THE EFFECTIVENESS OF FRONT-OF-PACK WARNING LABELS IN ASSISTING SOUTH AFRICAN CONSUMERS TO IDENTIFY UNHEALTHY PACKAGED FOODS

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KEYWORDS

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Food selection

Guideline Daily Amounts (GDA)

High in

Multiple Traffic Light (MTL)

Unhealthy foods

Purchasing intentions

Warning label (WL)

ACRONYMS

AESAN	Agency for Food Safety and Nutrition (France)
ANCOVA	Analysis of Covariates
BMREC	Biomedical Research Ethics Committee
BOP	Back-of-pack
BOPL	Back-of-pack labelling
CHD	Coronary heart disease
C–HIP	Communication–human information processing
CI	Confidence interval
COMA	Committee on Medical Aspects of Food Policy
COREQ	Consolidated Criteria for Reporting Qualitative Research
CVD	Cardiovascular disease
EA	Enumerator area
EUFIC	European Food Information Council
FAO	Food and Agriculture Organization
FCTC	Framework Convention for Tobacco Control
FOP	Front-of-pack
FOPL	Front-of-pack labelling
FSA	Food Standards Agency
FSANZ	Food Standards Australia New Zealand
GDA	Guideline Daily Amounts
GINA	Global Database on the Implementation of Nutrition Action
GTI	GEOTERRAIMAGE
HBM	Health Belief Model
HCSP	High Council for Public Health (France)
HIC	High-income countries
HSR	Health Star Rating
IARC	International Agency for Research on Cancer
IRB	International Research Board
LMIC	Low- and middle-income countries

MTL	Multiple Traffic Light
NCD	Noncommunicable disease
NID	National Income Dynamics Study
NLI™©	Neighbourhood Lifestyle Index®©
NIP	Nutritional information panel
NP	Nutrient profile
NPM	Nutrient Profile Model
PAHO	Pan American Health Organization
PI	Principal investigator
PUFAs	Polyunsaturated fatty acids
R146	Regulation 146
R3337	Regulation 3337
R429	Regulation 429
RCT	Randomised controlled trial
RI	Reference Intakes
RR	Relative risk
SADHS	South African Demographic and Health Survey
SANHANES-1	South African National Health and Nutrition Examination Survey
SFAs	Saturated fatty acids
SSB	Sugar-sweetened beverage
STARS	St Thomas' Atherosclerosis Regression Study
UK	United Kingdom
UNICEF	United Nations Children's Fund
UPF	Ultraprocessed food
VAT	Value-added tax
WHO	World Health Organization
WL	Warning label

ABSTRACT

Background

Unhealthy diets that are excessive in energy, saturated fats, trans-fat, sugar and salt are associated with obesity, hypertension, diabetes mellitus, coronary heart diseases and some cancers. Globally there is a decline in consumption of traditional diets and an increase in preference for energy-dense processed food, and South Africa is no exception in this regard. Concurrently, the prevalence of obesity and obesity-related complications is on the increase in South Africa and worldwide. The development of a simplified front-of-pack labelling (FOPL) system is one of the critical steps in assisting consumers to identify unhealthy food products and consequently contribute to stemming the obesity trajectory and its related complications.

Aims and objectives

The aim of this study was to evaluate the effectiveness of different FOPL systems. The study objectives were to explore the perceptions of adult consumers towards the WL and the design features that communicate warning to South African consumers. The second objective was to identify an effective FOPL system that would assist consumers to identify products high in nutrients of concern, identify unhealthy products and identify the FOPL system that reduced consumers' intention to purchase unhealthy products. The third aim was to evaluate the perceived effect of the most effective FOPL system on consumers' day-to-day food choices for their children.

Study design and data collection processes

A multiphase, mixed-methods design was utilised to achieve the study's objectives. The study was conducted in three phases, using both qualitative and quantitative approaches. The first qualitative study, constituting phase 1 of the study, was aimed at developing the most relevant warning label (WL) for South African consumers. In the randomised controlled trial (RCT), constituting phase 2 of the study, the WL developed in phase 1 was tested against two other existing FOPL systems (Guideline Daily Amounts (GDA) and Multiple Traffic Light (MTL)) to determine the most effective system for South African consumers. Participants were randomised into three different arms, according to the different labels. Based on the phase 2 findings, the final qualitative component (phase 3) explored participants', who were all parents of children aged below 16 years, views on the most effective FOPL

and the parental perceptions regarding the effects of the FOPL on their day-to-day food choices for their children.

Population and sample

The study population comprised adults aged 18–50 years, distributed according to gender, age, literacy, geographical location and urbanicity. Phase 1 data were collected from 113 purposively selected participants from three provinces (Gauteng, Kwazulu-Natal and Western Cape) and phase 2 data were collected from 1948 randomly selected adults, constituting a nationally representative sample. Phase 3 data were collected from 44 adults in Limpopo province, using a snowball sampling method.

Data collection

Both phase 1 and phase 3 used face-to-face focus group discussions. The discussions were guided by the focus group discussion guides developed by the researchers. Phase 1 (qualitative study) had two components: the first component was to explore the perceptions of South African adult consumers regarding the WL and the second component was to solicit the views of South African adults on the features that signal danger, with the aim of developing a relevant WL for South African consumers. Phase 2 data (RCT) were collected at participants' households, using a structured questionnaire. The questions assessed participants' ability to correctly identify products high in nutrients of concern and unhealthy products, and also assessed the effect of the FOPL on participants' intention to purchase unhealthy products. Each participant was exposed to only one set of labels and served as their own control mechanism. Phase 3 (qualitative study) assessed, via in-depth focus group interviews, South African consumers' views on the most effective FOPL (based on phase 2 findings), and how the label would influence their day-to-day food choices for their children.

Data analysis

The qualitative data were analysed using a combination of deductive and inductive thematic analysis. Two independent co-coders read through the transcripts. and the coding framework was developed after data analysis. For the quantitative data, each participant generated two ratings on unhealthiness, high levels of nutrients of concern and their intention to purchase each packaged product (one without FOPL and one with FOPL). R software was used for the statistical analysis. A modified Poisson regression model was used to compare the effects of each label. A relative risk (RR) > 1 implied a higher percentage of participants exposed to label X correctly identified products as high in nutrients of concern, or unhealthy, compared to those exposed to label Y. Similarly, an RR > 1 implied that label X discouraged purchases of products more than label Y.

Results

The qualitative data were arranged into several themes. In phase 1, participants had positive attitudes towards the WL and reported that it was easy to understand, was educational and would influence their purchasing behaviour. The elements perceived as depicting a warning included a black triangle set against a white background (referred to as a holding strap), the inclusion of an exclamation mark, the inclusion of words such as 'WARNING' and 'HIGH IN', and the use of an icon indicating nutrients in excess. Additionally, some participants recommended that the label be positioned in the top right corner of the product packaging. In phase 2, all FOPL tested improved the consumers ability to identify nutrients of concern contained in excessive amounts and to identify unhealthy products. All the tested FOPL also discouraged consumers from purchasing unhealthy products. In comparison the WL (developed in phase 1) performed the best in the three outcomes compared to either the MTL, the GDA and he WL. In phase 3, other consumers explained that the words 'HIGH IN' on the WL assisted them to correctly identify what products were unhealthy and high in nutrients of concern. Some participants further indicated that the WL evoked fear and made them think about the health implications related to the consumption of food bearing such a label. Participants explained that they intended to reduce or discontinue purchasing products with a WL for their children.

Conclusion

The WL is a potential policy tool that could be used to convey nutrition information to the South African population. The WL that is developed, based on participants' recommendations, could be a black triangle set against a white background, with the inclusion of the word 'WARNING', an exclamation mark in one of the triangles, and a suitable icon and the words 'HIGH IN' indicating the nutrient(s) in excess. A further recommendation was for the label to be positioned in the top right corner of product packages. Of the three labelling systems, the WL was the most effective in assisting consumers to identify nutrients of concern contained in excessive amounts, as well as unhealthy products, and was the most effective in reducing consumers' intention to purchase unhealthy products. These findings have important policy implications for those government departments that are attempting to promote healthier food choices among South Africans. The implementation of the WL in South Africa could therefore serve as one of the mechanisms, in conjunction with other proven approaches, to halt the increase in obesity prevalence and to reduce the incidence of noncommunicable diseases (NCDs).

DECLARATION

I declare that '*The effectiveness of front-of-pack warning labels in assisting South African consumers to identify unhealthy packaged foods'* is my own work. I declare that this work has not been submitted for any degree or examination at any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

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Date: 03/03/2024

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DEDICATION

- I lift the name of the Lord High. 'All things exist through Him, by Him and for Him.'
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1.1. Background

Unhealthy diets that are excessive in energy, saturated fats, trans-fat, sugar and sodium are associated with obesity and noncommunicable diseases (NCDs), such as hypertension, diabetes mellitus, heart diseases and some cancers (Hall *et al*., 2019; Rico-Campà *et al.*, 2019; Srour *et al.*, 2019). These conditions continue to accelerate more steeply in low- and middle-income countries (LMIC) (World Health Organization, 2014, 2018, 2021b). For example, by 2015, no country in Africa was anywhere near attaining its 2030 Sustainable Development Goals of reducing premature deaths from NCDs (United Nations, 2015) and halting the rise in obesity (2021 Global Nutrition Report: 2021; United Nations, 2021). Obesity-related (National Department of Health *et al*., 2019) and NCD-related mortality rates are high in South Africa, necessitating public efforts geared towards improving the dietary intakes of the South African population.

In 2016, NCDs accounted for 70% of deaths globally and 51% of deaths in South Africa (Statistics South Africa, 2017a; World Health Organization, 2020a), a prevalence rate that quickly rose to 57.4% a year later in South Africa (Statistics South Africa, 2018). Equally troubling is that, according to the latest statistics, the prevalence of obesity, an independent risk factor for NCDs (Banjare &Bhalerao, 2016), is increasing at a steep rate in South Africa (Department of Health *et al.*, 2007; Global Nutrition Report, 2018; Statistics South Africa, 2017b). The latest national results indicate that in 2016, 30% of men and 68% of women aged 15 years and above were either overweight or obese (National Department of Health *et al*., 2019).

Globally there has been a decline in consumption of traditional diets and an increase in accessibility and affordability of, and preference for, energy-dense, ultra-processed foods (UPFs) (Monteiro *et al.,* 2018), and South Africa is facing similar challenges (Baker *et al.,* 2020; Steyn *et al.*, 2006). South Africa has been experiencing an influx of UPFs since the early 1990s, which has led to increased consumption of these foods and drinks (Frank *et al.,* 2021; Igumbor *et al.,* 2012; Ronquest-Ross *et al.*, 2015). Easy access to UPFs accounts for altered dietary patterns, higher energy intakes, and a high prevalence of obesity and NCDs in South Africa (Igumbor *et al.,* 2012; Reardon *et al.,* 2021). NCDs are ranked among the top 10 causes of mortality in the country (Statistics South Africa, 2018). In addition to high morbidity and mortality from NCDs, obesity has a negative bearing on the country's economic performance (Shekar & Popkin, 2020) and also creates environmental challenges (Swinburn *et al.,* 2019).

UPFs are industrially formulated, ready-to-consume and ready-to-heat products, made by combining several substances derived from foods (Poti *et al.,* 2015; Monteiro *et al.,* 2016). These products are typically packaged, contain no or little nutritive value, and are high in calories (referred to as kilojoules in South Africa), added sugar, salt and saturated fats (Poti *et al.,* 2015; Monteiro *et al.,* 2016; Frank *et al.,* 2021). A high consumption of UPFs is associated with increased risks of obesity and NCDs (Rico-Campà *et al.,* 2019; Elizabeth *et al.,* 2020; Levy *et al.,* 2021). A randomised controlled trial (RCT) conducted in the US showed that when participants were fed UPFs for a period of two weeks, they gained about 0.9kg and when the same cohort was immediately fed unprocessed foods for the next two weeks, they lost all the weight they gained under the UPF diet (0.9kg) (Hall *et al.,* 2019). Another large observational study in France reported an association between high consumption of UPFs and higher risk of NCDs (Srour *et al.,* 2019).

It is worrisome that the promotion and availability of these products is particularly high in LMIC and that low socioeconomic populations, in particular, are often nutritionally at risk (Mora-García *et al.*, 2020). A study by Frank *et al.* (2021) revealed that in 2018, almost 80% of products available in South African supermarkets were ultra processed, compared to 73% in the US food chain (Menichetti *et al.*, 2022). Access and consumption in other LMIC are also increasing. Data from a survey in Colombia indicated that in 2005, UPFs contributed an average of 16% of the total energy intake and contributed 41% of energy consumption among high-UPF consumers (Khandpur *et al.,* 2020). In the period 2008–2009, UPFs accounted for 28% of the daily energy intake in Brazil (Martins *et al.,* 2013) while in 2012, UPFs accounted for 30% of the daily energy intake in Mexico (Marrón-Ponce *et al.,* 2018).

According to Vargas-Meza *et al.* (2019a), individuals with low income and a low level of literacy, or those residing in more disadvantaged areas, are typically at risk of consuming low-quality diets and an increased incidence of NCDs and obesity (Backholer *et al.,* 2012; Hayes *et al.,* 2019; NCD Risk Factor Collaboration, 2016). In addition, high NCD treatment costs impact negatively on the countries' economic circumstances, putting further strain on already-weak economies and increasing the disparities between high-income countries (HIC) and LMIC (World Health Organization, 2018; Shekar & Popkin, 2020). To address these health and food system inequalities, it is therefore important to implement policies that would benefit the vulnerable (Hayes *et al.*, 2019; Popkin & Ng, 2022). According to the socioecological model (Figure 1.1), obesity and NCDs result from an interplay of individual, relationship, community and societal factors (Bronfenbrenner, 1977; Centres for Disease Control and Prevention, 2022).

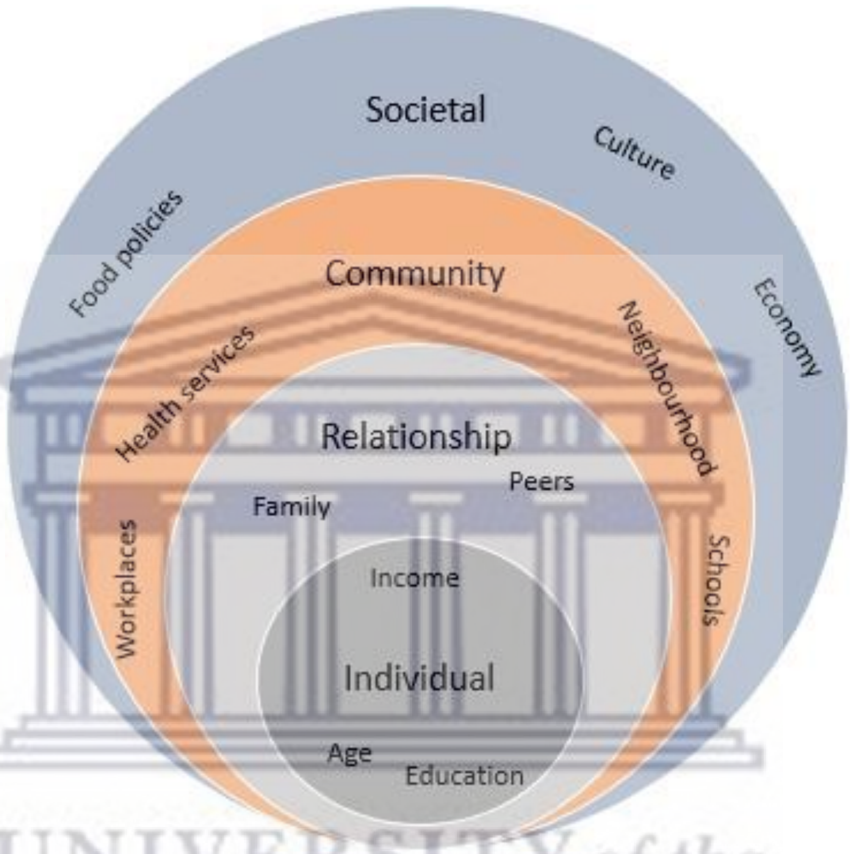


Figure 1.1: Socioecological determinants of obesity and NCDs
Source: Centres for Disease Control and Prevention (2022)

The socioecological model acknowledges that health determinants extend beyond an individual's sphere of control and include other social and environmental factors to which an individual is exposed (Israel *et al.,* 1998). For example, the high availability of UPFs that are of inferior quality but are more affordable (Popkin *et al*., 2012) and tastier (Swinburn *et al.,* 2011) makes unhealthy food a default choice for most consumers (Ares *et al*., 2018b). Individual efforts to improve dietary intake in such environments have been proven to be relatively unsuccessful (Capacci *et al.*, 2012; Vargas-Garcia *et al.*, 2017). Population-wide strategies are recommended instead (Gortmaker *et al.,* 2011; Hawkes *et al.*, 2015; Thow & Hawkes, 2013). According to Swinburn *et al.* (1999), population-wide obesity reduction is unlikely to occur until environmental factors are addressed. The added advantage is that, compared to individually targeted interventions, population-wide policies have a wider reach, put less emphasis on individual effort and are often more cost-effective (Frieden, 2010). For this reason, public policies and regulations that focus on the environment and societal norms should be a top priority and should make healthier eating an easier option (Gortmaker *et al.,* 2011; Hawkes *et al.,* 2015; WHO Regional Office for Europe, 2014).

To reduce the burden of obesity and NCDs, international organisations recommend multiple regulatory and legislative measures to limit exposure to unhealthy foods, especially UPFs, and to empower consumers to make healthier food choices (WHO Regional Office for Europe, 2020; World Cancer Research Fund, 2018; World Health Organization, 2010). The World Health Organization (WHO) recommends restrictive policies, such as the implementation of the Nutrient Profile Model (European World Health Organization & WHO, 2016), front-of-pack labelling (FOPL) (WHO Regional Office for Europe, 2020; World Health Organization, 2004), food taxes (World Health Organization, 2013a) and restrictions on the marketing of unhealthy foods and beverages to children (World Health Organization, 2010), by all its member states.

In response to the call to reduce obesity and NCDs, South Africa has thus far implemented a salt reduction regulation (National Department of Health, 2017), a trans-fat reduction regulation (National Department of Health, 2011) and a health promotion levy that mandates the imposition of tax on all sugar-sweetened beverages (SSBs) that exceed a threshold of 4g/100ml (National Treasury, 2018; Stacey *et al.*, 2021). Additionally, the still-active National Strategy for the Prevention and Control of Obesity (2015–2020) recommends simple FOPL as one of the strategic objectives (Department of Health, 2015). FOPL is the provision of nutrition information on the front of a package with the aim of informing consumers about the nutritional composition of food in a simplified manner (WHO Regional Office for Europe, 2020).

At the time of this study, the current Food Labelling Regulation 146 (R146) (National Department of Health, 2010) was under review to include FOPL as a strategy to prevent NCDs (National Department of Health, 2014). South Africa's National Department of Health has since updated the regulation as a draft Regulation for Food Labelling and Advertising (R3337) which was gazetted in April 2023 for public comment (National Department of Health, 2023).

There is a plethora of evidence that strongly supports FOPL as a simple and practical tool to inform and guide consumers in making healthier food choices (Kleef & Dagevos, 2015; Shangguan *et al.,* 2019; Viola *et al.,* 2016), thereby contributing to reduced consumption of nutrients of concern which may in turn reduce incidences of obesity and NCDs (Kees *et al.,* 2014). However, various types of FOPL are implemented worldwide (Global Food Research Program, 2022) with each differing according to their level of complexity (Kelly & Jewell, 2018). They thus have different levels of effectiveness in helping consumers to make healthier food selections (Newman *et al.*, 2018). Some years ago, the Institute of Medicine reported that by the year 2010, there would be more than 20 different types of FOPL in the marketplace (Institute of Medicine, 2010), with some FOPL systems dating as far back as 1989 (Kanter *et al.,* 2018). However, the literature on the tobacco industry shows evidence of label 'wear-out' after a period of three to five years due to familiarisation, which suggests the need for periodic label rotation to maintain labelling effectiveness (White *et al.*, 2015; Woelbert, 2019).

Based on the existing literature, there is no consensus on the most effective labelling format (Kanter *et al.,* 2018; Kelly & Jewell, 2018), as each FOPL system is inherently different and designed to achieve its own unique purpose. Some FOPL systems aim to simply inform consumers about the nutritional composition of food, without providing any additional insight into the healthfulness of the product (Food and Drink Federation, 2021). These include the GDA and the Reference Intakes (RI) that summarise and present the amounts of nutrients related to NCDs on the front of the package (Food and Drink., 2020), without offering any nutritional evaluation of the product (Newman *et al*., 2018). Other FOPL aim to assist consumers to identify healthier food options (endorsement logos – e.g., the Green Keyhole) (Larrson *et al*., 1999), others provide information related to either the healthfulness or unheathfulness of a product based on a graded scale (summary systems- e.g. Nutriscore) (Julia & Hercberg, 2018), while others warn consumers about unhealthy products containing excessive amounts of nutrients of concern but without alluding to healthier alternatives (e.g. WL) (Kelly & Jewell, 2018). These FOPL systems are discussed in detail in Chapter 3. Gorski Findling *et al.* (2018) reported that none of the FOPL systems is superior to any other due to their variability and the FOPL's unique objectives (Newman *et al.,* 2018). There is however strong evidence that some FOPL systems are more effective in communicating nutrition information than others (Newman *et al*., 2018; Temple, 2020) and each country should therefore select an FOPL based on its own unique profile and strategic focus (WHO Regional Office for Europe, 2020).

The FOPL that only summarises the nutrient list at the front of the pack requires mathematical and literacy skills and is therefore challenging for most consumers, thereby reducing its effectiveness in assisting consumers to select healthier diets (Egnell *et al*., 2018; Talati *et al*., 2017; Todd *et al*., 2022). Positive FOPL that summarise nutritional information to present the overall healthiness of a food product have been reported to assist consumers identify healthier products, and least helpful in helping consumers identify unhealthy products (Hutton & Greese, 2021). Other FOPL that presents the products' nutritional profile on a scale or continuum, ranging from most healthy to least healthy, have been reported to help consumers rank food according to their level of healthiness (Egnell *et al*., 2018). The latter FOPL has also been shown to assist consumers to identify both healthy and unhealthy food products (Pettigrew *et al*., 2023). On the other hand, FOPL that highlights nutrients in excess have been shown to be effective in assisting consumers to identify unhealthy products (Grummon & Hall, 2020; Taillie *et al.,* 2020b; Temple, 2020).

Some FOPL systems may be too complex, especially for the less educated (Deliza *et al.,* 2020; Ducrot *et al.*, 2016; Julia *et al*., 2017b), or less than ideal in that high-risk nutrients (added salt, sugar and saturated fats) may be masked and/or not disclosed (Söderlund *et al*., 2020; Silverglade & Heller, 2010). Inaccurate evaluations of the nutritional value of food products may lead to inaccurate perceptions of the healthfulness of such products (Kelly & Jewell, 2018). Each country should carefully consider its own unique sociodemographic characteristics and public health concerns when implementing an FOPL system to ensure that it is useful and effective for the population in question (WHO Regional Office for Europe, 2020). It is thus important that countries implement simple and user-friendly FOPL systems that are effective in encouraging consumers to embrace a healthier diet (WHO Regional Office for Europe, 2020).

This thesis investigates the FOPL format most suited to the South African context, with a focus on an FOPL system that informs consumers about nutrition information and product unhealthiness, and is effective in discouraging purchases of unhealthy products. Three different types of labelling system – the Guideline Daily Amounts (GDA), the Multiple Traffic Light (MTL) and the warning label (WL) – were considered and compared against each other.

1.2. Motivation for the study

1.2.1 Global perspective

Nutrition labelling is viewed as a potential means of contributing to the prevention of both obesity and NCDs by helping consumers to make healthier food choices (Cecchini & Warin, 2016; Hawkes *et al.*, 2015; Viola *et al.*, 2016). However, the existing nutritional information panel (NIP) is confusing and not easily accessible, as the information is usually placed on the side or at the back of food packages (Todd *et al*., 2021) and is in very small print (Todd *et al*., 2022; Todd *et al*., 2021). Several studies show that consumers find the terminology and numbers on the NIP difficult to interpret (De la Cruz-Góngora *et al.*, 2012; Kleef & Dagevos, 2015) and the font size too small (Jacobs *et al.,* 2011), thus affecting the labels' effectiveness (Song *et al.*, 2015). There is convincing evidence that consumers with low literacy levels and low nutrition knowledge mostly struggle to read back-of-pack (BOP) nutrition labels (De la Cruz-Góngora *et al.*, 2012; Grunert & Wills, 2007; Kleef & Dagevos, 2015; Irvine, 2014). According to current evidence, consumers could benefit from simpler FOPL (Becker *et al.*, 2015; Hock *et al.*, 2021; Song *et al.*, 2021).

FOPL, which is the nutrition labelling system appearing on the front of food packages, is designed to provide accessible, salient and easily understandable nutrition information at a glance (Braesco & Drewnowski, 2023). It has been shown to influence consumers' understanding of nutrition information and the healthfulness of various food products (WHO Regional Office for Europe, 2020).

Different FOPL systems exist, ranging from reductive to interpretive systems. A reductive system, such as the GDA, extracts and restates critical nutrients appearing in the NIP on the front of the pack without expressing any judgement about the overall healthiness of the product (Newman *et al.*, 2018). Nutrient amounts are presented in grams and percentages, but in the opinion of consumers, this system is as challenging as the NIP because of the need to interpret the numbers. An interpretive system, in contrast, such as an HSR and a WL, interprets the nutrition information on the NIP and presents the evaluation of the healthiness of the product on the front of the pack – in the form of a logo, an icon or colour coding. The latter system has received tremendous support from consumers as a better way to understand nutrition information (Arrúa *et al*., 2017; Centurión *et al*., 2019; Taillie *et al*., 2020b; Talati *et al*., 2019; Todd *et al*., 2022). Different interpretive FOPL systems exist, which vary according to their level of complexity and objectives. There is currently no consensus on the most effective FOPL system (Kanter *et al.,* 2018; Kelly & Jewell, 2018), and so different countries implement FOPL systems based on their own consumers' understanding of FOPL (WHO Regional Office for Europe, 2020).

1.2.2 South African perspective

South Africa is a society that is socioeconomically unequal, experiencing both high and low socioeconomic statuses simultaneously, with a high proportion of the population facing food insecurity (Statistics South Africa, 2019). This diversity may imply unique labelling requirements for South African consumers (van der Colff *et al*., 2015; WHO Regional Office for Europe (2020). Literature asserts that sociodemographic factors such as literacy level, income status, age, gender, race and ethnicity influence food labelling understanding (Christoph *et al*., 2018; Miller & Cassady, 2015; Perumal, 2023) and such dynamics should be considered when developing an FOPL for a country. Undermining such factors may lead to an ineffective FOPL.

Previous studies conducted in South Africa attest to consumers facing challenges in interpreting NIP information (Jacobs *et al.,* 2011; Koen *et al.,* 2018a; Koen *et al*., 2018b; Prinsloo *et al*., 2012; Todd *et al*., 2021; Todd *et al.*, 2022), based on sociodemographic variables (van der Merwe *et al*., 2013). These studies report language and literacy as some of the barriers to nutrition information understanding in South Africa. In a study by van der Merve *et al*. (2013) label knowledge was better among the Afrikaans and English-speaking groups than consumers who spoke African languages, confirming language as one of the barriers to label understanding in South Africa (Todd *et al*., 2021). NIP information is presented in English and may therefore be challenging for population members who are not proficient in the language.

A study conducted in Cape Town, South Africa, reported lower than average nutrition label knowledge (44%) among consumers and further reported that only a few (16%) participants could correctly interpret serving sizes (Koen *et al*., 2018a). NIP information interpretation is informed by serving sizes and any miscalculation may result in inaccurate interpretations of products' healthfulness. Interpretation of serving sizes was also reported as one of the challenges among consumers in Potchefstroom, South Africa (van der Merve *et al*., 2013). As a result, the NIP is reported as one of the least likely considerations when making food choices (Koen *et al*., 2018b; van der Merwe *et al*., 2013).

Lower socioeconomic status and food costs have been identified as other barriers to food label use in South Africa. Due to high food prices, individuals in the lower socioeconomic areas are often limited to unhealthy food choices irrespective the presence of the food labels (Bopape *et al*., 2022b; Todd *et al*., 2021). This potentially reduces the effectiveness of food labelling in this population group. Measures to improve food security and reduce food prices are an important consideration to improve the effectiveness of nutrition labelling in South Africa. The practice of buying products in bulk and repackaging them into smaller, unlabelled packaging by the informal sector is also cited as another barrier to label use in South Africa (Todd *et al*., 2021). This practice is often observed in lower socioeconomic areas, depriving the end users of access to essential nutritional information. Other barriers shared by South African consumers include limited shopping time (Todd *et al*., 2021), a label that is too long and time-consuming (Mandle *et al*., 2015), lack of motivation to use the labels, lack of enforcement and lack of trust between the food industry and the healthcare system (Todd *et al*., 2021).

To enable food label use, South African consumers recommend the implementation of a simple label that would be easy to understand, (Jacobs *et al*., 2011; Koen *et al*., 2018a), placed on the front of the food package (FOPL) (Todd *et al*., 2022), legible and uses bigger font sizes (Koen *et al*., 2018a; Todd *et al*., 2021) and that incorporates use of at least one South African language (Jacobs *et al*., 2011; Koen *et al*., 2018a; Koen *et al*., 2018b; Todd *et al*., 2021). To improve label legibility, the participants in Cape Town recommended the use of black text against a white background and the use of pictorial images such as familiar colours and shapes to improve label understanding, especially among the illiterate (Todd *et al*., 2021).

Very few studies have explored FOPL as an option to improve nutritional information in South Africa (Hutton & Resse, 2021; Koen *et al*. 2018c; Todd *et al*., 2021; Todd *et al*., 2022). Each of the four studies investigated different FOPL, however a common finding was that the GDA was the least understood by South African consumers, largely due to the need to still interpret the serving sizes and the nutrient amounts. Although widely implemented, the GDA may therefore not provide a solution to provision of easily accessible nutrition information. Hutton & Resse (2021) compared the performance of five FOPL in South Africa and found that the Nutriscore performed the best in assisting consumers to rank food products according to their level of healthiness, followed by the WL, MTL, Health Endorsement Logo and Reference Intakes (RI). Todd *et al*. (2022) found that the WL performed the best in assisting consumers to identify the unhealthiest products, followed by the low HSR. Koen *et* *al*. (2018c), on the other hand, explored the use of endorsement logos that point consumers to healthier foods for implementation in South Africa. The participants in the latter study were positive about the endorsement logo and recommended that the logo contain wording such as 'better choice' or 'healthy choice' and pictures depicting health or food.

Populations in LMIC are particularly at risk nutritionally (Vargas-Meza *et al.*, 2019a) and so the implementation of simple FOPL would potentiate a conducive environment for the selection of healthier foods by both the literate and the less literate. The link between Covid-19, obesity and co-morbidities, such as diabetes, and subsequent poor health outcomes due to obesity and NCDs has also increased the need for healthier diets (World Obesity Federation, 2021; Zhu *et al.*, 2020).

South Africa is a medium-income country, with a unique sociodemographic profile due to its diverse linguistic, cultural, educational and economic background. There are currently 11 official languages in the country and in 2020, the adult illiteracy rate was reported to be 10%, with the majority of illiterate individuals being black Africans (Khuluvhe, 2023). The diverse languages and educational statuses create a need for an FOPL that would be easily understandable by all members of the population irrespective of their demographic profiles. On the policy front, the current South African draft Labelling and Advertising of Foods Regulation (No. R429) (R429) makes provision for the inclusion of FOPL or endorsements on food packages to simplify the detailed NIP (National Department of Health, 2014). The R429 further stipulates that the endorsement logo should not mask the presence of undesirable qualities or nutritional content of a food. The FOPL systems that considers both the positive and negative nutrients, namely the endorsement logos and the summary systems, have the potential to mask the nutrients of concern as the algorithm could allow positive nutrients or food properties to cancel off the negative nutrients (Hodgkins *et al*., 2012; Khandpur *et al*., 2018; Söderlund *et al*., 2020). For this reason, the two types of FOPL were excluded in this study.

The lack of an FOPL in South Africa therefore creates an opportunity to test different FOPL systems among South Africans to identify a system that clearly highlights nutrients contained in excessive amounts and is easily understood by all South Africans, irrespective of their sociodemographic status. This study therefore seeks to establish the most effective FOPL for South African consumers and to explore consumers' perceptions of FOPL and its use in their day-to-day food choices for their children. The study's findings may be used to inform policies related to the implementation of FOPL in South Africa and the design of appropriate nutrition messages for the country.

This study considered both the reductive and the interpretive FOPL systems. At present the GDA appears voluntarily on packaged food in South Africa (Igumbor *et al.*, 2012) and is therefore included in this study to represent the reductive system. The MTL, which was previously proposed as a potential FOPL by the South African Department of Health, together with the WL represent the interpretive system. The WL has been shown to be effective in assisting consumers to identify unhealthy products high in nutrients of concern, hence its inclusion in this study.

1.3. Purpose of the study

The purpose of this study was to identify, from a range of options, an FOPL system that effectively conveys nutrition information and discourages consumers from purchasing unhealthy food products. This study was carried out in three phases, with the findings reported as journal publications (Chapters 5, 6 and 7 of this thesis). South Africa is a middle-income country comprising both upper and lower sociodemographic groups. The intention was to develop a FOPL system that would be understood by all groups in South Africa, including those with low levels of literacy. In 2020, the adult illiteracy rate was reported to be 10%, with the majority of illiterate individuals being black Africans (Khuluvhe, 2023). South Africa is also characterised by diverse cultural and language groups, which may be important considerations when designing an effective label (Conzola & Wogalter, 2001; Wogalter *et al.,* 2002).

1.4 Research questions

The research questions guiding the study were:

1. Phase 1: What design features do adult South African consumers deem to be important for a simplified front-of-pack warning label? (Chapter 5)

2. Phase 2: Which front-of-pack warning label most effectively communicates nutrition information to South African consumers? (Chapter 6)

3. Phase 3: How do adult consumers make sense of the most effective front-of-pack warning label and how would it influence their day-to-day food choices for their children? (Chapter 7)

1.5. Objectives of the study

The specific objectives for each phase were:

Phase 1 To explore the perceptions of adult consumers towards the WL and the design features (colour, shape, icons, text, size and the location on the front-of-pack) that communicate warning to South African consumers.

Phase 2 To evaluate the effectiveness of different front-of-pack warning labels to communicate nutrition information to South African consumers, using a randomised controlled trial (RCT).

- To evaluate the effect of different types of FOPL on the ability of consumers to identify food products high in critical nutrients (sugar, salt and saturated fatty acids).
- To evaluate the effect of different types of FOPL on the ability of consumers to identify unhealthy food products.
- To evaluate the effect of different types of FOPL on consumers' intention to purchase and consume food products high in undesirable nutrients.

Phase 3 To explore the perceptions of consumers regarding the most effective front-of-pack warning label and its use in their day-to-day food choices for their children.

1.6 Outline of the thesis

This thesis is presented in eight chapters and the format is by publication. Chapter 1 provides the introduction and background to the study, the purpose, the research questions and the objectives of the study. Chapter 2 presents the methodology followed in the study and Chapter 3 outlines the literature related to the topic. Chapter 4 provides a comprehensive review of different FOPL systems that have been implemented around the globe. Chapters 5, 6 and 7 present the results of the study in the form of published articles. Chapter 8 presents the discussion, limitations, conclusion and recommendations.

Articles included in this thesis

1. Bopape, M., Taillie, L. S., Frank, T., Murukutla, N., Cotter, T., Majija, L., & Swart, R. (2021). South African consumers' perceptions of front-of-package warning labels on unhealthy foods and drinks. PLoS ONE, 16(9), e0257626.

2. Bopape, M., De Man, J., Taillie, L. S., Ng, S. W., Murukutla, N., & Swart, R. (2022a). Effect of different front-of-package food labels on identification of unhealthy products and intention to purchase the products - A randomised controlled trial in South Africa. Appetite, 179, 106283.

3. Bopape, M., Taillie, L. S., & Swart, R. (2022b). Perceived effect of warning label on parental food purchasing and drivers of food selection among South African parents – An exploratory study. Frontiers Public Health, 10, 939937.

CHAPTER 2: METHODOLOGY

Chapter 2 presents the methodological processes followed in the execution of this study. The sections that follow discuss the research approach and design and their rationale, the methods used to collect and analyse the data and the population and sampling methods. Ethical considerations and measures to ensure data validity, reliability and trustworthiness are also included in this chapter.

2.1 Data sources

This study formed part of the South African National Obesity Prevention Project initiated by the National Department of Health and carried out by the University of the Western Cape. The aim of the bigger project was to develop a front-of-pack food labelling system for South Africa. The research team consisted of Prof Rina Swart (the principal investigator (PI)), Tamryn Frank and Makoma Bopape.

The current study constitutes the second part of the larger project and was carried out in three phases. The data for phases 1 and 2 were analysed as secondary data from the data collected in the Obesity Prevention Project, which was registered with the Biomedical Research Ethics Committee (BMREC) (reference BM18/9/13) (Appendix 1). The PI of the larger study gave permission for the researcher to perform the analyses for PhD study purposes (Appendix 2). The phase 3 data were collected as primary data as part of the current PhD study. Phase 1 data were collected between March 2019 and April 2019, and phase 2 data were collected between November 2019 and January 2020. The phase 3 data (reference BM20/5/6) (Appendix 3) were collected between November 2020 and December 2020, in March 2021 and in November 2021. The breaking up of the data collection period was due to the Covid-19 alert level 5 restrictions, which prohibited travelling and gatherings at that time.

2.2 Pragmatic worldview

Every research approach is grounded in a certain ‘worldview’ or ‘paradigm’ which explains the nature of knowledge and underpinning assumptions that guide decisions and actions taken during the study (Babbie, 2016; Creswell, 2014; Kivunja & Kuyini, 2017). A worldview is a set of beliefs and assumptions about knowledge that informs a study (Creswell, 2014). The literature classifies paradigms into four broad categories: postpositivism or positivism, constructivism, transformative, and pragmatism (Creswell, 2014). Table 2.1 distinguishes between the four different types of paradigms.

Table 2.1: Four types of research paradigms

Postpositivism	**Constructivism**
• Determines causes that influence outcomes • Reduces information to numbers • Observes and measures existing information • Verifies theories	• Seeks to understand concepts • Considers multiple participants' meanings • Is guided by social and historical influences • Generates theories
Transformative	**Pragmatism**
• Is intertwined with a political change agenda • Is power- and justice-oriented, and collaborative • Is change-oriented	• Arises out of situations and consequences • Is problem-centred • Is pluralistic • Is real-world practice-oriented

Source: Adapted from Creswell (2014)

Taking a stance on a particular paradigm ensures alignment between research design and research methods (Creswell, 2014; Kivunja & Kuyini, 2017). A paradigm informs the research design, which in turn informs the methodology to be followed in a research project (Creswell, 2014; Kivunja & Kuyini, 2017). Following this type of holistic approach ensures that there is synergy, from the research paradigm right up to the interpretation of data (Creswell, 2014; Feilzer, 2009).

The current study followed a pragmatic paradigm which, according to Creswell (2014), is an approach that emanates from actions, situations or consequences rather than from pre-existing conditions, as with postpositivism. The study arose out of the need to identify an effective FOPL system for South African consumers with a view to addressing rising levels of obesity and NCDs. Multiple approaches were examined so as to identify the most effective FOPL system within the South African context. Pragmatism is problem-centred (Creswell, 2014) and concerned with generating and applying practical solutions in the real world. Its underpinning principle is the utilisation of multiple strategies to derive knowledge about a problem (Creswell, 2014). Pragmatists argue that it is not possible to access the truth in the real world by using a singular scientific method to analyse a problem. The pragmatism paradigm therefore borrows and combines elements from the postpositivism, constructivism and transformative paradigms to understand and provide solutions to the problem (Creswell, 2014; Kivunja & Kuyini, 2017). Given its multiple-approach stance, pragmatism provides a philosophical basis for a mixed-methods research design (Creswell, 2014).

2.3 Study design

This study utilised a multiphase, mixed-methods research design which was divided into three phases: 1) qualitative, 2) quantitative, and 3) qualitative strands. A mixed-methods design involves the collection and integration of both qualitative and quantitative data to achieve the research objectives (Creswell, 2014; Feilzer, 2009; Kivunja & Kuyini, 2017). A multiphase, mixed-methods design connects quantitative and qualitative data, either through convergent or sequential or only qualitative and quantitative studies that are conducted longitudinally, and are aligned in such a manner that each phase builds on what was learned previously, to address the research objectives (Creswell, 2014; Feilzer, 2009). The current study followed the multiphase, mixed-methods approach, as presented in Figure 2.1.

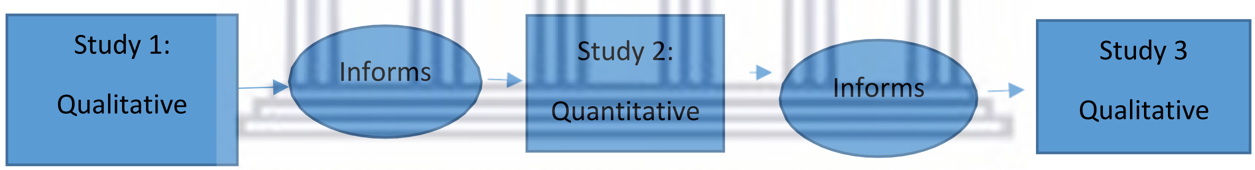


Figure 2.1: Multiphase, mixed-methods approach followed in the study
Source: Adapted from Creswell (2014) and Feilzer (2009)

Graff (2017) refers to a multiphase, mixed-methods design as an iterative, sequential mixed-methods design in which there are more than two phases. The sequential nature of these types of studies enables a deeper understanding of the findings from the preceding phase (Feilzer, 2009). A multiphase, mixed-methods approach is often used in programme evaluations where quantitative and qualitative approaches are used over time to support the development, adaptation and evaluation of specific programmes (Creswell, 2014), as in the current study. The researcher has to carefully state the research question for each phase which both contributes to the broader research aim and builds on the previous phase of the project (Creswell & Plano Clark, 2011).

The fundamental assumption supporting the design is that there is no single truth and that a combination of qualitative and quantitative methods leads to a more comprehensive understanding of the problem being investigated (Creswell, 2014; Denzin, 2010). Pragmatists believe that a combination of two designs allows for a greater diversity of findings than the two approaches conducted separately (Creswell, 2014; Denzin, 2010).

2.4 Application of a multiphase, mixed-methods design in the study

The initial phase (phase 1) employed a qualitative research design which aimed to probe participants' views regarding the WL and the elements they perceived as providing an effective 'warning'. This phase included in-depth discussions. Phase 1 culminated in the development of a WL, as informed by participants' perspectives. The findings from this phase informed one of the three FOPL systems (WL vs MTL vs GDA) tested in phase 2 of the study.

Phase 2 entailed a three-arm RCT (quantitative) aimed at determining the most effective FOPL system. This phase set out to obtain results that could be generalised to the entire South African population. To achieve this aim, the researchers sought to select a sample that was representative of the South African population, thus ensuring the objectivity and generalisability of the study's findings. In this phase, participants were randomly assigned to one of the three FOPL systems (GDA, MTL or the WL developed in phase 1), and the effective FOPL system was subsequently tested in phase 3 to further interrogate the findings.

Phase 3 of the study was intended to explore more fully the findings from the RCT study. The aim was to move beyond label understanding and to evaluate the potential impact of the WL on consumers' (parents') food selection, since parents are the main food purchasers in households (Lima *et al.*, 2018). The ultimate aim of food labelling is to influence purchasing habits, and this phase set out to evaluate the perceived effectiveness of the most effective FOPL in order to better inform the development of FOPL policy. The researcher acknowledges that intention may not necessarily translate to actual behaviour, however, intention could lead to behaviour change (Grummon & Hall, 2020; Taillie *et al.*, 2020). The researcher did not know, during the writing of the protocol, which FOPL system would go into phase 3, and so final decisions regarding the approaches to data collection and data analysis were deferred until after the interpretation of the phase 2 data. Once the phase 2 data had been analysed and interpreted, a qualitative study approach was adopted to evaluate participants' perceptions of the most effective FOPL system and its application to their day-to-day food choices for their children.

2.5 Integration or merging of data

Data integration is an essential component of mixed-methods research. Integration can be achieved by connecting, building or following a thread (Whitley *et al.*, 2020). According to Graff (2017), with a multiphase, mixed-methods research design, data are collected and analysed separately in each phase of the study, and conclusions from each phase are then integrated to formulate the overall conclusion. In the current study, conclusions drawn during each study phase were integrated to arrive at the overarching conclusions relating to the project.

2.6 Ethical considerations

Ethical clearance was granted by the Biomedical Research Ethics Committee (BMREC) of the University of the Western Cape (reference BM18/9/13) (Appendix 1) for phases 1 and 2, and a separate certificate was obtained for phase 3 (reference BM20/5/6) (Appendix 3). The purpose of the study, data collection procedures, and the right of the participants to refuse participation or withdraw from the study, were explained before the commencement of each study phase. In addition, participants were requested to sign either the consent form (quantitative phase) or confidentiality binding form (qualitative phase) as an indication of their willingness to participate and so as not to disclose the contents of the focus group discussions to others outside the focus groups.

2.6.1 Participant confidentiality, privacy and anonymity

Anonymity is the practice of ensuring that data acquired by the researchers do not contain information that could be used to identify respondents (Remler & Van Ryzin, 2011), while confidentiality ensures that the identifying information is known only to the researchers and is not publicly associated with participants' responses (Remler & Van Ryzin, 2011). To maintain confidentiality, raw data were shared only with the researchers and the statisticians directly involved in the study. Participants' names were not disclosed on the questionnaires, thereby ensuring anonymity and privacy; nor will participants' personal details be disclosed in the dissemination of the study's findings. Participants' household numbers were entered only on the first page of the questionnaire, and this information was not included with the raw data entered on the Excel spreadsheet. Only the PI had access to this information. Questionnaires were coded using unique identifiers instead of participants' household numbers.

2.6.2 Risks/benefits to the participants

Participants were informed that there were no direct financial benefits to them. This study posed no financial risks to the participants since data were collected either in the households (phase 2) or a walking distance from the participnats households (phase 3). Only the phase 1 participants travelled to the focus group discussion venues and they either received reimbursement for their travel expenses or transport was provided for them. All the participants, however, received a small token for their participation in the study. Moreover, the nature of the study posed minimal psychological and physical risks to participants. However, the researchers were prepared at all times to refer any participant who could have displayed any signs of emotional discomfort during data collection, to the nearest health facility.

2.7 Study population

Participants were male and female adults aged 18–50 years of age, categorised into low- and middle–high-income levels, literacy levels and urbanicity/rurality. 'Low income' was defined as income less than R1,600 (approximately US$100) per month 'and middle–high income' was R1,601 and above. The 'low income' category was based on the income at or below the old- age grant amount in South Africa (National Treasury, 2017). 'No literacy' was defined as adults with no formal schooling, 'low literacy' as adults with schooling between Grades 1 and 6 (Khuluvhe, 2023), and 'literate' as adults with Grade 7 schooling or above. Participants also included individuals responsible or partially responsible for household food purchases or, in their absence, those responsible for preparing family meals. Parents with children under the age of 18 years are likely to be 50 years or younger, hence the age limit of 50 years in the current study.

2.8 Phase 1: Methodology

An exploratory qualitative design was adopted to achieve the objectives of phase 1. An exploratory design is used when a subject is new and little is known about it (Neuman, 2006). This type of design enables researchers to gain more understanding of a concept from the affected individuals than would be possible with other designs. This phase was divided into two parts. The first part set out to evaluate consumers' opinions on the WL, while the second part sought to explore elements that participants viewed as communicating danger or a warning, and that would deter purchases of unhealthy food products.

2.8.1 Study setting

Data for phase 1 were collected from both urban and rural areas in three provinces of South Africa, namely KwaZulu-Natal, Gauteng and the Western Cape. The three provinces were purposively selected to include both urban and rural areas and to ensure a mix of ethnic and cultural groups. The three provinces differ in terms of size, sociodemographic, cultural and economic profiles (see section 2.9.1 for the description of the provinces).

2.8.2 Participants' recruitment and sampling

The market research company purposively selected, using its database, 120 participants whom they visited in their households for recruitment into the study. In purposive sampling, the researcher uses their own judgement to select participants who possess specific attributes that the researcher wishes to explore in an in-depth manner, to answer the research question (Grove *et al.,* 2015; Maltby *et al.*, 2010). Forty participants who met the inclusion criteria (Appendix 4) were recruited from each of the three provinces to represent the country's diverse sociodemographic and cultural profile. Phase 1included both males and females aged between 18 and 50 years who were not employed in the food industry, had children below 16 years under their care and were either the main decision maker, main buyer or shared responsibility in purchasing groceries at home. A total of 113 participants eventually signed up for the study, who were then divided into 12 focus groups.

2.8.3 Label design

Based on available literature (Hammond, 2011; Wogalter *et al.,* 2002) and expert advice, a design agency was commissioned to develop a number of warning label alternatives for testing among South African consumers. The intention was to design a warning label using shapes, colours, icons and text that would facilitate the easy identification of unhealthy products containing high amounts of nutrients of concern by South African consumers across all sociodemographic strata.

The agency, in consultation with the researchers, created several prototypes (Appendix 5) which an expert committee systematically rated until the options were narrowed down to a few alternatives for further testing among consumers. The expert committee comprised experts in nutrition, health, health promotion, economics, communication and media. Based on the expert committee's recommendations, the WL design that was tested qualitatively among South African consumers consisted of a black triangle set against a white background with the word 'WARNING' included. Each triangle would contain the words 'HIGH IN' together with an icon indicating the nutrients (sugar, salt or saturated fats) contained in excess (Figure 2.2). All the labels were written in English. The icons (e.g. salt shaker) represented the nutrients that were contained in high amounts to facilitate nutritional information understanding, especially for the illiterate (Lavriša *et al.*, 2020).

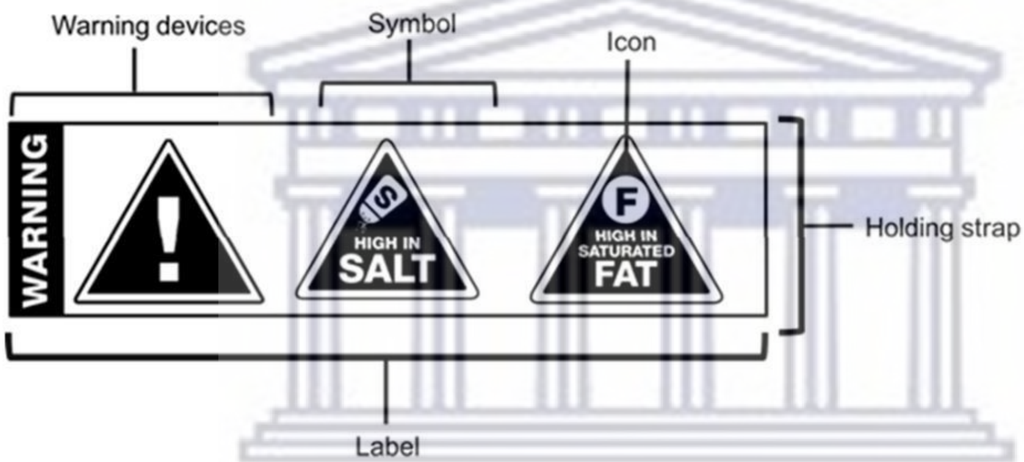


Figure 2.2: Original warning label

This original label (Figure 2.2) was used to evaluate participants' opinions of the WL in the first part of phase 1 of the study. Several other options (Table 2.2) went into testing in part 2 of phase 1.

Table 2.2: Warning elements tested in phase 1 of the study

Element	Options evaluated
Icons	4 icons for each nutrient (salt, sugar and saturated fats)
Symbol shapes	1 triangle and 1 octagon
Symbol colours	Octagon (1 black and 1 red); triangle (1 black and 1 red)
Holding strap colours	1 black and 1 white
Warning devices	Warning only; warning text accompanied by exclamation mark; black triangle only; red triangle only
Font	Upper case and lower case
Label size	Occupy 5%, 10%, 15% and 20% of the front of the package
Position	Top right and bottom right corner of the front of pack

2.8.4 Stimuli

Three-dimensional (3D) images of commercial products available in the South African marketplace, namely potato crisps, juice, cola and cereal, which were superimposed with the designed WL (Figure 2.3), were used as stimuli to explore participants' opinions of the WL.

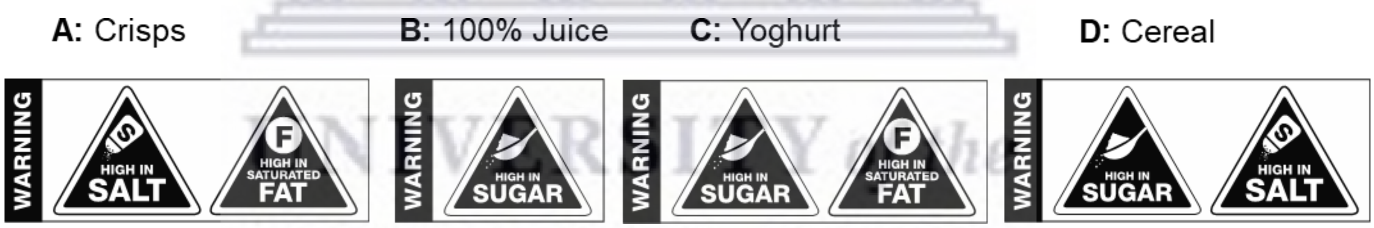


Figure 2.3: Products used in phase 1 of the study

Product categories and brands generating the highest sales in South Africa were selected, based on the 2018 Euromonitor. The selected products included those often perceived as unhealthy (soda and crisps) and healthy (fruit juice and cereal). The WL was placed in the top right corner on the front of the product package. The number of WLs on each product depended on the actual product's nutritional profile. For example, a product would carry only one triangle (with the relevant graphics) if it had one nutrient of concern in excess (e.g. salt). A product would carry all three triangles if it had all three nutrients of concern in excess (i.e. salt, sugar and saturated fats).

2.8.5 Data collection procedure

Data collection took place between March 2019 and April 2019. Data were collected face to face through 12 focus group discussions at prearranged venues that were convenient to the participants. One of the assumptions underlying focus group discussions is that because of 'safety in numbers', members are able to express themselves more freely than in one-on-one interviews. This adds richer information than would be the case if individuals were interviewed on their own (Bolderston, 2012). Focus group discussions were deemed suitable in this study because they would allow in-depth discussions and the sharing of thoughts and views among participants (Brink *et al.,* 2012). However, a limitation of focus groups is that individual voices may get lost (Brink *et al.,* 2012).

All focus group discussions were facilitated by one moderator from a contracted research company, and discussions only commenced after all group members had signed the focus group confidentiality binding form (Appendix 6). The discussions in each focus group continued until data saturation was reached for all the questions. The moderator was proficient in all the languages spoken by the participants. All the discussions were captured on the audio-visual recorder for later transcription and translation. In addition, each data collection facility was equipped with a round table and a data projector. Participants sat around the table and all images were projected onto the screen. All participants confirmed that they had good vision.

The moderator first explained the purpose of the study and the confidentiality of the proceedings, and then requested permission to capture the discussions on the audio-visual recorder. Once all questions had been addressed, the moderator asked the participants to sign the focus group confidentiality binding form (Appendix 6) to indicate their willingness to take part in the study. After signing, each participant, assisted by the moderator and the research assistant where necessary, completed the sociodemographic questionnaire (Appendix 7). The moderator then projected images of the four products (crisps, fruit juice, soda and cereal) onto the screen simultaneously and led the discussions to evaluate participants' opinions of the WL superimposed onto the front of the product packages.

After the first part had been completed, several prototypes were projected onto the screen and participants discussed the options that depicted a warning and were likely to discourage them from purchasing unhealthy products. The aim was to determine the elements associated with a warning, which would be taken into consideration in the final design of the WL proposed for South Africa. A total of 32 designs (Table 2.2) went into testing, similar to other countries that tested similar numbers of designs (Reyes *et al.*, 2019).

2.8.6 Focus group composition

Phase 1 data were collected through 12 focus group discussions. There is variability regarding the number of focus groups required to achieve a study's objectives (Guest *et al*., 2017). In a study conducted to evaluate the number of focus group discussions enough to reach data saturation (where no new ideas were still forth coming from one focus group to the other), Coenen *et al.* (2012) found that data saturation was reached at five focus groups. On the other hand, Guest *et al.* (2017) measured data saturation by the number of codes discovered and the findings were that two to three focus groups were enough to discover most (80%) of the themes and 90% of the themes were discoverable within three to six focus groups. Hennink *et al*. (2019) found that 96% of the codes were discovered at four focus groups and that no new codes emerged after the 6th focus group. The latter authors also found that meaning saturation (the point at which the understanding of a concept is fully reached and no new insights are coming forth) was reached at the sixth focus group discussion. Since most themes are discoverable at the third focus group discussion (Guest *et al.*, 2017), four focus groups were therefore argeted in each province to allow for any additional new themes. A minimum of four focus group discussions was therefore deemed adequate and hence the 12 targeted focus group discussions.

Each focus group was homogeneous, comprising members with similar sociodemographic and economic profiles. Homogeneity is achieved when participants with similar traits, such as sociodemographic characteristics or disease profile, are grouped together to form a focus group (Bolderston, 2012; Palinkas *et al.*, 2015). Its benefit is that it reduces member variability and is associated with willingness of participants to engage in discussions without fear of judgement (Femdal & Solbjør, 2018). In this study, focus groups were diversified according to age, gender, literacy, income and geographical location (section 2.7).

Each focus group consisted of 8–10 members in the current study. According to Grove *et al.* (2015), the size of the focus group should be manageable for effective moderation. A group size of 5–8 members is considered acceptable (Grove *et al.,* 2015). Other authors recommend a group size of 5–10 (Bolderston, 2012), hence the size of focus groups in the current study.

2.8.7 Focus group discussion guide

The moderator followed the guide (Appendix 8) during the discussions. The guide, developed by a team of researchers, consisted of mostly open-ended questions and made provision for further probing based on participants' responses. The development of the focus discussion guide was guided by the literature related to principles of an effective FOPL. As the guide was part of the bigger project, some of the questions were removed to suit the objectives of this study (see Appendix 8 for questions deleted). The guide had two sections: questions on 1) participants' opinions of the warning label, and 2) elements that participants associated with warning or danger. The first section explored participants' understanding of the warning label, the label's visibility, its perceived credibility, and its perceived effect on purchasing habits. The second section required participants to select the label elements that they perceived as (1) attention grabbing, (2) effective as a warning against unhealthy foods and drinks, and (3) likely to influence their purchasing behaviour.

Three language experts translated the focus group discussion guide into Zulu, Xhosa and Sepedi to accommodate participants' native languages, and the moderator facilitated the discussions using the group's preferred languages.

2.8.8 Data analysis

Reiterative inductive data analysis was used to analyse the qualitative data, and data were then organised into themes (Braun & Clarke, 2006; Nowell *et al.*, 2017). Inductive data analysis refers to data analysis in which codes are data driven rather than theory or literature driven (deductive) (Braun & Clarke, 2006; Maltby *et al.*, 2010; Nowell *et al.*, 2017). In the current study, coders went back and forth through the transcripts to identify codes from participants' responses until comprehensive themes had been generated. The advantage of thematic analysis is that it provides a rich and detailed account of data (Braun & Clarke, 2006; Nowell *et al.*, 2017).

Qualitative data analysis followed the five-step data analysis process, as recommended by Creswell (2014). First, the researcher transcribed and translated all the session recordings transcripts into English. The researcher and an independent co-coder then iteratively read through all the transcripts, assigned codes manually, and grouped similar codes into themes. The researcher and the co-coder followed this process independently, and then had a discussion to reach consensus on the codes and the final themes. Finally, the researcher matched quotes from the transcripts with the final themes and sought the co-coder's view on the appropriateness of the quotes to illustrate the themes.

2.8.9 Measures to optimise trustworthiness

Qualitative researchers advocate trustworthiness as a determinant of rigour and quality in qualitative research (Grove *et al.,* 2015; Korstjens & Moser, 2018). The following measures were taken to optimise trustworthiness in phases 1 and 3 of the current study:

Credibility

Credibility refers to the confidence that can be placed in the truth–value of research findings (Korstjens & Moser, 2018; Lincoln & Guba, 1985). According to Lincoln and Guba (1985), credibility can be increased through prolonged engagement, data collection triangulation, researcher triangulation, peer debriefing and member checking.

i) Prolonged engagement

In this study, prolonged engagement was achieved through the researcher/moderator allowing focus group members to discuss freely and at length. The researcher also built rapport with the participants by commencing focus group discussions on a lighter topic to allow members to relax and get comfortable in the group.

ii) Triangulation

Triangulation refers to the use of multiple data sources to improve the credibility of a qualitative study (Brink *et al.,* 2012; Shenton, 2004). Participants from diverse backgrounds were included in the focus group discussions to obtain viewpoints and experiences from a range of sources for richer data (data triangulation) (Korstjens & Moser, 2018; Shenton, 2004). Additionally, the design of the WL was based on suggestions from the expert group, ratings from the advisory group and opinions from the focus group discussions. In the case of researcher triangulation, two independent researchers read and coded the same transcripts separately, generated themes, and reached consensus on the final codes and themes. Where there were differences, the two researchers discussed the issues until they reached consensus on which codes and/or themes to include and which to discard. The two researchers followed the same steps when analysing the data. These approaches increased the trustworthiness of the data. The researchers further reviewed the themes and quotations to ensure their credibility.

iii) Transferability, dependability and confirmability

Transferability refers to the degree to which qualitative research results can be applied to other contexts and settings (Korstjens & Moser, 2018; Nowell *et al.*, 2017). Transferability can be achieved by describing in detail the study setting, participants and data collection procedure (Korstjens & Moser, 2018), while dependability and confirmability are optimised by providing details of the steps followed from the start of the research project to the interpretation of the findings (Korstjens & Moser, 2018). To optimise transferability, dependability and confirmability, this chapter provides a detailed description of the methodology followed, including the participants, setting, sample, sampling method, data collection methods and tools, data analysis and data interpretation.

2.8.10 Pilot study

A pilot study, which is a smaller version of a proposed larger study (Brink *et al*., 2012), was conducted to test the focus group discussion guide and to assess logistical issues pertaining to data collection. Logistical challenges, such as managing time and assisting participants with low literacy levels to fill in the sociodemographic questionnaire, were mitigated in subsequent focus groups. According to Neuman (2006), pilot testing improves the reliability and validity of a study. Through piloting, researchers are able to improve the quality of data collection processes, such as the quality of the questionnaire, the time required to collect the data and any other logistical issues related to data collection (Grove *et al.,* 2015; Neuman, 2006), including gaining access to participants (Seidman, 2013). The first two focus groups were meant as pilot study groups, however data from the pilot study were included in the final focus groups as no significant amendments were made to the data collection tool and processes.

2.9 Phase 2: Methodology

Phase 2 involved a face-to-face randomised controlled trial (RCT) to determine the most effective FOPL system. In an RCT, individuals are randomly allocated to one of two (or more) groups, which include both a control group and (an experimental group(s) (Kendall, 2003). RCTs are recognised as the most vigorous methodology for testing the effectiveness of different treatments based on their potential to reduce bias (Grove *et al.,* 2015), such as selection bias, as participants are allocated to groups at random (Altman & Bland, 1999; Grove *et al.,* 2015; Sibbald & Roland, 1998). Random allocation within RCTs is, however, not equivalent to haphazard distribution; rather, it refers to distribution where each individual stands an equal chance of being selected for participation in a group (Altman & Bland, 1999; Brink *et al*., 2012).

The RCT followed a pre-test/post-test control group design (Brink *et al.,* 2012) where participants were randomly assigned to one of the three arms. In each arm, all participants were subjected to the pre-test/control (no-FOPL condition) and post-test/experimental (FOPL condition) groups. This study therefore had two components: a within-subject factor (difference between a no-FOPL and an FOPL product) and a between-subject factor (difference between the three FOPL conditions). This RCT was pre-registered with 'As Predicted': 45567.

2.9.1 Study setting

Data were collected from all nine provinces in South Africa, namely Limpopo, KwaZulu-Natal, Mpumalanga, Western Cape, Northern Cape, Gauteng, Eastern Cape, North West and Free State. The combination of the nine provinces represented the diverse sociodemographic, economic and cultural profiles of the South African population.

Gauteng is the smallest province but is densely populated (with 26% of the country's total population) and is the economic hub of the country (South African Government, 2022). It is highly urbanised and draws people from all over the country. All ethnic groups are represented in the province, but the predominant groups are Zulu, English, Afrikaans and Sotho (South Africa Gateway, 2021). Kwazulu-Natal is the second-largest province (with 19% of the country's total population) (South African Government, 2022) and mostly comprises the Zulu ethnic group (with a 77% share) (South Africa Gateway, 2021). Next comes the Western Cape (with 12% of the country's total population) (South African Government, 2022), with Afrikaans being the main language spoken, followed by Xhosa and English (South Africa Gateway, 2021). The Eastern Cape province, with the 4th largest population size in South Africa (11.1%), lies in the eastern part of the country. The most predominant spoken language is isiXhosa followed by Afrikaans.

Limpopo is a predominantly rural province (The Editors of Encyclopaedia Britannica, 2020) and accounts for 10% of the South African population (South African Government, 2022). The province mainly consists of three ethnic groups, namely baPedi (Sepedi or Sesotho sa Lebowa speaking), vaTsonga (Tsonga speaking) and VhaVenda (Venda speaking) (South Africa Gateway, 2021). Mpumalanga, known as the place where the sun rises, is popular for its wildlife and natural scenery and accounts for 7.8% of the South African population (South African Government, 2022). SiSwati and isiZulu are the predominant languages spoken in the province, followed by Xitsonga and isiNdebele (South Africa Gateway, 2021). The North West province lies in the North of South Africa and houses 6.9% of the South African population (South African Government, 2022). The two main languages spoken in the province are Setswana and Afrikaans, with a small proportion speaking isiXhosa (South Africa Gateway, 2021). The Free State is the second smallest province in South Africa, (5.8% of the total Soth African population) and predominantly hosts the Basotho (South Sotho) tribe (South African Government, 2022). With regards to the land area, the Northern Cape is the largest province in South Africa but remains a province with the smallest population size (2.2%). Two languages are mainly spoken in the province, namely, Afrikaans followed by Setswana (South African Government, 2022).

2.9.2 Participants' recruitment and sampling

All households in all provinces were targeted for data collection. A stratified multiphase sampling method was applied to select a nationally representative sample size to ensure the generalisability of findings. In stratified sampling, the population, based on variables of interest, is divided into different subgroups so that each participant belongs to only one group (Brink *et al.,* 2012). Participants were stratified according to: 1) urban hierarchy (metro urban/metro traditional/non-metro urban/non-metro traditional), 2) provinces (all nine provinces), 3) socioeconomic status (low, middle, upper), 4) districts, 5) municipalities, and 6) population groups. Population groups referred to participants racial groups (African, Coloured, Indian or White). Socioeconomic status was based on the Neighbourhood Lifestyle Index®© (NLI™©) developed by an independent statistician and used by a geographical information service, GEOTERRAIMAGE (GTI), which provided maps for the survey. The NLI™© is a system modelled from population dwelling unit information that classifies neighbourhoods according to their income and lifestyle characteristics, ranging from 1 (lowest income/poorest community) to 10 (highest income/most affluent community). For this survey, NLI™© was categorised into three wealth status groups (low, middle and upper income).

Households were primary sampling units, and the statistician randomly selected one household per enumerator area (EA) as a starting point. The GTI maps provided the coordinates for the randomly selected household. As a starting point, fieldworkers from the research agency systematically sampled 15 households in each EA. With systematic sampling, a random starting point is selected, followed by every kth individual where k=population size/sample size (Bacon-Shone, 2020). The fieldworkers selected every fourth or sixth household, depending on the EA size, to reach the required sample size. Where the targeted household members were inaccessible or refused to participate, the households were replaced with the ones next to them, and sampling then resumed as originally planned. Some gated areas in the upper income level were inaccessible and were thus excluded from the study.

Within the households, individuals who were mainly responsible for grocery purchases were the most preferred. Alternatively, individuals who shared the responsibility for household grocery purchases were recruited and, in their absence, those responsible for meal preparation were selected. A sample size of 1526 was calculated *a priori* at a power of 90%, 95% confidence level, and an effect size of 0.136. The effect size was estimated from a study by Ducrot *et al.* (2015a). The sample was increased to 2500 to allow for attrition.

2.9.3 Stimuli

Fictitious packages of single products (chips, soda and fruit juice) and paired products (biscuits, cereal and yoghurt) were used as stimuli (Appendix 9). The products were created to avoid interference with factors such as participants' food preferences, and brand loyalty and familiarity during data collection. The nutrient profile of each product was matched to the nutrient profiles of existing commercial products. The selection was based on product categories enjoying the highest sales, according to Euromonitor 2018, with the products selected representing those considered to be unhealthy (crisps, soda, biscuits) (Murukutla *et al*., 2020) as well as those which are often misinterpreted as healthy (fruit juice, cereal and yoghurt) by the population (Duffett, 2018; Taylor *et al*., 2023).

The agency designed four sets of all the single and paired products. One set had no FOPL (control) and the other three had a different FOPL – using the GDA, MTL or WL – affixed to them (Appendix 9).

Real-world FOPL together with their underpinning Nutrient Profile Models (NPM) were applied for the GDA (Food and Drink Federation, 2021) and the MTL (FSA, 2016) (Appendix 10). The WL proposed for South Africa and the NPM proposed for South Africa (Bopape *et al.*, 2021; Frank *et al.*, 2021) were applied for the WL (Appendix 10). The products' nutrient profiles, however, remained constant across the three arms; only the FOPL differed according to the respective NPMs.

2.9.4 FOP labels tested in the study

The GDA, MTL and WL were tested in this study. The MTL and the GDA, as per their current nutrient profiles, included nutrients as currently applied within their respective systems, namely, energy (kJ), saturates (g), fat (g), sugar (g) and sodium (g) per 100g/ml, or serving size, respectively (Food and Drink Federation, 2021; FSA, 2016). The WL, as proposed by the researchers, included three nutrients of concern, namely saturated fat, sugar and sodium expressed per 100g/ml (Bopape *et al.*, 2021; Frank *et al.*, 2021). For yoghurt, a warning about artificial sweeteners was also included with the WL, as is the case in countries such as Mexico (Global Agricultural Information Network, 2020b). The WL appeared only on products containing large amounts of nutrients of concern and was placed in the top right corner on the front of the food packages, while the GDA and MTL appeared on all products. In the case of the GDA, nutrients of concern were expressed per %Reference Intakes, and in the case of the MTL, nutrients of concern were expressed per %RI and as colour codes (Appendix 10). The colours included red, denoting high nutrient levels, and amber and green, indicating medium and low nutrient levels, respectively. The WL was presented as a black triangle if the nutrient content per 100g/ml exceeded the NPM cut point.

2.9.5 Data collection

The fieldwork took place between 29 November and 12 December 2019 and between 6 and 31 January 2020. Fieldworkers were trained in how to collect data, and the data collection was conducted in the households in question. Written (electronic) informed consent was obtained after it had been confirmed that a potential participant met the selection criteria. Prior to participants signing the consent form, the fieldworkers explained the purpose of the study, the data collection procedure, confidentiality issues, and the right to refuse or withdraw from the study without any negative consequences. To avoid the priming effect, the fieldworkers only mentioned that they were going to ask questions related to certain food products, without informing the participants that the study was evaluating the FOPL. Once the participants had signed the consent form, the fieldworkers administered the electronic questionnaires face to face and captured all the responses captured on their tablets.

Randomisation took place before data collection (Figure 2.4), and participants' allocation to a group depended on the FOPL applied by fieldworkers on the particular day of data collection.

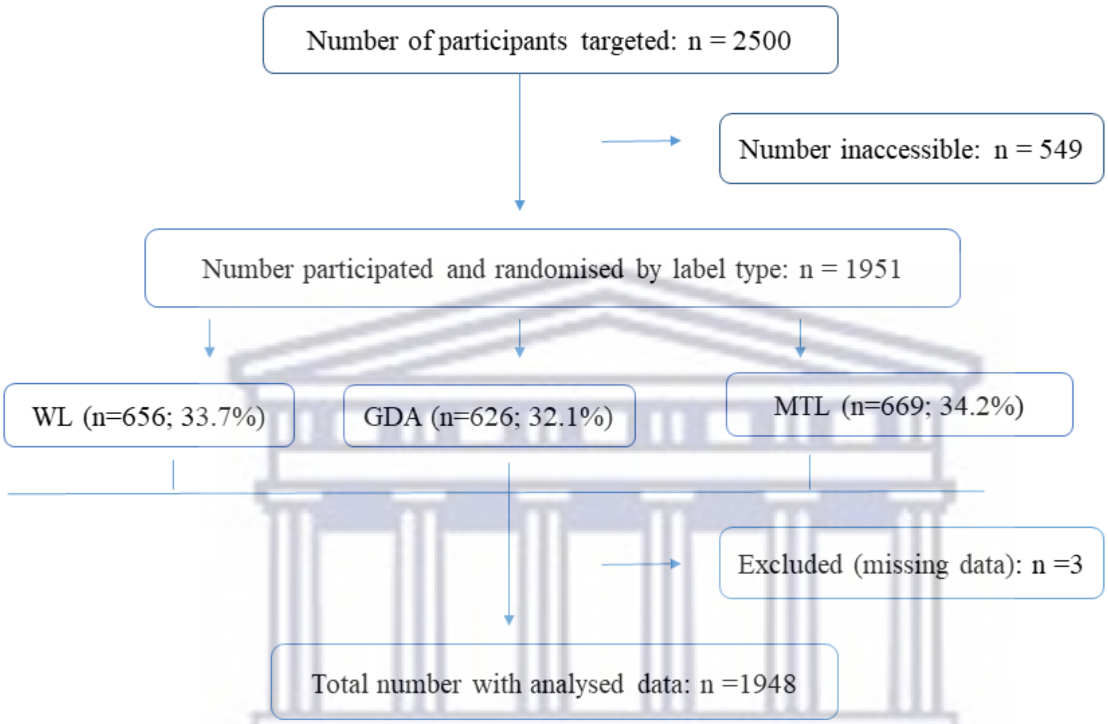


Figure 2.4: Randomisation according to label type

Participants were allocated to the WL, GDA or MTL arm. The allocations resulted in 33.7% of participants (n=656) being exposed to the WL, 626 (32.1%) being exposed to the GDA, and 669 (34.2%) being exposed to the MTL (Figure 2.4). The FOPL allocation was rotated among fieldworkers on a daily basis, with each fieldworker applying a different FOPL each day. Participants were therefore blind to the FOPL, whereas fieldworkers were always aware of the FOPL they were to administer. With blinding, the researchers, data collectors and/or participants were not aware of which arm participants would be allocated to.

According to Grove *et al.* (2015), blinding is important as prior knowledge of the treatment may influence the research outcomes (Bacon-Shone, 2020). For example, participants who are aware of the treatment beforehand may perform differently from those who are oblivious to the treatment (Sibbald & Roland, 1998) – a concept known as performable bias (Karanicolas *et al.,* 2010). Participants in the current study were deliberately blinded to the treatment to prevent this form of bias. Blinding may, however, be challenging for practitioners or data collectors where the treatment has to be physically administered (Karanicolas *et al.,* 2010). Hence, blinding was only applied to participants in this study.

2.9.6 Procedure

The data collection procedure and stimuli used were the same in all three experimental arms, except for the type of FOPL applied. In each experimental arm, all participants were first exposed to a no-FOPL condition (control phase), which was immediately followed by the FOPL condition (experimental phase) (Figure 2.5). In this RCT, participants therefore served as their own form of control (within-subject design), and performance was also compared across the three FOPL systems (between-subject design).

In the control phase, all participants across the three arms viewed the same packages with no FOPL and responded to questions posed. Immediately thereafter, each participant was exposed to the products bearing the FOPL that they had been allocated, followed by similar questions that had been posed in the control phase. Similar products were used in both the control and experimental phases; only the FOPL differed (with FOPL at this stage) (Appendix 9; Figures 2.5 and 2.6).

Figure 2.5: Single product images used in phase 2 of the study

Figure 2.6: Paired product images used in phase 2 of the study

2.9.7 Questionnaire

A structured, researcher-administered questionnaire was used to collect data. The questionnaire (Appendix 11), adapted from studies conducted by Khandpur *et al*. (2018a) and Reyes *et al.* (2019), had seven sections. Since this phase involved secondary analysis of the findings from the bigger project, the researcher focused on only two sections of the questionnaire. The first section comprised the sociodemographic questionnaire. The sociodemographic section included the participant's age, sex, educational level, language, frequency of household grocery purchasing, whether the participant was the main grocery buyer and decision maker, where the groceries were purchased most of the time, and the number of children (under the age of 18 years) who ate the food in the household. The second section contained questions relating to the identification of products high(er) in nutrients of concern, the identification of unhealthy(ier) products, and the influence of the WL on the intention to purchase the products.

For single products, participants were asked to state whether the products contained nutrients of concern (sugar, salt and saturated fat – with each nutrient addressed in a separate question) in higher amounts than are recommended for a healthy diet. The response options were: 1) yes, 2) no, or 3) unsure. For paired products, participants were asked to state the product (Product A or Product B) that contained higher amounts of nutrients of concern. Each set of the paired products appeared on the same A4-paper and were labelled as either Product A or B. The participants were required to make a comparison of the two. The response options were: 1) Product A, 2) Product B, 3) They contain the same amounts, or 4) I cannot tell from looking at the images.

To determine their ability to identify unhealthy products, participants were asked the following question: 'Do you think this product is healthy?' The response options were: 1) I think it is healthy, and 2) I think it is unhealthy. For paired products, the following question was asked: 'In your opinion, which one of Product A or Product B is most unhealthy?' The response options were: 1) Product A, 2) Product B, 3) They are similar, or 4) I cannot tell from looking at the images. The intention to purchase was evaluated from the following question: 'How likely are you to buy this/these product(s)? The response options were: 1) I would definitely not buy it, 2) I am unlikely to buy it, 3) I will consider buying it, 4) I will definitely buy it.

2.9.8 Outcome measures

The primary outcome for single products was the ability to correctly identify products high in nutrients of concern and to correctly identify unhealthy products. All the products tested in this study were high in nutrients of concern and were ultraprocessed. A product with either a WL, an amber colour or a red colour in the MTL was considered high in nutrients of concern and/or unhealthy. For paired products, the primary outcome was the ability to identify products higher in nutrients of concern and unhealthier products. The response 'unsure' was always regarded as incorrect. A product contained higher amounts of nutrients of concern or was unhealthier if it had more WLs or more amber or red colours. The other outcome was the ability to identify the label that most effectively discouraged participants from purchasing the products.

2.9.9 Data analysis

Data captured on the tablets were automatically converted into an Excel spreadsheet, cleaned by the researcher and analysed by the statistician (Jeroen De Man) using R software with the packages 'geepack' (Halekoh, 2006) and 'survey' (Lumley *et al.*, 2021). Following the data cleaning, three participants were excluded on the basis of missing data. The statistical analysis was therefore performed on 1951 participants.

Chi-square tests were conducted to determine participants' sociodemographic distribution according to label type, and the results were presented as counts and percentages. A modified Poisson regression was used to compare the effect between labels, with the follow-up outcome measures (the product shown with one of the three labels) as the dependent variable and the different labels as independent variables. To account for potential regression to the mean effect, an analysis of covariates (ANCOVA) was conducted with the no-FOPL (control) value included as a covariate. The following were adjusted for: age, gender, level of education, socioeconomic status, being the main buyer, having children below 16 years of age, and metropolitan residency. Comparisons of the two labels were presented as relative risk (RR) estimates. The RR is the likelihood of the occurrence of an outcome after exposure to a variable, as compared to the likelihood of its occurrence in a control group (Andrade, 2015). A RR >1 implied a higher percentage of participants exposed to Label X correctly identified products as high in nutrients of concern, or unhealthy, compared to Label Y. Similarly an RR >1 implied that a higher percentage of participants exposed to Label X were discouraged from purchasing the products, compared to Label Y.

The difference between the proportion of correct answers in the no-FOPL (control) and the FOPL (experimental) phase represented the within-subject differences, while the differences across different types of FOPL represented between-subject differences.

2.9.10 Pilot study

The questionnaire was piloted among 10 postgraduate students as well as 21 individuals from low sociodemographic backgrounds to test for face validity, logical flow and clarity of questions (Neuman, 2006). Based on the results of the pilot study, the questionnaire was shortened, unclear questions were rephrased and repeat questions were deleted. However, changes were only applied to the other section of the bigger project and not to questions related to the current study.

2.9.11 Reliability of the study

Reliability refers to the ability of an instrument to yield similar results repeatedly (Grove *et al.,* 2015). Reliability was ensured by training fieldworkers to ensure that the data were collected in a similar manner and that the questions were posed in similar ways to all the participants during the data collection process.

2.9.12 Validity of the study

Validity refers to the extent to which a study measures that which it intends to measure (Bacon-Shone, 2020; Brink *et al.,* 2012). Content validity in the current study was ensured through an evaluation of the questionnaire by experts in the food labelling and public health fields and by one staff member in the Department of Human Nutrition and Dietetics. Content validity is an assessment of how well the instrument represents all the components of the variables to be measured (Brink *et al*., 2012). The questionnaire was translated into different languages (Xhosa, Zulu, Sepedi and Tswana) to ensure content validity.

To ensure face validity, the questionnaire was piloted among postgraduate students in the public health sector who were knowledgeable about nutrition and 21 individuals with similar characteristics to the participants in the main study.

2.10 Phase 3: Methodology

Phase 3, similar to phase 1, followed an exploratory qualitative design. Participants were interviewed at length to evaluate their perceptions regarding the most effective FOPL. Based on phase 2 results, the WL ranked as the most effective FOPL – hence, the focus on the WL in this phase.

2.10.1 Study setting

Initially, the study was to be conducted in two provinces, Limpopo (see section 2.9.1 for the description of the province) and the Western Cape, with a total of 80 participants (40 per province) representing the differences in socioeconomic level and cultural backgrounds between the two provinces. In the light of the RCT results, which revealed the WL as the most effective FOPL, the Western Cape was eliminated as a study site as the WL had previously been tested in that province during phase 1 of the study.

2.10.2 Participants' recruitment and sampling

Seventy individuals were recruited for phase 3, however only 44 eventually participated in the study. A snowball sampling method was used to recruit 44 male and female adults to participate in the study. The inclusion criteria were individuals aged 18–50 and parents with children aged below 16 years. The sample also comprised individuals from both rural and urban areas. For a snowball sample, the researcher asks each participant to suggest someone else who meets the selection criteria and might be available for the study (Maltby *et al*., 2010). The researcher recruited participants both telephonically and face to face. In each area, the researcher identified a contact person (known to the researcher or a referral from community leaders) who were asked to refer the first participant.

2.10.3 Stimuli

The researcher used the same fictitious products (crisps, juice, soda, biscuits, cereal and yoghurt) as those used during the RCT as stimuli in this phase of the study. Only products superimposed with the proposed black WL for South Africa (Appendix 9) were used, as the WL outperformed other labelling formats.

2.10.4 Data collection procedure

The researcher, who also moderated the focus group discussion, collected data between November 2020 and December 2020, in March 2021 and in November 2021. The breaks between the data collection periods were due to Covid-19-related restrictions on travelling and physical gatherings. Data were collected face to face through seven focus group discussions in prearranged areas that were convenient to the participants, and all discussions were captured on an audio- recorder.

The researcher explained the objectives of the study and the study processes, the confidentiality of issues to be discussed, and the right to refuse participation. Once the researcher had responded to participants' questions, the focus group members signed the confidentiality binding form as an indication of their willingness to participate and their giving of permission to the researcher to record the discussions.

The researcher circulated the images of the six products among the group members so that they could view them closely. The focus group members were requested not to discuss what they saw on the images so as to prevent members from influencing one another. Once all members had seen the pictures, the researcher once more presented the images, one at a time and providing no information about the images, to make sure that all participants had had an opportunity to view them. The researcher then led the focus group discussion using the focus group discussion guide (Appendix 12). The focus group discussions lasted between 40 and 45 minutes each and were conducted until data saturation was reached for all questions. The researcher stopped probing each question further in each focus group when no new information was emerging from the discussions, that is when data saturation on the particular question was reached (Guest *et al*., 2006). All focus group discussions were audio-recorded, transcribed and analysed by the researcher.

2.10.5 Focus group discussions

In phase 3 of the study, participants were divided into seven focus groups comprising six to eight members each. According to Hennink *et al*. (2019) four to six focus groups are sufficient to identify almost all the codes and their meanings on a topic. One additional focus group was added during sampling in phase 3 to ensure data saturation., hence a total of seven focus groups in phase 3. Each focus group was homogeneous, according to the criteria outlined in section 2.7. The focus group discussion guide (Appendix 12) centred on participants' opinions of the WL, WL understanding, perceived influence of the WL on food purchases for their children, barriers to and enablers of label use, and perceived reaction of manufacturers to the WL's implementation. The researcher developed the focus group discussion guide in English and a language expert translated it into Sepedi.

2.10.6 Data analysis

The data analysis, as outlined in section 2.8.8, was then performed. The initial plan was to explore participants' views on the warning label in general. However, since the winning label was the same as that explored in phase 1, the researchers, in their analysis of the data, deviated from the initial plan by focusing only on aspects that were not part of the phase 1 findings. Following the socioecological model (Figure 1.1), the analysis therefore excluded label understanding and the perceived effect of the WL on adults' food purchases. The researcher instead focused on the perceived effect of the WL on parental selection of food products bearing the WL, for their children.

2.11 Ways in which bias was dealt with

Bias is an influence that produces an error or a distortion, which can affect the quality of evidence in research (Brink *et al.,* 2012).

2.11.1 Selection bias

In the RCT (phase 2), selection bias was minimised by randomly allocating participants to groups (Grove *et al.,* 2015) and by blinding participants to the label allocated to them (Grove *et al.,* 2015). Selection bias is an error that arises during the selection of participants, where individuals who sign up for a study differ from those potentially eligible for participation (Tripepi *et al.*, 2010). Minimising selection bias in this study reduced the effect of possible confounders on the study findings, thus increasing the likelihood that the results were influenced mainly by the FOPL. Selection bias also compromises representativity, meaning that the findings would not be applicable to the entire population. With the snowball sampling method (qualitative), the participants are likely to know each other, leading to a skewed sample. The sample may therefore not be representative of the whole population and the findings thus not generalizable to the entire population (Raina, 2015).

2.11.2 Non-response bias

Non-response bias refers to an error that occurs due to underrepresentation of certain survey respondents. This form of bias was minimised by increasing the sample size from 1526 to 2500 in phase 2 of the study. Minimising non-response bias ensures that results are generalisable to the wider adult population, as the sample size was representative enough.

2.11.3 Social desirability bias

Social desirability, defined as the tendency to respond in a socially moral or politically correct way (Remler & Van Ryzin, 2011), was minimised throughout this study by informing participants that there were no correct or incorrect responses. This form of bias was also minimised by explaining at the outset that the study was based on the products to be displayed (thereby not disclosing that the main focus was on the FOPL). Failure to address social desirability might have led to overestimation of the effectiveness of the FOPL, which might not be reflective of reality.

CHAPTER 3: LITERATURE REVIEW

3.1 Introduction

This chapter focuses on front-of-package labelling as a strategy to reduce obesity and NCDs. The literature review provides background on ultraprocessed foods as unhealthy foods that are high in nutrients of concern (Monteiro *et al*., 2016) and also provides literature that demonstrate the link between UPF and NCDs. This review is essential as motivation for the importance of labelling these ultraprocessed foods in an effort to deal with one of the major causes of NCDs.

The literature review starts by describing ulltraproceesed foods, providing the global and local UPF consumption patterns, prevalence of obesity and NCDs, and the determinants of UPF consumption. The two different types of food labelling (back-of-pack and front-of pack) are then presented to point out the differences and effectiveness of each type of labelling. This literature review interrogates the different FOPL including the label types, format, type of information/nutrients included its purpose and effectiveness in assisting consumers to select healthy foods. Chapter 2 therefore lays a foundation for chapter 4 that provides further information about FOPL to guide the selection of the most appropriate FOPL for South Africa.

3.2 The concept of ultraprocessed foods

Urbanisation and improved living standards, together with a rise in access to UPFs (Koiwai *et al.*, 2019; Monteiro *et al.*, 2013), have resulted in unhealthy population diets which are low in wholegrains and fruit and vegetables, and are high in calories, added salt, sugar, total fats and saturated fats (Claasen *et al.,* 2016; Satia, 2010). These poor diets are a major cause of morbidity and mortality worldwide (GBD 2015 Risk Factors Collaborators, 2016).

Ultraprocessed foods are a new concept, which have given rise to controversies around their definition and their role in informing dietary guidelines (Astrup & Monteiro, 2022). These products are associated with dietary intake patterns that are high in saturated fats, trans-fat, sugar and salt (Monteiro *et al.*, 2019). The concept of UPF was proposed in 2010 (Monteiro *et al.*, 2010) and is defined as industrially formulated, ready-to-consume and ready-to-heat products, made by combining several substances derived from foods (Monteiro *et al.*, 2016; Poti *et al.*, 2015). These foods are typically packaged; are high in calories; high in added sugar, salt, trans-fat and saturated fats; contain no or little fibre, protein and micronutrients; and contain several additives, such as flavourants and colourants (Frank *et al.*, 2021; Monteiro *et al.*, 2016; Poti *et al.*, 2015).

Although there is broad agreement regarding their lower dietary quality (Astrup & Monteiro, 2022), Astrup, in their debate against Monteiro (Astrup & Monteiro, 2022) believes that some healthier products have probably been misclassified as ultraprocessed. These misclassified products, according to Astrup & Monteiro (2022) include pomace olive oil, that is extracted after the first pressing of the olives, noncaloric sweetened yoghurt and burgers prepared on wholewheat flour. Monteiro, however, counters the belief about the misrepresentation of UPF classification (Astrup & Monteiro, 2022). For example, according to Monteiro, single ingredient items, such as Pomace olive oil are classified as processed rather than untraprocessed (Monteiro *et al*., 2019). UPFs typically include carbonated drinks, sweet or savoury packaged snacks, ice cream, candies, biscuits, cakes, breads, breakfast cereals, cereal and energy bars, milk drinks, fruit drinks, instant sauces, infant formulas, follow-on milks, infant cereals, and many ready-to-heat products, including pre-prepared pies, pasta and pizza dishes, instant soups, noodles and desserts (Monteiro *et al*., 2016).

Access to and consumption of UPFs have increased dramatically in South Africa (Frank *et al.*, 2021; Igumbor *et al.*, 2012; Ronquest-Ross *et al.,* 2015; Swart & Sambu, 2022), leading to serious public health (Igumbor *et al.*, 2012), economic (Erzse *et al.*, 2019; Kent *et al.*, 2017) and environmental challenges (2021 Global Nutrition Report, 2021). Literature shows a direct relationship between UPF consumption and NCDs such as hypertension and diabetes Chazelas *et al.*, 2019; Rico-Campà *et al.*, 2019; Srour *et al.*, 2019). In South Africa, it is estimated that in 2018, in the case of diabetes alone, the public-sector cost of individuals diagnosed with diabetes was approximately R2.7 billion and would be R21.8 billion if undiagnosed individuals were included (Erzse *et al.*, 2019). These challenges necessitate strong efforts to promote and support healthy diets.

3.3 Adult population dietary patterns

3.3.1 International perspective

Diets among the populations of all countries are becoming poorer and poorer, with low consumption of fruit and vegetables and increased consumption of foods high in saturated fat, sugar and salt (Grech *et al.*, 2017; Popkin, 2014; Popkin & Hawkes, 2016). An evaluation of dietary intake in 187 countries, South Africa included, revealed an increase in the intake of unhealthy products across all the countries, irrespective of income levels, between 1990 and 2010 (Imamura *et al.*, 2015). The study reported a shift to unhealthy diets, including a higher intake of red meat and processed meat, and diets high in saturated fat, trans-fat, free sugar and sodium (Imamura *et al.*, 2015) that are above the recommended levels (Pereira *et al.*, 2015; Stern *et al.*, 2014; Thow & Hawkes, 2013). These increases are evident in both HIC and LMIC (Popkin, 2014; Popkin & Hawkes, 2016), but especially in LMIC (Popkin & Hawkes, 2016).

3.3.2 South African perspective

Since the 1990s, South Africa has undergone a nutrition transition (Reardon *et al.*, 2003) leading to deviations from a more traditional diet to a Western type of diet (Pretorius *et al.*, 2012; Ronquest-Ross *et al.,* 2015; Vorster *et al.*, 2005). For example, a study of adolescents in Soweto, near Johannesburg, over a five-year period found that teenagers reported high consumption of fast food each week, with sweets, crisps and soft drinks ranking high among the total number of items consumed (Feeley *et al.*, 2012). The tendency towards low fruit and unrefined cereal intake, coupled with high consumption of processed food, has also been observed among adults in Soweto (Pretorius *et al.*, 2012). These dietary patterns are similarly observed in non-urban areas (Mashiane *et al.*, 2018).

A review of the FAOSTAT food balance sheets (1994–2009) and the Euromonitor International Passport (1999–2012) also provide evidence of a major shift in South Africa towards soft drinks, sauces, dressings and condiments, sweet and savoury snacks, meat, and fats and oils (Ronquest-Ross *et al.,* 2015). Furthermore, a systematic review of dietary studies conducted in South Africa between 2000 and 2015 revealed high sugar consumption (>10% of total energy) and low fibre intake among adults in (Mchiza *et al.*, 2015). Unfortunately, there are no recent national data on the dietary intakes of South African adults.

3.4 Association of unhealthy diets with NCDs and obesity

3.4.1 Diets high in sugar

High consumption of sugar, particularly added sugar, is associated with poorer diet quality, weight gain, increased risk of coronary heart disease (CHD) (De Koning *et al.*, 2012), diabetes (Malik *et al.*, 2010) and all-cause mortality (Mullee *et al.*, 2019). High consumption of added sugar is also associated with dental caries (Bernabé *et al.*, 2016; Sheiham & James, 2015). Added sugars are sugars, syrups or caloric sweeteners that are added to foods during processing or manufacturing, during food preparation at home or in restaurants and other food outlets, or at the table (Bowman, 2017).

According to Sánchez-Pimienta *et al.* (2016), SSBs are the major contributors of added sugar in people's diets. SSBs are all types of beverages containing free sugars, including carbonated or non-carbonated soft drinks, fruit/vegetable juices and drinks, concentrates, flavoured water, energy and sports drinks, and flavoured milk drinks (World Health Organization, 2017c). Free sugars are monosaccharides and disaccharides added to foods and drinks by the manufacturer, cook or consumer, as well as sugars naturally present in honey, syrups, fruit juices and fruit juice concentrates (World Health Organization, 2017c). Findings from a longitudinal study revealed that the consumption of more than 0.5 servings per day of SSBs, including 100% fruit juice over a period of four years, led to a 16% higher risk of type 2 diabetes mellitus over the subsequent four-year period (Drouin-Chartier *et al.*, 2019). In addition, a systematic review of studies reported an association between high consumption of SSBs and metabolic syndrome as well as type 2 diabetes (Malik *et al.*, 2010). The same systematic review showed that individuals who regularly consume one to two cans of SSBs a day, or more, have a 26% greater risk of developing type 2 diabetes than people who rarely consume such drinks (Malik *et al.*, 2010).

A report by Ronquest-Ross *et al.* (2015) indicates that in South Africa, soft drink consumption increased by 68.9% between 1999 and 2012. The largest increase was observed with carbonated drinks, followed by the fruit/vegetable group, particularly 100% fruit juice (Ronquest-Ross *et al.,* 2015). Findings from the latest South Africa Demographic and Health Survey (SADHS) also reported high SSB consumption (an average of 607 ml per day) where more than a third (36%) of the adult population reported consuming SSBs the day or night before data collection (National Department of Health *et al.*, 2019).

A study of 70,486 participants in the Japan Public Health Center-based Prospective Study found a direct relationship between high sugar intake, all-cause mortality and mortality from heart diseases, circulatory diseases and cerebrovascular diseases (Huang *et al.*, 2021; Janzi *et al.*, 2020). Yang *et al.* (2014) similarly reported a link between a high intake of added sugar and an increased risk of mortality from CVD and CHD. Although no association with CHD was reported in a study by Collin *et al.* (2019), a link was shown between high SSB consumption, including 100% fruit juice, and a higher all-cause mortality rate among the cohort of 13,440 participants. Lastly, a review of RCT studies revealed that a reduction in sugar intake resulted in a reduction in body weight (Te Morenga *et al.,* 2013), highlighting the contribution of sugar towards weight gain.

3.4.2 Diets high in added salt

Salt intake is high in South Africa (Eksteen & Mungal-Singh, 2015). Charlton *et al.* (2005) reported that in 2005, processed food such as bread, processed meats, stock cubes, soup powders and savoury snacks accounted for 55% of the total sodium intake in South African adults. Regarding frequency of consumption, in 2016, 13% and 14% of South African adults reported daily consumption of salty snacks and processed meats, respectively (National Department of Health *et al.*, 2019). This pattern was observed in both urban and non-urban areas, but to a larger degree in urban areas (National Department of Health *et al.*, 2019).

High sodium intake is implicated in high blood pressure (GBD 2015 Risk Factors Collaborators, 2016; Graudal *et al.,* 2017), strokes, CVD and death (Mozaffarian *et al.,* 2010). The findings from a study in the US reported an association between high sodium intake and a 32% increase in strokes, a 89% increase in stroke mortality, a 44% increase in CHD and a 61% increase in cardiovascular mortality (He *et al.*, 1999). Another review of studies similarly reported a high mortality rate from cardiovascular causes as a result of sodium intake above recommended levels (Mozaffarian *et al.*, 2014). In another review of studies by Graudal *et al.* (2017), a positive relationship was established between reduced sodium intake and reduced blood pressure, thus strengthening the case for people to reduce sodium intake in their diets (Vorster *et al.,* 2013; World Health Organization, 2020b).

3.4.3 Diets high in saturated fats

Although findings are mixed, there is evidence to support the role of saturated fatty acids (SFAs) in the atherosclerotic cardiovascular disease risk (Maki *et al*., 2021). In a systematic review by De Souza *et al*. (2015) however, no association was found between saturated fats intake and all-cause mortality, CVD, CHD, ischemic stroke or type 2 diabetes. Similarly, Laguzzi *et al*. (2021) did not find any association between saturated fat intake and subclinical atherosclerosis.

Other studies revealed that the replacement of SFAs with polyunsaturated fatty acids (PUFAs) resulted in fewer incidences of CVDs (Masquio *et al.*, 2015; Mozaffarian *et al.,* 2010), thus giving weight to the recommendations by health organisations to substitute dietary SFAs with PUFAs to lower CVDs (Krauss & Kris-Etherton, 2020; Vorster *et al.,* 2013; WHO/FAO Expert Consultation, 2003).

3.4.4 NCDs in the context of Covid-19

Individuals with pre-existing health conditions, such as hypertension, cancer, CVD, diabetes mellitus and acute kidney injury, are at a higher risk of severe morbidity and mortality from Covid-19. A study conducted in China found that the majority (72.2%) of patients admitted to ICU had underlying comorbidities, including hypertension (58.3%), diabetes (22.2%), CVD (25.0%) and cerebrovascular disease (16.7%) (Wang *et al.*, 2020). These findings were supported by Zhou *et al.* (2020) who reported high mortality among Covid-19 patients with underlying comorbidities. In another retrospective study of 7,337 cases of Covid-19 in China, it was reported that individuals with type 2 diabetes had a significantly higher mortality rate than non-diabetic individuals (Zhu *et al.*, 2020).

Previous studies in South Africa produced similar findings of higher morbidity and mortality in Covid-19 patients. For example, a retrospective study among healthcare workers throughout the country's nine provinces revealed that the disease was more severe in patients with hypertension (36.3%), diabetes (23.3%) and obesity (16.7%) (Ratshikhopha *et al.*, 2022). Another study conducted in South Africa supported the latter findings, revealing that mortality from Covid-19 occurred in patients with a prior diagnosis of hypertension (64%), followed by diabetes mellitus (52%) and obesity (12%) (Tshitangano *et al.*, 2022). The link between obesity, NCDs and severe outcomes from Covid-19 emphasises the need to urgently address these public health problems.

3.5 Prevalence of adult obesity

3.5.1 International perspective

The prevalence of obesity is increasing at a rapid rate worldwide (2021 Global Nutrition Report, 2021; World Health Organization, 2021c). Kelly *et al.* (2008) predicted that more than 50% of the world's adult population could either be overweight or obese by 2030 if current patterns continued. In monitoring countries' progress in addressing these scourges, the 2021 Global Nutrition Report (2021) predicts that no country in the world is on track to reduce obesity by the year 2025.

Data analysed from 195 countries, including South Africa, show that obesity has been increasing steadily. Between 1980 and 2015, a total of 603.7 million adults aged 20 years and above were overweight or obese, with a higher prevalence found among women than men (GBD 2015 Obesity Collaborators *et al.*, 2017). An analysis of worldwide statistics in 2016 revealed an even higher percentage. Shekar and Popkin (2020) reported a very high prevalence of 44% (more than 2 billion) among 20-year-olds and above, globally. Using a different age category (18 years and above), the World Health Organization (2021c) reported a 52% prevalence rate worldwide in 2016, with 39% of adults being overweight and 13% being obese. Over 70% of the adult population designated as overweight and obese lived in LMIC in 2016, showing that obesity is now a global problem and no longer a problem affecting the affluent only (Shekar & Popkin, 2020).

In fact, in richer countries, overweight and obesity are increasing more among disadvantaged groups. The disproportionate prevalence of obesity and NCDs is a result of lower socioeconomic groups being exposed to obesogenic environments, including having easy access to unhealthy food of inferior nutritional quality (Grech *et al.*, 2017; Hayes *et al.*, 2019). These groups are disadvantaged by the inequalities in food systems that force the poor to rely on cheap foods and diets (Global Nutrition Report, 2020). No global data beyond the 2016 data exist.

3.5.2 South African perspective

SADHS data revealed that in 2016, 31% of men and 68% of women aged 15 years and above were either overweight or obese (National Department of Health *et al.*, 2019). While the overweight/obesity prevalence remained the same for men, there was a marked increase of about 20% for women between the period 2003 and 2016 (Department of Health *et al*., 2007; National Department of Health *et al.*, 2019).

A secondary data analysis of the 1998 and 2016 SADHS and the National Income Dynamics Studies (NIDS) (2008, 2010–2011, 2012, 2014–2015 and 2017) among women of childbearing age showed an increase in prevalence of overweight from 51.3% to 60.0% and obesity from 24.7% to 35.2% between the periods 1998 and 2017 (Nglazi & Ataguba, 2022).

3.6 The burden of NCDs

3.6.1 Global perspective

NCDs remain among the top 10 leading causes of death both globally and locally (World Health Organization, 2021b). According to the World Health Organization (2021b), 85% of these deaths occur in LMIC, indicating a shift in the disease pattern from more developed to less developed countries. Data from 195 countries show that in 2015, cardiovascular diseases were the leading cause of death worldwide, accounting for 2.7 million deaths, followed by diabetes which accounted for 0.9 million deaths (GBD 2015 Obesity Collaborators *et al.*, 2017). In 2016, NCDs – including CVD, cancer, diabetes and chronic respiratory diseases – accounted for 41 million deaths worldwide, equivalent to 71% of all global deaths (World Health Organization, 2019b), with the number rising to 73.6% in 2019 (World Health Organization, 2021d). The latest statistics report high systolic blood pressure as the leading mortality risk factor, accounting for 10.8 million deaths (19% of all deaths) in 2019 (GBD 2019 Risk Factors Collaborators, 2020). In the same vein, in 2019, diabetes was reported to be the ninth leading cause of death, directly responsible for 1.5 million deaths worldwide (World Health Organization, 2021a).

3.6.2 South African context

In South Africa, a middle-income country, NCDs are similarly ranked as being among the top 10 leading causes of death and accounted for 57% of deaths in the country in 2016 (Statistics South Africa, 2018). It was reported that 13% of men and 16% of women had hypertension in 2003 (Department of Health *et al.,* 2007). More than a decade later, in 2016, according to the SADHS, the numbers had doubled to 44% of men and 46% of women with hypertension (National Department of Health *et al.*, 2019). In the case of diabetes, the South African National Health and Nutrition Examination Survey (SANHANES-1) reported a prevalence rate of 7.9% among men and 11% among women (Shisana *et al.*, 2013). The same study reported a hypertension prevalence rate of 20% among adults aged 15 years and above (Shisana *et al.*, 2013).

3.7 Causes of obesity and NCDs

The socioecological model (Figure 1.1) depicts the pathway along which obesity and NCDs develop. According to the conceptual framework, obesity and NCDs are caused by multiple factors occurring at the societal, community, relational and individual levels (Centres for Disease Control and Prevention, 2022).

Societal determinants include the economic, political and social factors that influence a population's health status (Swinburn *et al.*, 2019). Examples include national wealth, national health spending, policies and laws, culture and the food retail environment. These strongly influence community, relational and individual factors (Swinburn *et al.*, 2019). For example, governance may determine whether the regulatory systems allow or restrict marketing of unhealthy food and beverages to children (Swinburn *et al.*, 2019), and whether access to cheap, unhealthy processed food is regulated or not. Societal determinants are often present at the international, national or regional levels and usually affect wider communities (Swinburn *et al.,* 1999). These factors influence food processing, packaging, transportation, storage and ultimately the food that individuals purchase for their households. For example, efforts to improve food availability, transportation and storage have resulted in foods of lower nutritional quality that are higher in fat, salt and sugar (Branca *et al.*, 2019). Other societal determinants may include the price of food, which determines the type and amount of food procured for the household. The determinants of food intake at this level are difficult for individuals to tackle and may even be more than government departments can handle due to their complexity and other interests, such as profit (Swinburn *et al.,* 1999).

Community determinants are the conditions in which individuals live, including quality of care, access to education, health services, employment and transportation (Swinburn *et al.*, 2019). Community determinants are influenced by societal factors. For example, national budgetary constraints may limit healthcare funding and funding for schools and universities, which in turn affects the quality of healthcare, education and family income (relational determinant) (Swinburn *et al.*, 2019). The availability of vending machines at schools, poor availability of fruit and vegetables in supermarkets, a lack of safe places for physical activity and advertisement of unhealthy foods on billboards are some of the obesity determinants at the community level.

Relational determinants are the immediate support structures available to individuals, such as family, parents, siblings, friends and colleagues who influence individuals' eating patterns and health. Both societal and community factors affect relational determinants. Poor health resulting from inadequate healthcare is associated with lower household income and inadequate resources. Cultural beliefs and attitudes towards certain food and dietary patterns may influence the type of food purchased and how it is consumed at the community and household levels (Swinburn *et al.,* 1999).

Individual determinants include age (Ajaero *et al.,* 2020; Statistics South Africa, 2017b), gender (Ajaero *et al.,* 2020; Statistics South Africa, 2017b), educational and income status (Ajaero *et al.,* 2020; Mutyambizi *et al.*, 2019) and literacy levels (National Department of Health *et al.*, 2019). Other individual determinants include physical activity (Ajaero *et al.,* 2020), culture, nutrition knowledge, dietary preferences and time for food preparation (Beaglehole *et al.*, 2011; Branca *et al.*, 2019; Puoane *et al.*, 2012; Samodien *et al.*, 2021).

The rise in incidences of obesity and NCDs points to a public-wide challenge and necessitates public-wide policies that not only address individual factors but also incorporate policies that address broader social and environmental factors (Hawkes *et al.*, 2015; Roberto *et al.*, 2015; Swinburn *et al.*, 2011). Recognising the multi-dimensional causes of obesity and the multiple-pronged approach needed to reduce obesity and NCDs, the WHO, at its 57^{th} World Health Assembly (World Health Organization, 2012), endorsed nutrition labelling as one of the strategies to address these growing public health challenges. Other authors have subsequently supported nutrition labelling as one of the potential means of scaling obesity and NCD prevention efforts from the individual level to the population-at-large level (Cecchini & Warin, 2016; Hawkes *et al.*, 2015).

3.8 Nutrition labelling

Nutrition labelling is recognised as a core policy implemented at the societal level to enable informed decisions, encourage healthier food choices and reduce NCDs (Beaglehole *et al.*, 2011; Mazzocchi *et al.*, 2015). Nutrition labelling is the provision of information on the nutritional content of food products at the point of purchase (Cowburn & Stockley, 2005; Hamlin & McNeill, 2016) or consumption (Feunekes *et al.*, 2008) in an attempt to enable consumers to choose healthier foods (Grunert & Wills, 2007; Van Trijp, 2009). Nutrition labelling is most commonly applied to packaged food and beverages.

Various labelling formats exist, which differ in terms of the types and number of nutrients appearing on the label, the reference values used, icon shapes, colour, size, whether the information appears on front-of-pack or back-of-pack, and whether or not the label gives any interpretative guidance to the consumer (EUFIC, 2017; Kanter *et al.,* 2018).

According to the Codex Alimentarius Commission, nutrition labelling has two components: the nutrient declarations and the supplementary nutrition information (Codex Alimentarius, 2017). The nutrient declarations are the comprehensive list of nutrients that appears either at the side or at the back of the pack, also referred to as back-of-pack labelling (BOPL). The supplementary information is supplied on the front of the pack (referred to as FOPL) and is meant to enhance consumers' interpretation and understanding of the nutrient declarations. The supplementary information should appear in addition to the nutrient declarations, not act as a substitute (Codex Alimentarius, 2017).

3.9 Back-of-pack labelling (BOPL) and front-of-pack labelling (FOPL)

Back-of-pack labelling (known as NIP in South Africa) (Figure 3.1) is applied voluntarily on packaged products in South Africa. Regulation 146 (R146), however, mandates that the NIP must appear on all food packages where a health or nutrition claim is made, or when the product is meant for special dietary or medical purposes (National Department of Health, 2010). The draft Regulation 3337 (R3337), in contrast, mandates that all packaged products carry an NIP, except for items such as baking powder, bicarbonate of soda, culinary herbs and coffee extracts, among others (National Department of Health, 2023).

TYPICAL NUTRITIONAL INFORMATION

Average values	per 100 g	per 20 g serving (1 pack)
Energy	1550 kJ	310 kJ
Protein	11,9 g	2,4 g
Glycaemic carbohydrate	73 g	15 g
of which total sugar	2,5 g	0,5 g
Total fat	3,0 g	0,6 g
of which:		
saturated fat	0,7 g	0,1 g
trans fat	0,0 g	0,0 g
monounsaturated fat	0,5 g	0,1 g
polyunsaturated fat	1,8 g	0,4 g
Cholesterol	0 mg	0 mg
Dietary fibre*	3,3 g	0,7 g
Total sodium	662 mg	128 mg

Figure 3.1: Image of the nutritional information panel (as specified in R146)

Although the NIP was designed to guide consumers' food choices, several studies have reported that consumers found the labels difficult to interpret. For example, some studies revealed that challenges with the interpretation of the NIP were more pronounced among vulnerable groups, such as older consumers and consumers with lower levels of education and income (Ducrot *et al.*, 2015b; Koen *et al.*, 2018a). Some of the challenges raised in previous (including South African) studies were the failure to understand the scientific terminology used, uncertainty about serving sizes, and difficulty in interpreting the g/100g amounts (Feunekes *et al.*, 2008; Jacobs *et al.,* 2011; Koen *et al.*, 2018a). Another challenge raised was the inability to read the small print used (Jacobs *et al.,* 2011). In another study, South African consumers complained that the NIPs were too long and time-consuming to read (Mandle *et al.*, 2015).

Furthermore, NIPs were reported to be inaccessible due to their location at the back or side of the pack (Kleef & Dagevos, 2015) and, according to Golan *et al.* (2001), offer too much information which consumers may not read. Many consumers find themselves pressed for time (Newman *et al.*, 2018) and usually spend only a few seconds making a purchasing decision (Sanjari *et al.,* 2017). As a result, they may simply glance at the label without absorbing much of the information (Higginson *et al.*, 2002). Thus, a simpler and more accessible label indicating the product's nutritional composition would be more impactful in guiding consumers' choices. A study conducted by Jacobs *et al.* (2011) revealed that South African consumers found the NIP challenging and recommended a simpler labelling format instead. Simple nutrition labelling in the form of FOPL has been proposed as a tool to improve people's understanding of nutrients (Braesco & Drewnowski, 2023; Kleef & Dagevos, 2015; Viola *et al.*, 2016).

FOPL is recognised as a simple and practical tool that can be used to enhance consumers' understanding of nutrition information and help them to make healthier food choices (Institute of Medicine, 2012; World Cancer Research Fund, 2018; World Health Organization, 2017b). FOPL involves labels being applied to the front of food packages and used to complement NIPs found on the back or side of the packages (Newman *et al.*, 2018; WHO Regional Office for Europe, 2020). Simple FOPL that interprets the more detailed NIP (Hamlin & McNeill, 2016; Hersey *et al.*, 2013; Talati *et al.*, 2016) and presents the relevant information on the front of the pack in an easily understandable manner reduces the cognitive load and the time required to interpret the NIP.

The primary aim of FOPL is to assist consumers to make healthier food choices and to facilitate comparisons within and across food categories (Hamlin & McNeill, 2016; Kees *et al.,* 2014). FOPL thus has the potential to improve consumers' understanding of nutrition information and their ability to select healthier food options for themselves and their families (Kees *et al.,* 2014). Such increased awareness may lead to healthier food selection, which in turn could reduce the levels of obesity and NCDs. As a secondary objective, FOPL should encourage the reformulation of existing products or the development of new products so that they have healthier nutrient profiles (Kleef & Dagevos, 2015; WHO Regional Office for Europe, 2020). Furthermore, FOPL improves accessibility of nutrition information by virtue of it being presented in a more visible and simplified manner, particularly for consumers with limited shopping time (Hamlin & McNeill, 2016; Kleef & Dagevos, 2015). Consumers make quick decisions when shopping for food (Inman *et al.,* 2004; Park *et al.,* 1989), and simple FOPL can impact consumers' ability to utilise nutrition information effectively (Berning *et al.*, 2010).

3.10 Types of FOPL systems

Several FOPL systems are in use around the world and can be divided into two broad categories: interpretive or evaluative systems and non-interpretive or reductive systems (Figure 3.2). The systems are categorised according to the amount of nutritional information provided and the extent to which they assist consumers to evaluate product healthfulness or unhealthfulness (Hamlin *et al.,* 2015; Newman *et al.*, 2018; Talati *et al.*, 2017).

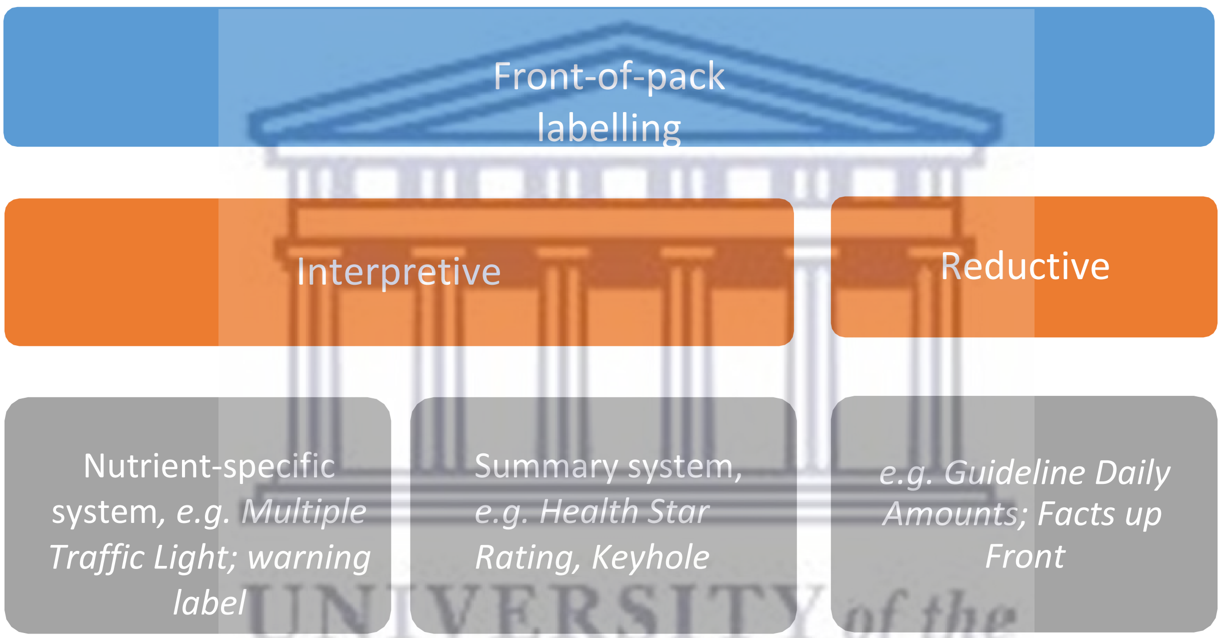


Figure 3.2: Types of FOPL systems

3.10.1 Reductive FOP food labels

The non-interpretive or reductive system presents nutrient information only, restating some of the information that appears in the NIP without expressing any opinion or providing any direction on the overall nutritional value of the product (Newman *et al.*, 2018). The GDA (now Reference Intakes (RI) (Food and Drink Federation, 2020) is an example of a reductive FOPL system (Figure 3.3).

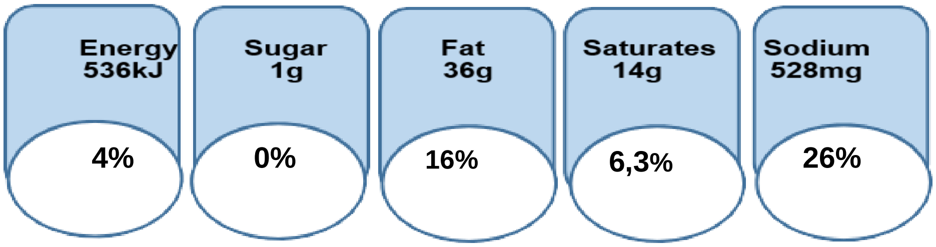


Figure 3.3: Guideline Dietary Amounts (GDA)

Similar to some of the interpretive FOPLsystems (e.g. MTL, WL, Nutriscore, etc), the reductive system also presents nutrients of concern on the front of the package. In addition, the GDA includes other negative nutrients, such as calories, trans-fat and total fat (Food and Drink Federation, 2021). Reductive labels assist consumers by reducing the amount of information they need to process, relative to the NIP (Newman *et al.*, 2018). The assumption underlying the reductive system is that consumers will be able to more easily find and process the less complex, more condensed information compared to the full list of nutrients appearing in the NIP. Despite these advantages, however, reductive labels are still regarded as time-consuming and difficult to interpret (Hawley *et al.*, 2013; Hersey *et al.*, 2013; Talati *et al.*, 2017).

A study conducted by the Food Standards Agency (FSA) in the UK revealed that consumers found the interpretation of the percentages confusing (FSA, 2009). Moreover, in their study, Grunert *et al.* (2010) found that consumers rarely pay attention to this type of labelling system when engaged in purchasing. In addition, a study by Egnell *et al.* (2018) reported that the RI (GDA) ranked the worst in determining products' healthiness compared to four other FOPL systems. (See section 3.10.1 for more information about the performance of the GDA.)

3.10.2 Interpretive FOP food labels

The interpretive or evaluative system provides an 'interpretation' or guidance on the relative healthfulness of a product (Andrews *et al.,* 2011; Hamlin *et al.,* 2015; WHO Regional Office for Europe, 2020). This makes the system more effective than the reductive system in directing food choices (Cecchini & Warin, 2016). This supports the notion that evaluative labels are more effective in helping consumers judge the nutritional quality of food products than labels that present only numerical values (Talati *et al.*, 2017). Critics of interpretive FOPL systems assert that although the systems provide more interpretation than reductive FOPL systems, the nutritional judgement provided may not always accurately represent the total nutrient composition of the product (Andrews *et al.,* 2011). The Codex requirement to include both the nutrient declarations and the FOPL on the product packages may help consumers to validate the nutrition information (Codex Alimentarius, 2017).

Interpretive systems categorise products according to a set of nutrient criteria or a nutrient profile, and they 'evaluate' food based on such pre-determined criteria (Hamlin *et al.,* 2015; Pereira, 2010). This in turn leads to a simple pictorial image or icon depicting food as 'healthy', 'unhealthy' or provide a symbol depicting a continuum of a product's healthiness (Jones *et al*., 2019). The interpretation by the manufacturer reduces the cognitive workload required to interpret the nutrition information, thereby saving consumers shopping time (Vargas-Meza *et al.*, 2019a), which is particularly important given that consumers spend only a few seconds making purchasing decisions (Grunert *et al.*, 2010; Sanjari *et al.,* 2017).

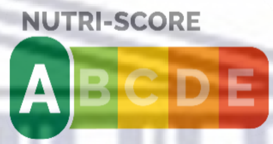
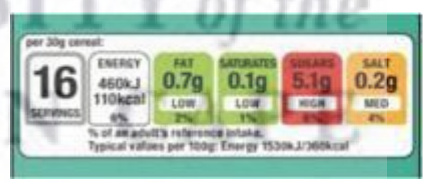
Interpretive systems are divided into two types (Braesco & Drewnowski, 2023; Hawley *et al.*, 2013; Kanter *et al.,* 2018; Kelly & Jewell, 2018), depending on the information communicated (Table 3.1): nutrient-specific systems, which evaluate the level of individual nutrients (Egnell *et al.*, 2018) and summary systems, which communicate an overall summary of the nutritional profile of a product. The nutrient-specific system presents negative nutrients associated with the development of obesity and NCDs – referred to as nutrients of concern or critical nutrients – on the front of the pack (Taillie *et al.*, 2020b). Such nutrients include calories, trans-fats, saturated fats, added/free/total sugar and salt/sodium, as well as artificial sweeteners (Institute of Medicine, 2012; Temple, 2020). By providing this information, it is hoped that consumers will be able to identify and avoid products high in nutrients of concern (Braesco & Drewnowski, 2023).

In addition to negative nutrients, the summary system also considers the nutrients and food components or ingredients such as protein, vitamins, and fruit and vegetables (referred to as positive nutrients) to sum up the overall nutritional quality of a product as a single score (Braesco & Drewnowski, 2023; Temple, 2020). This is to enable consumers to easily identify healthier and unhealthier foods (Pettigrew *et al*., 2023).

Summary systems can be further subdivided into: i) endorsement logos applied only on healthier products, e.g. Choices label (Lupton *et al.*, 2010) and Green Keyhole (Larsson *et al.,* 1999), and ii) scale-based graded labels indicating the overall nutritional quality of the products, e.g. Nutri-Score

(Julia *et al.,* 2017b) and Health Star Rating (Dickie *et al.,* 2018) (Table 3.1). Examples of nutrient-specific systems include the WL system (Carreño, 2015) and the MTL system (FSA, 2016) (Table 3.1). A more detailed description of different types of FOPL is provided in Chapter 4.

Table 3.1: Summary and nutrient-specific FOP labelling

Interpretive system	**Examples of an interpretive system**	**Icon/symbol**
Summary systems	Endorsement system, e.g. Green Keyhole	
	Scale-based graded system, e.g. Nutri-Score	
Nutrient-specific systems	Warning label (WL)	
		
	Multiple Traffic Light (MTL)	
		

Despite various studies having been conducted to test FOPL effectiveness, there is still no consensus on the ideal method of presenting FOP nutrition information (Kanter *et al.,* 2018; Kelly & Jewell, 2018). A wide variety of FOPL systems exist, with different purposes and underlying principles and presentations (Taillie *et al.,* 2020b; WHO, 2019), making it impractical to compare all the systems simultaneously. In addition, studies to date have been restricted to comparisons of three to five labels, adding to the difficulty of deciding on the most effective FOPL. It is the prerogative of each country to implement an FOPL system best suited to its unique public health challenges, based on its legal, sociodemographic and cultural context (WHO Regional Office for Europe, 2020).

3.11 Examples of FOPL systems

3.11.1 Guideline Daily Amounts (GDA)

The GDA system, now RI, (Food and Drink Federation, 2021), was first developed in 1998 with the aim of presenting concise nutritional information on the front of food packs (Food and Drink Federation, 2014). For the purpose of this study, the term GDA has been used, as it was at the project's conception. The GDA system is referred to as reductive as it does not provide the overall nutritional quality of a food product (Newman *et al.,* 2014). Rather, it shows the amount of calories, total fat, saturated fats, sugar and sodium, and their respective percentages of the Reference Intakes (%RI) per serving size (Food and Drink Federation, 2014). The nutrients shown on the GDA label reflect the amounts that a particular serving size can contribute to daily intakes. In this way, the GDA may help to encourage healthier eating (Food and Drink Federation, 2021). A serving size is the amount of a given food or drink typically consumed by an individual during a single consumption occasion (National Department of Health, 2010). Nutrition information per serving size is offered on the premise that consumers would get a sense of a realistic amount to consume at any one time and to evaluate the serving sizes within the context of their own food intake (Institute of Medicine, 2012).

The GDA values are not nutrient targets to aim for; instead, they provide ceiling amounts to be consumed per day (Denny, 2006). The latter values are based on the average nutrient requirements for adult women, per 2000 kcal requirements (Table 3.2) (Food and Drink Federation, 2021). When the GDA system is employed, the label appears on all foods, regardless of whether they are considered to be a healthful choice or not (Hodgkins *et al.*, 2012).

Table 3.2: Reference Intakes (RI) for nutrients displayed in the Guideline Daily Amounts (GDA)

Energy or nutrient	Reference Intake
Energy	8400kJ / 2000kcal
Total fat	70g
Saturates	20g
Carbohydrates	260g
Sugars	90g
Protein	50g
Salt	6g

Source: Food and Drink Federation (2021)

Studies have shown that consumers find the GDA system difficult to use (Ducrot *et al.*, 2016) due to their inability to comprehend the numerical figures on the label and to determine if the food is high or low in certain nutrients (Centurión *et al*. 2019; Ducrot *et al.*, 2016; Hobin *et al.*, 2015; Van Kleef *et al.*, 2008). A study conducted in Mexico and in the US reported that consumers found the GDA to be as complicated as the NIP (Nieto *et al.*, 2019). In contrast, consumers with a high level of education prefer the GDA as it provides more nutritional information (Patiño *et al.*, 2019). The GDA is therefore not suitable for individuals with a low level of education as they often lack the cognitive ability needed to interpret mathematical concepts (Hobin *et al.*, 2015).

3.11.2 Multiple Traffic Light (MTL)

The MTL has both interpretive and reductive properties in that it presents both the numerical nutrient values and the red, amber and green colours to depict whether the nutrient levels are high (red), medium (amber) or low (green) (Hodgkins *et al.*, 2012; Kleef and Dagevos, 2015). The colours thus expand on the quantitative component of the NIP by adding an evaluative component (Newman *et al.*, 2018) – hence its classification as an interpretive system. Some authors classify the MTL as a hybrid system (Hamlin *et al.,* 2015) due to its dual nature.

The red colour suggests that a product should be consumed occasionally and in small quantities, amber suggests a cautious approach to consumption, and green suggests that the product may be consumed on a regular basis (Kees *et al.,* 2014). The nutrient values are expressed per100g/ml and per serving size

(FSA, 2016). The nutrient threshold to obtain a green colour is based on the international trade requirements for nutrient-related claims, as specified by the Codex Alimentarius Commission (Codex Alimentarius, 2013). The red and amber colours are aligned to the GDA values, with the red colour being assigned when the nutrient level exceeds 25% of the GDA for that nutrient (Lobstein & Davies, 2009). However, in the case of sugar, instead of the GDA's 90g threshold, the Committee on Medical Aspects of Food Policy (COMA) recommended a 60g threshold as more appropriate (National Heart Forum, 2007). The amber colour is assigned to values in between the green and the red categories (Lobstein & Davies, 2009) (Tables 3.3 and 3.4). Healthier food products feature more green codes and fewer red codes (FSA, 2016). Similar to the GDA system, the MTL system (when applied) appears on all foods (Hodgkins *et al.*, 2012).

Table 3.3: Cut-off values/criteria for the MTL based on 100g of solid food

TEXT	LOW	MEDIUM	HIGH	
Colour code	Green	Amber	Red	
Fat	≤ 3.0g/100g	> 3.0g to ≤ 17.5g/100g	>25% of RIs > 17.5g/100g	>30% of RIs > 21g/portion
Saturates	≤ 1.5g/100g	> 1.5g to ≤ 5.0g/100g	> 5.0g/100g	> 6.0g/portion
Total sugars	≤ 5.0g/100g	> 5.0g to ≤ 22.5g /100g	> 22.5g/100g	> 27g/portion
Salt	≤ 0.3g/100g	> 0.3g to ≤ 1.5g/100g	>1.5g/100g	>1.8g/portion

Source: FSA (2016)

Table 3.4: Cut-off values/criteria for the MTL based on 100ml of drinks/liquids

TEXT	LOW	MEDIUM	HIGH	
Colour code	Green	Amber	Red	
Fat	≤ 1.5g/100ml	> 1.5g to ≤ 8.75g/100ml	>12.5% of RIs > 8.75g/100ml	>15% of RIs >10.5g/portion
Saturates	≤ 0.75g/100ml	> 0.75g to ≤ 2.5g/100ml	> 2.5g/100ml	> 3g/portion
Total sugars	≤ 2.5g/100ml	> 2.5g to ≤ 11.25g/100ml	> 11.25g/100ml	> 13.5g/portion
Salt	≤ 0.3g/100ml	>0.3g to ≤0.75g/100ml	> 0.75g/100ml	> 0.9g/portion

Source: FSA (2016)

The MTL label was first developed in 2005 by the Food Standards Agency (FSA) (FSA, 2007) and is currently applied voluntarily by industry in the UK. While the MTL system has been implemented by several food manufacturers and retailers globally, Ecuador is the only country that has made it mandatory on all food packages. Because its use is voluntary, several MTL formats exist, varying in size and shape, but are all consistent in the colours they use (Kees *et al.,* 2014). The UK's MTL incorporates both the qualitative aspect and the colour descriptors (FSA, 2007), while in Ecuador, only the traffic light colours are used (Freire *et al.*, 2016) (Table 3.1). The MTL is therefore also referred to as semi-interpretive as it combines both the interpretive colours and numbers (van der Bend & Lissner, 2019). The UK's MTL displays the sodium, total fats, saturated fats, total sugars and calories. However, calories and saturated fats are excluded from the Ecuador model (Table 3.1).

The interpretative representation (colour coding) in the MTL is expected to facilitate consumer understanding of the nutrition message (Roberto *et al.*, 2021), but the system still requires consumers to integrate the information from the label to determine the product's healthfulness (Talati *et al.*, 2016). Studies have shown that consumers have expressed their preference for the MTL, mainly because of its attractiveness (Antunez *et al.*, 2015; Pettigrew *et al.*, 2017). Several studies, too, have reported its effectiveness in assisting consumers make healthier food choices, compared to the GDA (Maubach *et al.,* 2014; Möser *et al.*, 2010). The MTL has also been praised for providing adequate nutrition information to consumers (Song *et al.*, 2021). Nevertheless, other studies have revealed that consumers have got confused when trying to identify unhealthy food products because of multiple colours (depicting different nutrients) appearing on the label – which points to the difficulty of summarising the nutrition information (Grunert *et al.,* 2010; Kees *et al.,* 2014; Machin *et al*., 2018). In another study, consumers found the amber colour confusing and did not know how to interpret it (De la Cruz-Góngora *et al.*, 2017). These findings reinforce the need for an even more simplified FOPL that requires no further interpretation by consumers.

3.11.3 Endorsement logos

Endorsement logos are single healthy symbols that indicate healthier foods within certain food categories (Koen *et al*., 2016). This labelling format interprets and therefore simplifies nutrition information for consumers (Al-Jawaldeh *et al*., 2020; Jones *et al*., 2019). Examples of endorsement logos include the Swedish Keyhole (Larsson, *et al*., 1999), Heart Symbol of the Heart and Stroke Foundation (South Africa), Weigless (South Africa) and Choices logo (Lupton *et al.*, 2010). This labelling format considers both positive nutrients and nutrients of concern to determine the healthfulness of a food product relative to other products within the same food category (Hodgkin *et al*., 2012), and does not consider products' unhealthiness (Kelly & Jewell, 2018).

A concern with endorsement logos is its consideration of positive nutrients that may mask the presence of high levels of nutrients of concern (Khandpur *et al*., 2018). For example, a product may contain high levels of sugar which may be masked by fortification of a product with fiber and vitamins (Hodgkins *et al*., 2012;). A study in New Zealand revealed that consumers viewed products bearing endorsement logos as healthier, despite their unhealthfulness and that consumers had a reduced perception of the products' link with poor health outcomes when the products contained an endorsement logo (Hawley *et al*., 2013). This misunderstanding of nutritional information may exacerbate increases in obesity and NCDs (Elizabeth *et al.,* 2020; Levy *et al.,* 2021; Rico-Campà *et al.,* 2019; Srour et al., 2019). In South Africa, the presence of a claim 'low GI' and symbols such as the South African Heart Foundation logo, increased the healthfulness perception of the packaged food (Todd *et al*., 2022).

Unlike the GDA and the MTL that appear on all food products, endorsement logos, only appear on food products with a healthier nutrient profile, with the aim to encourage selection of healthier foods (Kelly & Jewell, 2018). These labelling systems are referred to as positive systems since they only apply to products with 'healthier' attributes (WHO Regional Office for Europe, 2020). Endorsement logos therefore nudge consumers towards healthier products rather than warn against unhealthy products. According to Kelly & Jewell (2018), FOPL should enable consumers to identify unhealthy products for it to be effective. An experimental study showed that participants were more concerned with avoiding food products with a red colour (unhealthy) than the green colour-coded (healthier) products, supporting the move towards 'negative' food labelling (Scarborough *et al*., 2015).

Codex Alimentarius, (2013) and some other authors (Al-Jawaldeh *et al*., 2020; Andrews *et al*., 2011) perceive endorsement logos as health claims rather than front-of-pack labelling as the logos only appear on healthier foods. These logos may create a false perception of products' healthfulness (Hawley *et al*., 2013; Nobrega *et al*., 2020), leading to overconsumption of otherwise unhealthy products (Hodgkins *et al*., 2012). An experimental study by Hall *et al*. (2020) found that the presence of a claim 'high in Vitamin C' on a fruit juice, increased the healthfulness perception of the fruit juice amongst the study participants, thereby encouraging its consumption. Lower socioeconomic groups may be even more vulnerable to misinformation by endorsement logos due to their lower levels of nutrition knowledge (Hawley *et al*., 2013). This misunderstanding is particularly concerning given the relationship between UPF and NCDs (Elizabeth *et al.,* 2020; Levy *et al.,* 2021; Rico-Campà *et al.,* 2019; Srour et al., 2019).

Based on their categorization as health claims by Codex Alimentarius (2013) and also due to their potential to hide unhealthy levels of certain nutrients of concern, endorsement logos were therefore excluded in this study. The decision to exclude the latter was also based on one of the stipulations of the R429 which states that *'Endorsement logos, nutrient or health claims should not mask certain undesirable nutritional qualities or nutritional content of a food and thus mislead the consumer* (National Department of Health, 2014).

Only a few studies compared the performance of the endorsement logos against other FOPL. An experimental study by Ducrot *et al*. (2016) reported that the Tick symbol, together with the MTL, had a similar and lower effect on the nutritional quality of a shopping cart compared to the Five-Coloured-Nutrition-Label (type of FOPL). The two FOPL however, performed better than the GDA. Todd *et al*. (2022) on the other hand ound that the endorsement logo most assisted consumers to identify healthier foods in comparison to the WL, whereas the WL had the greatest effect in assisting consumers identify unhealthy products than the endorsement logo (Todd *et al*., 2022).

3.11.4 Nutrition warning labels

Nutrition WL has been proposed as an interpretative FOPL system which allows consumers to easily identify unhealthy food products containing excess amounts of nutrients (Grummon & Hall, 2020; Khandpur *et al.*, 2018a; Taillie *et al.,* 2020b; Temple, 2020). The ability to identify unhealthy products makes the selection of healthier foods easier (Lima *et al.*, 2019). A study by Pettigrew *et al*. (2023) however, found that other labels such as the Nutriscore performed better at assisting consumers identify unhealthy foods. Other studies have also reported the WL as less effective than the Nutriscore and the MTL in ranking foods according to the level of healthiness (Egnell *et al*., 2020; Pettigrew *et al*., 2023; Vandevijvere *et al*., 2020). These findings are however not surprising as the WL is designed to warn consumers about unhealthy levels of nutrients, as opposed to pointing consumers towards healthier foods (Kelly & Jewell, 2018). This assertion rests on the premise that it is more important to discourage unhealthy food purchases than to nudge consumers towards slightly healthier options, particularly in countries with a high prevalence of obesity and NCDs (WHO Regional Office for Europe, 2020). The WL has also been proven to be effective in discouraging purchases of unhealthy products (Acton *et al.*, 2019; Grummon & Hall, 2020; Jáuregui *et al*., 2020; Song *et al*., 2021). However, in other studies, the Nutriscore and the MTL performed better than the WL in modifying the consumers purchasing intentions (Egnell *et al*., 2020; Pettigrew *et al*., 2023).

Finland was the first country to introduce a WL for excessive sodium content in the early 1990s (Pietinen *et al.*, 2008). More than a decade later, Chile implemented the first 'HIGH IN' WL, indicating products with excessive sodium, saturated fats, total sugars and calories (Carreño, 2015), with other countries following suit, such as Israel (Global Agricultural Network Information Israel, 2018), Uruguay (Ministerio de Salud de Uruguay, 2018), Peru (Global Agricultural Information Network, 2017) and Mexico (Global Agricultural Information Network, 2020b). The WL is compulsory in Chile, and products must include separate black octagonal signs for each nutrient that exceeds pre-established criteria (Figure 1.1). Other countries such as Uruguay, Brazil and Mexico also use the black octagon, based on the Chilean model. An exception is Israel, which uses a red circle (Table 3.1).

The WL, unlike the GDA and MTL, only appears on packages of food containing excessive amounts of negative nutrients, thus making it easier for consumers to recognise unhealthy products (Kelly & Jewell, 2018). This is especially important when the aim is to assist consumers to cut through 'noisy' nutrition and health claims, which are very prevalent on packaged (including less-healthy) foods

(Andrews *et al.,* 2011). Additionally, by not appearing on core foods, the WL does not divert consumers' choices away from the food category and does not risk undermining the Food-Based Dietary Guidelines which recommend consuming a diversity of core foods (Khandpur *et al.,* 2018b). The WL assists consumers to more quickly understand nutrition information compared to the GDA and MTL (Arrúa *et al.*, 2017), and consequently saves shopping time (Grunert & Wills, 2007). Consumers have repeatedly shown a better understanding of the WL than either the GDA or MTL (Centurión *et al.,* 2019; Khandpur *et al.,* 2018b; Talati *et al.*, 2019). These findings will be further discussed in Chapter 6.

3.11.5 Nutriscore

The summary indicator system such as the Nutriscore and HSR, uses a scoring system that incorporates both the negative and positive nutrients to provide an evaluation of the healthiness or the uhealthiness of a product on a continuum (Jones *et al*., 2019). The Nutriscore has been reported as easy to understand (Julia & Hercberg, 2017) and effective in assisting consumers to identify both unhealthy and healthy products (Pettigrew *et al*., 2023). The Nutrisore is reported to be effective in assisting consumers to rank products according to the level of healthiness, thus having potential to assist consumers select healthier diets (Egnell *et al*., 2020; Pettigrew *et al*., 2023; Vandevijvere *et al*., 2020).

Similarly to the endorsement logo, with this system, the negative nutrients may be offset by the positive nutrients, resulting in a product receiving a healthy score despite the potentially high levels of nutrients of concern (Khandpur *et al*., 2018; Roberto *et al*., 2021; Söderlund *et al*., 2020). For this reason, similarly to the endorsement logos (3.10.3), the summary system was excluded in this study. This study only focused on FOPL that would assist consumers to identify unhealthy products, without considering the positive attributes of the product.

3.12 Nutrient Profile Model (NPM)

As discussed in previous sections, various FOPL systems are in use around the globe. Each system is underpinned by a set of criteria, known as Nutrient Profile Models (NPMs), that allow products to be ranked according to their level of healthiness (WHO Regional Office for Europe, 2021) (see Chapter 4 for the NPM underlying each FOPL system). The selected NPM determines the type of nutritional information that gets displayed on the front of the pack. This section discusses the types of NPM underpinning various FOPL. By definition, nutrient profiling is the science of classifying or ranking foods according to their nutritional composition in the interests of preventing diseases and promoting good health (Labonté *et al.*, 2018). **S**imilar to FOPL, different types of NPM exist, which vary according to the type and number of nutrients present, whether applied across the board or to different food categories, and whether thresholds or algorithms are used (Kelly & Jewell, 2018; Scarborough *et al.*, 2007). The NPM applied depends on the FOPL system selected (WHO Regional Office for Europe, 2021). For example, FOPL that aims to assist consumers to easily identify unhealthy products high in salt, sugar, saturated fat and artificial sweeteners (e.g. WL) is underpinned by an NPM that includes only these nutrients of concern.

The NPM needs to be formulated in a way that ensures that the FOPL it supports is sensitive enough to identify and signpost differences in products' healthiness or unhealthiness (World Health Organization, 2019a). The classification must also align with national dietary guidelines and meet expectations regarding the nutritional quality of food (World Health Organization, 2019a). In addition, it is important that the development of the NPM is government led to ensure that the criteria are evidence based, reflect national dietary guidelines and are free from conflict of interest (World Health Organization, 2019a).

3.12.1 Types of Nutrient Profile Models (NPMs)

Most NPMs focus on key nutrients such as added sugar, saturated fat and salt. Since there is no limit on the number of nutrients that can be included, other models include calories, total fats, total sugar and sweeteners. The NPMs for the WHO African Region include all six negative nutrient and non-sugar sweeteners (WHO Regional Office for Africa, 2019). These products are associated with the development of obesity and NCDs (Elizabeth *et al.,* 2020; Levy *et al.,* 2021; Srour *et al*., 2019).

Depending on the objective of the FOPL, the ranking of food can be applied to different food categories or across the board (Scarborough *et al.,* 2007). Different food categories are considered if the aim of the FOPL is to nudge consumers towards the selection of healthier versions within a food category (Rayner *et al.,* 2013). However, across-the-board application is more relevant if the aim is to encourage consumption of healthy options from among different food categories (such as switching from sweetened beverages to fruit) (Scarborough *et al.*, 2010). Categorisation can further be based on whether products exceed nutrient thresholds or are based on a calculated score according to a pre-determined algorithm.

i) NPMs based on nutrient thresholds

Nutrient thresholds are used for endorsement logos and nutrient-specific FOPL (Kelly & Jewell, 2018) and involve considering whether a product contains nutrients above or below a set threshold (Scarborough *et al.,* 2007). The application of threshold models allows for the classification of products as 'low fat', for example, or 'healthy' or 'healthier' (Scarborough *et al.,* 2007).

ii) NPMs based on algorithms

The algorithm system, also referred to as a scoring system, is often used with scae-based, graded labels (Scarborough *et al.,* 2007). NPMs that are based on algorithms consider both nutrients of concern (e.g. total energy, total sugars, saturated fats and/or sodium) as well as nutrients or ingredients to encourage (fruits, vegetables, nuts, fibre, protein, and/or vitamins and minerals) per 100g/ml to determine a score that is ultimately used to classify products' healthiness level. For example, the HSR ranks products according to their level of healthiness and uses an algorithm to assign the number of stars from the least healthy (0.5 stars) to the most healthy (5 stars). Similarly, the Nutri-Score uses an algorithm to rank products from the most healthy (A = green) to the least unhealthy (E = dark orange).

Critics of the algorithm system point out that the inclusion of nutrients to encourage often masks the high levels of nutrients of concern, and therefore categorise unhealthy products as healthy (Dickie *et al.,* 2018; Khandpur *et al*., 2018; Silverglade & Heller, 2010). Such anomalies undermine the credibility of the FOPL system (World Health Organization, 2019a). Further concerns relating to the use of algorithms is that some NPMs do not differentiate between added sugar and natural sugar, making it challenging to determine the actual healthiness of a product (World Health Organization, 2019a). A distinction between intrinsic and extrinsic sugar is important as the two have different health implications. The involvement of industry in the development of the algorithms, e.g. HSR NPM, is another concern as it has resulted in an NPM that is lax and allows energy-dense or nutrient-poor products to be categorised as healthy.

3.13 Conclusion

Literature provides evidence that all FOPL improve nutritional information understanding although to varying degrees. The interpretive FOPL that simplifies the scientific information at the back of the pack and makes it easier for consumers to understand the products' nutritional quality is more recommended than the reductive FOPL. Given the various types of FOPL (also see chapter 4), each country therefore needs to determine an FOPL for implementation based on its socio-demographic profile and the health agenda. The WL is a fairly new FOPL that seems to be effective in improving nutritional information understanding particularly in LMIC. The WL incorporates familiar features such as colour and icons to interpret the nutritional information for consumers. If considered as one of the FOPL to explore, South Africa therefore needs to develop a WL that would include features that are familiar to South African consumers. Chapter 5 provides more literature on the requirements of an effective FOPL, together with a study that was conducted to develop a WL relevant for the South African context.

CHAPTER 4: FRONT-OF-PACK LABELLING SYSTEMS AROUND THE GLOBE – TIMELINES AND CHARACTERISTICS

4.1 Introduction

FOPL systems have been in existence since the late 1980s (Larsson *et al.,* 1999), with the latest having been introduced as recently as the mid-2010s (Reyes *et al.*, 2019). The principle underlying each system is that it is a tool to assist consumers to select healthier diets (WHO Regional Office for Europe, 2020). FOPL systems vary by design (Hawley *et al.*, 2013; Newman *et al.*, 2018), intent (Kelly & Jewell, 2018), nutrient criteria set to evaluate products' nutritional quality (Labonté *et al.*, 2018), whether government led or not, and whether voluntarily or mandatorily applied (Roberto *et al.*, 2021; WHO Regional Office for Europe, 2020).

Each country applies (a) particular FOPL system(s) based on the country's strategic and policy objectives (Braesco & Drewnowski, 2023); therefore, no choice of FOPL by one country can be deemed superior to that of any other country (WHO Regional Office for Europe, 2020). A database of existing FOPL systems could serve as a resource for interested stakeholders who wish to do more work on the development of FOPL systems. Several authors continue to update existing databases. However, to the authors' knowledge, the latest analysis of existing FOPL systems was done in 2019 (Jones *et al.*, 2019). Several countries have implemented FOPL systems post 2019.

The aim of this chapter is to extend the existing FOPL databases by including countries that have recently introduced FOPL systems.

The following research question guided the literature search:

i) Which FOPL systems are currently implemented by countries around the world?

Sub-questions:

ii) Which nutrient profiling systems underpin each FOPL system?

iii) Are the FOPL systems applied voluntarily or mandatorily?

iv) Which implementation processes did the countries follow?

v) Is there any enforcement, monitoring and evaluation processes in place?

4.2 Search strategy

The following databases were consulted for the literature search: Google Scholar, Sabinet, PubMed, ScienceDirect, EBSCOHOST and Google specifically for international bodies, policy databases and reports of international organisations such as the WHO, the Global Database on the Implementation of Nutrition Action (GINA) and the World Cancer Research Fund International. These databases were consulted as they contain a cross-section of literature related to public health and public health policies. The following inclusion and exclusion criteria assisted in the literature search.

Inclusion criteria

The search criteria included all articles related to the research questions stated above, and the search was not restricted to any publication period or country of implementation. Search words included front-of-pack labelling, front-of-package labelling, types of FOPL, FOPL implementation process, mandatory FOPL, voluntary FOPL, enforcement of FOPL, FOPL nutrient criteria applied, their bases and who developed the criteria, FOPL monitoring and evaluation, FOPL enforcement strategies and FOPL implementation.

Exclusion criteria

Articles on types of FOPL that have been discontinued in their countries of implementation were excluded.

4.3 Results and discussion

4.3.1 Scope of implementation

The literature search identified 19 FOPL systems implemented in more than 27 counties worldwide. Each FOPL is presented separately in a table format (Tables 4.1, 4.2, 4.3 and 4.4), with its sources acknowledged. The implementation of FOPL varies, with some implemented worldwide (GDA) (Food and Drink Federation, 2021), some continentally (Facts up Front) (US Chamber of Commerce Foundation, 2017) or state-wide (MTL) (FSA, 2016), and others, such as warning labels, nationally

(Ares *et al.*, 2017; Global Agricultural Network Information Israel, 2018; Global Agricultural Information Network, 2020c). The various FOPL systems, as presented in Table 4.1, are categorised as summary systems (Temple, 2020), nutrient-specific systems (Kelly & Jewell, 2018) and reductive systems (Newman *et al.*, 2018). Summary systems include both the scale-based graded system, e.g. Nutri-Score (Julia *et al.,* 2017a) and endorsement logos, e.g. Keyhole (Larsson *et al.,* 1999).

Summary systems are presented in the form of a logo or icon which summarises the healthfulness of a food product (Kelly & Jewell, 2018) and usually appears on healthier products (Kelly & Jewell, 2018; Larsson *et al.,* 1999;). Nutrient-specific systems include the Multiple Traffic Light (MTL), labels (e.g. those implemented in the UK and Sri Lanka), and nutrition warning labels (WLs) (e.g. those implemented in Uruguay, Israel and Brazil). This type of system interprets the products' nutritional quality and expresses this interpretation in text, as icons or in different colours (Hawley *et al.*, 2013; Kanter *et al.,* 2018). Some FOPL systems are implemented in more than one country (e.g. Nutri-Score in France and Switzerland), while in other countries (e.g. Israel) more than one labelling system is implemented (red WL and green label) (Table 4.1).

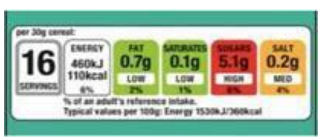
Table 4.1: Summary of FOPL systems implemented around the world since 1989 (*according to application, nutrients, etc.)

Types of FOPL systems	Example of FOPL system	Application	Nutrients	Nutrient scoring/ cut-off	Nutrient criteria developed by	Countries	References
Summary systems	Endorsement system, e.g. **Green Keyhole**	Applied to packaged and unpackaged healthier products. Uses algorithm to determine overall nutritional score.	Sodium, saturated fats, total fat, total sugar, dietary fibre, wholegrain, artificial sweeteners.	The logo appears on 25 different food groups (per 100g/ml). Criteria vary across food groups. Criteria based on Nordic nutritional recommendations.	Swedish Food Agency	Sweden, Norway, Denmark Ireland, Lithuania	(Andersson, 2021; Hersey *et al*., 2013; Kelly & Jewell, 2018; National Food Agency Sweden, 2019; Nordic Council of Ministers, 2010, 2014; The Danish Ministry of Food, 2009)
	Scale-based graded system, e.g. **Nutri-Score**	Applied to packaged and unpackaged products. Uses algorithm to determine overall nutritional score.	Energy, saturated fats, total sugar, sodium, proteins/fibre/ fruits/ vegetables, legumes/nuts and olives.	Graded from healthy to less healthy (A, B, C, D and E): A= most healthy. One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml). Criteria based on the UK Food Standards Agency nutrient profile system, modified for the French context by the High Council for Public Health (HCSP).	Santé Publique France; Agency for Food Safety and Nutrition (AESAN). French High Council for Public Health (HCSP) commissioned to confirm thresholds for the algorithm. Criteria based on the UK FSA nutrient criteria.	France Spain Belgium Switzerland Luxembourg	(Agency for Food Safety and Nutrition (AESAN) Scientific Committee (Working group) *et al*., 2021; Egnell *et al*., 2021; International Agency for Research on Cancer (IARC), 2021; Julia & Hercberg, 2018; Julia *et al.,* 2017b; Ministère de la Santé, 2021; Rayner *et al*., 2005; Vandevijvere, 2020; Vandevijvere *et al*., 2020)

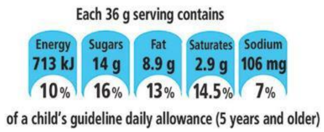
	Health Star Rating	Applied to unpackaged and packaged products. Uses algorithm to determine overall nutritional score.	Energy, saturated fat, total sugars, sodium, fibre, protein/fruit/ vegetables/nuts/ legumes.	Graded from healthy to less healthy (0.5 to 5 stars): 5 = most healthy. Applied to six different food categories (per 100g/ml).	Food Standards Australia New Zealand (FSANZ)	Australia New Zealand	(Australian Government Department of Health, 2014, 2019; Commonwealth of Australia, 2014; Food Standards Australia New Zealand, 2021a, 2021b; Jones *et al.*, 2018; Ministry for Primary Industries New Zealand Government, 2017; National Heart Foundation, 2017; New Zealand Food Safety, 2019)	
	Heart symbol – Better Choice logo	Applied to selected packaged foods.	Total fat, cholesterol, sodium.	Different thresholds determined for multiple products per 100g. Nutrient criteria based on Finnish Nutrition Recommendations and nutrition recommendations of the Finnish Heart Association	Finnish Heart Association; Finnish Diabetes Association	Finland	(Kinnunen, 2000; Pietinen *et al.*, 2010)	

	High Salt warning label	Applied to selected packaged and unpackaged products contributing significantly to high salt intake.	Sodium	Different thresholds determined for multiple products per 100g. Basis for nutrient criteria not identified	Ministry of Trade and Industry in collaboration with Ministry of Social Affairs and Health	Finland	(Institute of Medicine, 2010; Karppanen & Mervaala, 2006; Pietinen *et al.*, 2008, 2010; World Action on Salt, Sugar and Health, 2009)	
Nutrient-specific systems	**Green Label (Israel)**  	Positive label applied to products that are in their natural form or minimally processed with no additives.	Saturated fats, sodium, total sugar	Different thresholds determined for multiple products.	Scientific committee composed of nutrition and medical experts from academia and health sector, and government representatives	Israel	(Endevelt *et al.*, 2017; Gillon-Keren *et al.*, 2020)	
	Warning label (Israel) 	Applied to packaged foods containing excessive amounts of added nutrients of concern.	Saturated fats, sodium, total sugar	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Based on the Chilean nutrient profile model.	Israel	(Endevelt *et al.*, 2017; Gillon-Keren *et al.*, 2020; Jones *et al.*, 2019; Shahrabani, 2020; Shekar & Popkin, 2020; State of Israel Ministry of Health, 2022)	
	Warning label (Chile)	Applied to Packaged Products containing	Energy, total sugar, saturated fats and sodium	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Independent researchers from Chile University	Chile	(Corvalán *et al.*, 2013, 2019; Denecken, 2018; FAO *et al.,* 2017; Global Agricultural Network Information	

		excessive amounts of added nutrients of concern.		Criteria specifically designed for Chile using natural foods as gold standard.			Israel, 2018; Pandav *et al.*, 2021; Reyes *et al.*, 2019, 2020; Silver *et al.*, 2017; Taillie, *et al.*, 2020b; Taillie *et al.*, 2021; Villalobos Dintrans *et al.*, 2020)	
	Warning label (Peru) 	Applied to packaged products containing excessive amounts of added nutrients of concern.	Saturated fats, total sugars, sodium, trans-fats	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Based on the Chilean nutrient profile model.	Peru	(Jones *et al*., 2019; Meza-Hernández *et al.,* 2020; Niamh, 2019; Saavedra-Garcia *et al.,* 2022; Shekar & Popkin, 2020).	
	Warning label (Brazil) 	Applied to packaged products containing excessive amounts of added nutrients of concern.	Added sugar, sodium, saturated fats	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	National Agency of Sanitary Surveillance (Agência Nacional de Vigilância Sanitária – Anvisa)	Brazil	(De Morais Sato *et al*., 2018; Duran *et al.*, 2021; Global Agricultural Information Network, 2020a)	
	Warning label (Uruguay) 	Applied to packaged products containing excessive amounts of added nutrients of concern.	Added sugar, total fat, saturated fats and sodium	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Government departments; academia; Pan American Health Organization (PAHO); FAO; United Nations Children's Fund (UNICEF);	Uruguay	(Ares *et al*., 2017; Ares *et al.*, 2018b; Ares *et al*., 2021)	

					Honorary Commission for Cardiovascular Health. Adapted from the Chilean NPM.			
	Warning label (Mexico) 	Applied to packaged products containing excessive amounts of added nutrients of concern.	Calories, sugar, total fats, saturated fats, sodium, trans-fats, caffeine, non-caloric sweeteners	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Mexico National Institute of Public Health; academics and advocacy groups. Nutrient profile (NP) system based on the PAHO model.	Mexico	(Global Agricultural Information Network, 2020b, 2020c; Jáuregui *et al.*, 2020; Vargas-Meza *et al.*, 2019a; White & Barquera, 2020)	
	Warning label (Argentina) 	Applied to packaged products containing excessive amounts of added nutrients of concern.	Calories, sugar, total fats, saturated fats, sodium, caffeine, non-caloric sweeteners	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	NP based on the PAHO model	Argentina	(Castronuovo *et al.*, 2022; Ministerio de Salud de la República de Argentina., 2022)	
	Multiple Traffic Light (UK) 	Applied to all packaged food and non-alcoholic beverages.	Total fat, saturated fats, total sugar, sodium	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Ministry of Health, Food Standards Agency and other stakeholders	United Kingdom	(FSA, 2007, 2009, 2016; Sacks *et al.*, 2009)	

	Multiple Traffic Light (Iran) 	Applied to all packaged food and non-alcoholic beverages.	Calories, total sugar, total fats, saturated fats, sodium	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Food and Drug Administration, Iran	Iran	(Moslemi *et al.*, 2020; Zargaraan *et al.* 2017)	
	Multiple Traffic Light (Sri Lanka) 	Applied to all packaged food and non-alcoholic beverages.	Total fat, total sugar, sodium	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Food and Drug Administration, Sri Lanka	Sri Lanka	(Hettiarachchi *et al.*, 2018; Perera *et al.*, 2022; Republic of Sri Lanka, 2019)	
	Multiple Traffic Light (Ecuador) 	Applied to all packaged food and non-alcoholic beverages.	Total fat, total sugar, sodium	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml).	Criteria adapted from the UK MTL nutrient criteria	Ecuador	(Freire *et al.*, 2016; Orozco *et al.*, 2017; Sandoval *et al.*, 2019)	
	Multiple Traffic Light (Saudi Arabia) 	Applied to all packaged food and non-alcoholic beverages.	Total fats, saturated fats, total sugar, salt	One set of thresholds for solids and separate thresholds for non-alcoholic beverages (per 100g/ml). Criteria based on the Ecuador nutrient criteria.	Led by Food and Drug Administration, Saudi Arabia	Saudi Arabia	(Al-Jawaldeh *et al.*, 2020)	

Reductive systems	**Guideline Daily Amounts (GDA) – now termed Reference Intakes (RI)**  	Applied all to packaged food and non-alcoholic beverages.	Energy, total fats, saturates, total sugars, salt	Summary of the detailed nutrition information at the back or side of food packages presented per serving size. Nutrient criteria based on dietary reference values set by the Committee on Medical Aspects of Food Policy (COMA).	Based on requirements of an average female with an estimated 2000 kcal intake	European countries and implemented worldwide	(Food & Drink Federation, 2014, 2021)	
	Facts Up Front  	Applied to packaged food and non-alcoholic beverages.	Calories, saturated fats, sodium, total sugars. Label allows for positive nutrients, such as fibre, iron, calcium, etc.	Summary of the detailed nutrition information at the back or side of food packages presented per serving size.	Industry and retailers led by the Consumer Brand Association and Food Marketing Institute	United States	(Australian Department of Health (n.d.); Roberto & Khandpur, 2014; US Chamber of Commerce Foundation, 2017)	

* Note: The FOPL systems in Table 4.1 are shown according to application, nutrients, thresholds and country of implementation.

4.3.2 Label format

The WL system conveys the nutritional interpretation in the form of text, e.g. 'EXCESS IN' (Chile), colour and familiar shapes, e.g. black octagon in Chile and red circle in Israel (Global Agricultural Network Information Israel, 2018) (Table 4.1). By appearing only on unhealthy products, WLs assist consumers to easily identify unhealthy products (Arrúa, *et al.*, 2017). However, the MTL, another type of nutrient-specific system, uses colour (green, amber and red to indicate low, medium and high nutrient levels, respectively) to provide products' nutritional interpretation (FSA, 2016). In addition to the colour interpretation, the MTL provides actual amounts of nutrients of concern per 100g/ml on the front of the pack. The MTL therefore combines two types of labelling systems (Hamlin *et al.,* 2015) (Table 4.1). The provision of actual nutrient levels on the front of the pack is the reductive labelling system, which extracts nutrition information from the list at the back of the pack and only restates the amounts of nutrients of concern on the front of the pack. Examples of reductive systems include the R), which is widely implemented across the world, and Facts up Front, which is applied in the United States (Table 4.1).

4.3.3 Nutrient criteria

From the literature it is evident that each labelling system is underpinned by different nutrient criteria or profiles (Table 4.1). Each criterion reflects the objectives of a specific labelling system. For example, nutrient criteria underpinning WLs that aim to help consumers identify unhealthy products only include thresholds for nutrients of concern (Chile Ministry of Health, 2015; Gillon-Keren *et al.*, 2020), while nutrient criteria for summary systems use algorithms incorporating both nutrients of concern and nutrients to encourage (Australian Government Department of Health, 2019; National Food Agency Sweden, 2019) (Table 4.1).

As shown in Table 4.2, of the 20 FOPL systems identified in the current review, three (15%), namely the Keyhole, Nutri-Score and HSR, were based on algorithms. Four (20%) of the FOPL systems, namely the Israeli Green Label, Keyhole, Nutri-Score and HSR, included both unhealthy and healthy nutrients and food components. Healthy nutrients and food components include dietary fibre, proteins, fruits, vegetables, legumes and olives. Only the WLs provided warnings about nutrients in excess, and the number and types of nutrition warnings differed from country to country (Table 4.2). For example, all countries that have implemented nutrition warnings consider sugar, salt and saturated fats. Only two (1%) of the FOPL systems warn consumers about products that contain caffeine and non-caloric sweeteners. In addition, trans-fat is included in only two countries' systems (Table 4.2).

Tables 4.2: Summary of FOPL systems implemented across the world since 1989 (*according to algorithm usage, warning labels, etc.)

FOPL system	Relies on algorithms	Considers healthy nutrients	Sugar warning	Saturated fat warning	Trans-fat warning	Salt warning	Total fat warning	Calorie warning	Caffeine warning	Non-caloric sweetener warning
Keyhole	Yes	Yes	No	No	No	No	No	No	No	No
Nutri-Score	Yes	Yes	No	No	No	No	No	No	No	No
Health Star Rating	Yes	Yes	No	No	No	No	No	No	No	No
High Salt warning label	No	No	No	No	No	Yes	No	No	No	No
Green Label (Israel)	No	No	No	No	No	No	No	No	No	No
Warning label (red) (Israel)	No	No	Yes	Yes	No	Yes	No	No	No	No
Warning label (Chile)	No	No	Yes	Yes	No	Yes	No	Yes	No	No
Warning label (Peru)	No	No	Yes	Yes	Yes	Yes	No	No	No	No
Warning label (Brazil)	No	No	Yes	Yes	No	Yes	No	No	No	No
Warning label (Uruguay)	No	No	Yes	Yes	No	Yes	Yes	No	No	No
Warning label (Mexico)	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Warning label (Argentina)	No	No	Yes	Yes	No	Yes	Yes	No	No	No
Multiple Traffic Light (UK)	No	No	No	No	No	No	No	No	No	No

FOPL system	Relies on algorithms	Considers healthy nutrients	Sugar warning	Saturated fats warning	Trans-fats warning	Salt warning	Total fat warning	Calorie warning	Caffeine warning	Non-caloric sweetener warning
Multiple Traffic Light (Iran)	No	No	No	No	No	No	No	No	No	No
Multiple Traffic Light (Sri Lanka)	No	No	No	No	No	No	No	No	No	No
Multiple Traffic Light (Ecuador)	No	No	No	No	No	No	No	No	No	No
Multiple Traffic Light (Saudi Arabia)	No	No	No	No	No	No	No	No	No	No
Guideline Daily Amounts (GDA)	No	No	No	No	No	No	No	No	No	No
Facts Up Front	No	No	No	No	No	No	No	No	No	No

* Note: The FOPL systems in Table 4.2 are shown according to whether they rely on an algorithm, consider healthy nutrients, provide warnings of nutrients contained in high amounts, or contain non-caloric sweeteners.

4.3.4 *Mandatory or voluntary labelling*

While some labelling systems are applied voluntarily, e.g. Health Star Rating (Jones *et al.,* 2018), Keyhole (Larsson *et al.,* 1999), RI (Kelly & Jewell, 2018) and the UK Multiple Traffic Light (FSA, 2016), certain countries have made their systems mandatory (Ecuador, Iran, Sri Lanka, Mexico, Chile, Uruguay, Brazil, Israel (red label), Argentina and Peru) (Table 4.3).

Tables 4.3: Summary of FOPL systems implemented across the world since 1989 (*according to year of implementation, implementation process, etc.)

FOPL system	Mandatory	Government led?	Year implemented	Implementation process and challenges
Green Keyhole	No	Yes	Sweden, 1989 Norway and Denmark, 2009 Ireland, 2013 Lithuania, 2014	Implementation supervised by Food Safety authorities.
Nutri-Score	No	Yes, in collaboration with researchers	France, 2017 Spain, 2018 Belgium, 2019 Switzerland, 2019 Luxembourg, 2021	Implementation supervised by the French Agency for Public Health which reports to the Ministry of Health.
Heart symbol – Better Choice logo	No	No	Finland, 2000	Not identified.
Health Star Rating	No	Yes, in collaboration with industry, public health and consumer groups.	Australia, 2014 New Zealand, 2014	The Food Regulation Standing Committee is responsible for ensuring consistent application of the HSR system across Australia and New Zealand.
High Salt warning label	Yes	Yes	Finland, 1993	Label positioned at the back of the pack. Nutrient criteria revised in 2008. Heart symbol – Better Choice logo positioned at the front of the pack introduced in 2000.
Green label (Israel)	No	Yes	Israel, 2020	Criteria for saturated fats, sugar and salt should not exceed those set for the warning label (Israel).

Warning label (Israel)	Yes	Yes	Israel, 2020	Involves progressive lowering of nutrient thresholds to stimulate industry product reformulation. Started in the second phase of the Chilean NP thresholds and the last phase to be implemented in 2021.
Warning label (Chile)	Yes	Yes	Chile, 2016	Implemented over a period of three years, with cut-off points becoming stricter each year (2016, 2018 and 2019) to encourage product reformulation.
Warning label (Peru)	Yes	Yes	Peru, 2019	Involves progressive lowering of nutrient thresholds over time, six months post-approval of the regulation and second phase to be implemented 39 months later. Started in the second phase of the Chilean NP thresholds.
Warning label (Brazil)	Yes	Yes	Brazil, planned for 2022	All foods high in nutrients of concern are not eligible to carry a nutrition claim. Approved in 2020; implemented in 2022.
Warning label (Uruguay)	Yes	Yes	Uruguay, 2018	Approved in 2018; fully implemented in 2020. However, criteria revised immediately after implementation in 2020 and revised again in 2021. Inclusion of nutrition claim banned on products bearing a warning label.
Warning label (Mexico)	Yes	Yes	Mexico, 2020	The implementation of the law is planned to take place over three phases: Phase 1: 1 Oct 2020–30 Sept 2023 Phase 2: 1 Oct 2023–30 Sept 2025 Phase 3: 1 Oct 2025
Warning label (Argentina)	Yes	Yes	Argentina, 2022	Implementation will take place in two phases.
Multiple Traffic Light (UK)	No	Yes, in collaboration with a wide range of stakeholders	United Kingdom, 2006	Criteria revised in 2016 after implementation in 2006.
Multiple Traffic Light (Ecuador)	Yes	Yes	Ecuador, 2014	Not identified.
Multiple Traffic Light (Iran)	Yes	Yes	Iran, 2014	Voluntary labelling introduced in 2014 and mandatory since 2016.

Multiple Traffic Light (Sri Lanka)	Yes	Yes	Sri Lanka, 2016	Labelling for drinks introduced in 2016 and for foods in 2019.
Multiple Traffic Light (Saudi Arabia)	No	Yes	Saudi Arabia, 2018	Not identified.
GDA	No	No	Europe, 2006	Not identified.
Facts up Front	No	No	United States, 2013	Not identified.

* Note: The FOPL systems in Table 4.3 are shown according to the year of implementation, the implementation process, the monitoring and evaluation process, and whether the FOPL is mandatory or voluntary.

There are some risks attached to the voluntary application of labelling systems (Jones *et al.,* 2018; Ni Mhurchu *et al.,* 2017). Consequently, there are strong arguments in favour of countries adopting mandatory labelling systems instead (Jones *et al.*, 2019; Roberto *et al.*, 2021). For example, with voluntary labelling, industry can be slow to apply labels. There is also evidence of selective application of already-healthier options and failure to declare nutrients that are contained in excessive amounts (Ni Mhurchu *et al.,* 2017). The application of mandatory labelling, accompanied by strict monitoring and enforcement, ensures uptake of and adherence to stipulations in the relevant labelling laws or regulations (World Cancer Research Fund International, 2019).

Eleven (55%) of the FOPL systems reviewed, mainly the WL and MTL, were implemented mandatorily (Table 4.3). Mandatory labelling is usually unpalatable to industry. Thus, countries that have previously implemented mandatory labelling have encountered opposition from industry (Corvalán *et al.*, 2013; White & Barquera, 2020). Mandatory FOPL systems that are government led, such as the WL, are usually underpinned by stricter nutrient criteria than industry is prepared to accept. The literature shows that FOPL that is backed by sound scientific evidence and is government led is often more effective than industry-led FOPL initiatives (WHO Regional Office for Europe, 2020; World Cancer Research Fund International, 2019).

Government-led labelling is usually viewed by the public as credible and normally protects the public against any conflicts of interest by different role players (Jones *et al.*, 2019). In the current review, the government was involved in the development and implementation of 17 (85%) of the 20 FOPL systems studied (Table 4.3).

Tables 4.4: Summary of FOPL systems implemented across the world since 1989 (*according to monitoring and evaluation mechanisms and means of enforcement)

FOPL system	Nutrient criteria reviewed	Monitoring and evaluation	Enforcement
Green Keyhole	Yes	Nutrient criteria reviewed five times since 1989. Consumer awareness and use evaluated in 2008, 2009 and 2021. Industry's opinion of the logo evaluated in 2021.	Regulation (National Food Agency Sweden, 2019). Violation subject to a fine.
Nutri-Score	Yes	Nutrient criteria reviewed five years after implementation in France. Yearly assessment conducted 2018–2020 by Santé Publique France. Uptake by Belgium assessed one year after implementation. Impact of Nutri-Score on purchasing intention assessed in 2021.	Regulation. The following sanctions could apply if the labelling guidelines are not adhered to: • Request corrective action. • Suspend the right to use the logo until compliance is reached. • Revoke the right to use the logo by Santé Publique France for a set period of time.
Heart symbol – Better Choice logo	Not identified	Planned monitoring through spot checks. No evidence of monitoring identified.	No enforcement strategy identified.
Health Star Rating	Yes	Nutrient criteria evaluated two years and five years after implementation. Label uptake evaluated in 2018. Consumer label understanding and use evaluated in 2020.	No enforcement strategy identified.
High Salt warning label	Yes	Dietary surveys to determine sodium intake conducted. Evidence of product reformulation identified.	Salt labelling regulation. No enforcement strategies identified.
Green Label (Israel)	Not identified.	Not identified.	Food labelling regulation. Enforcement plan not identified.

Warning label (Israel)	Yes	Label use and intentions regarding future purchases evaluated in 2021. Attitudes towards label evaluated in 2021.	Regulation. Enforcement plan not identified.
Warning label (Chile)	Yes	Ministry of Health's annual evaluation of the implementation process since 2016. Changes in SSB purchases assessed in 2015 and 2017. Evidence of product reformulation following implementation of the law.	Food labelling and advertising law. Products not meeting requirements will not be sold. Distributors selling non-compliant products will be subject to a fine.
Warning label (Brazil)	Yes	Consumers' opinion of the label investigated in 2019.	Labelling regulation. Enforcement plan not identified.
Warning label (Uruguay)	Yes	Review of nutrient criteria not identified. Consumers' perceptions of the label evaluated in 2017. Consumers' awareness of the policy, use of labels and understanding of nutrition information evaluated one month after implementation.	Labelling regulation. Enforcement plan not identified
Warning label (Argentina)	Yes	Effect of FOPL on purchasing intentions and healthfulness perceptions of selected products evaluated in 2022.	FOPL law. The Promotion of Healthy Eating Law as part of Argentina's Consumer Protection Law; the Fair Trading Decree. In case of violation of the Fair Trading Decree, sanctions will be imposed.
Multiple Traffic Light (UK)	Yes	Consumer label understanding and use evaluated in 2009.	Evidence of enforcement not identified.
Multiple Traffic Light (Ecuador)	Yes	Knowledge and perceptions evaluated in 2016 and 2017, respectively. Effect on carbonated soft drinks purchases evaluated in 2019.	Violation could lead to cancellation of advertising rights. Enforcement strategy not identified.
Multiple Traffic Light (Iran)	Yes	Uptake by industry evaluated in 2016.	Part of the National Development Plan (2011–2016). Enforcement strategy not identified.
Multiple Traffic Light (Sri Lanka)	Yes	Consumer knowledge, perceptions, attitudes and practices evaluated in 2022.	Food regulation. Violation subject to a fine and a potential jail sentence.

Multiple Traffic Light (Saudi Arabia)	Not identified.	Not identified.	Not enforced.
GDA	Yes	Multiple studies conducted.	Not enforced.
Facts up Front	Not identified.	Not identified.	Not enforced.

* Note: The FOPL systems in Table 4.4 are shown according to monitoring and evaluation mechanisms and means of enforcement.

4.3.5 Monitoring and evaluation

Monitoring and evaluation is an integral part of an effective FOPL implementation strategy (Song *et al.*, 2021; World Health Organization, 2017a). Monitoring and evaluation will provide evidence of the effectiveness of food labels in supporting actions at the national, regional and global levels (World Cancer Research Fund International, 2019). Such evidence could be used to support existing actions, to call for modifications to current actions, and to inform FOPL implementation initiatives by other countries. Monitoring and evaluation involves comparing baseline and periodic data and can be conducted at various points, including uptake by industry (Jones *et al.*, 2019; WHO Regional Office for Europe, 2020), consumer attitudes, understanding and use of FOPL, product reformulation, the effect of FOPL on purchasing, and longer-term evaluation effects (impact evaluation), such as changes in actual consumption and health outcomes (Kelly & Jewell, 2018; WHO Regional Office for Europe, 2020).

One of the weaknesses identified in this review was the insufficient evidence of monitoring and evaluation strategies and implementation of existing FOPL systems. The literature search yielded some evidence of monitoring in 10 (53%%) of the FOPL systems (Table 4.4). Only Finland had conducted a national survey to determine food consumption (Table 4.4). Other monitoring and evaluation strategies included determining FOPL uptake by industry (Ministry for Primary Industries New Zealand Government, 2017), consumers' awareness and attitudes (Nordic Council of Ministers, 2010) and understanding of FOPL, and their purchasing behaviour (Egnell *et al.*, 2021; Taillie *et al.*, 2021). Although these monitoring and evaluation activities may not reveal actual behaviour, they are still valuable as they provide important information related to other FOPL outcomes. It is argued that the evaluation of an FOPL system should be conducted some time after its implementation, as new habits take time to develop (Zhen *et al.*, 2011). In a study conducted in Mexico, it was reported that there was a more pronounced decline in purchases of taxed beverages two years after the tax was imposed than one year after it was imposed (9.7% vs 5.5%)

(Colchero *et al.*, 2017). A two-year period could also be used to evaluate FOPL effectiveness. However, there is a need for longer-term evaluations of actual food consumption (dietary surveys) and the impact on health outcomes (Gillon-Keren *et al.*, 2020; Kleef & Dagevos, 2015). Future research needs to close this gap in order to provide more compelling evidence of labelling effectiveness (Song *et al.*, 2021).

4.3.6 Enforcement

Enforcement plans could only be traced for a few FOPL systems (n=7:35%). Strategies identified include the removal of non-compliant products from the shelves and the charging of penalties (FAO *et al*., 2017). Four (20%) of the 20 FOPL systems included the payment of fines for non-compliance. These were the Green Keyhole in Sweden, the WL in Chile and Peru, and the MTL in Sri Lanka (Table 4.4). Enforceable sanctions need to be actioned to ensure compliance with labelling regulations; otherwise; the labelling runs the risk of acting merely as a marketing tool and not serving its intended purpose (Jones *et al.*, 2019; World Health Organization, 2017a).

4.4 Conclusion

It is evident that governments pursue FOPL for the purpose of creating healthier food environments for the population. An increasing number of countries have been implementing FOPL systems since 2018, and (interestingly) more countries are adopting interpretive FOPL systems than reductive FOPL systems, with a preference, too, for mandatory as opposed to voluntarily labelling. However, the frequent lack of monitoring, evaluation and enforcement mechanisms is still a weakness, which needs to be addressed if FOPL is to be effectively implemented and widely embraced.

Of all the FOPL systems identified in this review of studies, only one (5%) (the High in Salt warning label) showed evidence of a dietary intake survey being conducted after the system's implementation. There were, however, several reports of short- to medium-term monitoring and evaluation taking place in respect of label awareness and use (32%), label uptake by industry (16%), product reformulation (16%) and changes in purchasing behaviour (11%).

CHAPTER 5: RESULTS

SOUTH AFRICAN CONSUMERS' PERCEPTIONS OF FRONT-OF-PACK WARNING LABELS ON UNHEALTHY FOODS AND DRINKS

This chapter presents the literature used in the preparation of the first manuscript (article), a description of the researcher's contribution to the article and the published article itself. Comments from the reviewers of the article and the authors' responses appear in Appendix 13.

5.1 Introduction

Warning labels aim to facilitate the quick identification of unhealthy products and to discourage purchases of unhealthy products that contain excessive amounts of nutrients of concern (Machín *et al.*, 2019; WHO Regional Office for Europe, 2020). This persuasive effect of the WL can be explained through the communication–human information processing (C–HIP) theoretical framework (Figure 5.1).

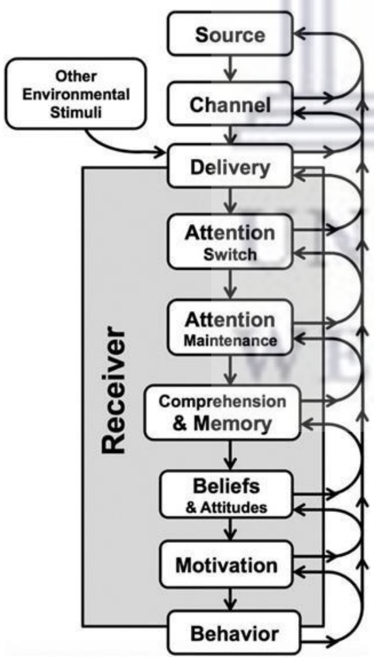


Figure 5.1: Communication–human information processing model

Source: Wogalter (2020)

According to the C–HIP theoretical framework, for the WL to achieve its objectives, nutrition information should flow from the source (e.g. manufacturer) through a channel (the WL on food packages) to the receiver (consumer). The consumer (receiver) must first be attracted and pay attention to the label, understand the label's meaning, modify their attitude, and be motivated to use the label (Wogalter, 2020). These processes feed back and forth into each other, and a breakdown in any of these stages leads to failure to reach the desired ultimate outcome of behaviour change (Wogalter, 2020). For example, a WL can influence understanding but fail to influence s change in attitude, resulting in failure to modify purchasing behaviour. Again, failure at a later stage in the hierarchy may influence an earlier step in the subsequent exposure. For example, a memory of the WL may result in failure to switch attention to the label in future exposures (section 5.4).

5.2 Communication–human information processing (C–HIP) theoretical framework

5.2.1 Source

The source is the originator or initial transmitter of the risk information (Wogalter, 2020). For the message to be received and acted on, the source of the message should be familiar, credible and an expert in the field (Wogalter, 2020). The setting determines the source of the warning and in the case of the WL, the source of the information is the manufacturer of the food products. Endorsement by government is seen as one of the strategies to increase credibility of nutrition information labels (De la Cruz-Góngora *et al.*, 2017; Jones *et al.*, 2019). An experimental study conducted in Mexico revealed that the inclusion of the statement 'Approved by the Ministry of Health' increased consumers' confidence in the labels as the Ministry was viewed as the highest health authority in Mexico (De la Cruz-Góngora *et al.*, 2017). Similarly, a study conducted in Brazil showed that government endorsement increased the credibility of the FOPL (De Morais Sato *et al.*, 2018). To this end, the WL implemented in Chile (Chile Ministry of Health, 2015) and Peru (Global Agricultural Information Network, 2017) includes the words 'Ministry of Health' to indicate endorsement of the labels by the governments of the respective countries.

5.2.2 Channel

The channel relates to how information is conveyed from the source to the receiver. Transmission routes could be visual (printed text warnings and pictorial symbols) or auditory (alarm tones, live voice and voice recordings) (Wogalter, 2020).

5.2.3 Delivery

It is not enough that the channel of communication is determined; it is also important for the warning to reach the appropriate audience for it to be effective (Wogalter, 2020; Wogalter *et al.,* 2011). WLs or signs that are, for example, printed and never distributed would then fail to transmit the necessary information. It is therefore important that once a determination is made to implement the WL, manufacturers follow through with the action so that the WL can have the desired effect.

5.2.4 Environmental stimuli

Other stimuli may compete with the WL and thus reduce its effectiveness. These may be in the form of other warnings or non-warning stimuli (Wogalter, 2020). They create 'noise' around the WL and may deflect receivers' attention away from it. Examples of environmental stimuli are announcements of competitions on the product packages which may clutter the packaging, or colourful backgrounds against which a WL may be less conspicuous (Bialkova *et al.,* 2013). The salience of the WL is therefore critical in ensuring the label's effectiveness. Label visibility will be dealt with in more detail in section 5.2.6.

5.2.5 Receiver

For a WL to be effective, it must first catch the receiver's attention and maintain it long enough for the receiver to notice the warning. Next, the WL must be understood and align with the receiver's existing attitudes and beliefs. Otherwise, the WL must be persuasive enough to evoke an attitude change towards the desired behaviour. Finally, the WL should motivate the receiver to modify their behaviour.

5.2.6 Attention switch

The first stage in the receiver component concerns the switch of attention. The WL should be conspicuous enough and be able to catch consumers' attention (Arrúa *et al.*, 2017; Taillie *et al.*, 2020b), even when consumers are not consciously searching for nutrition information (Arrúa *et al.*, 2017). This needs to occur in the presence of other competing stimuli on the product packaging, as discussed in section 5.2.4 above. Since many packages are cluttered, the WL must stand out from the background (i.e. be salient or conspicuous).

A conspicuous message increases the likelihood of reading, understanding, recall and ultimately label use in purchasing decisions (Taillie *et al.*, 2020b). Considering that food purchasing is a habitual activity

(Van't Riet *et al.*, 2011), the WL needs to swiftly catch people's attention to disrupt habitual decision patterns. Research points to the WL being more visible than other FOPL, even though in a study by Talati *et al.* (2019) no differences were pointed out in terms of the WL being more visible than other labels. In a study conducted in Canada, 58% of participants reported noticing the WL vs the no-FOPL condition, compared with 53% and 45% who reported noticing the Health Star Rating and MTL, respectively, vs the no-FOPL condition (Acton *et al.*, 2019). The salience of the label can be increased by using large and bold print, colour, borders or shapes, text and pictorial symbols (Ares *et al.*, 2021; Goodman *et al.*, 2018).

5.2.6.1 Print

Bold and large print is preferred as it stands out against most backgrounds and easily captures people's attention (Todd *et al.*, 2022).

5.2.6.2 Colour

Colour influences attention (Gabor *et al.*, 2020) and risk perception, and increases the likelihood of behaviour change (Grummon *et al.*, 2019; Roberto *et al.*, 2021). For example, a red stop sign is universally accepted as a signal for people to come to a complete halt to avoid danger (Cabrera *et al.*, 2017; Lehto & Clark, 1991). In a study to determine the most effective WL in Israel, results showed that consumers preferred a red WL (Gillon-Keren *et al.*, 2020). Results from a study by Goodman *et al.* (2018) in turn showed that the presence of the red colour in the WL improved consumers' understanding of nutrition information. In contrast, findings from a study by Cabrera *et al.* (2017) showed that black was deemed more indicative of product unhealthfulness than red. These findings are consistent with those from a study of Chilean consumers who identified more with a black colour, resulting in a black octagon being implemented in that country (Carreño, 2015). These findings support the assertion that colour interpretation is culturally learned and that each country needs to consider its own cultural context when deciding to implement a WL.

The background colour against which the label appears also influences the label's effectiveness (Khandpur *et al.*, 2019). Consumers should be able to distinguish the WL colour from the packaging's background colour (Wogalter *et al.,* 2002). Bialkova and Van Trijp, (2010) found that consumers preferred the monochromatic label to the multi-coloured label against a colourful background. The WHO Regional Office for Europe (2020) recommends the use of contrasting colours to enhance the label's effectiveness. Results from a study by Cabrera *et al.* (2017) revealed that black was easier to find on a product package than red. Another strategy to reduce the background noise could be to provide background tags that change the layout of the WL, e.g. by placing a black WL against a white background to increase visibility (Roberto *et al.*, 2021; World Health Organization, 2013b).

5.2.6.3 Borders

The WL is usually enclosed by borders associated with some form of risk (Ma *et al.*, 2018). For example, an octagon shape is used in Chile's WL (Chile Ministry of Health, 2015) and a red circle is used in Israel's WL (Global Agricultural Network Information Israel, 2018) as the shapes that best communicate nutrition information to the countries' respective populations. According to Wogalter *et al.* (2002), pointed shapes such as the triangle are a sign of danger, followed by the diamond and the octagon. However, in a systematic review, Taillie *et al.* (2020b) reported that the octagon shape is usually favoured more than either a circle or a triangle. It is important to note that the meanings attached to shapes depend on the country in which the labels are tested and that each country needs to test the effectiveness of different shapes before adopting an FOPL system.

5.2.6.4 Text

Words signalling danger have been acknowledged as an element that enhances the effectiveness of a WL (Kokole *et al.,* 2021; Roberto *et al.*, 2021). First, signal words such as 'DANGER', 'CAUTION' and 'WARNING' are usually used to attract attention to the WL and may increase risk perception (Grummon *et al.*, 2019; Wogalter *et al.,* 2011). Second, text is used to indicate the nature of the hazard (Wogalter *et al.,* 2002). In this case, the use of text such as 'HIGH IN' or 'EXCESS' may indicate the hazard linked to the consumption of the labelled products. In a study byGoodman *et al.* (2018), the use of the text 'HIGH IN' on the WL was associated with an increased likelihood of consumers correctly identifying products as high in saturated fat and sugar. Third, text may be used to explain the consequences of exposure to the hazard and to provide directives for avoiding the hazard (Kokole *et al.*, 2021). The Peruvian WL, for example, includes the phrase 'AVOID EXCESSIVE OVERCONSUMPTION' below the octagon, and if the product contains trans-fat, the text reads 'AVOID ITS CONSUMPTION' (Global Agricultural Information Network, 2017) as a further instruction to consumers. The Mexican WL includes the text 'CONTAINS CAFFEINE – AVOID IN CHILDREN' and/or 'CONTAINS SWEETENERS – NOT RECOMMENDED FOR CHILDREN' if the product contains caffeine and/or sweeteners (Global Agricultural Information Network, 2020c). However, for improved effectiveness, it is recommended that text be used in combination with other elements, such as borders, icons or images (Grummon *et al.*, 2019; WHO Regional Office for Europe, 2020).

The other important component in connection with text is the terms used to name nutrients (WHO Regional Office for Europe, 2020), particularly among individuals with lower literacy levels who may struggle to understand some terms (Lavriša *et al.*, 2020; Roberto *et al.*, 2021). It is important that terms used are clearly understood by the population (e.g. salt vs sodium), irrespective of social status.

5.2.6.5 Layout and placement

The location of the WL plays an important role in determining its effectiveness (Centurión *et al.,* 2019) and so the label should be placed where it is likely to capture the most attention (Khandpur *et al.*, 2019). Bialkova and Van Trijp (2010) recommend consistent placement of the label in one particular location on the food package. The human brain reuses the information last seen (Bialkova & Oberauer, 2010) and repetition of information speeds up response time in an information search (Bialkova & Van Trijp, 2010). In accordance with recommendations by international organisations, all current FOP labels are positioned in a consistent location with the WL, in particular, being positioned in the top right corner of the front of the food packages (Global Agricultural Information Network, 2017; WHO Regional Office for Europe, 2020). The recommendation to place the WL on the front and in the upper part of the product package is also echoed in the WHO Framework Convention on Tobacco Control (World Health Organization, 2013b).

5.2.6.6 Pictorial symbols

Pictorial symbols or icons that simplify nutritional information have been shown to be more effective in helping vulnerable groups (e.g. consumers with low literacy or low income) to understand such information than text labels or numerical presentations of information (Lavriša *et al.*, 2020; Roberto *et al.*, 2021). Symbols may be used to represent nutrients (e.g. a salt shaker for sodium) or to communicate messages about the nutritional quality of foods (WHO Regional Office for Europe, 2020). It is important that symbols are relatable to consumers – e.g. the use of an octagon as a stop sign in the Chilean WL or a traffic light in the UK MTL – for them to be meaningful. Pictures draw attention to things (Wogalter, 2020) and improve learning and memory, and may induce behavioural change (Hammond, 2011). A meta-analysis of studies in the tobacco industry demonstrated that pictorial images on cigarette packaging elicited feelings of fear and were associated with smokers' attempts to quit (Noar *et al.*, 2020; Sultana *et al.*, 2023).

5.3 Attention maintenance

For a label to be effective, it must maintain consumers' attention long enough for its content to be encoded (Conzola & Wogalter, 2001; Grunert & Wills, 2007) and it must be attractive to consumers (Wogalter, 2020).

The same features that enhance the attractiveness of labels also help to maintain people's attention. For example, in addition to attracting attention, large print increases legibility and thus the likelihood of consumers reading a label (Todd *et al.*, 2022). In addition, formatting may influence whether consumers' attention is maintained. Visual warnings that are well formatted and include blocks of white space (Hartley, 2003) are more likely to catch and sustain people's attention than warnings without these features (Wogalter, 2020). In addition, pictorial symbols enhance attractiveness and attention maintenance. As previously discussed, there is evidence that people are more attracted to labels that have pictorial symbols than to those with none. However, even a well-designed WL can result in failure to switch and maintain attention if exposure is repeated over an extended period of time, resulting in label familiarisation (Wogalter, 2020). The latter is discussed in greater detail in section 5.4 below.

5.4 Comprehension and memory

Once the label has been read by consumers and their attention is sufficiently maintained, the next stage in the communication process is for them to understand the message. The message on the label should provide the consumer with an appreciation of the risks involved and lead to an informed judgement about the product. For this reason, the WL should state the message as briefly, yet as explicitly, as possible (Wogalter, 2020).

The ease with which the message is understood depends both on the label and the consumer's characteristics. For maximum understanding, the design of the labels should consider the less educated. Simple, short, concise and frequently used terms and pictorial symbols are means to improve the comprehensibility of the message. The results of a qualitative study comparing the performance of the GDA, MTL and WL in Latin American countries revealed that a higher proportion (40.6%) of consumers from low-education backgrounds preferred and understood the WL, compared to those with medium-

(32.5%) and high-education backgrounds (27.2%) (Patiño *et al.*, 2019). Participants who preferred the WL explained that the label was attention grabbing and easy to read, and as such improved their ability to make healthier choices (Patiño *et al.*, 2019). A label that is poorly understood might be ignored and not further processed, while a label that is misinterpreted could induce hazardous behaviours.

Repeated exposure to the same WL might result in familiarity or habituation over time (Wogalter, 2020). This means that some memory of the label has been formed, implying that the label is no longer as visible as it was before. The downside of habituation is that the label might be ignored or avoided in future exposures, reducing its effectiveness (Wogalter, 2020). Several authors (Borland *et al.*, 2009; Hitchman *et al.*, 2014; White *et al.*, 2015; Woelbert, 2019) reported a decline in the effectiveness of the WL on tobacco packages over a three- to five-year period due to familiarisation with or a 'wear-out' of the labels. The repeated exposure over time removes the novelty of the WL, calling for the labels to be refreshed from time to time (White *et al.*, 2015; World Health Organization, 2013b). Borland *et al.* (2009) and White *et al.* (2015) reported a slight wear-out of the WL after two years of implementation in adolescent and adult smokers, respectively, and a definite decline five years after the implementation of the labels.

White *et al.* (2015) recommend a rotation of WL labels every five years, as the label will have lost its effectiveness by then. This is in contrast to the WHO Framework Convention for Tobacco Control (FCTC) that recommends a periodic rotation (every three to five years) of layout and design to prevent habituation even before it starts (World Health Organization, 2013b). Cunningham (2022) also recommends the annual rotation of WL and for countries to have several sets of the WL to use in the periodic rotations to keep the WL fresh and effective. Other types of rotation could involve varying current design elements (Cunningham, 2022). Periodic rotation is recommended as it gives countries an opportunity to incorporate new warning designs (Cunningham, 2022). However, according to Borland *et al*. (2009), governments may end up exceeding the minimum stipulations of the FCTC in the presence of a strong label. The latter would be characterised by a WL that is big in size and contains both text and graphics, and not text only (Borland *et al.*, 2009).

Taking lessons from the tobacco industry, one can expect that the WL on food products will be vulnerable to habituation if rotation does not take place. Based on this evidence, it is the recommendation of the current study that, in developing an effective WL for South Africa – which, in its proposed form, will be strong enough and will contain both graphics and text – the WL be rotated by government every three years from the year of implementation to ensure its sustained effectiveness.

5.5 Beliefs and attitudes

A label that successfully captures and maintains a consumer's attention and is well understood might still fail to elicit the desired behaviour if the consumer does not believe in the message or holds negative attitudes towards the message (Wogalter, 2020). At the same time, a message that is not aligned to a person's beliefs may result in the message not being acted on in future. To be effective, the message on the WL should concur with the receiver's beliefs and attitudes or be persuasive enough to change their beliefs and attitudes about a product (Wogalter, 2020). According to the Health Belief Model (HBM), individuals need to believe that they are at risk of negative consequences before they will modify their behaviour (Glanz *et al.,* 2002). Risk that is perceived to be high motivates a change in beliefs and attitudes, and ultimately elicits the desired reaction (Glanz *et al.,* 2002; Taillie *et al.*, 2020b).

A study comparing the effect of three types of FOPL vs a no-FOPL control condition revealed that the WL elicited stronger negative emotional reactions, and more reflection about the health effects of sugary drinks, than the control condition (Grummon & Hall, 2020). Familiarity with a product may be a hindrance to message effectiveness during the beliefs and attitudes stage, as consumers may believe that all that needs to be known about a product is already known. This belief may lead to a failure to search for any additional information. Familiar products tend to be perceived as less hazardous, and people who do not regard a product as hazardous are less likely to notice or read an associated WL. While it may not be easy to change beliefs and attitudes, presenting information in a form that will be noticed, read and understood may be helpful. In particular, the message must be strong and persuasive enough to override pre-existing knowledge and experience (Wogalter, 2020).

5.6 Motivation

To be effective at this stage, the WL must motivate the desired behaviour. An important factor influencing motivation is the cost of compliance. When people perceive the cost of compliance to be greater than the benefits, they are less likely to engage in the behaviour directed by the WL. The desired behaviour may not be achieved if it requires a lot of effort, requires too much money or takes too much time. Another factor is social behaviour. Some people would simply comply because they see others complying (Wogalter, 2020).

5.7 Behaviour

It is believed that individuals will engage in the warning-directed behaviour if motivated to do so (Conzola & Wogalter, 2001). To change behaviour, it is important that FOPL is visible and captures people's attention easily, is easy to understand and is strong enough to override consumers' pre-existing attitudes and beliefs.

Studies investigating people's understanding of a label need to be conducted among the population to ascertain that the final graphical design used is visible, attention grabbing and clearly understood, and also motivates a change in behaviour (WHO Regional Office for Europe, 2020). A qualitative study was therefore conducted in South Africa to explore the views of South Africans about the WL and to explore the elements understood to represent warnings within the South African context. The findings are presented as Publication #1 below.

Contribution of the researcher

MB, TF, NM, TC, LM and RS conceptualised the study. MB, TF and RS supervised the data collection. MB analysed the data and drafted the manuscript. All the authors reviewed, edited and approved the manuscript.

See Appendix 13 for comments from the reviewers, responses from the authors and communication from the journal editor.

5.8 Publication #1

Bopape, M., Taillie, L. S., Frank, T., Murukutla, N., Cotter, T., Majija, L., & Swart, R. (2021). South African consumers' perceptions of front-of-package warning labels on unhealthy foods and drinks. PLoS ONE 16(9), e0257626.

RESEARCH ARTICLE

South African consumers' perceptions of front-of-package warning labels on unhealthy foods and drinks

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Abstract

Front-of-package labeling (FOPL) is a policy tool that helps consumers to make informed food choices. South Africa has not yet implemented this labeling system. The aim of this study was therefore to explore adult South African consumers' perceptions of front-of-package warning labels on foods and non-alcoholic beverages (referred to as drinks in this paper) and their insights into features that could influence the effectiveness of the warning label. Using a qualitative approach, the study purposively selected consumers diversified by urbanization, gender, socioeconomic status, and literacy. We collected data from a total of 113 participants through 12 focus group discussions. Data were systematically coded and divided into five themes namely, positive attitudes toward warning labels, perceived benefits of warning labels, perceived behavior modification, perceived beneficiaries of warning labels, and effective attributes of warning labels. Almost all participants from all socio-economic backgrounds were positive about warning labels, reporting that warning labels concisely and understandably educated them about the nutritional composition of foods. Other perceived advantages were that warning labels warn of health implications, are easily understandable and could benefit child health. Some participants anticipated that warning labels would reduce their purchases of unhealthy foods, while others thought the labels would have no effect on their purchasing habits. Participants found the warning labels attention grabbing and stated that they preferred a black triangle placed on a white background (referred to as a holding strap henceforth), the words "high in" and "warning" in bold and uppercase text, an exclamation mark, and an icon depicting the excessive nutrient. In South Africa warning labels may improve consumer understanding of nutrition information and assist consumers in determining the nutritional quality of packaged foods and drinks.

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Introduction

The global prevalence of overweight and obesity is high [1, 2] and South Africa is no exception [3, 4]. Worldwide no country has been able to turn around the rising numbers [2, 5], and the increase has been particularly steep in South Africa [3, 4]. The South Africa Demographic and Health Survey (2016) reports an overweight and obesity prevalence of 31% among South African men and an even higher prevalence of 68% among South African women [4]. The prevalence of noncommunicable diseases (NCDs), such as hypertension and diabetes, is increasing annually in low- and middle-to-high-income countries, including South Africa [4, 6]. Comprehensive and effective corrective measures are needed to address these trends.

Due to urbanization, access to a wide variety of ultra-processed foods and non-alcoholic beverages (henceforth referred to as drinks in this paper) has increased remarkably in the South African market since the early 1990s [7, 8]. Several reports have demonstrated a link between high consumption of ultra-processed foods and drinks and the development of obesity and NCDs [9–11]. Urbanization has resulted in a shift from traditional diets to consumption of ultra-processed foods [8, 12, 13] made from multi-ingredient formulated mixtures containing little if any whole foods, such as ready-to-eat refrigerated processed meat (known as polonies), carbonated drinks, biscuits, and breakfast cereals, and that are typically high in sodium, sugar, saturated fats, and calories [14]. In a study conducted in Soweto, South Africa, most adolescents reported a high frequency of fast food consumption per week, with sweets, crisps, and soft drinks accounting for more than 65% of the total items consumed [15]. In other studies South African adults have reported very high sodium intakes due to consumption of processed food, including ultra-processed food [4, 12].

A simple, easily understandable food labeling system could assist consumers in identifying unhealthy food options amid the wide variety of packaged products available in markets and steer consumers away from them. Simplified FOPL has a role to play in addressing these health concerns by empowering consumers with information about products' nutrient content. Front-of-package labeling (FOPL) is a practical tool that empowers consumers to make informed food choices at the points of purchase and consumption [16, 17]. Several international studies have demonstrated the usefulness of FOPL in assisting consumers to identify unhealthy food products and discouraging selection of products identified as unhealthy [18–21].

FOPL systems range from reductive labels, which mainly summarize the nutrition information in the back-of-pack Nutrition Information Panel and present it on the front of the package, for example, Guideline Daily Amounts (GDA), to interpretive labels, which evaluate the nutritional quality of food products and present the information with icons or symbols, for example, warning labels and health logos [22, 23]. Evidence indicates that interpretive food labels are more effective in directing food choices than their counterparts [16, 20, 24].

Warning labels are interpretive FOPL systems that are implemented in countries such as Chile and Israel to highlight products that are excessive in energy, saturated fats, sugar and sodium [25, 26]. This labelling system aims to discourage purchasing and overconsumption of unhealthy products by flagging products which contain excessive nutrients of concern in a simple, visible and easily understood manner [20, 27]. Highlighting nutrients associated with NCDs may increase risk perception, foster easy identification of unhealthy products, and discourage their purchasing and overconsumption [24, 28, 29]. Consumers have limited shopping time [30, 31] and warning labels that are conspicuous serve as a means to quickly identify unhealthy products within a short period [32].

Recent studies in France, Australia, Brazil and Chile indicate that, in comparison with other systems, warning labels are more effective in decreasing the intention to purchase unhealthy foods and drinks [18, 28, 33] and in helping consumers identify less healthy foods and drinks [34, 35]. Evidence from the tobacco industry also points to the potential of health warning labels to reduce use of a harmful product [36, 37]. The use of health warning labels with images alongside text on tobacco packages has been associated with increased smoking cessation [39] and attempted cessation [38]. Warning labels increase risk perception through eliciting negative emotions such as fear, discomfort and worry and thus are effective at reducing purchasing intention [32, 38, 39].

Although studies revealed the successfulness of warning labels in dissuading consumers from purchasing unhealthy products and decreasing the perceived healthfulness of unhealthy products [20, 40], no significant differences in the mean nutritional composition of purchased products were noted in certain cases [41]. Warning labels by their binary nature (warning vs no warning) and because they do not state nutrient amounts are reported to be less informative, especially among the highly educated groups [21, 42]. The nutrition facts panel at the back of the package could however be used to complement the front of pack nutrition information.

Nutrition warning labels highlight excessive nutrients of concern and often include the text "high in" or "excess," warning consumers that the levels of those nutrients are above health recommendations [25, 27]. The text is usually enclosed in familiar shapes such as a triangle or octagon associated with some form of risk and may be accompanied by text depicting danger or caution [25, 43]. Repeated exposure to familiar shapes such as the stop sign or triangle attracts consumer attention [44] and increases danger or risk awareness [43]. Deliza et al. [45] found that participants located black triangles and black octagons most quickly on product packages in comparison to other shapes and FOPL formats. According to the Communication–Human Information Processing (C–HIP) Model, warning labels that are attended to, are well understood and increase risk perception, influence behaviour and may ultimately lead to habit change [46–48]. Use of color such as black or red, which is associated with 'stop' or danger [49]; bold font, which is attention grabbing [43]; and bigger label size enhance the labels' visibility and captures attention [43]. In a study by Cabrera et al. [50] a red stop sign with the text 'excess' was associated with the least perceived healthfulness and black was reported more visible. These attributes enhance the warning labels' effectiveness in informing consumers and steering them away from unhealthy food [51]. In addition pictorial images and icons further increase visibility [52] and simplify understanding of warning labels across various sociodemographic groups, including low-socioeconomic, low literate groups and children [18, 32]. Images are easy to understand and are more easily retained in memory [53].

The current nutrition panel currently used in South Africa is on the back of the packaged, is complicated and not well understood due to the terminology and the difficulty in interpreting numbers used [30, 54]. A study by Jacobs et al. [55] revealed that South African consumers previously expressed a need for an FOPL system that communicates nutrition information in a simple manner. South Africa as a country has not yet implemented any FOPL system The success of warning labels [18, 34, 35] in other countries created an opportunity to develop and test a a warning label that could effectively warn and modify South African consumers' purchases of unhealthy products. This study aimed to fill this gap by probing South African consumers' responses to warning labels and exploring their views on features that could enhance or diminish its effectiveness. The study explores (1) consumers' perceptions of warning labels and (2) consumers' views on design features that could influence the effectiveness of a warning label.

Materials and methods

Study design

The study required an in-depth understanding of participants' views of warning labels, so we followed an exploratory descriptive qualitative approach [56]. With an exploratory descriptive qualitative design, researchers gain more knowledge of a process or a situation from the affected individuals than with other designs [57]. The materials and methods followed in this study will be presented according to the Consolidated Criteria for Reporting Qualitative Research (COREQ) [58].

Setting

An independent market research company that has not done work for the food industry in the two years prior to this project collected data in two metropolitan and two non-metropolitan areas in each of three purposefully selected provinces in South Africa: Gauteng, KwaZulu-Natal and Western Cape. The provinces represent the country's diverse socioeconomic statuses and cultural beliefs and practices.

Sample

The market research company recruited participants through their existing database using a recruitment questionnaire developed by the research team (MB, LST, NM, TC, LM and RS) (S1 File). Data were collected from 12 focus groups of 8 to 10 members each, with a total of 113 participants taking part in the study. A sample of forty (40) participants was targeted per province to represent the various sociodemographic strata. The sample included adults primarily responsible for household food purchases purposefully selected using quotas stratified according to gender (male or female), age (18–29 years or 30–50 years), literacy (no literacy, low literacy, or literate), income (low or middle-high), urbanicity (urban or rural), and geographic location (Gauteng, KwaZulu-Natal, or Western Cape provinces) (Table 1). The focus groups were homogenous with each group consisting of participants with similar sociodemographic characteristics. We classified household income levels as low if less than R1,600 (approximately USD 100) per month and middle-high if R1,601 and above. We defined no literacy as adults with no formal schooling, low literacy as adults who had passed grades 1–6, and literate as adults who had passed grade 7 or higher.

Ethical considerations

We obtained ethical clearance from the University of the Western Cape Biomedical Research Ethics Committee (Reference number BM18/9/13). Fieldworkers shared a letter of information with interested participants during recruitment. We explained the aims of the study and the data collection procedure to the participants, who provided their written consent for participation prior to data collection. We also obtained participants' consent to record the discussions and informed that each group would be webcasted live to a group of researchers. Discussions were conducted in the language of the participants.

Label design

A design agency created several warning label prototypes for testing on South African consumers following a detailed design brief based on the latest literature [36, 43]. The designer was briefed to create an effective warning label using shapes, text and icons that would increase South African consumer's identification of the presence of unhealthy nutrients in foods and encourage healthy choices. The intent was also to ensure that the labels would be effective across diverse sociodemographic groups in South Africa. A committee comprised of experts in

Table 1. Socio-demographic characteristics of participants (n = 113).

	n (%)
Gender	
Male	31 (27.4)
Female	82 (72.6)
Age	
18–29 years	26 (23)
30–50 years	87 (77)
Urbanicity	
Urban	63 (55.7)
Rural	50 (44.2)
Literacy	
No literacy (no formal schooling)	5 (4.4)
Low literacy (grades 1–6)	49 (43.4)
Literate (grade 7 and above)	59 (52.2)
Work status	
Unemployed	62 (54.9)
Self-employed	18 (15.9)
Employed	20 (17.6)
Part-time employed	7 (6.2)
Seasonal worker	6 (5.3)
Combined family monthly income	
Low (R0–R1,600)	86 (76.1)
Middle-high (R1,601 and above)	27 (23.9)

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nutrition, health, health promotion, economics, communication, and media systematically rated each South African design to narrow down the range of options. Based on recommendations by the expert committee, we first tested black triangles on a white holding strap with the word "warning" (Fig 1).

Each triangle contained the text "high in" and icons depicting the nutrient of concern present, sugar, saturated fat, and/or sodium (Fig 2). The warning labels were superimposed on the front of four different food and drinks packages i.e. chips/crisps (square packet), fruit juice (bottle), yoghurt (yoghurt container) and cereal (rectangular box). A product high in all three nutrients would show three corresponding triangles with the relevant icons. We used this original warning label to evaluate consumers' perceptions of warning labels.

The second part of the study compared different design elements of the warning label (Table 2 and S1 Fig) to determine the preferred version.

We tested 32 design element options of the warning label. This included different types of icons for each nutrient, symbol shapes (triangles versus octagons), symbol colors (black versus red), holding strap colors (black versus white), warning devices (warning text only, warning text with an exclamation mark, black no warning device and red no warning device), text fonts (uppercase versus lowercase letters), and label sizes (Table 2). Other countries have similarly tested a number of prototypes [59].

Procedure

A trained moderator (with an assistant) from the market research company used a semi-structured focus group discussion guide or moderator guide (S2 File) prepared by the research team to collect data during March 2019 and April 2019 at suitable venues located in the pre-

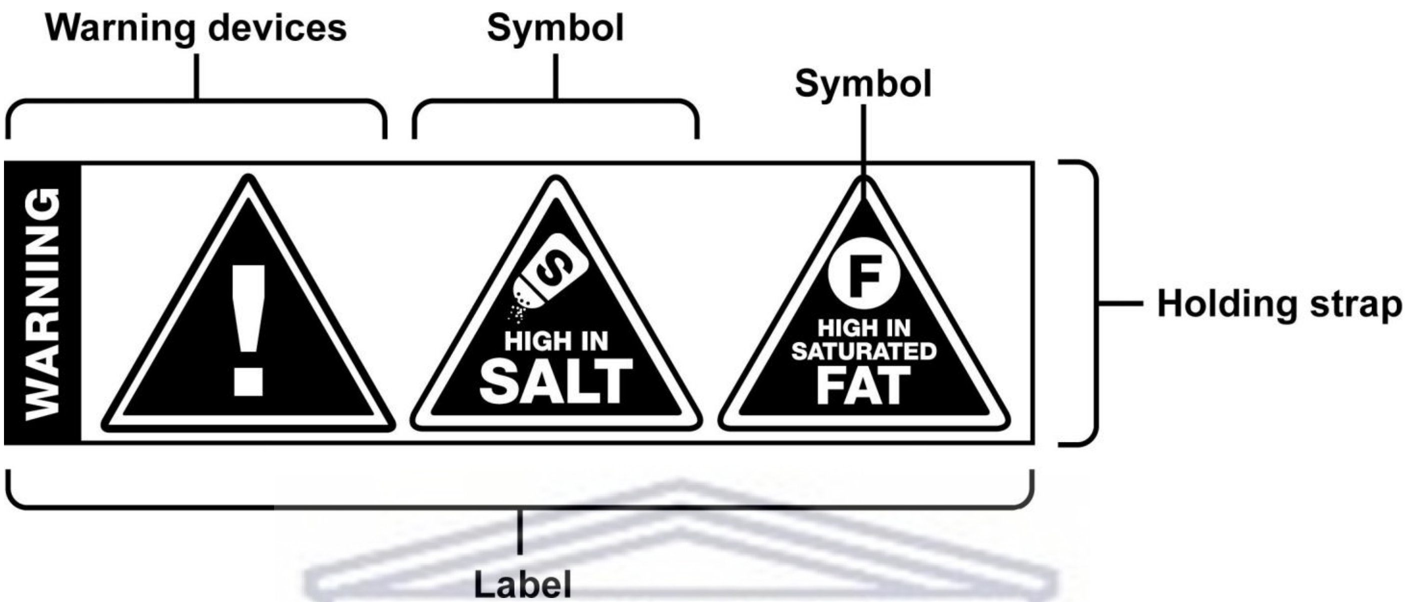

Fig 1. Image of the warning label designed for South African consumers.

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selected areas. All the interviews were conducted by one moderator who was appointed as a researcher at the time of data collection. The moderator had extensive experience in qualitative data collection and data analysis The stimulus material (warning labels) was projected on screens and each focus group discussion was recorded with an audio-video recorder.

A graphic designer superimposed the various warning label prototypes onto real packages of crisps, cereal boxes, yogurt containers, and fruit juice bottles available on the market. Labels were placed on each package according to the excessive nutrients in those products. For example, if a product contained excessive salt and saturated fats, we placed two warning labels, one for salt and another for saturated fats, on the package. We selected products based on the 2018 Euromonitor data ranking brands according to sales. The research team selected the product that would carry the highest number of nutrient warning labels (sugar, salt and saturated fat) from the five top-selling brands in each category.

Focus group discussion guide

We based the focus group discussion guide on instruments used in other countries. The authors of this paper collaborated to develop the guide which was piloted in two focus groups consisting of 8 to 10 participants each. The guide had two sections based on the objectives of the study. During the first section the moderator projected an image of four products, crisps,

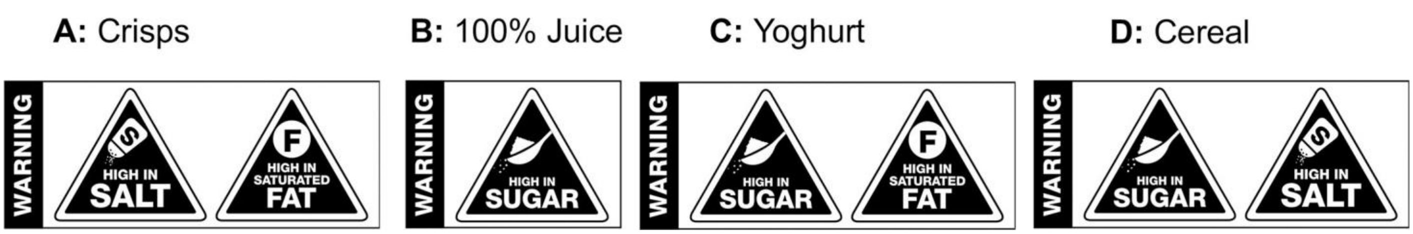

Fig 2. The original warning label with black and white triangles tested in the first part of the study (images from left to right: A) crisps, B)100% fruit juice, C) yoghurt and D) cereal).

https://doi.org/10.1371/journal.pone.0257626.g002

Table 2. Design elements tested.

Warning label element	Options tested
Icons	12: 4 salt icons, 4 sugar icons, 4 saturated fat icons
Symbol shapes	2: 1 triangle, 1 octagon
Symbol colors	4: black octagon, black triangle, red octagon, red triangle
Holding strap colors	2: black, white
Warning devices	4: warning text only, warning text with an exclamation mark, black triangle with no warning device, red triangle with no warning device
Text fonts	2: uppercase text, lowercase text
Label sizes	4: 5%, 10%, 15% and 20% of the front of pack surface area
Placement	2: top right corner and bottom right corner of the front of pack

https://doi.org/10.1371/journal.pone.0257626.t002

cereals, yogurts, and juices bearing the black warning label, on the screen for all participants to view and led the group discussion. The questions explored included the participants' understanding of the warning label, the label's perceived effect on purchasing habits, the label's visibility, and the label's credibility.

During the second section of the focus group discussions, the moderator projected alternatives to the original label (S1 Fig) on the screen. Participants selected the label format that was perceived as (1) attention grabbing, (2) effective as a warning against unhealthy foods and drinks, and (3) likely to influence their purchasing behaviors.

To accommodate participants' language preferences, the researchers translated the focus group guide and questionnaires, and the moderator facilitated the discussions in either English, Zulu, Xhosa, Tswana, or Sepedi. The moderator was fluent in all the languages the participants spoke. The moderator transcribed the recordings verbatim and then translated the data into English where applicable.

Data analysis

We used a data-driven inductive thematic analysis approach to analyze the data [60]. With this approach, one member of the research team (MB) and an experienced independent qualitative researcher identified emerging codes directly from participants' responses [60, 61] and developed themes. These two researchers read and reread the transcripts to become familiar with the data [62] and separately coded the data. The two coders compared their codes and agreed on the codes and themes that best represented participants' responses.

To ensure credibility, the research team observed the focus group discussion online and held debriefing sessions with the moderator after data collection. Our researcher (MB) and the independent coder followed the same process of reading the transcripts, developing codes, and organizing data into themes based on the participants' responses. We followed the same data collection procedure with all focus groups. The authors of this article reviewed the themes and the quotations.

Results

We extracted 5 themes and 16 subthemes from the data (Table 3 and S1 Table).

Positive attitude toward warning labels

Participants from all socio-economic backgrounds generally had positive attitudes toward warning labels. They attributed diseases to food choices and believed warning labels would

Table 3. Themes and subthemes.

Themes	Subthemes
Positive attitude toward warning labels	
Perceived benefits of warning labels	Warn of health implications
	Provide useful nutrition information
	Educational
	Easily understandable
	Benefit child health
	Provide succinct information
Perceived behavior modification	Cautiousness
	Indifference toward warning labels
Positive elements of warning labels	Visibility
	Color
	Position
	Text
	Emphasis
	Symbols
Perceived beneficiaries of warning labels	All consumers
	Individuals with medical conditions

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provide helpful nutrition information for food selections. One participant from a low-socio-economic background noted,

> "It is helpful;, look now we have all these ailments because we just eat anything and everything" (female, low income, low literacy, urban).

The participants also suggested that currently they lacked knowledge of nutritional quality of food products and that warning labels could enable them to make healthier food choices.

Perceived benefits of warning labels

The focus group discussions brought up several perceived advantages of warning labels. Participants believed warning labels would warn of health implications, provide useful nutrition information, would be educational, easily understandable, benefit child health, and provide succinct information.

Warn of health implications. A number of participants understood that warning labels on food packages would provide information relevant to their own personal health. They were of the opinion that warning labels alert them to negative health effects associated with excessive consumption of unhealthy products. This view surfaced irrespective of socio-economic status. One participant from a rural area said, "It shows that there is some danger with the chips, if you eat them too much you might end up sick" (female, middle-high income, literate, rural). Her response conveys the label's potential to discourage excessive consumption. For her, the warning label would help people recognize the health implications of eating too much of an unhealthy product. Another participant that warning labels draw one's attention away from the palatability of the food and to other important facts about the product, "Yes, it shifts your focus from just seeing nice chips to the health hazards on them" (female, low income, low literacy, urban).

In addition, participants believed the incidences of diseases such as heart disease would decrease if warning labels were implemented: "And they will minimize the amount of chronic diseases from the people and to those who have heart attacks, they would be easily warned (male, middle-high income, literate, rural). Another participant from a rural area also held the view that warning labels would help to prevent disease: "It will really help for preventing people from getting such ailments. I think they will really be helpful" (female, low income, no literacy, rural).

Provide useful nutrition information. Warning labels state which nutrients are present in excess and thus provide useful nutrition information to consumers. One participant from a low-socioeconomic background was of the opinion that this explicit function of warning labels will make consumers aware of the nutritional quality of the food they purchase, "There are people who are not meant to take high amounts of sugar or salt and so before they buy a food item they have to check for those things, and the labels become helpful because they know exactly what the nutrient content of the product they aim to buy is" (female, low income, no literacy, urban). This suggests that because the information is available before a purchase, it could potentially influence what consumers ultimately buy.

Another participant echoed the same sentiment, adding that the information was relevant to consumers, "I think it is for us to know what kind of food are we eating and what it contains" (female, low income, low literacy, urban). A participant from an urban area noted that the message is delivered clearly due to a label's simplicity, "Because it is very simple, it is saying that there is too much salt and therefore I must not buy it" (female, middle-high income, literate, urban).

Educational. The participants appreciated the labels' information, which they said was eye opening. They believed it would help them choose food more carefully and which, in turn, could help with disease management: "Personally it has changed my mindset regarding food because I now know that if I am not feeling well there is certain food that I can and cannot eat according to my health. For example, if I go to the clinic and I am diagnosed with high blood pressure then I know when I go to a store which food to pick that are healthy" (female, middle-high income, literate, rural).

Echoing that sentiment, another participant noted that the labels had enlightened her about the risks of food she had always assumed to be healthy and would help her check for the healthfulness of a product before making a purchase, "It does (help) because normally we would buy juice because it is considered healthy and now we know how to check for the levels of sugar in the juice; we now know how to check for levels of salt as well. We are well knowledgeable now (female, low income, no literacy, rural).

Easily understandable. Warning labels are designed to be easily interpreted and understood by all population groups irrespective of their income levels, ethnicity and age. A woman from a middle-high income group was of the opinion that warning labels in this format would be accessible to all members of the population, the illiterate, the young, and the elderly alike. This she attributed to the icons used to depict excessive nutrients: "The labels can be easily understood by the less literate, young people, and the elderly. The sign of a spoon full of sugar, even if you do not know how to read, it makes it easy to understand this is sugar. And the salt is easy to identify since we use it when laying the table" (female, middle-high income, literate, rural). Her response suggests that all people desire access to nutrition information irrespective of social standing and labels that accommodate people's information needs could assist with that.

Benefit child health. Participants perceived that warning labels would be beneficial to children's health. Showing concern for their children's well-being, they felt that knowledge about a food's nutrient content empowered them to make healthier choices for their children: "It helps us because we have children and we now know what to stop them from eating" (female, low income, no literacy, urban). This woman acknowledged that labels were a potential tool to identify products harmful to children's health.

Some participants noted that children become primary purchasers in the absence of their parents and that labels provide guidance: "A child can have R10 or R20 but now, as parents it is our duty to teach our children to stay away from food that is highly concentrated with this and that. Even if I am not there as a parent my child will know that too" (female, middle-high income, literate, urban). Another added, "When I send a child to buy something, they will see the sign and know whether this is good or not" (male, low income, no literacy, urban). The participants felt some level of comfort knowing that their children would have the means to independently judge whether food is healthful or not.

Provide succinct information. Warning labels only emphasize nutrients that are contained in excessive amounts without listing all the nutrition information. One urban participant appreciated the shortened and simplified presentation as it would save shopping time, "I also believe the reason why they came up with the triangle concept for the fat warning and salt is because in most cases you find that at the back they tell you about the kilojoules, so that small triangle you read fast unlike going through the whole nutritional table like the one we have now. I believe it is going to make our lives easier" (female, low income, low literacy, urban). This quote indicates that labels would simplify information in the nutrition facts panels which is a key advantage of the warning label. Consumers are interested in nutrition information but are discouraged by the long and complex nutrient list on the back of food products.

Perceived behavior modification

This theme addresses the participants' perceptions of the effect warning labels would have on their purchasing behaviors. When they discussed it, they brought up two subthemes, cautiousness and indifference toward warning labels.

Cautiousness. Warning labels are designed to increase the perception of risks associated with overconsumption of unhealthy food products. Some participants hinted that the information the labels provided would prompt them to reevaluate their purchasing habits. Some participants expected that they would buy products bearing labels less often: "It raises awareness because if you know that the food contains fat and you know you are not meant to take high amounts of fat then you have the option to reduce the extent to which you buy that specific product" (female, low income, no literacy, urban). The view reflects that it is an individual's choice and that she would not necessarily stop purchasing those products but would reduce the frequency of consumption. Another participant added that she would still buy the product but would decrease her purchasing frequency: "The label will tell me but that will not necessarily stop me from buying the product. I might be influenced to buy it less often but not to entirely disuse the product, particularly if it is something I love" (female, low income, no literacy, rural).

In contrast, other participants thought they would at some point stop buying products with warning labels. A male participant indicated that, although it would be difficult, he envisaged ultimately letting go of products bearing warning labels, "The other thing is that letting go of something at once is impossible, so you reduce the amount with time and then eventually leave the product" (male, low income, no literacy, urban).

Indifference toward warning labels. It should be acknowledged that some participants have strong opinions about food products and some were brand loyal, declaring that labels would not have any prohibitive effect on their purchasing habits despite the dangers associated with overconsumption of some products, similar to cigarette warnings that do not convince some to stop smoking. "It is like the cigarette problem, cigarettes are written 'Dangerous: smoking can kill you,' but smokers still smoke" (female, middle-high income, literate, urban).

Positive elements of warning labels

Participants mentioned several positive attributes that they felt could enhance the effectiveness of warning labels. They include visibility, color, position on the front of the package, text, emphasis, and symbols.

Visibility. Participants appreciated that warning labels were readily visible on the pack: "When you buy the yogurt, you can easily see the label" (male, low income, no literacy, urban). Another pointed out that the black triangle design made the warning more conspicuous against the colorful product packaging, "The black sign also makes it easy to see the label" (female, low income, low literacy, rural).

Color. Participants view was that black drew attention to the warning label and effectively contrasted with colorful product packages: "Even the yogurt container has bright blue and pink colors, and the black signs make you want to know what is written there" (female, middle-high income, literate, urban). The latter participant raised the interesting point that the colors raised curiosity. In the same vein, a participant from a different socioeconomic background suggested that a black and white label would raise interest in the information in the label, "It is black and white and colorful making you ask yourself what it says" (male, low income, no literacy, urban). Both participants addressed the need for warning labels to catch consumers' attention.

Some participants however seemed to prefer a red label as red is universally associated with danger. They likened red color to a red traffic light and warnings at construction sites. "A red colour would do, because we learnt at the construction sites that red means danger, if the traffic light turns red you know there is danger, it draws your attention (female, low income, low literacy, rural). Another participant added: "Even the traffic light when it signals red, it means stop or danger". (female, low income, low literacy, rural).

On the other hand there was a feeling that a red label would be too bright and ineffective when put against a red container. "That red just confuses everything because everything is red in color" (Female, middle-high income, literate, urban). Another participant added: "l think red on this package is too bright unlike on the other product, the color (black) is perfect on the package"" (female, low income, low literacy, urban). One more participant in the same group (female, low income, low literacy, urban) added: "you cannot place something with a red color on top of something with a red color".

Position. Participants appreciated that warning labels were strategically placed on the front of the package, so consumers would not have to search for them: "The warning sign is in a visible place because normally for you to see the warning sign you have to turn whatever it is that you are buying to see it, but with this it is on the front, it is just there and you can see it easily" (female, middle-high income, literate, urban). This response implies that searching for nutrition information was currently inconvenient and that warning labels might be more user-friendly. Another reiterated the convenience of the position, "This label is right because it is placed in front, people will be able to notice before taking the product" (female, middle-high income, literate, rural). This participant emphasized the value of attracting the attention of customers who are not actively looking for nutrition information so they will read the label before making a purchase.

Others added another dimension to the position of warning labels. A warning label in the top right corner of a package increased its visibility compared to a label at the bottom: "And because it is at the top near the name of the product it is easy to notice it" (male, low income, no literacy, urban). Another echoed the benefit of easy access to nutrition warnings, "When one reads, they do not start at the bottom but right at the top, and so you see the one at the top much quicker than you do with the one down there" (female, low income, no literacy, urban).

Text. The word "warning" particularly made an impact on our participants. They associated the text with harm linked to consumption of the product: "I would say it starts with the term 'warning,' obviously, you now know it is something that is not good, it makes us more aware" (female, middle-high income, literate, urban). This response implies that the text might contribute to the awareness that the other elements on the label initially raised. When asked how long it took them to notice the label, one participant said the word "warning" grabbed her attention and caused her to read the whole label, "It took me time until I saw the word 'warning,' then that shook me a bit (female, low income, low literacy, urban). The participant saying the text "shook" her indicates that the text elicited a strong emotional reaction.

Emphasis. When asked why the labels included an exclamation mark, some participants said they did not know, while others remarked that an exclamation mark itself indicated a warning: "The exclamation mark suggests a warning" (female, low income, no literacy, urban). One added that an exclamation mark not only indicates warning but also emphasis, "[An exclamation mark] is a sign of warning and emphasis" (male, low income, no literacy, urban). He suggests that the exclamation mark, accompanying the word "warning" could intensify the impact of the label.

Symbols. A combination of the triangle and icons seemed to grab participants' attention and increase their interest in the warning label: "I believe that it is easier to see based on the triangle and the icons, that of salt and sugar granules. With the products that we have that do not have the triangle sign you cannot see, when you walk into a store and when you see that triangle on the milk package obviously you want to see what is going on, are there new ingredients or.......I believe it can catch your eye when you walk into a store" (female, low income, low literacy, urban). Another participant from a low-socio-economic background was intrigued by the various elements on the label and stated, "It has so many signs and it will direct your eyes to the product for a longer time because you would be wondering why it has so many signs of warning" (male, low income, no literacy, urban). It sounds like the many elements made the label attention grabbing than hard to notice.

Other participants stated that they resonated more with the triangle shape than the octagon and preferred the triangle as a warning about the danger of overconsuming the labelled product. "The other one (octagon) is more visible but we prefer the triangle because we are used to it as a warning sign" (Female, Middle–High income, Literate, Urban).

Perceived beneficiaries of warning labels

When asked to whom the warning labels were directed, some participants replied all consumers, not specific groups. Yet others understood them to be meant for individuals with medical conditions.

All consumers. A participant who felt that warning labels were meant to inform all consumers said, "They are for us the consumers, to make an awareness on us that we must not just buy but check the ingredients first" (female, low income, low literacy, urban, Western Cape). As quoted in the section Benefits of warning labels above, a participant reminded us that warning labels could be relevant even to children, as they become purchasers at times, "My child will know that too".

Individuals with medical conditions. However, one participant who thought warning labels were only directed to individuals with medical conditions said, "I think it works for people who suffer from ailments such as sugar diabetes so that they are able to avoid food items they are not supposed to buy" (female, low income, no literacy, rural). Another added that in the absence of medical conditions, one was free to buy as one wishes, "I do not have any health-related problems, so I can definitely buy products with lots of sugar, the one with low sugar is not tasty for me" (female, low income, no literacy, rural).

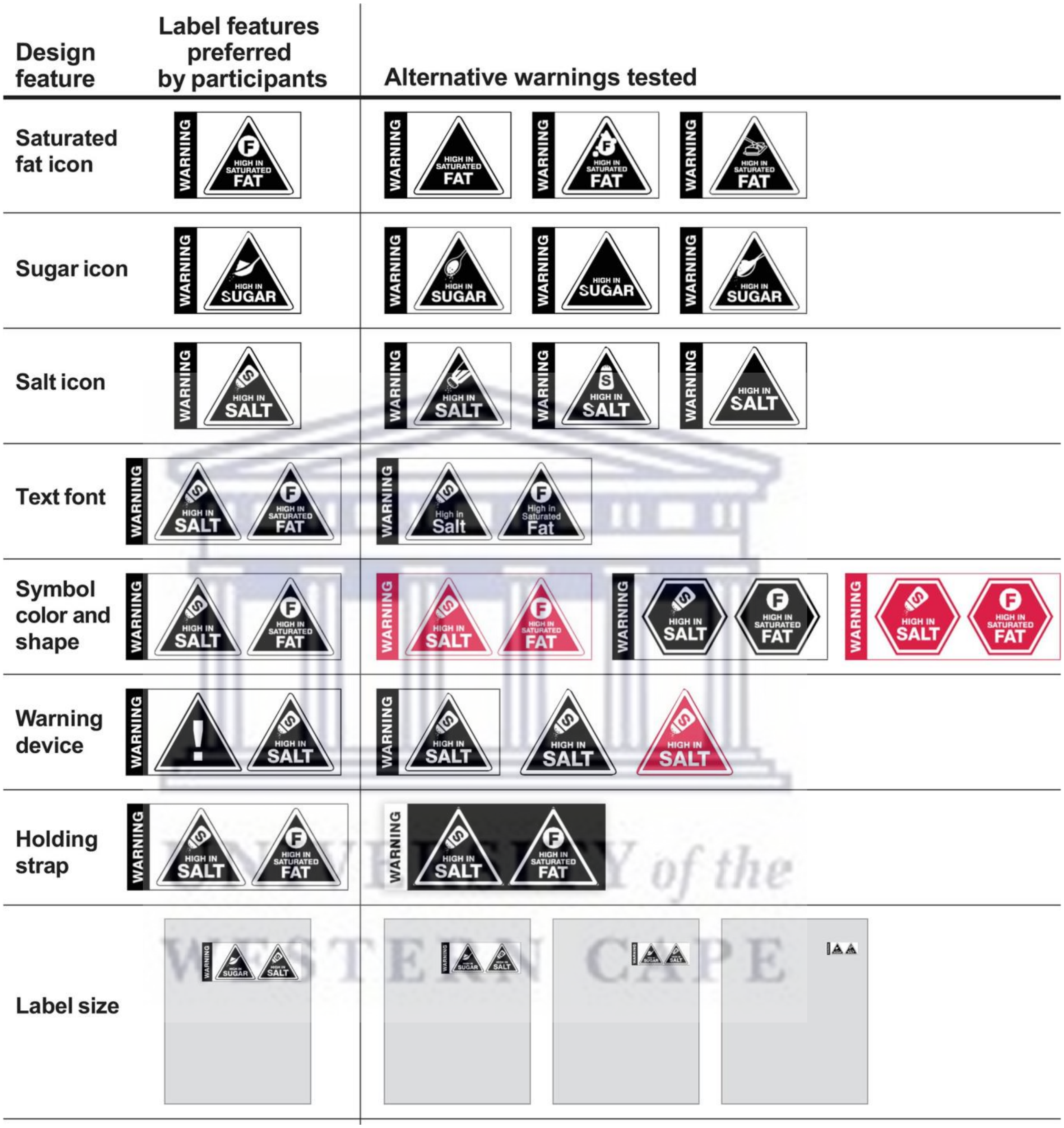

Fig 3. Design features that appealed to participants as depicting warning.

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Elements perceived effective as warning

Fig 2 shows the design features participants perceived as 1) attention grabbing, (2) effective as a warning against unhealthy foods and drinks, and 3) likely to influence their purchasing behaviours. They considered that a black triangle on a white background (holding strap), placement in the top right corner of the front of the package, and uppercase letters improved the visibility of the warning label. Participants viewed a combination of the word "warning" and a triangle with an exclamation mark as signal for danger. They also preferred a larger label compared to smaller sizes (Fig 3).

Discussion

This study found that adult South African consumers had a positive attitude toward warning labels on ultra-processed foods and drinks. Study participants felt that warning labels are easy to understand, provide important nutrition information, and could save shopping time. Our participants generally found warning labels visible and expressed that the warning labels increased risk perception. These elements are associated with the efficacy of warning labels [43]. An easily understandable and readily visible warning label attracts attention [43] and increases the likelihood of label reading, use and behavior modification [31, 43, 46, 63].Previous studies in Uruguay and Chile reported acceptance of warning labels among their participants and found the labels easy to interpret [59, 64]. Findings from quantitative studies support that consumers understand warning labels better than other label formats [27, 35, 65–67]. The advantage of easily understood warning labels is a wider coverage of consumers, even those without access to individual dietary counseling by health professionals.

This study also found a common perception that the summarized nutrition information on warning labels would easily help consumers identify unhealthy products at the point of purchase. Warning labels display only the nutrients in excess [27, 66], therefore consumers can quickly [68] and easily identify unhealthy products [18, 32]. This was supported by other participants in this study who were of the opinion that the warning labels would save them time. Consumers often have time constraints and warning labels that cut through the noise on the product packages would be beneficial [21, 69].

The use of familiar shapes [20, 52] and colors [70, 71] associated with danger increases the effectiveness of warning labels. As mandated by regulatory authorities, shapes and colors are used successfully in other industries, including the tobacco industry and segments of the food industry, to raise awareness of dangers of consuming those products [36]. However shape association with danger is culturally learned [41] and not universally interpreted in the same way [50]. In this study South African consumers perceived the black triangle in the warning label as depicting danger. A triangle is commonly used in construction sites, workplaces and road signs in South Africa to signal danger, so it is not surprising that consumers in our study in all sociodemographic groups favored it over the octagon shape. Consumers in Brazil [19] similarly related triangles with danger, but in other countries, such as Chile [59, 72] and Israel [26], consumers perceived the octagon as communicating a warning best. In the latter countries, the octagon stop sign was better understood than other shapes. These results indicate the need for each country to investigate its own context specific shape preference to improve the efficacy of the warning labels.

Although some consumers in this study, particularly those of low-socioeconomic status, perceived red as signaling danger and attention grabbing than black, black was deemed better as it contrasted with the colorful product backgrounds. Similarly, Cabrera et al. reported that black signs were easier to locate on colorful packages than red ones [50]. Color, particularly red, increases the visibility of FOPLs, increases risk perception, and influences behavior change [73]. However, visibility against the competing background is also important for warning label effectiveness [43] and a black label against a white background stood out more to our participants. In Israel, however, consumers preferred the red label [74]. Placement of the black triangle on a white background also could have improved the triangle's salience. Policy maker could further explore inclusion of a white background as a means to make the label stand out by s. The findings of this study also confirm that consumers preferred the black triangle on the white background (i.e. holding strap) than a black triangle on a black background or without any holding strap. Chile [72] and Uruguay [75] use black and white warning labels while Israel [26] uses red and white circles.

Text and icons are among the elements that our participants thought communicated nutrition information clearly and simply. Words such as "warning," "caution," "excess," and "high in" increase risk perception and improve effectiveness [38, 43, 50]. Similarly, in this study participants pointed out that the word "warning" on labels made it clear that they were being warned about the danger associated with consumption of the product. Evidence shows that icons that summarize nutrition information are beneficial to less literate groups [32, 76, 77], which is particularly important for South Africans with lower literacy levels.

An advantage of warning labels is their potential to influence consumers' purchasing behaviors [24, 28]. Quantitative studies evaluating implementation of warning labels show that chocolate and cookie sales decreased by 8.0% and 1.2%, respectively, in Chile [78] and decreased expenditures on sweets and desserts in an online simulated environment in Uruguay [41]. In this study consumers indicated their intentions to reduce purchases of unhealthy foods with warning labels, particularly the products they like. Some even expressed an intention to stop consumption of those products altogether over time. Similarly, in a qualitative study in Brazil consumers stated they would continue consuming products with warning labels but at reduced frequency [79]. The intention to reduce consumption of ultra-processed foods and drinks is in line with the South African Food Based Dietary Guidelines, which recommend consuming fats, salt, and sugar sparingly [80]. Other participants in the current study however perceived that they would not be deterred by the warning label in line with the Health Belief Model which posits that low risk perception does not elicit behaviour change. Familiarity with products also decreases the effectiveness of the warning labels [55, 81].

An experimental study in Uruguay reported that warning labels impacted children's food choices much better than the MTL [18]. In Brazil, de Morais Sato et al. found that parents perceived that easily read and understood warning labels would help their children independently identify unhealthy food products and would increase their autonomy in healthy food choices [79]. Our participants agreed that children would benefit from simple warning labels that encourage them to make healthy choices. This observation is critical, because reducing childhood obesity by reducing their consumption of ultra-processed foods and drink is urgent. Ultra-processed foods are often marketed as convenient and palatable and front-of-package warning labels steer attention towards the unhealthiness of the products.

Our participants recognized several design features that could potentially enhance the effectiveness of warning labels, including a black triangle on a white background (holding strap), location of the warning label in the top right corner of the package, and text in uppercase letters for clear visibility. They noted that a combination of the word "warning" with a triangle containing an exclamation mark on warning labels could further effectively alert consumers to potential health risks. They also preferred a larger warning label rather than a smaller one (S1 Fig).

A strength of the study is that it considered views of consumers from diverse sociodemographic backgrounds and offered them a combination of images of foods and drinks that are perceived as healthy and unhealthy to minimize preconceived notions about the nutritional quality of the products. As with any qualitative study, the sample is not representative of the entire population and the findings cannot be interpreted statistically. Understanding labels is important for influencing behaviors, and future research should investigate the influence of the warning label on purchasing behavior in a real shopping environment.

In conclusion, our results from focus groups in South Africa suggest that a policy mandating nutrition warning labels on unhealthy packaged foods could improve consumers' understanding of health risks and help them identify unhealthy foods and drinks. Certain design elements, such as color (black), shape (triangle), text (warning and 'High in'), use of exclamation mark and contrasting white background could enhance a label's ability to increase perception of the risks of consumption of unhealthy products.

Supporting information

S1 Fig. Label design elements tested.
(PDF)

S1 File. Participants' recruitment questionnaire for eligibility.
(PDF)

S2 File. Focus group discussion guide.
(PDF)

S1 Table. Themes, subthemes and quotes from focus groups discussions.
(PDF)

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CHAPTER 6: RESULTS

EFFECTIVENESS OF FRONT-OF-PACK LABELS – COMPARISON OF THE GDA, MTL AND WL

The second manuscript (article) is included in this chapter together with the researcher's contribution to the manuscript. An introduction providing the background to the manuscript, label understanding and the effect of the FOPL on the ability to identify unhealthy products and purchasing decisions is also presented. Comments from the reviewers of the article and the authors' responses appear in Appendix 14.

6.1 Introduction

The primary approach to testing a warning's effectiveness is to determine the degree to which the warning accomplishes its intended purposes (Wogalter, 2020). Within the scope of this study, the effectiveness of the FOPL was determined by the ability of the FOPL to assist consumers to identify products high in critical nutrients and to identify unhealthy products, as well as the ability of the FOPL to discourage purchasing of unhealthy products. Additionally, different systems were tested against each other to determine the most effective FOPL, as recommended by the WHO (WHO Regional Office for Europe, 2020).

Both consumers' understanding and the acceptability of FOPL are important, as these perceptions may influence label use and eventually food purchasing habits (Grunert *et al.*, 2010). The literature indicates that label understanding is poorer among low-income and low-socioeconomic individuals (Ducrot *et al.*, 2015a; Grunert *et al.*, 2010; Hawley *et al.*, 2013), making it imperative that countries test multiple formats to determine the most suitable FOPL for its population, before any implementation takes place (WHO Regional Office for Europe, 2020). Understanding can be evaluated either subjectively or objectively (Egnell *et al.*, 2018).

6.2 Subjective evaluation of FOPL

Subjective understanding refers to consumers' interpretation of the label information and the extent to which they believe they have understood this information (Grunert & Wills, 2007). Subjective evaluation of label understanding can include evaluation of label acceptability (attractiveness, likability) (Vargas-Meza, *et al.*, 2019b), perceived workload in label processing, and perceived product healthfulness (Arrúa *et al.*, 2017; Khandpur *et al.*, 2019).

6.3 Objective evaluation of FOPL

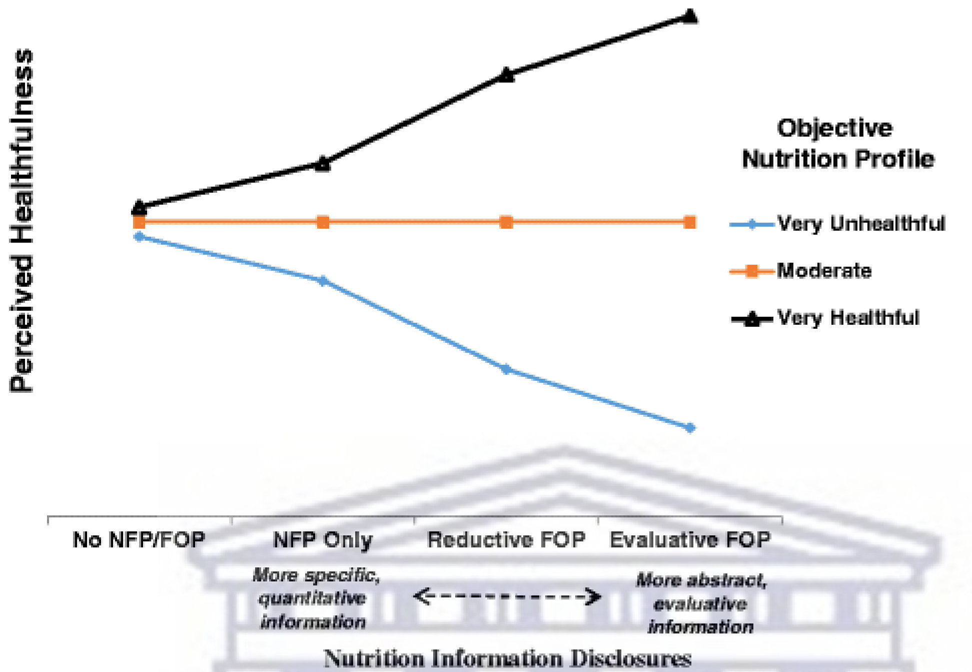
Objective understanding refers to the extent to which consumers are able to interpret the information as intended by its source (Grunert & Wills, 2007). Objective evaluation can include consumers ranking products according to their nutritional quality (Arrúa *et al.*, 2017; Egnell *et al.*, 2018; Khandpur *et al.*, 2019), evaluating the overall healthfulness of a product (Grunert & Wills, 2007; Khandpur *et al.*, 2019), and identifying products containing excessive amounts of nutrients (Khandpur *et al.*, 2019).

6.4 Effectiveness of FOPL in improving nutritional informationunderstanding

Studies have reported mixed findings related to the effectiveness of the FOPL in improving consumers' nutritional information understanding. While some studies report the FOPL (endorsement logos) ability to improve identification of healthier foods, others assisted consumers to rank food according to the level of their healthiness (Nutriscore). Findings from previous studies indicate that consumers were better able to identify unhealthy products from the WL better (Khandpur *et al.,* 2018a; Taillie, *et al.*, 2020a; Talati *et al.*, 2019) compared to when exposed to either the MTL or the GDA (Acton *et al.*, 2019; Taillie *et al.*, 2020b). These findings are supported by other studies in the tobacco industry that concluded that the use of labels with pictorial images improves understanding, especially of the risks associated with tobacco use (Bansal-Travers *et al.*, 2011; Hammond, 2011; Sultana *et al.*, 2023).

The effectiveness of the FOPL is explained through the diagnosticity theoretical framework (Alba *et al.,* 1991, cited in Newman *et al.*, 2018) which proposes a hierarchy of the effectiveness of nutrition information communicated to consumers (Figure 6.1). The hierarchy ranges from the no-NIP/FOP information at all (control condition), to the reductive FOPL (e.g. GDA), to the hybrid FOPL (e.g. Multiple Traffic Light), up to the interpretive FOPL (e.g. WL) (Figure 6.1).

According to the theory (Figure 6.1), all FOPL systems, albeit to varying degrees, should improve nutrition information understanding (diagnosticity) by simplifying nutrition information, as opposed to a no-FOPL condition (Newman *et al*., 2018). The theory further explains that the variable nature of each labelling system leads to different perceptions about how the conveyed nutrition information is understood by consumers. This in turn leads to differences in how consumers determine product healthfulness (Newman *et al.*, 2018).



Note: The No NFP/FOP control condition offers no FOP information and assumes that consumers choose not to examine the NFP on the back of the package; the NFP Only condition has NFP information available and consumers may choose to examine it, but there is no FOP information available; the reductive FOP reduces critical quantitative nutrition information (e.g., calories, saturated fat, sodium, sugar) from the NFP and places it on the front of the package (e.g., the Facts-up-Front icon); and the evaluative FOP provides information that helps consumers evaluate the meaning of the nutrient levels (e.g., the 0 to 3 stars format recommended by the Institute of Medicine), but offers no quantitative values for the nutrients. In terms of the accessibility/diagnosticity conceptual framework, all FOP conditions, relative to the NFP and FOP controls, make the nutrition information more accessible, and the evaluative FOPs are more diagnostic that the reductive FOPs, which in turn, are more diagnostic than the NFP alone.

Figure 6.1: Diagnosticity theoretical framework

Source: Newman *et al.* (2018)

According to the theory, at the far end of the continuum, where the product does not contain either an NIP at the back of the package or FOPL, consumers would not be able to determine the healthfulness of a product. This is the case where consumers do not consult the NIP and manufacturers do not offer the FOPL on the product package. For these consumers, nutrition information is not considered and is therefore ineffective.

In the presence of the NIP but no FOPL, consumers who read the NIP would be able to detect that a product is unhealthy, but their understanding may be limited by factors such as their literacy level, nutrition knowledge, and so on (Koen *et al.*, 2018a). Interpretive FOPL potentially offers diagnostic benefits by summarising whether a product is healthful or not, making interpretive FOPL most effective in communicating nutrition information to consumers.

6.4.1 Nutrient understanding and identification of unhealthy products

Several studies (Nieto *et al.*, 2019; Taillie *et al.*, 2020b) have consistently shown that the WL better assists consumers to identify unhealthy products compared to other FOP label formats. A study by Egnell *et al.* (2018) found that the Nutriscore, MTL and the HSR outperformed the WL in ranking food products according to the level of healthfulness. Meanwhile, a 2017 study found that consumers exposed to the WL perceived products with a WL as less healthy than the same products featuring the MTL or GDA (Arrúa *et al.*, 2017). Warning labels simplify decision making in that only problematic nutrients are highlighted (Kelly & Jewell, 2018). With the MTL, however, consumers still need to interpret the nutrition information according to the colours displayed.

Judging nutrition information based on multiple colours on a single product has been shown to be challenging for consumers (Grunert *et al.,* 2010; Kees *et al.*, 2014), hence its limitations in simplifying nutrition information. In contrast, the GDA simply presents the RI, which consumers still need to interpret and may find challenging (Kelly *et al.*, 2009), especially consumers with low education levels (Ducrot *et al.*, 2015a; Feunekes *et al.*, 2008). In addition, a study by Khandpur *et al.* (2018a) reported that, compared to the MTL, the WL assisted more consumers to identify foods high in nutrients of concern as well as unhealthy products. Several other studies showed that the WL had a greater impact in drawing attention to a product's healthfulness than other labels (Ares, *et al.*, 2018b; Grummon & Hall, 2020; Jáuregui *et al.*, 2022; Khandpur *et al.*, 2018a).

6.4.2 Discouraging purchasing and consumption of unhealthy products

Another strength of the WL reported in the literature is its potential to influence behavioural outcomes. Findings from various studies indicate that a reduced intention to purchase SSBs and other ultraprocessed foods was expressed more readily in the presence of the warning label than in the presence of other types of FOPL (Arrúa *et al.*, 2017; Khandpur *et al.*, 2018a). According to the Tobacco Warning Model, warnings serve to increase people's attention, which elicits negative emotions, more thinking about the harm that the product could inflict, and ultimately greater motivation for behavioural change (Brewer *et al.*, 2018; Noar *et al.*, 2016). Results of a meta-analysis of studies by Grummon and Hall (2020) similarly reported that a WL increased the perceived likelihood of a disease which, according to the HBM, increased the likelihood of behavioural change (Glanz *et al.,* 2002).

While other systematic reviews have reported mixed results in FOPL performance (An *et al.*, 2021), several experimental and real-life studies have shown that WLs are effective in discouraging the selection of unhealthy food. Results of an experimental study comparing the performance of the MTL and the WL highlight differences in the mean nutrient content of the purchased items (Machín *et al.*, 2017). Similarly, the WL did not perform any better in influencing food choices in the Netherlands (Egnell *et al.*, 2019). However, a meta-analysis of experimental studies by Grummon and Hall (2020) revealed that, compared to the no-FOPL condition, the WL resulted in a reduced intention to purchase SSBs. In the same study, the WL led to a reduction in calories from lower SSB purchases (Grummon & Hall, 2020), as was supported by findings from Acton *et al.* (2019). In the latter study, participants in the WL condition purchased beverages with less sugar, less saturated fats and fewer calories than those participating in the no-FOPL condition. The WL led to an 8% reduction in sodium and a 5% reduction in calories purchased (Acton *et al.*, 2019). These reductions translate into substantial differences at the population level (Acton *et al.*, 2019). Results from a different study found that although no significant differences were reported, the WL tended to reduce the likelihood of sugary drinks being selected compared to four other types of FOPL (Acton & Hammond, 2018; Song *et al.*, 2021), with similar findings being reported in a study by Mora-Plazas *et al.* (2022).

In actual in-store purchasing scenarios in Chile, the WL resulted in a 24% reduction in sales of SSBs following the implementation of the country's food labelling and advertising law (Taillie *et al.*, 2020c). The law includes mandatory warning labels on food and beverages high in nutrients of concern (Corvalán *et al.*, 2013). Another study conducted in Chile, one year after the implementation of the food labelling and advertising law, revealed that chocolate and cookie sales declined by 8.0% and 1.2%, respectively (Orellana, 2017). The effectiveness of the WL in modifying purchasing behaviour was also evident in Uruguay where expenditure on sweets and desserts declined due to the presence of the WL (Machín *et al.*, 2017). A qualitative study conducted among mothers one year after the implementation of Chile's labelling and advertising law also demonstrated that the WL had had an impact on children's food choices. Mothers reported that children started requesting products with fewer WLs (Correa *et al.*, 2019).

Considering the South African context, with high obesity and NCD rates, the aim of this study was therefore to determine the FOPL that would best assist consumers to identify unhealthy products as opposed to healthier ones. Given the known association between diet-related NCDs and unhealthy diets high in nutrients of concern, it was deemed appropriate to adopt an approach that would promote avoidance of unhealthy foods rather than promote choice of healthier foods (WHO Regional Office for Europe, 2020). FOPL systems that flag and present nutrients of concern on the front of the pack, e.g.

the WL, make it easier for consumers to identify products to avoid, thereby discouraging consumption thereof (Correa *et al.*, 2019; Machín *et al.*, 2017; Taillie *et al.*, 2020b). In contrast, FOPL systems that promote the selection of healthier products, e.g. the HSR, may (because of the algorithms that they use) allocate a healthier score to ultraprocessed foods, which contain excessive amounts of nutrients of concern, and rank these products as healthier (Singh *et al.*, 2022). This is worrying as the selection of the 'healthier' options may in fact encourage excessive consumption of unhealthy nutrients. Additionally, FOPL systems that extend a healthy connotation to food products have been shown to exert a health halo effect, leading to an overestimation of products' healthfulness and thus their overconsumption (Kelly & Jewell, 2018).

It is on the premise of seeking an FOPL to discourage consumption of unhealthy products that this RCT investigated the objective knowledge of products' unhealthiness rather than their healthiness. Findings from the RCT found that the WL was the most effective both in assisting participants to identify products high in nutrients of concern and unhealthy products and in discouraging participants from purchasing unhealthy products. The findings are presented as Publication #2 below.

<u>Contribution of the researcher</u>

SN, LTS, NM, TF, RS and MB developed the study protocol. MB and RS trained the fieldwork coordinators, supervised the fieldworkers' training and data collection, and processed and cleaned the raw data. JDM and MB analysed the data and drafted the manuscript. SN, LTS, NM and RS reviewed and approved the manuscript for publication.

See Appendix 14 for comments from the reviewers, feedback from the authors and communication from the journal editor.

6.5 Publication #2

Bopape, M., De Man, J., Taillie, L. S., Ng, S. W., Murukutla, N., & Swart, R. 2022. Effect of different front-of-package food labels on identification of unhealthy products and intention to purchase the products – A randomised controlled trial in South Africa. Appetite, 179, 106283.

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Effect of different front-of-package food labels on identification of unhealthy products and intention to purchase the products– A randomised controlled trial in South Africa

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ABSTRACT

This study aimed to evaluate the effect of different labels on participants identifying products high in nutrients of concern; identifying unhealthy products, and intention to purchase unhealthy products. This blinded randomised controlled trial included a representative sample of South African households (n = 1951). Per household we selected a member primarily responsible for food purchases. Participants were randomised into the Warning Label (WL), Guideline Dietary Amounts (GDA) or Multiple Traffic Light (MTL) arms. Each participant answered questions in a no label condition (control) followed by same questions in the label condition (experiment). Complete data were collected and analysed for 1948 participants (WL = 33.7%, GDA = 32.1% and MTL = 34.2%). The probability of correctly identifying products high in nutrients of concern and identifying products as being unhealthy was higher with the WL compared to the GDA or MTL for most items. There was no difference in performance between the GDA and the MTL when considering all items together. A higher percentage of participants reported a lower intention to purchase an unhealthy product after exposure to the WL compared to MTL for 5 out of 6 products; 2 out of 6 products for the WL compared to GDA and 2 out of 6 products for GDA compared to MTL. Compared to the control condition, exposure to each of the labels resulted in better identification of nutrients of concern, unhealthy products and a lower intention to purchase when considering all specific outcome items together. The WL showed a higher potential to enable South African consumers to identify products high in nutrients of concern, identify unhealthy products and discourage purchasing of unhealthy products.

1. Background

The prevalence of obesity and noncommunicable diseases (NCDs) is high in South Africa and continues to increase substantially (Statistics South Africa, 2017; WHO, 2018). Among the South African population, more than two-thirds of women and approximately one-third of men are overweight or obese (Statistics South Africa, 2017). Obesity and NCDs are leading causes of morbidity and mortality and have recently been associated with severe complications of infectious diseases such as COVID-19 (The Lancet, 2020; World Obesity Federation, 2021). Unhealthy diets that are high in energy are among the main causes of obesity and NCDs (WHO/FAO, 2003) and effective policies are needed to improve populations food intake and to address these conditions.

In South Africa and across the globe, consumers are continually being exposed to ultra-processed foods (Baker et al., 2020; Moodie et al., 2013; Puoane et al., 2012; Reardon, Timmer, Barrett, & Berdegue, 2003) resulting in diets of poorer quality (Igumbor et al., 2012; Imamura et al., 2015; Koiwai et al., 2019; Monteiro, Moubarac, Cannon, Ng, & Popkin,

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2013). These unhealthy products are typically high in energy, sugar, saturated fats and salt (Monteiro et al., 2021) which are nutrients linked to the development of obesity and diet-related NCDs (WHO/FAO, 2003). Policies need to be put in place to educate consumers about the nutritional composition and negative health consequences of these unhealthy foods.

The World Health Organisation (WHO) recognises front-of-package labelling (FOPL) as a means to provide accessible, simple and easily understandable nutrition information (WHO Regional Office for Europe, 2020). The principal aim of FOPL is to provide interpretive, attention grabbing and easily understandable nutrition information presented at the point of decision-making to assist all consumers to make informed food purchases and healthier dietary choices (WHO Regional Office for Europe, 2020). There is consensus that the presence of FOPL assists consumers to make a distinction between healthy and unhealthy food products (Khandpur et al., 2019; Temple, 2020). FOPL could thus be beneficial in assisting consumers identify unhealthy products containing excessive amounts of nutrients of concern.

In terms of the definition of 'unhealthy foods' within the South African policy context, the existing food labelling regulation (R146) only limits itself to the definition of health claims (National Department of Health, 2010). However, draft R429 (Guideline 14), currently in review, includes guidelines on the criteria for the commercial marketing of foods and non-alcoholic beverages to children. The proposed guideline mentions the aim of the Department of Health which is to restrict marketing of unhealthy foods and drinks to children. The document defines unhealthy foods as products high in fat, saturated fats, *trans*-fatty acids, free sugars, and sodium (salt) (National Department of Health, 2014). The term unhealthy foods is therefore a familiar concept within the regulatory and policy frameworks in the country. Additionally several studies have been conducted in South Africa where the term 'unhealthy foods' was used, so this definition of 'unhealthy foods' reflects the current state of understanding in this context (Mchiza, Temple, Steyn, Abrahams, & Clayford, 2013; Temple, Steyn, Myburgh, & Nel, 2006; Yamoah, De Man, Onagbiye, & Mchiza, 2021).

The existing FOPL formats, however, differ in their level of complexity and some may be more effective in conveying the healthiness of products based on their design and the level of information included (EUFIC, 2017; European Commission et al., 2020; Ikonen, Sotgiu, Aydinli, & Verlegh, 2020). The food industry in South Africa currently applies a voluntary GDA that consumers in other studies report to be challenging and confusing due to information overload and the technical terms used (Deliza, de Alcantara, Pereira, & Ares, 2020; Egnell, Talati, Hercberg, Pettigrew, & Julia, 2018). This underlines the need for a simpler FOPL format that can easily convey nutrient information within the South African context (Koen, Blaauw, & Wentzel-Viljoen, 2016). South Africa has not implemented an FOPL system and is in the process of updating the current Regulation 146 (R146) to include FOPL (National Department of Health, 2010, 2014). The selection of the FOPL should consider the country's unique context including the educational and income status of the population for it to be effective and equitable. FOPLs vary by format and design and can be classified as either reductive or interpretive (EUFIC, 2017; Ikonen et al., 2020; Kanter, Vanderlee, & Vandevijvere, 2018; Kelly & Jewell, 2018).

Reductive FOPL systems such as the Guideline Dietary Amounts (GDA) (Fig. 1) inform consumers by highlighting nutrients associated with NCDs on the front of pack without providing any conclusion about the healthiness of the product (Food and Drink Federation, 2013; Ikonen et al., 2020).

The GDA appears on all food products irrespective of their nutritional quality (Hodgkins et al., 2012) and requires consumers to make judgements about the healthfulness of the products. Due to the numerical interpretations required to understand the information on the label, reductive FOPLs tend to be the worst performing in informing consumers about the healthiness of food products (Deliza et al., 2020; Vargas-Meza, Jaúregui, Contreras-Manzano, Nieto, & Barquera, 2019). The GDA is currently voluntarily applied on the majority of packaged foods in South Africa (Igumbor et al., 2012) and may be familiar to South African consumers.

Interpretive nutrient specific systems such as the Multiple Traffic Light (MTL) and Warning Labels (Fig. 1) evaluate the nutritional quality of products by using interpretive aids such as colour, icons and shapes

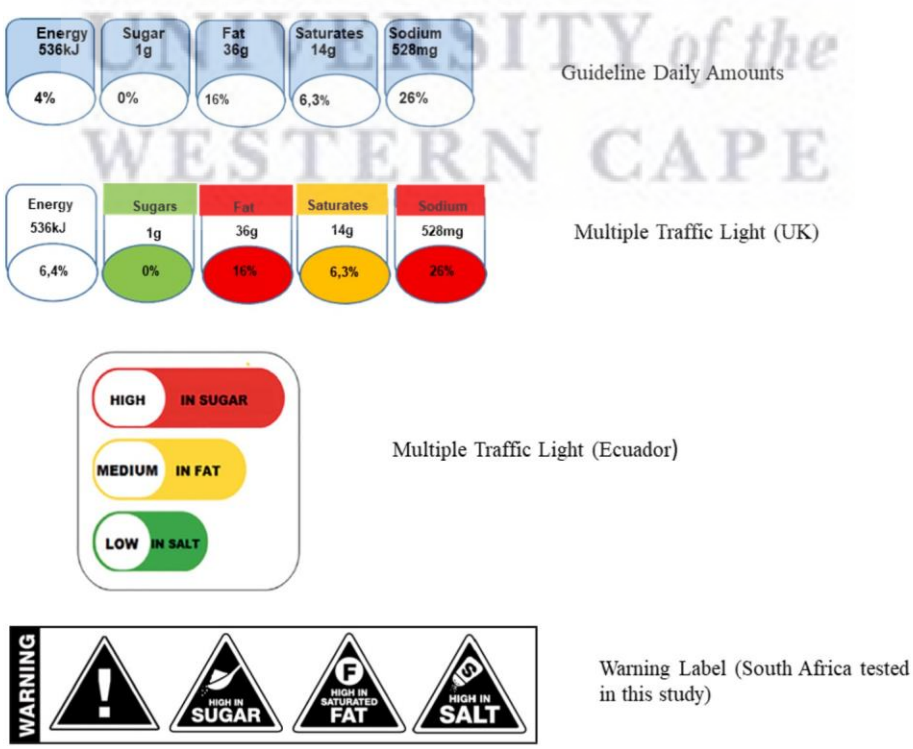


Fig. 1. Examples of front-of-package labels.

(European Commission et al., 2020; Ikonen, Sotgiu, Aydinli, & Verlegh, 2020; WHO Regional Office for Europe, 2020). The MTL label system uses colours to interpret whether the nutrient levels are high (red), medium (amber) or low (green) (European Commission et al., 2020; FSA, 2016; Ikonen, Sotgiu, Aydinli, & Verlegh, 2020) and could also include the numerical values of nutrients of concern (UK MTL).

The MTL is widely used, especially in European countries, and has been extensively studied worldwide (Acton, Jones, Kirkpatrick, Roberto, & Hammond, 2019; Jáuregui et al., 2022; Pereira, 2010). It is also implemented in other countries such as Ecuador (Freire, Waters, Rivas-Mariño, Nguyen, & Rivas, 2017), Iran (Zargaraan, Azizollaah, & Hosseini, 2017) and Sri Lanka (Republic of Sri Lanka, 2020). Several studies report higher effectiveness of MTL in assisting consumers to select healthier food options than other FOPL (Egnell et al., 2018; Song et al., 2021; Talati et al., 2016; van der Merwe, Bosman, & Ellis, 2014) and that consumers find the MTL attractive due to its colour combinations. However, MTL may be less helpful in assisting consumers evaluate the healthfulness of a product in cases where a product carries a different color for each nutrient and thus providing conflicting messages (Khandpur et al., 2018; Gorski Findling et al., 2018; Machín, Aschemann-Witzel, Curutchet, Giménez, & Ares, 2018), In such cases consumers have to integrate several messages simultaneously to evaluate the product which may be difficult (Jáuregui et al., 2022; Vargas-Meza, Jáuregui, Pacheco-Miranda, Contreras-Manzano, & Barquera, 2019). A recent study eliminated MTL as a potential FOPL for testing in South Africa following consumers' suggestions to implement black and white warning labels than colored FOPL (Todd, Guetterman, Volschenk, Kidd, & Joubert, 2022). Similar to the GDA, the MTL appears on foods irrespective of their overall nutritional value (Hodgkins et al., 2012) making it challenging to judge if a product is healthy or not especially in instances where each nutrient is allocated a different color. However, MTL has consistently outperformed the GDA in improving consumers understanding of the nutritional quality of products (Arrúa, Machín, et al., 2017; Egnell et al., 2018; Gorski Findling et al., 2018; Khandpur et al., 2018).

Warning Labels (WL) (Fig. 1) are another type of FOPL that use colour, pictorial images and texts such as 'high in' or "excessive' to interpret the products nutritional information (Chile Ministry of Health, 2015; WHO Regional Office for Europe, 2020). WLs have been found to outperform other labelling formats in assisting consumers identify unhealthy products (Taillie, Hall, Popkin, Ng, & Murukutla, 2020), being easy to understand (Talati, Egnell, Hercberg, Julia, & Pettigrew, 2019) and in reducing consumers intention to purchase unhealthy products compared to other labelling formats (Khandpur et al., 2018; Taillie et al., 2020). Results of a qualitative study in South Africa reveal that consumers found the WL simple and easy to understand (Bopape et al., 2021). The WL scheme aims to, at a glance, highlight and discourage selection of unhealthy products by clearly indicating nutrients that are excessive (Grummon et al., 2019; Kelly & Jewell, 2018; Taillie et al., 2020). Flagging nutrients in excess increases the perception of the risk associated with a product which is associated with reduced intention to purchase products bearing a WL (Grummon et al., 2019; Taillie et al., 2020). The scheme requires that WL only appear on unhealthy products. Countries such as Chile, Mexico, Uruguay and Peru introduced a black and white octagon shaped WL and Israel implemented one with red and white circles (Chile Ministry of Health, 2015; Global Agricultural Network Information Israel, 2018; Ministerio de Salud de, 2018; Ministerio de Salud del, 2018). Researchers in South Africa propose a black triangle on a white background bearing the words 'high in', 'warning' and including an exclamation mark (Fig. 1). This WL design was based on the results of a qualitative study conducted in 2019 among South African consumers of varying socio-economic, demographic and educational backgrounds (Bopape et al., 2021).

To our knowledge, no studies have been conducted in the African region, including South Africa, to compare and identify the FOPL that best enhances nutrient understanding among the countries' general population. This randomised trial aims to fill this gap by comparing the performance of three different types of FOPL in samples representative of South African households. Specifically, we will measure if these labels assist South African consumers to i) identify products high in nutrients of concern (i.e. saturated fats, sugar and salt); ii) identify unhealthy products and; iii) reduce their intention to purchase unhealthy food. This study will focus on the existing FOPL systems (GDA and MTL) and the proposed WL designed for South Africa, using their respective nutrient profile models (NPMs) and label design.

The findings of this study will provide evidence for public policies at national, regional and international levels that aim to inform and assist populations in making healthier dietary choices.

2. Methods

This study was a three-armed randomised controlled trial (RCT) with both a within and between subject factor. The within-subject effect corresponded to the difference between a no-FOPL vs. FOPL product. The between-subject effect corresponded to the difference between the three FOPL conditions. The reporting of the methodology was based on the CONSORT guidelines for reporting parallel group randomised trials (Schulz, Altman, & Moher, 2010). This trial was pre-registered with 'As Predicted': 45567

2.1. Sampling strategy and sample size

A stratified multistage random sampling strategy was used to obtain a representative sample of the South African population. Primary sampling units were pre-determined Enumerator Areas (EAs) which were proportionally stratified for: 1) geographical area (metro urban/metro traditional/non-metro urban/non-metro traditional), 2) socioeconomic status (low, middle and upper income categories), 3) province and 4) population groups. Socioeconomic status was based on the Neighbourhood Lifestyle Index®© (NLI™©) (Neighbourhood Lifestyle Index®©,) developed by an independent statistician and used by a geographical information service (GEOTERRAIMAGE (GTI)) (https://geoterraimage.com/neigbourhood-lifestyle-index/) that provided maps for the sur- vey. The NLI™© is a system modelled from population dwelling unit information classifying neighbourhoods according to their income and various lifestyle characteristics from 1 (lowest income/poorest community) to 10 (highest income/most affluent community). For this survey, NLI™© was categorised into three wealth status groups (low, middle, and upper income) groups, Per selected EA, 15 households were selected as secondary sampling units through interval sampling.

The sample size of 1526 households was calculated a priori at a power of 90%, estimated effect size of 0.136 (Ducrot et al., 2015) and 95% confidence level.. Although the latter study assessed acceptability, we could expect such an effect size in our study which is deemed relevant at population level. The sample was overestimated to 2500 to account for possible non-responses and hard to reach residential areas.

2.2. Participants' recruitment

Data were collected at the participants' households. Within each household the person primarily responsible for food purchases was selected if aged ≥18 years and after consent was obtained. If this person was not present, then somebody who was co-responsible for food purchases was selected. If the latter was not present, then someone who occasionally assisted with food preparation was selected.

Participants' recruitment and data collection were conducted by a research agency with extensive experience in data collection. Fieldworkers were trained on how to select households, recruit participants and how to administer the questionnaire. Data collection took place between 29 November−12 December 2019 and 6–31 January 2020. Ethical approval was granted by both the Biomedical Research Ethics Committee of the University of the Western Cape and the International

Research Board at the University of North Carolina (Chapel Hill). Areas in the upper income category were inaccessible (many resided in gated communities) and therefore excluded from the study. The exclusion of this small proportion of households was deemed acceptable as FOPL is deemed more relevant to lower socioeconomic groups that are harder to reach through education channels and other media (see Fig. 2 for a diagrammatic presentation of the number of participants that enrolled in the study).

2.3. Procedure

Participants were randomised to one of three study conditions: products containing a WL, products containing a GDA, or products containing MTL. Each fieldworker was assigned one label type on the day of data collection (either the WL, GDA or MTL) which were rotated daily and participants' label exposure depended on the label that the fieldworker applied on the day. Randomisation depended on the number of recruitment possible on the day of data collection. This procedure resulted in 33.7% (n = 656) being exposed to the WL, 32.1% (n = 626) to the GDA and 34.2% (n = 669) to the MTL (Fig. 2). Randomisation to the label type took place before participants were enrolled into the study and all the participants were blinded to the label they were allocated to. Blinding fieldworkers was not possible due to the data collection procedures followed.

In each experimental arm participants were first shown images,one at a time, of products without FOPL (control phase) followed by images of the same products bearing one of the three labels participants were allocated to (experimental phase) (Fig. 3). Each participant was exposed to both the control and experimental phase with the aim to determine the within and between subject effect. In both phases, participants were asked questions after they viewed the products. The questionnaire used in this study was adopted from a similar RCT study conducted in Brazil (Khandpur et al., 2018) (see Additional File 1). The adapted questionnaire was piloted on 10 post-graduate students from different language and socio-economic backgrounds for validity, logical flow, and clarity of questions. The questionnaire was further tested in two EAs on 21 individuals from low sociodemographic background. The pilot study resulted in the nutrition knowledge questionnaire (not part of this paper) being shortened as the questionnaire took too long to administer, unclear questions were rephrased and repeating questions were deleted (also not part of this paper). In addition to the primary outcomes, data on food consumption patterns, demographics and socio-economic status were collected. Data was collected using smartphones.

2.4. Stimuli

Products: Products used in this study included fictitious images of crisps, fruit juice and soda (single products) and two packets of sweet biscuits, cereal and yoghurt with different brand names (paired products) (see Additional File 2). The researchers developed four sets of fictitious products containing all nine products: one set without FOPL (control condition), and three with one of each FOPL: WL, GDA or MTL (see Additional File 2 for all products). The same products were used in both the control and the experimental phases. The selection of product categories was informed by top sales in South Africa in 2018 according to Euromonitor and were meant to represent a mix of products often perceived as unhealthy (crisps, sweet biscuits and soda) and products whose healthfulness is more ambiguous (100% fruit juice, cereals and yoghurt). The use of fictitious products was chosen to minimise bias due to participants' preconceived knowledge, product familiarity and brand preferences. All participants saw the same sets of products and the only variation was on the labels that were applied. Each product pair contained one product with lesser amounts of nutrients of concern.

The nutritional information on the products was based on similar commercial products available on the South African markets. The information was based on per 100 g/ml and these nutritional profiles were the same across the FOPL. The labels were allocated according to this information. The labels contained information about saturated fats, sugar, salt and artificial sweetener in the case of yoghurt in the WL arm. The nutritional information and interpretive information for each product is presented in Additional File 3). All the labels were placed on the top right corner of each food package.

Labels: The FOPL tested in this study were the GDA (Food and Drink Federation, 2013), MTL (FSA, 2016) and the WL designed for use in

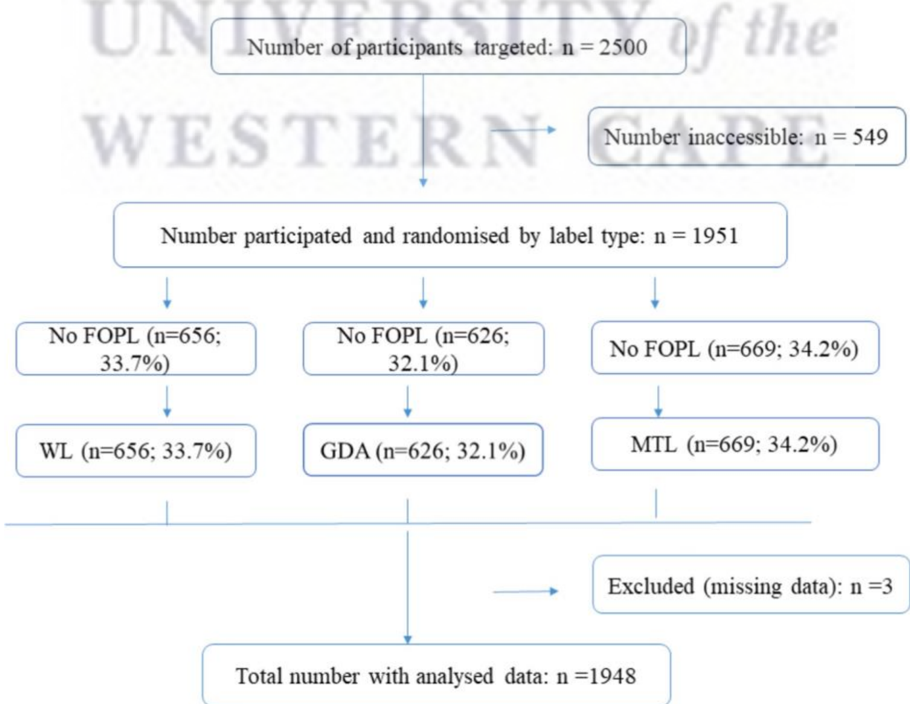


Fig. 2. Diagrammatic presentation of study enrolment and randomisation. WL = Warning Label; GDA = Guideline Dietary Amounts; MTL = Multiple Traffic Light.

Fig. 3. Example of images used as stimuli during data collection.

South Africa (Bopape et al., 2021) (Fig. 1). Real world FOPLs with their respective NPMs were used as a way to assess policy options in discussion. However, the lack of disentanglement of the NPM and the label design may create challenges in determining whether the outcomes are due to the underlying NPM or the label design itself. Energy (kJ), sugar (g), fat (g), saturates (g) and sodium (mg) content were presented per 100 g/ml for the GDA and MTL for each product. The WL only appeared on products that contained excessive amounts of nutrients of concern. The % Reference Intakes (RI) was based on the estimated requirements for a 70 kg adult (2000 kcal) (Food and Drink Federation, 2014). Nutritional interpretation for the MTL included the use of colour codes reflecting low (green), medium (amber) and high (red) nutrient content (FSA, 2016). The nutrient criteria for the WL were based on the proposed South African Nutrient Profile Model (Frank et al., 2021) and warnings were shown using a triangle sign.

2.5. Ethics

Ethical principles were applied in the execution of this study in accordance with the Declaration of Helsinki. Informed written consent was obtained from all participants before data collection commenced. Ethical approval was granted by both the Biomedical Research Ethics Committee of the University of the Western Cape (BM 18/9/13).

2.6. Outcome measures

For single products (crisps, juice and soda) assessment, the primary outcomes were whether the participant correctly identified products that were high in salt, sugar and saturated fat (yes/no/don't know) and correctly identified products as unhealthy (healthy/unhealthy). All products used in this study were unhealthy. A product was considered high in nutrients of concern or unhealthy if it either contained a WL or one or two colours on the MTL were either amber or red. For the paired-product (biscuits, cereal and yoghurt) assessment, the primary outcomes were whether the participant correctly identified the product that was higher in salt, sugar, or saturated fat; and whether the participant correctly identified the unhealthier product. For paired products, a product was considered higher in nutrients of concern or unhealthier if it had more WLs or either more amber or red than the green colours. In a case where the MTL had similar colour patterns, the unhealthiness was determined by the differences in nutrient amounts.

We examined change in intentions to purchase unhealthy products with the question: "How likely are you to buy this product for yourself or your family?" The responses were based on a four-point Likert scale with the following options: "I would definitely not buy it"; "I am unlikely to buy it"; "I will consider buying it"; "I will definitely buy it". All responses were collapsed into binary responses – 1 = Yes, 0 = No and "Don't know" responses were recoded as = 0.

2.7. Statistical analysis

To compare the effect between labels, a modified Poisson regression model was used with the follow-up (i.e., the product shown with one of the three labels), outcome measures as the dependent variable and the different labels as independent variables. To account for a potential regression to the mean effect, "analysis of covariance" was conducted with the baseline (control) value included as a covariate. As recommended for real-world trials (Kahan, Jairath, Doré, & Morris, 2014), we adjusted for potential confounders including: age, sex, level of education, socio-economic status, being the main responsible buyer, having children and metropolitan residence. Results were presented as relative risk (RR) estimates comparing two labels. RR > 1 implied a higher percentage of participants exposed to label X identified products high in nutrients of concern or unhealthy products correctly compared to participants exposed to label Y.

To measure the absolute effect for each label separately (i.e., within-subject differences), a paired comparison was used to calculate the difference between the proportion of right answers at baseline (i.e., the product was shown without a label) and follow-up (i.e., the product was shown with one of the three labels). Standard errors were calculated taking into account the paired design. In addition, the proportion of change from 'yes' to 'no' or vice versa was calculated between both data collection points.

For both between and within effect calculations, survey design weights and clustering at the level of the EAs were taken into account. Cases with missing data were rare (N 3) and deleted listwise. R software was used, with the packages "geepack"(Halekoh, 2006) and "survey" (Lumley, Maintainer, & Lumley, 2021). The hypotheses were specified before the data were collected, the analytic plan was pre-specified and any data-driven analyses are clearly identified and discussed appropriately.

3. Results

Table 1 presents the socioeconomic profile of the participants according to the FOPL type.

Table 1
Participants' sociodemographic information by FOPL type (n = 1948).

	WL 655 (33.6%)		GDA 626 (32.1%)		MTL 667 (34.2%)		TOTAL n = 1948	
Age Mean (SD)	37 (14)		38 (15)		36 (14)		37(14)	
	n	%	n	%	n	%	n	%
Socio-economic status								
Low	430	66	407	65	454	68	1291	66
Middle	181	27	181	29	184	28	546	28
High	44	7	38	6	29	4	111	6
Urban residence								
Yes	595	91	572	91	68	91	1775	91
No	60	9	54	9	59	8	173	9
Metropolitan residence								
Yes	400	61	366	58	364	55	1130	58
No	255	39	260	42	303	45	818	42
Gender								
Males	228	35	236	38	247	37	711	36
Females	427	65	390	62	420	63	1237	64
Educational level								
Primary (<Grade 7)	38	6	59	9	58	9	155	8
Secondary(Grades 7–11)	257	39	224	36	253	38	734	38
Grade 12	202	31	155	25	213	32	570	29
Tertiary	158	24	188	30	143	22	489	25
Primary grocery buyer								
No	51	8	47	8	51	8	149	8
Yes	376	57	357	57	378	56	1111	57
Share responsibility	228	35	222	35	238	36	688	35
Children < 18yrs present								
No	143	22	141	23	145	22	429	22
Yes	512	78	485	77	522	78	1519	78

WL = Warning Label; GDA = Guideline Dietary Amounts; MTL = Multiple Traffic Light.

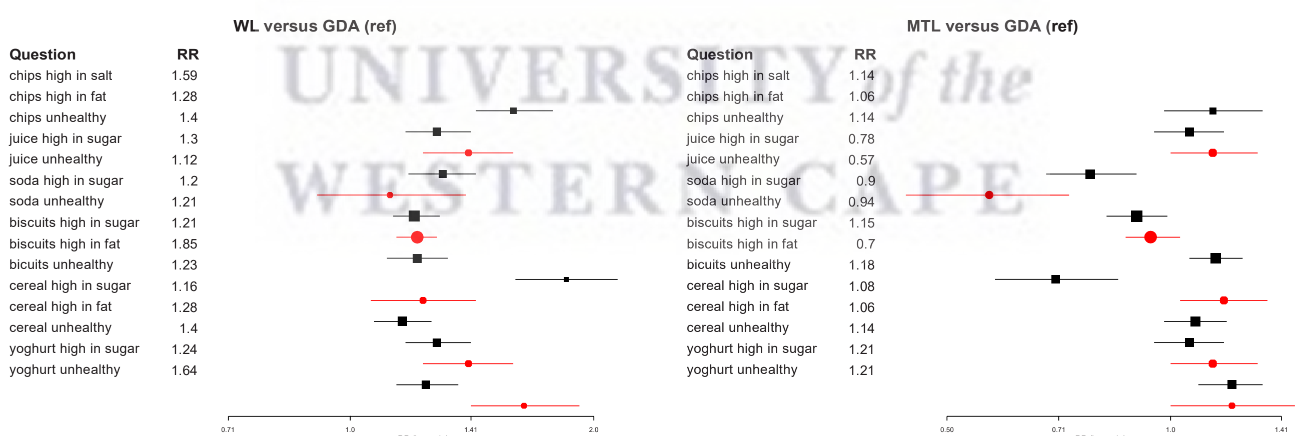
3.1. *Identification of products high in nutrients of concern*

Fig. 4 presents the differences (in relative risks) between the different FOPLs. The probability of correctly identifying products high in nutrients of concern was almost twice as high for certain products when exposed to the WL than to either the GDA or the MTL (black squares in Fig. 4). For example, the probability of correctly identifying that biscuits were high in fat was 1.85 (Confidence Interval (CI) = 1.60–2.14) times higher after exposure to the WL vs. to the GDA and the probability of correctly identifying that juice was high in sugar was 1.67 (CI = 1.47–1.89) times higher after exposure to the WL vs. to the MTL (Fig. 4).

The relative risks comparing the WL and the MTL showed a higher variability (Fig. 4) than the ones comparing the WL and the GDA with a minimum of 1.03 (CI = 0.96–1.12) for yoghurt high in sugar up to a maximum of 2.64 (CI=2.15–3.25) for biscuits high in fat. Relative risks comparing the GDA and the MTL (Fig. 4) did not indicate exposure to either label as more advantageous to a correct identification over the whole range of products.

3.2. *Identification of unhealthy products*

Similarly, a higher percentage of participants exposed to the WL correctly identified unhealthy products compared to the GDA and MTL groups (red dots in Fig. 4). When comparing exposure to the WL versus the GDA, the probability of correctly identifying unhealthy products was higher for all products and when comparing exposure to the WL versus the MTL, the probability was higher for all products except for biscuits (Fig. 4). For example, the probability of correctly identifying that yoghurt was unhealthy was 1.64 (CI = 1.4–1.91) times higher with the WL vs the GDA and was 1.97 (CI = 1.53–2.54) times higher with the WL vs the MTL for juice.



y ar yoghurt unhealthy
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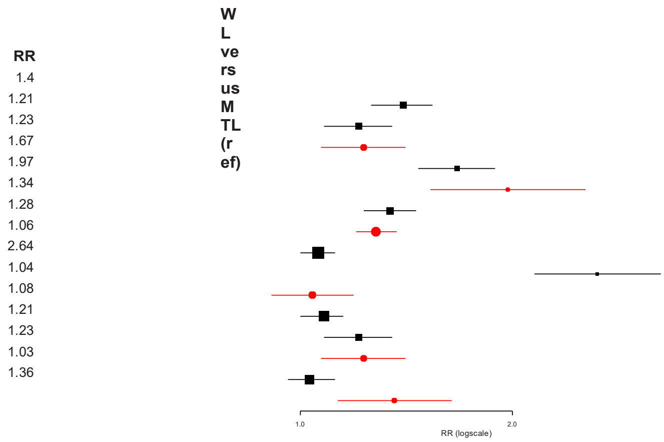

Fig. 4. Results of the relative risk between the different FOPLs. Box sizes reflect the precision of the estimate (larger = more precise) and the horizontal lines represent the 95% confidence interval. Black boxes correspond to the point estimates of reported nutrient excess while red circles correspond to the point estimates of reported as 'being unhealthy'. WL = Warning Label; GDA = Guideline Dietary Amounts; MTL = Multiple Traffic Light; RR = relative risk; Ref = Referent. Results were adjusted for age, sex, level of education, socio-economic status, being the main responsible buyer, having children and metropolitan residence.

3.3. Intention to purchase

Fig. 5 shows that the probability of expressing the intention to purchase unhealthy products was lower for most products bearing the WL than either the GDA or MTL (Fig. 5). For example, the probability of expressing the intention to purchase chips and soda for the group exposed to the WL was 0.75 (CI 0.67–0.85) and 0.81 (CI 0.71–0.92) times the probability for the group exposed to the GDA. The MTL performed worst with a higher RR than the GDA in more than 50% of the products.

3.3.1. Absolute change per label for the identification of nutrients of concern

We found a substantial increase in the proportion of participants identifying products as high in nutrients of concern after exposure to the WL for all products, except for biscuits high in sugar (See Additional File 5). The largest change in correctly identifying nutrients of concern after exposure to the WL was recorded for chips high in fat (37%), for biscuits high in fat (23%) and for juice high in sugar (23%). For the other labels, we also noticed an increase in several, but not all of the outcomes and point estimates were lower compared to the WL.

When comparing the proportion of participants that changed from incorrect to correct identification or vice versa, there was a relative difference between the labels. When comparing the GDA and MLT labels to the WL, a higher proportion of participants changed from correct identification to incorrect identification for the GDA and MLT labels. For example, for chips high in fat for the WL, 41.1% changed from incorrect to correct identification, while 4.5% changed from correct to incorrect identification. Subtracting both figures (41.1–4.5%) gives the actual difference pre-post: 36.6%. For the GDA, however, the proportion that changed from incorrect to correct was 29.0% and the proportion that changed from correct to incorrect was 14.7 (See Additional File 4).

3.4. Absolute change per label for the identification of unhealthy

Identification of unhealthy products improved for 4 out of 6 products after exposure to the WL; no significant difference was shown for chips and biscuits (See Additional File 4). The proportion of participants who correctly identified unhealthy products post-exposure to the WL improved by 24% for juice, 23% for cereal, 19% for yoghurt and by 7% for soda. Exposure to the GDA and MTL only improved identification for juice, cereal and yoghurt and estimates were lower than for the WL. Exposure to the GDA and MTL resulted in a substantial decrease in correct identification of chips being unhealthy. Similarly to nutrients of concern, we saw a relatively higher trend to change from correct to incorrect identification for the GDA and the MTL compared to the WL (See Additional File 4).

3.5. Absolute change per label for intention to purchase

Reported intention to purchase unhealthy products was significantly reduced post-exposure to the WL for all products. The GDA and the MTL showed a reduction for most, but not all products and the differences pre-and post-exposure were smaller (See Additional File 5).

4. Discussion

The findings of this study indicate that, compared to the GDA and the MTL, the WL mostly performed well in all three outcomes: assisting consumers identify products high in nutrients of concern, identifying unhealthy products and reducing intention to purchase unhealthy products. Overall, the GDA and the MTL also did facilitate some changes

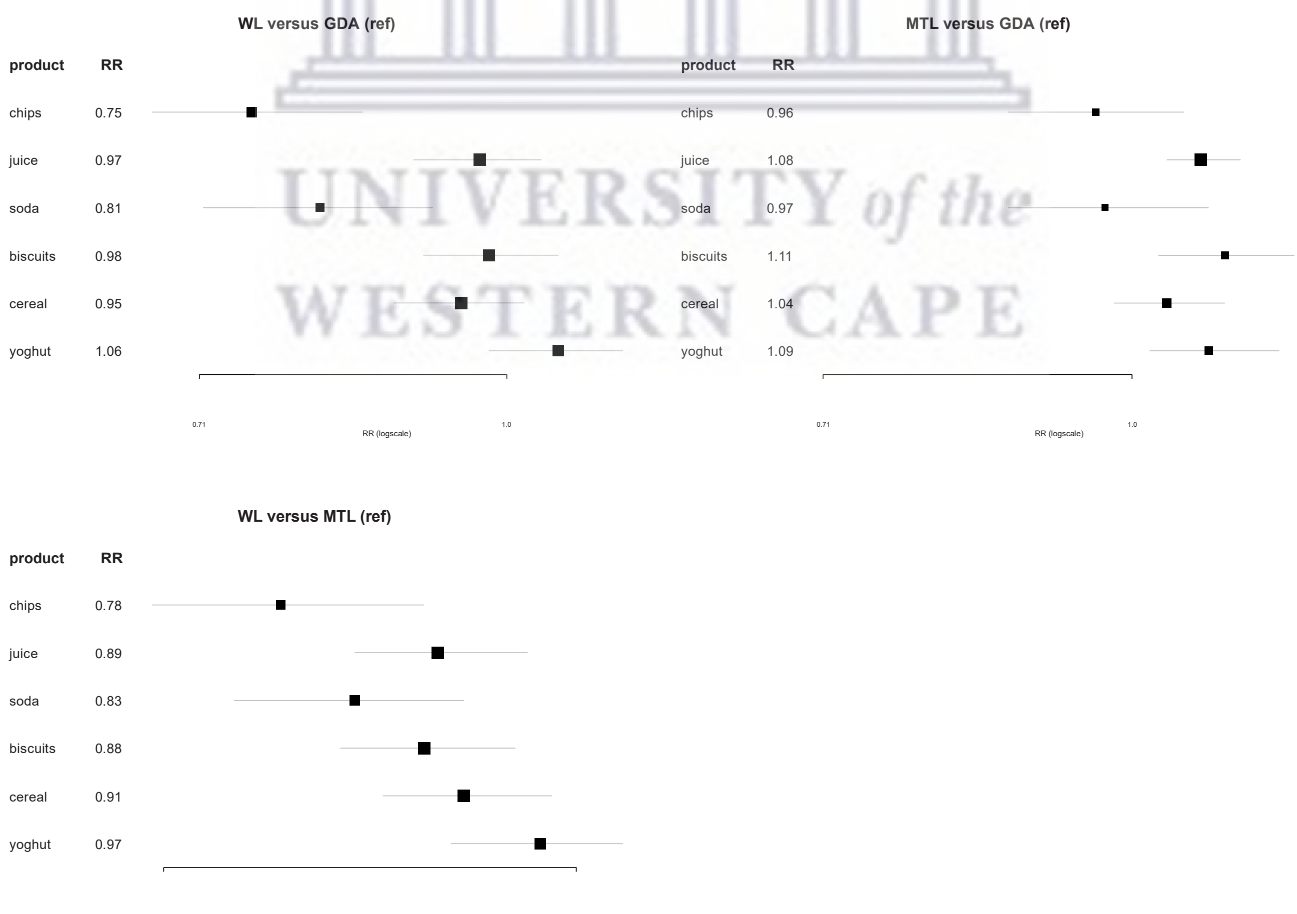

Fig. 5. Results of the comparison between the different FOPLs regarding "Intention to purchase" Box sizes reflect the precision of the estimate (larger = more precise) and the horizontal lines represent the 95% confidence interval. Black boxes correspond to the point estimates of intention to purchase. WL = Warning Label; GDA = Guideline Dietary Amounts; MTL = Multiple Traffic Light; RR = relative risk; Ref = Referent. Results were adjusted for age, sex, level of education, socio-economic status, being the main responsible buyer, having children and metropolitan residence.

in the three outcomes, but the effects were weaker and occurred in fewer of the studied products.

These findings for South Africa are consistent with other experimental studies. For example, a study in Brazil reported that more participants were able to identify products with excess nutrients in the presence of the WL than with the MTL (Khandpur et al., 2018). Moreover, other studies have reported challenges with consumers use and understanding of GDA and MTL (De la Cruz-Góngora et al., 2017; Vargas-Meza, Jaúregui, et al., 2019). A study in Uruguay reported that the GDA and the MTL performed the same in their evaluation of the healthfulness of products (Arrúa, Machín, et al., 2017).

Earlier studies have found that while the MTL performed better in assisting consumers identify healthier products (Taillie et al., 2020; Vargas-Meza, Jáuregui, et al., 2019), consumers still found the MTL challenging to interpret when the label contained two or three different colours (Grunert, Wills, & Fernández-Celemín, 2010; Kees, Royne, & Cho, 2014; Machín et al., 2018). Indeed, we found that for products that contained all three traffic light colours on the labels such as chips and biscuits used in this study, the MTL performed badly in assisting consumers to identify these products as being high in nutrients of concern. Chips, for example, contained an amber colour for sodium, which could have been difficult for the participants to interpret. The WL, due to its binary nature, unlike the GDA or MTL, only highlighted that chips were high in salt without mentioning other nutrients. Warning Labels, due to their single attribute nature, present concise and easy to interpret information and may therefore be more effective in informing consumers. It is however not clear if the difference in outcomes were due to the labels or their NPMs or how much is due to which.

4.1. Identifying unhealthy products

Our findings that the WL assisted more participants to identify unhealthy products are also consistent with past experiments in other countries (Arrúa, Curutchet, et al., 2017; Arrúa, Machín, et al., 2017; Khandpur et al., 2018; Neal et al., 2017; Newman, Burton, Andrews, Netemeyer, & Kees, 2018). A recent South African study reported similar findings (Todd et al., 2022). This is likely because the WL, in contrast to the GDA and the MTL, may have simplified and therefore guided consumer identification of unhealthy products (Cecchini & Warin, 2016; Newman et al., 2018) by only displaying nutrients that are in excess and thus cut through the information noise on the front of the packaging. Additionally, the use of the triangle on the warning label, associated with danger or caution in South Africa (Bopape et al., 2021) could also have led to increased risk perception and an indication of the unhealthiness of the product (Wogalter, Conzola, & Smith-Jackson, 2002). In comparison to the GDA and the MTL, the size of the WL used in this study was bigger, which could have increased its visibility and risk awareness. However a study by Vargas-Meza, Jaúregui, et al., 2019 found no difference between the WL and the MTL in assisting consumers identify products with the lowest nutritional quality.

In other experimental studies, the WL decreased healthfulness perceptions of unhealthy products and assisted participants identify unhealthy products (Khandpur et al., 2018; Lima, Ares, & Deliza, 2018) or refrain from choosing unhealthy snacks (Egnell et al., 2019). Due to its simplicity, WL are easy to understand and have been proven to be also effective in children (Correa et al., 2019), youth (Hock et al., 2021) and across educational levels (Pereira, 2010). A study exploring two FOPL showed that the presence of the WL enabled children to avoid the unhealthier snack and to choose the healthier option (Arrúa, Machín, et al., 2017). Our results suggest that the use of simple text and familiar icons such as a triangle within the WL would be particularly useful in a setting with low literacy skills such as South Africa. Additionally, the use of icons may enhance equitable access to nutrition information, given the mix of languages spoken in South Africa.

4.2. Intention to purchase

While intention is not necessarily the same as actual purchasing, it could however precede behavioural change (Grummon & Hall, 2020; Taillie et al., 2020). Findings from this study indicate that all three labels had an effect on reducing the reported intention to purchase unhealthy products, but more participants reported a reduced intention after exposure to the WL compared to either the GDA or the MTL. The WL has been reported to reduce intention to purchase unhealthy products due to its potential to improve nutrient content understanding (Grummon et al., 2019; Jáuregui et al., 2020; Song et al., 2021) and possibly through eliciting negative emotions towards unhealthy food (Taillie et al., 2020). The presence of texts such as 'high in' and 'warning' on the WL signals warning for consumers (Grummon et al., 2019; Lehto & Clark, 1991) and that could deter consumers from purchasing or consuming the unhealthy product (Conzola & Wogalter, 2001; Wogalter et al., 2002). The use of pictures or icons such as a teaspoon full of sugar enhances understanding of the unhealthiness of products especially among low literate groups and is suggested to improve adherence to health messages (Houts, Doak, Doak, & Loscalzo, 2006). Participants in a previous qualitative study in South Africa, felt that the use of the text 'warning' and the inclusion of an exclamation mark on the WL warned them about the danger linked to consumption of the product (Bopape et al., 2021). Consumers in another study reported that health warnings followed by nutrient warnings on food packages evoked fear and reduced their desire to purchase unhealthy foods (Grummon et al., 2019). However in an experimental study by Machín et al., 2018, both the WL and the MTL led to a similar effect of reduced selection of unhealthy products. The findings of this study are consistent with the results of a meta-analysis that reports decreased healthfulness perception and decreased intention to purchase unhealthy products when exposed to the WL (Grummon & Hall, 2020; Song et al., 2021). Countries that experience high obesity and NCD rates and aim to reduce consumption of unhealthy food could therefore benefit from implementation of the WL that easily flag unhealthy products and steer consumers away from such products.

5. Strengths & limitations

Our study was based on a probability sample, randomly collected from and hence representative for the general population of South Africa. Another strength was that data was collected in person and reached lower socio-economic segments of the population unlike online surveys that may be biased towards a more privileged group. The use of an RCT that compared the three FOPL formats, including the no label condition minimised the influence of confounding factors. An added advantage was that the participants interpreted the different FOPLs without any prior explanation of the labels which could have otherwise influenced the intention to purchase and increased the ability to correctly identify unhealthy products. The limitation of this study is that only three FOPLs were tested. However, the three labelling formats represent different labelling categories and the results should provide policymakers with the information required to determine the label that can assist South Africans identify and reduce the purchasing of unhealthy food. Because we used the actual nutrient profile models for the GDA and the MTL which do not require a warning for artificial sweeteners, the yoghurt only contained a warning for artificial sweeteners in the WL arm as per the WL nutrient profile model implemented in other countries, e.g. Mexico (Grunert & Wills, 2007). This could have influenced the ability of consumers to identify yoghurt as unhealthy. This study did not fully differentiate the effects of the type of label (including colour, and label size) and the different nutrient profiles that underpin the labelling system. It is the case that products for which the underlying NPMs are very unaligned, we are likely to see bigger differences in outcomes (compared to products for which the NPMs are more akin). Because this study did not disentangle the NPM and the FOPL, we are unable to tell whether the findings were due to the label designs alone or also due to the underlying NPMs and how much is due to which. We recommend future research that could investigate the effectiveness of FOPL when the NPMs are standardised.

The study was experimental and does not represent a real life scenario. Understanding of nutrient content and intention to purchase may not necessarily lead to behaviour change in a real life situation. Studies that determine the effect of WL on actual purchasing and consumption are therefore required.

6. Conclusion

In South Africa, WL performs better than the GDA and the MTL in enabling consumers to identify products high in nutrients of concern, identifying unhealthy products, and reducing their intention to purchase unhealthy products. Requiring mandatory WL for products as defined by a nutrient profile modelling system suitable for South Africa is a feasible and equitable policy that should be considered urgently as the country develops and updates its food labelling regulations.

Ethics

Ethical principles were applied in the execution of this study in accordance with the Declaration of Helsinki. Informed written consent was obtained from all participants before data collection commenced. Ethical approval was granted by both the Biomedical Research Ethics Committee of the University of the Western Cape (BM 18/9/13) and the International Research Board (IRB) at the University of North Carolina (Chapel Hill).

Authors' contributions

SN, LTS, NM, RS and MB conceived and designed the study. RS and MB executed the study, processed and cleaned the data. JDM performed statistical analysis and interpreted the data. RS, MB, SN, LTS and NM helped to analyse and interpret the data. MB and JDM drafted the manuscript. SN, LTS, NM and RS critically reviewed the manuscript. All authors read and approved the final manuscript.

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Declaration of competing interest

None.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2022.106283.

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Glossary

CI: Confidence Interval
FOPL: Front-of package Labelling
GDA: Guideline Daily Amounts
MTL: Multiple Traffic Light
NPM: Nutrient Profile Model
NCDs: Noncommunicable diseases
R146: Regulation 146
RCT: Randomised Controlled Trial
WHO: World Health Organisation
WL: Warning Label

CHAPTER 7: RESULTS

THE EFFECT OF THE WARNING LABEL ON DAY-TO DAY FOOD CHOICES

This chapter presents the literature used in the preparation of the third manuscript (article), the researcher's contribution to the article and the published article itself. Comments from the reviewers of the article and the authors' responses appear in Appendix 15.

7.1 Introduction

The results of the RCT (Chapter 6) revealed that South African consumers understood the WL better than either the GDA or the MTL. The WL also had the greatest impact in reducing consumers' intention to purchase unhealthy products. These results concur with the C–HIP theoretical framework which suggests that FOPL that is attractive, catches and maintains attention, is understandable, changes beliefs and attitudes, and motivates consumers to change will ultimately lead to behavioural change. Publication #1 provided insights into how South African consumers feel about the WL, with the results of the study showing that participants found the WL attention grabbing, easy to understand, educational and more likely to influence their purchasing habits. Publication # 2 revealed that of the three FOPL systems tested, the WL was the most likely to assist participants.

Phase 3 of the study initially aimed to further explore participants' views of the FOPL system rated the most effective in phase 2, thereby arriving at a deeper understanding of the findings. However, since the WL was rated the most effective and had already been explored in phase 1, phase 3 then focused on adults' (parental) perceptions of the effects of the WL on day-to-day food selection for their children. Phase 1 was limited to adults' perceptions of the effects of the WL and did not include their perceptions of their food selection for their children. Parents, being primarily responsible for food acquisition in households, are ultimately responsible for the food acquired for the household and for the types of food that their children eat (Lima *et al.,* 2018). The findings from this phase are presented as Publication #3 below.

<u>Contribution of the researcher</u>

MB, LTS and RS conceptualised the study. MB prepared the study protocol, collected and analysed the data, and drafted the manuscript. LTS and RS reviewed and approved the manuscript.

See Appendix 15 for comments from the reviewers, responses from the authors and communication from the journal editor.

7.2 Publication #3

Bopape, M., Taillie, L. S., & Swart, R. (2022b). Perceived effect of warning label on parental food purchasing and drivers of food selection among South African parents – An exploratory study. Frontiers Public Health, 10, 939937.

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Perceived effect of warning label on parental food purchasing and drivers of food selection among South African parents–An exploratory study

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Household food purchasing decision is a complex process influenced by factors such as marketing, cost, children food preference and parental choices. Most food products targeted toward children are unhealthy and are aggressively marketed to increase desirability among parents and children making healthier food selection even harder. The warning label (WL) is identified as a simple front-of-package labeling format that assist consumers to easily identify unhealthy foods and reduce their purchasing. This was a qualitative study that aimed to investigate the perceived effect of the warning label (WL) on parental food purchasing and drivers of food selection among parents. The study was conducted in a mainly rural part of South Africa, in Limpopo Province. Data were collected from 44 adult participants, all parents with children aged below 16 years selected using the snowball sampling method. Seven focus groups diversified according to age, literacy, income and urbanicity were utilized for data collection. Using a focus group discussion guide, parents were shown images of six products (crisps, soda, juice, biscuits, cereals, and yogurt) superimposed with the WL and questions asked were based on those images. Thematic analysis revealed that although some parents felt undeterred by the WL, some felt they would alter their food purchasing in the presence of the WL. Other parents felt they would reduce the frequency or the amount purchased or completely stop purchasing labeled products for their children. Motives behind perceived behavior modification included children's health being perceived as a priority and labeled products being viewed as unhealthy. Factors such as pressure from children, taste, poor nutrition knowledge and affordability seemed to influence parental food selection. These findings have important policy implications by providing evidence to policymakers that the WL may alter parental food purchasing and also provide insight into drivers of food selection among South African parents.

KEYWORDS
food purchasing, food selection, unhealthy food, warning label, parental

Introduction

Non-communicable diseases account for more than 51% of all deaths in South Africa (1) and are ranked among the top ten leading causes of mortality in the country (2). The link between poor diets and NCDs necessitates public efforts aimed at modifying food purchasing and consumption to reduce the burden of NCDs in the country.

Unhealthy diets are one of the major modifiable risk factors responsible for NCDs (3, 4). Currently NCDs account for more than 85% of premature deaths per year in low- and middle-income countries (5) posing a substantial burden on the economy (3, 6). In South Africa, it is estimated that for diabetes alone, in 2018, the public sector costs of diagnosed patients was approximately R2.7 billion (approximately 157 million USD) and would be R21.8 billion (approximately 1.25 billion USD) if both diagnosed and undiagnosed patients are considered (7).

Although mostly experienced later in life evidence suggests that diet-related NCDs start early in childhood and adolescence (8) Childhood presents a golden opportunity for NCD prevention as any healthy behaviors developed at this stage may have positive long lasting health implications (8, 9). Policies aimed at improving healthy food selection from an early age are seen as cost-effective public measures (9).

Parents are primary household food purchasers and although influenced by other external factors such as time constraints (10), pressure from children (11), taste (12), marketing (13), and food prices (10, 13), they are to some degree responsible for selecting food for their children (13, 14). Parental food selection plays a role in shaping children's health (15) and preventing current and potentially future diet- related-diseases (15, 16). Studies report that parents often base their purchasing decisions on perceived product healthfulness, health claims and attractive packaging (13, 17) rather than on the nutritional value of products (17). Most products targeted toward children are high in nutrients associated with NCDs - energy, fats, salt and/or sugar (18) and are aggressively marketed to increase desirability among children and parents alike (17). In an effort to provide the best for their children, parents are often misled by the attractive packaging and health claims that appear on product packaging (17, 19).

International organizations recommend provision of nutritional information as a strategy to assist consumers identify healthier food options (20, 21). Evidence from previous studies shows that consumers understand and prefer interpretive front-of-pack labeling (FOPL) (22, 23) as it presents nutrition information in a simplified format (21, 24). Interpretive FOPL simplifies nutrition information by providing interpretation or judgement about the nutritional value of products and may appear in the form of color coding, words, pictorial images or symbols (21, 25).

Existing research reveals that in the presence of the WL, an example of an interpretive FOPL, consumers are better able to understand the nutrient quality of food and select healthier food options (23, 26). WL interprets and simplifies nutrition information by presenting it in a form of familiar shapes such as the octagon shape resembling stop signs (27), triangles (28) and some include icons or symbols that represent nutrients that are in excess (21, 29). This is in contrast to the traditional list of nutrition information typically stated at the back of the pack or the non-interpretive FOPL which still require further interpretation by consumers (25). These positive effects of interpretive FOPL on food selection may play an important role in reducing NCDs (30).

Two conceptual framework models were adapted to explain pathways through which the WL influences purchasing decisions and to secondly explain drivers of food selection (Figure 1) (31, 32). According to the authors, the label needs to first capture consumer's attention. Once attended to, the label can work through two different pathways. The first pathway is through cognitive effects such as improving understanding and subsequently changing product perceptions (31). For example, the WL might assist consumers to understand that a product previously perceived as healthy is in fact unhealthy (23). This nutrition information should be presented in a manner that challenges existing beliefs and attitudes (31, 33) and such labels are likely to have the greatest impact (34). The second mechanism is through eliciting negative emotional reactions such as fear and worry or increasing risk perception (31, 32). In two separate experimental studies, exposure to the WL was reported to elicit negative emotions toward sugar sweetened beverages (35, 36). According to the Health Belief Model, high-risk perception motivates change in beliefs and attitudes and ultimately illicit desired reaction (37). Labels can also influence behavior by simply serving as a salient reminder of one's long-term health goals (31) or reinforcing current health beliefs and attitude (33). These cognitive and emotional influences can in turn affect attitudes toward foods or directly influence behavioral intentions with subsequent changed behavior (26, 38). The effectiveness of the label can however be influenced by income (39) taste (39), cost (40), product familiarity (41) and nutrition knowledge (42).

Warning labels have been reported to positively impact consumer behavior by shifting the desire away from unhealthy products (23, 43). Another study revealed that parents were reluctant to purchase unhealthy products for their children after exposure to the WL (26). In another separate study the application of the WL on products also led to decreased intention to consume and purchase labeled products (44).

A previous study evaluating the opinion of South African adult consumers on WLs revealed that consumers found the labels attention-grabbing, easy to understand and effective in warning against unhealthy food (28). Findings of the latter

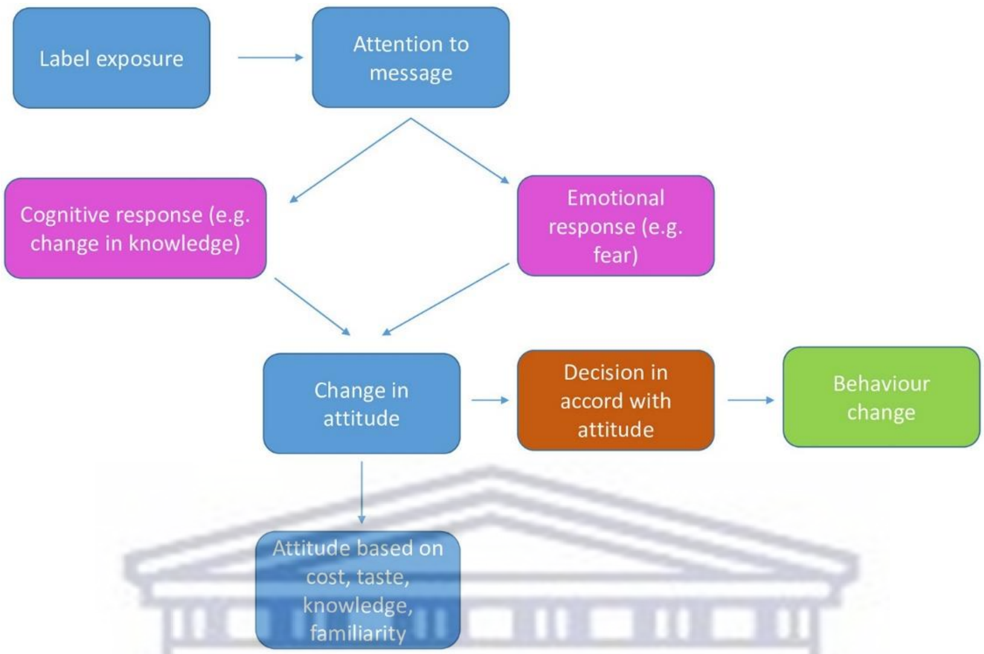

FIGURE 1
Conceptual framework that explains influence of warning label on food purchasing behavior.

study revealed that some consumers felt they would reduce consumption of products bearing WLs.

The latter study did not however investigate the perceived effect of the WL on parental food purchasing. Parents seem to select food differently for their children (12, 17) and parental view on the effect of the WL on food purchasing for their children is therefore important. Parental food selection shapes children dietary habits making it crucial to develop policies to guide parental food selection. Investigating drivers of parental food selection provides insights into reasons why parents provide certain foods for their children and forms basis for effective parental nutrition education programs. There is a gap in studies related to the parental determinants of food selection from predominantly rural areas of South Africa. This study aims to fill these gaps by investigating the perceived influence of the WL on parental food purchases, motives underlying these perceptions and drivers of food choices by parents.

TABLE 1 Socio-demographic characteristics of parents (*n* = 44).

	***n* (%)**
Gender	
Male	5 (11)
Female	39 (89)
Age	
18–29 years	10 (23)
30–50 years	34 (77)
Urbanicity	
Urban	18 (41)
Rural	26 (59)
Literacy	
Low literacy (grades 0–6)	14 (32)
Literate (grade 7 and above)	30 (68)
Combined family monthly income	
Low (R0–R1,600)	33 (77)
Middle-high (R1,601 and above)	11 (23)

Materials and methods

Participants

We collected data from seven focus groups consisting of 44 participants residing in Limpopo Province, South Africa. All participants were parents with children below the age of 16 years. Focus groups varied according to age (18–29 years and 30–50 years), income (low and middle-high), literacy level (low literacy and literate) and urban or rural residency (Table 1).

Low income was defined as an income below or equal to R1600.00 (approximately 94 USD) and income above R1600.00 was categorized as middle-high. Low literacy was defined as educational attainment at or below Grade 6 and a participant with Grade 7 and above was considered literate. The purpose of diversifying the groups was to capture potential differences in perceptions according to different ages, educational and socioeconomic status and urbanicity. The sample consisted of parents primarily responsible for either purchasing or preparing food within the households and having children below the age of 16 years. MB, one of the researchers, recruited participants both face-to-face and telephonically through the snowball sampling method. Ethical approval was obtained from Biomedical Research Ethics Committee of the University of the Western Cape. The materials and methods followed in this study are presented according to the Consolidated Criteria for Reporting Qualitative Research (COREQ) (45).

Stimuli

Discussions were based on 2D images of mock-up products (crisps, soda, juice, biscuits, cereals, yogurt) superimposed with the WL (referred to as labeled products in this study) (Figure 2). The nutrient content of each product mimicked a similar product that is currently on the market and each product package contained a WL based on the nutrients that were in excess. For example, a product high in sugar and saturated fats would contain a WL with two triangles indicating "high in sugar" and "high in saturated fats" (Figure 2).

Procedure

All discussions were conducted by MB using a focus group discussion guide (Additional File 1) developed by the researchers. Data collection took place between November 2020 and December 2020; in March 2021 and in November 2021. The break-up in data collection was due to coronavirus disease 2019 (COVID-19) restrictions. Venues most convenient to the participants were arranged and COVID-19 protocols were observed at all times. Participants kept a safe distance from each other, wore masks all the time and sanitized their hands before discussions started. All focus group discussions were captured on the audio recorder.

Before the commencement of the study, the moderator explained the aim of the study which was to explore the views of the participants on the images to be displayed during discussions. Once the purpose of the study was explained, participants were then requested to sign the focus group confidentiality binding form. Participants were shown different images and responded to questions based on those images. The images were first rotated within the focus group to ensure each participant had a closer view of the images together with all the graphics. Participants were requested to view the images in silence. Once all participants had viewed the images, the moderator presented the images again, one at a time, without providing any explanation, to ensure all participants were aware of all the images. Once completed, the moderator started the discussions with one image, chosen at random, and led the discussions until all responses were pointing to the warning label and not the product. Once participants' focus was on the warning label, the moderator then continued to ask questions based on the focus group discussion guide. Focus group discussions lasted between 40 min to 45 min and were conducted until data saturation was reached was for the questions. Discussions were held in Sepedi, the language that participants understood. MB moderated the discussions transcribed the recordings verbatim and translated the data to English.

Focus group discussion guide

The researchers developed a focus group discussion guide that was used during focus group discussions. The guide was based on the adapted conceptual framework (31, 32) (Figure 1) which suggest a hierarchy of events that determine the effect of the WL on food purchasing and drivers of food selection. The questions in the guide were aimed at investigating whether the WL caught participants' attention and understood the message conveyed by the WL. The aim of these questions was to ensure that all participants were aware of the WL before the discussions on the perceived influence could commence. Other questions on the discussion guide included the perceived effect of the WL on food choices for their children. Furthermore participants were asked about their impression about the label and for drivers of food choices, participants were asked about other factors that they could consider when making food choices for their children. A previous qualitative study reported that consumers in South Africa found the WL attention grabbing (28) and this paper therefore excludes discussions on this first step of the conceptual framework (Figure 1).

Data analysis

Data were analyzed following inductive thematic analysis (46). Although the framework was developed beforehand, the researchers allowed codes and themes to emerge from participants responses and not from predetermined codes (46). To ensure robustness of data analysis. MB and another experienced independent researcher (FP) separately analyzed all the transcripts following the iterative process (47) and each grouped similar information into codes. MB and FB discussed the codes and after reaching consensus on codes to include or exclude based on the conceptual framework and any other emerging data related to the framework, we each sorted and collated codes into themes that best represented participants' responses. We compared and finalized the themes based on

Single products with the WL	Product pairs within a food categorythe WL
 Potato crisps	 Two different sweet biscuits
 Orange juice	 Two different breakfast cereals
 Carbonated drink	 Two different yoghurts

FIGURE 2
Images used during data collection.

themes that were common between the two coders. The themes were supported with relevant quotes from participants for further clarity and explanation.

Trustworthiness of the study was ensured throughout the study process (46, 48). To ensure credibility MB built a rapport with participants by stating the purpose of the study and reasons why the researcher was interested in their views (49, 50), starting the discussions with light topics for icebreaking and listening attentively during discussions (49, 50). To ensure confirmability two independent researchers followed similar data analysis steps separately to generate codes and themes and agreed on themes that best represented participants' responses. The authors of this article also reviewed the themes and the quotations. To ensure transferability and dependability the study methodology followed in this study is fully described.

Results

We extracted six themes with several subthemes from the data.

Perceived meaning and usefulness of the WL

During discussions all parents were requested to share their views about the WL and the responses ranged from: ***WL cautions against nutrients in excess, WL promotes informed food choices*** and ***WL reminds of health consequences.***

WL cautions against nutrients in excess

A number of parents' remarked that the WL alerts them to nutrients that are contained in excessive amounts, to which one parent said: *"There is too much fat and too much salt in that package" (Male, urban, literate, middle-high income).* Another parent said*: "And this is high in salt. This tells you that this product contains too much salt" (Female, rural low literacy, low income).* This implies that some parents were able to correctly understand the message conveyed by the WL.

WL promotes informed food choices

One other view from some of the parents was that the WL would enable them to make informed food choices. This is what one parent said: *"As a parent, I will be the one going to the shops then I will know which products to buy for my child. I will first check the label and then know how my child will be eating. I will be aware of what I am feeding him (Female, rural, low literacy, low income)".* Another parent added: "So *if we have inherited diseases in the family and we are diagnosed with certain diseases or hypertension in the family, I'm going to check the label first. If the label says this product contains too much fat or too much sugar I'm going to stop buying it (Male, urban, literate, middle-high income)."*

Warning label reminds of health consequences

From the discussions it was evident that the presence of the WL made a number of parents think about the health consequences related to overconsumption of the labeled products. *"But if you think carefully, you will remember that eating too much sugar and too much salt causes diseases and then you will not buy them" (Female, urban, literate, low income). "I cannot buy a product that will make me sick at the end (Female, rural, low literacy, low income)."*

Emotional responses to warning labels

When asked how they would react if the WL was implemented and put on products in the supermarkets, the perceived emotional reaction from several parents was fear as illustrated by these responses: *"It will scare us" (Female, rural, literate, low income).* Another parent in the same group added: "*We will no longer buy as usual, we will start to be afraid" (Female, rural, literate, low income).* In response to the question, another parent said: *"I will be scared"* (Female, urban, literate, middle-high income) s*:*

Perceived effect of WL on parental food purchases

Parents were asked about their perceived reaction if products they usually purchased for their children would contain a WL. The following subthemes emerged: ***reduce the amount and frequency of purchasing, stop buying labeled products, continue buying labeled products*** and ***switch to a different product.***

It was evident that the WL affected a number of parents as noted by quotes such as: "*It's not going to be easy to buy products with labels for them" (Female, urban, literate, low income)* ' indicating some discomfort in buying products should they contain the WL in future. One parent said*: "This label is going to be helpful as we will be able to see that we actually were not feeding our children well and things would have to change (Female, rural). Even myself that's what I normally buy for my kids. So starting today I'm going to start paying attention to what I buy for them (Male, urban, literate, middle-high income).*

Reduce the amount and frequency of purchasing and consumption

Although some parents felt they would continue buying labeled products, others felt they would reduce the amount and frequency of buying and consuming such products. One parent said: *"Because mostly what we saw in those pictures is what we normally put in their (children) lunchboxes, which means we are going to cut*' *(Male, urban, literate, middle-high income)."* Another parent said: "*Let me give an example, like with crisps, there are those that come in strips of seven individual packets. I will buy one strip of seven small packets for my child and a big packet for myself, not for my child" (Female, rural).* Similarly another parent offered*: "Firstly maybe I'm going to buy the smaller amount of the pack. So I'm not going to buy the big bag" (Male, urban, literate, middle-high income).* This implied that parents viewed smaller packets of labeled products as better than the big ones.

Stop buying labeled products

When asked how the labels would affect food selection for their children, one parent said: *"Ya from my side I will completely stop. I'm not going to compromise the life of my children because of the nice time for only a short term*" *(Male, urban, literate, middle-high income).* Another parent added: "*I will not buy them for my children. We also want them to grow well. If we do not want fat and salt for ourselves, we also do not want it for them" (Female, rural, low literacy, low income).*

Continue buying it

Some parents acknowledged they would continue purchasing labeled products especially when shopping with their children. *"I will continue buying products with labels" (Female, urban, literate, low income).* Another parent added: *"Personally, I will buy the one with a warning label. A child will not eat one without the label as it will not be containing sugar" (Female, rural, literate, low income).* This implied that parents were willing to accommodate their children's food preferences.

Switch to a different product

Other parents' opinion was that they would instead consider other alternatives to labeled products. One parent said: "*I will check for other products without the warning signs" (Female, urban, literate, low income).* When asked what they would pack for children's lunch if they stopped buying labeled products parents in the current study said they would pack non-labeled products, fruit and water. One parent said: "*We will pack the one without the warning label"* (*Female, rural, low literacy, low income). Another* parent said this in response: *"Fruit, they are the healthy option. They do not have any negative consequences"* (*Female, rural, low literacy, low income*). When asked what would happen if the child does not enjoy the non-labeled product one parent said: *"They will get used to it"* (*Female, rural, literate, low income*).

Motivation for modifying purchasing behavior

Some parents further offered their reasons for intention to modify purchasing behavior that included: ***health as a priority*** and ***labeled products viewed as unhealthy.***

Health as a priority

A number of parents alluded to the importance of children being healthy from a young age: "Because children should also be healthy from childhood. We should take care of them while they are still small and not only start giving them healthy food when they are older. He should get used to them from an early childhood" (Female, urban, literate, low income).

When asked what they would do should unlabelled products be more expensive, some parents maintained that they would still not buy labeled products for their children. One parent remarked*: "My child's health is a priority. My child's health cannot be compared to any amount" (Female, urban, literate, low income).*

Labeled products viewed as unhealthy

Parents viewed products containing high amounts of nutrients of concern as unhealthy and that seemed to serve as motivation for intention to modify purchasing behavior. There was a general concern about the poor nutritional value of the labeled products. One parent said: "Food high in fat is unhealthy. They can cause diseases" (Female, urban, literate, low income). In addition, another parent said: as you can see, crisps contain salt and; fat is also written there (pointing at the pack). in the body they will just create a mess. We need to be selective with the type of snacks we eat, (choose) healthy ones (Female, rural, low literacy, low income).

Drivers of parental food selection

During discussions, drivers of food selection mentioned by parents included: ***pressure exerted by children, taste, poor nutrition knowledge and affordability***. Regarding ***pressure exerted by children*** one parent said: *"Most of the time we go with them and it's not easy. Because that kid will scream in the shop like you stole him whereas he is yours. even if you agree at home that you are not going to cry for these and that. (Male, urban, literate, middle-high income)."* Another parent felt ***taste*** play a role*: "A child will not eat one without the label (Female, rural, literate, low income)."* Another parent said: *"Lite ones do not taste nice. Children are controlled by sugary stuff, even us. It will stay in the fridge for a long time" (Female, urban, literate, middle-high income).*

Poor nutrition knowledge also emerged as one of the reasons for food selection. One of the parents believed that children are not at health risks due to their young age: *"I don't think these will affect children that much. Because they are still young they might not get very sick (Female, rural, literate, low income). On the other hand other parents viewed food high in sugar as harmless." "I don't think there is anything wrong with food high in sugar. For example if cereals are high in sugar, I can eat them with milk and then add no additional sugar" (Female, rural, low literacy, low income). Another parent said: "It is not possible to drink a hot drink (referring to fizzy drink). But you will not even feel its sweetness when it is cold, you just drink, no problem at all" (Female, rural, low literacy, low income). This implied there were compensatory measures one could take to balance the amount of sugar in food.*

Other parents felt compelled to purchase certain foods due to ***affordability***. One parent said: *"I will buy labeled products if unlabelled products are more expensive" (Female, urban, literate, low income).* Another one said*: "We give them whatever is available. If it's a month where you managed to buy cheaper ones that's what they will take to school, if you managed to buy expensive ones, that's what they will carry" (Female, urban, literate, middle-high income).*

When asked how frequently they felt labeled products should be consumed, their responses ranged from one to three times per week. One parent said: "*Once a week — because some of the products are needed in our bodies, even salt must not be a lot, but it is needed. Even sugar and alcohol. Not too much alcohol but just a little bit. We have to balance it like that" (Male, urban, literate, middle-high income).* Another parent said: *"So we still need snacks but not too often or every day"* and when asked how often this parent said*: "Maybe three times a week" (Female, rural, low literacy, low income).*

Perceived WL label understanding among children

As a possible determinant of food selection, parents were asked whether they thought children would understand the WL or not. Parents were divided, with some believing the label would be confusing for children. ***One*** parent said: *"It's only adults and* *literate people who will be able to read the label. Children and the illiterate will not be able to read it" (Female, rural, low literacy, low income).* Another parent added*: "They cannot understand what is happening there" (Male, urban, literate, middle-high income). Right, it will take time because they will not understand. Children are just a children, they will not understand what is happening. But in future, that thing will build up (Male, urban, literate, middle-high income).*

Strategies to maximize WL effectiveness*:* Following were parents' recommendations to improve awareness of the WL: ***parental education of children at home, education of children at school*** and ***education through mass media.***

Regarding ***parental education of children at home one*** parent said*: "But the best thing it will need us as parents or whoever is staying with the child to educate them" (Male, urban, literate, middle-high income)*. Another parent held a similar view: *Like if she buys the product and comes home with it, we can inform her that she can eat it but it has negative consequences' (Female, urban, literate, middle-high income).*

Other parents also emphasized the importance of modeling healthy eating habits at home. One parent said: "*Because if I keep on buying, my children will think these products are okay. If these products are not available at home, sometimes they might not have money to buy them"* (*Female, rural, low literacy, low income*).

On the other hand some parents were of the opinion that ***education of children by teachers at school*** would be better. Their view was that children were more receptive to teachers than their parents. One parent said: *"When you tell children not to buy biscuits or other stuff they sometimes think that you just don't want them to eat biscuits, but if they are taught about the label at school Sometimes children become moody when you tell them to do school work, but when they are at school they listen and do what teachers instruct them to do. So, if schools could be the ones promoting the label, teach them that such products are not good, they do this to the body... they would be hearing that in their classrooms and they listen to their teachers" (Female, rural, low literacy, low income).*

Another strategy that emerged during discussions is ***education through mass media.*** Parents recommended several avenues such as health education at the clinics, broadcasting over the radio and TV and address by the Ministry of Health. Some parents likened the implementation of the WL with the introduction of face masks for prevention of the spread of the Corona Virus. One parent said: "*But the issue about whether children would understand the label or not, if this could be addressed nationally, by the Minister of Health for example, and it's broadcasted live, same as when the president warns us to be careful, it will not be difficult, just like with masks, we are used to then now. It will not be difficult" (Female, rural, low literacy, low income).*

Discussion

This study revealed that a number of parents felt the WL would discourage selection of labeled products for their children. Motives for perceived behavior modification were child health being viewed as a priority and labeled products being viewed as unhealthy. In addition the current study revealed diverse drivers of food selection that included pressure exerted by children, taste, poor nutrition knowledge and affordability.

Some parents in the current study felt the WL enabled them to identify products that were high in nutrients of concern. This finding is supported by other experimental studies where the WL performed better in assisting consumers identify products with high amounts of risk nutrients (51, 52). The WL simplifies nutrition information by explicitly stating nutrients that are contained in high amounts. The inclusion of a triangle shape that is associated with danger (53) and icons related to nutrients of interest (e.g., a heap full teaspoon of sugar) could have also enhanced consumers understanding of the WL, thus increasing its effectiveness (53). Labels that are explicit and improve nutrient understanding are more effective in influencing behavior change (30) and may lead to reduced NCDs.

The WL seemed to have made a number of parents think about the negative health effects of indulging in products bearing the WL. Some parents indicated that the presence of the WL would trigger feelings of fear toward products bearing the label. Similar reactions of fear evoked by the WL and thinking about health harms have previously been reported (54). WLs flag unhealthful products and may raise consumers' awareness about the negative health consequences associated with their overconsumption. According to the Health Belief Model, labels that increase the perception of risk are more effective in altering attitudes and may ultimately result in behavior change (37). Modifying purchasing behavior would go a long way toward reducing accessibility of unhealthy food in the homes and potentially into the communities, contributing to reduced consumption of unhealthy food and resultant lowered NCDs and obesity prevalence.

Regarding the perceived effect of the WL, although some parents felt they would continue purchasing labeled products, should the WL be implemented, others felt they would alter their purchasing behavior. A number of parents felt they would reduce the amount and frequency of purchasing labeled products, others felt they would stop purchasing labeled products while some planned to switch to other alternatives. One of the goals of the WL is to discourage purchasing of unhealthy products (55) and parents in the current study expressed their intentions that align with this objective. A study in the UK reported that parents' intention to purchase sugar sweetened beverages was also reduced post exposure to the WL (35). Other researchers have also reported perceived changes in purchasing behavior post exposure to WLs. For example an experimental study in Colombia revealed that the WL reduced the likelihood to purchase "high in" products as compared to other front- of-package labels (56). Similarly other experimental studies reported reduced intention to purchase products bearing the WL (43, 44).

Parents could imagine using the WLs to help guide purchases for children's lunches. This remark was made upon the realization that products shown during the discussions were those they usually include in their children's lunchboxes. Nathan et al. (57) found that children mostly carried food that were not in line with dietary guidelines and that the majority of children carried discretionary food such as chips and sugar- sweetened beverages in their lunchboxes. Parents in the current study acknowledged the importance of healthier food selection for their children, a positive step in the direction toward behavioral change (31). There is evidence of cardiovascular diseases developing from a young age (58) and parents need to start selecting food wisely in order to inculcate healthy dietary patterns in their children much earlier in their lives.

Enablers of the WL in this study included health being viewed as a priority and labeled products being viewed as unhealthy. Health and nutrition were also previously reported as motivators for parental food choices (12). Parents in this study mentioned diverse factors that drove their purchasing behavior. Some parents in the current study reported succumbing to pressure exerted by children while shopping. This is a concept known as pester power which refers to the ability of children to nag their parents into purchasing products they would have otherwise not bought (11, 59). The products mostly demanded by children are usually high in sugar and fat and are hugely marketed toward children and the adolescents (11). While occasional consumption of unhealthy food is by itself not a health risk, a study in Australia revealed that the more parents gave in to children's food preferences, the lesser the preference for fruit, vegetables and untried foods (12). Pester power has also been associated with overweight and obesity in children and the adolescents (11). Parents in other studies similarly reported compromising healthy food purchasing to accommodate their children's food preferences and demands (10, 24).

Poor nutrition knowledge surfaced as one of the influencers of parental food selection. One view held by parents was that sugar does not pose any health problems for younger children. Others felt that sweetened beverages if taken cold would not have any health repercussions as they lose their sweetness when chilled. Such misconceptions could potentially fuel excess sweetened beverage consumption and obesity among children. Any implementation of WL regulations should therefore be linked to strong health education campaigns to improve label understanding and broader nutrition knowledge. This calls for the need to strengthen nutrition literacy initiatives by the health sector, academia and other non-governmental organizations.

Affordability was mentioned as another factor generally affecting parental food selection similar to findings in other studies (13, 24). Low socioeconomic groups often resort to cheaper and unhealthier alternatives which are typically energy-dense and high in nutrients associated with NCDs (60). Therefore, strategies addressing obesity cannot be isolated from food insecurity issues and regulatory measures when implemented need to ensure that healthy and affordable alternatives are accessible to all population groups (3). However, not all parents were willing to compromise on healthy food on account of food prices in the current study. Similarly another study reported that parents were willing to spend more on healthy food for the sake of their children's health (10).

Regarding parental perception on label understanding, a number of parents felt the WL would be meaningless to children. Parents recommended strategies to improve its effectiveness and that included education of children at home, education of children at school, education through mass media and demonstration of healthy eating habits at home. Similar strategies have previously been recommended (61, 62) and have yielded positive results in other countries. In Chile for example, schools assisted in promoting the WL understanding which led to children encouraging their mothers to purchase fewer labeled products (63).

The strength of this study is that discussions were based on a variety of products commonly classified as unhealthy (e.g., biscuits and soda) and those usually perceived as healthy (e.g., yogurt and muesli). Another strength was that all parents had children below the age of 16 years and were suitable to give views as parents. Understanding parental view on the effect of the WL is an important policy consideration as parents play an important role in shaping children's eating habits. The limitation of this study is that data were collected in only one Province and the results may not be generalizable to the entire population. However, the focus groups were diversified to capture opinions from diverse groups to improve the richness of the data. Another limitation inherent in qualitative studies is that focus group discussions can be easily swayed by one vocal group member. Quantitative studies with a representative sample size could be conducted to understand the widespread perceptions of parents in South Africa. This study was experimental and may not translate directly into actual purchasing behavior. The actual effect can only be determined once WLs are implemented. A potential bias for this type of study is demand effects. To deal with this effect, participants were invited to participate freely and were informed that there were no correct or incorrect responses. Additionally participants were only informed that the study was about their perceptions of the images (pictures) to be displayed during the discussions.

Conclusion

Based on our results parents believed they would reduce the quantity and frequency of consuming labeled products, stop purchasing labeled products and switch to non-labeled products. Some parents felt they would continue purchasing labeled products. Motives to switch to non-labeled products included health being a priority and labeled products being perceived as unhealthy. Drivers of food selection included pressure exerted by children, taste, poor knowledge and affordability. This study provides more clarity on factors influencing food selection by parents and how policy efforts may influence purchasing behavior of South African parents. These results strengthen the importance of implementing WLs in South Africa to benefit children health.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Biomedical Research Ethics Committee; University of the Western Cape. The patients/participants provided their written informed consent to participate in this study.

Author contributions

MB, LT, and RS conceptualized the study and contributed to the study design. MB collected and analyzed the data and drafted the original manuscript. RS acquired funding for the study and supervised the project. LT and RS reviewed and edited the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2022.939937/full#supplementary-material

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CHAPTER 8: DISCUSSION, LIMITATIONS AND CONCLUSIONS

8.1 Introduction

This chapter discusses the study's findings, conclusions and recommendations, as guided by the research questions. Phase 1 of the study (Publication #1) aimed to explore participants' opinions of the WL and to develop a WL, modelled on the Chilean WL, specifically designed for the South African context. Phase 2 of the study (Publication #2) aimed to compare three different FOPL systems, including the WL developed in phase 1, to identify the system that was the best understood and the most effective in discouraging the purchase of unhealthy products. Phase 3 of the study (Publication #3) aimed to explore parents' perceptions of the influence and effects of the WL on their day-to-day food selection for their children.

8.2 Rationale for the study

The prevalence of obesity and NCDs is rising, both globally (2021 Global Nutrition Report, 2021; World Health Organization, 2020a) and locally (National Department of Health *et al.*, 2019; Statistics South Africa, 2017a, 2018). No country in the world, South Africa included, is on track to halt the increasing prevalence of obesity or to reduce the rate of mortality from NCDs by 25% by the year 2025 (World Obesity Federation, 2020, 2023; 2021 Global Nutrition Report, 2021).

The current nutritional information tables, located at the back of food packages, are difficult to interpret and therefore not effective in guiding consumers to make informed food choices (Kelly & Jewell, 2018; Newman *et al.*, 2018). Front-of-pack labelling (FOPL), though, is recognised as an effective means of presenting nutrition information in a simple and visible manner, thus nudging consumers towards healthier diets (WHO Regional Office for Europe, 2020). A wide variety of FOPL systems currently exist, each of which differs in terms of its level of complexity and objectives (Kelly & Jewell, 2018; Newman *et al.*, 2018). It is incumbent upon each country to determine and implement an FOPL system that is suitable, given its strategic objectives and sociodemographic profile (WHO Regional Office for Europe, 2020). Currently South Africa does not implement any FOPL system. The primary aim of this study, therefore, was to develop an FOPL system to assist all South Africans to select healthier foods (and thus ensure diets), regardless of age and literacy level.

8.3 Summary of findings

8.3.1 Development of a WL

Phase 1 of the study (Publication #1) started off with the design of a WL based on evidence of its success in discouraging the consumption of unhealthy food in Chile (Correa *et al.*, 2019; Taillie *et al.*, 2021). Through consultations with local and international experts in nutrition, health, health promotion, economics, communication and media, the researchers proposed a WL that would be appropriate for the South African context. Several WL elements deemed to represent a warning in South Africa were also identified by the expert group and these were tested among South African consumers to identify the features to include in a South African WL. Overall, the participnats had a positive attitude towards the WL and found it both easy to understand and educational. Participants suggested a black triangle against a white background, the inclusion of the text, 'WARNING' and 'HIGH IN' in bold and in capital letters, an exclamation mark, icons, and the WL being placed at the top of the food package. These recommended features were also suggested in other studies (Cabrera *et al.*, 2017; Popova *et al.*, 2019; Taillie *et al.*, 2020a; WHO Regional Office for Europe, 2020; Wogalter, 2020).

Warning labels incorporate warning elements that are locally recognisable and thus make the nutrition information accessible to all (WHO Regional Office for Europe, 2020). Participants in phase 1 of the current study remarked that the triangle reminded them of the warning signs used in construction sites and recommended the inclusion of an exclamation mark, a unique feature in the WL in South Africa, which is used in road signs in South Africa. Such elements improved participants' understanding of the nutrition quality of products and enabled them to recognise that they were being warned about the products carrying these labels.

Previous studies reported the effectiveness of the WL in improving understanding of nutrition information (De Morais Sato *et al.*, 2018; Moran & Roberto, 2018; VanEpps & Roberto, 2016; Vargas-Meza *et al.*, 2019a). Participants in the current study indicated that the WL triggered thoughts about the health consequences of consumption of such products, with some participants indicating that they felt they would in future purchase fewer products with warning labels.

These findings support the notion that the effectiveness of a WL in one country does not automatically imply success in a different country (WHO Regional Office for Europe, 2020). For example, consumer testing revealed that a red circle represented a stronger warning sign among the Israeli population (Endevelt *et al.*, 2017; Global Agricultural Network Information Israel, 2018), whereas the black stop sign was deemed more effective in Chile as it was more distinguishable on the packaging (Corvalán *et al.*, 2013; Reyes *et al.*, 2019). Additionally, the simplicity of the WL that includes icons depicting nutrients of interest ensures labels' effectiveness among the illiterate and children (Houts *et al.*, 2006; Kelly *et al.*, 2009; Kleef & Dagevos, 2015). The recommendations emanating from the focus group discussions were considered when designing the final WL for South Africa.

8.3.2 Determining the most effective WL

The three outcomes measured in phase 2 of the current study (Publication #2) revealed that participants exposed to the WL were more likely to identify products high in nutrients of concern, to identify unhealthy products and to be discouraged from purchasing unhealthy products, compared to those exposed to either the GDA or the MTL. Phase 2 included a nationally representative sample, with participants from various sociodemographic backgrounds.

The phase 2 results reaffirmed the phase 1 finding that the WL, which incorporated familiar, local features, was more effective in informing South Africans about the nutrition quality of food products – irrespective of consumers' sociodemographic standing. This finding was consistent with findings from other studies which showed the effectiveness of the WL in assisting consumers identify unhealthy products (Arrúa *et al.*, 2017; Neal *et al.*, 2017; Newman *et al.*, 2018; Todd *et al.*, 2022). Although all three FOPL systems in the current study had the effect of modifying purchasing intentions, the WL (more than the GDA or MTL) influenced participants' intention to purchase fewer unhealthy products.

The above findings are not unique to the current study (Grummon *et al.*, 2019; Jáuregui *et al.*, 2020; Song *et al.*, 2021; VanEpps & Roberto, 2016). The interpretative nature of the WL may explain the difference in the performance among the three FOPL systems. The WL, by nature, interprets and simplifies the nutrition information, making it easier for consumers to comprehend the nutritional profile of food products. The use of familiar features enhances the nutrition information understanding, even among less literate individuals. Although the MTL is semi-interpretive, consumers are still required to interpret the colour codes, which may be difficult for consumers, particularly in the case where different colours appear together on a product (De la Cruz-Góngora *et al.*, 2017; Machin et al., 2018). On the other hand, the GDA has been reported as the worst performing in assisting consumers understand the nutrition information due to its noninterpretive nature (Hutton & Gresse, 2022; Jones *et al.*, 2019)). Consumers report the GDA difficult to comprehend due to the scientific terminology and the nutrient amounts presented on the label. Based on the phase 2 findings, the WL was then further explored among parents in phase 3 of the current study to determine its influence on parents' food choices for their children (Publication #3).

8.3.3 Parents' perceptions of the WL

Participants in phase 3 stated that the words 'HIGH IN' applied to product packages enabled them to identify unhealthy products and those containing excessive amounts of nutrients of concern – a feature that is unique to the WL (Kelly & Jewell, 2018). Participants based their judgement of products' nutritional quality on the presence of the text, 'HIGH IN' and 'WARNING', which they interpreted as a sign of the unhealthiness of a product. For example, some participants mentioned that food high in fat is unhealthy and may cause weight gain. Other studies have produced a similar outcome – where the WL was regarded as the most effective in assisting consumers to identify unhealthy products (Arrúa *et al.*, 2017; Neal *et al.*, 2017; Newman *et al.*, 2018; Todd *et al.*, 2022) and products containing excessive amounts of nutrients of concern (Khandpur *et al.*, 2018a; Hock *et al.*, 2021).

Participants indicated that the products displayed during the data collection process were those that they usually bought for their children and that the WL increased their awareness of these products' unhealthiness. These findings support the conclusion by Moran and Roberto (2018) that the WL may be a necessary tool to change parents' perceptions about the healthiness of food they previously thought was healthy. The educational impact of the WL could be used to support other initiatives, such as the inclusion of the WL in school curricula to educate children about food choices from a young age, the introduction of restrictions on marketing of unhealthy food to children, and the banning of unhealthy food in schools (Corvalán *et al.*, 2019). Negative effects, such as fear, worry, doubt and perceptions of high risk, are precursors to behaviour modification (Glanz *et al.,* 2002) – which may explain the expressed intention among participants in the current study to purchase fewer unhealthy products. Other authors reported similar findings – that the WL evoked negative feelings and more thoughts about the potential health hazards associated with the consumption of unhealthy food (Hall *et al.*, 2021; Taillie *et al.*, 2020b).

Participants shared that their children's health was a priority and that they would not willingly put their children's health at risk. Some participants indicated that they wanted their children to be healthy from a young age – hence their intention to modify their purchasing behaviour vis-à-vis labelled products. Furthermore, participants stated that the WL reminded them of the health consequences (and possible future health complications) of overconsumption of such labelled products (Roberto *et al.,* 2016).

Given the evidence of habituation and the ‘wear-out’ effect of labels over time, it is important for the government to ensure that the WL maintains its effectiveness (White *et al.*, 2015; Wogalter, 2020; World Health Organization, 2013b). Suggested strategies for reducing the risk of wear-out include designing and rotating different WLs or altering some of the design elements on the existing WL (Cunningham, 2022). According to Halim (2019), understanding the health risks associated with a product can play an important role in food choices. The current study investigated participants’ intentions to purchase. Naturally, it would be illuminating to conduct future evaluation – post-FOPL implementation – to determine how these intentions translated into actual UPF purchases by parents.

8.3.4 Integration of the three phases of the study

The golden thread running throughout the three phases of this study was that the WL, designed within a South African context (phase 1), was the most well-understood FOPL system among participants, assisted participants in identifying unhealthy products, and reduced participants’ intention to purchase unhealthy products in the future. Compared to the other two FOPL systems, the WL performed the best (phase 2). During further discussions in phase 3, participants stated that the words ‘HIGH IN’ applied to product packages enabled them to identify excessive nutrients – a feature unique to the WL (Kelly & Jewell, 2018). Similar findings were reported in other experimental studies (Khandpur *et al*., 2018a; Hock *et al*., 2021).

Similar to the findings in the current study, the literature emphasises that consumers find it difficult to interpret the numbers in the GDA (Deliza *et al*., 2020; Egnell *et al*., 2018) and difficult to interpret the colours in the MTL, particularly if the label contains different colours for two or all nutrients (De la Cruz-Góngora *et al*., 2017). Such challenges weaken the effectiveness of the GDA and MTL; hence, simpler and clearer labelling is required. The challenge with interpreting the MTL was however not reported in a study by Pettigrew *et al.* (2023). Another study reported that consumers with a high level of education found the WL too simplistic as it denied them access to actual amounts of nutrients in various food products. The FOPL does not replace the nutritional information tables, and consumers will continue to have access to the information at the back of the pack. The FOPL, though, is meant to be simple enough for all consumers to understand.

In the current study, participants indicated that they would modify their purchases of products bearing a WL either by reducing the frequency and quantity they purchased or by quitting purchasing such products altogether. These intended altered behaviours were attributed to feelings of fear and doubt evoked by the warning elements of the WL, particularly the words 'WARNING' and 'HIGH IN' and the mention of nutrients contained in high amounts, as well as the presence of the exclamation mark. These were the attributes that participants in phase 1 of the current study said constituted a warning. There was therefore a common theme running across all phases of the study.

Regarding the phase 2 results, not all participants indicated their intention to reduce their purchases of unhealthy products. These findings were reinforced in phase 3 where some participants indicated that they would continue purchasing products with a WL. Reasons given for their continuing to buy these products, despite the presence of the WL, included pestering from their children, affordability, poor nutrition knowledge and a desire to accommodate their children's food preferences. As reported in other studies, reasons for parents' food selection included children's 'pester power' (Huang *et al.*, 2016; Institute of Medicine, 2006;), the cost of food (Machín *et al.*, 2016; Maubach *et al.,* 2009), poor nutrition knowledge (Horstmann *et al.*, 2021) and a wish to satisfy their children's food preferences and tastes (Bathgate & Begley, 2011; Machín *et al.*, 2016). Childhood presents a golden opportunity for the prevention of NCDs, as habits developed at a young age can be carried over into adulthood (The NCD Alliance, 2011; Yan & Mi, 2021). Policies that support healthier eating at this life stage are therefore not only important but also urgent as they can halt the growing scourge of obesity, and the escalation rates of obesity-related morbidity and mortality among both young and old.

In 2018, the South African government implemented the Health Promotion Levy (SSB tax) in an effort to promote healthier diets, and the tax has led to a reduction in sugar consumption in the country (Essman *et al.*, 2021; National Treasury, 2018; Stacey *et al.*, 2021). This points to the beneficial effect of unhealthy food products being taxed. A lesson from other countries is that multiple strategies are required to achieve substantial reductions in the consumption of unhealthy products. In Chile, for example, the implementation of the WL, together with marketing restrictions to children and a ban on unhealthy food sales in schools, have resulted in a substantial decrease in unhealthy food purchases (Taillie *et al.*, 2021).

8.4. Contributions of the study

The current study contributes to new knowledge as it offers insights into the way in which the WL design communicates a warning to the South African population. Overall, participants were positive about the WL and found it conspicuous, easy to understand and educational. In terms of the optimal design, participants suggested a black triangle against a white background; the inclusion of the words, ‘WARNING’ and ‘HIGH IN’, which are in bold and capital letters; the inclusion of an exclamation mark and icons; and the WL being placed at the top of the food packaging. Participants’ opinions on features depicting a warning and those that would discourage purchases of unhealthy products were used as a basis for the proposed WL for South Africa.

The study provides evidence that, compared to the GDA and the MTL, the WL is the most understood FOPL in South Africa. The WL proved to be more effective in assisting consumers to identify products containing excessive amounts of nutrients of concern, to identify unhealthy products, and to alter their intention to purchase unhealthy products in the future.

Parents, for example, reported that the presence of the WL on products would make them reconsider their purchasing habits. Parents stressed that their children’s health was a priority, and that they were interested in feeding their children well. This sentiment was shared by parents from both lower and higher socioeconomic and sociodemographic backgrounds, thus showing the value of the WL among people from diverse backgrounds. During the discussions, some of the parents admitted that they were continuing to buy unhealthy products because of pestering from their children, the cost of food and their desire to accommodate their children’s food preferences. It was also evident that some parents’ food choices were the result of poor nutrition knowledge.

The evidence produced in this study in support of the need for an effective FOPL system in South Africa led to the formulation of the current draft Regulation 3337 (R3337) related to food labelling and advertising of foodstuffs. This draft regulation was gazetted by the South African National Department of Health (21 April 2023) (National Department of Health, 2023) and proposes the adoption and implementation of the WL together with the NPM that was developed for the South African WL. While the adoption of the WL is a welcome initiative that will help to improve the diets of South Africans, certain mechanisms need to be put in place to ensure its ongoing effectiveness. As indicated in Chapter 4 of this thesis, some countries have not mapped out their enforcement strategies and monitoring and evaluation plans. If these are overlooked in South Africa, it may weaken the country’s efforts to implement the FOPL system (Jones *et al.*, 2019; WHO Regional Office for Europe, 2020).

8.5. Recommendations arising from the study

8.5.1 Recommendations for policymakers

The current study's findings provide policymakers with scientific evidence of the need for an FOPL system that is specifically designed for the South African context. Based on the study's findings, it is recommended that a WL in the form of a black triangle be implemented in South Africa.

The findings from this study point to the WL being used as a possible policy tool to assist consumers to easily identify unhealthy products, including UPF and thereby encourage healthier diets in South Africa. Consumption of UPF continues to escalate in South Africa and the implementation of the WL is one step in the right direction towards reducing their intake. To optimise the WL's value, it is recommended that the FOPL system be implemented in tandem with supporting strategies, such as mass campaigns about the value of FOPL (Pereira *et al.,* 2023), the inclusion of the WL in school curricula, and the formulation of appropriate policies, including marketing restrictions and the banning of sales of unhealthy products to children in schools (Corvalán *et al.*, 2019). South Africa currently lacks such policies but local policymakers could possibly be swayed by best practices in other countries such as Chile where the simultaneous implementation of the WL, restrictions on marketing and banning of unhealthy food in schools had a marked effect on purchasing and consumption behaviour. South Africa could learn from such positive experiences and outcomes (Taillie *et al*., 2020c; Taillie *et al*., 2021).

It is concerning that at present South Africa does not have a system of defining unhealthy foods. Thus, the implementation of the WL and an appropriate NPM would go a long way towards distinguishing between unhealthy and healthy foods, which would not only inform consumers' food purchases but would also reveal to the government what products to regulate or ban.

Despite its potential benefits, the implementation of the WL will only be effective if certain measures are put in place. These include the enforcement of regulations by government to ensure compliance, as well as structured and regular monitoring and evaluation, with clear outcomes and timeframes to assess implementation and impact (Jones *et al.*, 2019). This study recommends that there should be frequent monitoring of the WL implementation by the Department of Health. The monitoring activities could include spot checks by health inspectors, monitoring of changes in product purchases, evidence of product reformulation, and changes in consumer perceptions towards the WL. Furthermore, based on the evidence in Mexico that reductions in purchasing of products bearing a WL were higher in the second year than in the first year after implementation, this study recommends that evaluation studies be conducted after two years of implementation of the WL in South Africa. The literature from the tobacco industry points to the habituation of the WL after a certain period, and so this study recommends rotation of the WL every three years to minimise the risk of label wear-out. These plans need to be outlined before the implementation of the FOPL system to ensure implementation success (Kelly & Jewell, 2018; World Cancer Research Fund International, 2019).

Food insecurity remains a challenge in South Africa (Statistics South Africa, 2019), limiting food choices among the disadvantaged. In tandem with policies that restrict consumption of cheaper and nutritionally inferior food products high in nutrients of concern, policymakers should consider other policies, such as subsidising fresh and healthy products to make food more affordable. The South African government currently exempts certain basic foodstuffs, such as brown bread, maize meal and fruit and vegetables, from Value Added Tax (VAT) (Jansen & Calitz, 2017) to improve affordability. However, this seems insufficient given the high food prices in South Africa. It is also hoped that product reformulation will not result in more price spikes. According to McLaren *et al.* (2010), price increases could be an unintended consequence of product reformulation. More work needs to be done in this area.

8.5.2 Recommendations for future research

Label understanding may not be the best outcome of label effectiveness testing as understanding may not necessarily translate into behaviour modification (Braesco & Drewnowski, 2023), particularly as other studies have not established a link between label understanding and purchasing habits (An *et al*., 2021; Braesco & Drewnowski, 2023). According to the literature, the most effective evaluation measure is the evaluation of actual purchases (WHO Regional Office for Europe, 2020). Other evaluation measures include impact on product reformulation, impact on actual dietary intake and impact on health outcomes, such as obesity and NCDs rates (Braesco & Drewnowski, 2023). Although the findings from the current study provide a useful starting point, implementers should go beyond label understanding and include more evaluation studies. Several gaps related to nutrition literacy were identified in all three phases of the current study. This study therefore recommends that a thorough quantitative study be conducted to investigate nutrition literacy among South Africans.

8.6 Limitations

This study was experimental and none of the three phases tested real-life scenarios. Understanding and intentions may not directly translate into actual behaviour in a real-shopping environment.

Consequently, there is a need to explore actual purchasing behaviour in a real-life scenario. However, this is only possible once the WL is implemented as a policy.

Social desirability is a likely form of bias in this study, especially in phases 1 and 3, as participants could have responded to please the researchers. This form of bias was minimised by the researchers explaining to the participants that participation was voluntary and that there were no correct or incorrect responses, and by probing during discussions to delve more deeply into participants' responses.

Another limitation is that phase 3 (qualitative) of the current study only included rural participants, and so the results may not necessarily be generalisable to the entire population. However, the findings from phase 1 (qualitative) of the current study and the findings from a study by Jáuregui *et al.* (2022) reveal that the WL produces similar responses across different socioeconomic groups. Based on the findings from these latter studies, the current findings may be deemed applicable to all South African population groups and will contribute to population policies that are aimed at improving dietary intakes of children. Future studies may include a larger sample size that incorporates both rural and urban populations.

The other limitation is that real-life FOPL policies, together with their NPMs, were implemented but the NPMs were not standardised across the groups in the RCT. This lack of standardisation makes it difficult to determine the extent to which the outcomes of the RCT were due to the FOPL graphics or the NPM. It is therefore recommended that future studies be conducted in which the NPM is standardised.

Another limitation is that only three FOPL were tested in this study and it is therefore not known how the participants would have responded to the other FOPL formats. This study however focused on FOPL that would not potentially mask the presence of high levels of nutrients of concern, hence only the three FOPL were tested. Additionally, the three represent different FOPL categories and provide the necessary information to guide policy makers regarding the FOPL suitable for South African consumers.

8.7 Conclusion

The findings from this study confirm the potential of the WL to improve understanding of nutrition information within the South African population. The WL that was developed, based on participants' recommendations, features a black triangle set against a white background, the word 'WARNING', an exclamation mark in one of the triangles, an icon and the words 'HIGH IN' indicating the nutrient(s) in excess. A further recommendation was for the label to be positioned in the top right corner of the product packages.

These findings have important policy implications for the government departments tasked with promoting healthier food choices among South Africans. Adopting healthier eating patterns is considered key to reducing obesity and NCDs in the country. The implementation of the WL in South Africa could therefore serve as a first step towards halting the increase in obesity prevalence and reducing the incidence of NCDs.

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Appendix 1: BMREC (18/9/13) Registration and BMREC (18/9/13)Renewal

UNIVERSITY of the WESTERN CAPE

OFFICE OF THE DIRECTOR: RESEARCH
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18 November 2019

Prof R Swart
Dietetics and Nutrition
Faculty of Community Health Sciences

Ethics Reference Number:	BM18/9/13
Project Title:	Evaluating simplified nutrition information labels for South Africa.
Approval Period:	15 November 2019 – 15 November 2020

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report in good time for annual renewal.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

BMREC REGISTRATION NUMBER -130416-050

Appendix 2: Permission from PI to use data for PhD purposes

UNIVERSITY *of the* WESTERN CAPE

FACULTY OF COMMUNITY AND HEALTH SCIENCES

DEPARTMENT OF DIETETICS AND NUTRITION

31 March 2020

The Chairperson
Higher Degrees Committee
Faculty of Community and Health Sciences
University of the Western Cape
Robert Sobukwe Road
BELLVILLE
7535

Dear Sir

PERMISSION TO DO SECONDARY DATA ANALYSES ON EXISTING DATA

I am the PI on the research project "Evaluating simplified nutrition information labels for South Afria" (BM 18/9/13).

Hereby I grant permission to Makoma Bopape (student number 3924798) to use the data generated by this survey towards her PhD. She will have access to anonymized data only.

Kind regards

RSwart
RINA SWART
Supervisor

Private Bag x17, Bellville 7535, South Africa
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Appendix 3: BMREC (BM20/5/6) Registration

UNIVERSITY *of the* WESTERN CAPE

60 YEARS *of hope, action & knowledge*

22 June 2020

Ms MM Bopape
School of Public Health
Faculty of Community and Health Sciences

Ethics Reference Number:	BM20/5/6
Project Title:	The effectiveness of front of pack warning labels in assisting South African consumers to identify unhealthy packaged foods
Approval Period:	12 June 2020 – 12 June 2023

I hereby certify that the Biomedical Science Research Ethics Committee of the University of the Western Cape approved the scientific methodology and ethics of the above mentioned research project.

Any amendments, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

Please remember to submit a progress report annually by 30 November for the duration of the project.

Permission to conduct the study must be submitted to BMREC for record-keeping.

The Committee must be informed of any serious adverse event and/or termination of the study.

Ms Patricia Josias
Research Ethics Committee Officer
University of the Western Cape

Director: Research Development
University of the Western Cape
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Email: research-ethics@uwc.ac.za

NHREC Registration Number: BMREC-130416-050

FROM HOPE TO ACTION THROUGH KNOWLEDGE.

Appendix 4: Recruitment questionnaire

Recruitment Questionnaire

Date: ________________________ Month: ________________________ Year: 2019

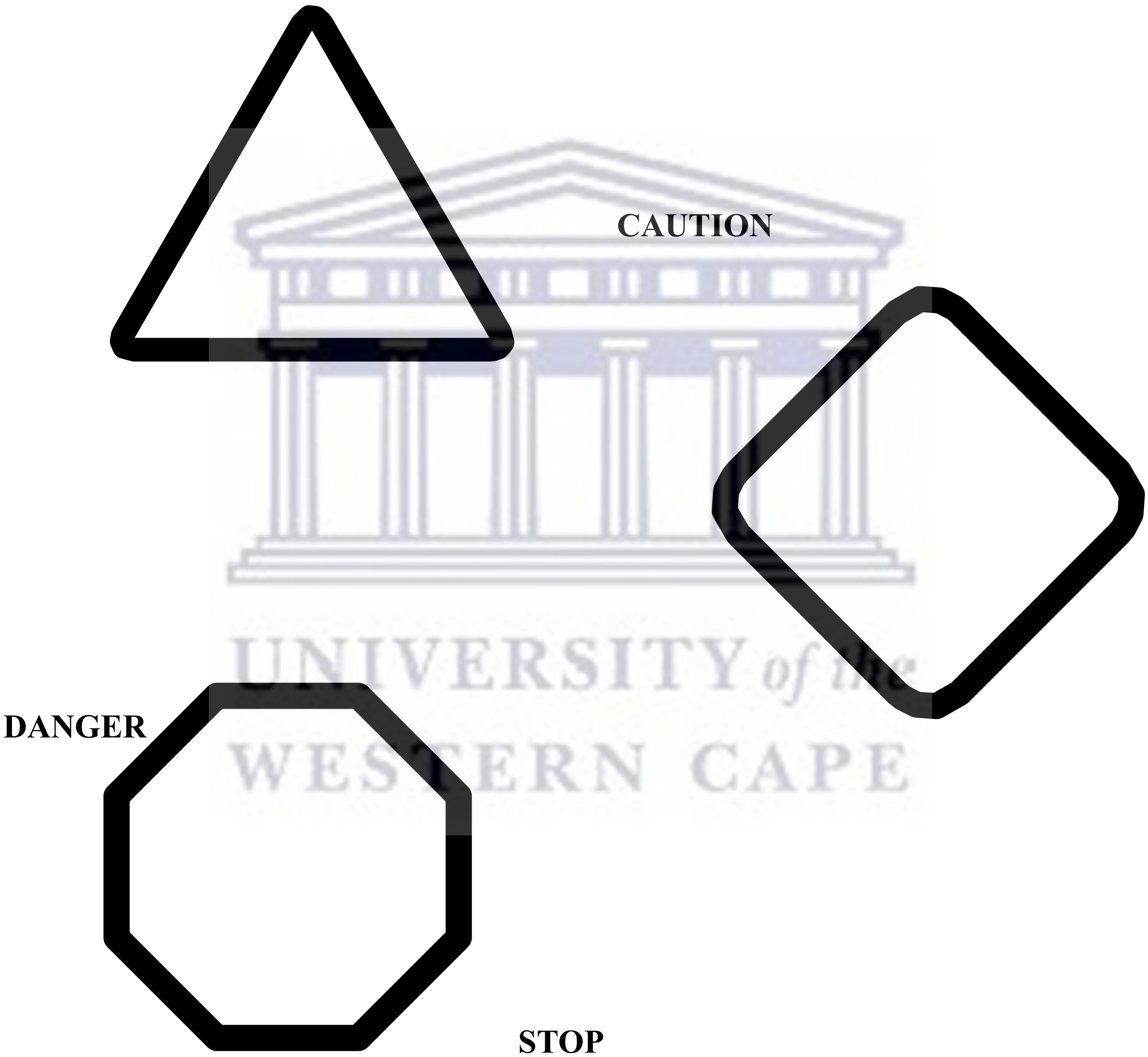
1	Location of residence	☐ Soweto ☐ Diepsloot ☐ Cosmo City ☐ Zandspruit ☐ Adams Mission ☐ Umbumbulu ☐ Ndwedwe ☐ Durban Central ☐ Khayelitsha ☐ Khayamandi ☐ Fisantekraal ☐ Gugulethu
2	Do you work in any of the following industries?	☐ Health promotion (thank and terminate) ☐ Market research (thank and terminate) ☐ Advertising (thank and terminate) ☐ Tobacco (thank and terminate) ☐ Food and beverage (e.g., supermarkets, restaurants, retail companies) (thank and terminate) ☐ None of the above (continue)
3	How often do you purchase branded packaged foods and drinks? *(ensure a mix of participants)*	☐ Never (thank and terminate) ☐ Rarely ☐ A few times a week ☐ About once a day ☐ Multiple times a day
4	Are you…?	☐ Male ☐ Female
5	Are you…?	☐ 18–35 yrs old ☐ 36–50 yrs old

6	Please indicate your highest level of education attained.	☐ No schooling (Not literate) ☐ Grade 1 – up to Grade 7 (low literacy) ☐ Passed Grade 7 and above (literate)
7	Please indicate your household income category *(check quota and ensure a mix of participants)*	☐ No income: R0 ☐ Low income: R1–R1 600 ☐ Middle income: R1 601–R25 600 ☐ Upper income: R25 601 and above
8	Are you the parent or caregiver for children aged 16 years and below? (*check quotas and ensure a mix of participants*)	☐ Yes ☐ No
9	Are you the main decision-maker for food purchases in your home? *(check quotas and ensure a mix of participants)*	☐ Yes ☐ No
10	Are you the main buyer of food and groceries in your home? *(check quotas and ensure a mix of participants)*	☐ Yes, I am the main buyer ☐ No, but I do share the responsibility ☐ No, I am not the main buyer
11	From where do you buy food and groceries most of the time?	☐ Loyalty clubs ☐ Stokvel clubs ☐ Retailers (supermarkets) ☐ Retailers (spaza shops, vendors) ☐ Other (specify) ____________________
12	In a typical week, how often do you consume packaged branded foods, such as breakfast cereal, crisps, sweetened beverages, sweets, biscuits, etc.? (*check quotas and ensure a mix of participants*)	☐ Never ☐ Rarely ☐ A few times a week ☐ About once a day ☐ Multiple times a day

Appendix 5: Options considered in developing the original warning label

SHAPES

These are internationally recognised warning shapes which are options available to us to create our warning labels.



SHAPES

We have decided to use the triangle and octagon as our holding shapes.

Our designs have used a combination of iconography and typography to communicate the warning message.

The triangle or octagon offers the best shape for the most effective design layouts.

The triangle, in conjunction with an exclamation mark, is a very recognised warning symbol in South Africa and is widely used in road signs for general warnings.

WARNING SHAPES FAMILIAR TO SOUTH AFRICANS


CRIME
ALERT
Do Not Stop


STOP

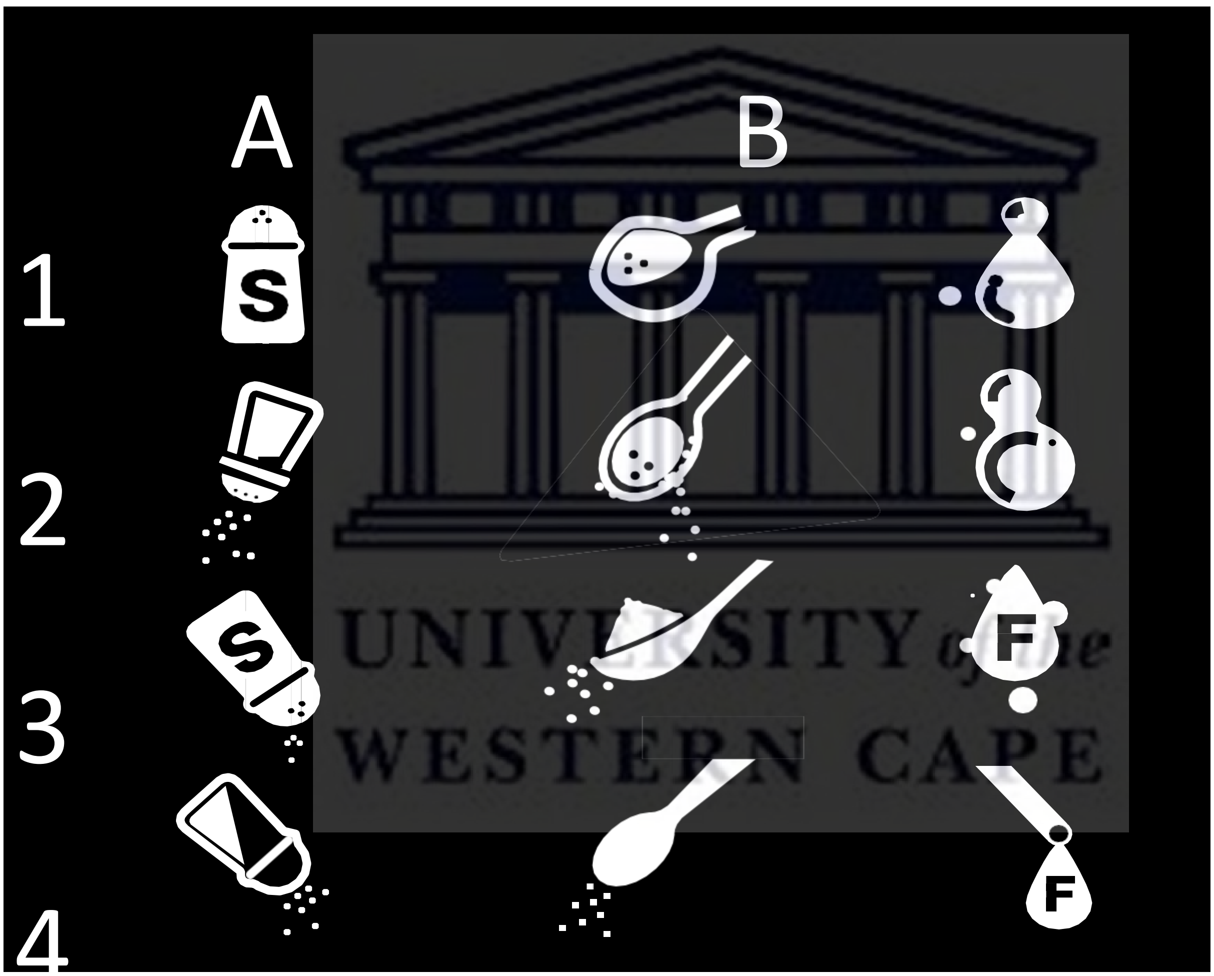

HI-JACKING
HOT SPOT


DANGER
CROCODILES

PICTOGRAPHY

A pictogram or icon conveys its meaning through its visual resemblance to a physical object. This can be very literal in the case of certain objects but also very vague in the case of others. In situations where the object is not an obvious one, the pictography can be bolstered with recognised warning symbols or typography.

We have designed four different icons for salt, sugar and saturated fat. The designs communicate clearly and effectively in any size.



We have chosen to use the Helvetica Neue typeface. Helvetica is a neutral typeface that has great clarity and no intrinsic meaning in its form. This will ensure that the combination of the icons and type will be clear and concise. Helvetica is authoritative in its design and will therefore give the warning symbols the required gravity in conveying their message.

HELVETICA NEUE

a b c d e f g h i j k l m n o p q
r s t u v w x y z
A B C D E F G H I J K L M
N O P Q R S T U V W X Y Z

Helvetica has been widely used by the US government. For example, federal income tax forms are set in Helvetica, and NASA used the typeface on the Space Shuttle orbiter. The Canadian government also uses Helvetica as its identifying typeface. In the European Union, Helvetica is legally required to be used for health warnings on tobacco products, such as cigarettes. Helvetica is also used for the application of health warnings on cigarette boxes in South Africa.

Appendix 6: Focus group confidentiality binding form

UNIVERSITY OF THE WESTERN CAPE

Private Bag X 17, Bellville 7535, South Africa
Tel: +27 21-959 2809, Fax: 27 21-959 2872

E-mail: soph-comm@uwc.ac.za

FOCUS GROUP CONFIDENTIALITY BINDING FORM

Title of Research Project: **The effectiveness of front-of-pack warning labels in assisting South African consumers of different age groups to identify unhealthy food options**

The study has been described to me in language that I understand. My questions about the study have been answered. I understand what my participation will involve and I agree to participate of my own choice and free will. I understand that my identity will not be disclosed to anyone by the researchers. I understand that I may withdraw from the study at any time without giving a reason and without fear of negative consequences or loss of benefits. I understand that confidentiality is dependent on participants' in the Focus Group maintaining confidentiality.

I hereby agree to uphold the confidentiality of the discussions in the focus group by not disclosing the identity of other participants or any aspects of their contributions to members outside of the group.

Participant's name………………………………………..

Participant's signature…………………………………..

Date………………………

Appendix 7: Sociodemographic questionnaire used in phase 1 of the study

Demographic Section

Are you ….. ?	Male	**1**
	Female	**2**
How old are you?	18–24 years	**1**
	25–29 years	**2**
	30–39 years	**3**
	40–50 years	**4**
What is your highest level of education?	No formal schooling	**1**
	Completed some formal schooling but did not complete primary school (>Gr 1 and <Gr7/Std 5)	**2**
	Completed primary school and some secondary Schooling	**3**
	Completed secondary schooling (Grade 12/matric)	**4**
	University degree	**5**
Do you have children between the ages of 3 and 16 who reside with you?	Yes	**1**
	No	**2**
Which of the following best describes your main work status over the past 12 months?	Unemployed	**1**
	Self-employed	**2**
	Wage earner	**3**
	Part-time employed	**4**
	Casual worker	**5**
Which of the following categories best describes your <u>combined monthly household</u> income category?	No income: R0	**1**
	Low income: R1–R1 600	**2**
	Middle income: R1 601–R25 600	**3**
	Upper income: R25 601and above	**4**

Appendix 8: Focus group discussion guide used in phase 1 of the study

MODERATOR'S GUIDE

Purpose of the Moderator's Guide

This research guide has been developed for the use of the group Moderator for efficient conduct of the research. This guide should be used to steer group discussion to the specified topic areas that need to be covered and the specific questions of interest within each topic area.

Overview of the Moderator's Tasks

The Moderator is required to lead participants through all components of the research. They are to provide instructions, answer questions, and maintain a level of focus and motivation among the group.

Before the study begins, the following need to be done:

1. Labels for testing: Labels for testing will be superimposed onto mock-up packs of four different food and drinks packages (*note, four is likely the minimum number of packages required in most countries to test the labels on varied packaging shapes)*. Proposed food packages are chips/crisps (square packet), cereal (rectangular box), yoghurt (yoghurt container) and fruit juice (bottle). An image of the 4 packaged foods/drinks with the label will be projected onto a screen (Appendix D – Visual tool). Therefore, just prior to the testing, the moderator should confirm that the audiovisual material, including the order of the presentation, is ready. Prepare a colour printed version of the material to be projected on screen as back-up for each participant (screens are often small in the focus group rooms).

2. Some careful thought should be given to how the respondents are seated for the discussions. They should be seated so that they can all see the material that will be presented to them easily. The seating should also encourage involvement and discussion from all participants in the group. Keep in mind that participants will have to complete rating sheets (Appendix E) independently. Clipboards or small tables will be useful for this aspect.

3. Prepare and check all recording and web casting equipment.

4. Ask participants to read the information sheet (Appendix F) and complete the consent form (Appendix G) as appropriate, including on camera if required by the Biomedical Research Ethics Committee for illiterate participants, and then fill out the short demographics questionnaire (page #2 in the Rating sheet booklet) for

use for later analysis, while they wait.

The research assistant should be present to help with note taking and to assist participants, without leading or biasing responses, as necessary (for example, to assist low literacy participants to fill out the rating exercise).

Note, most questions in this Moderator's Guide are qualitative and are to be discussed. A few questions require ratings to be provided; however, for no-literacy groups, rather than provide written ratings, verbal reactions may be sought.

5. Ask all participants to turn off their mobile phones (if they have them).

During the group discussions, the Moderator's roles and responsibilities are as follows.

a. The Moderator will need to facilitate open discussion among all participants. They must also manage the duration of the discussion, ensuring that all elements of the label are given the same amount of discussion time, and that the discussion remains focused.

b. It is not necessarily intended that these questions be asked exactly as they are worded here. The discussion should be more like a conversation than a set of structured questions. The discussion should be as informal as possible, and participants should be encouraged to speak openly and freely.

c. To the point above, the Moderator should set the pace of questions appropriately – even as she probes in all questions in the moderator guide, she may increase or slow down the speed of the discussion based on participants' engagement in the discussion. The Moderator will have to exercise own judgment to achieve a balance between thoroughness and avoidance of redundancy in the line of questioning.

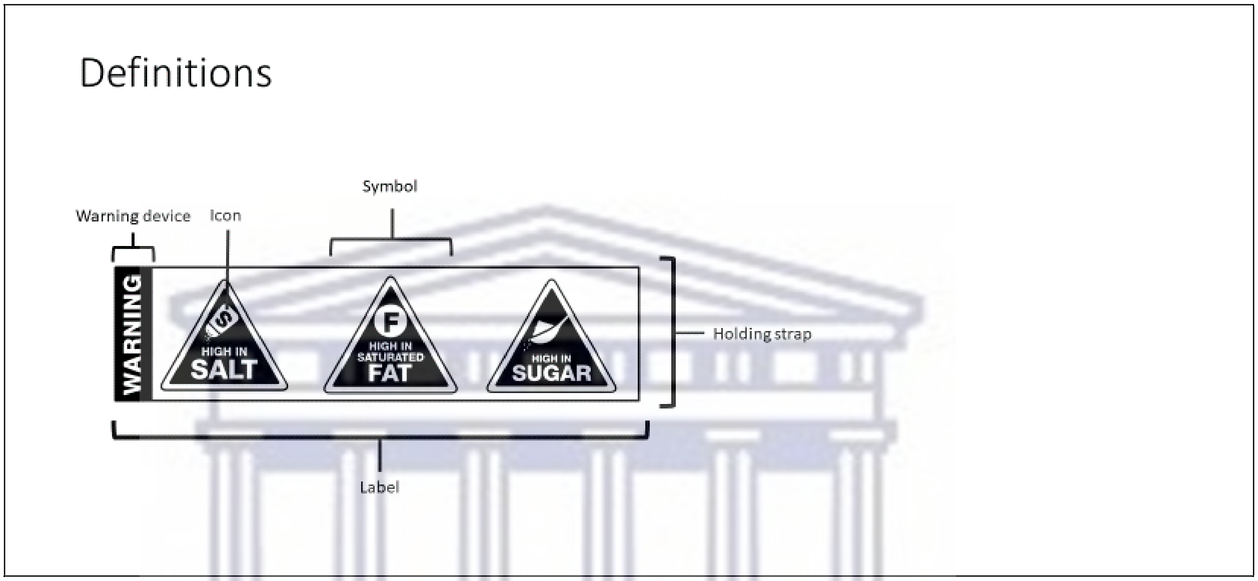
d. The Moderator will need to probe with questions such as "Why?" and "What does that mean to you?" in order to fully understand participants' responses.

e. The Moderator will also need to make sure that all participants in the group have an opportunity to express their opinions at different times during the discussion.

f. Because each group of participants may be different, a responsive approach should be used for the research. That is, the Moderator should be flexible in their conduct of each group, to allow for individual and group reactions to each element of labels and discussion points. For this reason, the groups may vary in terms of the topics covered and the focus of issues that are discussed.

g. The Moderator and research assistant will need to facilitate the completion of a rating sheet during the session. Please take careful note of moments in the session when ratings ought to be conducted.

h. Moderator: The following are the elements of the front-of-pack (FOP) warning label that will be tested. Please familiarise yourself with them so that you may guide the participants effectively.



MODERATOR SCRIPT:

1. Introduction and explanation to participants:

"Hello, my name is……, and I will be conducting the session today, and this is ……, who will assist me by taking notes and helping in the conduct of the research.

Thank you for participating in this study today. We're interested in people's reactions to proposed labels for the front of food and drink packages. I will show you a label that is being proposed. I will ask you for your reactions to it.

This study is all about YOUR experiences. There are NO right or wrong answers to anything we discuss today. Having your honest opinion is very important. When you were invited to participate in this discussion today, you already received an information sheet (Appendix F) explaining the purpose of the study as well as the measures that will be taken to ensure that your identify will not be revealed to anyone, and that you may stop participating at any time without negative implications for yourself. Please be assured that your identity will not be revealed to anyone outside this research project. Your answers will be combined with the answers of others so that your identity cannot be known. Therefore, please answer all questions without hesitation. If any of you have questions about the project and your participation, I can answer those questions now. Please also feel free to stop me during the discussion if you think of another question.

As we are here as part of a group, you will hear information about the others in this room and you will also hear their opinion on the labels that we will show you. To give each one in his room the assurance that their identity and their opinions will not be shared by any of you outside of this room, we also need to agree with each other that we will not share information with others. In front of you, you will find a consent form stating all of this (Appendix G) which you can sign as such an agreement to each other. Does this sound okay to you? Shall we proceed? *[Moderator, please note that the consent form must be a loose page – not bound in the booklet with responses – and must be collected before participants proceed to fill in the forms, in order to signal separation of their names/signatures from their responses.]*

With your permission, we would like to record the group. [*Moderator, if the groups are being viewed from a one-way mirror, or if they are being webcast, please inform the participants of this and assure them of the confidentiality of their participation.*] The recording will only be used to help us with analysing the results. Your personal details are confidential, and we will not keep or pass on any personal information about you. Is it OK for us to record the group? Can each of you please sign the consent form to indicate your agreement.

[Turn the recording equipment on to record this part of the research – the recording will help with analysing the results and key points from the discussion.]

[Moderator: Ensure that all participants have completed the demographic questionnaire on page #2 of the booklet before commencing. If some have not done so yet, then allow them to finish it here before you begin.]

Warm-up: Participants' introduction

Before we go on to the discussion on labels, it would help us to know a little bit about each of you and for us to get to know one another. Please tell us your name, where do you live, and something about yourself ... I'll start

….

[NOTE to moderator: The goal here is to introduce each person and make everyone comfortable with one another.]

Discussion about the proposed label

Now, I am going to show you an image of some products and then we will discuss what you see. First, I want to make sure that you can all see the image that I project clearly, so I will show you a trial image and once you confirm that you can see it clearly, we will proceed to the main image. ***QUESTIONS HAVE BEEN REMOVED AS THEY ARE NOT PART OF THIS PAPER AND ALL OTHER QUESTIONS THAT ARE NOT PART OF THIS PAPER HAVE BEEN REMOVED.***

[Then, proceed to show the main image for testing. Keep it up for 10 seconds or so until everyone seems to have seen it clearly. Then turn off the image.] [SHOW SLIDE #4]

Visibility/Memorability

- Did you notice any labels on the packages? Before we discuss it together, in the questionnaire before you, please turn to page #4 *[Moderator, direct participants to the appropriate place in the booklet.]* ***QUESTIONS HAVE BEEN REMOVED AS THEY ARE NOT PART OF THIS PAPER***

- Now, I'm going to project the image back up again and this time I want you to focus closely on a set of labels you will see on the front of the food and drink packages. Study this set of labels closely and I will ask you some questions about it. *[SHOW SLIDE #4]*

[Moderator: Project the image back again for about 10 seconds. Point to the FoPLs and ensure that all participants have seen it clearly. Once all participants have seen it clearly, turn off the image.]

[If necessary, reiterate the following:] I would like to reiterate that your experience is really important and there is no right and wrong answers. Also, as we are talking about your personal opinions and experiences, it is not necessary for everyone to agree with each other. It is helpful for us to find out the different opinions that people have, as well as where people have the same opinions, so please feel free to tell us whatever you think and feel, even if it might be different to what other people in the room are saying. Also, let's please make sure that only one person speaks at a time. Please allow each person to complete what they are saying.

<u>Visibility/Memorability</u>

- Was the label easily visible? Did it grab your attention? How visible was it? Was it immediately visible or not? Did it catch your eye?
- Was the label memorable?
- Can you recall it for me now? What exactly did it look like? What do you recall of its shape, colour? Was there any text in it? What did it say? *[Without leading their answers, probe respondents' memory of its shape, colour, text, icon, etc.]*

<u>Comprehensibility</u>

- What do you think is the purpose of these labels?
- What did you understand from the labels?
- Were the labels indicating that the food and drinks were healthy or unhealthy?
- Was it easy to understand? Is there anything you did not understand or that confused you about it?
- Who is it directed to? Do you think it is directed to you? If not, you who do you think it is directed to?
- Was it believable?
- Is there anything about this label that is culturally inappropriate? Is there anything about it that is likely to be difficult to understand/interpret in South Africa?

<u>Potential effectiveness</u>

- Did it change your attitudes towards the food/drinks that you just saw?
- How did it change attitude, if at all?

- If you were to see this label on packages in a store, would it affect your decision to purchase that product or not? *How* would it affect your purchasing?

- Think of a packaged food or drink that you typically buy. If that product had this label, would it affect your purchase of it? How would it affect your purchase? Would it increase or decrease how often you purchased it?

- In your opinion, what would be the benefits of placing labels like this on unhealthy foods? Whom will they help?

- In your opinion, what are the harms of placing labels like this on unhealthy foods? Whom would they hurt?

- How do you think that labels like this can help/hurt South African society? DO you think they would be effective in addressing the obesity epidemic among adults? … Among children? Why or why not?

<u>Improvements to the label's memorability</u>

- What aspect of the label had the most impact on you and why?

- What was most MEMORABLE in these labels? What image do you remember most? What words do you remember most?

- Was there anything offensive or inappropriate about it?

[NOTE TO RESEARCH PRIMARY INVESTIGATORS: *What follows from this point on in the protocol is a means for testing alternatives to elements in the original label. In the sections that follow, we provide questions to test alternatives to ALL of the label elements. And, we suggest how additional label features may be tested, such as label size and placement. However, note that the execution of all of the following sections may cause the research to be lengthy and redundant. Hence, it is recommended that <u>only alternatives to the most crucial label elements be tested</u>.]*

Now, we'd like to consider various elements of the label design, and I'd like your views on whether changing it would improve the effectiveness of the label or not. I'll project an image of the original label again and show you the same design with some alterations.

[Project one of the original images again.] [SHOW SLIDE #5]

So, here you see one of the original labels again.

[Move to the next image (slide) which will contain both the original label and the different coloured label (by COLOUR) in a split screen.] [SLOW SLIDE #6]

And, here you see both the original label and the altered one. Please turn to page #6 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you, in your opinion …
  - Which label is more attention-grabbing? Memorable?
  - Which one is more easily visible on a pack?
  - Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
  - Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together.]*
  - Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
  - Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
  - Which colour do you remember most?
  - Do the alterations increase or decrease your intent to purchase the product? Why or why not?
  - Is there anything inappropriate or offensive about the alternative proposed?
  - Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, I'd like to look at the label even more closely. This time, I'd like you to consider the ICONS or the pictures we've used in the label. I'll show you one of the original labels again, and an alternative to the original.

[Moderator to move to the appropriate slides, in step with the discussion and questions below.]

Let's start with the icon of FAT. Here's one of the original labels with the icon originally used to depict fat. *[SHOW SLIDE #7]* And now here are some other ways in which we could depict fat. *[Moderator to move to the appropriate slides, in step with the discussion and questions.] [SHOW SLIDE #8]* Please turn to page #7 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you…
  - Which one is more attention-grabbing? Memorable?
  - Which one is more easily visible on a pack?
  - Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
  - Do any of the alternative icons look more unhealthy or less unhealthy than the original product icon? Or are they the same? *[Moderator, show all products together.] [SLIDE #8]*
  - Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
  - Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
  - Do the alterations increase or decrease your intent to purchase the product? Why or why not?
  - Is there anything inappropriate or offensive about the alternative proposed?
  - Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, let's move to the icon of SUGAR. Here's the original label with the icon originally used to depict sugar *[SHOW SLIDE #9]*. And now here are some other ways in which we could depict sugar." *[Moderator to move to the appropriate slides, in step with the discussion and questions.] [SHOW SLIDE #10]* Please turn to page #8 and answer the questions about these options.

[Moderator, please direct participants to complete the short rating exercise of the comparison. Once completed, participants should move to discuss the alternatives. Once all participants have concluded the rating, proceed…]

- Of the options before you…

➢ Which one is more attention-grabbing? Memorable?

➢ Which one is more easily visible on a pack?

➢ Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?

➢ Do any of the alternative icons look more unhealthy or less unhealthy than the original product icon? Or are they the same? *[Moderator, show all products together.] [SLIDE #10]*

➢ Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?

➢ Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?

➢ Do the alterations increase or decrease your intent to purchase the product? Why or why not?

➢ Is there anything inappropriate or offensive about the alternative proposed?

➢ Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, let's move to the icon of SALT. Here's the original label with the icon originally used to depict salt *[SHOW SLIDE #11]*. And now here are some other ways in which we could depict salt. *[Moderator to move to the appropriate slides, in step with the discussion and questions.] [SHOW SLIDE #12]* Please turn to page #9 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you …

➢ Which one is more attention-grabbing? Memorable?

➢ Which one is more easily visible on a pack?

➢ Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?

➢ Do any of the alternative icons look more unhealthy or less unhealthy than the original product icon? Or are they the same? *[Moderator, show all products together SLIDE #12]*

- Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
- Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
- Do the alterations increase or decrease your intent to purchase the product? Why or why not?
- Is there anything inappropriate or offensive about the alternative proposed?
- Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, I'd like us to look again at the ICON we've used in the labels. I'll show you the original with and without the ICON. *[SHOW SLIDE #13]*

[Moderator to move to the appropriate slides, in step with the discussion and questions below.]

Here's the original label with the icon originally used to depict salt, sugar and fat. And now here it is without those accompanying icons. *[Moderator to move to the appropriate slides, in step with the discussion and questions.]*

[Moderator will reiterate to the group that we are just talking about the icons and the two products displayed are just as an example.] Please turn to page #10 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you …
  - Which one is more attention-grabbing? Memorable?
  - Which one is more easily visible on a pack?
  - Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
  - Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together.][SLIDE #1.]*
  - Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?

- ➢ Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
- ➢ Do the alterations increase or decrease your intent to purchase the product? Why or why not?
- ➢ Is there anything inappropriate or offensive about the alternative proposed?
- ➢ Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, I'd like us to look at the TEXT we've used in the label. I'll show you the original again, and alternatives to the original.

[Moderator to move to the appropriate slides, in step with the discussion and questions below.]

- Here's the original TEXT and here are alternatives. *[SHOW SLIDE #14] [Moderator to move to the appropriate slides, in step with the discussion and questions.]* Please turn to page #11 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you …
  - ➢ Which one is more attention-grabbing? Memorable?
  - ➢ Which one is more easily visible on a pack?
  - ➢ Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
  - ➢ Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together SLIDE #14.]*
  - ➢ Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
  - ➢ Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
  - ➢ Do the alterations increase or decrease your intent to purchase the product? Why or why not?

- Is there anything inappropriate or offensive about the alternative proposed?
- Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, I'd like us to look at the SYMBOL/HOLDING SHAPE we've used for the label. *[Moderator, point to the outside shape to ensure that participants have understood exactly what was meant.]* Here's the original label. And now here is an alternative shape. *[SHOW SLIDE #15] [Moderator to move to the appropriate slides, in step with the discussion and questions below.]* Please turn to page #12 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you …
  - Which one is more attention-grabbing? Memorable?
  - Which one is more easily visible on a pack?
  - Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
  - Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together.]*
  - Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
  - Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
  - Do the alterations increase or decrease your intent to purchase the product? Why or why not?
  - Is there anything inappropriate or offensive about the alternative proposed?
  - Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, I'd like us to look at the WARNING DEVICES in the label. *[Moderator, ensure that the participants understand what is being referred to.]* I'll show you the original again, and an alternative to the original.

[Moderator to move to the appropriate slides, in step with the discussion and questions below.] [SHOW SLIDE #16]

Here's the original label with the original warning device. And now here are two alternatives: one with an additional exclamation mark and one without the warning text. *[Moderator to move to the appropriate slides, in step with the discussion and questions.]* Please turn to page #13 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you …

  - Which one is more attention-grabbing? Memorable?
  - Which one is more easily visible on a pack?
  - Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
  - Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together.]*
  - Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
  - Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
  - Do the alterations increase or decrease your intent to purchase the product? Why or why not?
  - Is there anything inappropriate or offensive about the alternative proposed?
  - Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, I'd like us to look at the HOLDING STRAP we've used around the label. *[Moderator, ensure that the participants have understood what is referred to.]* I'll show you the original again, and an alternative to the original. *[SHOW SLIDE #17]*

[Moderator to move to the appropriate slides, in step with the discussion and questions below.]

Here's the original (white). And now here is an alternative (black). Please turn to page #14 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

- Of the options before you …

  - Which one is more attention-grabbing? Memorable?
  - Which one is more easily visible on a pack?
  - Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
  - Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together.]*
  - Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
  - Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
  - Which colour do you remember most?
  - Do the alterations increase or decrease your intent to purchase the product? Why or why not?
  - Is there anything inappropriate or offensive about the alternative proposed?
  - Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, moving on, I'd like us to consider how different SIZES of the label may improve or reduce its effectiveness. *[Moderator to move to the appropriate slides, in step with the discussion and questions below.] [SHOW SLIDE #18]* Please turn to page #15 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

Here's the original label. And now here are alternatives in different sizes.

- Of the options before you …

- Which one is more attention-grabbing? Memorable?
- Which one is more easily visible on a pack?
- Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?
- Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together.]*
- Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?
- Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?
- Do the alterations increase or decrease your intent to purchase the product? Why or why not?
- Is there anything inappropriate or offensive about the alternative proposed?
- Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Now, moving on, I'd like us to consider how PLACEMENT of the label on the front of the package may improve or reduce its effectiveness. *[SHOW SLIDE #19] [Moderator to move to the appropriate slides, in step with the discussion and questions below.]* Please turn to page #16 and answer the questions about these options. ***QUESTIONS REMOVED***

[The moderator then asks:]

Here's the original label. And now here is an alternative placement position.

- Of the options before you …
    - Which one is more attention-grabbing? Memorable?
    - Which one is more easily visible on a pack?
    - Do the alterations improve your understanding of the label? That is, does it give you a more accurate understanding of what the label intends to say? How does it do so?

- Does this set of products look more unhealthy or less unhealthy than the original product set? Or are they the same? *[Moderator, show all products together.]*

- Do the alterations increase or decrease the label's effectiveness as a warning about the product's unhealthiness? Why or why not?

- Do the alterations increase or decrease your understanding of the food's healthfulness? Why or why not?

- Do the alterations increase or decrease your intent to purchase the product? Why or why not?

- Is there anything inappropriate or offensive about the alternative proposed?

- Of the options before you, which one do you think is more likely to be effective in grabbing people's attention and deterring the purchase of an unhealthy food?

Energy

QUESTIONS REMOVED

Comparative rating

Now, thinking of all the labels you've seen today, does any **one** label stand out for you? Which one would that be?

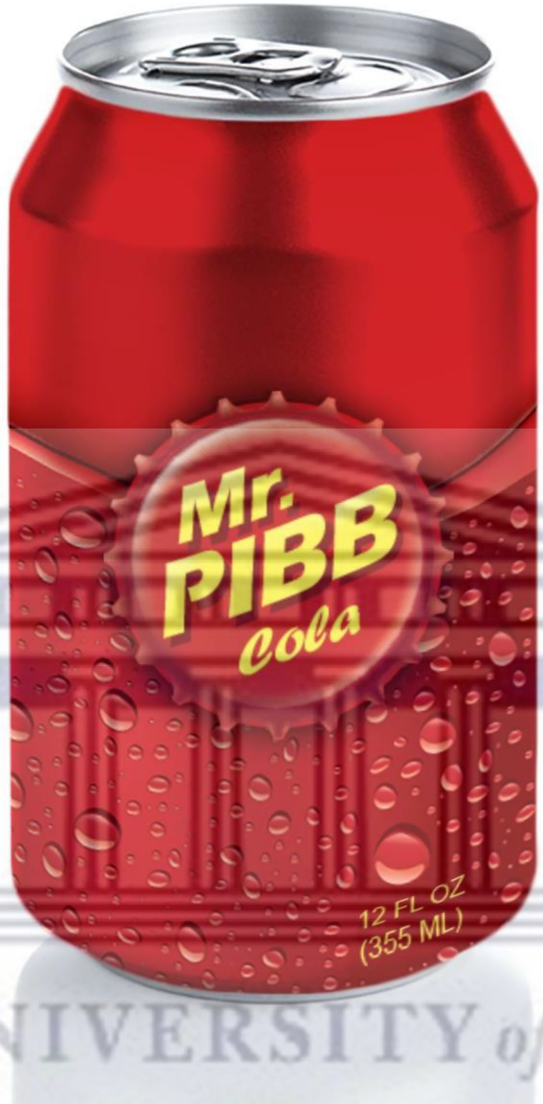
General discussion

QUESTIONS REMOVED

Appendix 9: Product images used in phase 2 of the study

IMAGES USED DURING THE CONTROL PHASE (NO FOPL)


Juicy
Juice
ORANGE JUICE
1L


Mr.
PIBB
Cola
12 FL OZ
(355 ML)


BRITANNIA
Marie
GOLD
Tea time biscuit
150 G


Post
Sunshine Crunch
BREAKFAST CEREAL
500g

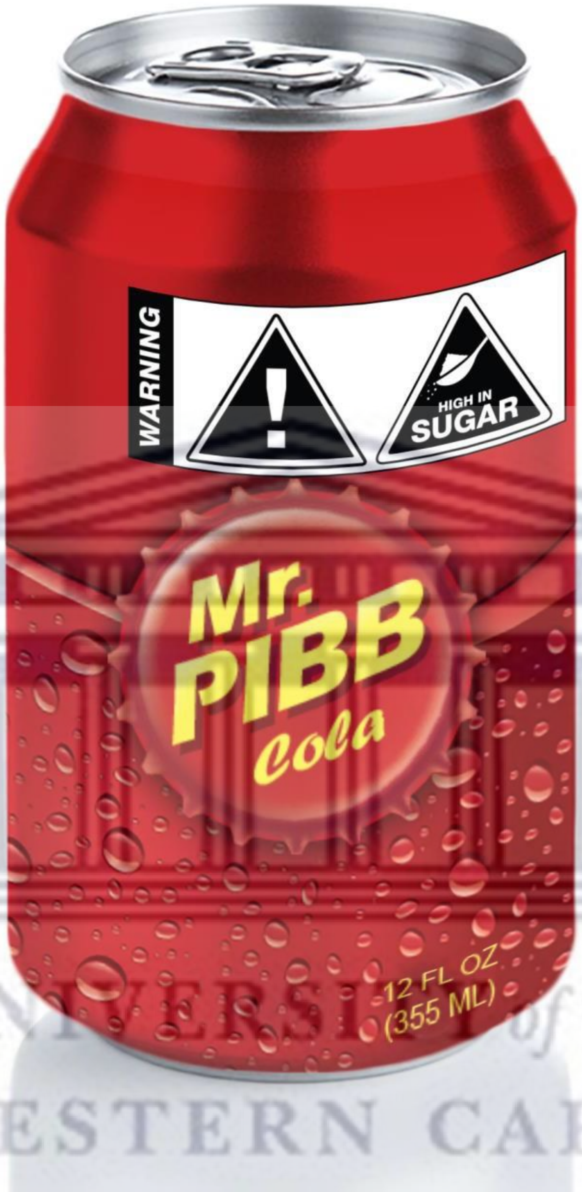
Post
great flakes
BREAKFAST CEREAL
500 g


Yoyo
STRAWBERRY
YOGHURT
175 g


Yoyo LIGHT
BLACKBERRY
YOGHURT
175 g
Contains artificial sweetener

IMAGES USED IN THE WL ARM


WARNING
HIGH IN
SUGAR
Juicy
Juice
ORANGE JUICE
1L


WARNING
HIGH IN
SUGAR
Mr.
PIBB
Cola
12 FL OZ
(355 ML)


KOEKiHUIS
WARNING
HIGH IN SUGAR
F
HIGH IN SATURATED FAT
STRAWBERRY
Twirls
150 G


BRITANNIA
Marie
GOLD
Tea time biscuit
WARNING
F
HIGH IN SATURATED FAT
150 G

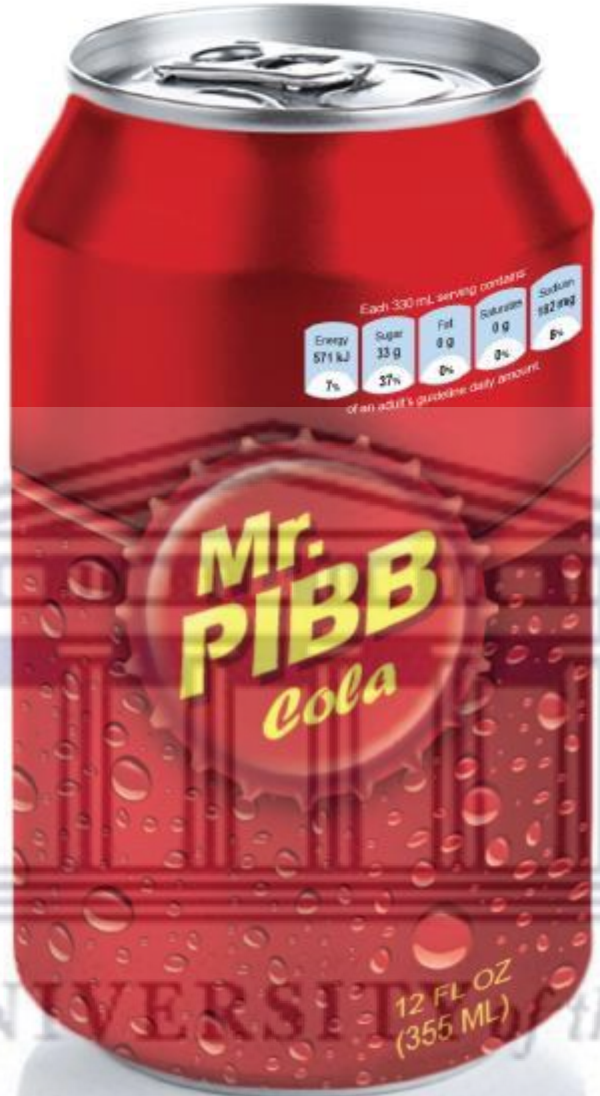

Post
great flakes
BREAKFAST CEREAL
500 g


WARNING
HIGH IN SUGAR
HIGH IN SATURATED FAT
Post
Sunshine Crunch
BREAKFAST CEREAL
500g


WARNING
HIGH IN
SUGAR
Yoyo
STRAWBERRY
YOGHURT
Yoyo
LIGHT
BLACKBERRY
YOGHURT
175 g
Contains artificial sweetener

IMAGES USED IN THE GDA ARM


Juicy
Juice
ORANGE JUICE
1L


Each 330 mL serving contains
Energy 571 kJ 7%
Sugar 33 g 37%
Fat 0 g 0%
0 g 0%
of an adult's guideline daily amount
Mr. PIBB
Cola
12 FL OZ
(355 ML)


KOEKiHUIS
Each 33 g serving contains:
Energy 667 kJ 8%
Sugar 11.7 g 13%
Fat 6.3 g 9%
Saturates 4 g 20%
Sodium 109.2 mg 5%
of an adult's guideline daily amount.
STRAWBERRY
Twirls
150 G


BRITANNIA
Each 32 g serving contains
Energy 512 kJ 6%
Sugar 0.2 g 0%
Fat 7 g 10%
Saturates 4.2 g 21%
Sodium 19.2 mg 1%
of an adult's guideline daily amount
Marie
GOLD
Tea time biscuit
150 G


Post
Each 40 g serving contains:
Energy
139 kJ
2%
Sugar
0 g
0%
Fat
2.0 g
3%
Saturates
0.4 g
<1%
Sodium
7.6 mg
0%
of an adult's guideline daily amount.
great flakes
BREAKFAST CEREAL
500 g

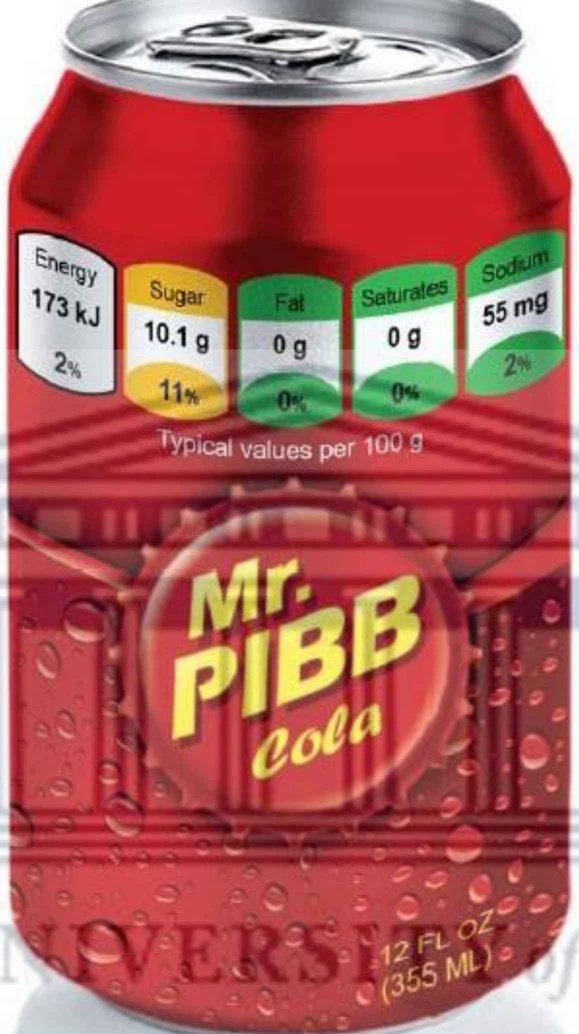

Each 40 g serving contains:
Energy 139 kJ 2%
Sugar 6.9 g 8%
Fat 7 g 10%
Saturates 3.3 g 17%
Sodium 21.2 mg 1%
of an adult's guideline daily amount.
Post
Sunshine Crunch
BREAKFAST CEREAL
500g


Each 175 g serving contains:
Energy 744 kJ 9%
Sugar 21.7 g 24%
Fat 2.6 g 4%
Saturates 1.9 g 10%
Sodium 82.3 mg 3%
of an adult's guideline daily amount.
Yoyo
STRAWBERRY YOGHURT


Each 175 g serving contains:
Energy 490 kJ 6%
Sugar 13.7 g 15%
Fat 3.5 g 5%
Saturates 2.1 g 11%
Sodium 63 mg 3%
of an adult's guideline daily amount.
Yoyo LIGHT
BLACKBERRY YOGHURT

IMAGES USED IN THE MTL ARM


Energy
189 kJ
2%
Sugar
8 g
9%
Fat
0 g
0%
Saturates
0 g
0%
Sodium
1 mg
<1%
Typical values per 100 g
Juicy Juice
ORANGE JUICE
1L


Energy
173 kJ
2%
Sugar
10.1 g
11%
Fat
0 g
0%
Saturates
0 g
0%
Sodium
55 mg
2%
Typical values per 100 g
Mr.
PIBB
Cola
12 FL OZ
(355 ML)


BRITANNIA
Marie
GOLD
Tea time biscuit
Energy
1600 kJ
19%
Sugar
0.5 g
1%
Fat
22 g
31%
Saturates
13 g
65%
Sodium
60 mg
3%
Typical values per 100 g
150 G


Post
Energy
348 kJ
4%
Sugar
0 g
0%
Fat
5 g
7%
Saturates
1 g
5%
Sodium
19 mg
1%
Typical values per 100 g
great
flakes
®
BREAKFAST CEREAL
500 g


Post
Energy
348 kJ
4%
Sugar
17.2 g
19%
Fat
5 g
25%
Saturates
8.3 g
42%
Sodium
53 mg
2%
Typical values per 100 g
Sunshine
Crunch
BREAKFAST
CEREAL
500g


Energy
425 kJ
5%
Sugar
12.4 g
14%
Fat
1.5 g
2%
Saturates
1.1 g
6%
Sodium
47 mg
2%
Typical values per 100 g
Yoyo
STRAWBERRY
YOGHURT


Energy
280 kJ
3%
Sugar
7.8 g
9%
Fat
2 g
3%
Saturates
1.2 g
6%
Sodium
36 mg
2%
Typical values per 100 g
Yoyo
LIGHT
BLACKBERRY
YOGHURT

Appendix 10: Products' nutritional information and interpretations

Nutritional information for the GDA by serving size

Nutrients (Reference value)	Volume/weight	Energy (8 400kJ)		Sugars (90g)		Fat (70g)		Saturates (20g)		Sodium (2 400mg)	
		kJ	% RI	g	% RI	g	% RI	g	% RI	mg	% RI
Mr Pibb Cola	100ml	173	2	10,1	11	0	0	0	0	55	2
Marie Gold	100g	1600	19	0.5	1	22	31	13	65	60	3
Strawberry Twirls	100g	2022	24	35.5	39	19.2	27	12.1	61	331	14
Viazi Crisps	100g	536	6	1	1	36	51	14	70	528	22
Orange juice	100ml	189	2	8	9	0	0	0	0	1	<1%
Yoghurt strawberry	100g	425	5	12.4	14	1.5	2	1.1	6	47	2
Yoghurt blackberry	100g	280	3	7.8	9	2	3	1.2	6	36	2
Great Flakes	100g	348	4	0	0	5	7	1	5	19	1
Sunshine Crunch	100g	348	4	17.2	19	17.7	25	8.3	42	53	2

Note: RI = Reference Intakes

Nutritional information and colour codes for the MTL per 100g/ml (according to typical values per 100g of Reference Intakes of an adult: 8 400kJ)

Nutrients (Reference value)	Volume/weight	Energy (8 400kJ)		Sugars (90g)		Fat (70g)		Saturates (20g)		Sodium (2 400mg)	
		kJ	% RI	g	% RI	g	%RI	g	% RI	mg	% RI
Mr Pibb Cola	100ml	173	2	10.1	11	0	0	0	0	55	2
Marie Gold	100g	1 600	19	0.5	1	22	31	13	63	60	3
Strawberry Twirls	100g	2 022	24	35.5	39	19.2	27	12.1	61	331	14
Viazi Crisps	100g	536	6	1	1	36	51	14	70	528	22
Orange juice	100ml	189	2	8	9	0	0	0	0	1	<1%
Yoghurt strawberry	100g	425	5	12.4	14	1.5	2	1.1	6	47	2
Yoghurt blackberry	100g	280	3	7.8	9	2	3	1.2	6	36	2
Great Flakes	100g	348	4	0	0	5	7	1	5	19	1
Sunshine Crunch	100g	348	4	17.2	19	17.7	25	8.3	42	53	2

Cut-off values/criteria for the MTL based on 100g of solid food

TEXT	LOW	MEDIUM	HIGH	
Colour code	Green	Amber	Red	
			>25% of RIs	>30% of RIs
Fat	≤ 3.0g/100g	> 3.0g to ≤ 17.5g/100g	> 17.5g/100g	> 21g/portion
Saturates	≤ 1.5g/100g	> 1.5g to ≤ 5.0g/100g	> 5.0g/100g	> 6.0g/portion
Total sugars	≤ 5.0g/100g	> 5.0g to ≤ 22.5g /100g	> 22.5g/100g	> 27g/portion
Salt	≤ 0.3g/100g	> 0.3g to ≤ 1.5g/100g	>1.5g/100g	>1.8g/portion

Source: FSA (2016)

Cut-off values/criteria for MTL based on 100ml of drinks/liquids

TEXT	LOW	MEDIUM	HIGH	
Colour code	Green	Amber	Red	
			>12.5% of RIs	>15% of RIs
Fat	≤ 1.5g/100ml	> 1.5g to ≤ 8.75g/100ml	> 8.75g/100ml	>10.5g/portion
Saturates	≤ 0.75g/100ml	> 0.75g to ≤ 2.5g/100ml	> 2.5g/100ml	
Total sugars	≤ 2.5g/100ml	> 2.5g to ≤ 11.25g/100ml	> 11.25g/100ml	> 13.5g/portion
Salt	≤ 0.3g/100ml	>0.3g to ≤0.75g/100ml	> 0.75g/100ml	> 0.9g/portion

Source: FSA (2016)

Cut-off values for the WL (expressed per 100g/ml) and based on the proposed SA Nutrient Profile Model

Nutrients (Reference value)	Volume/ weight	Other		Sugars (10g solids; 5g liquids)			Saturates (4g solids; 3g liquids)		Sodium (400mg solids; 100mg liquids)	
				G	WL		g	WL	mg	WL
Mr Pibb Cola	100ml			10.1	sugar		0		55	
Marie Gold	100g			0.5			13	Saturated fat	60	
Strawberry Twirls	100g			35.5	Sugar		12.1	Saturated fat	331	
Viazi Crisps	100g			1			14	Saturated fat	528	Salt
Orange juice	100ml			8	sugar		0		1	
Yoghurt Strawberry	100g			12.4	sugar		1.1		47	
Yoghurt blackberry	100g	artificial sweetener		7.8			1.2		36	
Great Flakes	100g			0			1		19	
Sunshine Crunch	100g			17.2	sugar		8.3	Saturated fat	53	

Source: Frank *et al.* (2021)

Appendix 11: Questionnaire used in phase 1 of the study

EVALUATING SIMPLIFIED NUTRITION INFORMATION LABELS FOR SOUTH AFRICA							
dateint	Date of interview	dd / mm / yy	eaid	Area identifier			
Id	Unique id		hh	Household number		Interviewer id	
sex	Sex	M / F	age	Age of respondent			

INDIVIDUAL CHARACTERISTICS							
gc1	What is your highest school education level (grade) completed?	Highest grade completed (fill in number)					
gc2	Did you complete a tertiary level qualification?	Yes .... 1 No… 2					
		Speak well	Y	N	Write well	Y	N
gc3A	Which of the South African languages do you speak or write well? *(CIRCLE ALL CORRECT ANSWERS)*	Afrikaans	1	2	Afrikaans	1	2
gc3E		English	1	2	English	1	2
gc3N		Ndebele	1	2	Ndebele	1	2
gc3O		Northern Sotho	1	2	Northern Sotho	1	2
gc3S		Sotho	1	2	Sotho	1	2
gc3I		SiSwati	1	2	SiSwati	1	2
gc3T		Tsonga	1	2	Tsonga	1	2
gc3U		Tswana	1	2	Tswana	1	2
			1	2		1	2

gc3V gc3X gc3Z		Venda Xhosa Zulu	1 1	2 2	Venda Xhosa Zulu	1 1	2 2	

gc4	How often do your household USUALLY purchase groceries? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	A few times a month………………………. A few times a week……………………... About once a day……………………….. Multiple times a day……………………..	1 2 3 4	
gc5	Are you the main buyer of groceries in your home? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Yes, I am the main buyer…………….. No, but I do share the responsibility… No, I am not the main buyer ………..	1 2 3	
gc6	Are you the main decision-maker for grocery purchases in your home? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Yes, I am the main decision maker… No, but I do share the responsibility.. No, I am not the decision maker ……	1 2 3	
gc7	Where do you buy groceries MOST of the time? *(CIRCLE ONLY* ***ONE*** *ANSWER.)*	Informal retailers……………………….. Stokvel / loyalty clubs………………….. Formal retailers (supermarkets)…..….. Other (specify)………………………..	1 2 3 99	
gc8 gc9	How many people eat (most of the time) from the food you purchase for this hh? (FILL IN THE NUMBER)	No of adults (including yourself)……. ☐ ☐ No of children (<18yrs)………......... ☐ ☐		

CONSUMPTION

		Never	Monthly	Weekly	Daily	
	How often do you consume any of the following beverages?					
con1	Regular soda or diet soda……………………………………...........	1	2	3	4	
con2	Fruit juice or fruit drink in cans/boxes or from powdered mix……..	1	2	3	4	
con3	Any type of flavoured yoghurt…………………………………………	1	2	3	4	

	How often do you consume the following snacks or foods?	Never	Monthly	Weekly	Daily	
con14	Potato chips (crisps not hot chips)……………………………………	1	2	3	4	
con15	Cookies or biscuits……………………………………..…………….	1	2	3	4	
con19	Sweet breakfast cereal…………………………………………………	1	2	3	4	

Step A1

	Please enter the identifier of the set of images that you are using	N ………….. O…………… P ………….	1 2 3	

Please look at IMAGE A.

Now, please answer the questions below.

imA1	How likely are you to buy this product for yourself or your family?	I would definitely not buy it …………... I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imA2	In your opinion does this product contain sugar at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	
imA3	In your opinion does this product contain salt at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	
imA4	In your opinion does this product contain saturated fat at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	

imA5	Do you think this product is unhealthy or healthy?	I think it is unhealthy …………………. I think it is healthy……………….…….	1 2	Skip to imA7 if answer is 2 (healthy)
imA6	How unhealthy do you think this product is?	I think it is a little unhealthy ……......... I think it is somewhat unhealthy…........ I think it is very unhealthy…………	1 2 3	
imA7	How healthy do you think this product is?	I think it is a little healthy ……............. I think it is somewhat healthy…..……. I think it is very healthy…………….	1 2 3	Skip if answer to imA5 was 1 (unhealthy)

Step A2

Please look at IMAGE B.

Now, please answer the questions below.

imB1	How likely are you to buy this product for yourself or your family?	I would definitely not buy it …………... I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imB2	In your opinion does this product contain sugar at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	
imB3	In your opinion does this product contain salt at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	
imB4	In your opinion does this product contain saturated fat at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	

imB5	Do you think this product is unhealthy or healthy?	I think it is unhealthy ………………… I think it is healthy…………………..……	1 2	Skip to imB7 if answer is 2 (healthy)
imB6	How unhealthy do you think this product is?	I think it is a little unhealthy ……......... I think it is somewhat unhealthy…........ I think it is very unhealthy…………	1 2 3	
imB7	How healthy do you think this product is?	I think it is a little healthy ……............. I think it is somewhat healthy…...……. I think it is very healthy…………….	1 2 3	Skip if answer to imB5 was 1 (unhealthy)

Step A3

Please look at IMAGE C.

Now, please answer the questions below.

imC1	How likely are you to buy this product for yourself or your family?	I would definitely not buy it …………... I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imC2	In your opinion does this product contain sugar at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	
imC3	In your opinion does this product contain salt at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	
imC4	In your opinion does this product contain saturated fat at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure………………………………….	1 2 88	
imC5	Do you think this product is unhealthy or healthy?	I think it is unhealthy ………………… I think it is healthy…………………..……	1 2	Skip to imC7 if answer is 2 (healthy)

imC6	How unhealthy do you think this product is?	I think it is a little unhealthy ……......... I think it is somewhat unhealthy…......... I think it is very unhealthy………….	1 2 3	
imC7	How healthy do you think this product is?	I think it is a little healthy …….............. I think it is somewhat healthy…...……. I think it is very healthy…………….	1 2 3	Skip if answer to imB5 was 1 (unhealthy)

Step A4

Please look at IMAGE D and note that each product has a different letter assigned to it.

Now, please answer the following questions.

imD1	How likely are you to buy these products for yourself or your family?	I would definitely not buy it …………... I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imD2	In your opinion which one of product A or product B contains the higher amount of sugar?	Product A……………………………. Product B……………………………. They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imD3	In your opinion which one of product A or product B contains the higher amount of salt?	Product A……………………………. Product B……………………………. They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imD4	In your opinion which one of product A or product B contains the higher amount of saturated fat (fat that is bad for your heart)?	Product A……………………………. Product B……………………………. They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imD5	In your opinion which one of product A or product B is most unhealthy?	Product A……………………………. Product B……………………………. They are similar……………………….. I cannot tell from looking at the images	1 2 3 88	

Step A5

Please look at IMAGE E and note that each breakfast cereal has a different letter assigned to it.

Now, please answer the following questions.

imE1	How likely are you to buy these products for yourself or your family?	I would definitely not buy it ………….. I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imE2	In your opinion which one of product A or product B contains the higher amount of sugar?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imE3	In your opinion which one of product A or product B contains the higher amount of salt?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imE4	In your opinion which one of product A or product B contains the higher amount of saturated fat (fat that is bad for your heart)?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imE5	In your opinion which one of these two products is most unhealthy?	Product A……………………………… Product B……………………………… They are similar……………………….. I cannot tell from looking at the images	1 2 3 88	

Step A6

Please look at IMAGE F and note that each flavour yoghurt has a different letter assigned to it.

Now, please answer the following questions.

imF1	How likely are you to buy these products for yourself or your family?	I would definitely not buy it ………….. I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	

imF2	In your opinion which one of product A or product B contains the higher amount of sugar?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imF3	In your opinion which one of product A or product B contains the higher amount of salt?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imF4	In your opinion which one of product A or product B contains the higher amount of saturated fat (fat that is bad for your heart)?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imF5	In your opinion which one of these two products is most unhealthy?	Product A……………………………… Product B……………………………… They are similar……………………….. I cannot tell from looking at the images	1 2 3 88	

PHASE B

Step B1

Please look at IMAGE G.

Now, please answer the questions below.

imG1	How likely are you to buy this product for yourself or your family?	I would definitely not buy it ………….. I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imG2	In your opinion does this product contain sugar at levels higher than recommended for a healthy diet?	Yes …………………………………….. No……………………………………… Unsure…………………………………	1 2 88	
imG3	In your opinion does this product contain salt at levels higher than recommended for a healthy diet?	Yes …………………………………….. No……………………………………… Unsure…………………………………	1 2 88	
imG4	In your opinion does this product contain saturated fat at levels higher than recommended for a healthy diet?	Yes …………………………………….. No……………………………………… Unsure…………………………………	1 2 88	
imG5	Do you think this product is unhealthy or healthy?	I think it is unhealthy ………………… I think it is healthy……………….……	1 2	Skip to imG7 if answer is 2 (healthy)
imG6	How unhealthy do you think this product is?	I think it is a little unhealthy ……......... I think it is somewhat unhealthy…......... I think it is very unhealthy…………	1 2 3	
imG7	How healthy do you think this product is?	I think it is a little healthy …….............. I think it is somewhat healthy…...……. I think it is very healthy…………….	1 2 3	Skip if answer to imG5 was 1 (unhealthy)

Please look at IMAGE H.

Now, please answer the questions below.

imH1	How likely are you to buy this product for yourself or your family?	I would definitely not buy it ………….. I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imH2	In your opinion does this product contain sugar at levels higher than recommended for a healthy diet?	Yes …………………………………….. No……………………………………… Unsure………………………………….	1 2 88	
imH3	In your opinion does this product contain salt at levels higher than recommended for a healthy diet?	Yes …………………………………….. No……………………………………… Unsure………………………………….	1 2 88	
imH4	In your opinion does this product contain saturated fat at levels higher than recommended for a healthy diet?	Yes …………………………………….. No……………………………………… Unsure………………………………….	1 2 88	
imH5	Do you think this product is unhealthy or healthy?	I think it is unhealthy ………………… I think it is healthy……………….……	1 2	Skip to imH7 if answer is 2 (healthy)
imH6	How unhealthy do you think this product is?	I think it is a little unhealthy ……........ I think it is somewhat unhealthy…........ I think it is very unhealthy…………	1 2 3	
imH7	How healthy do you think this product is?	I think it is a little healthy ……............ I think it is somewhat healthy…..……. I think it is very healthy…………….	1 2 3	Skip if answer to imH5 was 1 (unhealthy)

Step B3

Please look at IMAGE I.

Now, please answer the questions below.

imI1	How likely are you to buy this product for yourself or your family?	I would definitely not buy it ………….. I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imI2	In your opinion does this product contain sugar at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure…………………………………	1 2 88	
imI3	In your opinion does this product contain salt at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure…………………………………	1 2 88	
imI4	In your opinion does this product contain saturated fat at levels higher than recommended for a healthy diet?	Yes …………………………………….. No………………………………………. Unsure…………………………………	1 2 88	
imI5	Do you think this product is unhealthy or healthy?	I think it is unhealthy …………………. I think it is healthy………………..……	1 2	Skip to imI7 if answer is 2 (healthy)
imI6	How unhealthy do you think this product is?	I think it is a little unhealthy ……........ I think it is somewhat unhealthy…......... I think it is very unhealthy…………	1 2 3	
imI7	How healthy do you think this product is?	I think it is a little healthy ……............ I think it is somewhat healthy…..……. I think it is very healthy…………….	1 2 3	Skip if answer to imI5 was 1 (unhealthy)

Step B4

Please look at IMAGE J and note that each product has a different letter assigned to it.

Now, please answer the following questions.

imJ1	How likely are you to buy these products for yourself or your family?	I would definitely not buy it …………... I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imJ2	In your opinion which one of product A or product B contains the higher amount of sugar?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imJ3	In your opinion which one of product A or product B contains the higher amount of salt?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imJ4	In your opinion which one of product A or product B contains the higher amount of saturated fat (fat that is bad for your heart)?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imJ5	In your opinion which one of product A or product B is most unhealthy?	Product A……………………………… Product B……………………………… They are similar……………………….. I cannot tell from looking at the images	1 2 3 88	

Step B5

Please look at IMAGE K and note that each product has a different letter assigned to it.

Now, please answer the following questions.

imK1	How likely are you to buy these products for yourself or your family?	I would definitely not buy it …………... I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imK2	In your opinion which one of product A or product B contains the higher amount of sugar?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imK3	In your opinion which one of product A or product B contains the higher amount of salt?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imK4	In your opinion which one of product A or product B contains the higher amount of saturated fat (fat that is bad for your heart)?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imK5	In your opinion which one of these two products is most unhealthy?	Product A……………………………… Product B……………………………… They are similar……………………….. I cannot tell from looking at the images	1 2 3 88	

Step B6

Please look at IMAGE L and note that each flavour yoghurt has a different letter assigned to it

Now, please answer the following questions.

imL1	How likely are you to buy these products for yourself or your family?	I would definitely not buy it …………... I am unlikely to buy it………………….. I will consider buying it ……………….. I will definitely buy it …………………..	1 2 3 4	
imL2	In your opinion which one of product A or product B contains the higher amount of sugar?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imL3	In your opinion which one of product A or product B contains the higher amount of salt?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imL4	In your opinion which one of product A or product B contains the higher amount of saturated fat (fat that is bad for your heart)?	Product A……………………………… Product B……………………………… They contain the same amount…….. I cannot tell from looking at the images	1 2 3 88	
imL5	In your opinion which one of these two products is most unhealthy?	Product A……………………………… Product B……………………………… They are similar……………………….. I cannot tell from looking at the images	1 2 3 88	

Appendix 12: Focus group discussion guide used in phase 3 of the study

Data collection material: 1) All participants will fill in a sociodemographic questionnaire before focus group discussions commence. 2) A4 posters with pictures of five mock-up food products superimposed with a warning label will be shown to the participants. The following products will be used: a packet of chips, 100% fruit juice, sweet biscuits, cereal and yoghurt. (The same ones that we used in the RCT study.)

Data collection process

The information leaflet (soft or hard copy) will be shared with participants, and all participants will be required to fill in the focus group confidentiality binding form before data collection starts.

The moderator will introduce herself, give a brief background about herself and then explain the purposes of the study. The participants will then introduce themselves to get them comfortable with one another.

The moderator explains that she is going to show them posters with five food packages and requests that they look at the packages carefully and freely share their thoughts (the moderator might need to move around the room to allow participants to see the posters clearly). The moderator explains that they will have a discussion around the products and that all responses are acceptable.

The moderator then shows the participants pictures of packaged food products (one at a time) with a warning label and asks: Tell me…..

1. ***What do you see on this picture?*** *(noticeability of the label)*
2. ***What comes to your mind when you see these pictures?***
3. ***What are your thoughts about this label that appears on these products?*** *(understanding, take away message, implications)*

Probing questions:

Is the label noticeable? What makes it to be noticeable or not noticeable?

What information do you think this label is trying to convey? What do these labels mean? How do you interpret the label?

Now I am going to show you the images again. I want you to think about whether you would purchase these products for your child.

4. ***If this label appears on food products, how would it influence what you buy or not buy for your child/children?***

Probing question:

What are your thoughts regarding this label in relation to the kind of food you would buy for your child?

What effect do you think this label will have on foods you put in a lunchbox for your child? ***(try to probe for each product separately)***

Would you consider anything else other than the label when purchasing groceries for the house?

5. ***What is your final impression about the label and the use of food labels by food manufacturers?***

Probing questions:

What do you like or dislike about this label? Who in your opinion would be able to use or not use this label? Do you think children will understand the labels? Please explain.

What effect do you think the labels will have on your child? Please explain.

6. **General question**

What difficulties do you encounter when reading food labels on food packages?

Appendix 13: Reviewers' comments and authors' responses (Publication #1)

PONE-D-21-13158

The Editor

South African consumers' perceptions of front-of-package warning labels on unhealthy foods and drinks PLOS ONE

Dear Dr. Bopape,

Thank you for submitting your manuscript to PLOS ONE. After careful consideration, we feel that it has merit but does not fully meet PLOS ONE's publication criteria as it currently stands. Therefore, we invite you to submit a revised version of the manuscript that addresses the points raised during the review process.

Authors' response

The Editor
Plos One Journal
05 July 2021

Dear Editor

Re: Response to reviewers

Thank you for considering our manuscript for publication in the Plos One Journal and for the valuable feedback we received from the reviewers. All inputs were considered and attached please receive our responses to the suggestions (as reflected in the revised manuscript with track changes).

1. In particular, as recommended by reviewer 2, please include a more comprehensive overview of the use of warning labels in your introduction. For instance, you do not describe pictorial or graphic warning labels as described by Pechey et al. While this publication postdates the conduct of the focus groups, this style of warning label should nevertheless be described and the relative merits discussed.

Our response: Thank you for the reference to the paper by Pechey et al. (2020). This article was considered as a model for reviewing the introduction of our paper.

A more comprehensive overview of warning labels is now included. More information regarding design elements that improve the efficacy of warning labels is included as well as discussion of emerging studies around warning labels – Lines 105–142.

2. Lines 488–498. I think more could be made of the differences between countries regarding consumer shape preferences, as justification for the need to replicate this type of research locally. This finding highlights the importance of having culturally relevant shapes, as shapes are not universally interpreted in the same manner.

Our response: Thank you for this comment. We now refer to the fact that shapes are not interpreted the same way and that each country should explore shape preferences within its own context – Lines 588–597.

3. Please check the guidelines for reference lists. Some titles are fully capitalized, while others have only the first word of the title and proper nouns capitalized. You can manage this in Endnote by without having to change the titles of references by editing the output settings. In the bibliography section choose sentence style capitalization in the title capitalization subsection. Although, recheck the titles carefully as proper nouns such as place names will have had their capitalization removed.

https://journals.plos.org/plosone/s/submission-guidelines#loc-references

Our response: Thank you for pointing out aspects where guidelines were not applied correctly. We have now attended to formatting and all titles are in sentence case.

Minor corrections

4. Line 60. Other than when used in reference to grains, i.e. intact grains, the phrase 'intact foods' is not commonly used to describe other groups of unprocessed or minimally processed foods.

Our response: Thank you for this comment. We have now removed the word 'intact' and substituted it with 'whole'– Line 60.

5. Lines 69–70. This sentence referring to access to ultra-processed foods is not needed in this paragraph justifying the FOPL. You have already linked ultra-processed foods to NCDs in lines 56–58.

Our response: Thank you for noting that the sentence is not needed. We have now deleted the sentence – Lines 69–70.

6. Line 129 and elsewhere. Data is the plural of datum so should be 'data were' collected.

Our response: Thank you for the comment. We have edited the manuscript and the phrase "data was" is now edited to "data were" throughout the manuscript.

7. Lines 211–212. Presumably the moderator first transcribed the recordings verbatim and THEN translated the data into English where applicable. In which case this sentence should be reordered.

Our response: Thank you for this comment. We have reordered the sentence – Lines 272–273.

8. Lines 227–228. The aim of the study does not need to be repeated here.

Our response: Thank you for the suggestion. The aim of the study was deleted – Lines 292–293.

9. Line 501. The use of the word thus in this sentence implies that the reason for the preference for black is explained in the first half of the sentence, when in fact the rationale for preferring black is provided in the second half of the sentence. Therefore, suggest rewording as 'black was deemed more effective'.

Our response: We substituted the term 'thus' with 'deemed' – Lines 600–601.

10. Line 511. Presumably you mean a white triangle on a black background and NOT a black triangle on a black background.

Our response: Thank you for the comment on the framing of the sentence in Line 511. We have left the sentence as it is as a black triangle was also tested against a black background – Line 612.

11. Line 543. Should read ultra-processed foods (plural).

Our response: Thank you for noting the need to change the word into plural. We have now changed the word 'food' to 'foods' – Line 646.

12. Line 544. Should read labels (plural).

Our response: Thank you for the comment. We have now changed the term 'label' to 'labels' – Line 648.

Please ensure that your manuscript meets PLOS ONE's style requirements, including those for file naming. The PLOS ONE style templates can be found at:

https://journals.plos.org/plosone/s/file?id=wjVg/PLOSOne_formatting_sample_main_body.pdf and https://journals.plos.org/plosone/s/file?id=ba62/PLOSOne_formatting_sample_title_authors_affiliati ons. pdf

Our response: Thank you for the comment and for referring us to these websites. We have done the following:

- Inserted pilcrow to indicate 1st set of equal contributors (cover page)
- Corrected punctuation after each author's name (cover page)

- Abbreviation (NY) removed under affiliations (cover page)

- Corrected punctuation when labelling figures (e.g. substituted colon with a full stop after Fig 1 and Fig 3 when labelling figures)

- Attempted to label the files correctly.

13. When reporting the results of qualitative research, we suggest consulting the COREQ guidelines or other relevant checklists listed by the Equator Network, such as the SRQR, to ensure complete reporting (http://journals.plos.org/plosone/s/submission-guidelines#loc-qualitative-research). In this case, please consider including more information on the number of interviewers, their training and characteristics. Moreover, please provide the interview guide used as a Supplementary file.

Our response: Thank you for the comments and the suggestion to consult the COREX guidelines regarding reporting of the qualitative research results. We consulted the COREX guidelines and added more information on the number of interviews, their credentials and we have also attached the interview guide.

14. Consider including more information on the number of interviewers, their training and characteristics.

Our response: We have now indicated that all the interviews were conducted by one moderator – Line 243 and that the moderator had extensive experience in qualitative data collection and data analysis – Lines 244–245.

15. Please provide the interview guide used as a Supplementary file.

Our response: We have now attached the focus group discussion guide or moderator guide as a Supplementary File (S2 File).

16. Thank you for stating the following in the Acknowledgments Section of your manuscript: [We thank School of Public Health at the University of the Western Cape and the DSI/NRF CoE in Food Security UID 91490) for support.]

We note that you have provided funding information that is not currently declared in your Funding Statement. However, funding information should not appear in the Acknowledgments section or other areas of your manuscript. We will only publish funding information present in the Funding Statement section of the online submission form.

Please remove any funding-related text from the manuscript and let us know how you would like to update your Funding Statement. Currently, your Funding Statement reads as follows:

[This study was funded by Bloomberg Philanthropies. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.]

Our response: Thank you for the opportunity to clarify this point. The authors did not receive any funding from the DSI/NRF CoE in Food Security, but only administrative support – Line 673.

Our Funding Statement therefore remains: [This study was funded by Bloomberg Philanthropies. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.]

17. Thank you for stating the following in the Financial Disclosure section: [This study was funded by Bloomberg Philanthropies. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript].

We note that you received funding from a commercial source: Bloomberg L.P. Please provide an amended Competing Interests Statement that explicitly states this commercial funder, along with any other relevant declarations relating to employment, consultancy, patents, products in development, marketed products, etc.

Our response. Thank you for noting the mentioning of Bloomberg LP as a funder in this study. We would like to draw it to your attention that Bloomberg LP was erroneously mentioned and the study was actually funded by Bloomberg Philanthropies, as explained in the cover letter.

18. We note that you have stated that you will provide repository information for your data at acceptance. Should your manuscript be accepted for publication, we will hold it until you provide the relevant accession numbers or DOIs necessary to access your data. If you wish to make changes to your Data Availability statement, please describe these changes in your cover letter and we will update your Data Availability statement to reflect the information you provide.

Our response: This is noted and there are no changes to the statement.

19. We note that Figures in your submission contain copyrighted images. All PLOS content is published under the Creative Commons Attribution License (CC BY 4.0), which means that the manuscript, images, and Supporting Information files will be freely available online, and any third party is permitted to access, download, copy, distribute, and use these materials in any way, even commercially, with proper attribution. For more information, see our copyright guidelines: http://journals.plos.org/plosone/s/licenses-and-copyright.

Our response: Thank you for the comment. We removed all images with copyrights and only remain with images that can be freely available online, and can be used in any way, with proper attribution.

20. Reviewer #1:

    Thank you for letting me review this manuscript. This is a topic worthy of discussion since the high prevalence of overweight and obesity. However, there are some comments:

In Line 150, please add the references after the sentence: "...detailed design brief based on the latest literature".

Our response: We have now cited sources of the design brief submitted to the designers – Line 208.

21. According to the following article (An, 2021), Graphic with health effect labels showed the largest impact on dissuading consumers from choosing them. Why the design of graphic (e.g., graph of health effect, which displays a picture of an obese belly or decayed teeth with relevant descriptions, and graphic with nutrient profile, which displays a picture of sugar added in the drinks with corresponding descriptions) was not used in the label design in this study?

An R, Liu J, Liu R, Barker AR, Figueroa RB, McBride TD. Impact of Sugar-Sweetened Beverage Warning Labels on Consumer Behaviors: A Systematic Review and Meta-Analysis. Am J Prev Med. 2021;60(1):115-126. doi:10.1016/j.amepre.2020.07.003

Our response: Thank you for the comment and reference to an article by An et al. (2020). We have considered different warning label formats and noted that in literature warning labels containing familiar shapes such as an octagon or a triangle improved consumers understanding of nutrient composition and assisted consumers to identify unhealthy products.

Introduction

22. The introduction fails to provide a comprehensive overview of the topic. The authors did not include a thorough analysis of the literature to clearly convey what is known about the topic and what are the knowledge gaps. The authors should include a more detailed analysis of the growing body of evidence around warning labels.

Our response: Thank you for the suggestion to improve on the introduction. We have now provided more information about warning labels and interrogated the growing evidence around them, including their merits – Lines 105–142.

23. Considering that the manuscript is focused on warning labels, details on other FOP nutrition labelling schemes is not necessary. The inclusion of Figure 1 is not necessary in the context of the manuscript.

Our response: Thank you for the comment. We have deleted Fig 1 (Lines 86 and 87) and have removed detailed references to either the GDA or the MTL from the introduction (Lines 88–94).

24. The contribution of the manuscript should be more clearly presented. How does the manuscript contribute to the literature? Is the contribution related to the specific context (South Africa)?

Our response: Thank you for pointing out the failure of the manuscript to clearly indicate its contribution. This study aims to explore the citizens' view of warning labels as a potential labelling format to guide food purchasing within the South African context. We revised the manuscript to capture that – Lines 151–164.

Objectives

25. The authors state that one of the aims of the manuscript was to identify “features that enhance or diminish the effectiveness of a warning label”. However, the design is not appropriate to address this objective. Qualitative research enables to explore a specific topic but cannot be regarded as appropriate to evaluate the effectiveness of a public policy or to identify features that enhance or diminish its effectiveness. The authors could refer to “identify citizens’ views on features that could influence the effectiveness of warnings” or something like that.

Our response: Thank you for the comment. We amended the objective to reflect that the aim of the study was to explore citizens’ views on features that could influence the effectiveness of warnings, instead of identifying design features that enhance or diminish the effectiveness of warnings – Line 160–164.

Materials and Methods

26. How was the number of participants selected?

Our response: The total number targeted was 120, 40 from each province and they were selected to reach a quota for socioeconomic status, urbanicity vs. rurality, gender and age. Lines 184–191.

27. Did the authors rely on theoretical sampling for the design of the study?

Our response: No, we used purposive sampling where we decided on the criteria and recruited all the participants before we commenced with data collection.

28. How did the authors manage participants’ heterogeneity? Did they conduct focus groups with participants from very different settings? This should be better explained.

Our response. Thank you for the question. All the focus groups were homogeneous, each group consisted of participants with similar sociodemographic characteristics – Lines 189–191.

29. What was the purpose of creating so many warning labels? Do the authors think that participants were actually able to pay attention to the nuances between all the designs?

Our response: The aim was for participants to choose from a wide range of elements and not to make the choice options too limited. We refer to a study where a number of prototypes were shown to the participants – Lines 237–238.

30. Qualitative research is not appropriate to select the most attention grabbing, the most effective or the most likely to influence purchasing behaviour. Quantitative research should have been used for this purpose. In addition, the social interactions during focus groups make it not possible to assess individual opinions on the topic.

Our response: We revised the manuscript to capture that the responses reflect opinions of the group in general and all reference pointing to the study determining the 'most attention grabbing, the most effective or the most likely to influence purchasing behaviour' has been removed throughout the manuscript – Lines 161–162; 230; 267–269; 547–549.

31. The authors should have included the question guide. It is an essential element to evaluate the validity and reliability of qualitative research.

Our response: Thank you for suggesting that we include the interview guide. We have now attached it as a Supplementary File (S2 File).

32. How did the authors handle the influence of participants' characteristics on their opinions?

Our response: We grouped participants according to their various characteristics (age, literacy level and economic status) to allow maximum participation.

Results

33. Additional details are needed in the Results section to more clearly convey the results. I recommend the authors to include quotes in Table 3.

Our response: We have attached themes, subthemes and quotes as Supplementary Table (S1 Table).

34. The authors should be careful about the interpretation of the results. As I have previously mentioned, they are dealing with focus groups and therefore results should be interpreted considering their qualitative nature. Several changes should be made throughout the text.

Our response: Thank you for the comment. We revised the entire results section and the abstract and amended to suit qualitative results.

35. I recommend the authors not to refer to "the most understood design features".

Our response: We changed the heading to: Elements perceived effective as warning – Line 545.

36. How could the authors generalize their results to different groups of participants? For example, they stated that "participants from all socioeconomic backgrounds" had positive attitudes towards the warnings. They did conduct separate focus groups? Did all participants explicitly state their opinion?

Our response: Thank you for the opportunity to clarify. We grouped participants according to their sociodemographic status and analysed responses per focus group. The warning labels were positively appraised in all the focus groups.

Discussion

37. The flow and clarity of the Discussion section could be improved.

Our response: We revised the entire discussion section and attempted to improve on its flow and clarity.

38. The authors should rewrite many parts of the discussion where they refer to the comparison of labels and design features considering the type of data they are dealing with. For example, they state "black was more effective".

Our response: We rewrote the discussion section to reflect the qualitative nature of the study. For example, we refrained from depicting some warning elements as being more effective than others and instead expressed participants' views about those elements – Lines 602–603; 611–612.

39. An important point the authors should discuss is related to the contraposition between citizens' opinions and actual effectiveness of the policy. This is particularly relevant for the discussion, as the authors could encourage other researchers to base policy decisions exclusively on qualitative data.

Our response: Any contrapositions made between participants views and policy were reviewed and sentences constructed differently – Lines 41–42; 409, 600–601; 651.

40. As far as I know, the Uruguay nutrition labelling policy entered into force in 2020, so I guess that there are no studies showing changes in expenditure. This should be clarified in Line 527, as I think the authors are mixing up an experimental study with the evaluation of policy impact.

Our response: Thank you for the comment. We have now indicated that the studies were experimental – Lines 629 and 640.

42 The limitations of the study should be better acknowledged in the paper, as well as suggestions for further research.

Our response: Thank you for the suggestion to better acknowledge the limitations of the study and make suggestions for future research. We have expanded on the limitation of the study (Lines 659–660) and made suggestions for future research (Lines 661–662).

We hope that we have addressed all the input satisfactorily.

From: **PLOS ONE** <em@editorialmanager.com>
Date: Fri, Sep 17, 2021 at 4:49 PM
Subject: Notification of Formal Acceptance for PONE-D-21-13158R1 - [EMID:12a09c062c09d7a2]
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PONE-D-21-13158R1
South African consumers' perceptions of front-of-package warning labels on unhealthy foods and drinks

Dear Dr. Bopape:

I'm pleased to inform you that your manuscript has been deemed suitable for publication in PLOS ONE. Congratulations! Your manuscript is now with our production department.

If your institution or institutions have a press office, please let them know about your upcoming paper now to help maximize its impact. If they'll be preparing press materials, please inform our press team within the next 48 hours. Your manuscript will remain under strict press embargo until 2 pm Eastern Time on the date of publication. For more information please contact onepress@plos.org.

If we can help with anything else, please email us at plosone@plos.org.

Thank you for submitting your work to PLOS ONE and supporting open access.

Kind regards,
PLOS ONE Editorial Office Staff

on behalf of
Dr. Jane Anne Scott
Academic Editor
PLOS ONE

Appendix 14: Reviewers' comments and authors' responses (Publication #2)

<u>Responses to the first review</u>

Reviewer #1: General Comments

Indeed, while the manuscript describes a randomized trial investigating objective understanding of several front-of-pack labels, the authors only provide very limited indication as to what information was actually available in the experiment to participants (only references are provided for the actual thresholds for warnings and MTL – that are not aligned, only figures of the products with no labels etc.).

It is therefore unclear what exactly the participants were exposed to in each trial arm. However, to accurately assess the quality of the research, it is essential that readers can access the actual information available in each trial arm (i.e. nutrient profile of each food and associated front-of-pack label in each trial arm).

Unless this information is provided, no evaluation of the quality of the work proposed can be provided.

<u>Our response</u>: Thank you for pointing out the gap in information related to nutritional composition of products used in the current study as well as the information that was available in each trial arm.

Detailed nutritional information for each product, nutritional judgement and the nutrient profile used for the MTL and the WL are now included. (See Additional File 4.)

All images that we used in the current study are now attached as Additional File 2, and these are arranged according to the different experimental arms.

Reviewer #2: Dear Authors

Every day the WL labeling system has proven to be an understandable and effective label to identify healthy products in different countries outside of Latin America. So I think the article is robust and offers results that could be used for the country's politics. Below, add my suggestions and comments.

Major Comment:

* It is a bit complex to identify the role of products without FOPL, as well as products with MTL and MTL+GDA. I would suggest adding a figure (possibly supplementary) that describes the procedure of how the labels were displayed for each control and experimental phase. Likewise, instead of the image of the products in figure 3, I would add an example of each FOPL and add a supplementary file with all the products that were used in their different versions. I think it would be clearer for the reader.

Our response: Thank you for suggesting that we add more information to clarify the procedure that we followed in this study and for the suggestion to include all the images that participants were exposed to.

Additional information regarding the flow process on how the labels were presented to participants in both the control and experimental phases is now presented as Additional File 1.

All the images are now attached as Additional File 2 and Figure 3 has been amended to include an example of each FOPL

Specifics:

Page 7, Line 107. "1.2.1, sampling strategy and sample size"…please specify based on which (Reference type national information on geography and demography) the geographic areas, socioeconomic status, etc. were identified.

Our response: Thank you for suggesting that we clarify the national information on geography and demography upon which sampling was determined.

More details on the sampling criteria upon which EAs and participants were selected is included on page 7; Lines 110–116.

Page 8, Line 138. "Each fieldworker was assigned one label type on the day of data collection (either the WL, GDA or MTL)…" Did the fieldworker know before applying the questionnaires which label was assigned? Or was it hidden (blind) for them to apply the survey?... explain.

Our response: The sentence was rephrased to indicate that fieldworkers were aware of the label before administering the questionnaire as they had to present the labels to participants. This was done to ensure equal application of the label per EA. See page 9; Lines 149–150.

Page 10, Line 180. The questions used for the different outcomes were validated or were they used in previous studies?... Please add the reference if applicable. If it is within the possibilities of the study, it would be very good to add the complete questionnaire to know the order of the survey.

Our response: Thank you for the suggestions to include the source of the questionnaire.

The questionnaire used in this study is attached as Additional File 3 and the source is acknowledged (see page 9; Line 159). Information on the piloting of the questionnaire is included on page 9; Line 160.

Page 12,Lline 217. Table 1. Add at the end of the title the total number of participants (n=1,948). In addition, I would add the n, as well as what the data represents for each FOPL group, for example: WL (n=XXXX) % GDA (n=XXXX) % MTL (n=XXXX) %. Please, add a column with the percentages of the total population and finally, remove the (%) from each variable in the first column except for the age variable.

Our response: Table 1. The total number of participants (n=1948) is now added at the end of the title (see page 13; Line 236) and number of participants, together with the percentages are added per label type (page 13).

We did not remove the % from the first column to make the Table easier to read. Instead, we added both the n and % to differentiate from the mean age.

Page 18, Line 320. Add another article that measured purchase intent with low and medium SES population showed similar results found in this article: https://doi.org/10.1186/s12889-020-08549-0

Our response: Thank you for suggesting the article by Jáuregui et al, (2018). We have included it as one of the citations. See page 19; Line 343.

Page 19, Line 344. A point in favor is that the FOPLs were placed in front of the products and the participants interpreted the different FOPLs without any prior explanation for what the intention to purchase and the identification of unhealthy products could have been higher. To consider.

Our response: Thank you for this suggestion. This strength is now included on page 20; Lines 365–368.

Minor Comments:

** The images need more quality, they look blurry and it is difficult to interpret the results.

Our response: The images have been reformatted and should look clearer now.

***Add the total n in the titles of the supplementary tables.

Our response: The total n (n=1948) has now been added (Additional Files 5).

Responses to the second review

Reviewer #2: General Comments

As a general comment, I'm glad that the authors provided the much-needed information as to the nutrient profile of the stimuli that were used in a supplemental table. Considering that these elements were entirely necessary for a proper assessment of the methodology that was undertaken for the experiment, no review of the manuscript could be conducted without this information.

Overall, the manuscript deals with an interesting topic, investigating the effects of various types of labels on consumer response. However, a number of serious concerns have arisen from the additional documents having been added, as well as to the general methodology of the experiment (including the statistical analyses) and the conclusions being drawn from it. As they stand now, the results obtained are more related to the selection of products by the researchers than the inherent qualities of the labels, as the MTL label appears to have been 'set to fail' by design in a number of the comparisons.

Moreover, the general tone of the manuscript reads more as an advocacy statement than a scientific paper, with clear exaggerations in some cases (the lexicon includes words such as 'dangers', 'inundated', 'inferior', etc.), and a somewhat binary view of nutrition, whereby products would be 'healthy' or 'unhealthy'. This should be clearly modified to conform to the standard practice in the scientific community and to better reflect the current evidence relating to dietary behaviour in relation to health, which is far from simple.

Our response: Thank you for pointing out the need to tone down some of the words used in the paper. We have replaced the first use of the term 'danger' with 'negative health consequences'. Please see Line 20. However, because the word 'danger' in Lines 365 and 399 came directly from the participants during a qualitative study, they were thus left as such.

The word 'inundated' was replaced with 'exposed'. Please see Line 13. 'Inferior' was replaced with 'poorer' (Line 15) and 'better' was replaced with 'outperformed' (Line 83).

These serious concerns can in part only be addressed through adapted statistical analysis and modifications in the text, but the main conclusions of the study need to be highly tampered down considering the important limitations to the methods.

Reviewer #2: Major Comments

Choice of stimuli

The objective of the study is to compare the performance of various types of labels, with an experimental design using very limited set of stimuli that are tested in pairs. This type of experiment allows to investigate the comparative effectiveness of various front-of-pack labels' graphical design – all other variables being standardized. In particular, this type of design is adequate to investigate whether a 'warning' type of message is better conveyed through a 'red' – in the MTL system – a warning – in the Warning labels system – or a greater percentage – in the GDAs system. This can only be guaranteed if the nutrient profile is standardized between the conditions, or somewhat equalized between systems.

Else, one cannot draw conclusions whether the effectiveness of a given system is tied to its graphical design or its nutrient profile model. Both are important, but it is essential in experimental designs to disentangle the two elements, and experimental designs are actually made for this purpose. Only in quasi-experimental designs in purchasing situations with a large number of food choice stimuli – see for example papers by Crosetto et al. [1], Egnell et al. [2,3] or Acton at al. [4] – the condition of standardization of the nutrient profiles can be relented. This is not the case here, given that the nutrient profiles of the tested stimuli – though fictitious – are not at all standardized or even equalized across conditions

Our response: The goal of this paper was not to specifically test different designs to convey the same information, but rather different real-world FOPL systems. FOPL systems are comprised of two different parts: the visible communication tool (the label itself) and the underlying nutrient profile. It is the case in the real world that products with the same exact nutrient profile (as in this study) would bear different FOPL because of the nutrient profile system. Because the goal of this study was to identify which FOPL system works best, we did not try to differentiate between the visible element and the nutrient profile because we wanted it to match the real-world scenario. Secondly, it is not possible for the different labelling types to fully match on nutrient profile because some elements only exist for some FOPL (for example there is no equivalent of the green TLL for warnings).

Because we were not able to fully differentiate the effects of the type of label itself and the different nutrient profiles that underpin the labelling system in this study, we have thus included this limitation as part of Lines 420–427.

Worse yet, the multiple traffic lights and the reference intakes, which should actually provide the same information (except for the colour-coding) appear for one to have been calculated based on 100g and the other for a portion of the product. Either the information on Additional Table 4 is inaccurate, or the calculation of the various elements incorporated in the FOP used for stimuli are inaccurate.

For example, the first product (Mr Pibb Cola) is allocated an 11% value for reference intakes for sugars, an amber in the MTL system and one warning.

The second (Marie Gold) is allocated a 31% reference value for fat, a 65% reference value for saturates, two reds in the MTL and one warning.

Our response: Thank you for noting the differences between the GDA and the MTL in Additional File 4 (now Additional File 3). We have reconverted the serving sizes (for the MTL) into per 100g to match the GDA information. However, the values were the same, except that the MTL was in serving sizes and the GDA presented per 100g. We confirm that since we only changed the values to per 100g/ml, the new values have no bearing on the original colour allocations. Please see Additional File 3.

Considering the information provided, in the first case the warning label appears at the same level as one amber (so probably more efficient at providing a deterrence signal), in the second at the same level as two 'reds' (so probably less efficient at providing a deterrence signal). The inconsistency between the signals provided are entirely due to the selection of products, where the authors should have standardized the various options so that a clear comparison could be drawn between 'reds' and 'warnings' to compare the relative effectiveness of one or the other design at providing a deterrence signal.

Our response: As per our response above, the aim of the study was to test the FOPL that best conveyed nutrition information to participants using real-world FOPL policies. The number of warnings, colours of the MTL and percentages were dependent on the nutrient profile model applied as per the respective FOPL system and not on allocation by researchers. The nutrient profile for products in the different arms was exactly the same. Whether a product ended up with a higher percentage, two warnings or one red was completely a function of the nutrient profile models underpinning the %RI, MTL or WL.

More concerning, in some cases, whereas there is a clear discrimination between the products using one system, it is not the same for the others. In yogurts for example, both are allocated an 'amber' while they are not allocated the same type of warning (one for sugars and the other for artificial sweeteners – the figure in this case appears wrong, as no warning at all appears on the package in Figure 2).

Our response: Once again, we would like to emphasise that the FOPL applied was a result of the existing nutrient profile model and not allocation by the researchers, same as the labels would have appeared in a real-world scenario. To date, neither the MTL nor the GDA nutrient profiles specify a warning for or mention of artificial sweeteners. Because the allocation of the FOPL was based on their associated nutrient profile model, the labelling on the yoghurt therefore did not include any statement on the presence of artificial sweeteners. We acknowledge that the warning for artificial sweeteners may have contributed to improved ability to identify yoghurt as unhealthy in the WL arm. This limitation is pointed out in Lines 420–424. However, the WL arm carried the sweetener warning as per the nutrient criteria and FOPL policies in other countries, e.g. Mexico and Argentina.

Finally, without any consideration to the nutrient profile, the images of the products appear clearly to favour one of the tested arms, as the area on the package devoted to the labels are not standardized either. Hence, in each case, the warning labels took much more space, and were therefore much more visible than the other labels. In the case of the first product in Additional file 2 (Viazi Crisps), for example, the labels for MTL and GDAs take up 1.4x4.1cm while the warning labels on the same product take up 2.6x8.8cm, so quadruple the size (22.8 cm² vs. 5.74). For the multiple traffic lights and the reference intakes, numbers presented on the product were not event legible without a magnifying glass. Hence, there is no way of concluding whether the effectiveness of one given system is actually related to the graphical design in itself, the underlying nutrient profile model or even the sheer size of the labels affixed on the products…

Our response: Thank you for the suggestion to include label size as a possible deterrent to FOPL effectiveness in the current study. Because we looked at the labelling systems in totality, it was not possible to disaggregate the various elements (e.g. size, nutrient profile) of the different labels. This limitation is now included as part the discussion in Lines 367–371 and Lines 424–427. We recommend future research that could investigate the effectiveness of FOPL when all conditions are standardised for the different FOPLs.

Additionally, we have further on clarified, in the introduction, that the aim of this study was to test existing (GDA and MTL) and proposed FOPL (SA WL) which have their own underlying nutrient profile models and label design. Please see Lines 116–118. Please also see additional information in the methods section (Lines 216–218) explaining that we used the real nutrient profile systems for each FOPL.

Considering that the MTL system and the warning label system have been implemented both in various ways, with various nutrient profile models to underpin them (for warning labels, PAHO, Chilean, Mexican, Canadian or Israeli models vary considerably in terms of the nutrient thresholds being used), then it is clear that there is no 'gold standard' in terms of the nutrient profile applied, and that it should be in particular adapted to the experimental design being tested.

Our response: We acknowledge the lack of a gold standard for nutrient thresholds and the different nutrient profiles implemented in various countries. It is for this reason that researchers in South Africa investigated a nutrient profile model suitable for use within the South African context (Frank, T., Thow, A.-M., Ng, S. W., Ostrowski, J., Bopape, M., & Swart, E. C. (2021). A Fit-for-Purpose Nutrient Profiling Model to Underpin Food and Nutrition Policies in South Africa. Nutrients, 13(8), 2584. Doi: 10.3390/NU13082584). This nutrient profile was therefore used to guide the WL arm in the current study.

In the specific case of the present experiment, the direct comparisons of the labels make little to no sense at all, considering the various elements at play in the different intervention arms of the study. At the very least the main models should account for these various elements, which is not the case at present. Also, the conclusions being drawn are clearly overstatements as to the beneficial effects of the warning labels that are inherently favoured in the methodological design of the study.

Our response: As per the previous suggestions, we explained that we were testing real-world policies; however, we have included this as one of the limitations. We acknowledge that our study did not have enough variability to account for the differences in FOPL. Please see Lines 420–427. The results of this study, however, still provide important insight into how consumers understand the different FOPL.

Qualification of products

From the introduction, food products are introduced as being either 'healthy' or 'unhealthy'. This appears as a simplistic view of diets and foods towards a dichotomization of dietary behaviour, which could lead to detrimental effects. More concerning appears to be the definition used for 'unhealthy' products, whereby any product with an 'excessive' level of a nutrient of concern should be considered 'unhealthy'. There is currently no gold standard in nutrition allowing for such a dichotomous view of foods or even diets, in particular considering that amount and frequency of consumption of various types of foods intervene in the definition of a healthy diet. Determining the 'excessive' level of a given nutrient of concern varies depending on policy priorities, and even this definition of nutrient thresholds is not standardized depending on the country.

Also, this type of perspective of diet fuels the misled perception of nutrition as 'hygienist', leading to some of the best options in policy being discarded only because of the way they are being framed.

Our response: Thank you for pointing to the challenge related to food categorisation. We do agree that while foods are complex, it is necessary to use a reductionist approach for the purposes of policy implementation. Many international organisations define unhealthy food as packaged products that are high in nutrients of concern (e.g. WHO, PAHO) and categorise food as healthy vs unhealthy. Countries that have implemented mandatory warning FOPL have used the same approach. The definition of unhealthy in this study is therefore not unique, but aligned to the international definition, particularly for those countries that have implemented mandatory warning FOPL. This definition is applicable in this instance as this study seeks to inform policy in South Africa that aims to inform and discourage consumers from consuming products high in nutrients of concern.

Definition of 'unhealthy' products – framing

In the methods section, at no point do researchers clearly identify how the 'correct' answer was reached. If all products were to be considered 'unhealthy' then please state so. As it appears, 'unhealthy' products are defined only through the lens of the Warning label.

Hence, considering the inconsistency of the different nutrient profile models, by design some of the labels cannot perform properly, as the information is not available to consumers – except in the warning labels arms.

Our response: All products used in this study were unhealthy and by definition that meant a product containing either a WL, an amber or red colour or both. This information is now included in Lines 236–238 and 241–244.

In particular, for the MTL, both soda and orange juice only receive an amber, while they all receive from one to two warnings. This is a major concern, as the signal sent by an 'amber' is by no means equivalent to a 'warning'. As such, this is a clear breach of standards in randomized trials, as there is no equivalence between trial arms. This is especially concerning as the method is of an experimental design, with a very limited set of products. It would have been easy to modify the choice of products – or the nutrient profile – to allow for meaningful comparisons.

Our response: The colour allocation depended on products' nutrient profile and according to the MTL nutrient profile model, soda and orange juice qualified for an amber colour and as per the proposed nutrient prolife for South Africa the two products qualified for sugar warnings. We do agree that the amber is not equivalent to a warning and this study did not mean to equate the two. The products were presented with their respective FOPL, and participants had to demonstrate if they understood their meaning or not.

Another breach of trial ethics concerns the way the questions are framed, which provide an advantage to one of the trial arms. The questions as they appear to be framed appear to provide an advantage to a binary system, as they are framed as 'higher than recommended'. Such a framing would by definition lead some participants to uncertainty as to graded approaches such as the MTL, in which 'medium' levels are incorporated in the system. Again, this is a breach of the necessary equivalence of trial arms by design of the researchers. A question framed in a more neutral way (for example: 'To your point of view, what is the level of X nutrient in the product?') would probably have led to other responses.

Alternatively, a controlled situation in which no stimuli had intermediate ratings in the MTL would have allowed to avoid this bias.

As such, the only meaningful comparison across arms for single product assessment – in particular for 'unhealthy' products is the chips. The other comparisons should not appear as strongly in the results, as they are made from a somewhat biased selection of products.

Our response: The study aimed to test the FOPL that would most assist consumers identify 'high in' = unhealthy products and this system requires a binary system. We do not consider this a breach of trial ethics, but a testing of specific underlying FOPL systems that have been implemented or proposed. We would like to reiterate that this study aimed to compare existing policies and their ability to inform consumers based on this study's objectives and the country's strategic objective which is to assist consumers easily identify unhealthy products as products high in select nutrients shown to be linked to poorer health outcomes.

On the point regarding product selection bias, we would like to clarify that the product selection was not based on researchers' preference, but on the top selling food categories according to the Euromonitor.

The Euromonitor was used to identify products within each category that were likely to carry the highest number of nutrients of concern. The products used represented a range of products, representing a mix of products often perceived as unhealthy (crisps, sweet biscuits and soda) and products not clearly healthy or unhealthy (100% fruit juice, cereals and yoghurt).

Product comparison

The main issue in the methods is the selection of the pairs of products, in which only the warning labels would lead to any meaningful comparisons. The three pairs being tested were yogurts, biscuits and cereals.

In the yogurts case, by design of the researchers, the MTL is the same, with only one amber for the sugars. Interestingly, Additional Table 3 states that one of the yogurts should have carried a warning for artificial sweeteners while the images of the products in the warning label do not carry such a label. This would need to be clarified, to avoid hints of manipulation towards a forgone conclusion. So, Line 171 is clearly misleading in this case.

Our response: The nutrient profile of products across all label conditions and the FOPL allocation was not decided upon by the researchers but rather based on existing FOPL systems which determines both the nutrient profiling model and designs. According to the MTL nutrient profile, the two yoghurts qualified for the same colours, which may happen in a real-life scenario. The testing in this study was to determine if participants would be able to distinguish the one higher in nutrients of concern or the unhealthier one as the nutrient profile/composition of the two yoghurts was not the same. Please see Additional File 2 that shows an image of a yoghurt containing a warning for artificial sweetener (WL arm).

Considering the choice of products, by **design** the MTL could not perform correctly in the yogurts category. This is unacceptable bias in research, in particular when it could have been avoided in a *controlled* experimental setting as this one.

The only way to correct this is to limit the main comparisons to cereals and biscuits, for which some comparison can be drawn directly.

As such, the results obtained are purely a factor of this inconsistency: warning and MTL perform as well in cases where they have been appropriately designed (i.e. in pairs of biscuits). Conversely, they perform worse in cases where they have been *by design* set to fail (i.e. in yogurts and juice).

Our response: Additional File 4 (now Additional File 3) indicates a difference of 8g for sugar and 19.3mg for sodium between the two yoghurts. The colour allocation was therefore not based on researchers' bias but on the NPM applied. The design made provision for the two yoghurts to carry any of the three colours. The product (yoghurt) was therefore not set by researchers to fail but carried the particular colours due to the nutrient profile applied.

Reviewer #2: Minor Comments

Introduction

In general references in the introduction should be updated; most references in the introduction in particular date before 2015, while there has been a large body of literature on the subject of FOPL since, including a network meta-analysis of their performance that should be incorporated early on in the introduction.

Line 9: the references are clearly misquoted, as the author appears as 'Editorial'.

Our response: Thank you for noting the mistake with the citation for one of the authors. We have corrected the author's name. Please see Lines 9 and 678. We have also updated some of the references in the introduction to include most recent studies around FOPL.

Line 51: please include that warning labels and MTL are *nutrient-specific* schemes and not summary systems.

Our response. We have made an insertion to indicate that WL and MTL are *nutrient-specific* schemes. Please see Line 56.

Line 58: please use an updated reference for MTL, it dates back 2009, while MTL reference framework has been updated in the UK in 2013. Also, the countries implementing the MTL reach beyond Europe, as Saudi Arabia and Iran have introduced similar systems.

Our response: Thank you for the suggested reference update and the suggestion to include other countries that implement MTL. We changed the MTL publication year to 2016 (please see Line 64) and included other countries where MTL is implemented. Please see Lines 64–66.

Lines 57–66: please reformulate the entire paragraph. The challenge presented by the MTL is not related to the fact that multiple colours appear at once, but rather when there is a conflict between different signals in different nutrients, whereby a priority is necessary (2 ambers vs. 1 green and 1 red). This is more frequent than in the warning label as there are 3 colours rather than a binary system, but technically, there could also be conundrums in the case of the warning labels (a warning for sugars in one case vs. a warning on saturates).

Our response: Thank you for the suggestion that we reformulate the entire paragraph. Please see Lines 66–78 for the modification.

Also, the fact that the MTL appears on all products rather than on a fraction of products could be seen as a positive factor of the system, as consumers then receive both promotion cues (with green) and deterrence cues (with amber and red).

Our response: Thank you for suggesting the positive aspect of the MTL. However, another school of thought is that positive nutrients, lower levels of nutrients of concern in this case, do not nullify higher levels of other nutrients of concern which are to be limited in order to address obesity and NCDs. The green colour may dilute the effect of the red when they both appear on a product, leading to consumers misjudging the relative unhealthiness of the product. In that case, the green may be misleading more than being helpful.

As it is, the paragraph appears to discard MTL as being a suboptimal option, while most studies investigating it have shown its superiority in particular compared to the GDAs. Please reformulate.

Our response: We have included studies that show the effectiveness of MTL vs the GDA. Please see Lines 83–84.

Line 74: Please provide a precision as to which are the comparators being used when stating ‘better’, as warning labels have not necessarily always appeared as the most effective options in the various comparisons used as reference.

Our response: Thank you for this input. The aim was to highlight that the WL provides multiple benefits and the studies cited included the advantages of the WL in the identification of nutrients in excess, unhealthy products, reduce intention to purchase unhealthy products and that warning labels are easy to understand. We separated the sources to indicate a reference for each instance where the WL was shown to perform better. Please see Lines 89–95.

Lines 76–80: please simplify. Sentences appear repetitive.

Our response: Thank you for the advice to simplify Lines 76–80. We have restructured the sentence to make it easier to read. Please see Lines 80–83.

Line 93: the use of ‘unhealthy’ products needs to be revised (see major comment on the topic).

Our response: Kindly see major comments for our reason to refer to products as unhealthy.

Methods

Line120: please provide some information as to the effect size estimate. A 0.136 estimate appears first as very low considering the type of study (much higher effect sizes have been identified in the literature) and second particularly precise. Please provide the reference for this estimate

Our response: We acknowledge that compared to other studies, the effect size is small. We modified the sentence (please see Lines 145–148). The estimated effect size was based on the predicted performance of the WL against the MTL and the GDA (Ducrot *et al*, 2015). We assumed that a small effect size (d=1.5) would be relevant as this concerns an effect at population level. In addition, other authors of similar studies used even lower effect sizes (0.036). Impact of nutrient warning labels on choice of ultra-processed food and drinks high in sugar, sodium, and saturated fat in Colombia: A randomized controlled trial (Mora-Plazas *et al,* 2022).

Ducrot, P., Méjean, C., Julia, C., Kesse-Guyot, E., Touvier, M., Fezeu, L., Hercberg, S., & Péneau, S. (2015). Effectiveness of Front-Of-Pack Nutrition Labels in French Adults: Results from the NutriNet-Santé Cohort Study. PloS One, 10(10), e0140898. https://doi.org/10.1371/journal.pone.0140898

Line 120: please provide some information as to the inflation rate estimate provided. It corresponds to a+40% inflation rate which is particularly large in a trial in which only a limited follow-up is required.

Our response: Thank you for the advice to provide information regarding the inflation rate estimate. We have included our rationale for over-inflating the calculated sample size to 2500. Please see Lines 148–149.

Line 134: please provide the number of the research board approval. Also, please state whether the trial was registered in *clinicaltrials.gov.*

Our response: Thank you for suggesting that we add the ethics approval number and to state whether the trial was registered in clinicaltrials.gov or not. Please see Line 230 for the ethics board number (BM 18- 9-3).

The trial was not registered with clinicaltrial.gov, but with 'As predicted' - *Evaluating simplified nutrition information labels in South Africa* (#45567). Please see Lines 127–128.

Line 141: please provide some indication as to the number of participants enrolled each day, as this would provide some information as to the randomization process, which is not 1:1:1, but rather dependent on the given day's recruitment possibility.

Our response: We agree that randomisation depended on the number of recruitment possible on the day of data collection. Please see Lines 173–174.

Line 158: the framing of the questions need to be discussed (see major comment above).

Our response: Kindly see our response in the major comment section above.

Line 210: It is not clear how the model for the Poisson regression was arrived at, considering that multiple stimuli appear to have been used simultaneously as well as multiple outcome measures.

Our response: Please see Line 252 for the reformulated statement explaining how the Poisson regression was arrived at.

Results

The variability of the RR between warning and MTL are a product of the stimuli selection and the inconsistency between nutrient profiles (see major comment above). Any interpretation that the MTL performs with more variability is due to the *design* of the study and by no means by inherent characteristics of the label.

Our response: Please see our response in the major comments above.

Discussion

The authors overstate their results, not taking into consideration the major flaws in the design of the stimuli used in the study. The discussion should incorporate much more nuanced interpretation of the results in light of the limitations of the method and relate also studies in which the warning labels did not perform as well compared to the MTL. The discussion as it is at present only relates results in line with the study, while there are remaining issues to be investigated. This appears somewhat single-oriented and reads more as an advocacy piece for the warning labels. Finally, only studies from Latin America are related, while the warning labels have been tested elsewhere. A comparison of the populations/policy priority areas would be interesting to investigate whether the comparisons are legitimate.

Our response: We toned down our findings by incorporating the limitations brought about by different FOPLs, e.g. label size, within the discussion section in order to accurately frame the interpretation of our findings. Please see Lines 367–369 and 424–427.

Thank you for the suggestion to include other studies where the WL did not perform that well compared to the WL. Please see Lines 369–371 and 402–403 for the additional studies.

We have also included studies conducted outside Latin America where the WL was tested: Egnell *et al,* 2019 (The Netherlands); Neal *et al,* 2017 (Australia); Hock *et al,* 2021 (six countries including Canada, UK and Australia); Jáuregui, A, 2022 (six countries including Australia, Canada, UK); Todd *et al.*, 2022 (South Africa).

Lines 303–313: please reformulate.

What your study shows is not that the presence of 'multiple' colours are misleading, but rather that a graded stimuli may be more difficult to understand than a binary one. In particular as in your study the amber is *by design* supposed to perform as well as a warning in a number of the comparison sets. Also, the framing of the question entailed binary responses, hence a better performance of the warning labels.

Our response: Thank you for the suggestion to reformulate. We agree that the graded label may be more difficult to understand than the binary one and we believe that this has been captured as such in Line 353. Given that all products were unhealthy and some unhealthier than others (product pairs) we wanted to test how participants would classify a product with an amber colour, given the binary nature of our study's objectives. The researchers did not equate any of the FOPL but left the decision to the participants.

Lines 314–323: please refrain from using the term 'unhealthy' to define any product having at least one warning, in particular considering the nutrient profile assigned to fruit juices and sodas, which clearly did not provide a comparable assessment. Please also add some information as to the fact that warning labels take up a sizeable portion of the product in the experiment compared to the other labels, and the salience due to sheer size alone could have driven the results.

Our response: Please see our response in the major comments above.

Responses to the third review

Editor and Reviewer Comments:

Reviewer #1: Comments

The responses provided by the authors do not allow to alleviate any of the concerns on methodology that were largely detailed in the first round of reviews, and the revised manuscript contains only a limited number of modifications in particular to the discussion.

The initial comments therefore still stand, and the responses from the authors do not appear to provide an adequate rebuttal. Only two of the main concerns will be noted again:

1. Selection of products:

That the nutrient profiles underlying each label should be used as they have been developed is not in question and is not the main issue that was detailed in the comments.

What is concerning is that the evaluation of the labels is done based on a selection of 9 products, out of probably a few dozens in real life (if not more), with highly variable nutrient contents. Considering the very selected nature of the products in this type of experimental study (and the fact that the products were actually presented as fictitious), it is absolutely necessary to standardize the conditions in which they are used to test the labels. It would have been adequate to select products with aligned nutrient profiles from real-life products on the market, in particular considering the highly variable nature of the food categories that were selected.

Given the method that is used, the selection of the products is tested and not the labels themselves. This is evidenced by the alignment between the results and the selection, in which the differences between the effectiveness of the MTL and WL are particularly apparent for products for which the stimuli were not aligned (i.e. when the amber stimuli is considered to be the deterrent signal).

The authors should not dismiss this concern upfront and should discuss it more at length.

Our response: Thank you for your comments. The selection of product categories was informed by top sales in South Africa in 2018 according to Euromonitor and were meant to represent a mix of products often perceived as unhealthy (crisps, sweet biscuits and soda) and products whose healthfulness is more ambiguous (100% fruit juice, cereals and yoghurt) (Lines 207–210). The use of fictitious products was chosen to minimise bias due to participants' preconceived knowledge, product familiarity and brand preferences. (Lines 210–212).

The nutritional information of the fictitious products was based on real products, as you have noted. We selected similar commercial products based on per 100g/ml and these nutritional profiles were the same across the FOPLs (Lines 216–218).

What differed is the nutrient profile model used to determine the specific details of each FOPL (e.g. whether a traffic light was red or yellow or green). Because the accompanying NPMs for each FOPL were different, it is the case as the reviewer noted that products for which the underlying NPMs are very unaligned; we are likely to see bigger differences in outcomes (compared to products for which the NPMs are more akin), but we cannot tell whether this is due to the label designs alone or also due to the underlying NPMs and how much is due to which. As explained previously, we chose to do this because, in reality, FOPL policies contain multiple elements: both the FOPL design itself and the underlying NPM. We wanted to apply real-world FOPLs with their underlying NPMs as a way to assess policy options in discussion. However, the reviewer's point is well taken, and we have now acknowledged that the lack of disentanglement of the NPM and the FOPL label design could have influenced the current findings (Lines 225–230, Lines 366–367 and Lines 435–439). We also now recommend future studies that could investigate the effectiveness of FOPL when the NPMs are standardised (Lines 439–441).

2. Framing of healthy/unhealthy

The authors have dismissed the concern over the qualification of products as 'unhealthy' based on guidance documents from PAHO or WHO. However, while policy guidance documents do indeed use the term unhealthy to define the broad target of policymaking, the definition of a product as 'unhealthy' is by no means in consensus within the scientific community (in particular when considering the variability in the thresholds that are used to define 'high in'). Legislation may refer to products directly as 'high in' products or 'HFSS' for high in fat, salt and sugar, which are more descriptive terms or to unhealthy in some cases.

My contention is that the use of such terminology without a clear reference to a scoping paper that clarifies under the South African policy perspective what is 'unhealthy' as a definition, can be viewed as rather exclusive than inclusive as a term in scientific studies, as it provides a value judgment from a definition that is from the authors themselves. Considering the policy nature of the topic that is addressed in this paper, the choice of terminology is not neutral and could also impact the way the results are taken up and disseminated from a policy perspective.

Our response: Regarding the use of the term 'unhealthy' within the South African policy perspective, the existing food labelling regulation (R146) only addresses labelling for health claims and is silent on any other definitions related to product healthiness. However, draft R429 (Guideline 14), currently in review, includes guidelines on the criteria for the commercial marketing of foods and non-alcoholic beverages to children. The proposed guideline specifically makes mention of the aim of the Department of Health which is to restrict marketing of unhealthy foods and drinks to children. The document further expands on the definition of unhealthy foods, which are – products high in fat, saturated fats, trans-fatty acids, free sugars and sodium (salt). The term unhealthy foods is therefore a concept that is familiar within the regulatory and policy frameworks in the country. Additionally, several studies have been conducted in South Africa where the term 'unhealthy foods' was used, so this definition of 'unhealthy' reflects the current state of understanding in this context (please see Lines 31–42).

Reviewer #2: Minor Comments

Page 7, Lines 110–116. Add the references of 'GEOTERRAIMAGE (GTI))' and 'Neighbourhood Lifestyle Index®© (NLI™©)'

Our response: The reference has now been added. Please see Line 138.

Page 9, Line 158. Add more detail on the piloting of the questionnaire. Type of population... how many questionnaires were applied... what changes were made with the pilot version of the questionnaire vs. the final questionnaire, etc.

Our response: Thank you for the suggestion to include more information regarding the pilot phase. Please see Lines 186–192 for additional information regarding the pilot study.

Graphs 1 and 3 are still not entirely clear, check the quality.

Our response: We improved on the quality of images 1 and 3 and they are clearer now.

Additional File 1, Structure it as a follow-up to Figure 2. That is, place the total number of participants at the top, place the n and the percentage of participants in each arm. You can even put the collection dates in the control and experimental phase (if applicable).

Our response: Thank you for suggesting that Additional File 1 be presented as a follow-up to Figure 2. We have tentatively incorporated Additional File 1 into Figure 2 (please see Figure 2).

Reviewer #3: Review of APPETITE-D-22-00317R1

Effect of different front-of-package food labels on identification of unhealthy products and intention to purchase unhealthy products – a Randomised Controlled Trial.

I should make clear that I was not one of the original reviewers but have been asked to review the resubmission and the authors' responses to the original reviews. I had no major concerns about any aspect of the paper and so, for the sake of fairness, I have not introduced any new issues at this stage that reflect my own subjective opinions or preferences. Instead, I focus on the authors' response to the original review and suggest only minor additional points where I think small, easy to make changes as the manuscript is being finalised would increase the clarity of reporting.

I enjoyed reading this paper and found it to be interesting and well written. The introduction sets out a clear rationale; the study design, analyses and interpretation seem appropriate; and the sample is representative. The authors raise one of the issues that I always wonder about as a cognitive scientist when reading about FOPL – how people reconcile conflicting information across the standard label formats (e.g. where one attribute is 'good' and one is 'bad' on a multi-nutrient traffic light label) and test the utility of a viable single attribute format.

Review Responses

I agree completely with the original reviewers that the reader needs to see what was provided to participants and this has now been provided. All of the other specific and minor issues also appear to have been addressed in a satisfactory way.

Minor additional suggestions to consider:

Line 21. Suggest removing the first use of the word 'easily'.

Our response: Thank you for pointing this out. The first use of the word 'easily' is now deleted from the sentence. Please see Line 22.

Lines 98–99. I found the description of the design confusing and would suggest instead "using a mixed design with both a within and between subjects factor".

Our response: We take note that the phrasing could have been confusing, and we have rephrased the sentence to make it clearer. Please see Lines 122–124.

We however did not change the RCT design to the mixed design as suggested to reflect that there were different arms which participants were randomised to.

Lines 120–121. The phrasing around the sample size calculation is unclear: "The sample size of 1526 households was calculated at a G-power of 90% and 95% confidence level, with an effect size of 0.136." Do you mean that the sample size was calculated a priori using G*Power to be able to detect an effect size of 0.136 with 90% power and an alpha of .05? Or was this calculated retrospectively and this is an estimate of the size of effect that could be detected with a sample of this size? Please rephrase to clarify.

Our response: The sentence was rephrased to indicate that the a priori sample size calculation considered the power of 90%, effect size of 0.136 and 95% confidence level. Please see Line 145–146.

Table 1: In amending the table in response to reviewer comments, some inconsistency has been introduced. Headings state that the data are presented as n (%), but the % is actually presented in a separate column. I would either put the % values in brackets to align with the header or update the header.

Our response: We updated the headers in Table 1 to include the 'n' and '%'.

Line 244. Suggest changing "nutrients" for "nutrients of concern" for consistency and clarity.

Our response: 'Nutrients' is now substituted with 'nutrients of concern'. Please see Line 279.

Reviewer #4:

This is an interesting study on an important topic, and the paper is generally nicely written. My only concern is that you don't appear to have matched the WL "treatment" to the other "treatments" in terms of the visual impact per se (i.e. regardless of the content of the label). At first glance the WL label stands out for immediate visual impact and stark presentation compared with the more colourful and subtle GDA and MTL alternatives, leaving the possibility that the observed differences were due to presentation per se rather than the warning message. Previous studies have shown that appearance of package labels can have a big impact on consumers regardless of content, for example green signalling healthy options more so than red labels with the same content. I don't consider this a game breaker, because the results are nonetheless important, but this should at least be discussed in the discussion.

Our response: Thank you for the suggestion to include the label size as a possible determinant of the FOPL performance in the current. This limitation is now included as part the discussion in Lines 367–371 and Lines 424–427.

---------- Forwarded message ---------
From: **Appetite** <em@editorialmanager.com>
Date: Thu, Aug 18, 2022 at 12:41 PM
Subject: Decision on submission to Appetite
To: Makoma Bopape <makoma.bopape@ul.ac.za>

Manuscript Number: APPETITE-D-22-00317R3

Effect of different front-of-package food labels on identification of unhealthy products and intention to purchase unhealthy products – a Randomised Controlled Trial

Thank you for the careful revision of your manuscript. I find that you have satisfactorily answered the review comments, and I am therefore pleased to accept this version of the manuscript for publication in Appetite.

If there are any additional comments, please find these appended below.

Your accepted manuscript will now be transferred to our production department. We will create a proof which you will be asked to check, and you will also be asked to complete a number of online forms required for publication. If we need additional information from you during the production process, we will contact you directly.

We appreciate you submitting your manuscript to Appetite and hope you will consider us again for future submissions.

Kind regards,
Gaston Ares
Section Editor

Appetite

Editor and Reviewer comments (if available):

Appendix 15: Reviewers' comments and authors' responses (Publication #3)

REVIEWER #3

Contribution to the field

This paragraph is mostly about warning labels and research outside of Africa. It's not clear what this specific study contributes to the literature (other than it hasn't been done before).

Our response: We have expanded on the potential contribution of this study to the public health nutrition field. Please see the respective sections in the submission.

Abstract

Line 17. The statement "Parents are responsible..." is strongly worded, when in fact many factors affect household purchasing decisions (price, available, children's preferences, etc.). Moreover, it seems to imply that parents are to blame for unhealthy food consumption and doesn't explain why food marketing to children is an issue (the second sentence). I'm not sure why the authors chose to begin their paper this way. I suggest starting with a sentence that better describes the complexity of household food purchasing decisions,

Our response: We have revised and modified the statements to reflect the complex nature of food purchasing decisions and that food marketing makes healthier food selection harder. Please see Lines 4–8.

Lines 29–34. Since this is qualitative research, the findings can only describe the range of potential parental responses to the WL. When presenting results, all statements should be qualified. For example (Line 29): "all" parents did not feel they would alter their food purchasing. Was it most parents, a few parents, or a subset of parents?

Our response: Thank you for the suggestion to qualify statements about parents. We have reviewed and improved on the statements. Please see Lines 20–21.

Introduction

Line 55. Again, I think it is an overstatement to say that parents are ultimately responsible.

Our response: Thank you for the suggestion to review the statement about parental role in food selection which may have been overstated. Please see Lines 50 and 51 for the revised statement.

Methods

I would like to see much more detail about the group methodology.

How were participants shown the images – all at once, what were they told about the products and the images, about the purpose of the study? This information is in the discussion guide, but it should be explained in the manuscript and, importantly, why it was presented in this way.

Our response: Thank you for pointing out the gap in fully describing the group methodology. We have now included information related to the purpose of the study, as explained to the participants, the way images were exposed in the focus groups, what participants were told or not told about the products and the images, and the rationale behind the methodology. Please see Lines 150–162.

What specific questions were asked, and how are they related to the conceptual framework? That wasn't clear to me.

Our response: Thank you for the input to include questions that were asked in this study and how they relate to the framework. According to the framework, an FOPL will be effective if it is attended to, well understood, will modify attitudes and motivate individuals to modify their behaviour. The framework further explains that there are modifying factors to food purchases that include cost, children's food preferences, nutrition knowledge, etc. The questions that were asked in this study related to these concepts. Please see Lines 170–177.

How are the themes identified related to the conceptual framework? It seems that some were related, but not all were included (e.g. attention to message). If not the conceptual framework, what were the main research questions and how did the coders decide something was theme?

Our response: First, please see Lines 177–179 for an explanation on the section of the conceptual framework that was excluded in this study. Second, although the questions were informed by the framework, the themes were drawn from participants' responses and were not predetermined. Please see Lines 182–183. Themes that were related to the framework (e.g. motivation for modifying purchasing behaviour) were therefore included even though they were not part of the initial framework.

There is not enough information to understand how rigorous the methods were. Was there a codebook, was there any kind of reliability testing, did both coders code all the transcripts, what happened if the two coders did not agree?

Our response: Thank you for pointing to the need to include more information on the data analysis process. We have expanded on the data analysis section by explaining the process from reading the transcripts, reaching consensus on the codes and themes and assigning quotes to the themes. Please see Lines 183–189.

These were focus groups, but the moderator used a semi-structured interview guide. Does this mean that they asked each person the questions one-by-one, or was there a group discussion (as typically done in a a focus group)?

Our response: We changed the semi-structured interview guide to focus group discussion guide, as used during data collection. Please see Lines 17, 142, 168

Who is MB (moderator) and how are they similar (or not) to focus group participants. What kind of experience and training did the focus group moderator and coders have in qualitative research?

What was the race of participants?

Our response: MB was one of the researchers in this study. MB is a senior lecturer and currently teaches research methodology, and supervises undergraduate and postgraduate students who engage in qualitative research. She has some experience in facilitating focus group discussions from previous research work.

FB is in the psychology field and has extensive experiencing in qualitative research and data analysis. All participants were black South Africans, similarly to MB.

Line 171. I do not believe that the methodology is fully described.

Our response: We have now expanded on the data collection methodology and data analysis.

Results

As noted in the abstract, statements about "parents" in general may be misleading. Did all parents say this, a few parents, did these themes appear in all groups? Wording to explain the frequency and context of all themes is necessary.

Our response: We reviewed the results section to indicate that not all the parents shared the same views. The number of responses were not analysed quantitatively as this study is intended to reflect the qualitative nature of parents' views regarding the effect of the WL on food purchasing and drivers of food selection. We recommend that future quantitative studies, with a representative sample size, be conducted to determine parental perceptions of the warning label on food selection. Please see Lines 480–481.

I'm also curious why they note the gender and urban/rural status of the quote, but not income or literacy level (as the groups were divided this way). It would be interesting to understand whether these themes were universal, or whether they appeared in some groups but not others, and which ones.

Our response: We have included the literacy and income levels for all the quotes cited in this study.

Beginning Line 198. I don't understand the "fear" response. This seems a bit extreme. What were parents afraid of? Is there some sort of historical context to why "they" (not clear who) is trying to scare them. Since all the quotes are from "female rural" respondents, did this come out in one group, or was it more widespread?

Our response: The responses were captured as shared by the participants. Participants used words such as '*the warning will scare us*', '*we will be afraid*'. These findings are in line with results from other studies that show that the WLs elicited negative reactions such as fear, worry, etc. among participants.

A number of study limitations should be mentioned:

Focus group discussions can be easily swayed by one vocal group member. Statements do not necessarily mean that everyone in the group agrees.

Our response: Thank you for the suggestion to include this limitation. We have included it in Lines 480–48.1

In addition, statements are not representative of all parents. Quantitative research is needed to understand how widespread these perceptions are and whether they are more prevalent among certain groups of parents.

Our response: Please see Lines 477–478 for this limitation and the recommendation in Lines 481–482.

It seems likely that participants knew the "right" answers (i.e. they shouldn't give their children foods with warning labels). Potential demand effects are a major limitation of this study. Any efforts to offset this bias should be discussed.

Our response: To deal with demand effect, participants were invited to participate freely and were informed that there were no correct or incorrect responses. Additionally, participants were not informed that the study was about the WL, but that the study was about their perceptions on the images to be displayed during discussions. Please see these additions in Lines 484–488.

Since the same person recruited participants, moderated the groups, transcribed the audio recordings, translated them into English, and conducted thematic analysis (with one other person), these study findings are highly influenced by that person's biases. This limitation is a major one.

Our response: Although one individual was involved in participants' recruitment, moderation of groups and data analysis, we believe appropriate steps were taken to ensure the trustworthiness of data. First, the selection of participants was based on predestined selection criteria which were adhered to during sampling. Second, the moderator was familiar with the language spoken by the participants. The triangulation of findings (codes and themes) which the researcher and the independent coder worked on separately further improved the trustworthiness of the research findings. We therefore believe that adequate measures were taken to minimise bias in this study.

REVIEWER 2:

A few specific points need to be considered.

Introduction

Lines 4–47: The public sector costs of diagnosed patients were approximately R2.7 billion and 47 would be R21.8 billion if both diagnosed and undiagnosed patients are considered.

Comment: Authors should consider using more popular currency references, such as the dollar or the euro.

Our response: We have included the figures in both Rands and US dollars. Please see Lines 40–41.

Materials and methods

Line 127. MB recruited participants face-to-face through the snowball sampling method.

Comment: Apparently MP is one of the researchers. Therefore, it is important that it is identified at this time or else the acronym is omitted and only "the researcher" is placed.

Our response: We have explained that MB is one of the researchers. Please see Lines 128–129.

Line 139. All interviews were conducted by MB using a semi-structured interview guide.

Comment: Authors should clarify whether the interviews mentioned in this sentence are focus groups. As it stands, it appears that interviews were conducted in addition to the focus groups.

Our response: All discussions were focus-group discussions. Semi-structured interviews were replaced with focus group discussions throughout the document and any references to interviews were deleted.

On Wed, Jul 20, 2022 at 1:13 PM Frontiers Public Health Editorial Office
<publichealth.editorial.office@frontiersin.org> wrote:

Dear Dr Bopape,

Frontiers Public Health Editorial Office has sent you a message. Please click 'Reply' to send a direct response

I am pleased to inform you that your manuscript "Perceived effect of warning label on parental food purchasing and drivers of food selection among South African parents - an exploratory study" has been approved for production and accepted for publication in Frontiers in Public Health, section Public Health and Nutrition. Proofs are being prepared for you to verify before publication. We will also perform final checks to ensure your manuscript meets our criteria for publication (https://www.frontiersin.org/about/review-system#ManuscriptQualityStandards).

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