

Using existing dietary data for evaluating the construct validity of a nutrient profiling model

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LIST OF ABBREVIATIONS

DOH	Department of Health
DQI	Diet Quality Index
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
FVLN	Fruits, Vegetables, Legumes and Nuts
FBDGs	Food Based Dietary Guidelines of South Africa
FCTSA	Condensed Food Composition Tables of South Africa
FSANZ	Food Standards Australia New Zealand
HDI	Healthy Diet Indicator
MRC	Medical Research Council
NCDs	Non Communicable Diseases
No	Number
NPM	Nutrient Profiling Model
UK	United Kingdom
WHO	World Health Organization

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ABSTRACT

AIM: Nutrient profiling can be defined as ‘the science of categorising foods according to their nutritional composition’ and can be used as a valuable tool in food labelling legislation. Validation is an absolute essential step in the implementation of a nutrient profiling model (NPM), it is important to verify whether or not the NPM has a good solid scientific basis and if it is at all suitable for South Africa. This mini-dissertation investigated the construct validity of a NPM for South Africa.

OBJECTIVES: 1) To test construct validity for the nutrient profiling model by examining the relationship between the way the NPM categorises foods and the healthiness of diets in South Africa. 2) To assess if the quality of a diet will improve if ‘unhealthy’ foods are replaced by ‘healthy’ foods as defined by the NPM.

STUDY DESIGN: Nested in the South African leg of the international PURE (Prospective Urban and Rural Epidemiology) study at baseline.

METHOD: The PURE (Prospective Urban and Rural Epidemiology) baseline study conducted in the North-West province in 2005, was identified as a suitable dataset of food intake. For the first objective the proportion of respondent’s diets consisting of healthy or unhealthy food, as classified by the NPM, was calculated. The respondents were divided into four groups based on their dietary quality as characterised by the Diet Quality Index (DQI), the lower the DQI-score the better the diet quality. The proportion of healthy or unhealthy foods were compared to the DQI-scores using one-way ANOVA’s, p-values were calculated using the Tukey post-hoc test. For the second objective the diet quality of four different diets consisting of either YES foods (according to NPM), NO foods, a combination of YES and NO were calculated and compared.

RESULTS: The model displayed good construct validity by showing a statistically significant positive relationship between the proportion of ‘healthy’ ($p < 0.0001$) and ‘unhealthy’ ($p < 0.0001$) foods, as classified by the NPM, and participants’ DQI-scores. The second objective was also confirmed and a diet consisting of ‘healthy’ foods or a diet where ‘unhealthy’ foods were substituted by ‘healthy’ foods, had a better DQI than diets consisting only of ‘unhealthy’ foods

CONCLUSION: Construct validity was confirmed by proving that the better the diet quality of the respondents the bigger their proportion of foods categorised as 'healthy' by the NPM and vice versa.

Keywords: Nutrient profiling model, construct validity, healthiness of food

UITTREKSEL

DOEL: Die profilering van nutriënte kan gedefinieer word as 'die wetenskap wat voedselsoorte kategoriseer volgens die samestelling van hulle voedingswaarde en kan gebruik word as 'n waardevolle verwysingsraamwerk in die wetgewing van voedsel-etikettering. Validering is 'n absoluut noodsaaklike stap in die implementering van 'n nutriënt profileringsmodel (NPM), dit is belangrik om te verifieer of die NPM 'n soliede wetenskaplike basis het en of dit enigsins geskik is in die Suid-Afrikaanse konteks. Hierdie skripsie het die konstrugeldigheid van 'n NPM vir Suid-Afrika ondersoek.

DOELWITTE: 1) Om die geldigheid van die nutriënt profileringsmodel te toets deur die verhouding te ondersoek tussen die wyse waarop die NPM die voedselsoorte kategoriseer en die gesondheid (voedingswaarde, gebalanseerdheid) van eetgewoontes in Suid-Afrika.

2) Om vas te stel of die kwaliteit van die dieet sal verbeter indien 'ongesonde' voedselsoorte vervang word deur 'gesonde' voedselsoorte soos gedefinieer deur die NPM.

SAMESTELLING VAN DIE STUDIE: Ingebed in die Suid-Afrikaanse afdeling van die PURE (Prospective Urban and Rural Epidemiology) basislynstudie.

METODE: Die PURE (Prospective Urban and Rural Epidemiology) basislynstudie wat in 2005 in die Noordwes Provinsie gedoen is, is geïdentifiseer as 'n geskikte datastel vir voedselinname. As eerste doelwit is die verhouding van die respondent se diëte wat uit gesonde en ongesonde voedselsoorte bestaan het, soos geklassifiseer deur die NPM, bereken. Die respondent is in vier groepe ingedeel wat gebaseer is op die kwaliteit van die dieet soos gekarakteriseer deur die 'Diet Quality Index'(DQI). Hoe laer die telling hoe beter was die gehalte van die dieet. Die verhouding van gesonde en ongesonde voedselsoorte is vergelyk met die DQI-tellings deur eenriging ANOVA's te gebruik, p-waardes is bereken deur die Tukey post-hoc-toets te gebruik. As tweede doelwit is die kombinasie van die kwaliteit van vier verskillende diëte wat uit óf JA-voedselsoorte (volgens NPM) óf NEE-voedselsoorte bestaan, bereken en vergelyk.

RESULTATE: Die model het goeie konstrukvaliditeit bewys deur 'n statisties beduidende positiewe verhouding tussen die proporsie van 'gesonde' (<0.0001) en 'ongesonde' ($p < 0.0001$) voedselsoorte aan te dui, soos geklassifiseer deur die NPM, en deelnemers se DQI-tellings. Die tweede doelwit is ook bevestig en 'n dieet wat uit 'gesonde' voedselsoorte of 'n dieet waar 'ongesonde' voedselsoorte vervang is met 'gesonde' voedselsoorte, het 'n beter DQI-telling gehad teenoor diëte wat net uit 'ongesonde' voedselsoorte bestaan het.

GEVOLGTREKKING: Konstrukvaliditeit is bewys deur te bewys dat hoe beter die dieet-gehalte van die respondente hoe groter was die proporsie van hulle voedselsoorte wat as 'gesond' geklassifiseer is deur die NPM en omgekeerd.

Sleutelwoorde: Nutrient profileringsmodel, konstrukvaliditeit, gesondheid van voedsel

CHAPTER 1

1. INTRODUCTION

1.1 Background and problem statement

Non-communicable diseases (NCDs) are the leading public health issue globally. According to the World Health Organization's (WHO) 2010 Global Status Report on NCDs, it accounted for almost two thirds of all deaths globally, with cardiovascular diseases, cancer, diabetes and chronic lung disease as the major contributors (WHO, 2010). The same report indicated that almost 80% of all NCD's occur in low- to middle income countries of which South Africa is one. Deaths due to NCDs are estimated to increase globally by 15% between 2010 and 2020, with the greatest increase in Africa, South-East Asia and Eastern Mediterranean, where the increase could be as much as 20%. According to the WHO report on NCDs in South Africa, for the year 2010, 28% of all deaths in South Africa were due to NCDs (WHO, 2011).

There is now, as stated by a joint report of the WHO and Food and Agriculture Organization of the United States (FAO) expert consultation group , a convincing amount of evidence suggesting that dietary habits not only influence the existing health problems of an individual, but it is also a determinant of whether or not a person will develop NCDs such as chronic heart disease, diabetes and cancer (WHO, 2003).

When considering the above evidence it becomes evident that countries across the globe need to take action against the development of NCDs in order to stop this group of diseases from mercilessly killing millions each year.

The choices consumers make are greatly affected by the claims made on food products (Chan *et al.*, 2006; Roe *et al.*, 1999; Williams, 2005). The healthiness of a specific food is a very important consideration for modern day consumers in order to decide which products to buy. The food labelling legislation is there to control what is allowed or not allowed to be printed on food labels, in order to prevent the food industry from misleading consumers. There are very specific legislated regulations to determine when a manufacturer can make a certain claim on its products. The mandate of the Department of Health (DOH), Directorate: Food Control in terms of labelling of foodstuffs (Foodstuffs, Cosmetics and Disinfectants Act, no 54/1972) is:

- To educate and enlighten the consumer to make an educated decision when purchasing a foodstuff;
- To protect the consumer against any deceiving or misleading practices which may have a negative effect on his/her health;
- To educate, inform and protect the manufacturer.

On 20 July 2007 the DOH, Directorate: Food Control, published draft Regulations Governing the Advertising and Labelling of Foodstuffs, No. R642 in the Government Gazette for comments. Local and international stakeholders submitted 103 sets of comments on the Draft Regulations (no. R. 642 of 2007). Even though many of the comments posted were of a positive nature, some of them did highlight several negative issues with the Draft Regulations and the scientific soundness thereof (Personal communication with Ms. A. Booyzen, Department of Health, directorate: Food Control).

The section of the Draft Regulations which was commented on extensively was the now infamous Annexure 6 (Foodstuffs not considered essential for a healthy diet and for which NO nutrient content, GI, certain comparative, health, slimming or any other claim with a health or nutritional message will be permitted). In essence Annexure 6 consisted of a list of foods which were not permitted to carry any kind of health claim, based on their lack of healthiness. It was widely argued that Annexure 6 was based on subjective reasoning rather than objective scientific evidence. From the comments received, it was quite clear that Annexure 6 would have to be dealt with in a more scientific manner. Taking the comments into consideration, the DOH since then published new regulations relating to labelling (R146 of 2010, DOH Directorate Food Control) – usually referred to as the first part of the new labelling regulations. This regulation (R146) allows only for certain nutrient content claims but not any other nutrient and/or health claims to be made and address other issues regarding labelling. The second part of the regulations will deal with the nutrient and/or health claims once the concerns of the stakeholders on the scientific validity of food products to be excluded from nutrient and/or health claims has been addressed (R146 of 2010, DOH Directorate Food Control).

It was at this point that the idea of investigating the possible use of a nutrient profiling model as part of the food labelling legislation was born. The report by Wentzel-Viljoen *et al.* (2010), took the first step in identifying and evaluating a nutrient profiling model (NPM) for South Africa.

Before any NPM can be used, it must be validated to assess if it is applicable to a specific country. This NPM could provide the scientific evidence in deciding which products are eligible or not to make a nutrient and/or health claim.

1.2 Purpose and importance of the study

There are several different types of validity testing as summarised by Townsend (2010), namely: content validity, criterion validity, convergent and discriminant validity, predictive validity and construct validity. The purpose of this study was to test the construct validity of an existing nutrient profiling model for South Africa.

Testing validity is an absolute essential step in developing a nutrient profile model. According to Steiner & Norman (2001), the level of confidence we are able to place on assumptions we make about people, based on their scores from a health scale, is really only established by constructing validity. Differently put, nutrient profiling is an 'instrument' to score the healthiness of foods, and, just as medical equipment/instruments need to be tested before it can be marketed/used, NPMs should also be validated and tested, before being implemented in the Public Health sector (Arambepola *et al.*, 2008).

Construct validity refers to whether or not the scale being tested, in this case the NPM, correlates with the theorised scientific construct that it measures, in this case the healthiness of diets (Cronbach & Meehl, 1955). To put it simply, when determining the construct validity of the nutrient profile we try to answer the following question: "Are we actually measuring what we think we are measuring?".

It is important to note that this project is part of a larger study, conducted by Wentzel-Viljoen and colleagues (2012), to test the validity of a nutrient profiling model for South Africa. This mini-dissertation only covers construct validity as content and convergent validity was addressed in another part of the study by Wicks *et al.* (2012).

1.3 Aim and objectives

1.3.1 Aim

The aim of this study was to test the construct validity of an existing nutrient profiling model for use in South Africa. This was done according to specific suggested validation approaches as described in the 'Guiding principles and framework manual for the development and adaptation of nutrient profiling models' (WHO, 2011b).

1.3.2 Objectives

In order to achieve the aim the following objectives were set:

- a) To test the construct validity by examining the relationship between the ways the NPM categorises foods and the healthiness of diets in South Africa.
- b) To test the construct validity by assessing if the quality of a diet can improve when foods not eligible to carry a health claim are replaced by foods that would be eligible to carry a health claim as defined by the nutrient profile model.

1.4 Definitions

1.4.1 Nutrient profiling: Nutrient profiling can be defined as the science of categorising food according to their nutrient composition aiming to aid in disease prevention and health promotion (Rayner *et al.*, 2005; Scarborough *et al.*, 2005; Tetens *et al.*, 2003; Townsend, 2010; WHO, 2011).

1.4.2 Claim: A claim in relation to a food stuff, means any written, pictorial, visual, descriptive or verbal statement, communication, representation or reference brought to the attention of the public in any manner including a trade name or brand name and referring to the characteristics of a product in particular to its nature, identity, nutritional properties, composition, quality, durability, origin or method of manufacture of the product (as per Regulation 146 of 2010, DOH Directorate Food Control).

1.4.3 Health claim: A health claim refers to a statement made on a product (or its components) claiming that the product is related to the health of an individual.

Examples of health claims could be 'helps lower cholesterol' and 'good for your heart' (WHO, 2011)

1.4.4 Content claim: A content claim on a product is a claim implicating the amount of a certain nutrient in that product. Examples include: 'trans-fat free', 'high in fibre' and 'a good source of protein' (WHO, 2011).

1.4.5 Diet quality scores: Diet quality scores are involved with the evaluation of both variety and the quality of the complete diet, making it possible to assess the associations between entire foods and health status, rather than nutrients alone (Wirt & Collins, 2009).

1.5 Structure of this dissertation

This mini-dissertation is presented in article format and therefore, this research will be submitted for publication in a peer-reviewed journal.

The introductory chapter (Chapter 1) is followed by a literature review (Chapter 2). In this chapter the latest research with regards to the prevalence of non-communicable disease, nutrient profiling, nutrient and/or health claims, regulations governing food labelling, diet quality and the validation of a nutrient profiling model are discussed.

Chapter 3 includes an article where the two validations done in order to test the construct validity of a nutrient profiling model is described. This article will be submitted as part of a series in the Public Health Nutrition journal.

The last chapter (Chapter 4) gives a summary of the main findings of this mini-dissertation. Some recommendations for future research in nutrient profiling and the validation thereof is given.

For chapters 1, 2 and 4, a collective reference list is included directly following Chapter 4. Since Chapter 3 is in article format, it has its own reference list at the end of this specific chapter, according to the "Authors instructions" (not included) for the Public Health Nutrition journal.

CHAPTER 2

2. LITERATURE REVIEW

2.1 Introduction

In this chapter the latest research relating to the incidence of non-communicable disease, nutrient profiling, nutrient and/or health claims, regulations governing food labelling, diet quality and the validation of a nutrient profiling model are discussed.

It is noteworthy that previous research done on the validation of nutrient profiling models is extremely limited, in fact, the validation of a nutrient profiling model has only been completed once preceding the research presented in this mini-dissertation and the mini-dissertation by Wicks (2012).

2.2 The non-communicable disease burden on modern-day society

Non communicable diseases (NCDs) can be described as slowly progressing illnesses with a long, often lifelong, duration. According to the WHO, NCDs can be divided into four main types: cancer, diabetes, cardiovascular disease (like strokes and heart attacks) and chronic respiratory diseases (such as asthma and chronic obstructed pulmonary disease) (WHO, 2010).

Non communicable diseases are without a doubt the primary cause of death worldwide, accounting for 63% of all deaths annually, killing 36 million people each year (WHO, 2010; WHO, 2008). Even more frightening is the fact that 9 million of these deaths are people younger than 60 years of age (WHO, 2008).

Although NCDs are popularly believed to be most prevalent in the developed countries of the world due to their largely sedentary lifestyle and Westernised diet (WHO, 2008; WHO, 2010), the WHO reported that 80% of all NCD deaths take place in low- and middle-income developing countries, of which South Africa is one. This trend is further strengthened by the fact that 28% of NCD related deaths in low- to middle-income countries are people younger than 60 years of age, compared to 13% in high-income countries (WHO, 2008). Figure 1 gives a clear indication of the relationship between the prevalence of NCD-related deaths and the country income. This trend suggests that the lower the income the higher the prevalence of NCDs.

Many low-to middle-income countries are currently in the middle of a nutrition transition. By its very definition the nutrition transition occurs when populations change their nutrient intakes and dietary patterns by accepting westernised lifestyles. This typically happens during times of urbanisation, acculturation as well as social and economic progression and the prevalence of NCDs in developing countries can be linked to this (Vorster *et al.*, 2005). According to Popkin (2004) the dietary changes in developing countries have been happening at an alarming rate and at a time in their economic and social development when one would not yet be expecting it.

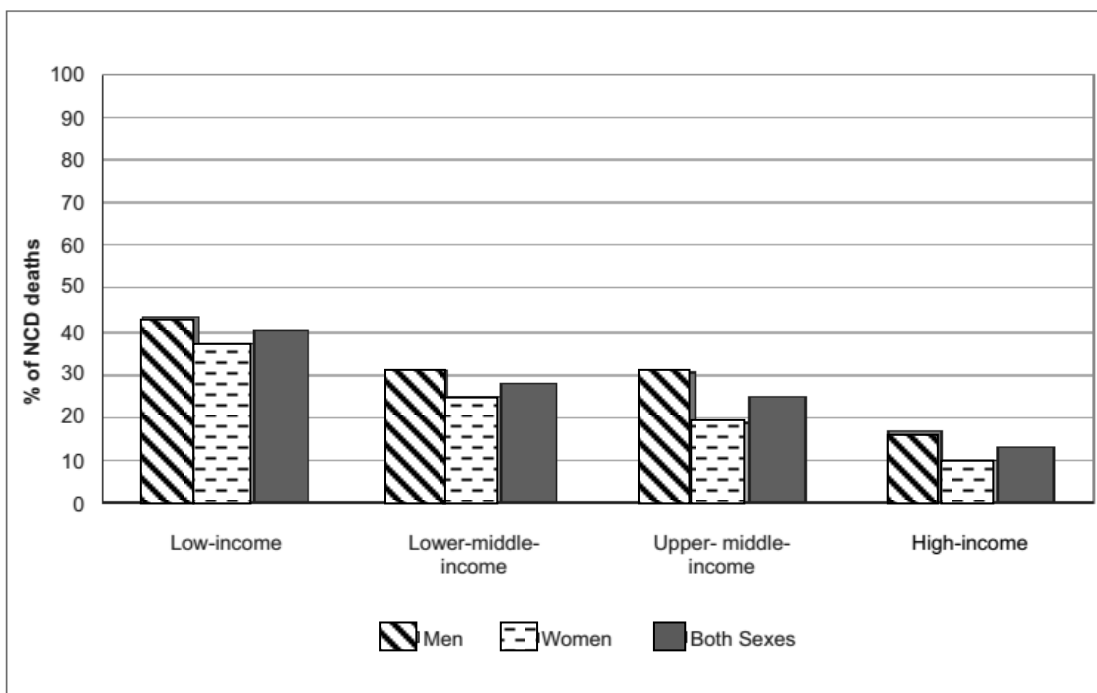


Figure 1. Proportion of NCD prevalence in people under the age of 60 per country income (WHO, 2008)

This is exactly the phenomenon happening in South Africa. In isolation, a nutrition transition already poses enormous challenges to the public health sector of any given country, but for South Africa this is not where it ends. South Africa is facing what has been described by Bradshaw *et al.* (2003) as a quadruple burden of disease. This is a jumble of NCDs, diseases related to pre-transitional times (such as poverty related malnutrition), injuries and the human immunodeficiency virus (HIV) (Bradshaw *et al.*, 2003). Not one of these four components of South Africa’s quadruple burden of disease may be ignored and strategies should be put in place in an attempt to lessen the burden of disease.

The WHO states that NCDs are triggered by a set of preventable risk factors which are the leading cause of death regardless of economic development (WHO, 2010). These risk factors include hypertension (accounting for 13% of deaths globally), smoking (9%), elevated blood glucose levels (6%), physical inactivity (6%), overweight and obesity (5%) (Mayosi *et al.*, 2009; WHO, 2008). When investigating the prevalence of these risk factors in the South African population it comes as no surprise that 28% of deaths in South Africa are NCD-related (WHO, 2008). A staggering 65,2% of all South Africans are overweight, 42,2% have elevated blood pressure, 34% have elevated cholesterol levels, 31,3% are obese and 10,6% have increased blood glucose levels (WHO, 2011).

At this point it is important to note the undeniable link between NCDs and dietary intake. In a joint report by the WHO and FAO, it was reported that by altering lifestyle factors, as much as 90% of type 2 diabetes cases and 80% of coronary heart disease cases could likely be avoided. Also, approximately 33% of all cancers can be circumvented by sustaining a normal weight, regular life-long exercise and a healthy diet (WHO, 2003).

2.3 Nutrient and health claims

It is important to first establish what exactly nutrient and health claims are. Nutrient content claims are defined by the Food and Drug Administration (FDA) as “a claim on a food product that directly or by implication characterises the level of a nutrient in a food”. Examples of this include ‘low sodium’, ‘low fat’, ‘high in fibre’, ‘no trans-fats’, ‘contains only 20kJ’. Health claims on the other hand refers to “any claim made on the label of a food item that expressly or by implication, characterises the relationship of any substance to a disease or health-related condition.” This includes ‘third party’ references, written statements (e.g. reduces heart disease risk) and symbols (e.g. a heart symbol) (FDA, 2009).

In the modern-day democratic world one would like to believe that the food choices consumers make are based on free will. However, the extent to which the consumer actually choose freely is debatable as a number of different factors influence and guide their choices, of which food labelling and the presence of nutrient and health claims is but one. The argument is that consumers do not freely choose their food, but rather select it based on reasoning influenced by external factors such as the nutrient and health claims made on the packaging (Caraher & Coveney, 2003).

Australian researchers did a study in 2006 to determine whether or not consumers were affected by claims made on food labels. It was reported that, although the consumers in question were not entirely convinced that the claims made on food products were truthful, the claims made still influenced their choices and they also tended to eat more of a product if it claimed to be low-fat (Chan *et al.*, 2006). The results from a number of studies also indicated that the choices consumers make are affected by the claims made on food products (Barreiro-Hurle *et al.*, 2010; Bech-Larsen & Gurnet, 2003; Pothoulaki & Chryssochoidis, 2009; Tuorila & Cardello, 2002; Van Trijp & Van der Lans, 2007). Claims on food products may lead to a “halo” effect, where the fact that a product has a nutrient and/or health claim on it leads the consumer to believe that it is a good product altogether and discourages the consumer to even consider evaluating the full nutritional value of the product (Roe *et al.*, 1999; Williams, 2005).

Worldwide, the fact that consumers’ choices are increasingly influenced by the nutrient and health claims made on the products is excellent news for the food industry and may lead manufacturers to jump at the opportunity to increase their sales with their labelling. It is for this reason that every country should have a policy in place to guide the industry into making true and correct claims on food products without misleading the consumer. Caraher & Conevey (2003) argues that the food policy should always seek to offer the social infrastructure required to make the food choices of the consumer healthier. Often, food policy and public health interventions focus on the tail-end of the food chain, meaning when the food has already reached the consumer’s mouth, but as Caraher & Conevey (2003) so aptly puts it, the focus needs to shift from “post-swallowing” intervention to “pre-swallowing” intervention. The key, in other words, is to focus on prevention rather than cure. Food labelling policy is one way of doing this.

2.4 Labelling legislation in South Africa

The mandate of the Department of Health (DOH), Directorate: Food Control in terms of labelling of foodstuffs (Foodstuffs, Cosmetics and Disinfectants Act, no 54/1972) is (although already mentioned in Chapter 1, it also takes reference in this chapter):

- To educate and enlighten the consumer to make an educated decision when purchasing a foodstuff;
- To protect the consumer against any deceiving or misleading practices which may have a negative effect on his/her health;
- To educate, inform and protect the manufacturer.

The draft Regulations Governing the Advertising and Labelling of Foodstuffs, No. R 642 were published for comments in the Government Gazette on 20 July 2007. Local and international stakeholders submitted 103 sets of comments. From the comments it was clear to the Directorate Food Control that most of the role players showed general appreciation and support for one of the key objectives and essential principles behind the regulations, namely improving the labelling and advertising to promote healthier eating habits, thereby encouraging better food choices and improving public health with regards to a reduction in the incidence of chronic diseases of lifestyle in the long term.

Even though most comments were positive in nature, some serious issues requiring further attention were also identified from the comments (Personal communication with Ms. A. Booyzen, Department of Health, Directorate: Food Control). One section of the draft regulations, Annexure 6, in particular evoked quite a reaction from the scientific community as well as the food industry. Annexure 6 had the following heading: *“Foodstuffs not considered essential for a healthy diet and for which NO nutrient content, GI, certain comparative, health, slimming or any other claim with a health or nutritional message will be permitted”*. In short, it contained a list of foods which were regarded as unfit to carry any form of nutrient or health claim. The comments received, argued that this section was not subjective or scientific in any way, but rather based on objective opinion. The general feeling was that Annexure 6 should be replaced by a more scientific evidence-based approach.

2.5 Nutrient profiling

Generally, nutrient profiling can be defined as “the science of categorising food according to their nutrient composition” (Drewnowski & Fulgoni, 2007; Rayner *et al.*, 2005; Scarborough *et al.*, 2005). Previously, nutrient density scores were only associated with and applied to the diet as a whole, however, with the development of the science of nutrient profiling, nutrient density scores are adapted to be applied to single foods. Nutrient profiling models should be based on a uniform, rigorous and science-driven base (Drewnowski & Fulgoni, 2007).

According to Verhagen & Van den Berg (2008) and Drewnowski & Fulgoni (2007), nutrient profiling can be done for a variety of reasons, including the following: 1) to evaluate the nutritional quality of individual foods, 2) to move consumers to make healthier food choices, 3) to control the

promotion of foods to children, and; 4) identifying food products eligible to carry a health or nutrient content claim. The latter is the main rationale behind making a nutrient profiling model part of the South African food labelling legislation.

By implementing a nutrient profiling model as part of the South African food labelling legislation both the consumer and the manufacturer will benefit. The consumer will be protected from food products where nutrient and content claims mask the overall “unhealthiness” of the specific food item. Manufacturers will be moved to improve the nutritional composition of their foods in order to make a specific nutrient or content claim. The main benefit for the manufacturers will be that all manufacturers will now be competing on a much more even playing field (Wentzel-Viljoen *et al.*, 2012). By influencing consumer choices and the composition of the food items on the shelves, nutrient profiling has a considerable potential to be applied as a policy tool in improving public health nutrition and lessening the burden of diet-related chronic disease and thus NCDs (Drewnowski & Fulgoni, 2007; Sacks *et al.*, 2011).

A very important expected outcome of implementing a NPM is that the model will move the industry to improving the nutrient profile and thus the ‘healthiness’ of their food items which will in turn lead to healthier diets. According to Combris *et al.* (2007) depending on the scenario, the food group and the nutrient considered, an improvement in the composition of a product could potentially lead to an improvement in an individual’s nutritional intake of 1-22%.

It is important to emphasize that nutrient profiling is not a universal remedy of some sort, it is not capable of solving all health and food related problems. The NPM measures and assesses the nutrient composition of individual foods. However when analysing an individual’s diet as a whole it is quite clear that the nutrient composition of the individual foods within the diet is not the only determinant of the healthiness of the diet. It is also determined by the variety of foods included in the diet, the combinations in which these foods are consumed, the portion sizes and the frequency of the foods consumed. Differently put, the NPM measures the prudence of the diet and not the adequacy thereof (Sacks *et al.*, 2011; WHO, 2011).

In applying a NPM as a standard for making health claims, the aim is to avoid a situation where a claim on a food product disguises the overall detrimental nutritional impact of a product based on its overall composition, using an evidence-based approach (Wentzel-Viljoen *et al.*, 2012).

2.6 A suitable nutrient profiling model for South Africa identified

The aim was not to re-invent the wheel and create a nutrient profiling model for South Africa from scratch, but rather to study the existing nutrient profiling models used around the world, and identify one suitable for South Africa and then validate the suitability of this nutrient profiling model in the South African setting.

In September 2010 the WHO released a draft document named 'Guiding principles and framework manual for the development and implementation of nutrient profile models' to be used by countries as a guiding tool. During the whole process of implementing a nutrient profile model for South Africa these guidelines were followed.

In 2010 Wentzel-Viljoen *et al.* (2010) completed a report "Evaluation of existing nutrient profiling models" as the first step towards the development, testing and evaluation of a suitable and relevant nutrient profile model for South Africa. This would essentially provide the Department of Health: Directorate Food Control with a scientific evidence based approach to determine the eligibility of foods to carry nutrient and health claims. The report concluded that the Australian and New Zealand Nutrient Profiling Model (FSANZ-model) is recommended for use in South Africa as a tool to determine if a food is eligible to carry a health claim or not.

The FSANZ model was developed on the basis of a nutrient profiling model created by Mike Rayner and colleagues in the United Kingdom (UK). The original model was created as a tool to tightly regulate the control on the advertising of food for children in terms of saturated fat, sugar and sodium (FSA, 2009). The developers of the FSANZ model made a number of modifications to the UK-model to fit their specific needs, especially because, unlike the UK-model, the FSANZ model was intended to be used on food products for the whole population and not only on products intended for children (FSANZ, 2007).

Except for providing the "Guiding principles and framework manual for the development and implementation of nutrient profile models" (WHO, 2011b) the WHO also presented a workshop in South Africa on using the manual on the 14th of April 2011 (in Pretoria) and the 15th of April 2011 (in Potchefstroom). Professor Mike Rayner, the brain behind the nutrient profiling model used in the United Kingdom, also attended this meeting. During this meeting Prof. Rayner stated that the FSANZ model was an improvement on the original UK-model and that there was no need to develop a new nutrient profiling model for South Africa (Wentzel-Viljoen *et al.*, 2012). In conclusion the WHO workshop supported what Wentzel-Viljoen *et al.* (2010) concluded: The

FSANZ model can be regarded as an appropriate model to use as the basis of the South African model.

What made the UK-model the perfect basis for the FSANZ model was the fact that the nutritional recommendations of the UK-model are very similar to the Dietary Reference Values used in Australia and New Zealand (Wentzel-Viljoen *et al.*, 2012). South Africa is a Member of State of the WHO, which implies that the WHO guidelines are used. Both the Dietary Reference Values of Australia and New Zealand are comparable to the WHO guidelines for the prevention of chronic diseases (Table 1) (Australian government, 2006; Rayner *et al.*, 2009; WHO, 2003). The FSANZ model is therefore based on the prudence of the diet.

The detailed explanation of the FSANZ model will be discussed in section 2.7

Table 1 Comparison between the nutritional recommendation for the UK Nutrient Profiling Model, Reference Values for Australia and New Zealand for moderately active woman and the WHO guidelines used in South Africa

Nutrient	Recommendations for UK Nutrient Profiling Model (Rayner <i>et al.</i> , 2009)	Australian and New Zealand Reference values, based on a Moderately active women (19-50years)	WHO: Ranges of population nutrient intake goals (based on 8300kJ diet)*
Energy	2130 kcal (8916kJ) Weighted average of the EAR for boys and girls in the 11-14 and 15-18 year age bands.	8750kJ Based on: median height for adult women in the 1995 Australian National Nutrition Survey was 161.4cm. At BMI=22 and a PAL of 1.6, this yields and EAR of 8700 – 8800kJ per day	To maintain a healthy weight
Saturated fat	11% of energy (26g)	10% energy (26g) (Australia); 12% energy (New Zealand)	<10% of total energy (20g)
Total sugar	21% of energy Non-milk extrinsic sugar: 11% of energy	No nutrient reference values The Australian Dietary Guidelines comment that there is no evidence that 15-20% energy from sugars is incompatible with a healthy diet; The New Zealand Dietary Guidelines suggest no more that 15% of total energy should be derived from sucrose and free sugars	<10% free sugars (all monosaccharide's and disaccharides added to food by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and fruit juices)
Sodium	2400mg Based on the RNI of 1600mg/day multiplied by 1.5 to achieve consistency with the UK Scientific Advisory Committee on Nutrition recommendation of 2400mg	UL = 2300mg	<2000mg
Protein	RNI rounded to nearest 5 (45g for woman)	RDI = 46g	10-15% of total energy
Fibre	20-24g The amount specified by COMA (18g) for a daily faecal weight of at least 100g was based on the Englyst method; this was converted to the equivalent using AOAC method	AI = 25g	>25g per day total dietary fibre
Fruit and vegetables	50% increase in consumption is recommended which would give a total of 380g/day (excludes potato which is classified as bread)	Australian recommendations: 300g fruit; 375g vegetables (including potatoes); no equivalent recommendation for New Zealand	≥400g per day (South African Food Based Dietary Guidelines > 400g)

*WHO. 2003. Diet, nutrition and the prevention of chronic diseases

AI = Adequate Intake
 BMI = Body Mass Index
 EAR = Estimated Average Intake
 RDI = Recommended Dietary Intake
 UL = Upper Limit

AOAC = Association of Official Analytical Chemists
 COMA = Committee Medical Aspects of Food & Nutrition Policy
 PAL = Physical Activity Level
 RNI = Reference Nutrient Intake

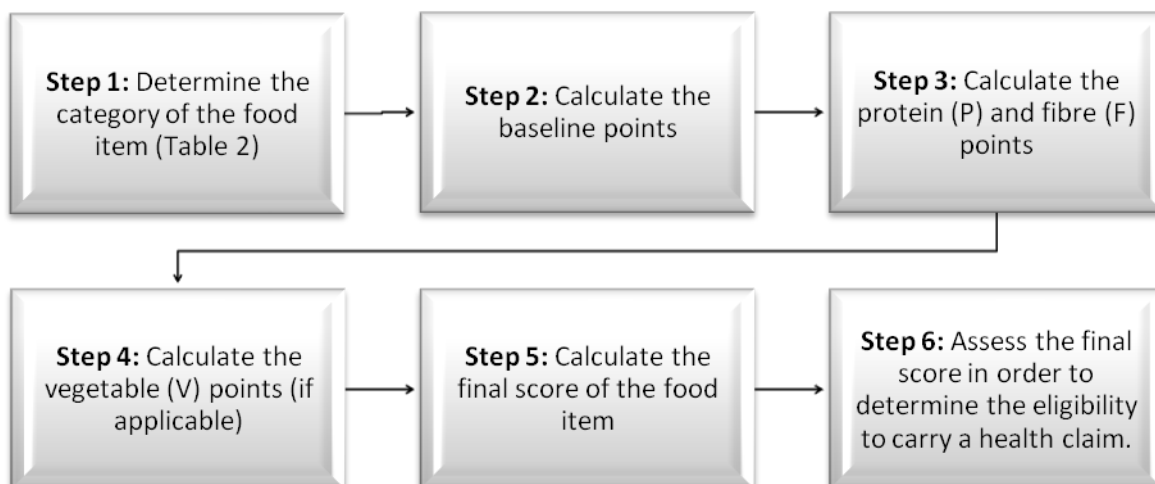
2.7 The FSANZ nutrient profiling model

The aim of the FSANZ (FSANZ, 2009) model is to determine if a specific food is eligible to carry general and high level claims based on its nutrient profile and it was developed to classify the foods of the population as a whole and not only part thereof (e.g. children).

The FSANZ model classifies foods high in sodium, saturated fat and sugar while recognising dairy products, fruit, vegetables, nuts, fish, lean meat and unsaturated fats as significant components of a healthy diet. The scoring of the FSANZ model can be explained as follows:

- The points allocated are based on the nutritional composition of 100g/100mℓ of a food product.
- Baseline point allocation is based on the total energy, saturated fat, total sugar and sodium content of each food product.
- The percentage of fruit and vegetables (including legumes and nuts), and the protein and fibre content of each food products makes up the Vegetable (V), Protein (P) and Fibre (F) points of the calculation. This part of the calculation will only be relevant if the product in question scored less than 11 baseline points.
- The final score = Baseline Score – V points – P points – F points.

The best way to understand the FSANZ model is to divide it into several steps:



Step 1: Determine the category of the food item

All food products are divided into one of three categories as described in Table 2

Table 2 Food product categories of the FSA NZ model

CATEGORY	FOOD PRODUCTS INCLUDED	SCORING CRITERIA
Category 1	Beverages (excluding milk, which meets the definition for a category 2 product)	A category 1 food is regarded as eligible to carry a claim if it's final score is <1 point.
Category 2	All foods not included in either category 1 or 3 and milk or evaporated milks or dried milks.	A category 2 food is regarded as eligible to carry a claim if it's final score is <4 points.
Category 3	Category 3: Cheese and processed cheese, edible oil, edible oil or spreads, margarine and butter.	A category 3 food is regarded as eligible to carry a claim if it's final score is <28 points.

Step 2: Calculate the baseline points

Once a product has been placed in category 1, 2 or 3, its baseline points can be calculated. Baseline point allocation is based on the total energy, saturated fat, total sugar and sodium content of each food product per 100g/100mL of food product.

For category 1 and 2 products a maximum of 10 baseline points can be awarded per nutrient. Table 3 is used to determine the score for each nutrient.

For category 3 a maximum of 23 baseline points can be awarded per nutrient. Table 4 can be used to determine the score of each nutrient.

For all three categories:

Total baseline score = (points for average energy content) + (points for saturated fatty acids) + (points for total sugars) + (points for sodium)

Table 3 Baseline points for category 1 and 2 products

Points	Average energy content (kJ) per 100g or 100mℓ	Saturated fatty acids (g) per 100g/100mℓ	Total sugars (g) per 100g/100mℓ	Sodium (mg) per 100g/100mℓ
0	≤ 335	≤ 1	≤ 4.5	≤ 90
1	>335	> 1	> 4.5	> 90
2	>670	> 2	> 9	> 180
3	> 1005	> 3	> 13.5	> 270
4	> 1340	> 4	> 18	> 360
5	> 1675	> 5	> 22.5	> 450
6	> 2010	> 6	> 27	> 540
7	> 2345	> 7	> 31	> 630
8	> 2680	> 8	> 36	> 720
9	> 3015	> 9	> 40	> 810
10	> 3350	> 10	> 45	> 900

Table 4 Baseline points for category 3 products

Points	Average energy content (kJ) per 100g/100mℓ	Saturated fatty acids (g) per 100g/100mℓ	Total sugars (g) per 100g/100mℓ	Sodium (mg) per 100g/100mℓ
0	≤ 335	≤ 1	≤ 4.5	≤ 90
1	>335	> 1	> 4.5	> 90
2	>670	> 2	> 9	> 180
3	> 1005	> 3	> 13.5	> 270
4	> 1340	> 4	> 18	> 360
5	> 1675	> 5	> 22.5	> 450
6	> 2010	> 6	> 27	> 540
7	> 2345	> 7	> 31	> 630
8	> 2680	> 8	> 36	> 720
9	> 3015	> 9	> 40	> 810
10	> 3350	> 10	> 45	> 900
11	> 3685	> 11		> 990
12		> 12		> 1080
13		> 13		> 1170
14		> 14		> 1260
15		> 15		> 1350
16		> 16		> 1440
17		> 17		> 1530
18		> 18		> 1620
19		> 19		> 1710
20		> 20		> 1800
21		> 21		> 1890
22		> 22		> 1980
23		> 23		> 2070

Step 3: Calculate the protein (P) and fibre (F) points

Foods products with a baseline score of 11 or more are not allowed to score P points unless they score the maximum number of points allowed for fruit, vegetables, nuts and legumes.

A maximum of five P points and five F points may be awarded. Both the P and F points are scored per 100g/mL of product.

Table 5 can be used to award P and F points.

Table 5 Protein points (P points) and fibre points (F points)

Points	Protein (g) per 100g or 100mℓ	Fibre (g) per 100g or 100 mℓ
0	≤ 1.6	≤ 0.9
1	> 1.6	> 0.9
2	> 3.2	> 1.9
3	> 4.8	> 2.8
4	> 6.4	> 3.7
5	> 8.0	> 4.7

Step 4: Calculate the vegetable points

To calculate the V points the quantity of the following characteristics of the food item will be required:

- percentage of the non-concentrated fruit, vegetable, legumes and nuts (FVLN); and
- percentage of the concentrated (dried) fruit and-, vegetable ingredients; and
- percentage of non-FVLN ingredients of the food product.

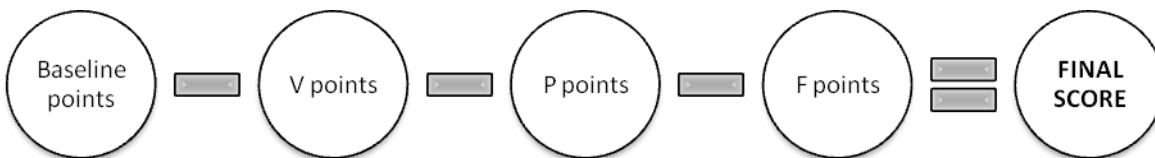
Due to low moisture content, nuts, legumes, coconut, spices, herbs, fungi, seeds and algae are classified as non-concentrated and therefore concentrated (dried) refers only to fruit and vegetables rather than FVLN.

Use Table 6 to determine the V points. V points are divided into two columns where points can be scored based on whether the fruit, vegetable, legumes and nuts in the food item are concentrated or not.

Table 6 Fruit and vegetable points (V points)

	Column 1	Column 2
Points	% concentrated fruit, vegetable and legumes	% fruit, vegetables, nuts and legumes
0	< 25	≤ 40
1	≥ 25	> 40
2	≥ 43	> 60
5	≥ 67	> 80

Step 5: Calculate the final score



Step 6: Assess the final score in order to determine the eligibility to carry a health claim.

A product’s eligibility to carry a health claim is not only determined by the final score, but also by the category the product was classified as. Examples of how the NPM classifies food items is illustrated in Table 7. Refer to Table 2 in order to determine the eligibility to carry a health claim.

Table 7 Examples of food item classification by the nutrient profiling model*

Food name	Category	Average energy content (kJ) per 100g or 100mL		Saturated fatty acids (g) per 100g or 100mL		Total sugars (g) per 100g or 100mL		Sodium (mg) per 100g or 100mL		Baseline points	% concentrated fruit, vegetable and legumes		% fruit, vegetables, nuts and legumes		Protein (g) per 100g or 100mL		Fibre (g) per 100g or 100mL		Final score	YES/NO
		/100g	Pt	/100g	Pt	/100g	Pt	/100g	Pt		value	Pt	value	Pt	/100g	Pt	/100g	Pt		
Cold drink, carbonated	Category 1	175	0	-	0	10,3	2	7	0	2	-	0	-	0	-	0	-	0	2	NO
100% Guava Juice	Category 1	208	0	-	0	-	0	6	0	0	-	0	100	0	0,2	0	0,3	0	0	YES
High fibre biscuit	Category 2	1770	5	4,34	4	8,5	1	710	7	17	-	0	-	0	11,4	0	1,9	1	16	NO
Milk, low fat (2%)	Category 2	213	0	1,28	1	0	0	46	0	1	-	0	-	0	3,3	2	0	0	-1	YES
Butter	Category 3	3040	9	47,7	30	0	0	826	9	48	-	0	-	0	50,56	0	0	0	48	NO
Cheese, Gouda	Category 3	1577	4	18,7	18	0	0	511	5	27	-	0	-	0	23,9	0	0	0	27	YES

* Nutrient values based on South African Medical Research Council (MRC) food composition tables (Wolmarans *et al.*, 2010)

2.8 The importance of validating the nutrient profiling model

Testing validity is an absolute essential step in developing a nutrient profile model. According to Steiner & Norman (2001), the level of confidence we are able to place on assumptions we make about people, based on their scores from a health scale, is really only established by validating a nutrient profiling model. Differently put, nutrient profiling is an “instrument” to score the healthiness of foods, and, just as a piece of medical equipment/instrument needs to be tested before it can be marketed/used, nutrient profiling models should also be validated and tested, before being implemented in the Public Health sector (Arambepola, *et al.*, 2008). If proper validation is not done, the food industry and nutrition scientists can't be expected to have any confidence in the model.

In 2011 the WHO developed a document named ‘Guiding principles and framework manual for the development or adaptation of nutrient profile models’ with the purpose of providing support for organisations and institutions, such as government ministries and agencies, food producers and retailers, as well as non-governmental organisations concerned with food and health issues, to develop or adapt nutrient profiling models (WHO, 2011b).

The document describes a whole series of validation tests to be done in the validation of a nutrient profiling model:

- Content validity – described as ‘the extent to which the measurement incorporates the domain of the phenomenon under study’ (Last, 2001).
- Convergent validity – described as ‘the extent to which the measurement correlates with an external criterion, of the phenomenon under study, at the same point in time’ (Last, 2001).
- Discriminant – Arambepola *et al.* (2007) described discriminant validity as the comparison with measures of variables that are not closely related.
- Construct validity – described as ‘the extent to which the measurement corresponds to theoretical concepts (constructs) concerning the phenomenon under study’ (Last, 2001).
- Predictive validity - is described as ‘the extent to which the measurement is able to predict an external criterion of the phenomenon under study’ (Last, 2001).

The validation processes, as described in the WHO guideline (WHO, 2011) falls mainly in two categories:

1. To ensure that the classification of food items by the nutrient profiling model is credible and,
2. To consider the role of the 'healthiness' of food items in sustaining human health.

The first category deals with the accuracy, consistency and credibility of the way the nutrient profiling model classifies food items. This category is also classified as the most important concern for the developers of NPMs and the WHO motivates that all the validation processes within this first category should be done by totally newly developed or adapted nutrient profiling models. The validation processes in this category are:

- To identify a small number of 'indicator' foods and assess whether the results produced by the nutrient profiling model contradicts the FBDG's. This is a type of 'content validity' assessment. The aim of this assessment is to determine if any obvious inconsistencies, which may weaken the credibility of the nutrient profiling model, exist. This is a weak form of validation (WHO, 2011).
- To develop dataset of nutrient composition of foods representative of the population. These foods should then be ranked in order of healthiness by a sample of nutrition experts. This ranking is compared to the way the nutrient profiling model classifies the foods. This reasonably strong form of validation determines whether the way the nutrient profiling model categorises food agrees with the views of nutrition experts (WHO, 2011).
- To compare the results from the model being validated with previously validated models. This determines the convergent validity (WHO, 2011).

The second category of validation processes are more complicated and validates the concept of nutrient profiling, for example the role of the healthiness of food items in human health (WHO, 2011). These validation processes are as follows:

- Using appropriate dietary survey data to calculate the proportion of the respondents' diet consisting of healthy and unhealthy foods, as classified by the nutrient profiling model. Hereafter the quality of their diets is determined using a calibrated diet quality indicator and they are split into groups based on their dietary quality. The percentage of the respondents' diets consisting of healthy foods is compared with their dietary quality, with the belief that healthier diets will consist of a greater proportion of healthy foods compared to unhealthy diets. This determines construct validity and is a rather strong form of validation (WHO, 2011).
- Assembling two diets, one theoretically healthy and the other theoretically unhealthy, with the use of nutrient recommendations. Using a nutrient composition dataset as classified

by the nutrient profiling model, it can be determined if it is possible to assemble a theoretically healthy/unhealthy diet using only foods that are classified as healthy/unhealthy by the nutrient profiling model. The expectation would be that it is possible. This determines construct validity and is a rather strong form of validation (WHO, 2011).

- Using appropriate prospective cohort data with baseline information on food consumption. The cohort is split into groups based on the percentage of their diet consisting of healthy foods (according to the nutrient profiling model). This is used to determine the incidence of diet-related diseases in the various groups, with the expectation that the group with the largest consumption of healthy foods at baseline would have a lowered risk of diet related diseases. This is a very strong form of validation and determines predictive validity (WHO, 2011).

2.9 Construct validity as part of the validation process

As mentioned in the previous section, there are several different types of validity testing WHO (2011). It is important to note that this project is part of a bigger study, conducted by Wentzel-Viljoen and researchers (2012), to test the validity of a NPM for South Africa. This mini-dissertation only deals with the second category of validation as mentioned in section 2.8 and specifically evaluates the construct validity. The content and convergent validity was addressed in the other part of the study by Wicks *et al.* (2012).

Construct validity refers to whether or not the scale being tested, in this case the NPM correlates with the theorised scientific construct that it measures, in this case the healthiness of diets (Cronbach & Meehl, 1955). According to the WHO guideline (WHO, 2011) evaluation of construct validity involves testing whether:

- healthy foods (as identified by the nutrient profile model) make healthy diets (as defined by an independent, preferably validated dietary quality index);
- unhealthy foods make unhealthy diets.

In determining the construct validity of a NPM the relationship between the way the NPM evaluates individual foods and the 'healthiness' of the diets in South Africa will be compared. This is that the 'healthiness' of a diet as well as the 'healthiness' of an individual food can both be observed as theoretically related 'constructs' (Arambepola *et al.*, 2008). The evaluation of

construct validity by using existing dietary data is especially useful because it is stripped of subjective opinion (Volatier, *et al.*, 2008).

The expectation when implementing a NPM is that the intake of healthy food will lead to a healthier diet and ultimately to better health. When evaluating construct validity of a nutrient profiling model the aim is to test whether or not the intake of food depicted as healthy by the nutrient profiling model will in fact lead to healthier diets.

2.10 Assumptions

A number of assumptions were made in order to validate the nutrient profiling model:

2.10.1 Total sugar

When using the NPM the total amount of total sugar is needed. Since the nutrient profiling model was based on the FSANZ model, the way FSANZ defines total sugar is applicable. According to FSANZ total sugar includes all added mono- and disaccharides as well as intrinsic sugars such as fructose and lactose. For the purposes of this study the Condensed Food Composition Tables of South Africa (Wolmarans *et al.*, 2010) were used. These food composition tables only give the amount of added sugar in g/100g. By definition added sugar is all mono- or disaccharides added to food, not including sugars naturally occurring in foods such as the fructose in fruits or the lactose in milk. For the purposes of this study the assumption was made that the added sugar of all foods, as given in the food composition tables, will be used as the sugar component of the nutrient profiling model.

2.10.2 Fruit, vegetable, nut and legume content

In cases where the labels of food items gave no indication of the percentage of fruit, vegetable, nuts or legumes present in the food, it was assumed that the food item contained no fruits, vegetables, nuts or legumes.

2.11 Diet Quality

The 'reductionist'/'less is more' approach of focusing on the impact of single nutrients in the prevention/development of disease has long been the focus in nutritional epidemiology (Waijers *et al.*, 2006). However this approach has its limitations due to the fact that supplementation with single nutrients failed to protect against cancers (The Alpha-Tocopherol Beta-carotene Cancer Prevention Study group, 1994; Omenn *et al.*, 1996) and CVD (Bjeklacovic *et al.*, 2008). What should be taken into account is that foods may, due to its bio-chemical complexity, interact with one another (Dolman *et al.*, 2013; Waijers *et al.*, 2006). For this reason dietary patterns have been receiving an increased amount of attention over the last few decades and the assessment of the diet is being approached in a more holistic way. In this approach not only nutrients, but also the dietary quality, the intricacy of dietary behaviours and interactions are considered. One way to measure the quality of the diet is the use of theoretically defined dietary patterns founded on existing nutrition knowledge (Waijers *et al.*, 2006).

In the WHO guidelines, with regard to nutrient profiling models (WHO, 2011) in the section on content validity, it is stated that a known, calibrated index of dietary quality should be used in the validation process covered in this study. The 'healthiness' of the respondents' diets should be calculated using a known method of determining diet quality, for example diet quality scores (Arambepola *et al.*, 2008; WHO, 2011).

Several diet quality scores exist and it is necessary to decide on a specific score to use for the validation. Theoretically any correlation between the performance of the NPM and any diet quality score will be determined by the criteria used in calculating the quality score. In evaluating the British NPM the Patterson diet quality index (DQI) was used due to the fact that it has been assessed for its predictive validity and assesses overall dietary patterns and estimates the risk for chronic (non-communicable) diseases (Arambepola *et al.*, 2008). The DQI measures, just like the NPM, not '*whether or not the diet is adequate*' but '*whether the diet lowers or elevates ones risk of developing non-communicable diseases*'. The components of the DQI closely correlates with the different nutrients food components such as fruit and vegetables used as the focus of the NPM. This is exactly what makes the DQI a much more suitable diet quality index to test the NPM with, compared to indexes such as the Healthy Diet Indicator (HDI) (Hujbregts *et al.*, 2009) or the Thiele-index (Thiele *et al.*, 2004). The HDI and the Thiele-index uses a much larger collection of nutrient components, including vitamins and minerals, than the NPM and is aimed at the adequacy and not

only the prudence of the diet. Lastly, the vitamins and minerals included in the Thiele-index and HDI is not always available on food labels, a fact which also contributed to the decision to use the DQI.

The DQI (Table 8) was developed in 1994 by Patterson *et al.* (1994) to determine the overall dietary intake patterns and to use these patterns in the prediction of the risk for chronic diseases. A higher DQI-score is indicative of a poorer diet quality.

The DQI (Table 8) consists of the intakes of eight components related to disease and health risk, namely: total fat, saturated fat, total cholesterol, number of servings of fruit and vegetables, the number of servings of starch and legumes, protein, sodium and calcium (Seymour *et al.*, 2003) (Patterson *et al.*, 1994). The cut-off points for each of the components are based on diet recommendations by the WHO. Seymour *et al.* (2003) adapted the cut-off points to ensure that it takes the changes in the dietary recommendations by the WHO into account. These adaptations will be used this study. Table 8 gives a summary of the eight components and their cut-off points.

Table 8 Recommendations, scores and cut-points for the eight components of the Diet Quality Index

Dietary recommendation	Score	Cut-point
Reduce total fat intake to \leq30% of energy	0	\leq 30%
	1	>30-40%
	2	>40%
Reduce saturated fatty acid intake to <10% of energy	0	<10%
	1	10-13%
	2	>13%
Reduce cholesterol intake to <300 mg/day	0	<300 mg
	1	300-400 mg
	2	>400 mg
Eat five or more servings daily of a combination of vegetables and fruits	0	\geq 5 servings
	1	3-4 servings
	2	0-2 servings
Eat six or more servings daily of breads, cereals, and legumes	0	\geq 6 servings
	1	4-5 servings
	2	0-3 servings
Maintain protein intake at moderate levels (lower than twice the RDA[‡])	0	\leq 100% RDA
	1	>100-150% RDA
	2	>150% RDA
Limit total daily intake of sodium to \leq2,400 mg	0	\leq 2400 mg
	1	>2400-3400 mg
	2	>3400 mg
Maintain adequate calcium intake (approximately DRI[§] levels)	0	\geq DRI
	1	2/3 DRI-<DRI
	2	<2/3 DRI

* Adapted from Seymour *et al.*

‡ RDA - Recommended Dietary Allowance

§ DRI - Dietary Reference Intake

2.12 Conclusion

This concludes the literature review of this mini-dissertation. In this literature review the following were discussed: the global NCD burden and its connection to healthy eating habits, nutrient and health claims, labelling legislation in South Africa, the concept of nutrient profiling, identifying a nutrient profiling model for South Africa, an in-depth discussion of the FSANZ model, the validation of a nutrient profiling model and specifically the construct validity of a nutrient profiling model.

The next chapter (Chapter 3) contains an article based on the validations done to prove the construct validity of a nutrient profiling model for South Africa.

CHAPTER 3

3. ARTICLE

Using existing dietary data to evaluate the construct validity of a nutrient profiling model for South Africa

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Abstract

Objectives: 1) To test construct validity for the nutrient profiling model by examining the relationship between the way the nutrient profile model (NPM) categorises foods and the healthiness of diets in South Africa. 2) To assess if the quality of a diet will improve if 'unhealthy' foods are replaced by 'healthy' foods as defined by the NPM.

Design: Nested in the South African leg of the international PURE (Prospective Urban and Rural Epidemiology) study at baseline.

Setting: South Africa

Methods: The PURE (Prospective Urban and Rural Epidemiology) baseline study conducted in the North-West province in 2005 was identified as a suitable dataset of food intake. For the first objective the proportion of respondent's diets consisting of healthy or unhealthy food, as classified by the NPM, was calculated. The respondents were divided into four groups based on their dietary quality as characterised by the Diet Quality Index (DQI), the lower the DQI-score the better the diet quality. The proportion of healthy or unhealthy foods were compared to the DQI-scores using one-way ANOVA's, p-values were calculated using the Tukey post-hoc test. For the second objective the diet quality of four different diets consisting of either YES foods (according to NPM), NO foods, a combination of YES and NO were calculated and compared.

Results: The model displayed good construct validity by showing a statistically significant positive relationship between the proportion of 'healthy' ($p < 0.0001$) and 'unhealthy' ($p < 0.0001$) foods, as classified by the NPM, and participants' DQI-scores. The second objective was also confirmed and a diet consisting of 'healthy' foods or a diet where 'unhealthy' foods were substituted by 'healthy' foods, had a better DQI than diets consisting only on 'unhealthy' foods

Conclusion: Construct validity was confirmed by proving that the better the diet quality of the respondents the bigger their proportion of foods categorised as 'healthy' by the NPM and vice versa.

Keywords: Nutrient profiling model, construct validity, healthiness of food

Introduction

Non-communicable diseases (NCDs) are the leading public health issue globally. According to the WHO's 2010 Global Status Report on NCDs, NCDs accounted for almost two thirds of all deaths globally, with cardiovascular diseases, cancer, diabetes and chronic lung disease as the major contributors⁽¹⁾. In the same report it is reported that almost 80% of all NCDs occur in low- to middle income countries of which South Africa is one. NCD deaths are estimated to increase globally by 15% between 2010 and 2020, with the greatest increase in Africa, South-East Asia and Eastern Mediterranean; where the increase could be as much as 20%⁽²⁾. According to the WHO report on NCDs in South Africa, for the year 2010, 28% of all deaths in South Africa were due to NCDs⁽³⁾.

The WHO states that NCDs are triggered by a set of preventable risk factors which are the leading cause of death regardless of economic development⁽¹⁾. These risk factors include: Hypertension (accounting for 13% of deaths globally), smoking (9%), elevated blood glucose levels (6%), physical inactivity (6%), overweight and obesity (5%)^(1,4). When looking at the prevalence of these risk factors in the South African population, 28% of deaths in South Africa are NCD-related⁽¹⁾. A staggering 65,2% of all South Africans are overweight, 42,2% have elevated blood pressure, 34% have elevated cholesterol levels, 31,3% are obese and 10,6% have increased blood glucose levels⁽³⁾.

South Africa is currently in a nutrition transition, a phenomenon which occurs when populations change their nutrient intakes and dietary patterns by accepting westernised lifestyles⁽⁵⁾. In isolation a nutrition transition already poses enormous challenges to the public health sector of any given country, but for South Africa this is not where it ends. South Africa is facing what has been described by Bradshaw *et al.*⁽⁶⁾ as a quadruple burden of disease. This is a jumble of NCDs, diseases related to pre-transitional times (such as poverty related malnutrition), injuries and the human immunodeficiency virus (HIV)⁽⁶⁾. Not one of these four components of South Africa's quadruple burden of disease could be ignored and strategies should be put in place in an attempt to lessen the burden of disease.

When examining the current global situation as well as the South African situation in particular, with regard to NCDs, it becomes evident that action needs to be taken against the development of NCDs in order to stop this group of diseases from mercilessly killing millions each year.

According to the WHO, unhealthy diets are regarded as a leading cause of NCDs globally, predominantly stroke, heart disease and various forms of cancer⁽⁷⁾. In the same joint report by the WHO and the FAO, it was reported that by altering lifestyle factors, as much as 90% of type 2 diabetes cases and 80% of coronary heart disease cases could likely be avoided. Also approximately 33% of all cancers can be prevented by sustaining a normal weight, regular life-long exercise and a healthy diet⁽⁷⁾.

This means that if a population can be moved towards healthier diets it may lead to a decrease in the NCD risk of that specific population. Therefore, a public health approach in the battle against NCDs, would be for a country to implement and improve legislation aiming to better the food intake of the population. One such approach would be to implement a nutrient profiling model as part of the food labelling legislation regarding the health and content claims made on food products.

Generally nutrient profiling can be defined as the science of categorising food according to their nutrient composition^(8,9,10). Previously nutrient density scores were only associated with and applied to the diet as a whole, however, with the science of nutrient profiling, nutrient density scores were adapted to be applied to single foods⁽¹¹⁾. Nutrient profiling models should be based on a uniform, rigorous and science-driven base⁽¹¹⁾.

According to Verhagen & Van den Berg⁽¹²⁾, nutrient profiling can be done for a variety of intentions, including the following: 1) to evaluate the nutritional quality of individual foods, 2) to move consumers to make healthier food choices, 3) to control the promotion of foods to children, and 4) identifying food products eligible to carry a health or content claim. The latter is the main rationale behind the decision of the South African Department of Health, Directorate: Food Control, to implement a nutrient profiling model as part of the South African food labelling legislation.

In 2010 Wentzel-Viljoen *et al.*⁽¹³⁾ completed a report on 'Evaluation of existing nutrient profiling models. The report concluded that the Australian and New Zealand Nutrient Profiling Model (FSANZ-model) is recommended for use in South Africa as a tool to determine if a food is eligible to carry a health claim or not.

Testing validity is an absolute essential step in developing a nutrient profile model. According to Steiner & Norman⁽¹⁴⁾, the level of confidence we are able to place on assumptions we make about people, based on their scores from a health scale, is really only established by validating the health scale in question. Differently put, nutrient profiling is an 'instrument' to score the healthiness of foods, and, just as a piece of medical equipment/instrument needs to be tested before it can be marketed/used, nutrient profiling models should also be validated and tested, before being implemented in the Public Health sector⁽¹⁵⁾.

In 2011 the WHO released a document named 'Guiding principles and framework manual for the development and implementation of nutrient profile models'⁽¹⁶⁾ to be used by countries as a guiding tool. During the whole process of implementing a nutrient profile model for South Africa these guidelines were followed. In this document various validations are mentioned including content validity, criterion validity, convergent and discriminant validity, predictive validity and construct validity. This study focused only on construct validity.

Construct validity refers to whether or not the scale being tested, in this case the nutrient profiling model correlates with the theorised scientific construct that it measures, in this case the healthiness of diets⁽¹⁷⁾. According to the WHO guideline⁽¹⁶⁾ evaluation of construct validity involves testing whether:

- healthy foods (as identified by the nutrient profile model) make healthy diets (as defined by an independent, preferably validated dietary quality index);
- unhealthy foods make unhealthy diets.

In this study construct validity was evaluated using two approaches:

1. The aim of the first approach was to examine the relationship between the ways the NPM categorises foods and the healthiness of diets in South Africa.
2. The aim of the second approach was to assess if the quality of a diet can improve when foods not eligible to carry a health claim are replaced by foods that would be eligible to carry a health claim as defined by the nutrient profile model.

Methods

Study design

This study was nested in the South African leg of the international PURE (Prospective Urban and Rural Epidemiology) study at baseline.

Study population and dietary data collection

The PURE (Prospective Urban and Rural Epidemiology) baseline study conducted in the North-West province amongst Setswana speaking individuals in urban and rural areas was identified as a suitable dataset to use for the purposes of validating a nutrient profiling model. The PURE study was carried out in accordance with the guidelines in the Declaration of Helsinki, and the Ethics Committee of the North West University, South Africa approved all procedures involving human volunteers (No. 04M10). The study was explained to all volunteers in their home language after which they signed an informed consent form. The study was conducted amongst volunteers recruited from 6000 randomly selected households and the study population consisted of black South African men (n=750) and women (n=1260). All volunteers were included if they reported to be healthy. Any volunteers using chronic medication for non-communicable diseases and/or any self-reported illness were excluded. The anthropometric and/or dietary data for some of the volunteers could, for various reasons, not be collected, and as a result they were excluded from the total study population. A total of 1710 volunteers were included in the final study population⁽¹⁸⁾.

The dietary intake of the participants was obtained through a validated, culturally sensitive Quantified Food Frequency Questionnaire (QFFQ) with a good reproducibility⁽¹⁸⁾. The QFFQ was previously developed⁽¹⁹⁾ and validated for this particular population⁽²⁰⁾. The QFFQ's were completed by trained fieldworkers in the home language of the participants and were concerned with the food intake over the past 30 days. Food portion photographs⁽²¹⁾, appropriate containers, utensils and examples of certain foods were used to report portion sizes. This was done in household measures and converted to weights with the use of standard food quantity tables⁽²²⁾. The South African Food Composition Database System of the South African Medical Research Council was used to calculate the daily nutrient and food group intakes of the participants⁽²³⁻²⁵⁾.

Calculation of nutrient profiling scores

A software program was developed to calculate the nutrient profiling scores of food items, based on the FSANZ nutrient profiling model⁽²⁶⁾. The software programme was used to calculate the final score of each of the foods consumed by the PURE population, according to their specific NPM food category. The final score of each food item determined the eligibility of the food item to carry a nutrient and/or health claim or not. A food eligible to carry a health claim were marked 'YES' and a food not eligible to carry a health claim was marked 'NO'. More than 180 food items from the PURE-2005 dataset were "tested" using the NPM.

For the first construct validity approach a list of foods from the various food groups were generated for each participant. After calculating the nutrient profiling score of each food item, the foods eaten by each participant were then split into foods eligible to carry a nutrient and/or health claim and foods not eligible to carry a nutrient and/or health claim.

For the second approach four menus were compiled consisting of typical food items consumed by the population of the PURE study. A 24-hour recall was also completed for each participant in the PURE 2005 baseline collection and this was used, together with the Food Based Dietary Guidelines (FBDGs)⁽²⁷⁾ to compile a diet consisting only of food characterised as 'being eligible to carry a health claim' by the NPM (referred to as the YES diet). The second menu only contained food characterised as 'not being eligible to carry a health claim' by the NPM (referred to as the NO diet). Both diets were analysed for energy, macro and micro-nutrient composition using FoodFinder 3 that is based on The South African Food Composition Database System of the South African Medical Research Council (MRC)⁽²³⁻²⁵⁾. A third menu (referred to as the COMBINED menu) was created by calculating the combined mean values of the nutrients from the YES and NO menus. In addition, four "NO" food items in the diet were substituted with "YES" food items to investigate its effect on dietary quality. Portions sizes were used according to the typical portion sizes reportedly consumed by the PURE 2005 population. If portion sizes were in household quantities the MRC Food Quantities Manual⁽²²⁾ was used to convert it to weights of food.

Diet quality

In the WHO guidelines for development or adaption of nutrient profiling models⁽¹⁶⁾, the section on construct validity, states that a known, calibrated index of dietary quality should be used in the validation process of a NPM.

Several diet quality scores exist and it is necessary to decide on a specific score to use for this validation. Theoretically any correlation between the performance of the NPM and any diet quality score will be determined by the criteria used in calculating the quality score. In evaluating the British NPM, the Patterson diet quality index (DQI) was used due to the fact that it has been assessed for its predictive validity and assesses overall dietary patterns and estimates the risk for chronic (non-communicable) diseases⁽¹⁵⁾. The DQI measures, just like the NPM, not whether or not the diet is adequate, but whether the diet lowers or elevates ones risk of developing non-communicable diseases. The focus is on the prudency and not the adequacy of the diet.

The DQI consists of the intakes of eight components related to disease and health risk, namely: total fat, saturated fat, total cholesterol, number of servings of fruit and vegetables, the number of servings of starch and legumes, protein, sodium and calcium^(28,29). The cut-off points for each of the components are based on diet recommendations by the WHO. Seymour *et al.*⁽²⁸⁾ adapted the cut-off points to ensure that it takes the changes in the dietary recommendations by the WHO into account. These adaptations was used in this study. Table 1 gives a summary of the eight components and their cut-off points.

For the first construct validity approach, the nutrient and food-group data for each participant as calculated using the QFFQs and the South African Food Composition Database System was used to calculate the diet quality of each participant. However the following modification was made: One limitation of the QFFQ is that it does not specifically evaluate the discretionary salt intake of the participants. It was showed by Charlton *et al.*⁽³⁰⁾ that discretionary salt intake accounted for 45.5% of the total Na intake in black South Africans. For this reason the sodium intake of the population was adjusted by adding 46% to the sodium intake. This modification was also made by Dolman *et al.*⁽³¹⁾ in calculating diet quality scores of the PURE population.

In calculating the number of portions per day from the various food groups, the Food Based Dietary Guidelines for South Africa (FBDG) booklet for adults (25-60 years of age) was used⁽²⁷⁾. In order to differentiate between the participants based on their DQI scores, they were divided into four groups based on the cut-points used by Arambepola, *et al.*⁽¹⁵⁾ in validating the UK nutrient profiling model. The four groups were named most healthy (DQI \leq 5), healthy (DQI = 6-7), less healthy (DQI = 8-9) and least healthy (DQI \geq 10) (Table 2).

For the second approach the DQI for each of the four menus was calculated to characterise the healthiness of all four menus. It is important to remember that the lower the DQI score, the better the diet quality of an individual. In order to differentiate between the participants based on their DQI scores, they were divided into four groups based on the cut-points used by Arambepola, *et al.*⁽¹⁵⁾ (as illustrated in Table 2) in validating the UK-NPM. The four groups were named Most Healthy, Healthy, Less Healthy and Least Healthy.

Table 1 Recommendations, scores and cut-points for the eight components of the DQI*

Dietary recommendation	Score	Cut-point
Reduce total fat intake to \leq30% of energy	0	\leq 30%
	1	>30-40%
	2	>40%
Reduce saturated fatty acid intake to <10% of energy	0	<10%
	1	10-13%
	2	>13%
Reduce cholesterol intake to <300 mg/day	0	<300 mg
	1	300-400 mg
	2	>400 mg
Eat five or more servings daily of a combination of vegetables and fruits	0	\geq 5 servings
	1	3-4 servings
	2	0-2 servings
Eat six or more servings daily of breads, cereals, and legumes	0	\geq 6 servings
	1	4-5 servings
	2	0-3 servings
Maintain protein intake at moderate levels (lower than twice the RDA¥)	0	\leq 100% RDA
	1	>100-150%
	2	RDA >150% RDA
Limit total daily intake of sodium to \leq2,400 mg	0	\leq 2400 mg
	1	>2400-3400
	2	mg >3400 mg
Maintain adequate calcium intake (approximately DRI§ levels)	0	\geq DRI
	1	2/3 DRI-<DRI
	2	<2/3 DRI

* Adapted from Seymour *et al.*

¥ = RDA - Recommended Dietary Allowance,

§ = DRI - Dietary Reference Intake

Table 2 DQI groups based on cut-points

Most healthy Group 1	Healthy Group 2	Less Healthy Group 3	Least healthy Group 4
DQI ≤ 5	DQI = 6 – 7	DQI = 8 - 9	DQI ≥ 10

Based on the cut-points used by Arambepola, *et al.*⁽¹⁵⁾

Statistical analysis

As a last step in completing the first construct validity approach the proportion YES or NO foods of each participant were compared to their DQI-scores using one-way ANOVA's, p-values were calculated using the Tukey post-hoc test. The Statistica 10 software package was used.

Results

Results from the first construct validity approach

Table 3 illustrates the p-values for the 'NO'- foods consumed between the different DQI categories. The differences in the amount of NO foods between the DQI groups 1,2 and 3 were statistically significant ($p < 0.05$), indicating a statistically higher % NO foods as the diet quality decreases. However no statistical significant difference in NO foods were observed between DQI group 3 and 4.

The same pattern was observed when examining the amount of 'YES' foods consumed between the different DQI categories (Table 4). Statistically significant differences in the amount of YES foods were observed between DQI groups 1,2 and 3, indicating a statistically higher percentage YES foods as the diet quality increases. Again no significant difference in percentage NO foods were observed between DQI group 3 and 4. Figure 1 gives a clear indication of the patterns observed when examining the way the amount of YES and NO foods differs with a difference in diet quality.

Results from the second construct validity approach

The NO diet had a DQI score of 13, and was therefore characterised as least healthy by the DQI. The YES diet had a DQI score of 7, and was therefore in the second cut-off group of the DQI, indicating that it is characterised as 'healthy'. The influence of the NO diet was so big that even

though the COMBINED diet had a lower DQI score (11) than the NO diet, it was still not low enough to be characterised as healthier than the NO diet. The diet with four NO items were replaced with YES items the DQI changed from a score of 13 to 9 (moving from Least Healthy to Less Healthy).

Table 3 The differences in the amount of NO foods consumed by the individuals of the PURE study, between the different DQI categories.

	Most healthy DQI ≤ 5 n = 1130	Healthy DQI =6-7 n = 562	Less healthy DQI =8-9 n = 201	Least healthy DQI ≥ 10 n =56
Most healthy DQI ≤ 5		p=0.000106*	p=0.000008*	p=0.037372*
Healthy DQI =6-7	p=0.000106*		p= 0.078815	p=0.731678
Less healthy DQI =8-9	P=0.000008*	p=0.078815		p=0.985904
Least healthy DQI ≥ 10	P=0.037372*	p=0.731678	p=0.985904	

* A p-value of < 0.05 was considered statistically significant

Table 4 The differences in the amount of YES foods consumed by the individuals of the PURE study, between the different DQI categories.

	Most healthy DQI ≤ 5 n = 1130	Healthy DQI =6-7 n = 562	Less healthy DQI =8-9 n = 201	Least healthy DQI ≥ 10 n =56
Most healthy DQI ≤ 5		p=0.000068*	p=0.000008*	p=0.013022*
Healthy DQI =6-7	p=0.000068*		p=0.046726*	p=0.538915
Less healthy DQI =8-9	p=0.000008*	p=0.046726*		p=0.998233
Least healthy DQI ≥ 10	p=0.013022*	p=0.538915	p=0.998233	

* A p-value of < 0.05 was considered statistically significant

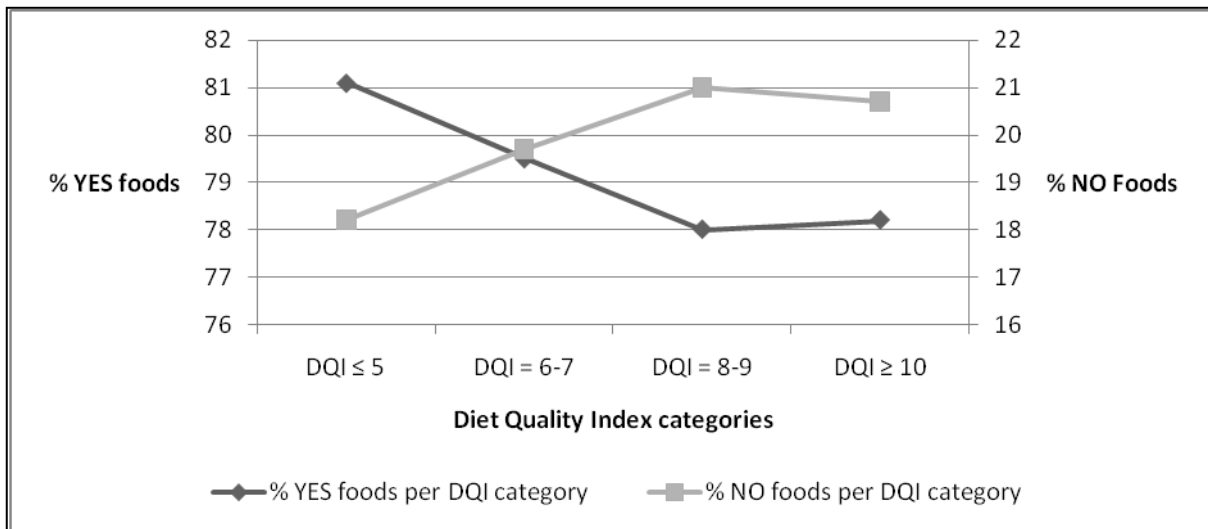


Figure 1 Percentage YES (primary y-axis) and NO foods (secondary y-axis) consumed per DQI group.

Discussion

It is noteworthy that the research done on the validation of nutrient profiling models is extremely limited, in fact, the validation of a nutrient profiling model has only been completed once, by Arambepola *et al.*⁽¹⁵⁾, preceding the research presented in this paper.

This paper was aimed at proving construct validity of a nutrient profiling model in South Africa and two approaches in this regard were performed. In the first approach construct validity was largely confirmed due to the fact that the amount of YES foods consumed by the participants had a statistically significant increase with an increase in the quality of respondents' diets, and the amount of NO foods consumed had a statistically significant increase as the diet quality decreases. This corresponds well with the findings of Arambepola *et al.*⁽¹⁵⁾ in the validation study of the UK NPM. The differences between both the consumption of YES and of NO foods and the diet quality in the fourth DQI group failed to show any statistical significance and seemed to have a slightly opposite effect than what is observed from the rest of the data. This does however not mean that construct validity is not confirmed, because it should be noted that only 56 participants had a diet quality poor enough to be grouped in the fourth DQI group, compared to the 1130 participants falling in the first DQI group. A possible explanation could be that the sample size of the fourth group was simply too small to give a true indication.

In terms of the second construct validity approach construct validity was again confirmed by proving that the diet quality of a diet consisting of only YES-foods had a much better diet quality (DQI = 7) than a diet consisting only of NO-foods (DQI = 13). This was further strengthened by the fact that when the four items of the NO-diet were replaced by YES-foods, the diet quality moved from a diet quality of 13 to a diet quality of 9, making it less unhealthy than before. This proves that only a few 'healthy' changes in the diets of consumers could already have an effect on their overall diet quality.

A limitation of nutrient profiling validation studies is that 'healthiness' as defined by the NPM can certainly not be regarded as the only determinant of a healthy diet. Other factors such as the variety of foods consumed, the portion sizes as well as the frequency of consumption all play a valuable role in determining the healthiness of diet ⁽¹⁵⁾. As mentioned before, the NPM does not deal with the adequacy of the diet, but the prudence of it. For this reason no-one should ever assume that just because a food is regarded as healthy by the NPM, it can be consumed in large, uncontrolled amounts. We were limited in that we had only the added sugar content of the products available (according to the South African MRC Food composition tables) and thus had to use that instead of using the preferable total sugar content.

In essence, however, this study proved that the NPM has an excellent correlation with a known and validated diet quality score, the DQI and will provide a scientific basis for nutrient and health claims in South Africa.

The inclusion of food items, regarded by the NPM as healthy, into the diets of free-living human beings could have an effect on the diet quality and possibly the future disease risk of such an individual (note that the DQI has been validated in terms of future disease risk). Furthermore, by validating the NPM, it strengthens the possibility that the implementation of the NPM as part of the labelling legislation of South Africa may move the industry to improving the nutrient profile and thus the 'healthiness' of their food items, which may in turn lead to healthier food choices and ultimately healthier diets.

Seeing that the WHO⁽⁷⁾ regards unhealthy diets as a major cause of NCDs worldwide and the fact that 28% of deaths in South Africa are due to NCDs⁽⁴⁾, the successful implementation of a NPM in South Africa may also lead to a reduction in the NCD risk of South Africans and ultimately a

reduction in the mortality rate of the country. This will prove the NPM as a very successful strategy to lower the quadruple burden of disease in South Africa.

The results of this validation study is entirely in agreement with the construct validation done on the UK model⁽¹⁵⁾, which served as the basis of the FSANZ⁽²⁶⁾ model on which our model were based. This proved that the NPM, even though originally developed for Europeans and then adapted for the Australian and New Zealand population, is indeed suitable to be implemented in the South African setting.

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CHAPTER 4

4. OVERALL CONCLUSIONS, LIMITATIONS AND RECOMMENDATIONS

The aim of the study presented in this master's mini-dissertation was the validation of a nutrient profiling model suitable for South Africa. The data presented in this thesis concerned only one of the validation methods described in the WHO document on 'Guiding principles and framework manual for the development or adaptation of nutrient profiling models' (WHO, 2011), namely construct validity. The other validity methods were completed by fellow researchers at the North West University.

This chapter is concerned with a short summary of the findings of this study:

4.1 Construct validity

In this study two different approaches to confirm construct validity was used. In the one the quality of the respondents diets were compared with the percentage of YES or NO foods present in their diets and in the other approach we compared the effect of YES or NO foods in series of generated diets on the diet quality of the diets in question.

In both these instances a very good correlation between the amount of YES foods in the diet and the quality of the diet was observed. This correlation indicated that the higher the percentage 'YES' foods in the diet, the higher the diet quality of the diet, indicating that the NPM is accurate in its classification of food products.

The NPM showed very good construct validity. Due to the fact that the WHO regards unhealthy diets as a major cause of NCDs worldwide (WHO, 2003) and 28% of deaths in South Africa are due to NCDs (Mayosi *et al*, 2009) the successful implementation of a NPM in South Africa may also lead to a reduction in the NCD risk of South Africans and ultimately a reduction in the mortality rate of the country. This will prove the NPM as a very successful strategy to lower the quadruple burden of disease in South Africa. Furthermore the excellent correlation between the NPM and a validated measurement of diet quality, such as the DQI, proves that the DQI is in fact the scientifically based alternative for Annexure 6, the DOH was looking for.

4.2 Limitations of the study

- I. It should be kept in mind that the NPM is concerned with the prudence of the diet and not the adequacy thereof; it can therefore not be regarded as a universal solution for all nutrition related problems. Even though validating the NPM means that the credibility of classification of foods by the NPM is confirmed, it doesn't mean any food regarded as healthy by the NPM can be eaten without restriction. Portion sizes of foods should still be taken into account by the consumer. For example, a diet high in kilojoules will still lead to obesity even if the consumer exclusively uses food classified as healthy by the NPM.
- II. The validation of nutrient profiling models is very new and has, to our knowledge, only been attempted once preceding this study. Therefore the findings of this study could not be compared to a large number of other studies.
- III. The total sugar content of products is taken into account when nutrient profiling scores of food items are calculated. We were limited in that we had only the added sugar content of the products available (according to the MRC Food composition tables) and thus had to use that instead of using the preferable total sugar content.

4.3 Recommendations

- I. As mentioned, this mini-thesis is only concerned with one leg of the validation process. On its own it can never confirm the validity of the NPM. Therefore it is strongly recommended that all other validation approaches, as done by other researchers at the North West University, also be reported on.
- II. It is strongly recommended that the NPM be updated regularly and validations be repeated where necessary, to keep up with all the new research in the field of nutrition.

CHAPTER 5

5. REFERENCES OF CHAPTERS 1,2 AND 4

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