

Obesogenic food-environment: The sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations.

Obesity: From birth to less than 5 years of age a weight-for-age more than 3 Standard Deviations (SD) above the World Health Organization child growth standards median and from

5 to less than 19 years a Body Mass Index-for-age more than 2 SD above the World Health Organization growth reference median.

Overweight: From birth to less than 5 years of age a weight-for-age more than 2 SD above the World Health Organization child growth standards median and from 5 to less than 19 years a Body Mass Index-for-age more than 1 SD above the World Health Organization growth reference median.

Policy: a policy is a principle or set of principles to guide decision and set direction. For the purpose of this study policies are defined as actions that aim to improve the human diet.

Regulation: a rule or instruction made and maintained by an authority.

Strategy: a plan of action or policy designed to achieve an overall aim.

Total sugar: refers to the sum of all intrinsic (lactose, fructose and galactose) and added sugars (monosaccharides and disaccharides) (SADoH, 2014).

Unhealthy foods: foods high in fats, sugars and/or salt (i.e. energy-dense, nutrient-poor foods) as defined by the World Health Organization (WHO, 2015c).

Ultra-processed products: Industrial formulations manufactured with several ingredients. Like processed products, ultra-processed products include substances from the culinary ingredients category, such as fats, oils, salt, and sugar. Ultra-processed products can be distinguished from processed products based on the presence of other substances that are extracted from foods but have no common culinary use (e.g. casein, milk whey, protein hydrolysate, and protein isolates from soy and other foods); substances synthesized from food constituents (e.g. hydrogenated or interesterified oils, modified starches, and other substances not naturally present in foods); and additives used to modify the colour, flavour, taste or texture of the original product. Unprocessed or minimally processed foods usually represent a tiny proportion of or are absent in the list of ingredients of ultra-processed products, which often have 5, 10, 20 or more items. Several techniques are used in the manufacture of ultra-processed products, including extrusion, moulding and pre-processing through frying. Examples include soda-drinks, packaged snacks, “instant” noodles, and chicken nuggets (Monteiro, 2009).

World Health Assembly: the decision-making body of the World Health Organization, attended by delegations from all World Health Organization Member States and focuses on a specific health agenda, one of the main functions being to determine the policies of the Organization.

## ABBREVIATIONS

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|                  |  |
|------------------|--|
| DoH:             | Department of Health   |
| DoHSA:           | South African Department of Health nutrient profiling model for restricting food marketing to children |
| ECHO Commission: | Ending Childhood Obesity Commission  |
| EMRO:            | World Health Organization's Eastern Mediterranean Regional Office nutrient profiling                   |
| HFSS:            | High in fats, sugar and/or salt foods  |
| NCDs:            | Non-communicable Diseases  |
| NNS:             | Non-nutritive sweeteners   |
| Ofcom:           | United Kingdom Office of Communication nutrient profiling model  |
| REU:             | World Health Organization's Regional Office for Europe nutrient profiling model                        |
| SADoH:           | South African Department of Health   |
| SAFBDGs:         | South African Food Based Dietary Guidelines  |
| satfat:          | saturated fat  |
| SANPM:           | South African nutrient profiling model   |
| WHA:             | World Health Assembly  |
| WHO:             | World Health Organization  |

# TABLE OF CONTENTS

---

|   |             |
|---|-------------|
| <b>ACKNOWLEDGEMENTS.....</b>  | <b>I</b>    |
| <b>ABSTRACT .....</b>   | <b>II</b>   |
| <b>DEFINITIONS .....</b>  | <b>VI</b>   |
| <b>ABBREVIATIONS .....</b>  | <b>VIII</b> |
| <br>  |             |
| <b>CHAPTER ONE: BACKGROUND INFORMATION AND RATIONALE FOR THE STUDY .....</b>              | <b>1</b>    |
| <b>1.1 Background information and rationale for the study.....</b>                        | <b>1</b>    |
| <b>1.2 Aims and objectives.....</b>   | <b>4</b>    |
| 1.2.1 Aim.....  | 4           |
| 1.2.2 Objectives .....  | 4           |
| <b>1.3 Ethical approval .....</b>   | <b>4</b>    |
| <b>1.4 Structure .....</b>  | <b>4</b>    |
| <b>1.5 Research team.....</b>   | <b>5</b>    |
| <br>  |             |
| <b>CHAPTER 2: LITERATURE REVIEW.....</b>  | <b>8</b>    |
| <b>2.1 The rise of child overweight and obesity as a global and national problem.....</b> | <b>8</b>    |
| <b>2.2 Approaches to address childhood obesity .....</b>                                  | <b>10</b>   |
| 2.2.1 Strategy for the prevention and control of obesity in South Africa 2015-2020 .....  | 11          |
| 2.2.2 Cost-effectiveness of childhood obesity prevention .....                            | 11          |
| <b>2.3 Environmental factors that drive obesity, including food marketing.....</b>        | <b>12</b>   |
| 2.3.1 Consumer food environment in South Africa .....                                     | 13          |

|   |   |            |
|---|---|------------|
| 2.3.2   | The exposure and persuasive power of child-directed food marketing.   | 13         |
| 2.3.2.1   | The nature and extent of child-directed food marketing .....  | 13         |
| 2.3.2.2   | The effect of child-directed food marketing on children’s food preferences .....  | 15         |
| <b>2.4</b>  | <b>Global initiatives to limit children’s exposure to food and non-alcoholic beverage marketing .....</b>                 | <b>16</b>  |
| 2.4.1   | Industry self-regulation in the form of child-directed food marketing codes or pledges .....                              | 17         |
| 2.4.2   | Statutory regulations and their impact on restricting the marketing of foods and non-alcoholic beverages to children..... | 18         |
| <b>2.5</b>  | <b>Nutrient profiling — defining foods and non-alcoholic beverages high in saturated fats, sugar and/or salt.....</b>     | <b>20</b>  |
| 2.5.1   | Nutrient profiling models in South Africa.....  | 24         |
| <b>2.6</b>  | <b>Nutrient profiling models used/recommend for use by statutory bodies .....</b>   | <b>26</b>  |
| <b>2.7</b>  | <b>Food processing .....</b>  | <b>26</b>  |
| <b>2.8</b>  | <b>Conclusion.....</b>  | <b>28</b>  |
| <b>CHAPTER 3</b>  | <b>.....</b>  | <b>30</b>  |
| <b>CHAPTER 4</b>  | <b>.....</b>  | <b>54</b>  |
| <b>CHAPTER 5</b>  | <b>.....</b>  | <b>73</b>  |
| <b>CHAPTER 6: GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS.....</b> |   |            |
| <b>6.1</b>  | <b>General discussion .....</b>   | <b>96</b>  |
| <b>6.2</b>  | <b>Strengths and limitations of the study .....</b>   | <b>98</b>  |
| <b>6.3</b>  | <b>Way forward and recommendations .....</b>  | <b>99</b>  |
| <b>6.4</b>  | <b>Conclusion.....</b>  | <b>100</b> |

|  |            |
|--|------------|
| <b>REFERENCES .....</b>  | <b>101</b> |
| <b>ADDENDUM 1: CONTENT AND STYLE GUIDELINE FOR BRITISH JOURNAL OF NUTRITION .....</b>                  | <b>118</b> |
| <b>ADDENDUM 2: PUBLISHED ARTICLE.....</b>  | <b>132</b> |
| <b>ADDENDUM 3: CONTENT AND STYLE GUIDELINE FOR APPETITIE .....</b>                                     | <b>142</b> |
| <b>LIST OF TABLES</b>  |            |
| Table 1-1: Research team and their role in the study.....  | 5          |
| Table 2-1: The different characteristics of nutrient profiling models.....                             | 22         |
| Table 2-2: United Kingdom Food Standards Agency traffic-light-labelling criteria for green (low) ..... | 25         |

## CHAPTER ONE:

### BACKGROUND INFORMATION AND RATIONALE FOR THE STUDY

---

#### 1.1 Background information and rationale for the study

The prevalence of childhood overweight and obesity have increased dramatically and seems to be increasing even more rapidly in certain low-income and middle-income countries (Lobstein *et al.*, 2015). Unfortunately, South African children form part of these concerning statistics. Recent data indicate that the number of overweight children between the ages of 2 and 5 years has increased from 10.6% (Labadarios *et al.*, 2007) to 18.1% (Shisana, 2013) and the combined overweight and obesity prevalence of children between the ages of 6 to 15 years has increased from 7.8 % (Kruger *et al.*, 2006) to 13.5% (Shisana, 2013). Children who are overweight or obese (from now on only referred to as childhood obesity) have a high risk of developing a number of non-communicable diseases (NCDs) and significantly lower mean quality of life scores (Puhl & Latner, 2007; Keating *et al.*, 2011a; Keating *et al.*, 2011b). Childhood obesity is also a strong predictor of adult obesity (Kelsey *et al.*, 2014), which holds major health and economic consequences for the individuals, their families and society as a whole (Nader *et al.*, 2006; Litwin, 2014; Sonntag *et al.*, 2015). The ‘obesogenic’ (obesity-promoting) food environment that promotes the consumption of foods and non-alcoholic beverages high in fats, sugar and/or salt (hereafter referred to as HFSS foods) is recognized as a key driver in the global childhood obesity pandemic (Swinburn *et al.*, 2011; Lobstein *et al.*, 2015). There is also growing evidence that food marketing affects the food preferences of children, their consumption and purchasing requests to parents (McGinnis *et al.*, 2006; Roberto *et al.*, 2010; Boyland & Halford, 2013; Sadeghirad *et al.*, 2016) and that food preferences learned during childhood often persist throughout a person’s lifetime (Deckelbaum & Williams, 2001; Cooke, 2007; Birch & Doub, 2014). Child-directed food marketing is extensive and research indicates that it primarily concerns HFSS food products (Roberto *et al.*, 2010; Zimmerman & Bell, 2010; Boyland & Halford, 2013; Kelly *et al.*, 2014). Regrettably, due to rapid urbanisation and acculturation in numerous low-income and middle-income countries, many children are now raised in these ‘obesogenic’ food environments (Lobstein & Dobb, 2005; Hawkes & Lobstein, 2011; Swinburn *et al.*, 2011).

The global increase in childhood obesity and the recognition that food marketing practices may influence the food preferences of children have resulted in consumer groups, parents, teachers, healthcare professionals and public health advocacy organizations calling for greater control over the marketing of foods to children (Galbraith-Emami & Lobstein, 2013). As a result, several countries around the world have published policies on marketing to

children, including statutory controls, industry-led self-regulation and co-regulatory arrangements (industry led with government oversight) (Hawkes & Lobstein, 2011). In 2010, the World Health Organization (WHO) published a set of recommendations for the marketing of food and non-alcoholic beverages to children. These recommendations were endorsed by the 63<sup>rd</sup> World Health Assembly (WHA 63.14) (WHO, 2010). However, the progress in addressing childhood obesity has been slow and inconsistent therefore the WHO Commission on Ending Childhood Obesity (ECHO Commission) was established in 2014 to review and address gaps in existing obesity prevention mandates and strategies (WHO, 2016). In 2016, the WHO released the ECHO Commission report, a core recommendation being to reduce children's exposure to *all* forms of marketing of HFSS foods in view of "unequivocal evidence that the marketing of unhealthy foods and sugar-sweetened beverages is related to childhood obesity". The ECHO Commission also notes with concern "the failure of Member States to give significant attention to Resolution WHA 63.14" and "requests that they address this issue"(WHO, 2016).

Research reports that voluntary restrictions, such as the European Union (EU) pledge to change food and beverage marketing to children under the age of twelve on television, print and the internet in the EU, are ineffective in preventing the marketing of HFSS foods to children. This is due to the fact that voluntary restrictions' nutritional criteria are less stringent, they do not include all marketing channels, their age limits are too low and not all members of the food industry participate in such commitments (Huizinga & Kruse, 2016). These findings therefore support earlier calls for government-led policy or regulation to restrict the marketing of HFSS foods to children (Gortmaker *et al.*, 2011). Such a policy is of high priority and is included in the WHO Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013-2020 (WHO, 2013) due to potential population-wide effects, cost-effectiveness and sustainability (Magnus *et al.*, 2009; Swinburn *et al.*, 2015). Governments should take the lead in combating childhood obesity by implementing a policy that aims to reduce the impact of HFSS food marketing on children (Kelly *et al.*, 2013).

Effective implementation of such a policy requires a clear definition of the foods that should be restricted from being marketed to children, unless the marketing of all foods is to be prohibited (Kelly *et al.*, 2013). Nutrient profiling is defined as "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health" (Rayner *et al.*, 2004; WHO, 2011), and is suggested by the WHO to support child-directed food marketing restrictions (WHO, 2016). Numerous nutrient profiling models with different aims have been developed by academics, health organizations, national governments and food industries throughout the world. However, research has

indicated that the models classify foods differently (Brinsden & Lobstein, 2013; Rayner *et al.*, 2013; Scarborough *et al.*, 2013) and that few have been thoroughly tested and validated (WHO, 2011). In South Africa, the South African nutrient profiling model (SANPM) is accepted and used as the first screening process to determine a food product's eligibility for nutrient and/or health claims (DOH, 2014). This model enjoys support from all stakeholders involved as it was thoroughly tested and validated before implementation as part of regulation (Wentzel-Viljoen *et al.*, 2012; Wicks, 2012; Lee, 2013).

Due to the substantial increase in childhood obesity in South Africa and in recognition of the need for a policy to restrict children's exposure to HFSS food marketing, the South African National Department of Health (SADoH), Directorate: Food Control, published a draft regulation (DOH, 2014) for comments in 2014, aiming to restrict the marketing of *all* HFSS foods and non-alcoholic beverages (from now on only referred to as foods) to children. In April 2015 the SADoH also published the Strategy for the Prevention and Control of Obesity in South Africa 2015-2020 (SADoH, 2015), a multi-sectoral approach to halt the scourge of obesity in the country, with a specific objective being to ensure responsible and ethical advertising and marketing of food by the food industry. The draft regulation recommends using the South African Department of Health nutrient profiling model for restricting the marketing of foods to children (DoHSA) to determine if a food product is permitted for marketing to children. The DoHSA model for restricting the marketing of foods to children is an adapted model and is based on the SANPM. The draft regulation was published in 2014 (DOH, 2014) without any justification for the classification criteria used by the DoHSA model and without any consultation or inputs from stakeholders. Neither the DoHSA model nor the SANPM model have ever been tested or validated for the purpose of regulating the marketing of foods to children.

Numerous stakeholders have questioned the need for a regulation that aims to restrict the marketing of HFSS foods to children; some also commented that the draft regulation was not sufficiently evidence-based and too strict. Many stakeholders also questioned the fact that the DoHSA model was based on the SANPM as the SANPM was never tested or validated for this purpose of restricting the marketing of HFSS foods to children. Consequently, the need for an evidence-based framework for regulating the marketing of foods to children with the support of an appropriate and valid nutrient profiling model was identified.

## **1.2 Aims and objectives**

### **1.2.1 Aim**

This study aims to develop a framework for regulating the marketing of foods and non-alcoholic beverages to children in South Africa with the support of an appropriate nutrient profiling model. The framework will be submitted to the SAdoH for consideration to be implemented as part of the child-directed food marketing regulations.

### **1.2.2 Objectives**

The following objectives support the aim:

- (1) to assess the appropriateness of the SANPM for child-directed food marketing regulations in South Africa;
- (2) to establish convergent validity of the SANPM and DoHSA models for child-directed food marketing regulations in South Africa;
- (3) to evaluate the absolute exclusion criteria of other nutrient profiling models; and
- (4) to develop a suggested framework to regulate the marketing of foods and beverages to children in South Africa.

## **1.3 Ethical approval**

Ethical approval was obtained from the North-West University Health Research Ethics Committee (NWU-00331-15A1).

## **1.4 Structure**

This thesis is presented in article format and is divided into six chapters. The format and referencing of the three articles (Chapters 3 – 5) are according to the respective journals' guidelines and these are attached as addendums.

**Chapter 1** provides background information on the study, establishes the need for the study, states the aim and objectives and the structure of the thesis and lists the role of each member of the research team.

**Chapter 2** examines the relevant literature on the childhood obesity epidemic, including topics such as the drivers of the obesity pandemic, obesity prevention strategies, food marketing restrictions, nutrient profiling, the South African nutrient profiling model, nutrient profiling

models used for child-directed food marketing restrictions/regulations and the validity of nutrient profiling models.

**Chapter 3** presents the first article manuscript. The title of Manuscript 1 reads: **‘Restricting the marketing of foods and non-alcoholic beverages to children in South Africa: are all nutrient profiling models the same?’** This manuscript documents the differences between the nutrient profiling models used to support child-directed food marketing restrictions and highlights the strengths and weaknesses of the different models. This article has been accepted for publication in *British Journal of Nutrition* (doi: 10.1017/S0007114516004244).

**Chapter 4** presents the second article manuscript. The title of Manuscript 2 reads: **‘Assessing the construct validity of nutrient profiling models to regulate the marketing of foods and non-alcoholic beverages to children in South Africa’.** This manuscript documents the differences between South African dietitians’ perception of the ‘healthiness’ of foods and the classification of the same foods by various nutrient profiling models. This manuscript will be submitted to *British Journal of Nutrition*.

**Chapter 5** presents the third article manuscript. The title of Manuscript 3 reads: **‘A framework to regulate the marketing of foods and non-alcoholic beverages to children in South Africa’.** This manuscript explores the absolute exclusion criteria of various nutrient profiling models. Following this, it suggests an evidence-based framework for regulating the marketing of foods and non-alcoholic beverages that supports the South African Strategy for the Prevention and Control of Obesity. This manuscript will be submitted to *Appetite*.

**Chapter 6** consists of the conclusion which summarizes the essential findings of the study and provides recommendations for future research.

**Chapter 7** includes the references of chapters 1, 2 and 6.

## 1.5 Research team

The role of each co-worker in this study is described in Table 1-1.

**Table 1-1: Research team and their role in the study**

| <b>Team Members</b>              | <b>Affiliation</b>   | <b>Role in the Study</b>  |
|----------------------------------|--|---|
| Mrs Mariaan Wicks<br>(Dietitian) | Centre of Excellence for<br>Nutrition, North-West<br>University, | Part-time Ph.D. student.<br>Designed and planned the<br>study, obtained the literature, |

| Team Members  | Affiliation  | Role in the Study   |
|---|--|---|
|   | Potchefstroom, South Africa  | performed the nutrition information data collection, analysed and interpreted the data and documented the study.<br><br>Leading author on all of the manuscripts.   |
| Prof. Edelweiss Wentzel-Viljoen<br>(Dietitian & Nutritionist) | Centre of Excellence for Nutrition, North-West University, Potchefstroom, South Africa                         | Promoter of PhD thesis.<br><br>Essential guidance regarding the protocol development and data collection. Participated in the statistical analysis plan and provided guidance regarding the writing of the thesis and the interpretation of the results.<br><br>Co-author of all manuscripts. |
| Dr. Hattie Wright<br>(Dietitian)                              | Faculty of Science, Health, Education and Engineering, University of the Sunshine Coast, Queensland, Australia | Co-promoter of PhD thesis.<br><br>Provided guidance regarding writing of the thesis and the interpretation of the results.<br><br>Co-author of all manuscripts.   |
| Ms Marike Cockeran<br>(Bio-statistician)                      | Centre of Excellence for Nutrition, North-West University, Potchefstroom, South Africa                         | Provided assistance with the statistical analysis.  |
| Mr Willie Smit<br>(Engineer)                                  | Private  | Developed electronic nutrient criteria algorithms for each of the included nutrient profiling models in Microsoft Excel 2013.   |
| Ms Janlie Delport<br>(Dietitian)                              | Centre of Excellence for Nutrition, North-West   | Captured television food advertisements.  |

| Team Members | Affiliation  | Role in the Study |
|--------------|--|-------------------|
|              | University,<br>Potchefstroom South<br>Africa & Potchefstroom<br>Hospital |                   |

## CHAPTER 2: LITERATURE REVIEW

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“He who has health has hope, and he who has hope has everything.” – Arabian Proverb

Childhood obesity is one of the most serious public health challenges of the 21st century and the prevalence has increased at an alarming rate. The World Health Assembly (WHA) set “halt[ing] the rise in diabetes and obesity” in adults and children as one of the global health targets in 2013 (WHA, 2013). The food environment, which promotes the consumption of foods and non-alcoholic beverages high in fat, sugar and/or salt (hereafter referred to as HFSS foods), is recognized as a key driver in the global childhood obesity pandemic (Swinburn *et al.*, 2011; Galbraith-Emami & Lobstein, 2013; Lobstein *et al.*, 2015). In 2010, the World Health Organization (WHO) published a set of recommendations for the marketing of food and non-alcoholic beverages to children. These recommendations were endorsed by the 63<sup>rd</sup> WHA (WHA 63.14) (WHO, 2010). In 2016, the WHO released the Ending Childhood Obesity Commission report, which notes with concern “the failure of Member States to give significant attention to Resolution WHA 63.14” and “requests that they address this issue”(WHO, 2016a).

This literature review firstly focuses on the dramatic rise in childhood obesity and the different approaches that have been taken to address this problem. The environmental factors that drive childhood obesity are discussed against the background of the current childhood obesity epidemic, specifically the exposure and persuasive power of food and non-alcoholic beverage marketing on children’s dietary behaviour. The global initiatives to limit children’s exposure to food marketing are discussed with specific focus on food marketing restrictions and the use of nutrient profiling models to support these restrictions. Finally, the chapter reports on the actions required to develop an effective and evidence-informed framework to support food-marketing restrictions.

### **2.1 The rise of child overweight and obesity as a global and national problem**

Childhood overweight and obesity are global public health concerns as the prevalence has increased dramatically over the past three decades and appears to be rapidly increasing in low-income and middle-income countries as well (Lobstein *et al.*, 2015). According to the 2013 United Nations Children’s Fund, World Health Organization (WHO) and World Bank estimates (UNICEF, 2015), the number of overweight children worldwide have increased from 32 million to 42 million during the last decade. In Africa, the number of children who are overweight or

obese has nearly doubled in the last 25 years, increasing from 5.1 million to 10.3 million (WHO, 2014b). The alarming fact is that the vast majority of overweight or obese children are now living in developing countries, where the rate of increase has been more than 30% higher than that of developed countries (WHO, 2014b). Unfortunately, the South African childhood overweight and obesity story is quite similar to that of other developing countries. The most recent data report that the number of overweight children between the ages of 2 and 5 years has increased from 10.6% (Labadarios *et al.*, 2007) to 18.1% (Shisana, 2013). The combined overweight and obesity prevalence of children between the ages of 6 to 15 years has increased from 7.8 % (Kruger *et al.*, 2006) to 13.5% (Shisana, 2013). The combined overweight and obesity prevalence of children between the ages of 6 to 15 years in South Africa is higher than the global prevalence of 10% in schoolchildren (Gupta *et al.*, 2012), but lower than current levels in the United States of America (USA) [18% for obesity and 32.6% for combined overweight and obesity in children aged 6 to 11 years (2009-2010)] (Flegal *et al.*, 2012; Mchiza & Maunder, 2013). Research has indicated that in low-income and middle-income countries, groups of high socioeconomic status in urban areas tend to be the first to have high obesity prevalence, but the burden of obesity shifts to low socioeconomic status groups and rural areas as the country's gross domestic product increases (Monteiro *et al.*, 2004; Mendez *et al.*, 2005; Swinburn *et al.*, 2011). If no action is taken to halt this epidemic, the anticipated increase in overweight and obese children in South Africa will become an even greater concern.

Obesity is the result of complex biological, behavioural, social, economic and environmental interactions that promote a positive energy balance. The change in the global food system, which is producing and marketing more affordable HFSS foods has been identified as a main driver of the obesity epidemic (Swinburn *et al.*, 2011). Not only do children who are overweight or obese (from now on only referred to as childhood obesity) have a high risk of developing a number of non-communicable diseases (NCDs), they also have a significantly lower quality of life due to physical and psychological problems (Keating *et al.*, 2011a; Keating *et al.*, 2011b; Tsiros *et al.*, 2013). This subsequently leads to lower academic achievement and lower economic productivity (Puhl & Latner, 2007). What is more, childhood obesity is a strong predictor of adult obesity (Kelsey *et al.*, 2014), which increases the risk even further for developing obesity-related NCDs (Daniels, 2006). This results in major health and economic consequences for the individuals, their families and society as a whole (Nader *et al.*, 2006; Litwin, 2014; Sonntag *et al.*, 2015a). The increasing burden of childhood obesity and the high economic costs of related diseases on society (Wang *et al.*, 2011) have highlighted the need for urgent and substantial action from a variety of stakeholders (Roberto *et al.*, 2015). Subsequently, the prevention of obesity is a core priority of the WHO and its Member States.

The WHO set global targets to halt the rise of obesity in the Global Action Plan on the Prevention and Control of Non-communicable Diseases (WHO, 2013a) and the Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition (WHO, 2014a).

## **2.2 Approaches to address childhood obesity**

Due to the major health and economic impact of childhood obesity, the global public health community and many national governments around the world have emphasized the need for coherent and comprehensive strategies to effectively and sustainably prevent and manage childhood obesity. As a result, numerous research studies have been devoted to finding successful childhood obesity prevention strategies. Unfortunately, limited success has been reported (Swinburn & Egger, 2002; Singh *et al.*, 2007; Swinburn *et al.*, 2011). Wang and colleagues (2013) report that the majority of the intervention studies focused on individual behavioural change and aimed to improve diet, physical activity or both through health and education campaigns in a school-based setting. Some of the interventions led to short-term improvements in obesity and related risk factors, however, their sustainability and affordability were identified as major challenges to their success (Swinburn *et al.*, 2011). The fact that such programmes did not address the underlying drivers of the epidemic was also identified by Swinburn and colleagues (2011) as a key limitation. Interventions that motivate behavioural change have an important role to play in obesity prevention, but changing one's behaviour to responsible dietary behaviour and food preferences in a food environment that continuously promotes the consumption of HFSS foods is extremely difficult.

There is general agreement, based both on research and practice, that government-led food policies and regulations are required to effectively assist in behavioural change, as children's food environments are central to their learned food preferences and dietary behaviours (Hawkes *et al.*, 2015a). Examples of food policies include restricting the marketing of HFSS foods to children, interpretive front-of-pack labelling, healthy food policies in schools, and taxes on HFSS foods, such as sugar-sweetened beverages (Kumanyika *et al.*, 2008; Cecchini *et al.*, 2010; Gortmaker *et al.*, 2011; Mozaffarian *et al.*, 2012). Policy-led strategies that address the food environment have several strengths compared with health education and promotion campaigns (Swinburn & Egger, 2008) as they have the potential to influence food preferences and supply. Food policies are of high priority as they are cost effective, feasible, and have population-wide effects. Food policies reduce nutrition inequalities by improving benefits to more disadvantaged populations and, once established, the policies are sustainable. Food policies also support other societal objectives, such as protecting children

from exploitation and enabling consumers to make informed food choices. Regulations also carry the strongest accountability controls (Swinburn *et al.*, 2015a).

The progress in addressing childhood obesity has been slow and inconsistent. This has resulted in the establishment of the WHO Commission on Ending Childhood Obesity (ECHO Commission) in 2014 to review and address gaps in existing obesity prevention mandates and strategies (WHO, 2016a). In 2016, the WHO released the ECHO Commission report. One of the core recommendations to reduce children's exposure to *all* forms of marketing of HFSS foods, in view of "unequivocal evidence that the marketing of unhealthy foods and sugar-sweetened beverages is related to childhood obesity."

### **2.2.1 Strategy for the prevention and control of obesity in South Africa 2015-2020**

The Strategy for the Prevention and Control of Obesity in South Africa 2015-2020 (SADoH, 2015) was released in April 2015 due to the escalating prevalence of overweight and obesity in South Africa and the significant economic burden that obesity imposes on an already strained healthcare system. The aim of the strategy is to reform 'obesogenic' environments and enablers, while enhancing opportunities for increased physical activity and healthy food options in every possible setting, including healthcare facilities, early development centres, schools, workplaces and the community at large.

Childhood obesity is singled out in the South African Obesity Strategy due to the large perceived benefits that obesity prevention may have for a country. The strategy is a multi-sectoral approach to halting the scourge of obesity in the country and focusses on six main goals. Goal two of the South African obesity strategy aims to create an enabling environment in which 'healthy' food preferences can be established, a specific goal being to ensure responsible and ethical advertising and marketing of food by the food industry.

### **2.2.2 Cost-effectiveness of childhood obesity prevention**

Obesity prevention is particularly relevant to policy makers and health service providers who are concerned with the best use of resources (Cawley, 2007). Studies estimating the likely cost-effectiveness (i.e. the costs regarded acceptable for the benefits gained) of obesity intervention strategies are limited. This could possibly be due to the limited number of obesity interventions that produced strong evidence of effectiveness. It could also be because of the complexity of the assumptions and associated uncertainty in translating behaviour change into improved body-mass index (BMI) and BMI into disability-adjusted life-years (DALYs) or other long-term health benefits for which costs can be assessed. Studies that provide economic assessments were identified from several recent reviews of childhood obesity interventions

(Oude Luttikhuis *et al.*, 2009; John *et al.*, 2012). Restricting the marketing of HFSS food to children and five other community-based, non-clinical interventions were judged dominant in that they would result in both health gains and real cost saving in health services in the society (Lobstein *et al.*, 2015).

Restricting the marketing of HFSS foods to children has been identified as one of the top three money-saving interventions (Haby *et al.*, 2006; Gortmaker *et al.*, 2011). The intervention has shown modest effects at an individual level but prove highly cost-effective, because benefits mount up to the whole population and the cost of implementation is relatively low.

### **2.3 Environmental factors that drive obesity, including food marketing**

Evidence shows that children's food environments influence their dietary behaviour (Hawkes *et al.*, 2013), specifically their food preferences (Cohen & Babey, 2012; Gardner, 2015), and that past consumption can predict future behaviour (Stigler & Becker, 1977). Factors of the food environment that influence children's food preferences and ultimately their dietary behaviour include the home environment (Savage *et al.*, 2007; Kral & Faith, 2009), social and cultural norms around food (Rozin, 2006; Sobal *et al.*, 2006), the *overall* food supply with regard to availability and affordability in a national and local context (Wardle & Cooke, 2008) and food marketing (McGinnis *et al.*, 2006; Cairns *et al.*, 2013). Regrettably, children's food environments have changed substantially during the last decades as the affordability, palatability and supply of HFSS foods have increased substantially. These HFSS foods are also more accessible and convenient. They are also persuasively and persistently marketed (Kitchen *et al.*, 2004; Osei-Assibey *et al.*, 2012; Devi *et al.*, 2014; Hawkes *et al.*, 2015b). This 'obesogenic' food environment has been defined as 'the sum of the influences that the surroundings, opportunities or conditions of life have on promoting obesity in individuals and populations' (Swinburn & Egger, 2002), and is now recognized as a key driver to the obesity pandemic (Swinburn *et al.*, 2011). Unfortunately, due to rapid urbanization and acculturation in numerous low-income and middle-income countries, many children are now raised in these obesogenic food environments (Lobstein & Dobb, 2005; Hawkes & Lobstein, 2011; Swinburn *et al.*, 2011).

Due to the association between the obesogenic food environment and the global increase in childhood obesity, environmental factors that promote 'unhealthy' dietary preferences and behaviour have become of great public health concern (WHO, 2013a). Child-directed food marketing and its influences on children's food preferences and dietary behaviour, are of specific concern (Oates *et al.*, 2002; Story & French, 2004) and has been thoroughly studied.

### **2.3.1 Consumer food environment in South Africa**

By making their foods more available, affordable and acceptable, food manufacturers in South Africa have succeeded in increasing the market share and per capita consumption of their products (Igumbor *et al.*, 2012). Traditional food retailers such as small convenience stores, 'spaza shops' (small informal shops) and informal public markets have been replaced, in both the urban and rural settings, by supermarket outlets as the primary place from which South Africans purchase their food (D'Haese & Van Huylenbroeck, 2005). Food companies have increased the availability of their food products by involving informal traders. Some companies have developed incentives for people to set up informal outlets in townships by providing them with point-of-sale display material, refrigeration equipment, lighting boards and by delivering products directly to their stores (D'Haese & Van Huylenbroeck, 2005; Alexander *et al.*, 2011). It has also been reported that food companies make use of specific marketing strategies to make their food more acceptable to the South African population (Igumbor *et al.*, 2012). Food promotion strategies, food packaging designed to promote products, television advertising and multi-media marketing are but a few. According to a study conducted by Temple *et al.* (2008), 16% of advertisements during a 37.5 hour recording of children's television programming featured food products, and 55% of these food advertisements were of foods of poor nutritional value such as refined breakfast cereals, sweets and high sugar beverages.

### **2.3.2 The exposure and persuasive power of child-directed food marketing**

#### **2.3.2.1 The nature and extent of child-directed food marketing**

A number of systematic reviews have analysed the nature and extent of child-directed food marketing (McDermott *et al.*, 2004; Hastings *et al.*, 2006; McGinnis *et al.*, 2006; Cairns *et al.*, 2013; Sonntag *et al.*, 2015b). A systematic review conducted by Jenkin and colleagues (2014) documented the different persuasive marketing techniques that food marketers use to promote food to children via television. The most frequently used persuasive marketing techniques included premium offers, promotional characters, nutritional and health claims, the theme of 'taste' and the emotional appeal of 'fun'. Several other persuasive techniques were also described and included such as the use of animation as a production technique, themes of exclusivity or novelty and the emotional appeal of action, adventure and fantasy. The review concluded that such persuasive techniques were used more often to promote HFSS foods.

To date, a number of international research studies quantifying television food advertising have been conducted and many focused on the 'healthiness' of advertised foods. The systematic review conducted by Cairns and colleagues (Cairns *et al.*, 2013) reports that child-

directed food advertisements were broadcasted frequently. The majority were of HFSS foods, specifically sugar-sweetened breakfast cereals and beverages, savoury snacks, confectionary and fast foods. Research studies conducted in developing countries report that food promotion in low- and middle-income countries mirrors that of high-income countries (AKTAŞ ARNAS, 2006; Karupaiah *et al.*, 2008; Huang *et al.*, 2011; Cairns *et al.*, 2013). Children in developing countries may also be more vulnerable to food marketing as they are less familiar with, and potentially less critical of, advertising than children in developed countries are. They may also be specifically targeted as an entry point into developing markets as children are more flexible than their parents (Hastings *et al.*, 2006). An unpublished South African study reported that the majority of television food advertisements aired during children's programming times and family viewing times were of HFSS foods, which included sweets, confectionary, savoury snacks and sugar sweetened breakfast cereals and beverages (Delport, 2015).

Retail displays and in-store promotions, product design and formulation, product labelling and packaging, athletes promoting a food product and even licensed characters and tie-in characters from television shows and cinema films are all strategies that attract attention to products. All of these creative promotion techniques provide food marketing with its persuasive power and echoes the techniques used for television advertising (Hebden *et al.*, 2011).

Food products often display nutrient and/or health claims as a marketing strategy as it aims to increase the sales of food products (Hawkes, 2004; Campos *et al.*, 2011). Unfortunately, various research studies from different countries reveal that children's food products that display nutrient claims had either a similar or worse nutrient profile than their counterpart without nutrient claims (Colby *et al.*, 2010; Mehta *et al.*, 2012; Chacon *et al.*, 2013; Devi *et al.*, 2014; Rodrigues *et al.*, 2016). A recently released study from Brazil reports similar results, but specifically refers to the sodium content being higher in child-directed food products displaying nutrient claims (Rodrigues *et al.*, 2016). The frequency and location of outdoor sugar-sweetened beverage advertisements in Soweto, South Africa, was recently explored by Moodley and colleagues (Moodley, 2015). They found that advertisements were located in close proximity to primary and high schools. Another South African study, conducted in schools in the Western Cape, reported that 60% of the included schools had branded food or beverage advertisement boards displaying the schools' names (de Villiers *et al.*, 2012).

Although television advertising remains the most popular channel through which child-directed food marketing occurs (Cairns *et al.*, 2013), estimates in the United States suggest that the expenditure on television food advertising is declining (McGinnis *et al.*, 2006). There is evidence of a significant redirection towards advertising and brand promotion through other forms of media (McNeal & Ji, 2003; Harris *et al.*, 2010; Galbraith-Emami & Lobstein, 2013).

Children now spend more time using digital media than watching television as mobile device ownership has increased rapidly (Coughlan, 2016). Much of the evidence on the marketing of foods to children refers to television food advertising, yet in the digital age, food marketing has undergone a “paradigm shift” (Sandberg *et al.*, 2010). Marketing in digital media is characterized by powerful creative techniques that include extensive HFSS food-themed game applications (or “apps”); social media content created by users themselves; word-of-mouth social media communication, such as “liking”, sharing and commenting on marketing; and paid partnership with vloggers popular to children (a video blogger, on a video platform such as YouTube). Children’s food environments are becoming more diverse and the evidence on the mechanisms through which food marketing works and the influences on childhood obesity is growing. Numerous research studies have examined the nutritional content of foods marketed to children through these alternative marketing strategies and reported that HFSS foods are promoted most of the time (Moore & Rideout, 2007; Alvy & Calvert, 2008; Berry & McMullen, 2008; Lee *et al.*, 2009; Culp *et al.*, 2010; Hawkes, 2010; Roberto *et al.*, 2010).

### **2.3.2.2 The effect of child-directed food marketing on children’s food preferences**

Children are specifically vulnerable to food marketing as they are unable to understand the persuasive intent of commercial marketing and are unable to distinguish advertisements from programmes (Oates *et al.*, 2002; Story & French, 2004). Children do not have the ability to understand the relationship between food choices and future chronic diseases (Cairns *et al.*, 2009; Magnus *et al.*, 2009). Empirical research in cognitive, behavioural and economic psychology has established that food marketing interferes with the individual’s ability to act in their long-term self-interest by choosing ‘healthy’ foods and can contribute to the development of ‘unhealthy’ food preferences (Greenfield, 2011).

Studies have demonstrated that food marketing results in increased preference (Chernin, 2007; Dixon *et al.*, 2007) and consumption (Buijzen *et al.*, 2008; Harris *et al.*, 2009; Andreyeva *et al.*, 2011; Dovey *et al.*, 2011) of HFSS foods and that children who are overweight are particularly vulnerable (Buijzen *et al.*, 2008; Harris *et al.*, 2009). Food marketing directly affect children’s food preferences, nutrition knowledge and consumption behaviour by creating familiar and positive associations (Cairns *et al.*, 2013). Robinson *et al.* (2007) and Letona *et al.* (2014) discovered that children prefer the taste of branded food products over identical products in plain packaging (Robinson *et al.*, 2007; Letona *et al.*, 2014). Research studies have also analysed the nature and effects of food marketing through digital media on children and the findings suggest that advergaming may significantly affect children’s dietary behaviour (Cicchirillo & Lin, 2011; Lascu *et al.*, 2013; Paek *et al.*, 2014).

The effect of promotional campaigns on children's dietary preferences and consumption patterns have also been analysed (Kopelman *et al.*, 2007; Forman *et al.*, 2009; Carter *et al.*, 2011; Jones & Kervin, 2011; Keller *et al.*, 2012; McAlister & Cornwell, 2012). Collectable toys increase children's brand awareness (McAlister & Cornwell, 2012). Recently published research studies extended previous experimental research by demonstrating that collectable fast food toys, specifically tie-ins from movies, are associated with increased consumption of fast foods in young children from both urban and rural areas (Emond *et al.*, 2016; Longacre *et al.*, 2016). Product packaging is a critical factor in consumers' decision making as creative colourful packaging and the use of on-pack promotions influence children's food choices and their perception of a food product (Silayoi & Speece, 2004; Elliott, 2009). Research studies examining the effect of breakfast cereal packaging demonstrated that it creates brand awareness amongst children and that children can recognize characters used on the front of the packs (Hill & Tilley, 2002; McNeal & Ji, 2003). Breakfast cereals marketed to children were also found to be 'less healthy' when compared to non-children's breakfast cereals (Schwartz *et al.*, 2008; Devi *et al.*, 2014). An older research study found that attractive packages targeting children are likely to encourage them to pester their parents to buy the product (Gelperowic & Beharrell, 1994).

It is widely acknowledged that children require special consideration with regard to marketing activities as they lack the cognitive skills to understand the persuasive intent of commercial marketing and that they live in and are active partakers of an increasingly interactive and multisensory media environment (Cassim, 2010). Taste preferences and brand loyalty is established early in life and it can persist into adulthood (McGinnis *et al.*, 2006; Bronnenberg *et al.*, 2012; Cairns *et al.*, 2013; Hawkes *et al.*, 2015a), making children 'buyers-for-life', specifically in relation to the food industry. Many children in Western societies have a substantial amount of money to spend on their own requirements and desires, which qualifies them as an important *primary* market (McNeal, 1992). Children are also important market *influencers*, as a substantial amount of evidence has proven that children effect daily household purchases of especially snack foods and breakfast products. This is commonly referred to as 'pester-power' (McNeal, 1992; Gunter & Furnham, 1998; Nicholls & Cullen, 2004; McDermott *et al.*, 2006).

#### **2.4 Global initiatives to limit children's exposure to food and non-alcoholic beverage marketing**

As mentioned in Chapter one of this manuscript, the global increase in childhood obesity and the recognition that food marketing practices may influence the food preferences of children resulted in the release of a number of initiatives to limit children's exposure to HFSS food

marketing (Hawkes & Lobstein, 2011; Galbraith-Emami & Lobstein, 2013). In 2010, the WHO published a set of recommendations for the marketing of food and non-alcoholic beverages to children. It was endorsed by the 63<sup>rd</sup> WHA (Resolution WHA 63.14) (WHO, 2010). In 2016, the WHO released the ECHO Commission report, which notes with concern “the failure of Member States to give significant attention to Resolution WHA 63.14” and “requests that they address this issue”(WHO, 2016a). The WHO Regional Office for Europe also released the a report discussing the implications of digital food marketing on child-directed food marketing policy action in November 2016 (WHO, 2016b). Governments should therefore take the lead in combating childhood obesity by implementing a policy that aims to reduce the impact on children of marketing of HFSS foods (Kelly *et al.*, 2013).

#### **2.4.1 Industry self-regulation in the form of child-directed food marketing codes or pledges**

Aware of the concern regarding child-directed food marketing and childhood obesity, leading food and beverage companies responded by proposing a number of company-led voluntary and self-regulatory codes and pledges to adopt a more responsible approach in their marketing of foods to children (Brinsden & Lobstein, 2013; Galbraith-Emami & Lobstein, 2013). The companies committed to not advertising foods to children for food products that fulfil specific nutrient criteria. However, different companies are making different pledges with different criteria in different regions of the world (Brinsden & Lobstein, 2013). These existing self-regulatory codes and pledges are funded and administered by economic operators in the food and marketing sectors that have a vested interest in communicating to children. These codes and pledges are largely part of companies’ corporate social responsibility and include for example the Children’s Food and Beverage Advertising Initiative (CFBAI, 2009), the European Union (EU) Pledge (EU-Pledge, 2012), The International Food and Beverage Association (IFBA) pledge (IFBA, 2008), the Australia Food and Grocery Council’s Responsible Children’s Marketing Initiative (AFGC, 2011) and the South African Marketing to Children Pledge (SA-Pledge, 2008). The majority of these codes and pledges apply primarily to television advertising and some have only recently started to include other forms of marketing (WHO, 2016b).

The remarkable efforts of many food and beverage companies to reduce children’s exposure to HFSS food marketing should be recognized. However, independent assessment of industry-led self-regulation have shown the codes and pledges to be insufficient in limiting children’s exposure to HFSS food marketing (Galbraith-Emami & Lobstein, 2013; Raine *et al.*, 2013; Roberto *et al.*, 2015; Huizinga & Kruse, 2016). The narrow range of media, the weak definition of marketing, the absence of many large food companies and the lack of

enforceability or penalties for failure, suggest that self-regulatory pledges are unlikely to reduce children's exposure to the marketing of HFSS foods sufficiently (Galbraith-Emami & Lobstein, 2013; Lobstein *et al.*, 2015; Huizinga & Kruse, 2016). A study conducted by Huizinga and Kruse (2016) investigated whether food companies who have signed the EU pledge were in fact refraining from marketing HFSS foods to children. They discovered that due to the less stringent classification criteria used by the pledge to classify HFSS foods, food products such as high fat, high-salt crisps and snack foods would pass the nutritional criteria and be classified as non-HFSS foods.

In South Africa, the *South African Marketing to Children Pledge* was adopted by the Advertising Standards Authority (ASA) on the 1<sup>st</sup> of August 2008 (SA-Pledge, 2008). Companies partaking in the *South African Marketing to Children Pledge* are committed to marketing communications with a view to promoting healthy dietary choices and lifestyles to children twelve years old and younger (SA-Pledge, 2008). Each participating company is required to develop an individual company action plan that outlines how they will meet the core principles, which include the advertising message, product endorsement, marketing promotions and advertising and marketing communications on or in close proximity to pre-school and primary school premises. Currently no *specific nutrition criteria* have been developed or implemented by pledge members.

#### **2.4.2 Statutory regulations and their impact on restricting the marketing of foods and non-alcoholic beverages to children**

There is general agreement that a government-led policy or regulation is required to restrict the marketing of HFSS foods to children (Gortmaker *et al.*, 2011). Such a policy is of high priority and is included in the WHO Global Action Plan for the Prevention and Control of Non-communicable Diseases 2013-2020 (WHO, 2013b) due to potential population-wide effects, cost-effectiveness and sustainability (Magnus *et al.*, 2009; Swinburn *et al.*, 2015b). It is therefore recommended that governments take leadership in combating childhood obesity by implementing a policy that aims to reduce the impact of HFSS food marketing on children (Kelly *et al.*, 2013). A small number of countries have statutory regulations restricting the marketing of HFSS foods to children. Most have thus far relied on voluntary moves by food companies, which has not been sufficient in achieving the task (Galbraith-Emami & Lobstein, 2013). Ireland and the United Kingdom (UK) have statutory restrictions on television advertising in and around child-directed programming. The province of Quebec, Canada, have statutory regulations restricting the advertising of any product, not only food and beverages (Raine *et al.*, 2013), and South Korea introduced regulation to restrict the advertising of energy-dense, nutrient-poor foods to children in 2009 (Hawkes & Lobstein, 2011). A

systematic review conducted by Galbraith-Emami and Lobstein (2013) examining the impact of statutory regulation to limit children's exposure to HFSS food marketing brings to light that these policies may have the potential to reduce children's exposure significantly, but they are typically narrow in scope and have not been as effective as expected at the start. The lack of comprehensive definitions of the marketing media to be covered, the products which should be included and the audience which should be protected by such as regulation has been identified by the authors as limiting factors.

The systematic review conducted by Galbraith-Emami and Lobstein (2013) examined the data available on levels of exposure of children to the marketing of HFSS foods since the introduction of statutory and voluntary codes. The findings of their research indicated that the exposure of children to HFSS food marketing could be reduced, but, that this was only occurring in certain circumstances. It was reported that the codes and regulations used for child-directed food marketing practices were not consistent or comprehensive and that they should be strengthened (Galbraith-Emami & Lobstein, 2013). In the absence of complete bans on child-directed food marketing, comprehensive and consistent governmental approaches across countries are required to regulate not only the exposure of children to, but also the power of HFSS food marketing.

The whole point of taking action to reduce the extent of food marketing to children is to lessen preference for and consumption of HFSS foods. If any form of marketing encourages children to eat HFSS foods, there is a case for intervention. A number of statutory regulations and transnational food and drink manufacturer pledges aiming to reduce children's exposure to HFSS food marketing exist, but many of the highly effective alternative marketing strategies, such as digital marketing, are not included in these regulations and pledges.

Due to the substantial increase in childhood obesity in South Africa and in recognition of the need for a policy to restrict children's exposure to HFSS food marketing, the South African National Department of Health (SADoH), Directorate: Food Control, published a draft regulation (DOH, 2014) for comments in 2014. It aims to restrict the marketing of *all* HFSS foods to children. As previously mentioned, the SADoH also published the Strategy for the Prevention and Control of Obesity in South Africa 2015-2020 (SADoH, 2015) in May 2015. This strategy is a multi-sectoral approach to halt the scourge of obesity in the country, with a specific objective being to ensure responsible and ethical advertising and marketing of food by the food industry.

## **2.5 Nutrient profiling — defining foods and non-alcoholic beverages high in saturated fats, sugar and/or salt**

There is considerable disagreement between public health advocates and representatives of the food and marketing industries over the precise definition of HFSS foods (Arambepola *et al.*, 2008; Jenkin *et al.*, 2009). The effective implementation of a policy that aims to restrict the marketing of HFSS foods to children should be founded on a clear definition of the foods that should be restricted, unless the marketing of all foods is to be prohibited (Kelly *et al.*, 2013). Nutrient profiling is defined as “the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health” (Rayner *et al.*, 2004; WHO, 2011) and can be used to score the ‘healthiness’ of individual foods and thereby generate definitions of ‘more healthy’ and ‘less healthy’ foods (Arambepola *et al.*, 2008). The WHO suggests that nutrient profiling be used to support child-directed food marketing regulations (WHO, 2016a). Nutrient profiling is also considered by Scarborough and colleagues (2007) as a systematic, transparent and logical process for developing criteria according to which to classify foods. A nutrient profiling model is a set of equations or algorithms that place all foods onto a continuum of ‘healthiness’ ranging from ‘most healthy’ to ‘least healthy’. Nutrient profiling models are used as tools to support a number of public health nutrition interventions. At present, a number of food companies, governments and non-governmental organizations use nutrient profiling models to support labelling schemes aimed at identifying healthier food choices (Cooper *et al.*, 2016). Nutrient profiling models are also used for child-directed food marketing and nutrient and/or health claim regulations (Rayner *et al.*, 2013; DOH, 2014). It is a growing field and numerous nutrient profiling models with different aims have been developed by academics, health organizations, national governments and food industries throughout the world. However, research has indicated that the models classify foods differently (Brinsden & Lobstein, 2013; Rayner *et al.*, 2013; Scarborough *et al.*, 2013). This discrepancy is one of the main reasons for differences between self-regulatory pledges/codes and statutory regulations/restrictions recommended by governments and health organizations (Galbraith-Emami & Lobstein, 2013; Huizinga & Kruse, 2016).

Nutrient profiling models classify foods differently due to their different features and aims. Some models use across-the-board nutrient criteria to classify foods into a limited number of food categories (for example foods and drinks ) (Rayner, 2009; FSANZ, 2013). Others use food category-specific nutrient thresholds for foods in many sub-categories (for example breakfast cereals, savoury snacks, cheeses, etc.) (WHO, 2015b; WHO, 2015a). Some classify foods solely based on nutrients to limit (WHO, 2015b; WHO, 2015a), while some also include

elements such as dietary fibre to encourage (FSA, 2011; FSANZ, 2013; DOH, 2014). The use of food categories have many benefits, but they are very difficult to define accurately, which is especially problematic when there is a need for a model that is compulsory rather than voluntary (Scarborough *et al.*, 2010). It is also of concern that food categories can be defined in such a manner that they favour a specific food company's own products (Galbraith-Emami & Lobstein, 2013; Huizinga & Kruse, 2016). Deciding on the type of nutrient profiling model to use is a difficult and important decision to make, as it can affect the impact of the policy that it intends to support (Table 2.1).

**Table 2-1: The different characteristics of nutrient profiling models**

| Feature of the model | Choice of model           | Application of the model  | Impacts of the decision   | Other considerations   |
|----------------------|---------------------------|---|---|--|
| <b>Criteria</b>      | 'Across-the-board'        | Applying the same definition of 'unhealthy' to all food categories  | -No need to define food categories<br>-Some foods previously represented as 'healthy' may be categorized as 'less healthy' (e.g. Olive oil) | -No consensus on how food categories should be defined<br>-Can be difficult to allocate foods to food categories   |
|                      | 'Category-specific'       | Applying different definitions of 'unhealthy' to different food categories  | -Need to define food categories   |  |
| <b>Nutrients</b>     | A short list of nutrients | When aiming for a short practical model   | -May not reflect all public health concerns   | -Increasing the number of nutrients does not necessarily increase the sensitivity or specificity of the model<br>-Difficulties in defining some nutrients<br>-Food composition data may not be available for all nutrients |
|                      | A long list of nutrients  | When aiming for a model that reflects all nutrient-related concerns   | -May be more expensive  |  |
| <b>Base</b>          | Per 100g/ml               | Categorizing foods solely on the basis of the nutrient quality  | -Requires different criteria for foods and drinks   |  |
|                      | Per 100kcal               | Categorizing foods solely on the basis of the nutrient quality  | -No need for different criteria for foods and drinks  |  |
|                      | Per serving               | Categorizing foods on the basis of the nutrient quality of the foods and taking some account of how foods deliver their nutrients | -Need to define serving size  | -Little consensus on how to define serving sizes<br>-Difficult to define serving size when serving size varies considerably (e.g. milk)  |
| <b>Type of model</b> | Threshold                 | For simple and/or category-specific models  | -Easy to understand   |  |
|                      | Scoring                   | For more complex and/or across-the-board models   | -Harder to understand<br>-Can be used for different purposes using different scoring thresholds   |  |

Adapted from: Scarborough *et al.*, 2010.

The use of nutrient profiling models for obesity prevention strategies has increased substantially during recent years. This has contributed to a considerable increase in the amount of nutrient profiling models available for such policies. Little research has, however, been conducted on the accuracy of these models and no consensus exists on the 'ideal' nutrient profiling model (Townsend, 2010; Chiuve *et al.*, 2011; Rayner *et al.*, 2013). Accuracy in the context of nutrient profiling refers to whether the model measures what it is designed to measure and can be assessed in various ways, including convergent validity (the correlation between how the nutrient profiling model ranks the 'healthiness' of foods in comparison to other valid measures which, theoretically, should correlate) (Arambepola *et al.*, 2008; Townsend, 2010). The validation of the accuracy of a nutrient profiling model is a clear necessity before the model is implemented into policy. However, many models are developed and applied with little testing to demonstrate validity (Townsend, 2010; Chiuve *et al.*, 2011; Rayner *et al.*, 2013). Drewnowski and Fulgoni (2008) suggest that the validity testing of nutrient profiling models be given the highest research priority, as without proper validation, any model would be questioned by experts in the field of nutrition and the food industry. Unfortunately, very few nutrient profiling models have been thoroughly tested and validated to assess their accuracy (WHO, 2011).

The WHO (2011) recommends that policy makers seeking to use a nutrient profiling model for regulatory reasons should adapt an existing model from an authoritative source for example a national government or academic institution that has been validated, as it is more cost-effective and time-saving (WHO, 2011; Rayner *et al.*, 2013). There are many nutrient profiling models available that may be used or that have been designed for child-directed food marketing restrictions. Research now also suggests that nutrient profiling models designed for other applications, such as nutrient and/or health claim regulations, may also be suitable for this purpose (Rayner *et al.*, 2013; Julia *et al.*, 2014).

However, Monteiro (2009) argues that the nutrient profile of a food may not be the only indication of the 'healthiness' of that particular food item, as other features (such as additives) unrelated to the nutrient composition of a food are not detected by nutrient profiling models and may make products intrinsically harmful to health. A study comparing the classification of foods by five individual nutrient profiling models found a consistent positive evaluation of fruits and vegetables and a consistent negative evaluation of fatty and sugary foods, which is in agreement with dietary guidelines (Garsetti *et al.*, 2007). However, there were differences in the food classification by the selected nutrient profiling models for the majority of the processed foods. Garsetti *et al.* (2007) warn that the variances in nutritional recommendations,

calculation of scores and rational of the nutrient profiling models lead to the dissimilarities in food classification.

### **2.5.1 Nutrient profiling models in South Africa**

In South Africa, the South African Nutrient Profiling Model (SANPM) is used as the first screening tool to support the regulation of nutrient and/or health claims (DOH, 2014). The model is based on the nutrient profiling model developed by the United Kingdom (UK) Food Standards Agency (FSA) and adapted by Food Standards Australia New Zealand (FSANZ) for the regulation of health claims. In 2012, this model was adopted by the South African National Department of Health (SADoH), Directorate: Food Control, to support the regulation of nutrient and/or health claims in South Africa. This model enjoys support from all stakeholders involved as it was thoroughly tested and validated before implementation as part of regulations (Wentzel-Viljoen *et al.*, 2012; Wicks, 2012; Lee, 2013). This a scoring model that classifies foods by using across-the-board nutrient criteria.

In order to reduce the impact of obesity and NCDs on children in South African, the SADoH set nutrition standards for the types of food that can and cannot be marketed to children of different ages in 2014 (DOH, 2014). It was decided that restrictions will be placed on the marketing of any foods that fall below these nutrition standards. The SADoH nutrient profiling model for restricting food marketing to children (DoHSA) was therefore developed in 2014 by the SADoH, Directorate: Food Control, to support child-directed food marketing restrictions in South Africa. It was published as a draft regulation in 2014 (DOH, 2014) without any justification for the classification criteria used by the DoHSA model and without any consultation or inputs from stakeholders. The model is an adapted nutrient profiling model based on the SANPM. The DoHSA and SANPM models have never been tested or validated for the purpose of regulating the marketing of foods to children.

The DoHSA model classifies foods as follows:

- (1) First, does the food pass the SANPM screening criteria?
- (2) Second, does the food contain any added fructose, added non-nutritive sweeteners, added fluoride or added aluminium through an additive or ingredient?
- (3) Third, do the nutrient levels in the food or beverage per 100g/ml exceed the UK Food Standards Agency Criteria (per 100g/100ml) as indicated in the table below?

**Table 2-2: United Kingdom Food Standards Agency traffic-light-labelling criteria for green (low)**

| Undesirable nutrient                                   | Nutrient levels in food (per 100g) | Nutrient levels in non-alcoholic beverage (per 100ml) |
|--|------------------------------------|---|
| Total sugars<br>(sum of the intrinsic and added sugar) | 5g                                 | 2.5g  |
| Total Fat  | 3g                                 | 1.5g  |
| Saturated fat  | 1.5g                               | 0.75g   |
| Sodium/salt  | 120mg Sodium/0.3g Salt             | 120mg Sodium/0.3g Salt                                |

Table 2-3 describes the characteristics of the DoHSA and SANPM models.

**Table 2-3 Characteristics of the DoHSA and SANPM models**

| Model | Type of model         | Classification criteria | Nutrients to limit   | Nutrients/ elements to encourage              |
|-------|-----------------------|-------------------------|--|---|
| SANPM | Scoring               | Across-the-board        | Energy, sfat, total sugar, salt/sodium   | Protein, fruits, vegetables, legumes and nuts |
| DoHSA | Scoring and threshold | Across-the-board        | Energy, total fat, sfat, total sugar, salt/sodium, NNS, added fluoride and aluminium | Protein, fruits, vegetables, legumes and nuts |

SANPM: South African Nutrient Profiling Model;; DoHSA: South African Department of Health nutrient profiling model for restricting food marketing to children; sfat: saturated fat; NNS: non-nutritive sweeteners

## **2.6 Nutrient profiling models used/recommend for use by statutory bodies**

Internationally, other nutrient profiling models have been developed independently from the food industry to restrict the marketing of HFSS foods to children. Some of these models include the United Kingdom Office of Communication nutrient profiling model (Ofcom) (FSA, 2011) and the newly proposed WHO Regional Office for Europe nutrient profiling model (REU) (WHO, 2015b) and Eastern Mediterranean Regional Office nutrient profiling model (WHO, 2015a).

The Ofcom model was developed in 2005 by the UK FSA and adopted by the UK regulatory body for communications industries in 2007. The model is currently used in legislation that restricts the marketing of HFSS foods to children under the age of 16 years on television. This model generates a score that determines whether the food can be advertised to children or not. Two threshold levels are set: one for food and one for non-alcoholic beverages (FSA, 2011). This model has been extensively tested and validated (Azais-Braesco *et al.*, 2006; Arambepola *et al.*, 2008).

The REU model is a nutrient profiling model that was developed in 2013 by the WHO regional office for Europe with the assistance and inputs of member states. Its objective was to serve as a common model to improve the nutritional quality of foods marketed to children in member states across Europe (WHO, 2015b). The model was published for recommendations by the WHO Regional Office for Europe in early 2015. The model is based on two existing models, the Norwegian model (NDoH, 2013) developed by the Norwegian government and adopted by industries with minor changes made for voluntary restrictions in Norway, and the model developed by the Danish Forum of Responsible Food Marketing Communications – endorsed by the Danish government for voluntary restrictions in Denmark (FRFMC, 2013). The model was tested by European member states. It is a threshold model that uses category-specific nutrient thresholds.

The EMRO nutrient profiling model is a model developed in 2014 by the WHO Eastern Mediterranean regional office with the assistance and input of member states (WHO, 2015a). The model is based on the REU model with minor adaptations as suggested by the member states. It is in the testing phase and is a threshold model that uses category-specific nutrient thresholds.

## **2.7 Food processing**

It is widely accepted by now that the increased production and consumption of industrially processed foods and drinks is a significant cause of the current obesity problem (WHO, 2003;

Monteiro, 2009; Swinburn *et al.*, 2011; Lobstein *et al.*, 2015). Food processing is generally overlooked in authoritative information, education programmes and public health nutrition policies (Monteiro, 2009). Conventional work on nutrition and public health has always focused on foods and their nutrient content. Food guides and Food-based Dietary Guidelines are all designed to encourage the consumption of 'healthier' foods, by which is usually meant those higher in vitamins, minerals and nutrients described to have a positive effect on health. Dietary assessments and recommendations usually use classifications of foods and beverages that largely overlook or minimize the significance of industrial food processing (Monteiro *et al.*, 2010). Due to this, food with very different nutritional profiles and impact on eating patterns and health, such as whole grain products, breakfast cereals, cookies and cereal bars are classified within the same group of grains, cereals and cereal products (Monteiro *et al.*, 2010). The same applies to whole fresh fruits, canned fruits in syrup and fruit juices, which are all classified as fruits. Almost all foods and beverages are processed in some form, but of great importance for human health are differences resulting from the type, intensity and purpose of food processing (Monteiro, 2009). Monteiro (2009) proposes that foods and beverages be divided into three groups namely:

- Group 1 is for unprocessed or minimally processed foods. It includes foods that have been submitted to some process that does not substantially alter the nutritional properties of the original foods. Processes include cleaning, removal of inedible fractions, portioning, refrigeration, freezing, pasteurization, fermenting, pre-cooking, drying, skimming, bottling and packaging.
- Group 2 is of substances extracted from whole foods. Processed culinary or food industry ingredients. These include oils, fats, flours, pastas, starches and sugars.
- Group 3 is for ultra-processed foods (UPP). These result from the processing of several foodstuffs, including ingredients from Group 2 and small amounts of minimally processed foods from Group 1. Processes used in the production of Group 3 products include salting, sugaring, baking, frying, deep frying, curing, smoking, pickling, canning and also frequently used preservatives and cosmetic additives, the addition of synthetic vitamins and of minerals, and sophisticated types of packaging. These industrial processes are all designed to create durable, accessible, convenient, attractive ready-to-eat or ready-to-heat products, of which many are 'fast' foods and convenient foods. However, Monteiro (2009) argues that not all harmful effects of UPP are captured by nutrient profiling, and that the precautionary principle should be heeded in the meanwhile in the absence of evidence to the contrary. He suggests taking prudent advice to governments and health

authorities and using all possible methods to stop and reverse the replacement of minimally processed foods with UPP.

## 2.8 Conclusion

Childhood obesity in South Africa is increasing at an alarming rate (Shisana, 2013) and is a public health concern. As previously described, the 'obesogenic' food environment that promotes the consumption of HFSS foods has been recognized as a key driver in this global pandemic (Swinburn *et al.*, 2011; Galbraith-Emami & Lobstein, 2013; Lobstein *et al.*, 2015). Actions are required to address the impact and power of HFSS food marketing on children's food preferences and ultimately their dietary behaviour to achieve the global health target and to halt the rise in adult and childhood obesity. Despite the fact that various initiatives aiming to limit children's exposure to HFSS food marketing have been implemented, limited success has been achieved, a key factor being the lack in a detailed definition or classification of HFSS foods (Galbraith-Emami & Lobstein, 2013; Huizinga & Kruse, 2016; WHO, 2016a). Consequently, it is important that governments take leadership in combating childhood obesity by implementing an evidence informed policy that aims to reduce the impact of HFSS food marketing on children (Kelly *et al.*, 2013). However, in order for such a policy to be effectively implemented, a clear definition of HFSS foods is required. The WHO (2016a) suggests that a nutrient profiling model be used to support child-directed food marketing restrictions. There are, however, numerous nutrient profiling models available and research has indicated that the models classify foods differently (Brinsden & Lobstein, 2013; Rayner *et al.*, 2013; Scarborough *et al.*, 2013). Few of the nutrient profiling models have been thoroughly tested and validated (Townsend, 2010; Chiuve *et al.*, 2011; WHO, 2011; Rayner *et al.*, 2013). In recognition of the need for a policy to restrict children's exposure to HFSS food marketing, SAdoH, Directorate: Food Control, published a draft regulation (DOH, 2014) in 2014, aiming to restrict the marketing of *all* HFSS foods to children. The draft regulation recommends using the DoHSA nutrient profiling model to determine whether a food product would be permitted for marketing to children. The DoHSA model is an adapted model based on the SANPM. Neither the DoHSA nor the SANPM models have been validated for this purpose. Against the background of the South African childhood obesity pandemic, the draft regulations to restrict the marketing of HFSS foods to children in South Africa was published in 2014. Unfortunately, South Africa lacks literature on: 1) the appropriateness of the SANPM and DoHSA models for child-directed food marketing regulations in South Africa; 2) convergent validity of the SANPM and DoHSA models for child-directed food marketing regulations in South Africa; and 3) an evidence-based framework to regulate the marketing of foods and beverages to children in South Africa. For this reason, this study makes a valuable contribution by providing evidence

on a suggested nutrient profiling model appropriate for child-directed food marketing regulations. The convergent validity of the suggested model and the development of a suggested framework will be submitted to the SAdoH for consideration to be implemented as part of the child-directed food marketing regulations.

## CHAPTER 3

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*This manuscript is formatted according to the guidelines of British Journal of Nutrition, with exception of the font and line numbers (Annexure 1). This manuscript has been accepted for publication (doi: 10.1017/S0007114516004244) (Annexure 2)*

### **Restricting the marketing of foods and non-alcoholic beverages to children in South Africa: Are all nutrient profiling models the same?**

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## **Abstract**

The World Health Organisation has called for governments to improve children's food environment by implementing restrictions on the marketing of foods high in fat, sugar and/or salt (HFSS) to children. Nutrient profiling models are used to define HFSS foods and support child-directed food marketing regulations. The aim of the study was to assess the suitability of the South African nutrient profiling model (SANPM), developed and validated for health claim regulations, for child-directed food marketing regulations. The SANPM was compared to four models specifically developed for such regulations. A representative list of 197 foods was compiled by including all foods advertised on South African free-to-air television channels in 2014 and foods commonly consumed by South African children. The nutritional information of the foods was sourced from food packaging, company websites and a food composition table. Each individual food was classified by each of the five nutrient profiling models. The percentage of foods that would be allowed according to the different models ranged from 6% to 45%, the models also varied considerably with regards to the type of foods allowed for marketing to children. The majority of the pairwise comparisons between the models yielded kappa statistics greater than 0.4, indicating a moderate agreement between the models. An almost perfect pairwise agreement ( $\kappa = 0.948$ ) existed between the SANPM and a model extensively tested and validated for such regulations, the United Kingdom Food Standards Agency model (Ofcom). The SANPM is considered appropriate for child-directed food marketing regulations in South Africa.

*Key words:* Nutrient profiling, marketing of foods, regulation, nutrition, childhood obesity

## Introduction

The prevalence of childhood obesity has increased dramatically during recent years and is no longer only prevalent in high-income countries<sup>(1;2;3;4)</sup>. Recent data reported that over the last decade the prevalence of overweight children in South Africa (genders combined) increased from 10.6% to 18.2%<sup>(5;6)</sup>. Childhood obesity has a large impact on the quality of life of children and pose major health and economic consequences for themselves, their families and the society as a whole<sup>(7)</sup>. The obesogenic environments which promote the consumption of foods high in fat, sugar and/or salt (HFSS) are thought to be a key driver in the global childhood obesity epidemic<sup>(8; 9)</sup>. Unfortunately, due to rapid urbanisation and acculturation in numerous low-income and middle-income countries many children are now raised in these obesogenic environments<sup>(8;10;11)</sup>.

There is growing evidence that food marketing impacts food preferences of children, their consumption and purchasing requests to parents<sup>(12;13;14;15)</sup>. Child-directed food marketing is extensive, perhaps most prominent on television<sup>(16)</sup>, and research indicates that it primarily concern HFSS food products<sup>(14;15;17;18)</sup>. The global increase in childhood obesity and the recognition that food marketing practices may influence the food choices of children has resulted in an increased public debate with regard to the best course of action to improve the food environments of children. In 2010, the World Health Organization (WHO) published a set of recommendations for the marketing of food and non-alcoholic beverages to children that were endorsed by the 63<sup>rd</sup> World Health Assembly (WHA 63.14)<sup>(19)</sup>. In 2016, the WHO released a report by the Commission on Ending Childhood Obesity whom notes with concern “the failure of Member States to give significant attention to Resolution WHA 63.14” and “requests that they address this issue”<sup>(20)</sup>. Governments should therefore take leadership in combating childhood obesity by implementing a policy which aims to reduce the impact on children of marketing of HFSS foods<sup>(3;20;21)</sup>. In order for such a policy to be effectively implemented, a clear definition of the foods that should be restricted is required, unless the marketing of all foods is to be prohibited<sup>(22)</sup>. Nutrient profiling is defined as “the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health”<sup>(23;24)</sup>, and is suggested by the WHO to support child-directed food marketing restrictions<sup>(20)</sup>. Numerous nutrient profiling models with different aims have been developed, by academics, health organizations, national governments and food industries throughout the world. However, research have indicated that the models classify foods differently<sup>(25;26;27)</sup> and that few have been thoroughly tested and validated<sup>(23)</sup>.

The manner in which nutrient profiling models have been constructed vary considerably. Some models use across-the-board nutrient criteria to classify foods in a limited amount of food

categories (for example foods and drinks)<sup>(28;29)</sup>. Others use food category-specific nutrient thresholds for foods in many sub-categories (for example breakfast cereals, savoury snacks, cheeses, etc.)<sup>(30;31)</sup>. Some classify foods solely based on nutrients to limit<sup>(30; 31)</sup> while some also include elements, such as dietary fibre, to encourage<sup>(28;32;33)</sup>. It is recommended that policy makers seeking to use a nutrient profiling model for regulatory reasons should rather adapt an existing model from an authoritative source that has been validated as it is more cost-effective and time saving<sup>(23;25)</sup>. There are now a large number of models available that are used or designed for child-directed food marketing restrictions. Research also suggests that models designed for other applications, such as nutrient and/or health claim regulations, may also be suitable for this purpose<sup>(25;34)</sup>.

In South Africa, the South African nutrient profiling model (SANPM) is used to support the regulation of nutrient and/or health claims<sup>(33)</sup>. This model enjoys support from all stakeholders involved as it was thoroughly tested and validated before implementation into the regulation<sup>(35;36;37)</sup>. The South African National Department of Health, Directorate: Food Control, published a draft regulation aiming to restrict the marketing of *all* HFSS foods to children in 2014<sup>(33)</sup>. The draft regulation recommends using the South African Department of Health's (DoHSA) nutrient profiling model which is an adapted model based on the SANPM. The SANPM was, however, developed and validated<sup>(35;36;37)</sup> to assess whether food products are eligible to carry a nutrient and/or health claim in South Africa and not to regulate food marketing to children. Using the SANPM in the context of restricting the marketing of HFSS foods to children could be problematic as the model was never tested for this purpose. Therefore this manuscript aims to explore how appropriate the SANPM is as a food classification tool for regulating the marketing of foods to children in South Africa.

## **Materials and methods**

The SANPM was compared with four existing non-industry nutrient profiling models that were designed by national government departments, academic research groups and authoritative organizations to restrict the marketing of HFSS foods to children. The nutrient profiling models were compared to determine if the models agree on (a) the percentage of foods permitted (overall strictness) and (b) the type of foods permitted for child-directed food marketing.

### *The nutrient profiling models used for comparison*

In total, five nutrient profiling models were identified and included for a comparison (Box 1):

#### **Box 1: The five nutrient profiling models included in the investigation**

*South African nutrient profiling model (SANPM)*<sup>(28;33)</sup>: Based on the model developed by the United Kingdom (UK) Food Standards Agency (FSA) and adapted by Food Standards Australia New Zealand (FSANZ) for the regulation of health claims. In 2012, this model was adopted by the South African National Department of Health, Directorate: Food Control, to support the regulation of nutrient and/or health claims in South Africa. The validity of the model has been demonstrated<sup>(35;36;37)</sup>. This model is a scoring model which uses across-the-board nutrient criteria.

*United Kingdom Office of Communication nutrient profiling model (Ofcom)*<sup>(32)</sup>: Developed in 2005 by the UK FSA and adopted by Ofcom (the UK regulatory body for communications industries) in 2007 to support the regulation of food advertising during programmes aimed at children under the age of 16 years. This model has been extensively tested and validated<sup>(38;39)</sup> and is a scoring model which uses across-the-board nutrient criteria.

*World Health Organization Regional Office for Europe nutrient profiling model (REU)*<sup>(30)</sup>: A nutrient profiling model developed in 2013 by the WHO regional office for Europe with the assistance and inputs of member states. The model is based on two existing models, the Norwegian model<sup>(40)</sup> developed by the Norwegian government and adopted by industry with minor changes made for voluntary restrictions in Norway, and the model developed by the Danish Forum of Responsible Food Marketing Communications – endorsed by the Danish government for voluntary restrictions in Denmark<sup>(41)</sup>. The model was tested by European member states. The model is a threshold model which uses category-specific nutrient thresholds.

*World Health Organization Eastern Mediterranean Regional Office nutrient profiling model*<sup>(31)</sup>: A nutrient profiling model developed in 2014 by the WHO Eastern Mediterranean regional office with the assistance and inputs of member states. The model is based on the REU model with minor

adaptions as suggested by the member states. The model is in the testing phase and is a threshold model which uses category-specific nutrient thresholds.

*South African Department of Health nutrient profiling model for restricting food marketing to children (DoHSA)<sup>(33)</sup>*: Developed in 2014 by the South African Department of Health, Directorate: Food Control, to support child-directed food marketing restrictions in South Africa and published as a draft regulation<sup>(33)</sup>. The model is an adapted nutrient profiling model. The model classifies foods firstly by using the SANPM (across-the-board scoring model) and secondly, the UK FSA front-of-pack traffic light labelling criteria (category-specific nutrient threshold) per 100g/100ml for green (low)<sup>(42)</sup> and then finally, the presence of non-nutritive sweeteners, fluoride, fructose and aluminium<sup>(42)</sup>.

Table 1 describes the characteristic of the above-mentioned nutrient profiling models. Energy, saturated fat, sugar (total or added) and sodium/salt were used by all five models to classify foods. *Total sugar* refers to the sum of all intrinsic (lactose, fructose and galactose) and added sugars (monosaccharides and disaccharides) and *added sugar* refers to any sugar added to food by manufacturers, cooks or consumers during processing or preparation. A *non-nutritive sweetener* is a food additive (other than a monosaccharide or disaccharide sugar), of which one serving of 5 g provides  $\leq 8$  kJ (1.9 kcal) and a sweet taste equivalent to 5 g of sucrose<sup>(30;33)</sup>.

**Table 1** Characteristics of the five nutrient profiling models

| Model | Type of model | Classification criteria | Nutrients to limit                              | Nutrients/elements to encourage               |
|-------|---------------|-------------------------|---|---|
| SANPM | Scoring       | Across-the-board        | Energy, saturated fat, total sugar, salt/sodium | Protein, fruits, vegetables, legumes and nuts |
| Ofcom | Scoring       | Across-the-board        | Energy, saturated fat, total sugar, salt/sodium | Protein, fruits, vegetables, legumes and nuts |

| Model | Type of model         | Classification criteria | Nutrients to limit  | Nutrients/elements to encourage               |
|-------|-----------------------|-------------------------|---|---|
| REU   | Threshold             | Food-category-specific  | Energy, total fat, saturated fat, added sugar, salt/sodium, alcohol, NNS                      | None  |
| EMRO  | Threshold             | Food-category-specific  | Energy, total fat, saturated fat, added sugar, salt/sodium, alcohol, NNS                      | None  |
| DoHSA | Scoring and threshold | Across-the-board        | Energy, total fat, saturated fat, total sugar, salt/sodium, NNS, added fluoride and aluminium | Protein, fruits, vegetables, legumes and nuts |

SANPM: South African Nutrient Profiling Model; Ofcom: United Kingdom Office of Communication nutrient profiling model; REU: World Health Organization's Regional Office for Europe nutrient profiling model; EMRO: World Health Organization's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA: South African Department of Health nutrient profiling model for restricting food marketing to children; NNS: non-nutritive sweeteners

Nutrient criteria algorithms were developed in Microsoft Excel 2013 according to the food classification criteria of the included nutrient profiling models. Each food item was individually classified, according to these nutrient criteria.

#### *Development of a representative food list*

Research indicates that the majority of the food advertisements on television are of savoury snacks, confectionary, sugar sweetened beverages and fast food meals<sup>(14;15;17;18)</sup>. Research also indicates that nutrient profiling models generally classify these foods as “unhealthy” and that there is less of an agreement between models with regards to the classification of foods such as cheese, full cream milk and non-nutritive sweetened beverages<sup>(25)</sup>. In order to effectively compare how the included nutrient profiling models classified a variety of foods a representative food list was developed as recommended by literature<sup>(25)</sup>. The representative food list was developed in such a manner that it would allow the researchers to compare the classification of a variety of foods from various food groups. The representative food list included foods advertised on South African free-to-air television channels in 2014 and foods reported by recently published literature to be commonly consumed by South African children.

Firstly, all advertised food (child-directed and adult-directed) on free-to-air South African television channels (SABC 1, 2, 3 and eTV) in 2014 were included, because children are not only exposed to television advertisements aired during child-directed programming<sup>(43)</sup>. Television recordings on four weekdays (Monday to Thursday) and on Saturdays from 06:00 to 22:00 during the months of April, June, September and November of 2014 were used. These months were included in order to capture advertisement changes during the different seasons and holidays such as Easter and Christmas. The food advertisement list consisted of the names of the food products, names of the manufacturing companies; number of advertisements recorded during the sample time, presence of child actors in these advertisements and whether these advertisements were shown during child-directed programmes. A total of 1030 food advertisements were aired over the four month period. Advertisements were excluded if they were promoting (1) alcoholic beverages, coffee, tea or chewing gum; (2) retailers who provided a variety of products; (3) baby or toddler foods and milks; and (4) meal replacement supplements. This exclusion resulted in a total of 615 advertisements marketing 137 different food products.

Secondly, single food items and meals commonly consumed by South African children (3-18 years) were identified from published literature<sup>(44;45;46;47;48;49)</sup> and were included in the food list. This resulted in the identification of 60 additional food items.

Finally, a food list containing foods from various food groups was compiled. The food list consisted of 197 foods of which 137 were foods advertised on South African free-to-air television channels and 60 were foods reported to be commonly consumed by South African children from the published literature.

#### *Collection of the nutritional information of foods*

The majority of the foods included in the food list were packaged foods. The nutritional information of these foods was sourced from the nutrition information panel indicated on the food items by using the George Institute Data Collection Application version 1.1<sup>(50)</sup>. Nutritional information of fast food meals, restaurant meals and foods containing no nutrition information panel was sourced from the websites of companies. If no nutritional information was available on these particular webpages, the nutritional information of a similar food was sourced from the Condensed Food Composition Tables for South Africa (CFCTSA)<sup>(51)</sup>.

#### *Statistical analyses*

The proportion of foods allowed by each nutrient profiling model to be marketed to children was calculated and the overall pairwise agreement between the models was assessed by

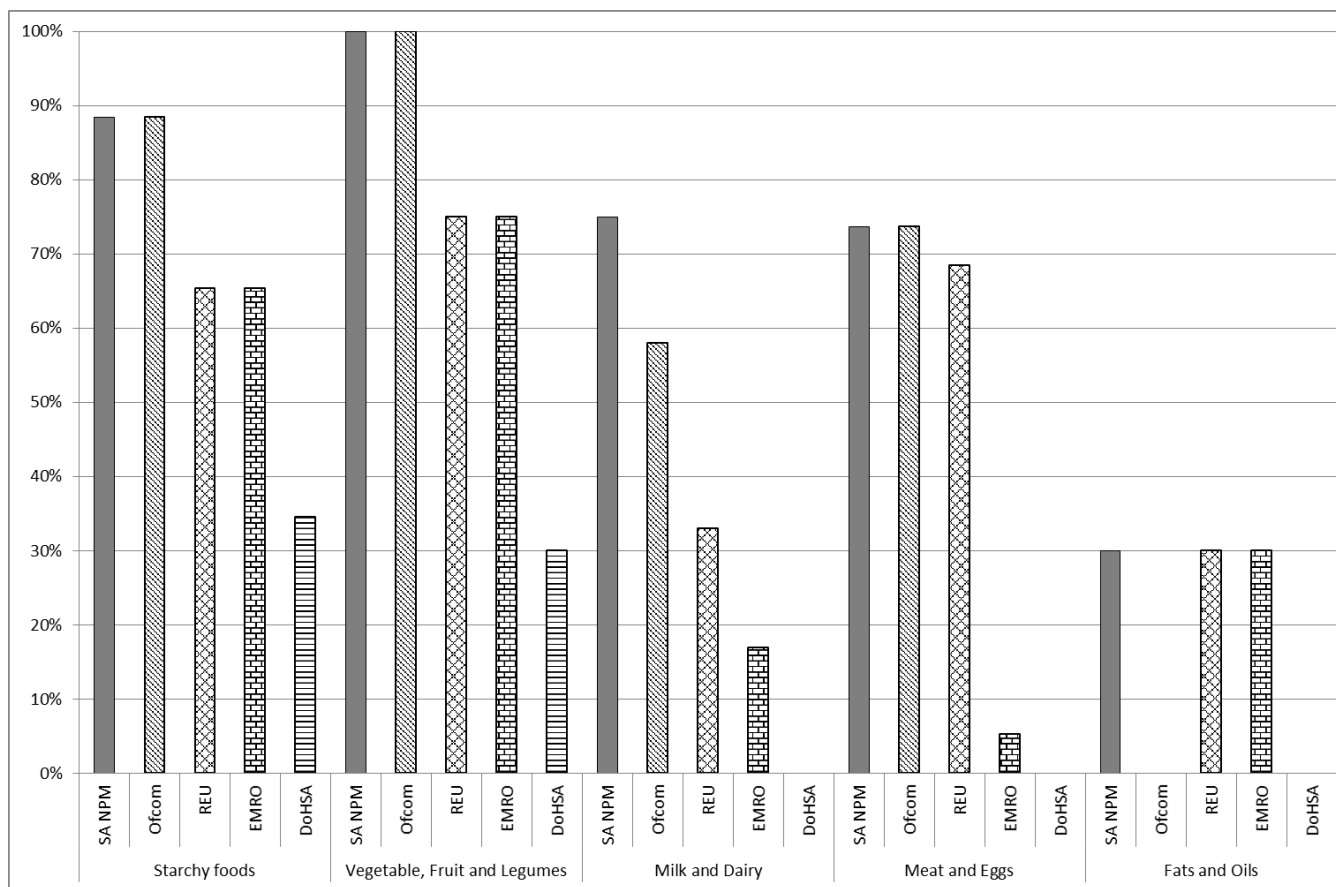
making use of Cohen's kappa coefficient. Agreements were assessed as follows: 0.00-0.20 "slight"; 0.21-0.40 "fair"; 0.41-0.60 "moderate"; 0.61-0.80 "substantial"; and 0.81-1 "almost perfect"<sup>(52)</sup>.

The included foods were divided into food groups based on the revised South African Food-Based Dietary Guidelines (SAFBDGs)<sup>(53)</sup>. The main purpose of the SAFBDGs is to guide the South African public to choose "healthy" diets, which implies that these diets are adequate, meet all nutrient requirements and protect people against the development of diet-related non-communicable diseases<sup>(53)</sup>. By keeping the main purpose of the SAFBDGs<sup>(53)</sup> in mind as well as the contribution of sugar-sweetened beverage consumption to the added sugar intake<sup>(54)</sup> and the obesity<sup>(55)</sup> of children, the following eight food groups were chosen: *starchy foods* (breads, grains, potatoes and cereals); *vegetables, fruits and legumes*; *milk and dairy products*; *meat and eggs*; *fats and oils* (margarines, cooking oils and peanut butters); *composite dishes* (foods composed of items from more than one category such as beef stew); *sugar-sweetened beverages*; and lastly *HFSS foods* (foods which are not part of the SAFBDGs for healthy eating such as sweets, confectionary and savoury snacks). For each type of food in the food groups listed above, the number of nutrient profiling models that would allow the food to be marketed to children was calculated.

## Results

Of the 615 food advertisements captured, 125 (20%) were aired during child-directed programmes and 269 (43.7%) used child actors<sup>(56)</sup>. The most frequently advertised foods were foods from the *HFSS foods* (51.5%); *composite dishes* (14%) and *sugar-sweetened beverages* (13.6%) food groups. The majority of the foods reported by literature to be frequently consumed by South African children were from the *HFSS foods* (27.84%) and *vegetable, fruits and legumes* (20.59%) food groups.

Figure 1 illustrates the percentage of foods from each food group which will be allowed for marketing to children when applying the five nutrient profiling models. Interestingly, the DoHSA model only allows foods from the *starchy foods* (35%) and *vegetable, fruit and legume* (30%) food groups to be marketed to children while the SANPM allows a selection of food from all the food groups to be marketed to children. The percentage of foods allowed for child-directed food marketing from the *milk and dairy* groups ranged from 0% (DoHSA) to 75% (SANPM). The only models allowing foods from the *HFSS foods* and *sugar-sweetened beverages* food groups to be marketed to children are the SANPM (11%, respectively) and Ofcom models (11%, respectively).



**Figure 1** The percentage of foods from different food groups allowed to be marketed to children according to each of the nutrient profiling models

SANPM: South African Nutrient Profiling Model; Ofcom: United Kingdom Office of Communication nutrient profiling model; REU: World Health Organization Regional Office for Europe nutrient profiling model; EMRO: World Health Organization's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA: South African Department of Health nutrient profiling model for restricting food marketing to children

Table 2 summarises the explanations for differences in food classification by the included nutrient profiling models. For example, Bran Flakes (breakfast cereal) was restricted for marketing by the REU and EMRO models due to the high sodium content of this specific food product.

**Table 2** Examples of foods of which the classification by nutrient profiling models differed

| Food group     | Foods of which classification differed | Nutrient profiling model |       |     |      |       | Reason why marketing to children is not permitted  |
|----------------|--|--------------------------|-------|-----|------|-------|--|
|                |  | SANPM                    | Ofcom | REU | EMRO | DoHSA |  |
| Starchy foods  | Bran Flakes                            | ✓                        | ✓     | X   | X    | X     | Thresholds exceeded:<br><ul style="list-style-type: none"> <li>Sodium: REU, EMRO and DoHSA</li> <li>Total sugar: DoHSA</li> </ul>  |
|                | Corn Flakes                            | X                        | X     | ✓   | ✓    | X     | Score exceeded:<br>SANPM, Ofcom and DoHSA  |
|                | Oats                                   | ✓                        | ✓     | ✓   | ✓    | X     | Threshold for total fat exceeded   |
| Milk and Dairy | Cheese, cheddar                        | ✓                        | X     | X   | X    | X     | Score exceeded: Ofcom<br>Thresholds exceeded:<br><ul style="list-style-type: none"> <li>Total fat: REU, EMRO and DoHSA</li> <li>Saturated fat: REU, EMRO and DoHSA</li> <li>Sodium: REU, EMRO and DoHSA</li> </ul> |
|                | Milk , full cream                      | ✓                        | ✓     | X   | X    | X     | Thresholds exceeded:<br><ul style="list-style-type: none"> <li>Total fat: REU, EMRO and DoHSA</li> <li>Saturated fat: DoHSA only</li> </ul>  |
|                | Milk, low fat                          | ✓                        | ✓     | ✓   | ✓    | X     | Thresholds exceeded:<br><ul style="list-style-type: none"> <li>Total fat: DoHSA</li> <li>Saturated fat exceeded: DoHSA</li> </ul>  |
|                | Yogurt A, sweetened                    | ✓                        | ✓     | X   | X    | X     | Thresholds exceeded:<br><ul style="list-style-type: none"> <li>Added sugar: REU and EMRO</li> <li>Total sugar: DoHSA</li> <li>Sodium: EMRO</li> </ul>  |
|                | Yogurt B, sweetened (less added sugar) | ✓                        | ✓     | ✓   | X    | X     | Thresholds exceeded:<br><ul style="list-style-type: none"> <li>Total sugar: DoHSA</li> <li>Sodium: EMRO</li> </ul>   |
| Meat and Eggs  | Chicken, meat and skin, roasted        | ✓                        | ✓     | ✓   | X    | X     | Threshold exceeded:<br><ul style="list-style-type: none"> <li>Sodium: EMRO and DoHSA</li> </ul>  |
|                | Tuna in vegetable oil                  | ✓                        | ✓     | ✓   | X    | X     | Thresholds exceeded:   |

| Food group                | Foods of which classification differed      | Nutrient profiling model |       |     |      |       | Reason why marketing to children is not permitted  |
|---------------------------|---|--------------------------|-------|-----|------|-------|--|
|                           |   | SANPM                    | Ofcom | REU | EMRO | DoHSA |  |
|                           |   |                          |       |     |      |       | <ul style="list-style-type: none"> <li>Saturated fat: EMRO and DoHSA</li> <li>Sodium: DoHSA</li> </ul>   |
| Fats and Oils             | Canola oil                                  | ✓                        | X     | ✓   | ✓    | X     | Score exceeded: Ofcom<br>Thresholds exceeded: <ul style="list-style-type: none"> <li>Total fat: DoHSA</li> <li>Saturated fat: DoHSA</li> </ul> |
|                           | Polyunsaturated medium fat spread (50% fat) | ✓                        | X     | ✓   | ✓    | X     | Score exceeded: Ofcom<br>Thresholds exceeded: <ul style="list-style-type: none"> <li>Total fat: DoHSA</li> <li>Saturated fat: DoHSA</li> </ul> |
| Sugar sweetened beverages | Energy drink, non-nutritive sweetened       | ✓                        | ✓     | X   | X    | X     | Threshold of non-nutritive sweeteners exceeded   |
| HFSS foods                | Fruit ice, Orange flavoured                 | ✓                        | ✓     | X   | X    | X     | Food category not permitted: REU and EMRO<br>Threshold exceeded: <ul style="list-style-type: none"> <li>Total sugar: DoHSA</li> </ul>          |
|                           | Custard, Vanilla flavoured                  | ✓                        | ✓     | X   | X    | X     | Food category not permitted: REU and EMRO<br>Threshold exceeded: <ul style="list-style-type: none"> <li>Total sugar: DoHSA</li> </ul>          |

SANPM: South African Nutrient Profiling Model; Ofcom: United Kingdom Office of Communication nutrient profiling model; REU: World Health Organization's Regional Office for Europe nutrient profiling model; EMRO: World Health Organization's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA: South African Department of Health nutrient profiling model for restricting food marketing to children

Table 3 indicates that an almost perfect pairwise agreement was found between the SANPM and Ofcom models, and a moderate agreement between the SANPM, REU and EMRO models. The SANPM showed no agreement with the DoHSA model.

**Table 3** Pairwise kappa values calculated for the five models

|       | SA NPM    | REU     | EMRO     | DoHSA   |
|-------|-----------|---------|----------|---------|
| Ofcom | 0.948**** | 0.464** | 0.417**  | 0.177   |
| SANPM |           | 0.484** | 0.447**  | 0.161   |
| REU   |           |         | 0.668*** | 0.251*  |
| EMRO  |           |         |          | 0.447** |

SANPM: South African Nutrient Profiling Model; Ofcom: United Kingdom Office of Communication nutrient profiling model; REU: World Health Organization's Regional Office for Europe nutrient profiling model; EMRO: World Health Organization's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA: South African Department of Health nutrient profiling model for restricting food marketing to children; \* = "fair", \*\* = "moderate", \*\*\* = "substantial", \*\*\*\* = "almost perfect"<sup>(52)</sup>

The DoHSA model, a combined nutrient profiling model, was the strictest. This model allows only 6% of foods on the food list to be marketed to children. The REU and EMRO models which are category-specific nutrient threshold models allow 32% and 20%, respectively. The most lenient models were the two across-the-board scoring models – the SANPM which allows 45% of the foods to be marketed to children and the Ofcom model allows 42%.

## Discussion

The main findings of this research study were that the included nutrient profiling models varied considerably with regards to their overall strictness and that the DoHSA model is by far the strictest nutrient profiling model and the SANPM is the most lenient with regard to restricting the marketing of foods to children in South Africa. Other research studies have also compared nutrient profiling models for the purpose of restricting the marketing of "unhealthy" foods to children<sup>(57;58;59)</sup>. The percentage of foods allowed to be marketed to children, according to Scarborough *et al.*<sup>(57)</sup>, ranges from 2.4% to 39.88% and, according to Rayner *et al.*<sup>(58)</sup>, from 4.76 % to 39.88 %. A research study conducted by Brinsden and Lobstein<sup>(59)</sup> also compared nutrient profiling models but classified foods previously permitted to be advertised in the United States of America, and reported the percentage of foods allowed to be marketed to children ranged from 14% to 49%.

Another output in which the included nutrient profiling models differ regardless of their overall strictness, is the type of foods the models would permit for marketing to children<sup>(25;57)</sup>. The nutrient profiling models generally agree that foods such as sweets, savoury snacks and sugar sweetened beverages should be restricted for marketing to children. However, the models displayed little agreement on the type of foods that should be permitted for marketing to children as the classification of foods such as full cream milk, cheese, sweetened yogurt, tinned peaches, breakfast cereals, etc. were undecided. Scarborough *et al.*<sup>(57)</sup> and Rayner *et al.*<sup>(58)</sup> compared nutrient profiling models by using a representative list of foods that were advertised during child-directed programmes in 2008. Similar to our findings, the models included in their research agreed on foods that should not be allowed to be marketed to children (sugary and fatty foods, mostly snacks and confectionary) but the models have shown little agreement on foods allowed for marketing. In contrast, the nutrient profiling models compared by Brinsden and Lobstein<sup>(59)</sup> found little agreement on both foods permitted and not

permitted to be marketed to children. Discrepancy in the findings was attributed to including nutrient profiling models developed by both governments and the food industry<sup>(59)</sup>. Government-led nutrient profiling models are significantly more restrictive than industry-led nutrient profiling models due to their stricter sugar and sodium/salt criteria. In comparison to the findings of previous research articles, the SANPM is rather lenient when it is applied for restricting the marketing of HFSS foods to children. Rayner *et al.*<sup>(25)</sup> define a strict nutrient profiling model, as a model that classifies most foods as “unhealthy”. Thus the SANPM could still be considered as a relatively strict model even though certain foods from food groups generally considered to be “unhealthy” (*sugar-sweetened beverages* and *HFSS foods* groups) were permitted for marketing to children. The DoHSA model is very strict and permits few foods for marketing to children. The additional nutrient threshold criteria<sup>(42)</sup> of the DoHSA model were the main reason for its stringency.

Nutrient profiling models differ in both their strictness and the type of foods they would permit for marketing to children due to the differences in their respective structures. These differences include the nutrients used, the number of food categories the model contains, the type of model (across-the-board or category-specific), and the additional classification criteria. In this research article, the across-the-board nutrient profiling models (SANPM and Ofcom models) were found to be more lenient than the category-specific models (REU and EMRO models). This could be due to the fact that across-the-board scoring nutrient profiling models motivate the fact that certain food groups should be eaten more often than others by applying the same definition of “unhealthy” to all food groups. This motivation, however, means that foods, such as non-nutritive sweetened beverages and certain fruit ices from the *sugar-sweetened beverages* and *HFSS foods* groups, are permitted to be marketed to children by the SANPM and Ofcom models. This is in contrast with category-specific threshold models that motivate “healthier” foods within a food group to be chosen more often by applying different definitions of “unhealthy” to different food groups<sup>(60)</sup>. Category-specific nutrient profiling models also prohibit certain food groups, such as sweets, confectionary, fruit juices and edible ices, from being marketed to children irrespective of their nutrient content. This is due to the fact that these nutrient profiling models intend to motivate the public to rather choose “healthier” foods from food groups proven to be essential components to “healthy” diets<sup>(57)</sup>.

Nutrient profiling models are also now used by the food industry to reformulate food products. However, concerns have been raised that in order to “pass” some of the nutrient profiling models’ classification criteria, certain foods which ordinarily would not “pass” the nutrient profiling models’ classification will now be developed<sup>(61)</sup>. Such foods include highly-processed food products with little or no nutritional value or foods artificially fortified with ingredients

considered healthy. In order to prevent such foods from “passing” the selected nutrient profiling model, policy makers are urged to adapt the chosen model by including additional classification criteria. Exclusions are thus made to the model or additional food categories are added. The SANPM was adapted by the South African Department of Health, Directorate: Food Control in order to create the proposed DoHSA model (Box 1). The proposed DoHSA model uses the SANPM as the first classification step followed by the UK FSA front-of-pack traffic light labelling criteria for green (low)<sup>(42)</sup>. The DoHSA model also excludes foods with the following food additives: non-nutritive sweeteners, fluoride, fructose and aluminium<sup>(42)</sup>. The non-nutritive sweetener criterion resulted in some of the foods permitted for marketing by the SANPM to be excluded by the DoHSA model. The use of non-nutritive sweeteners in the fight against childhood obesity is, however, uncertain, as the use of non-nutritive sweeteners is recommended by some<sup>(62;63)</sup> while others are against it<sup>(64)</sup>. The additional nutrient threshold criteria<sup>(42)</sup> of the DoHSA model mean that certain foods generally considered as essential components to a healthy diet, such as apples and low fat milk, are classified as “unhealthy”. It is, therefore, of the utmost importance that policy makers are aware of the fact that adaptations made to nutrient profiling models could negatively affect the way in which they classify foods, which in return will impact the type of food marketing that children are exposed to. It can be concluded that the additional threshold criteria<sup>(42)</sup> of the DoHSA model are very strict and allow few foods to be marketed to children.

Nutrient profiling models do not only vary in the way that they have been constructed, but also to the degree in which they have been validated<sup>(25)</sup>. Unfortunately, validity testing of nutrient profiling models are limited and no golden standard for assessing the way in which nutrient profiling models classify foods exists<sup>(25)</sup>. The Ofcom model has been extensively tested<sup>(57;58;59;65;66;67)</sup> and validated<sup>(38;39)</sup> for the purpose of regulating the marketing of foods to children. When comparing the SANPM to the Ofcom model, an almost perfect pairwise agreement was found (construct validity). This was, however, expected as the models are based on one another. Even so, there are still distinct differences between the models although they have the same basic principles. The Ofcom model classifies foods in one of only two food categories (foods or beverages). The SANPM has an additional food category for cheese and processed cheese with a calcium content > 320 mg/100 g, edible oils, edible oil spread, margarine and butter. Foods within this food category are allowed to obtain a higher score in comparison to that of foods in the other food categories due to the naturally high total energy, total fat and saturated fat content of these foods. This additional food category meant that the percentage of foods permitted by the SANPM and Ofcom models from the *milk and dairy* (allowing 75% and 58%, respectively) and *fats and oils* (allowing 30% and 0%, respectively) groups varied considerably. A moderate pairwise agreement was found between

the SANPM and the REU and EMRO models, the models also classify foods from the *fats and oils* food group similarly. No statistically significant level of agreement was found between the SANPM and the DoHSA models, the DoHSA model also prohibits any of the foods included in the *milk and dairy* and *fats and oils* food groups to be marketed to children. Available data indicate that the intake of milk and calcium by South African children is low due to the price of certain dairy products and lack of knowledge on the nutritional value of milk and dairy products. The accessibility and affordability of highly-processed packaged foods are increasing and, therefore, it can be argued that the thresholds of the chosen nutrient profiling model be set appropriately so that certain cheeses and yogurts with little added sugar, be allowed for marketing to children

The comparison between the nutrient profiling models provided valuable information with regards to the suitability of the SANPM for child-directed food marketing regulations and highlighting the similarities and differences between the included models. The comparison also emphasised the importance of testing a nutrient profiling model before implementation into policy. However, the limitations of such a comparison should also be taken into consideration as more validity studies are needed to confirm the included nutrient profiling models' accuracy with regards to classifying or ranking the 'healthiness' of foods. The WHO recommends that the nutrient profiling model being used to regulate the marketing of foods to children should align with the Food Based Dietary Guidelines of the country in which it is intended for use<sup>(23)</sup>. It could, therefore, be argued that the nutrient profiling model used to regulate the marketing of foods to children in South Africa should permit "healthy" foods within the food groups that the SAFBDGs promote. The SANPM aligned well with the SAFBDGs during the validity testing for nutrient and/or health claim regulatory use<sup>(35)</sup>. However, no validity testing of the DoHSA model have been conducted to date.

### *Limitations*

The analysis reported in this article only included food advertisements broadcasted on free-to-air South African television channels and foods commonly consumed by the targeted population as identified from published literature. Food marketed to children through other forms of marketing, such as radio broadcasts, product placements, product packaging and internet advertisements, were not included and cross-continent food marketing through international television channels were also not included.

## *Conclusion*

The nutrient profiling models included in this article vary considerably in both the total amount of foods and the type of foods allowed for marketing to children. The SANPM, already accepted and used by the South African food industry as the first screening process to determine a food product's eligibility for a nutrient and/or health claim, is appropriate as the first screening process for regulating the marketing of HFSS foods to children. The SANPM displays the best agreement with the Ofcom model and it permits certain dairy products, such as low-fat yogurt, to be marketed to children. But further research is recommended to assess the validity of the SANPM and to develop an evidence-based framework to assist in the exclusion of certain highly-processed foods that are included by the SANPM due to limited nutritional values (such as energy drinks with non-nutritive sweeteners).

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## CHAPTER 4

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*This manuscript is formatted according to the guidelines of British Journal of Nutrition (Annexure 1), with the exception of the font and line numbers, which will be inserted before submission.*

### **Assessing the construct validity of nutrient profiling models to regulate the marketing of foods and non-alcoholic beverages to children in South Africa**

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## **Abstract**

Nutrient profiling is defined as the science of categorizing foods according to their nutritional composition for the purpose of preventing disease and promoting health. Internationally, nutrient profiling has recently proliferated, specifically within the context of restricting the marketing of foods and non-alcoholic beverages high in fat, sugar and/or salt to children. The aim of this study was to validate the South African nutrient profiling model in the context of child-directed food marketing regulations. Registered dietitians in South Africa were requested to categorize 120 foods into one of six positions on the basis of their 'healthiness' via an online survey. These categorizations were used to produce a standard ranking of the 120 foods. The standard ranking was compared with the results of applying five included nutrient profiling models to the 120 foods. The Spearman's rank correlation coefficient was used to compare the average scores awarded to the 120 foods by the dietitians with the nutrient profiling models. A total of 85 dietitians participated in the study. All of the included nutrient profiling models showed medium to strong correlation with the standard ranking (Spearman's correlation = 0.38-0.71;  $p = 0.001$ ). The South African nutrient profiling model showed the strongest correlation with the standard ranking of foods. The results suggest that the SANPM, originally designed to screen food for their eligibility for a nutrient and/or health claim, is also a valid nutrient profiling model to use in regulating the marketing of foods to children in South Africa.

*Key terms:* Nutrient profiling, validating, marketing of foods, regulation, childhood obesity

## Introduction

Nutrient profiling is defined as ‘the science of categorizing foods according to their nutritional composition for reasons related to preventing disease and promoting health’<sup>(1)</sup>. Internationally, nutrient profiling have proliferated, specifically within the context of restricting the marketing of foods and non-alcoholic beverages high in fat, sugar and/or salt (from here on referred to as HFSS foods) to children<sup>(2)</sup>. But, the different nutrient profiling models classify foods differently<sup>(2; 3; 4; 5)</sup> and the validity of only a few nutrient profiling models have been established<sup>(6)</sup>. In South Africa, the South African nutrient profiling model (SANPM) is used as the first screening process to determine a food product’s eligibility for a nutrient and/or health claim<sup>(7)</sup>. This model enjoys support from all key stakeholders (the food industry, government and nutrition professionals) as the suitability of this model for nutrient and/or health claim regulations was tested and validated prior to adoption as part of the regulations<sup>(8; 9)</sup>.

Childhood obesity has increased dramatically during recent years and is growing in low-income and middle-income countries<sup>(10; 11; 12)</sup>. Unfortunately, childhood obesity has also increased substantially in South Africa<sup>(13; 14)</sup>. The changes in children’s food preferences and the influence of food, social, and information environments in shaping these preferences have been identified as key contributing factors to this epidemic<sup>(15; 16)</sup>. Obesity prevention policies that support an environment that encourages the learning of healthy food preferences have an important role to play in children’s lives. Therefore, the World Health Organization (WHO) and research scientists recommend regulating HFSS food marketing to children<sup>(15; 17; 18)</sup> as such a practice has produced large gains with regard to health outcomes at population level and is cost-effective<sup>(19)</sup>.

In recognition of the need for such a policy, the South African National Department of Health, Directorate: Food Control, published a draft regulation aiming to restrict the marketing of *all* HFSS foods to children<sup>(7)</sup>. The draft regulation recommends using the South African Department of Health’s (DoHSA) nutrient profiling model to determine if a food product is permitted for marketing to children. The DoHSA model is an adapted nutrient profiling model based on the SANPM. Neither the SANPM nor the DoHSA models have been validated for the purpose of regulating the marketing of HFSS foods to children. Therefore, the appropriateness and validity of the SANPM and DoHSA models for child-directed food marketing regulations need to be established. Comparing a nutrient profiling model with another model that has been designed for a similar purpose and that has been validated, is one method of testing for construct validity of a nutrient profiling model<sup>(20)</sup>. First, the SANPM and DoHSA models were compared to three existing non-industry-developed nutrient profiling models for the regulation of the marketing of HFSS foods to children. The SANPM was found

appropriate as a first screening step for regulating the marketing of HFSS foods to children<sup>(5)</sup> [Chapter 3 of this thesis, manuscript published]. However, the comparisons between models of unknown accuracy have been reported to be of limited value<sup>(21)</sup> and the fact that some models were based on one another is also a limitation for this method of construct validity testing<sup>(5)</sup> [Chapter 3 of this thesis, manuscript published]. Therefore, another form of construct validity testing of the SANPM and DoHSA models in the context of child-directed food marketing regulations is prudent.

The best and most obvious method of assessing validity of a nutrient profiling model is to compare the model with the 'golden standard' for defining a healthy food<sup>(22)</sup>. Unfortunately, measuring the validity of a nutrient profiling model is challenging as there is no 'golden standard' for classifying the 'healthiness' of foods<sup>(20; 22; 23)</sup>. Another method of validation that has been proposed by Rayner *et al.*<sup>(24)</sup>, is to compare the classification of foods by the nutrient profiling models to the ranking of the same foods by nutrition professionals. This method of validity testing was previously used by Scarborough *et al.*<sup>(25)</sup> and was considered to be more systematic and transparent than the methods generally used, even though it was reported that nutrition professionals were not entirely logical and consistent in the way that they ranked the foods. Townsend<sup>(26)</sup> developed a conceptual framework for establishing the validity of nutrient profiling models and suggested that predictive validity (a form of criterion-related validity) is the absolute in validation assessment as the capacity of a nutrient profiling model to improve diet quality and/or the health status of consumers is assessed. However, it is not always feasible to conduct predictive validity testing of a nutrient profiling model. Therefore, the comparison of nutrient profiling models to the views of nutrition professionals provides a relatively simple and inexpensive method of evaluating the consistency of models when compared to other methods<sup>(26)</sup> even though it has limitations and a risk of bias<sup>(21)</sup>. This study, therefore aims to assess the construct validity of the SANPM and DoHSA models for the purpose of regulating the marking of HFSS foods to children in South Africa by comparing the classification of foods by nutrient profiling models to the ranking of the same foods by dietitians.

## **Methods**

This study consisted out of two parts. During the first part of the study South African dietitians ranked the 'healthiness' of 120 foods which represented foods frequently marketed and consumed by South African children. In part two ranked foods were compared to the classification of the same foods by a selection of nutrient profiling models.

## **Part 1: Ranking of foods according to 'healthiness'**

South African dietitians' perception of the 'healthiness' of individual foods was assessed according to a method developed and tested by Scarborough and colleagues<sup>(25; 27)</sup>. For the purpose of this study a dietitian was defined as a health professional registered with the Professional Board for Dietetics and Nutrition of the Health Professions Council of South Africa (HPCSA) and who is also a full member of the Association of Dietetics in South Africa (ADSA). An anonymous online survey was specifically created for this study and sent to all full members of ADSA via their weekly announcements mailer in September and November of 2015. The survey consisted of three sections: (1) participant information leaflet and informed consent form for the dietitians; (2) background information on the study; (3) demographic questions and questions relating to the 'healthiness' of foods. A section that enabled participants to view their responses and to make revisions if required was also provided.

In section 3 of the survey dietitians were asked to provide their highest academic qualification, the year in which that qualification was obtained and their primary work environment. The dietitians were then asked to rank the 'healthiness' of 40 foods, across different food groups, on a 6-point Likert scale with 1 being described as 'less healthy' and 6 as 'more healthy' foods. Each survey contained an individualised food list (n = 40 foods) which consisted of packaged and whole foods randomly selected from a master list of 120 foods. Foods used in the survey were selected from a representative food list developed for the purpose of comparing nutrient profiling models. The 120 foods included, the top 60 foods most frequently marketed to children in South African and the top 60 foods most frequently consumed by South African children<sup>(5)</sup> [Chapter 3 of this thesis, manuscript published]. The number of foods included in the survey and the number of positions provided for ranking of the foods were based on the findings of Scarborough and colleagues<sup>(27)</sup>.

Dietitians were informed that, for the purpose of the survey, a 'more healthy' food was a food that should be consumed regularly by children as part of a healthy eating plan to support optimal growth and development. A 'less healthy' food was a food that should be consumed infrequently as the food does not support optimal growth and development of children. The following clarification definitions were also provided to dietitians: *total sugar* refers to the sum of all intrinsic (lactose, fructose and galactose) and added sugars (monosaccharides and disaccharides) and *added sugar* refers to any sugar added to food by manufacturers, chefs/cooks or consumers during processing or preparation<sup>(28)</sup>. A *non-nutritive sweetener* refers to a food additive (other than a monosaccharide or disaccharide sugar), of which one serving of 5 g provides  $\leq 8$  kJ (1.9 kcal) and a sweet taste equivalent to 5 g of sucrose<sup>(7; 29)</sup>. Dietary energy (kJ), total fat, saturated fat, total sugar, added sugar, sodium, protein and fibre

content per 100g/ml and an indication whether the additives fluoride, aluminium, fructose and/or non-nutritive sweeteners are present was provided for each individual food to assist with food classification.

Responses received from the dietitians were captured in a spreadsheet. In order to determine if each food item from the master list (n = 120 foods) received an equal opportunity to be classified and that all of the positions on the Likert scale was represented, the following information was documented for each individual food item: 1) the number of times classified and 2) the number of times that a specific ranking was received. Responses were excluded if the dietitian placed more than 80% of foods in any one position<sup>(25)</sup>. This exclusion was made to account for participant fatigue that may result in thoughtless choices. Finally, the 120 foods from the survey were ranked on a continuum of 'healthiness' according to the average rankings awarded by dietitians.

### ***Part 2: Testing of the nutrient profiling models***

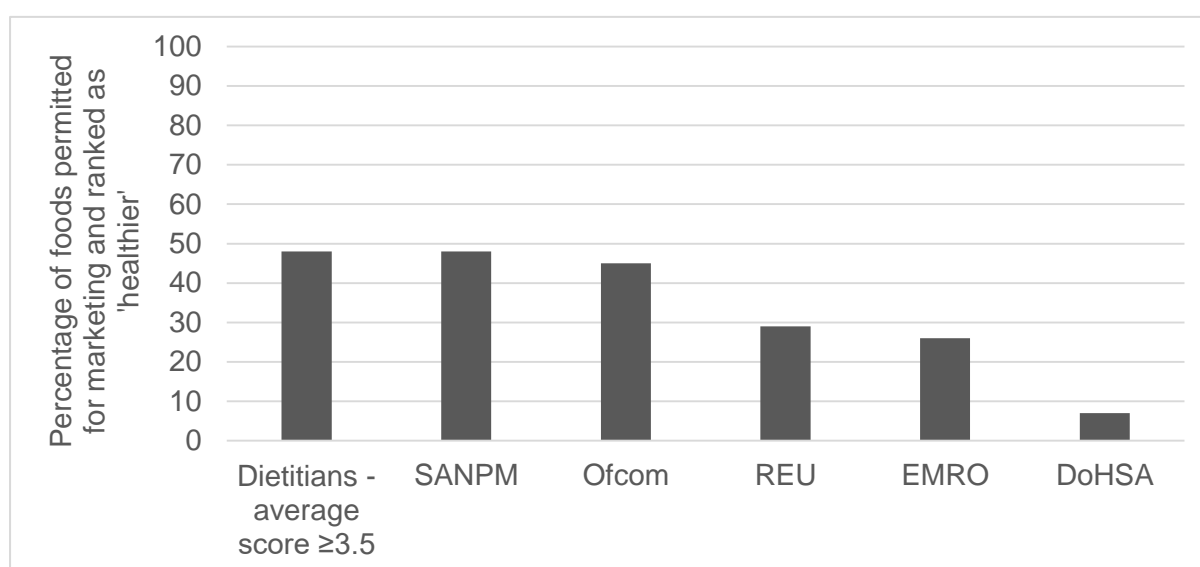
The following five non-industry developed nutrient profiling models were included for testing: SANPM; United Kingdom Office of Communication nutrient profiling model (Ofcom); World Health Organization Regional Office for Europe nutrient profiling model (REU); World Health Organization Eastern Mediterranean Regional Office nutrient profiling model (EMRO) and the DoHSA model. All of these models, with the exception of the SANPM, were developed for the purpose of restricting the marketing of HFSS foods to children. A complete description of the models is provided elsewhere<sup>(5)</sup>.

Nutrient criteria algorithms were developed in Microsoft Excel 2013 according to the food classification criteria of the included nutrient profiling models. Each food item was individually classified according to these nutrient criteria and the proportion of foods that each model would permit or prohibit for child-directed food marketing was calculated. In order to compare the classification of foods by the nutrient profiling models with the views of the dietitians, the researchers followed the method used by Scarborough and colleagues<sup>(25)</sup> and considered foods with an average ranking greater than 3.5 (mid-point of the scale) as a 'healthier' food. The relationship between the nutrient profiling models' classification of foods and the average rankings awarded by the dietitians was tested by conducting a Spearman's rank correlation analysis. The Spearman's rank correlation coefficient was used to evaluate the strength of the relationship, where coefficients between 0.10 and 0.29 represented a small association, coefficients between 0.30 and 0.69 represented a moderate association and coefficients greater than 0.70 a strong association.

## Results

The survey was sent out to 1010 ADSA members, 85 responses were received of which none were excluded, yielding an 8.4% response rate. Dietitians who completed the survey included private practicing dietitians (28%), dietitians working at an academic or research institution (27%), working in a hospital setting (19%), working in a community or public health nutrition setting (13%), and working in the food industry (13%). Post-graduate qualifications included honours degrees (16%), masters degrees (27%) and PhD's (7%).

The DoHSA model was the strictest model allowing only 7% of the foods for marketing to children, whereas the SANPM was the most lenient model allowing 48% of the foods. The dietitians viewed 40% of the foods as 'more healthy' foods, as these foods received an average score of 3.5 or more (figure 1).



**Figure 1** Percentage of foods permitted by the nutrient profiling models for child-directed food marketing compared with the percentage of foods ranked as 'healthier' by the dietitians .

Table 1 shows the results when the Spearman's rank correlation test was used to compare the average ranking awarded to the 120 foods by the dietitians with the classification of the foods by each of the different nutrient profiling models. A strong association existed between the average ranking of 'healthiness' of foods awarded by the dietitians and the classification of marketability of foods by the SANPM.

**Table 1** Spearman’s rank correlation coefficient for the dietitians’ standard rankings and nutrient profiling models classification

| Nutrient profiling model | Spearman rank correlation coefficient |
|--------------------------|---------------------------------------|
| SANPM                    | 0.71*                                 |
| Ofcom                    | 0.68*                                 |
| REU                      | 0.64*                                 |
| EMRO                     | 0.60*                                 |
| DoHSA                    | 0.38*                                 |

\*p<0.001

The top 10 and bottom 10 ranked foods according to the views of the dietitians are reported in Table 2. The included nutrient profiling models prohibited all of the bottom ranking foods from marketing to children. Interestingly, the DoHSA model prohibited the marketing of foods such as oranges, bananas and uncooked oats porridge, which are all part of the top 10 ranked foods according to the views of the dietitians.

**Table 2** The top 10 and bottom 10 ranking foods according to the dietitians and the corresponding child-directed food marketing classification by the nutrient profiling models

| Food item   | Rank | Dietitians’ average ranking | Nutrient profiling models classification |       |     |      |       |
|---|------|-----------------------------|--|-------|-----|------|-------|
|   |      |                             | SANPM                                    | Ofcom | REU | EMRO | DoHSA |
| Orange, raw   | 1    | 5.92                        | ✓  | ✓     | ✓   | ✓    | X     |
| Spinach, boiled   | 2    | 5.92                        | ✓  | ✓     | ✓   | ✓    | ✓     |
| Carrot, boiled (flesh and skin)                             | 3    | 5.81                        | ✓  | ✓     | ✓   | ✓    | ✓     |
| Mixed vegetables: carrot, cauliflower, green beans (frozen) | 4    | 5.80                        | ✓  | ✓     | ✓   | ✓    | ✓     |
| Banana, raw   | 5    | 5.77                        | ✓  | ✓     | ✓   | ✓    | X     |
| Pumpkin, boiled   | 6    | 5.75                        | ✓  | ✓     | ✓   | ✓    | ✓     |
| Chicken, white meat, cooked                                 | 7    | 5.62                        | ✓  | ✓     | ✓   | X    | ✓     |
| Cabbage, boiled   | 8    | 5.54                        | ✓  | ✓     | ✓   | ✓    | ✓     |
| Samp and beans (1:1)  | 9    | 5.50                        | ✓  | ✓     | ✓   | ✓    | ✓     |
| Oats, uncooked  | 10   | 5.35                        | ✓  | ✓     | ✓   | ✓    | X     |

| Food item   | Rank | Dietitians' average ranking | Nutrient profiling models classification |       |     |      |       |
|---|------|-----------------------------|--|-------|-----|------|-------|
|   |      |                             | SANPM                                    | Ofcom | REU | EMRO | DoHSA |
| Potato crisps, tomato flavour                       | 111  | 1.38                        | X  | X     | X   | X    | X     |
| Seasoning powder for maize meal porridge            | 112  | 1.37                        | X  | X     | X   | X    | X     |
| Biscuits, raspberry & vanilla jam filling           | 113  | 1.31                        | X  | X     | X   | X    | X     |
| Cold drink, carbonated, orange                      | 114  | 1.27                        | X  | X     | X   | X    | X     |
| Biscuits, chocolate wafers with sweet cream filling | 115  | 1.21                        | X  | X     | X   | X    | X     |
| Sweets, chocolate, milk & biscuits                  | 116  | 1.20                        | X  | X     | X   | X    | X     |
| Biscuits, iced vanilla                              | 117  | 1.19                        | X  | X     | X   | X    | X     |
| Sweets, lollipop, caramel                           | 118  | 1.17                        | X  | X     | X   | X    | X     |
| Potato crisps, salted                               | 119  | 1.14                        | X  | X     | X   | X    | X     |
| Coffee creamer                                      | 120  | 1.14                        | X  | X     | X   | X    | X     |

✓ : Child-directed food marketing permitted; X: Child-directed food marketing prohibited

The food products that were classified differently by the included nutrient profiling models in comparison with the views of dietitians are included in Table 3. For example, peanut butter with no added salt or sugar was considered a 'more healthy' food by the dietitians (average score 4.96), but all of the included nutrient profiling models prohibited peanut butter for child-directed food marketing.

**Table 3** A comparison between the different nutrient profiling models' child-directed food marketing classification and the 'healthiness' ranking by dietitians

| Food item                                | Dietitians' average ranking | Nutrient profiling models classification |       |     |      |       |
|--|-----------------------------|--|-------|-----|------|-------|
|  |                             | SANPM                                    | Ofcom | REU | EMRO | DoHSA |
| Corn flakes with honey                   | 1.69                        | ✓  | ✓     | ✓   | ✓    | X     |
| Jelly, prepared with water               | 2.27                        | ✓  | ✓     | X   | X    | X     |
| Peaches in syrup, tinned                 | 2.49                        | ✓  | ✓     | X   | X    | X     |
| White bread                              | 2.83                        | ✓  | ✓     | ✓   | ✓    | X     |
| Fruit ice, orange flavoured              | 3.00                        | ✓  | ✓     | X   | X    | X     |
| Custard, with non-nutritive sweeteners   | 3.04                        | ✓  | ✓     | X   | X    | X     |
| Popcorn, salted                          | 3.54                        | X  | X     | X   | X    | X     |
| Apple juice, 100% pure                   | 3.57                        | ✓  | ✓     | X   | X    | X     |
| Cheese, cheddar                          | 3.79                        | ✓  | X     | X   | X    | X     |
| Flavoured milk, sweetened                | 3.79                        | X  | X     | X   | X    | X     |
| Breakfast cereal, bran flakes            | 4.12                        | ✓  | ✓     | X   | X    | X     |
| Yogurt, flavoured, low fat               | 4.31                        | ✓  | ✓     | X   | X    | X     |
| Peas, tinned                             | 4.37                        | ✓  | ✓     | X   | X    | X     |
| Tuna, in vegetable oil                   | 4.57                        | ✓  | ✓     | ✓   | X    | X     |
| Milk, full cream                         | 4.71                        | ✓  | ✓     | X   | X    | X     |
| Canola oil                               | 4.79                        | ✓  | X     | ✓   | ✓    | X     |
| Milk, low fat                            | 4.83                        | ✓  | ✓     | ✓   | ✓    | X     |
| Baked beans in tomato sauce              | 4.89                        | ✓  | ✓     | ✓   | ✓    | X     |
| Peanut butter, smooth, no salt and sugar | 4.96                        | X  | X     | X   | X    | X     |
| Bread, whole wheat                       | 5.08                        | ✓  | ✓     | ✓   | ✓    | X     |
| Beef stew, with vegetables               | 5.15                        | ✓  | ✓     | ✓   | ✓    | X     |
| Oats, uncooked                           | 5.35                        | ✓  | ✓     | ✓   | ✓    | X     |
| Chicken, white meat, cooked moist        | 5.62                        | ✓  | ✓     | ✓   | X    | X     |
| Banana, raw                              | 5.77                        | ✓  | ✓     | ✓   | ✓    | X     |
| Orange, raw                              | 5.92                        | ✓  | ✓     | ✓   | ✓    | X     |
| Spinach, boiled                          | 5.92                        | ✓  | ✓     | ✓   | ✓    | X     |

✓ : Child-directed food marketing permitted; X: Child-directed food marketing prohibited

## Discussion

This study aimed to assess the construct validity of the SANPM and DoHSA models in the context of child-directed food marketing regulations by comparing various nutrient profiling models to the views of South African dietitians. There is paucity in the literature on using construct validity to validate the use of a nutrient profiling model for regulation of child-directed food marketing. This study found a strong positive correlation between foods ranked 'healthier' by dietitians and foods permitted for marketing to children by five nutrient profiling models, including the SANPM.

It can be presumed that the foods viewed by the dietitians as 'healthier' foods would be permitted for marketing to children. In this study the dietitians viewed 40% of foods on the list to be 'healthier' whereas the SANPM and Ofcom models would permit 48% and 45% of the foods on the list for marketing to children. The REU, EMRO and DoHSA models would only permit 29%, 26% and 7% of the included foods for marketing to children. Our findings are in agreement with Scarborough *et al.* <sup>(25)</sup> who also compared the views of nutrition professionals to nutrient profiling models. They reported, depending on the specific nutrient profiling models used in their research, the nutrition professionals were also either more lenient or stricter than the nutrient profiling models. Previous research has shown that nutrient profiling models differ with regard to the percentage of food permitted for child-directed food marketing due to the differences in their respective structures<sup>(2; 4; 5)</sup>. These differences include the nutrients used to classify foods, the number of food categories contained in the model, the type of model (scoring or threshold), the principles of the model (across-the-board or category-specific) and any absolute exclusion criteria included in the model. In this study, the across-the-board scoring models (SANPM and Ofcom) were the most lenient models (Figure 1) and correlated the strongest with the views of the dietitians (Table 1). By applying the same definition of 'unhealthy' across all food groups, across-the-board scoring models motivate that certain food groups should be eaten more often than others. As a result of this principle, across-the-board models permit more foods for marketing to children. On the other hand, the REU and EMRO models are category-specific nutrient profiling models, implying that these models use different definitions of 'unhealthy' for different food groups<sup>(30)</sup>. By classifying foods in this manner, the category-specific nutrient profiling models intend to motivate the public to rather choose 'healthier' foods from food groups proven to be essential components of healthy diets<sup>(31)</sup>. Consequently, these models permit fewer foods for marketing to children as they prohibit certain food groups, such as sweets, confectionary, fruit juices and edible ices, from being marketed to children, irrespective of their nutrient content.

In the ranking of foods according to 'healthiness', dietitians and the SANPM, Ofcom and REU models had 100% agreement on the top 10 ranked foods and there was a 100% agreement between the dietitians and all nutrient profiling models with the bottom 10 ranked foods (Table 2). There was some disagreement between the dietitians and the DoHSA and EMRO nutrient profiling models for the ranking the 'healthiness' of foods. This discrepancy may be explained by the DoHSA model's total sugar and saturated fat thresholds and the EMRO model's sodium threshold. The DoHSA model prohibited oranges and bananas due to the total sugar (fructose) content and uncooked oats due to the saturated fat content. Cooked chicken was prohibited by the EMRO model due to the sodium content, since the EMRO model has a sodium threshold of 40mg per 100g serving for fresh and frozen meat and poultry<sup>(29)</sup>. Oranges and spinach, both receiving an average ranking of 5.92, were ranked the 'healthiest' foods according the dietitians and coffee creamer and salted potato crisps both receiving an average score of 1.14 as the 'least healthy' foods. During construct validity testing of the SANPM for nutrient and/or health claim regulations in South Africa, green apples with an average score of 5.9 were reported to be the 'healthiest' food item according to the view of nutrition professionals, whereas carbonated cold drinks, sweet biscuits, maize-based savoury snacks and coffee creamers, all with an average score of 1.3, were reported to be the least healthy food items<sup>(8)</sup>. The 'healthiest' food item according to the nutrition professionals in the study conducted by Scarborough and colleagues<sup>(27)</sup> was raw green pepper with an average score of 5.91 and the 'least healthy' food item was clotted cream with an average score of 1.21. These findings indicate that nutrition professionals generally agree on the 'healthiness' of food groups as the 'healthiest' foods in all of the studies were foods from the vegetable and fruit food groups and the 'least healthy' foods were foods from the sweets and confectionary, savoury snacks and fats and oils food groups. This could explain why the SANPM correlated so strong ( $r = 0.71$ ;  $p = 0.001$ ) with the views of the dietitians as the model permits all fruits and vegetables for marketing and why the DoHSA model displayed the weakest correlation ( $r = 0.37$ ;  $p = 0.001$ ) due to its strict total sugar threshold.

Apart from the disagreement between dietitians and the EMRO and DoHSA nutrient profiling models on the 'healthiness' of the top 10 and bottom 10 ranked foods, there were disagreement between dietitians and one or more nutrient profiling models on the 'healthiness' of other foods too (Table 3). The dietitians awarded corn flakes with honey an average score of 1.64, whereas all of the included models, with the exception of the DoHSA model, would permit this food item for child-directed food marketing. This discrepancy could possibly be as a result of the dietitians interpreting the term "added honey" as a product with a high added sugar content. The SANPM and Ofcom models would allow peaches in syrup, orange flavoured fruit ice and custard containing non-nutritive sweeteners for marketing to children.

The dietitians viewed all of these foods products as 'less healthy' foods and the REU, EMRO and DoHSA models agreed as marketing to children would be prohibited by these models. The SANPM and Ofcom models would permit custard containing non-nutritive sweeteners for marketing to children, as the models do not have a non-nutritive sweetener criterion or outright exclusion criterion if a food product contains non-nutritive sweetener. The peaches in syrup and orange flavoured fruit ice would be permitted as a result of the fruit content of the products. Bran flakes, low fat flavoured yogurt and tinned peas were all classified as 'more healthy' foods according to dietitians although they were prohibited from marketing by the REU, EMRO and DoHSA models. Bran flakes and tinned peas were prohibited due to their sodium content and low fat flavoured yogurt due to its added sugar content. Interestingly, peanut butter with no added salt or sugar was prohibited from marketing by all the NPMs due to its saturated fat content but was classified as a 'more healthy' food by dietitians. Scarborough and colleagues<sup>(27)</sup> reported similar results and argued that this may imply that the nutrition professionals were using descriptive prompts, such as "whole wheat" and "low fat" to guide their judgements over and above the nutritional data provided. With regard to peanut butter, it could also be argued that in the South African context, the dietitians evaluated this product to be a high energy, affordable and healthy source of a protein. The dietitians could also have evaluated peanut butter in the serving size that is would normally be consumed and not per 100g serving as required by the nutrient profiling models. In addition, peanut butter is used as part of the South African school feeding programme, which could have influenced the scoring of the dietitians. The fact that nutrient profiling models classify foods per 100g/ml serving is a limitation and has always been a point of discussion and debate<sup>(32)</sup>. However, it is important to remember that one of the main functions of nutrient profiling is to compare foods with each other, and in order to do this effectively, a standard portion size is required. Unfortunately, no standard portion sizes are available in South Africa and the concern that food manufacturers could manipulate portion sizes of food products in order to pass the nutrient profiling criteria is a reality. There are for example jelly sweets available on the South African market reporting a serving size of 4.2g, however, the packet size is 75g. The marketability of this product will differ when the food is classified per single serving (4.2g) or per 100g serving size. Children will most probably consume the product as it is packaged and not in the portion size as displayed on the nutrition information panel.

Our results support the findings of other nutrient profiling model comparison studies which have shown that there is generally agreement that foods such as sweets, savoury snacks and sugar sweetened beverages should be restricted for marketing to children but that little agreement exists on the type of foods that can be permitted for marketing<sup>(4; 5; 33)</sup>. It has, however, been argued by Cooper *et al.*<sup>(21)</sup> that comparison between two models of unknown

accuracy are of limited value. Therefore, the comparison of nutrient profiling models to the views of dietitians provided another relatively simple and inexpensive method of evaluating the consistency of models<sup>(25; 26)</sup>. The decision to permit foods for child-directed marketing which there is disagreement on between dietitians and/or nutrient profiling models, such as tinned peas, 100% fruit juice and non-nutritive sweetened foods, might be a decision for policy makers. Once policy makers have selected a model, adaptations can be made in various ways, for example creating exemptions to the model or adding classification criteria. Policy makers should, however, be aware of the fact that different nutrient profiling models designed for similar purposes can classify foods differently<sup>(2; 4; 5)</sup> and that the adaptations they make to a model will impact the type of food marketing that children are exposed to. As previously reported, the additional nutrient threshold criteria<sup>(34)</sup> of the DoHSA model meant that certain foods generally considered healthy and also viewed by dietitians as healthy food (e.g. oranges and bananas) were prohibited for marketing to children<sup>(5)</sup> [Chapter 3 of this thesis, manuscript published].

The comparison between the views of South African dietitians and nutrient profiling models provided valuable information with regard to construct validity of the SANPM for child-directed food marketing regulations. It highlighted the similarities and differences between the included models and the views of the dietitians. The SANPM displayed a strong association ( $r = 0.711$ ;  $p < 0.001$ ) with the views of dietitians, whereas the DoHSA model, displaying a moderate rank correlation coefficient ( $r = 0.376$ ;  $p < 0.001$ ), displayed the weakest association. Recently, the SANPM was found appropriate as the first screening process for regulating the marketing of HFSS foods to children<sup>(5)</sup> [Chapter 3 of this manuscript]. In this manuscript, we have shown that the SANPM is also valid for the purpose of regulating the marketing of foods to children in South Africa. Previously, validity of the SANPM for nutrient and/or health claim regulations in South Africa was established by using a number of different methods<sup>(8; 9)</sup>. It could therefore be argued that validity of the SANPM in the South African context has been established and that the findings of this manuscript support the use of the SANPM for child-directed food marketing regulations.

### *Limitations*

Limitations to the study include a low response rate compared to other (8.4% vs. 24-26%)<sup>(8; 27)</sup>, this might have been due to only recruiting dietitians and not all nutrition professionals. Despite the low response rate the average rankings awarded to the 120 foods by dietitians are similar to that of others<sup>(8; 27)</sup>. The analysis reported in this article only included food advertisements broadcast on free-to-air South African television channels and foods commonly consumed by the targeted population as identified from published literature. Food

marketed to children by means of other forms of marketing, such as radio broadcasts, product placements, product packaging and internet advertisements, were not included and cross-continent food marketing through international television channels were also not included.

### *Conclusion*

Regulating the marketing of HFSS foods to children will provide the South African government with a cost-effective population wide strategy to combat childhood obesity by improving the environment children are exposed to. In order for such a regulation to be effectively implemented, an appropriate and valid nutrient profiling model is needed. The SANPM, already accepted and used by the South African National Department of Health (R. 429) and the food industry as the first screening process to determine a food product's eligibility for a nutrient and/or health claim, has shown to also be a valid tool to regulate the marketing of foods to children. Previously, the model went through extensive validity testing and we have now indicated that the model displayed the strongest association with the views of South African dietitians. Further research is however recommended to develop an evidence-based framework to assist with the classification of foods that dietitians and nutrient profiling models disagree on regarding their 'healthiness' and thus their marketability to children.

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## CHAPTER 5

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*This manuscript is formatted according to the guidelines of Appetite (Annexure 3).*

### **A framework to regulate the marketing of foods and non-alcoholic beverages to children in South Africa**

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## **Abstract**

The South African National Department of Health published the Strategy for the Prevention and Control of Obesity in South Africa 2015-2020, with a specific objective being to ensure responsible and ethical marketing of foods and non-alcoholic beverages to children. Internationally, numerous nutrient profiling models are used to support child-directed food marketing regulations by defining high fat, sugar and/or salt foods. The aim of this study was to support the South African obesity strategy by developing an evidence-based framework for regulating the marketing of high fat, sugar and/or salt foods and non-alcoholic beverages to children. The South African nutrient profiling model was included as the first screening process as previous research indicated that the model was appropriate and valid for this purpose. Next, the scientific evidence supporting the absolute exclusion criteria used by other non-industry developed nutrient profiling models specifically developed for regulating the marketing of foods to children, was evaluated. This was done because previous research indicated that the South African nutrient profiling model permitted certain highly processed foods for marketing to children. The inclusion of an absolute exclusion criterion for non-nutritive sweeteners was found to be scientifically sufficient. The suggested framework was developed by including the South African nutrient profiling model and a non-nutritive sweetener criterion. It is recommended that this evidence-based framework be incorporated in to a regulation to restrict the marketing of foods high in fat, sugar and/or salt to children in South Africa as part of the South African obesity strategy.

## Background information

Childhood overweight and obesity is a global public health concern as the prevalence has increased dramatically during the past three decades and seems to be increasing even more rapidly in certain low-income and middle-income countries (Lobstein *et al.*, 2015). Unfortunately, South African children form part of these concerning statistics as recent data indicate that the number of overweight children in South Africa (both sexes combined) has increased from 10.6% to 18.2% during the last decade (Labadarios *et al.*, 2007; Shisana, 2013). Children who are overweight or obese (from now on only referred to as childhood obesity) have a high risk of developing a number of non-communicable diseases (NCDs) and have significantly lower mean quality of life scores (Puhl & Latner, 2007; Keating *et al.*, 2011a; Keating *et al.*, 2011b). Childhood obesity is also a strong predictor of adult obesity (Kelsey *et al.*, 2014), which poses major health and economic consequences for the individuals, their families and society as a whole (Nader *et al.*, 2006; Litwin, 2014; Sonntag *et al.*, 2015). The 'obesogenic' (obesity-promoting) food environment that promotes the consumption of foods and non-alcoholic beverages high in fat, sugar and/or salt (hereafter referred to as HFSS foods) is recognized as a key driver in the global childhood obesity pandemic (Hawkes & Lobstein, 2011; Swinburn *et al.*, 2011; Lobstein *et al.*, 2015). There is also growing evidence that food marketing impacts children's food preferences, their consumption and their purchasing requests to parents (McGinnis *et al.*, 2006; Roberto *et al.*, 2010; Boyland & Halford, 2013; Sadeghirad *et al.*, 2016) and that food preferences acquired during childhood often persist throughout a person's lifetime (Deckelbaum & Williams, 2001; Cooke, 2007; Birch & Doub, 2014). Child-directed food marketing is widespread and research indicates that this marketing predominantly concerns HFSS food products (Roberto *et al.*, 2010; Zimmerman & Bell, 2010; Boyland & Halford, 2013; Kelly *et al.*, 2014).

Food preferences are well established as important determinants of food intake (Drewnowski & Hann, 1999). It has been recognised that some aspects of food preference are inherent such as infants' preference of sweet tastes (Ventura & Mennella, 2011), however, most aspects of food preference is flexible and learned over time (Hawkes *et al.*, 2015b). A major determinant of food preference is the familiarity of taste. The establishment of food preference involves both the reinforcement of inherent preferences (e.g. sweet taste) and/or the abolishment of less favourable food dislikes, such as for vegetables (Hawkes *et al.*, 2015b). Children who are repeatedly exposed to the taste of a food result in increased acceptance and intake over time (Harris, 2008; Remington *et al.*, 2012). In low-income and middle-income countries, food companies often purposefully make their products readily available and

affordable in order to create new food preferences for their products and new eating habits involving their food products (Hawkes, 2002).

The global increase in childhood obesity and the recognition that food marketing practices may influence the food preferences of children have resulted in consumer groups, parents, teachers, healthcare professionals and public health advocacy organizations calling for greater control on the marketing of HFSS foods to children (Galbraith-Emami & Lobstein, 2013). In 2010, the World Health Organization (WHO) published a set of recommendations for the marketing of food and non-alcoholic beverages to children. It was endorsed by the 63<sup>rd</sup> World Health Assembly (WHA 63.14) (WHO, 2010b). In 2016, the WHO Commission on Ending Childhood Obesity (ECHO) report was released, a core recommendation being to reduce children's exposure to *all* forms of marketing of HFSS foods, in view of "unequivocal evidence that the marketing of unhealthy foods and sugar-sweetened beverages is related to childhood obesity" (WHO, 2016).

There is general agreement that a government-led policy or regulation is required to restrict the marketing of HFSS foods to children (Gortmaker *et al.*, 2011; Hawkes *et al.*, 2015a; Kraak *et al.*, 2016). In order for such a policy to be implemented effectively, a clear definition of the foods that should be restricted is required, unless the marketing of all foods is to be prohibited (Kelly *et al.*, 2013). Nutrient profiling is defined as "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health" (Rayner *et al.*, 2004; WHO, 2011), and is suggested by the WHO to support child-directed food marketing regulations (WHO, 2016). Numerous nutrient profiling models with different aims have been developed, although the models classify foods differently (Brinsden & Lobstein, 2013; Rayner *et al.*, 2013; Scarborough *et al.*, 2013; Wicks, 2016) and few have been thoroughly tested and validated (WHO, 2011; Rayner *et al.*, 2013). In South Africa, the South African nutrient profiling model (SANPM) is accepted and used as the first screening process to determine a food product's eligibility for nutrient and/or health claims (DOH, 2014). This model enjoys support from all stakeholders (government, food industry and nutrition experts) involved as it was thoroughly tested and validated before implementation into the regulation (Wentzel-Viljoen *et al.*, 2012; Wicks, 2012; Lee, 2013).

In April 2015, the South African National Department of Health (SADoH) published the Strategy for the Prevention and Control of Obesity in South Africa 2015-2020 (SADoH, 2015), a multi-sectoral approach to halt the scourge of obesity in the country, with a specific objective being to ensure responsible and ethical advertising and marketing of food by the food industry. The SADoH, Directorate: Food Control, published a draft regulation (R. 429) in 2014 that aims to restrict the marketing of *all* HFSS foods to children (DOH, 2014). The draft regulation

recommends using the South African Department of Health's (DoHSA) nutrient profiling model to determine if a food product is permissible for marketing to children. The DoHSA model is an adapted model based on the SANPM that aims to regulate the marketing of HFSS foods to children in South Africa. Numerous stakeholders have questioned the need for a regulation that aims to restrict the marketing of HFSS foods to children. Some also commented that the draft regulation was not sufficiently evidence-based and too strict. Many stakeholders questioned the use of the SANPM in the context of restricting the marketing of HFSS foods to children, as the model has not been tested or validated for this purpose. Consequently, the need for an evidence-based framework for regulating the marketing of HFSS foods to children with the support of an appropriate and valid nutrient profiling model was identified. This manuscript aims to develop an evidence-based framework for regulating the marketing of foods to children that will support the South African obesity strategy by assisting in the management and prevention of childhood obesity.

## **Methods**

### *Establishing the suitability of the South African nutrient profiling model for regulating the marketing of foods to children*

The SANPM is an across-the-board scoring model. The model classifies foods by awarding points to the food; the points are awarded according to the nutrients to limit (saturated fat, total sugar, total energy (kJ) and sodium) and the nutrients or components to motivate (protein, fibre, fruits, vegetables, legumes and nuts). The SANPM is based on a model developed by the United Kingdom Foods Standards Agency and adapted by the Food Standards Australia New Zealand for the regulation of health claims (FSANZ, 2013).

First, the suitability of the SANPM for child-directed food marketing regulations should be established. Comparing a nutrient profiling model with another model that has been designed for a similar purpose and has been validated, is one method of testing for validity of a nutrient profiling model (WHO, 2010a). Therefore, the SANPM was firstly compared to four existing non-industry nutrient profiling models that had been developed for regulating the marketing of HFSS foods to children. The nutrient profiling models were compared to determine if the models agree on (a) the percentage of foods permitted (overall strictness) and (b) the types of foods permitted for child-directed food marketing. The SANPM was found appropriate as a first screening step for regulating the marketing of HFSS foods to children (Wicks *et al.*, 2016c) [Chapter 3 of this thesis, manuscript published]. However, the fact that some models were based on one another is a limitation for this type of validity testing (Cooper *et al.*, 2016; Wicks *et al.*, 2016c). Concerns were also raised about its classification of highly-processed foods with limited nutrient density.

### *Establishing convergent validity of the South African nutrient profiling model for regulating the marketing of foods to children*

Secondly, the SANPM underwent further testing to establish its convergent validity for regulation of child-directed food marketing (Townsend, 2010; WHO, 2011; Cooper *et al.*, 2016). This was established by comparing the classification of 120 foods by the SANPM and the four non-industry developed nutrient profiling models to the views of South African dietitians (Wicks *et al.*, 2016b) [Chapter 4 of this thesis, manuscript in preparation]. This method of validity testing has been proposed by the WHO (WHO, 2011) and Rayner *et al.* (2004) due to the absence of a 'gold standard' for validating nutrient profiling models ability to classify foods according to their 'healthiness' (Arambepola *et al.*, 2008). Townsend (2010) and Scarborough *et al.* (2007) also report the comparison of nutrient profiling models to the views of nutrition professionals to be a transparent, systematic, simple and inexpensive method of evaluating the validity of models. The SANPM was found to be valid for the purpose of regulating the marketing of HFSS foods to children in South Africa (Wicks *et al.*, 2016a) [Chapter 4 of this thesis, manuscript in preparation] although concerns were raised about its classification of highly processed foods with limited nutrient density.

### *The development of a suggested framework for regulating the marketing of foods to children*

The recent proliferation of nutrient profiling models meant that it was unnecessary to develop a new model for the purpose of this research as this would have been time consuming and costly (Rayner *et al.*, 2013). It is recommended and supported by the evidence that the SANPM can be used as a first screening process in the evidence-based framework for regulating the marketing of HFSS foods to children (Wicks, 2016; Wicks *et al.*, 2016b) [Chapters 3 & 4 of this thesis]. The SANPM was included as the first screening process as the model displayed an almost perfect pairwise agreement ( $\kappa = 0.948$ ) with a model extensively tested and validate for regulating the marketing of foods to children, the United Kingdom Foods Standards Agency model. The SANPM also displayed the strongest correlation with the standard ranking of 'healthiness' of foods according to the views of South African dietitians ( $r = 0.71$ ;  $p = 0.001$ ). Additional classification criteria are, however, needed as part of the framework to ensure that highly-processed foods containing additives (which could possibly be harmful for child growth and development) are excluded for marketing to children. Highly-processed foods are also nutritionally inferior to unprocessed or minimally processed foods (da Costa Louzada *et al.*, 2015; Moubarac *et al.*, 2017).

The absolute exclusion criteria used by existing non-industry nutrient profiling models to restrict the marketing of HFSS foods to children was identified for possible inclusion into the

suggested framework (Table 1). These models are described in detail elsewhere (Wicks, 2016) [Chapter 3 of this thesis, manuscript published].

**Table 1** The absolute exclusion criteria of various nutrient profiling models

| Nutrient profiling model | Absolute exclusion criteria  |
|--------------------------|--|
| Ofcom                    | The model applies equally to all food and non-alcoholic beverages, there are no exemptions |
| REU                      | >1g/100g total fat from industrially produced <i>trans</i> fatty acids                     |
|                          | ≥ 0.5% of total energy from alcohol  |
| EMRO                     | >1g/100g total fat from industrially produced <i>trans</i> fatty acids                     |
|                          | ≥ 0.5% of total energy from alcohol  |
| DoHSA                    | Added fructose   |
|                          | Added non-nutritive sweeteners   |
|                          | Added fluoride   |
|                          | Added aluminium  |

Ofcom: United Kingdom Office of Communication nutrient profiling model; REU: World Health Organization's Regional Office for Europe nutrient profiling model; EMRO: World Health Organization's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA: South African Department of Health nutrient profiling model for restricting food marketing to children

It was then decided to evaluate the absolute exclusion criteria used by these models (Table 1) against evidence in the literature. It was not considered necessary to review literature about the alcohol criteria as the framework to be developed included only non-alcoholic beverages.

## *Evaluating the evidence supporting absolute exclusion criteria*

### Industrially produced *trans* fatty acids

*Industrially produced trans fatty acids* refers to the major *trans* fatty acids in the diet, which are typically isomers of 18:1 *trans* derived from partial hydrogenation of vegetable oils, a technique that produces semi-solid fats for use in commercial baking and frying, margarines and foods manufacturing (SADoH, 2011; WHO, 2015b). The SADoH has regulations in place to limit the maximum *trans* fat content of any manufactured or imported oils and fats, either alone or as part of processed foods, to less than 2 grams per 100 grams. This is valid for retail settings, catering businesses, restaurants, bakeries and so on (SADoH, 2011).

### Non-nutritive sweeteners

A *non-nutritive sweetener* is a food additive (other than a monosaccharide or disaccharide sugar), of which one serving of 5 g provides  $\leq 8$  kJ (1.9 kcal) and a sweet taste equivalent to 5 g of sucrose (DOH, 2014; WHO, 2015b). It includes artificial non-nutritive sweeteners (e.g. aspartame, sucralose, saccharin and acesulfame potassium) and natural non-nutritive sweeteners (e.g. stevia).

There is growing concern that added sugars, especially in the form of sugar sweetened beverages, increase overall energy intake and may reduce the intake of essential nutrients, leading to an 'unhealthy' diet, obesity and a number of diet-related NCDs (Malik *et al.*, 2010; Malik *et al.*, 2013). Current data indicate that children consume high levels of sweetened beverages, including sweetened milks, fruit-flavoured drinks, soft drinks and energy drinks (Swithers, 2015). Replacing added sugars with non-nutritive sweeteners (NNS) is one of the possible strategies that have been advocated to manage and prevent childhood obesity, as NNS satisfy the desire for sweet taste without the harmful effects strongly associated with added sugar intake (Blackburn *et al.*, 1997; Drewnowski & Bellisle, 2007). As a result, added sugars are now often replaced with NNS in various foods frequently consumed by children, including beverages, yogurts, ice-creams and custards (ADA, 2004). However, despite the growing and widespread use of NNS by children (Ng *et al.*, 2012; Sylvetsky *et al.*, 2012), consistent and clear scientific evidence supporting their effectiveness in promoting weight loss or preventing diet related NCDs are inconclusive (Fowler *et al.*, 2008; Laska *et al.*, 2012; Swithers, 2015). In fact there is evidence that suggest regular consumption of NNS beverages increases the risk of obesity and NCDs (Fowler *et al.*, 2008; Duffey *et al.*, 2012; Laska *et al.*, 2012; Tate *et al.*, 2012; Swithers, 2013; Swithers, 2015). These rather counterintuitive outcomes may be because NNS exposure interferes with learning the basic relationships

between sweet tastes and energy delivery or that NNS exposure persistently alters sweet preferences, leading to enhanced intake of added sugars from various foods throughout adulthood. It is therefore important to recognize that even if NNS beverage consumption can produce weight loss compared to sugar-sweetened beverages, this does not necessarily indicate that NNS are 'healthy', only that they may be less problematic than sugar-sweetened beverages.

The development of dental caries is another concern which is linked to the intake of added sugars, specifically sugar-sweetened beverages (Moynihan & Petersen, 2004; Sheiham & James, 2014). Dental caries is the most common chronic childhood disease (Marcenes *et al.*, 2013) and have been associated with childhood obesity (Marshall *et al.*, 2007). Pain from untreated caries can affect school attendance, eating and speaking, and subsequently children's growth and development. A research study conducted by Sohn and colleagues (2006) brought to light that children with a high carbonated soft drink consumption pattern, including sugar-sweetened and NNS beverages, showed significantly higher caries experiences, even when compared with children with a high 100% fruit juice consumption. Others also reported that regular consumption of sugar-sweetened beverages are predictive of dental caries, however, 100% fruit juices intake were associated with a lesser extent of dental caries or none at all (Heller *et al.*, 2001; Marshall *et al.*, 2003; Marshall *et al.*, 2007). Replacing sugar-sweetened beverages with NNS beverages has been suggested as a possible strategy to prevent dental caries, but children who consume high volumes of carbonated soft drinks may also have other undesirable eating patterns and may eat a high number of added sugars from other sources (Park *et al.*, 2012). High carbonated soft drink consumption is concerning in itself as it may replace the consumption of beverages such as milk and water, which provide essential nutrients for optimal health and development.

We know that from a very young age children have a preference for sweet tastes (Desor & Beauchamp, 1987; Mennella, 2008; Mennella & Bobowski, 2015). Therefore the regular use of added sugars and NNS may enhance children's preferences for sweet foods counteracting the development of food preference for other flavours that are not sweet, such as vegetables, which can interfere with the development of lifelong food preference for more healthy food choices (Mennella, 2014).

### Fructose

Fructose is a monosaccharide that naturally occurs in fruit, honey and some vegetables. The frequent consumption of fructose from industrial and commercial products such as carbonated soft drinks, other sugar-sweetened beverages, and high fructose corn syrup is currently

increasing at a concerning rate (Havel, 2005; Kelishadi *et al.*, 2014). The frequent consumption of fructose from industrialized foods have been associated with increased risk of metabolic syndrome, cardiovascular diseases and weight gain (Stanhope *et al.*, 2009; Teff *et al.*, 2009; Kelishadi *et al.*, 2014; van Buul *et al.*, 2014). It is also recommend in the recently published WHO guideline on sugar intake for adults and children (WHO, 2015a) that the intake of free sugars, which includes fructose, should be limited to address unhealthy weight gain and dental caries.

### Aluminium

Aluminium is abundant in the environment. However, in normal biological systems, aluminium has no recognized role and is not essential for any known living system (Williams, 1996). Food is the major source of aluminium exposure (Yokel & Florence, 2006). Aluminium additives are widely used in many food products such as flour, baking powder, firming agents, anticaking agents and several food colouring agents. Subsequently, these aluminium additives are used in the preparation of many processed foods regularly consumed by children and adults. Adverse effects such as encephalopathy, cognitive deficits in young children, metabolic bone disease and microcytic anaemia have been reported due to chronic exposure to aluminium (Bondy, 2014; Willhite *et al.*, 2014). The European Food Safety Authority (EFSA) has established a tolerable weekly intake for aluminium, which is 1 mg aluminium per kg body weight per week (Aguilar *et al.*, 2008). However, a Joint Food and Agricultural Organization and WHO Expert Committee on Food Additives report states that the dietary exposure estimates of children to aluminium-containing additives could exceed the tolerable weekly intake by as much as twofold (FAO/WHO, 2011). Children are at higher risk of exposure to aluminium from sweets and snack foods compared with adults (Yeh *et al.*, 2016). It is not necessary for food companies to report the added aluminium levels in processed foods. Thus, uncertainty exists about the exact amount of added aluminium in processed food products on the South African market

### Fluoride

Fluoride occurs naturally in abundant amounts in the environment and as such is an inevitable part of a person's life. Fluoride is considered an essential trace element as small amounts have been proven to be beneficial in preventing dental caries, but excessive intake may in the long run lead to the development of dental fluorosis in children (Browne *et al.*, 2005; Koblar *et al.*, 2012). Systemic exposure to elevated concentrations of fluoride has also be shown to be neurotoxic during the highly vulnerable windows of brain development in infants and young children and may result in permanent brain injury (Choi *et al.*, 2012; Choi *et al.*, 2015). Apart

from fluoridated water, fluoride in beverages such as juices, carbonated soft drinks and tea infusions may be important sources of fluoride in children's diets (Jiménez-Farfán *et al.*, 2004; Jedra *et al.*, 2005). Research has shown that the fluoride content of such beverages vary considerably (Opydo-Szymaczek & Opydo, 2010). In South Africa, the final Regulations Related to Foodstuffs for Infants and Young Children (R991/2012) prohibits added fluoride in all infant formulae and foodstuffs as a result of the possible harmful effects of excessive intake (SADoH, 2012). There is a need for continued monitoring of the fluoride content of foods intended for and marketed to children. It is, however, not compulsory for food manufacturers to report the fluoride content of a food product on the nutrition information label.

#### *Deciding which exclusion criteria to include*

All of the exclusion criteria reviewed had warranted scientific reasons for inclusion in the framework. However, as mentioned in the introductory section of this manuscript, the aim of the framework is to support the South African obesity strategy by assisting in the management and prevention of childhood obesity. There is scientific evidence supporting the regulation of added aluminium in foods marketed to children, but we do not recommend it as an absolute exclusion criterion. We rather recommend that, in order to protect children from high added aluminium exposure and as a health precautionary measure, the levels of added aluminium in food products be declared and that maximum levels for added aluminium in food products be established in South Africa to protect not only children, but the public as a whole, from the possible harmful effects.

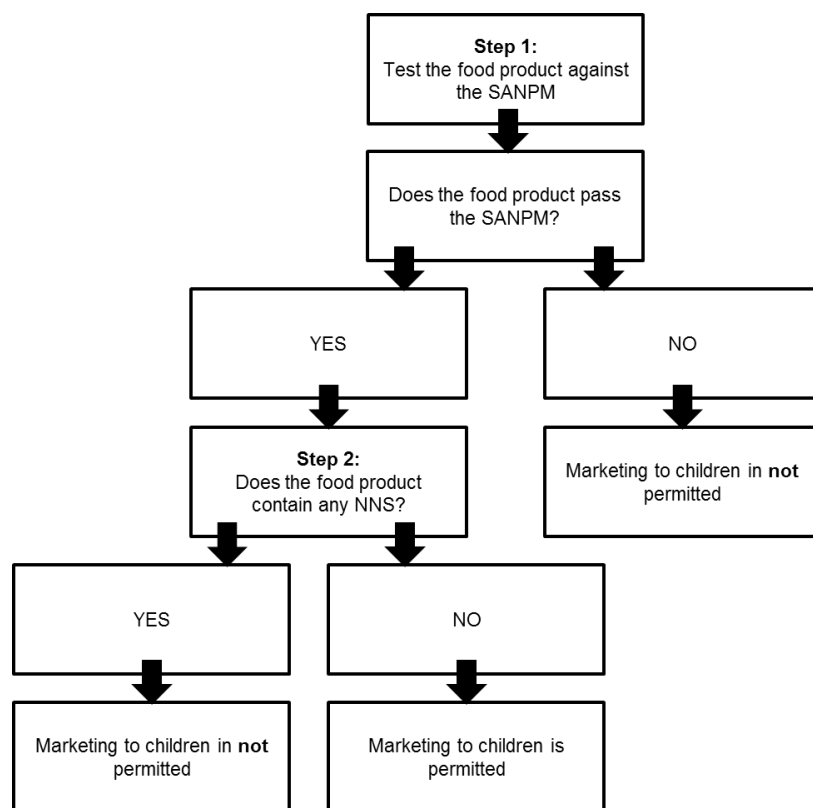
The scientific evidence supporting the regulation of added fluoride in foods marketed to children is also warranted; however, again we do not recommend it as an absolute exclusion criterion in the suggested framework. We recommend that added fluoride be included on nutrition information labels and in that in the future the SADoH establishes maximum levels in food.

In South Africa, it is compulsory to display the total sugar content of a food product on its nutrition information panel. *Total sugar* refers to the sum of all intrinsic (lactose, fructose and galactose) and added sugars (monosaccharides and disaccharides) (SADoH, 2014). Therefore the fructose content of a food product is included. The SANPM classifies a food based on its total sugar content thus also addressing its fructose content. Consequently, a highly processed food containing added fructose corn syrup will be prohibited from marketing to children by the SANPM and an additional exclusion criterion for fructose is not warranted. We do not recommend that added fructose be added as an absolute exclusion criterion to the suggested framework.

An absolute exclusion criterion for NNS in the suggested framework is necessary within the context of regulating the marketing of HFSS foods to children. No substantial evidence exists to support the use of NNS in the management and prevention of childhood obesity. The consumption of NNS beverages have also been associated with the development of dental caries in children (Sohn *et al.*, 2006). Sensory experiences shape and modify flavour and taste preferences from early on (Mennella *et al.*, 2004; Mennella & Castor, 2012; Mennella, 2014) and children’s natural preference for sweet foods does not change easily. However, our growing knowledge about how food marketing affects children’s food preferences can help us direct children towards more healthy food preferences. Therefore, the possibility that NNS can support a preference for sweet foods and that children do not have the ability to distinguish between added sugars and NNS, justifies this exclusion criterion.

### A suggested framework for regulating the marketing of foods to children in South Africa

Figure 1 illustrates the suggested evidence-based framework for regulating the marketing of foods to children in South Africa. The SANPM is used as the first screening process and there after an absolute exclusion criterion for non-nutritive sweeteners



SANPM: South African nutrient profiling model; NNS: non-nutritive sweeteners

**Figure 1.** The suggested framework for regulating the marketing of foods to children in South Africa

## Conclusion

In order to support the South African obesity strategy for reducing childhood obesity rates, an evidence-based plan of action is required to effectively address the power of HFSS food marketing on children's food preferences. The researchers therefore set out to develop a suggested framework to regulate the marketing of HFSS foods to children in South Africa. The SANPM was identified as an appropriate and valid tool for regulating the marketing of foods to children in South Africa and as such was included in the framework as initial screening point (Wicks *et al.*, 2016c; Wicks *et al.*, 2016b) [Chapters 3 & 4 of this thesis]. We showed that around 50% of products currently marketed and eaten by children in South Africa will be suitable for marketing to children using the SANPM alone. Based on the current scientific evidence NNS was added as an absolute exclusion to the framework in a bid to reduce the intake of sugar sweetened beverages and sweetened foods and to reduce children's preference for sweet food products thereby indirectly improving the overall 'healthiness' of the diet. It is recommended that this evidence-based framework be incorporated into the regulation to restrict the marketing of HFSS foods to children in South Africa as part of the South African Strategy for the Prevention and Control of Obesity. However, the South African government should also set a defined timeline for outcomes, support the monitoring of child-directed food marketing and enable regulatory bodies to hold non-compliant companies accountable for children's exposure via all marketing practices and media platforms, to all HFSS foods (Kraak *et al.*, 2016). Further research for the establishment of maximum levels of added aluminium and fluoride in foods for South Africa is also recommended and a separate regulation, similar to the *trans* fatty acid regulations, should be legislated as soon as suitable cut-points have been established.

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## CHAPTER 6:

# GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

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### 6.1 General discussion

This research resulted from questions about the scientific accuracy of the draft regulations (R. 429) relating to the marketing of HFSS foods to children (SADoH, 2014). The use of the SANPM in the context of child-directed food marketing restrictions has also been questioned since it was originally tested and validated for the regulation of nutrient and/or health claims. Regulating the marketing of HFSS foods to children will provide the South African government with a sustainable, population-wide and cost-effective measure to combat childhood obesity (Magnus *et al.*, 2009; Gortmaker *et al.*, 2011; Swinburn *et al.*, 2015) that is increasing globally (Lobstein *et al.*, 2015) and in South Africa (Shisana, 2013). The implementation of a regulation that restricts the marketing of HFSS foods to children will support the South African obesity strategy and will assist the country in reducing premature mortality from NCDs and in achieving the Sustainable Development Goal to achieve healthy lives for all.

However, in order for such a regulation to be successfully implemented, a clear definition of the foods that should be restricted is required, if not the marketing of *all* foods should be prohibited (Kelly *et al.*, 2013). A government-defined, standardized nutrient profiling model that supports the regulation HFSS food marketing to children in South Africa will protect children from the harmful impacts of marketing of HFSS foods. The implementation of an effective regulation relating to the marketing of foods to children in South Africa is dependent on information on the following aspects: 1) the appropriateness of the SANPM for regulating the marketing of foods to children, 2) the convergent validity of the SANPM for regulating the marketing of foods to children, 3) scientific information supporting the absolute exclusion criteria used by other nutrient profiling models.

By establishing whether the SANPM could be used for the purpose of regulation the marketing of HFSS foods to children in South African, this study provided valuable information regarding the development of a suggested framework.

*In Chapter 3 the appropriateness of the SANPM for regulating the marketing of foods to children is addressed (manuscript published in the British Journal of Nutrition doi: 10.1017/S0007114516004244)*

The SANPM was found to be appropriate as the first screening process for regulating the marketing of HFSS foods to children. The SANPM displayed the best agreement with the Ofcom model, a model that has been tested extensively and that has been validated for regulating the marketing of foods to children in the UK. By permitting foods such as canola oil, cheese and low fat yogurt for marketing to children, the SANPM demonstrated that it classifies foods in line with the SAFBDGs. The WHO recommends that the nutrient profiling model being used to regulate the marketing of foods to children should align with the Food Based Dietary Guidelines of the country in which it is intended for use (WHO, 2011). However, due to the structure of the SANPM, certain highly processed foods, such as NNS energy drinks, were also permitted for marketing to children. Therefore, additions to the classification criteria of the SANPM are needed to assist the model in excluding such highly processed foods from marketing to children.

*Chapter 4 (manuscript in preparation) discusses the establishment of convergent validity of the SANPM for regulating the marketing of foods to children*

Previously, the SANPM underwent extensive validity testing for nutrient and/or health claim regulations. Since it displayed the strongest association with the views of South African dietitians in this research, the SANPM is a valid tool for regulating the marketing of foods to children in South Africa. However, there were some discrepancies between the SANPM and the dietitians, mainly because the SANPM is concerned about the 'healthiness' of the individual food and not the 'healthiness' of the diet of which the food may form part of. Also, the SANPM classifies food per 100g/ml serving where the dietitians may have classified the food according to the actual portion size in which the food is usually consumed. The classification of some of the foods by the dietitians was surprising. It seemed as if the dietitians were using descriptive prompts to guide their judgements of the 'healthiness' of foods over and above the nutrition information provided to them. The SANPM and dietitians did not agree on the classification of certain highly processed foods containing NNS. Additions to the SANPM are recommended to assist in the classification of specifically foods containing NNS.

*The evaluation of absolute exclusion criteria of other nutrient profiling models is discussed in Chapter 5 (manuscript in preparation)*

The evaluation of the absolute exclusion criteria used by the other nutrient profiling models provided interesting results. Added aluminium and fluoride exclusion criteria was not added to the framework as they do not contribute to the development of childhood obesity. However, there is scientific evidence to motivate the inclusion of added aluminium and fluoride on the nutrition information panels' of foods and to support the establishment of maximum levels of these additives in food intended for child and adult consumption in South Africa.

The only absolute exclusion criterion found necessary for inclusion in the framework for regulating the marketing of foods to children was the NNS criterion. There are evidence that NNS consumption may promote a preference for sweet foods and may contribute to the development of dental caries (Mennella *et al.*, 2004; Sohn *et al.*, 2006; Mennella & Castor, 2012; Mennella & Bobowski, 2015). There is also a concern that children do not have the ability to distinguish between the sweet taste provided from NNS and the sweet taste provided from added sugar leading to the intake of food products high in sugar and low in nutrients.

*A suggested framework for regulating the marketing of HFSS foods to children in South Africa is given in Chapter 5 (manuscript in preparation)*

The SANPM was included as the first screening process in the suggested framework. The SANPM is already accepted and used by the South African government and the food industry for regulating a nutrient and/or health claim (SADoH, 2014) and was also found to be appropriate and valid for regulating the marketing of HFSS foods to children in South Africa (Wicks, 2016; Wicks *et al.*, 2016). The NNS absolute exclusion criterion was added as the second screening step because of the possible link between NNS intake and a preference for sweet foods.

## **6.2 Strengths and limitations of the study**

### *Strengths*

The SANPM was compared to several other non-industry nutrient profiling models that were designed by national government departments, academic research groups and authoritative organizations to restrict the marketing of HFSS foods to children. This comparison provided valuable information regarding how the SANPM compares to international models and highlighted the difference between these international models.

The food list used to compare the nutrient profiling models included foods advertised on South African free-to-air television channels in 2014 (Delpont, 2015) and foods reported by recently published literature as commonly consumed by South African children (Wicks, 2016). This inclusion meant that the nutrition profiling models could be used to classify a wide variety of foods from various food groups. This provided valuable information regarding the included nutrient profiling models' classification of not only the foods that would be prohibited for marketing but also the foods that would be permitted for marketing to children.

The comparison of the classification of foods to the views of South African dietitians' provided valuable information with regard to how the different nutrient profiling models compare to an external criterion for measuring the 'healthiness' of foods.

### *Limitations*

The analysis reported in this study only included food advertisements broadcasted on free-to-air South African television channels and foods commonly consumed by the targeted population as identified from published literature. Food marketed to children by means of other forms of marketing, such as radio broadcasts, product placements, product packaging and internet advertisements, were not included, nor was cross-continent food marketing through international television channels included.

The dietitians' response rate to the survey was low compared to other (8.4% vs. 24-26%) (Scarborough *et al.*, 2007; Wicks, 2012). Despite the low response rate the average rankings awarded to the 120 foods by dietitians were similar to that of others (Scarborough *et al.*, 2007; Wicks, 2012). This method of validity testing is, however, subject to considerable bias (Cooper *et al.*, 2016) and therefore further validation studies are recommended.

### **6.3 Way forward and recommendations**

Our study found that the numerous nutrient profiling models designed for a similar purpose classify foods differently. These differences mean that certain foods recommended by the SAFBDGs, such as certain cheeses and yogurt with little added sugar, are prohibited for marketing to children by some of the nutrient profiling models. In the case of the DoHSA model, we found that the adaptations made to the model negatively affected the manner in which the model classifies foods. We therefore recommend that other countries who intend to develop a standardized nutrient profiling model for restricting marketing to children thoroughly test and validate the chosen model before it is implemented into regulation.

By developing a suggested framework to regulate the marketing of HFSS foods to children, we provided a standardized definition of HFSS foods. However, to regulate the marketing of HFSS foods to children effectively, additional definitions are required, such as asking what marketing entails, what is meant by children, what channels of marketing are included, and so forth. We therefore recommended that these much needed terms be defined by the South African government. Additionally the South African government should support the monitoring of food marketing practices and enable regulatory bodies to hold non-compliant companies accountable for children's exposure via all marketing practices and media platforms to HFSS food marketing.

When the absolute exclusion criteria of the four additional nutrient profiling models were evaluated, scientifically sound evidence was found for the establishment of maximum levels for both fluoride and aluminium. We therefore recommend that the SAdoH establish such levels to protect children and adults from the possible harmful side effects of these additives. It should also be made compulsory to indicate on the label if fluoride and/or aluminium is added to the product.

#### **6.4 Conclusion**

This research provides valuable information regarding the use of a nutrient profiling model for child-directed food marketing regulations. The appropriateness and construct validity of the SANPM for regulating the marketing of foods to children in South Africa was established. Finally, a suggested framework for regulating the marketing of foods to children in South Africa was developed by including a NNS absolute exclusion criterion. We recommend that this framework be legislated to regulate the marketing of foods to children in South African as part of the Strategy for the Prevention and Control of Obesity in South Africa 2015-2020 (SAdoH, 2015).

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# ADDENDUM 1: CONTENT AND STYLE GUIDELINE FOR BRITISH JOURNAL OF NUTRITION

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Instructions for contributors

*British Journal of Nutrition* (BJN) is an international peer-reviewed journal that publishes original papers and review articles in all branches of nutritional science. The underlying aim of all work should be to develop nutritional concepts.

## SUBMISSION

This journal uses [ScholarOne Manuscripts](#) for online submission and peer review.

Complete guidelines for preparing and submitting your manuscript to this journal are provided below.

## SCOPE

BJN encompasses the full spectrum of nutritional science and reports of studies in the following areas will be considered for publication: Epidemiology, dietary surveys, nutritional requirements and behaviour, metabolic studies, body composition, energetics, appetite, obesity, ageing, endocrinology, immunology, neuroscience, microbiology, genetics, and molecular and cell biology. The focus of all manuscripts submitted to the journal must be to increase knowledge in nutritional science.

**The journal does NOT publish papers on the following topics:** Case studies; papers on food technology, food science or food chemistry; studies of primarily local interest; studies on herbs, spices or other flavouring agents, pharmaceutical agents or that compare the effects of nutrients to those of medicines, complementary medicines or other substances that are considered to be primarily medicinal agents; studies in which a nutrient or extract is not administered by the oral route (unless the specific aim of the study is to investigate parenteral nutrition); studies using non-physiological amounts of nutrients (unless the specific aim of the study is to investigate toxic effects); food contaminants.

### In vivo and in vitro models

Studies involving animal models of human nutrition and health or disease **will only be considered for publication** if the amount of a nutrient or combination of nutrients used could reasonably be expected to be achieved in the human population.

Studies involving in vitro models **will only be considered for publication** if the amount of a nutrient or combination of nutrients is demonstrated to be within the range that could reasonably be expected to be encountered in vivo, and that the molecular form of the nutrient or nutrients is the same as that which the cell type used in the model would encounter in vivo.

### Extracts

Studies involving extracts **will only be considered for publication** if the source of starting material is readily accessible to other researchers and that there are appropriate measures for quality control, that the method of extraction is described in sufficient detail with

appropriate quality control measures, that the nutrient composition of the extract is characterised in detail and that there are measures to control the quality of the composition of the extract between preparations, and that the amount of extract used could reasonably be expected to be achieved in in the human population (or in animals if they are the specific target of an intervention).

Studies involving extracts in in vitro models **will only be considered for publication** if the above guidelines for studies involving extracts are followed, and that the amount and molecular form of the extract is the same as that which would be encountered by the cell type used in the model in vivo.

## **Probiotics**

Studies involving probiotics may be considered provided that the primary focus of the study/review is the effects on nutrient absorption and/or metabolism. Studies/reviews that focus primarily on probiotics per se will not be considered.

**Manuscripts submitted to BJN that are outside of the journal's scope or do not meet the above requirements will be rejected immediately.**

## **REVIEW PROCESS**

BJN uses a single blind review process.

As part of the online submission process, authors are asked to affirm that the submission represents original work that has not been published previously, and that it is not currently being considered by another journal. Authors must also confirm that each author has seen and approved the contents of the submitted manuscript. Finally, authors should confirm that permission for all appropriate uses has been obtained from the copyright holder for any figures or other material not in his/her copyright, and that the appropriate acknowledgement has been made to the original source.

At submission, authors are asked to nominate at least four potential referees who may then be asked by the Editorial Board to help review the work. Manuscripts are normally reviewed by two external peer reviewers and a member of the Editorial Board.

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#### *Journal articles*

1. Rebello SA, Koh H, Chen C *et al.* (2014) Amount, type, and sources of carbohydrates in relation to ischemic heart disease mortality in a Chinese population: a prospective cohort study. *Am J Clin Nutr* **100**, 53-64.
2. Villar J, Ismail LC, Victora CG *et al.* (2014) International standards for newborn weight, length, and head circumference by gestational age and sex: the Newborn Cross-Sectional Study of the INTERGROWTH-21st Project. *Lancet* **384**, 857-868.
3. Alonso VR & Guarner F (2013) Linking the gut microbiota to human health. *Br J Nutr* **109**, Suppl. 2, S21–S26.
4. Bauserman M, Lokangaka A, Gado J *et al.* A cluster-randomized trial determining the efficacy of caterpillar cereal as a locally available and sustainable complementary food to prevent stunting and anaemia. *Public Health Nutr*. Published online: 29 January 2015. doi: 10.1017/S1368980014003334.

### Books and monographs

1. Bradbury J (2002) Dietary intervention in edentulous patients. PhD Thesis, University of Newcastle.
2. Ailhaud G & Hauner H (2004) Development of white adipose tissue. In *Handbook of Obesity. Etiology and Pathophysiology*, 2nd ed., pp. 481–514 [GA Bray and C Bouchard, editors]. New York: Marcel Dekker.
3. Bruinsma J (editor) (2003) *World Agriculture towards 2015/2030: An FAO Perspective*. London: Earthscan Publications.
4. World Health Organization (2003) *Diet, Nutrition and the Prevention of Chronic Diseases*. Joint WHO/FAO Expert Consultation. WHO Technical Report Series no. 916. Geneva: WHO.
5. Keiding L (1997) *Astma, Allergi og Anden Overfølsomhed i Danmark – Og Udviklingen 1987–1991 (Asthma, Allergy and Other Hypersensitivities in Denmark, 1987–1991)*. Copenhagen, Denmark: Dansk Institut for Klinisk Epidemiologi.

### Sources from the internet

1. Nationmaster (2005) HIV AIDS – Adult prevalence rate. [http://www.nationmaster.com/graph-T/hea\\_hiv\\_aid\\_ad...](http://www.nationmaster.com/graph-T/hea_hiv_aid_ad...) (accessed June 2013).

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## **APPENDIX: MATHEMATICAL MODELLING, STATISTICS AND NOMENCLATURE**



## Restricting the marketing of foods and non-alcoholic beverages to children in South Africa: are all nutrient profiling models the same?

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### Abstract

The WHO has called for governments to improve children's food environment by implementing restrictions on the marketing of 'unhealthy' foods to children. Nutrient profiling (NP) models are used to define 'unhealthy' foods and support child-directed food marketing regulations. The aim of the present study was to assess the suitability of the South African NP model (SANPM), developed and validated for health claim regulations, for child-directed food marketing regulations. The SANPM was compared with four NP models specifically developed for such regulations. A representative list of 197 foods was compiled by including all foods advertised on South African free-to-air television channels in 2014 and foods commonly consumed by South African children. The nutritional information of the foods was sourced from food packaging, company websites and a food composition table. Each individual food was classified by each of the five NP models. The percentage of foods that would be allowed according to the different NP models ranged from 6 to 45%; the models also varied considerably with regard to the type of foods allowed for marketing to children. The majority of the pairwise comparisons between the NP models yielded  $\kappa$  statistics >0.4, indicating a moderate agreement between the models. An almost perfect pairwise agreement ( $\kappa = 0.948$ ) existed between the SANPM and the UK Food Standards Agency model (United Kingdom Office of Communication nutrient profiling model), a model extensively tested and validated for such regulations. The SANPM is considered appropriate for child-directed food marketing regulations in South Africa.

**Key words:** Nutrient profiling; Marketing of foods; Marketing regulation; Nutrition; Childhood obesity

The prevalence of childhood obesity has increased dramatically during recent years and is no longer only prevalent in high-income countries<sup>(1–4)</sup>. Recent data report that over the last decade the prevalence of overweight children in South Africa (both sexes combined) has increased from 10.6 to 18.2%<sup>(5,6)</sup>. Childhood obesity has a large impact on the quality of life of children and poses major health and economic consequences for themselves, their families and the society as a whole<sup>(7)</sup>. The obesogenic environments that promote the consumption of foods high in fat, sugar and/or salt (HFSS) are thought to be a key driver in the global childhood obesity epidemic<sup>(8,9)</sup>. Unfortunately, because of rapid urbanisation and acculturation in numerous low-income and middle-income countries, many children are now raised in these obesogenic environments<sup>(9,10,11)</sup>.

There is growing evidence that food marketing impacts food preferences of children, their consumption and purchasing requests to parents<sup>(12–15)</sup>. Child-directed food marketing is

extensive, perhaps most prominent on television<sup>(16)</sup>, and research indicates that it primarily concern HFSS food products<sup>(14,15,17,18)</sup>. The global increase in childhood obesity and the recognition that food marketing practices may influence the food choices of children have resulted in an increased public debate regarding the best course of action to improve the food environments of children. In 2010, the World Health Organization published a set of recommendations for the marketing of food and non-alcoholic beverages to children that was endorsed by the 63rd World Health Assembly (WHA 63.14)<sup>(19)</sup>. In 2016, the WHO released a report by the Commission on Ending Childhood Obesity, which notes with concern 'the failure of Member States to give significant attention to Resolution WHA 63.14' and 'requests that they address this issue'<sup>(20)</sup>. Governments should therefore take leadership in combating childhood obesity by implementing a policy that aims to reduce the impact on children of marketing HFSS foods<sup>(3,20,21)</sup>. In order

**Abbreviations:** DoHSA, South African Department of Health nutrient profiling model for restricting food advertising to children; EMRO, WHO's Eastern Mediterranean Regional Office nutrient profiling model; HFSS, high in fat, sugar and/or salt; Ofcom, United Kingdom Office of Communication nutrient profiling model; REU, WHO's Regional Office for Europe nutrient profiling model; SAFBDG, South African Food-Based Dietary Guidelines; SANPM, South African nutrient profiling model.

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for such a policy to be effectively implemented, a clear definition of the foods that should be restricted is required, unless the marketing of all foods is to be prohibited<sup>(22)</sup>. Nutrient profiling is defined as 'the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health'<sup>(23,24)</sup>, and is suggested by the WHO to support child-directed food marketing restrictions<sup>(20)</sup>. Numerous nutrient profiling models with different aims have been developed, by academics, health organisations, national governments and food industries throughout the world. However, studies have indicated that the models classify foods differently<sup>(25-27)</sup> and that a few have been thoroughly tested and validated<sup>(28)</sup>.

The manner in which nutrient profiling models have been constructed vary considerably. Some models use across-the-board nutrient criteria to classify foods in a limited amount of food categories (e.g. foods and drinks)<sup>(28,29)</sup>. Others use food category-specific nutrient thresholds for foods in many sub-categories (e.g. breakfast cereals, savoury snacks, cheeses, etc.)<sup>(30,31)</sup>. Some classify foods solely on the basis of nutrients to limit<sup>(30,31)</sup>, whereas some also include elements such as dietary fibre to encourage consumption<sup>(28,29,32)</sup>. It is recommended that policy-makers seeking to use a nutrient profiling model for regulatory reasons should rather adapt an existing model from an authoritative source that has been validated, as it is more cost-effective and time saving<sup>(23,25)</sup>. There are now a large number of models available that are used or designed for child-directed food marketing restrictions. Previous studies also suggest that models designed for other applications, such as nutrient and/or health claim regulations, may also be suitable for this purpose<sup>(25,34)</sup>.

In South Africa, the South African nutrient profiling model (SANPM) is used to support the regulation of nutrient and/or health claims<sup>(33)</sup>. This model enjoys support from all stakeholders involved as it was thoroughly tested and validated before implementation into the regulation<sup>(35-37)</sup>. The South African National Department of Health, Directorate: Food Control, published a draft regulation aiming to restrict the marketing of *all* HFSS foods to children in 2014<sup>(33)</sup>. The draft regulation recommends using the South African Department of Health's (DoHSA) nutrient profiling model, which is an adapted model based on the SANPM. The SANPM was, however, developed and validated<sup>(35-37)</sup> to assess whether food products are eligible to carry a nutrient and/or health claim in South Africa and not to regulate food marketing to children. Using the SANPM in the context of restricting the marketing of HFSS foods to children could be problematic as the model was never tested for this purpose. Therefore, this study aimed to explore how appropriate the SANPM is as a food classification tool for regulating the marketing of foods to children in South Africa.

#### Methods

The SANPM was compared with four existing, non-industry nutrient profiling models that were designed by national government departments, academic research groups and authoritative organisations to restrict the marketing of HFSS foods to children. The nutrient profiling models were compared to determine whether the models agree on (a) the percentage of

foods permitted (overall strictness) and (b) the type of foods permitted for child-directed food marketing.

#### The nutrient profiling models used for comparison

In total, five nutrient profiling models were identified and included for comparison (Box 1).

Table 1 describes the characteristics of the above-mentioned nutrient profiling models. Energy, SFA, sugar (total or added) and Na/salt were used by all five models to classify foods. *Total sugar* refers to the sum of all intrinsic (lactose, fructose and galactose) and added sugars (monosaccharides and disaccharides), and *added sugar* refers to any sugar added to food by manufacturers, cooks or consumers during processing or preparation. A *non-nutritive sweetener* is a food additive (other than a monosaccharide or disaccharide sugar), of which one serving of 5 g provides  $\leq 8$  kJ (1.9 kcal) and a sweet taste equivalent to 5 g of sucrose<sup>(30,33)</sup>.

Nutrient criteria algorithms were developed in Microsoft Excel 2013 according to the food classification criteria of the included nutrient profiling models. Each food item was individually classified, according to these nutrient criteria.

#### Development of a representative food list

Previous studies indicate that the majority of food advertisements on television are of savoury snacks, confectionery, sugar-sweetened beverages and fast-food meals<sup>(14,15,17,18)</sup>. Studies also indicate that nutrient profiling models generally classify these foods as 'unhealthy', and that there is less agreement between models with regard to the classification of foods such as cheese, full-cream milk and non-nutritive, sweetened beverages<sup>(25)</sup>. In order to effectively compare how the included nutrient profiling models classified a variety of foods, a representative food list was developed as recommended by the literature<sup>(25)</sup>. The representative food list was developed in such a manner that it would allow the researchers to compare the classification of a variety of foods from various food groups. The representative food list included foods advertised on South African free-to-air television channels in 2014 and foods reported by recently published literature to be commonly consumed by South African children.

First, all advertised foods (child-directed and adult-directed) on free-to-air South African television channels (SABC 1, 2, 3 and eTV) in 2014 were included, because children are not only exposed to television advertisements aired during child-directed programming<sup>(40)</sup>. Television recordings on 4 weekdays (Monday to Thursday) and on Saturdays from 06.00 to 22.00 hours during the months of April, June, September and November of 2014 were used. These months were included in order to capture advertisement changes during the different seasons and holidays such as Easter and Christmas. The food advertisement list consisted of the names of the food products, names of the manufacturing companies, number of advertisements recorded during the sample time, presence of child actors in these advertisements and whether these advertisements were shown during child-directed programmes. A total of 1030 food advertisements were aired over the 4-month period. Advertisements were excluded if they were promoting

**Box 1. The five nutrient profiling models included in the investigation**

*South African nutrient profiling model (SANPM)*<sup>(28,33)</sup>; based on the model developed by the UK Food Standards Agency (FSA) and adapted by Food Standards Australia New Zealand for the regulation of health claims. In 2012, this model was adopted by the South African National Department of Health, Directorate: Food Control, to support the regulation of nutrient and/or health claims in South Africa. The validity of the model has been demonstrated<sup>(35–37)</sup>. This model is a scoring model that uses across-the-board nutrient criteria.

*United Kingdom Office of Communication nutrient profiling model (Ofcom)*<sup>(32)</sup>; developed in 2005 by the UK FSA and adopted by Ofcom (the UK regulatory body for communications industries) in 2007 to support the regulation of food advertising during programmes aimed at children under the age of 16 years. This model has been extensively tested and validated<sup>(38–39)</sup> and is a scoring model that uses across-the-board nutrient criteria.

*WHO's Regional Office for Europe nutrient profiling model (REU)*<sup>(33)</sup>; a nutrient profiling model developed in 2013 by the WHO regional office for Europe with the assistance and inputs of member states. The model is based on two existing models, the Norwegian model<sup>(40)</sup> developed by the Norwegian government – adopted by industry with minor changes made for voluntary restrictions in Norway – and the model developed by the Danish Forum of Responsible Food Marketing Communications – endorsed by the Danish government for voluntary restrictions in Denmark<sup>(41)</sup>. The model was tested by European member states. The model is a threshold model that uses category-specific nutrient thresholds.

*WHO's Eastern Mediterranean Regional Office nutrient profiling model*<sup>(31)</sup>; a nutrient profiling model developed in 2014 by the WHO Eastern Mediterranean regional office with the assistance and inputs of member states. The model is based on the REU model with minor adaptations as suggested by the member states. The model is in the testing phase and is a threshold model that uses category-specific nutrient thresholds.

*South African Department of Health nutrient profiling model for restricting food marketing to children*<sup>(33)</sup>; developed in 2014 by the South African Department of Health, Directorate: Food Control, to support child-directed food marketing restrictions in South Africa and published as a draft regulation<sup>(33)</sup>. The model is an adapted nutrient profiling model. The model classifies foods first by using the SANPM (across-the-board scoring model) and second, the UK FSA front-of-pack traffic light labelling criteria (category-specific nutrient threshold) per 100 g/100 ml for green (low)<sup>(42)</sup> and then, finally, the presence of non-nutritive sweeteners, fluoride, fructose and aluminium<sup>(42)</sup>.

**Table 1. Characteristics of the five nutrient profiling models**

| Models | Type of model         | Classification criteria | Nutrients to limit  | Nutrients/elements to encourage               |
|--------|-----------------------|-------------------------|---|---|
| SANPM  | Scoring               | Across-the-board        | Energy, SFA, total sugar, salt/Na   | Protein, fruits, vegetables, legumes and nuts |
| Ofcom  | Scoring               | Across-the-board        | Energy, SFA, total sugar, salt/Na   | Protein, fruits, vegetables, legumes and nuts |
| REU    | Threshold             | Food-category specific  | Energy, total fat, SFA, added sugar, salt/Na, alcohol, NNS                      | None  |
| EMRO   | Threshold             | Food-category specific  | Energy, total fat, SFA, added sugar, salt/Na, alcohol, NNS                      | None  |
| DoHSA  | Scoring and threshold | Across-the-board        | Energy, total fat, SFA, total sugar, salt/Na, NNS, added fluoride and aluminium | Protein, fruits, vegetables, legumes and nuts |

SANPM, South African nutrient profiling model; Ofcom, United Kingdom Office of Communication nutrient profiling model; REU, WHO's Regional Office for Europe nutrient profiling model; NNS, non-nutritive sweeteners; EMRO, WHO's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA, South African Department of Health nutrient profiling model for restricting food marketing to children.

(1) alcoholic beverages, coffee, tea or chewing gum; (2) retailers who provided a variety of products; (3) baby or toddler foods and milks; and (4) meal replacement supplements. This exclusion resulted in a total of 615 advertisements marketing 137 different food products.

Second, single food items and meals commonly consumed by South African children (3–18 years) were identified from the published literature<sup>(44–46)</sup> and were included in the food list. This resulted in the identification of sixty additional food items.

Finally, a food list containing foods from various food groups was compiled. The food list consisted of 197 foods, of which 137 were foods advertised on South African free-to-air television channels and sixty were foods reported to be commonly consumed by South African children from the published literature.

*Collection of nutritional information of foods*

The majority of foods included in the food list were packaged foods. Nutritional information of these foods was sourced from

the nutrition information panel indicated on the food items by using the George Institute Data Collection Application version 1.1<sup>(50)</sup>. Nutritional information of fast-food meals, restaurant meals and foods containing no nutrition information panel was sourced from the websites of companies. If no nutritional information was available on these particular webpages, the nutritional information of a similar food was sourced from the *Condensed Food Composition Tables for South Africa*<sup>(51)</sup>.

#### Statistical analyses

The proportion of foods allowed by each nutrient profiling model to be marketed to children was calculated, and the overall pairwise agreement between the models was assessed by using Cohen's  $\kappa$  coefficient. Agreements were assessed as follows: 0.00–0.20 'slight', 0.21–0.40 'fair', 0.41–0.60 'moderate', 0.61–0.80 'substantial' and 0.81–1 'almost perfect'<sup>(52)</sup>.

The included foods were divided into food groups on the basis of the revised South African Food-Based Dietary Guidelines (SAFBDG)<sup>(53)</sup>. The main purpose of the SAFBDG is to guide the South African public to choose 'healthy' diets, which implies that these diets are adequate, meet all nutrient requirements and protect people against the development of diet-related, non-communicable diseases<sup>(53)</sup>. By keeping the main purpose of the SAFBDG<sup>(53)</sup> in mind as well as the contribution of sugar-sweetened beverage consumption to added sugar intake<sup>(54)</sup> and obesity<sup>(55)</sup> of children, the following eight food groups were chosen: *starchy foods* (breads, grains, potatoes and cereals); *vegetables, fruits and legumes*; *milk and*

*dairy products*; *meat and eggs*; *fats and oils* (margarines, cooking oils and peanut butter); *composite dishes* (foods composed of items from more than one category such as beef stew); *sugar-sweetened beverages*; and finally *HFSS foods* (foods that are not part of the SAFBDG for healthy eating such as sweets, confectionery and savoury snacks). For each type of food in the food groups listed above, the number of nutrient profiling models that would allow the food to be marketed to children was calculated.

#### Results

Of the 615 food advertisements captured, 125 (20%) were aired during child-directed programmes and 269 (43.7%) used child actors<sup>(56)</sup>. The most frequently advertised foods were foods from the *HFSS foods* (51.5%), *composite dishes* (14%) and *sugar-sweetened beverages* (13.6%) food groups. The majority of foods reported by literature to be frequently consumed by South African children were from the *HFSS foods* (27.84%) and *vegetable, fruits and legumes* (20.59%) food groups.

Fig. 1 illustrates the percentage of foods from each food group, which will be allowed for marketing to children when applying the five nutrient profiling models. Interestingly, the DoHSA model only allows foods from the *starchy foods* (35%) and *vegetable, fruit and legume* (30%) food groups to be marketed to children, whereas the SANPM allows selection of food from all the food groups to be marketed to children. The percentage of foods allowed for child-directed food marketing from the *milk and dairy* groups ranged from 0% (DoHSA) to

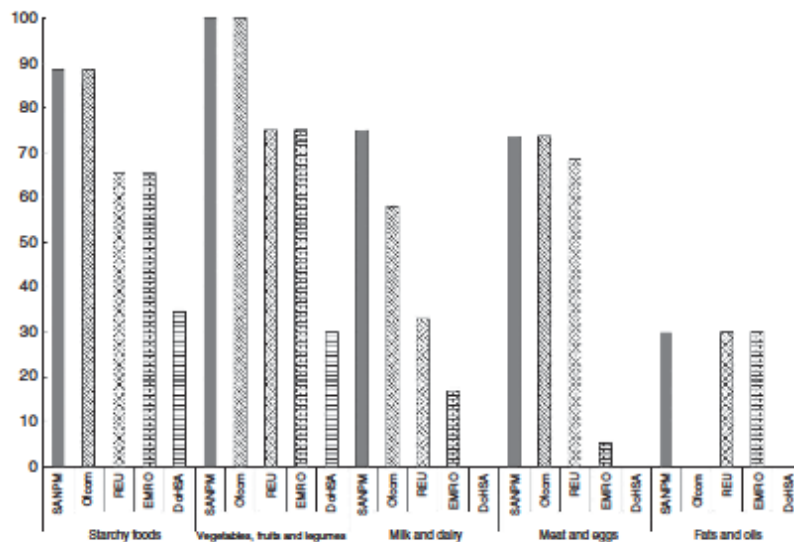


Fig. 1. The percentage of foods from different food groups allowed to be marketed to children according to each of the nutrient profiling models. SANPM, South African nutrient profiling model; Ofcom, United Kingdom Office of Communication nutrient profiling model; REU, WHO's Regional Office for Europe nutrient profiling model; EMRO, WHO's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA, South African Department of Health nutrient profiling model for restricting food marketing to children.

75% (SANPM). The only models allowing foods from the *HFSS foods* and *sugar-sweetened beverages* food groups to be marketed to children were the SANPM (11%) and United Kingdom Office of Communication nutrient profiling model (Ofcom) models (11%, respectively).

Table 2 summarises the explanations for differences in food classification by the included nutrient profiling models. For example, bran flakes (breakfast cereal) was restricted for marketing by the WHO's Regional Office for Europe nutrient profiling model (REU) and the WHO's Eastern Mediterranean Regional Office nutrient profiling model (EMRO) models because of the high Na content of this specific food product.

Table 3 indicates that an almost perfect pairwise agreement was found between the SANPM and the Ofcom models, and a moderate agreement between SANPM, REU and EMRO models. The SANPM showed no agreement with the DoHSA model.

The DoHSA model, a combined nutrient profiling model, was the strictest. This model allows only 6% of foods on the food list to be marketed to children. The REU and EMRO models, which are category-specific nutrient threshold models, allow 32 and 20%, respectively. The most lenient models were the two across-the-board scoring models – the SANPM model that allows 45% of the foods to be marketed to children and the Ofcom model that allows 42%.

#### Discussion

The main findings of this study were that the included nutrient profiling models varied considerably with regard to their overall strictness, and that the DoHSA model is by far the strictest nutrient profiling model and the SANPM is the most lenient with regard to restricting the marketing of foods to children in South Africa. Other research studies have also compared nutrient profiling models for the purpose of restricting the marketing of 'unhealthy' foods to children<sup>(26,57,58)</sup>. The percentage of foods allowed to be marketed to children, according to Scarborough *et al.*<sup>(57)</sup>, ranges from 2.4 to 39.88% and, according to Rayner *et al.*<sup>(58)</sup>, from 4.76 to 39.88%. A research study conducted by Brinsden & Lobstein<sup>(26)</sup> also compared nutrient profiling models but classified foods previously permitted to be advertised in the USA, and reported that the percentage of foods allowed to be marketed to children ranged from 14 to 49%.

Another output in which the included nutrient profiling models differ, regardless of their overall strictness, is the type of foods the models would permit for marketing to children<sup>(25,57)</sup>. The nutrient profiling models generally agree that foods such as sweets, savoury snacks and sugar-sweetened beverages should be restricted for marketing to children. However, the models displayed little agreement on the type of foods that should be permitted for marketing to children as the classification of foods such as full-cream milk, cheese, sweetened yogurt, tinned peaches, breakfast cereals, etc. were undecided. Scarborough *et al.*<sup>(57)</sup> and Rayner *et al.*<sup>(58)</sup> compared nutrient profiling models by using a representative list of foods that were advertised during child-directed programmes in 2008. Similar to our findings, the models included in their study agreed on foods that should not be allowed to be marketed to children (sugary and fatty foods, mostly snacks and confectionery); however,

the models have shown little agreement on foods allowed for marketing. In contrast, the nutrient profiling models compared by Brinsden & Lobstein<sup>(26)</sup> found little agreement on both foods permitted and not permitted to be marketed to children. Discrepancy in the findings was attributed to including nutrient profiling models developed by both governments and the food industry<sup>(26)</sup>. Government-led nutrient profiling models are significantly more restrictive than industry-led nutrient profiling models because of their stricter sugar and Na/salt criteria. In comparison to the findings of previous research articles, the SANPM is rather lenient when it is applied for restricting the marketing of HFSS foods to children. Rayner *et al.*<sup>(25)</sup> defined a strict nutrient profiling model – a model that classifies most foods as 'unhealthy'. Thus, the SANPM could still be considered as a relatively strict model, even though certain foods from food groups generally considered to be 'unhealthy' (*sugar-sweetened beverages* and *HFSS foods* groups) were permitted for marketing to children. The DoHSA model is very strict and permits a few foods for marketing to children. The additional nutrient threshold criteria<sup>(42)</sup> of the DoHSA model were the main reason for its stringency.

Nutrient profiling models differ in both their strictness and the type of foods they would permit for marketing to children because of the differences in their respective structures. These differences include the nutrients used, the number of food categories the model contains, the type of model (across-the-board or category-specific) and the additional classification criteria. In this research article, the across-the-board nutrient profiling models (SANPM and Ofcom models) were found to be more lenient than the category-specific models (REU and EMRO models). This could be because of the fact that across-the-board scoring nutrient profiling models motivate the fact that certain food groups should be eaten more often than others by applying the same definition of 'unhealthy' to all food groups. This motivation, however, means that foods such as non-nutritive, sweetened beverages and certain fruit ices from the *sugar-sweetened beverages* and *HFSS foods* groups are permitted to be marketed to children by the SANPM and Ofcom models. This is in contrast with category-specific threshold models that motivate 'healthier' foods within a food group to be chosen more often by applying different definitions of 'unhealthy' to different food groups<sup>(59)</sup>. Category-specific nutrient profiling models also prohibit certain food groups such as sweets, confectionery, fruit juices and edible ices from being marketed to children irrespective of their nutrient content. This is because of the fact that these nutrient profiling models intend to motivate the public to rather choose 'healthier' foods from food groups proven to be essential components to 'healthy' diets<sup>(57)</sup>.

Nutrient profiling models are also now used by the food industry to re-formulate food products. However, concerns have been raised that in order to 'pass' some of the nutrient profiling models' classification criteria, certain foods that ordinarily would not 'pass' the nutrient profiling models' classification will now be developed<sup>(60)</sup>. Such foods include highly-processed food products with little or no nutritional value or foods artificially fortified with ingredients considered healthy. In order to prevent such foods from 'passing' the

**Table 2.** Examples of foods of which the classification by nutrient profiling models differed

| Food groups                             | Foods for which classification differed     | Nutrient profiling model        |       |     |      |       | Reason why marketing to children is not permitted  |
|---|---|---------------------------------|-------|-----|------|-------|--|
|   |   | SANPM                           | Otcom | REU | EMRO | DoHSA |  |
| Starchy foods                           | Bran flakes                                 | ✓                               | ✓     | X   | X    | X     | Thresholds exceeded:<br>• Sodium: REU, EMRO and DoHSA<br>• Total sugar: DoHSA  |
|   | Com flakes                                  | X                               | X     | ✓   | ✓    | X     | Score exceeded: SANPM, Otcom and DoHSA   |
| Milk and dairy                          | Oats  | ✓                               | ✓     | ✓   | ✓    | X     | Threshold for total fat exceeded   |
|   | Cheese, Cheddar                             | ✓                               | X     | X   | X    | X     | Score exceeded: OtcomThresholds exceeded:<br>• Total fat: REU, EMRO and DoHSA<br>• SFA: REU, EMRO and DoHSA<br>• Sodium: REU, EMRO and DoHSA |
|   | Milk, full cream                            | ✓                               | ✓     | X   | X    | X     | Thresholds exceeded:<br>• Total fat: REU, EMRO and DoHSA<br>• SFA: DoHSA, only   |
|   | Milk, low fat                               | ✓                               | ✓     | ✓   | ✓    | X     | Threshold exceeded:<br>• Total fat: DoHSA<br>• SFA exceeded: DoHSA   |
|   | Yogurt A, sweetened                         | ✓                               | ✓     | X   | X    | X     | Threshold exceeded:<br>• Added sugar: REU and EMRO<br>• Total sugar: DoHSA<br>• Sodium: EMRO   |
|   | Yogurt B, sweetened (less added sugar)      | ✓                               | ✓     | ✓   | X    | X     | Thresholds exceeded:<br>• Total sugar: DoHSA<br>• Sodium: EMRO   |
|   | Meat and eggs                               | Chicken, meat and skin, roasted | ✓     | ✓   | ✓    | X     | X  |
| Fats and oils                           | Tuna in vegetable oil                       | ✓                               | ✓     | ✓   | X    | X     | Threshold exceeded:<br>• SFA: EMRO and DoHSA<br>• Sodium: DoHSA  |
|   | Rapeseed oil                                | ✓                               | X     | ✓   | ✓    | X     | Score exceeded: OtcomThreshold exceeded:<br>• Total fat: DoHSA<br>• SFA: DoHSA   |
| Sugar-sweetened beverages<br>HFSS foods | Polyunsaturated medium fat spread (50% fat) | ✓                               | X     | ✓   | ✓    | X     | Score exceeded: OtcomThreshold exceeded:<br>• Total fat: DoHSA<br>• SFA: DoHSA   |
|   | Energy drink, non-nutritive sweetened       | ✓                               | ✓     | X   | X    | X     | Threshold of non-nutritive sweeteners exceeded   |
|   | Fruit ice, orange flavoured                 | ✓                               | ✓     | X   | X    | X     | Food category not permitted: REU and EMROThreshold exceeded:<br>• Total sugar: DoHSA   |
|   | Custard, vanilla flavoured                  | ✓                               | ✓     | X   | X    | X     | Food category not permitted: REU and EMROThreshold exceeded:<br>• Total sugar: DoHSA   |

SANPM, South African nutrient profiling model; Otcom, United Kingdom Office of Communication nutrient profiling model; REU, WHO's Regional Office for Europe nutrient profiling model; EMRO, WHO's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA, South African Department of Health nutrient profiling model for restricting food marketing to children.

**Table 3.** Pairwise  $\kappa$  values calculated for the five models

|       | SANPM    | REU     | EMRO     | DoHSA   |
|-------|----------|---------|----------|---------|
| Ofoom | 0.948*** | 0.464** | 0.417**  | 0.177   |
| SANPM |          | 0.484** | 0.447**  | 0.161   |
| REU   |          |         | 0.668*** | 0.251*  |
| EMRO  |          |         |          | 0.447** |

SANPM, South African nutrient profiling model; REU, WHO's Regional Office for Europe nutrient profiling model; EMRO, WHO's Eastern Mediterranean Regional Office nutrient profiling model; DoHSA, South African Department of Health nutrient profiling model for restricting food marketing to children; Ofoom, United Kingdom Office of Communication nutrient profiling model; \*, fair; \*\*, moderate; \*\*\*, substantial; \*\*\*, almost perfect<sup>(27)</sup>.

selected nutrient profiling model, policymakers are urged to adapt the chosen model by including additional classification criteria. Exclusions are thus made to the model or additional food categories are added. The SANPM was adapted by the South African Department of Health, Directorate: Food Control in order to create the proposed DoHSA model (Box 1). The proposed DoHSA model uses the SANPM as the first classification step followed by the UK Food Standards Agency front-of-pack traffic light labelling criteria for green (low)<sup>(42)</sup>. The DoHSA model also excludes foods with the following food additives: non-nutritive sweeteners, fluoride, fructose and aluminium<sup>(42)</sup>. The non-nutritive sweetener criterion resulted in some of the foods permitted for marketing by the SANPM to be excluded by the DoHSA model. The use of non-nutritive sweeteners in the fight against childhood obesity is, however, uncertain, as the use of non-nutritive sweeteners is recommended by some<sup>(61,62)</sup> while others are against it<sup>(63)</sup>. The additional nutrient threshold criteria<sup>(42)</sup> of the DoHSA model mean that certain foods generally considered as essential components to a healthy diet, such as apples and low-fat milk, are classified as 'unhealthy'. It is, therefore, of utmost importance that policymakers are aware of the fact that adaptations made to nutrient profiling models could negatively affect the way in which they classify foods, which in return will impact the type of food marketing that children are exposed to. It can be concluded that the additional threshold criteria<sup>(42)</sup> of the DoHSA model are very strict and allow a few foods to be marketed to children.

Nutrient profiling models do not only vary in the way that they have been constructed but also to the degree in which they have been validated<sup>(25)</sup>. Unfortunately, validity testing of nutrient profiling models is limited, and no gold standard for assessing the way in which nutrient profiling models classify foods exists<sup>(25)</sup>. The Ofoom model has been extensively tested<sup>(26,57,58,64-66)</sup> and validated<sup>(38,39)</sup> for the purpose of regulating the marketing of foods to children. When comparing the SANPM with the Ofoom model, an almost perfect pairwise agreement was found (construct validity). This was, however, expected as the models are based on one another. Even so, there are still distinct differences between the models, although they have the same basic principles. The Ofoom model classifies foods into one of only two food categories (foods or beverages). The SANPM has an additional food category for cheese and processed cheese with a Ca content >320 mg/100g, edible oils, edible oil spread, margarine and butter. Foods within

this food category are allowed to obtain a higher score in comparison with that of foods in the other food categories because of the naturally high total energy, total fat and SFA content of these foods. This additional food category means that the percentage of foods permitted by the SANPM and Ofoom models from the *milk and dairy* (allowing 75 and 58%, respectively) and *fats and oils* (allowing 30 and 0%, respectively) groups varied considerably. A moderate pairwise agreement was found between the SANPM and the REU and EMRO models; these models also classify foods from the *fats and oils* food group similarly. No statistically significant level of agreement was found between the SANPM and the DoHSA models; the DoHSA model also prohibits any of the foods included in the *milk and dairy* and *fats and oils* food groups to be marketed to children. Available data indicate that the intake of milk and Ca by South African children is low due to the price of certain dairy products and lack of knowledge on the nutritional value of milk and dairy products. The accessibility and affordability of highly-processed packaged foods are increasing, and therefore it can be argued that the thresholds of the chosen nutrient profiling model be set appropriately so that certain cheeses and yogurts with little added sugar be allowed for marketing to children.

The comparison between the nutrient profiling models provided valuable information with regard to the suitability of the SANPM for child-directed food marketing regulations and highlighting the similarities and differences between the included models. The comparison also emphasised the importance of testing a nutrient profiling model before implementation into policy. However, the limitations of such a comparison should also be taken into consideration as more validity studies are needed to confirm the included nutrient profiling models' accuracy with regard to classifying or ranking the healthiness of foods. The WHO recommends that the nutrient profiling model being used to regulate the marketing of foods to children should align with the Food-Based Dietary Guidelines of the country in which it is intended for use<sup>(20)</sup>. It could, therefore, be argued that the nutrient profiling model used to regulate the marketing of foods to children in South Africa should permit 'healthy' foods within the food groups that the SAFPBDG promote. The SANPM aligned well with the SAFPBDG during the validity testing for nutrient and/or health claim regulatory use<sup>(65)</sup>. However, no validity testing of the DoHSA model has been conducted to date.

#### Limitations

The analysis reported in this article only included food advertisements broadcasted on free-to-air South African television channels and foods commonly consumed by the targeted population as identified from published literature. Foods marketed to children through other forms of marketing, such as radio broadcasts, product placements, product packaging and internet advertisements, were not included, and cross-continent food marketing through international television channels were also not included.

#### Conclusion

The nutrient profiling models included in this article vary considerably in both the total amount of foods and the type of



foods allowed for marketing to children. The SANPM, already accepted and used by the South African food industry as the first screening process to determine a food product's eligibility for a nutrient and/or health claim, is appropriate as the first screening process for regulating the marketing of HFSS foods to children. The SANPM displays the best agreement with the Ofcom model and it permits certain dairy products such as low-fat yogurt to be marketed to children. However, further research is recommended to assess the validity of the SANPM and to develop an evidence-based framework to assist in the exclusion of certain highly processed foods that are included by the SANPM owing to limited nutritional values (such as energy drinks with non-nutritive sweeteners).

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The authors declare that there are no conflicts of interest.

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# ADDENDUM 3: CONTENT AND STYLE GUIDELINE FOR APPETITIE

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**APPETITE**

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### TABLE OF CONTENTS

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|                                   |            |
|-----------------------------------|------------|
| • <b>Description</b>              | <b>p.1</b> |
| • <b>Audience</b>                 | <b>p.1</b> |
| • <b>Impact Factor</b>            | <b>p.1</b> |
| • <b>Abstracting and Indexing</b> | <b>p.2</b> |
| • <b>Editorial Board</b>          | <b>p.2</b> |
| • <b>Guide for Authors</b>        | <b>p.4</b> |



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*Appetite* is an international research journal specializing in cultural, social, psychological, sensory and physiological influences on the selection and intake of foods and drinks. It covers normal and disordered eating and drinking and welcomes studies of both human and non-human animal behaviour toward food. *Appetite* publishes research reports, reviews and commentaries. Thematic special issues appear regularly. From time to time the journal carries abstracts from professional meetings.

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