Title

Consumer Understanding, Perception and Interpretation of Serving Size Information on Food Labels: A Scoping Review

Author List and Affiliations

Tamara Bucher *[A,B], Kerith Duncanson [A,B], Beatrice Murawski [B,C], Klazine Van der Horst [D], David Labbe [D]

[A] School of Health Sciences, Faculty of Health and Medicine, The University of Newcastle, Callaghan NSW 2308, Australia

[B] Priority Research Centre for Physical Activity and Nutrition, The University of Newcastle, Callaghan NSW 2308, Australia

[C] School of Medicine and Public Health, Faculty of Health and Medicine, The University of Newcastle, Callaghan NSW 2308, Australia

[D] Nestlé Research Center, Lausanne 1000, Switzerland

Corresponding author: Tamara Bucher tamara.bucher@newcastle.edu.au

Kerith Duncanson kerith.duncanson@newcastle.edu.au

Beatrice Murawski beatrice.murawski@newcastle.edu.au

Klazine van der Horst Klazine.VanDerHorst@rdls.nestle.com

David Labbe david.labbe@rdls.nestle.com

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Abstract

This scoping review investigated how consumers perceive and interpret serving size information on food packages. A search of seven databases (2010 to September 2017) was followed by title and abstract screening, with relevant articles assessed for eligibility in full-text. Fourteen studies met inclusion criteria, with relevant data extracted by one reviewer and checked for consistency by a second reviewer.

Five studies reported poor understanding of nutrition facts labelling and portion size, with information to 'benchmark' serving size against reported as helpful in two studies. Consumer attitudes towards serving size labelling were measured in six studies and identified that serving size information was interpreted as indicative of nutrient intake regardless of portion size recommendations. Increased labelled serving sizes resulted in increased portion sizes in three studies, with three studies reporting the opposite or neutral effect for discretionary food portion sizes.

The influence of labelled serving size on consumer attitudes and consumption is complex and sometimes counterintuitive. As labelled serving size can impact on consumption, any changes may result in unintended public health consequences. The effects of labelled serving size format changes should be tested carefully within experimental and ecological contexts and accompanied by tailored, comprehensive and serving size-specific food literacy initiatives.

Keywords Food labelling; serve size; obesity; back of pack label; BOP; front of pack label; FOP; food marketing; nudging

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Introduction

Optimal nutrition enhances wellbeing and reduces physical and mental health risks across all life stages, whereas sub-optimal as well as over-nutrition are risk factors for lifestyle diseases (e.g., type-2 diabetes, heart disease) that have become endemic worldwide [1]. To guide populations on healthy food selection and overall dietary intake, most countries have implemented food guidance systems that have been developed using evidence-based food, health, disease and life stage information [2-4]. These guidance systems include recommended food choices across food groups, including numbers of serves of a particular size (serve sizes) that are gender and age specific.

The food environment in which people select, prepare and consume food has changed considerably in the past generation and is expected to continue to change at an equally rapid rate. Improvements to agricultural practices, food transportation, food processing and food storage have contributed to an increase in food availability and variety [5]. A decrease in home prepared foods and increased purchasing and consumption of packaged foods has led to increased reliance on food package labels for information about the composition of foods purchased and consumed [6-8]. In this context, the importance of serving size and nutrition information labelling is paramount for consumer awareness and understanding of their food purchasing and consumption behaviours.

The term serving size pertains to the labelled serving size found on a food label, unlike portion size which describes the actual amount of food that has been consumed. However, the terms serving size and portion size are often used interchangeably, which may lead

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consumers to believe they mean the same thing, but there is a distinct difference. This misconception has led to confusion of food labelling, designed to guide food selection and consumption [9].

In recent decades, portion sizes (the actual consumption of food) and portions offered (the size of packages and restaurant meals) have increased globally, leading to a greater caloric intake [10]. The association between increased portion sizes and weight gain has also been acknowledged and documented around the world [11-12]. This increase has been observed for food consumption both inside the home and outside the home [13], especially with regards to foods high in energy [14]. Several short-term studies have shown that providing a larger serve of snacks [15-16], sugar-sweetened beverages [17] and individual meals [15, 18-21] leads to increased consumption, of both volume and energy. All of the described factors have the potential to substantially, negatively affect food consumption and health status at a global level.

Food labels display a plethora of information for consumers, including serving sizes, nutrition information, ingredients list and sometimes, health claims. The volume and nature of information may be difficult to interpret. Both Australia and the USA, as well as other countries across the world, have detailed information on how to interpret and understand food labels [22-23]. The literature provides mixed information on consumer understanding and use of food labels. A systematic review by Cowburn and Stockley [24] found that most consumers looked at nutrition labels often or sometimes with some participants indicating that labels influences their food purchases. A study that used eye-tracking technology to investigate consumer attention specific to labelled serving size

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information concluded that the proportion of people looking at this information at all times is trivial (approximately 1% of participants) [25]. Moreover, reviews show that consumers lack understanding with regard to some nutrition label terms [24]. Low health literacy is associated with less food label use and poorer[26] with lower overall literacy skills are associated with less accuracy when estimating serving sizes [27].

In most countries, listing the serving size in the nutrition information panel is mandatory but the unit amount is determined by the food manufacturer, so serving size can vary between products in the same food category and of the same size. At a conceptual level, the 'per serving' information is useful for consumers to estimate how much of a nutrient they are consuming. For example, if an individual with cardiovascular disease is monitoring fat consumption, they may use the 'per serving' amount to help calculate their daily total fat intake from packaged foods [28].

Some countries such as the USA and Canada regulate the labelled serving size. In May 2016, the US FDA announced a new nutrition facts label for packaged foods to reflect new scientific information, including the link between diet and chronic diseases such as obesity and heart disease [29]. This new regulation included updates on serving sizes and labelling requirements for certain package sizes. As the portion sizes consumed have increased within the last decade [10], these regulations have been updated.

For packaged foods that contain between one and two servings, such as a 20-ounce (600ml) soda or a 15-ounce (425 gram) can of soup, the calories and other nutrients will now be

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required to be labelled as one serving, because people typically consume this amount in one sitting. These specified serving sizes somewhat translate to serve sizes in the national level food guidance systems, but are not exactly identical, which adds another layer of complexity and confusion for consumers.

The current standards for serving sizes and portion size guidance (how much should be consumed) stir confusion and there are many barriers to the uptake of serving size guidance such and the heterogeneity between the rules and regulations surrounding serving sizes as well as interchangeable terminology. A study conducted by Spence et al. (2013) found that consumers felt conflicted with inconsistent messages about 'what' and 'how much' they should eat [30]. Consumers obtained information regarding serving sizes from a number of sources including dietitians and food packages, much of which was contradictory or inconsistent [30]. Consumers describing the burden of deciphering food labels and how it leads to meaningless serving size guidance also found that some serving size suggestions (e.g., cereal) were too small and queried the generalisability of serving size advice [30].

With complex food environments and consumer confusion surrounding serving size labels [30], changes need to be made to simplify food labelling and assist consumers in choosing healthy portion sizes. Several suggestions on how this could be achieved have been made. One suggestion concerns the manipulation of labelled serving sizes to influence food choices and consumption [31]. This type of manipulation is called 'health framing' and capitalises on consumers' perceptions of serving sizes. For example, food items with

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smaller serving sizes are more likely to be considered healthier than a larger serving size of a comparable food item [32]. Other suggestions are to improve consumer education and health literacy related to food labels, the standardisation of terminologies used [9] and the introduction of a standardised food volume measurement unit such as the international food unit [33]. However, to improve food labelling and help consumers make informed decisions about portion size, we need to understand how consumers interpret serving size information and how this influences product perception and consumption.

The aim of this scoping review was to explore potential mechanisms of action between serving size labelling and consumer behaviour by investigating consumer understanding and interpretation of the serving size information on food labels.

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Materials and methods

The scoping review reported herein followed the five-stage framework proposed by Arksey and O'Malley [34]. These stages are intended to facilitate the processes of identifying a research question, identifying relevant studies, selecting studies, charting the data and collating, summarising and reporting the results.

The following research questions were developed and defined under consideration of Participants or Population group, Intervention, Control or Comparator condition, Outcomes and Study type (PICOS) [35].

1. How do consumers interpret the meaning (understand the quantity) of the labelled serving size information and does this have an impact on food choice? (perception, understanding, selection, consumption)
2. Does this differ between core and discretionary food groups?
3. Do consumers differentiate between the Front of Pack (FOP) labelled serving size and portion guidance (usually BOP)?
4. Are there any recommendations for effective serving size display to ensure correct understanding and usage (e.g., to understand product nutrition information; to select healthier product options; or to manage reasonable consumption)?

The above research questions were defined to keep the overall focus on consumers' understanding of the labelled serving size with eligible scientific articles published since 2010.

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Seven electronic databases were used to search for relevant studies and these included: MEDLINE, The Cochrane Library, EMBASE (Excerpta Medica Database), CINAHL (Cumulative Index to Nursing and Allied Health), Scopus, PsycInfo and Business Source Ultimate. The search was comprised of truncated key words used individually and in combination, these included: "point of sale", "point of purchase", "nutrition/food/health/front of pack/back of back" and "label/rating/symbol/information or logo", "menu/food" and "label", "nutrition and guideline/panel/table/profile/summary or score", or "nutrition fact label", "portion size", "serve", "serving" or "serves". The full search strategy is included as supplemental material (S1). Studies were limited to human subjects only and where possible, a number of terms describing various diseases were excluded. The search was also limited to studies published between 2010 and September 2017.

Results of the search were exported to EndNote X8 (Clarivate Analytics, Philadelphia, US), where duplicates were removed using the inbuilt function in Endnote, which enables automatic identification of duplicates. These were then checked manually before duplicates were excluded. The remaining titles and abstracts were uploaded to Covidence (Veritas Health Innovation, Melbourne, Australia. Available at www.covidence.org), where members of the research team were able to undertake the two screening processes. The title and abstract screening was shared between three reviewers (KB, AA, XYK) with any studies categorised as 'retrieve' or 'unclear' included for full-text screening. The full-text screening was conducted by two reviewers (AA and XYK) with a third reviewer (KB) independently assessing any conflicts.

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196

197 To guide study selection, a set of eligibility criteria were established that aligned with the
198 research questions listed in Stage 1. A study was eligible, if it provided information on how
199 consumers perceive, understand or interpret the labelled serving size (e.g.,
200 recommended vs. usual portion), if it provided information on how the labelled serving size
201 on food labels influences product perception, choice or consumption or if it provided
202 information on whether consumers differentiate between the Front of Pack (FOP) labelled
203 serving size and portion guidance (which is sometimes found on Back of Pack labels) and
204 relates to dietary recommendations such as serve sizes.

205

206 Studies were excluded, if they reported information on calorie labelling of menus, or the
207 general impact of FOP labelling on consumers. Studies were also excluded, if serving size as
208 such was not addressed on the label (e.g., the study focuses on the impact of new low-
209 energy density food and related nutritional information on consumer behaviour), or if the
210 study was concerned with the impact of the presence/absence of serving size and other
211 FOP elements and not the impact of serving size or amounts on food choice or intake. Any
212 reports on the impact of portion-related activities on calorie-related outcomes were
213 beyond the scope of this review, as were studies focused on any forms of portion size
214 education other than those provided on the label (unless strictly relating to education on
215 serving size labelling). Studies could not be included where there was no study parameter
216 relating to consumer behaviour (i.e., perception, interpretation, food choice, intake), or if
217 the study was merely descriptive in nature (e.g., an overview of different types of labels on

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the market). Studies examining packaging waste were also deemed irrelevant for this review.

Relevant data, including study design (e.g., study type, sample size and setting), sample characteristics (e.g., age, gender and weight), description of labels, study outcomes (including attitudes and behaviour) and conclusions was extracted by one reviewer into an Excel spreadsheet. A second reviewer checked the data extracted from each study for consistency.

Data was further divided into the following sub sections, each of which were summarised in table format:

1) Study selection: authors (year), country, study type and design, sample size, description of study arms/conditions, study setting, participant age, gender ratio and weight status.

2) Description of included studies: authors (year), food type, food label type, main findings relating to attitudes, main findings relating to behaviour, implications.

Data was described in a narrative format, by grouping studies by features and findings.

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Results

STUDY SELECTION

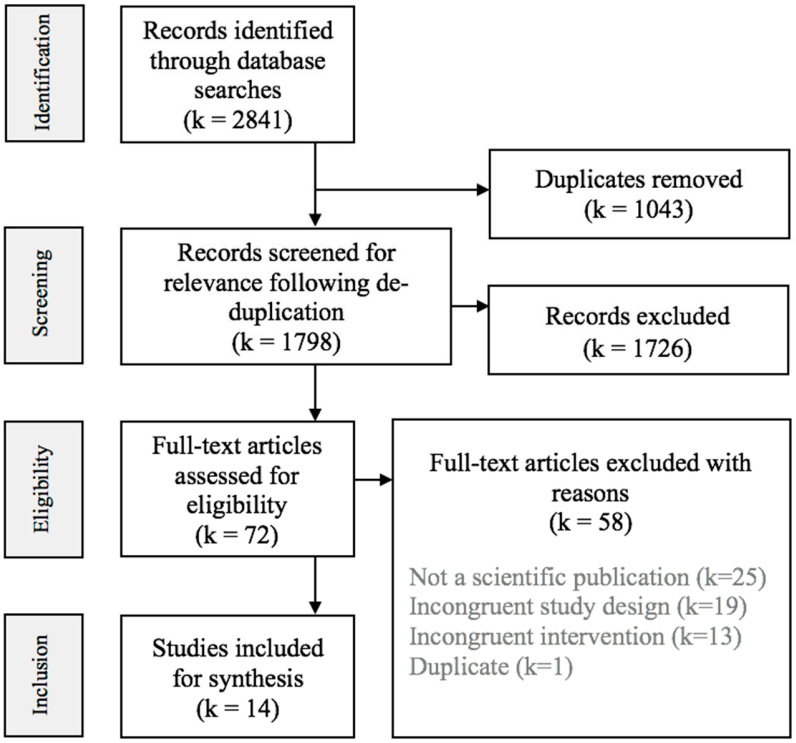

Figure 1. Flow Diagram of Study Selection for food label serving size information scoping review

A total of 2,841 studies were identified as part of the electronic database searches (MEDLINE (k = 644), The Cochrane Library (k = 36), EMBASE (k = 720), CINAHL (k = 169), Scopus (k = 859), PsycINFO (k = 222), Business Source Ultimate (k = 191). One thousand and forty-three duplicates were removed, which left 1,798 titles and abstracts to be screened. One thousand seven hundred and twenty-six studies were deemed irrelevant based on title and abstract screening, with disagreement resolved by a third reviewer. The remaining 72 full-text reports were assessed for inclusion by two reviewers, with conflicts

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252 resolved by discussion and consensus. Fourteen studies were included for the final
253 synthesis (see Figure 1).
254
255 The fourteen studies were conducted between 2010 and 2017 in four different countries
256 including nine from the United States of America (USA) [36-44], two from The Netherlands [45-46]
257 and one each from Canada [47] , Australia [48] and South Africa [49]. Sample sizes across these
258 studies ranged from n = 51 [42] to n = 16,048 [43] with a mean of n = 2,218, including ten
259 studies with less than 1,000 participants and four studies of over 1,000 participants. The
260 settings in which these studies were conducted included online (k = 4), University course (k
261 = 3), community settings (k = 3), laboratory (k = 2), home-completed survey (k = 1),
262 University dining hall (k = 1), fast food restaurants (k = 1) and a cinema (k = 1). Table 1
263 provides a summary of descriptive data for each of the included studies.

Table 1. Food label serving size information scoping review summary of included studies

Meta-data	**Study characteristics**				**Sample characteristics**		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
Christoph and Ellison (2017) USA	Experimental (non-randomised, no control)	1,069	Food selections photographed pre-and post-meal, coded for selection, servings and *MyPlate* categories for nutrition label users (n = 235) and nonusers (n = 834)	University dining hall	University students	M = 19 SD = 1.3	60% males 40% females 24% overweight or obese (BMI)
Dallas et al. (2015) USA	4-arm experimental (non-	273	**Study 1** (n = 101): consumer belief about serving sizes on BOP labels;	**Study 1**: online **Study 2**:	Online representative panel - adults	M = 27 SD = 6.3	55% male 45% female

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Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
	randomised, no control) single time point		**Study 2** (n = 51): exposure to current v. proposed BOP label; **Studies 3** (n = 60) **and 4** (n = 61): influence of exposure to current v. proposed label influences on food portions served and purchased for others.	basketball game queue **Studies 3 and 4**: University marketing course			Mean BMI = 23.8
Hydock et. al. (2016) USA	3-arm experimental trial (non-randomised, no	753	**Study 1** (n = 208): Intake x current or proposed (double) serving sizes of five; **Study 2** (n = 347):	Laboratory	University students	Study 1: M = 32, SD = 12	54% males 46% females BMI not

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Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
	control group)		Virtual portioning (for self) of 6 foods x label viewing. Study 3 (n = 198) Nutritional label showing current or larger serving size x confectionery portion.			Study 2: M = 31, SD = 10 Study 3: M = 20, SD = 1	reported
Jones et al. (2015) Canada	2-arm experimental survey design (randomised to group, no control	2,011	Beverage energy content estimation x per serving/per container/dual-column. Cracker energy content x	Online	Adults	50% of sample aged 16 – 18 years	50% males 50% females 22% overweight or obese (BMI);

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Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
	group)		single serving small font/single serving large font/number of servings per bag Preference for serving size display format.			Age range: 16 – 24 years	12% BMI not stated
Lando et al. (2012) USA	10-arm 3 x 3 experimental trial (randomised, no control group)	9,493	Calories and nutrients per serving and per container x perception of (healthfulness and calorie content per container and	Online	Adult	M = 46 SD = 15.5	51% male 49% female Mean BMI = 28.5 SD = 7.1

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Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
			per serving).				
Miller et al. (2016) USA	Pre-post experimental survey design (non-randomised, no control group)	358	Pre-and 2 weeks post 8 x 'inconsistent' product pair comparison x healthful (sodium or saturated fat) and 2 'consistent' product pair comparison x healthful (sodium or saturated fat)	Mailed survey	Members of the Sacramento, California community	35% <40 years; 26% 40 – 60 years: 39% >60 years Age range:	40% male 60% female BMI not reported

Table 1. Food label serving size information scoping review summary of included studies

Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
						20 – 78 years	
Mohr et al (2012) USA	Experimental (randomised, no control) between-subjects design with measured moderator	151	Health frame (yes/no) x discretionary weight (low/high) x product category (pizza vs. soup) with measured moderator (dietary concern, guilt)	Online	Adults	M = 46 SD = NR	46% male 54% female BMI not reported
Roberto et al. (2012a)	3-arm RCT	243	Original smart choices label (servings per package) x	Online	Adults	M = 26 SD =	37% males 63% females

Table 1. Food label serving size information scoping review summary of included studies

Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
USA			Modified smart choices label (incl. serving size) x No calorie label			10.0	Mean BMI = 27.3
Spanos S, et al. (2015) Australia	4-arm RCT (pilot study)	100	Portion size: 200g Pizza in 12 pieces or 400g Pizza in 24 pieces (equal grams) Labelling: Packaging for 200g pizza and one 400g pizza included NO information about number of servings; Packaging for	Laboratory	University students	M = 21 SD = 2.3	100% females Mean BMI = 21.5 SD = 2.95 range = 16.1–34.7

Table 1. Food label serving size information scoping review summary of included studies

Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
			two other 400g pizza conditions either included statement "Contains 2 servings" or "Contains 4 servings"				
Tal et al (2017) USA	1) Observational 2) Experimental (2 x 2)	51	**Study 1**: Comparison of FOP image with actual reported serving size of 158 common cereals **Study 2**: Varied serving sizes (exaggerated, multiple serving size x	University course	University students	M =22 SD = NR Age range: 18 – 55 years	31% male 69% female BMI not reported

Table 1. Food label serving size information scoping review summary of included studies

Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
			recommended single-serving size) for 2 cereals.				
van der Merwe (2012) South Africa	Cross sectional	229	Face to face delivered survey to measure consumer ability to: (i) locate and manipulate information; (ii) assess accuracy of nutrient content claims and which health/nutrient claims are allowed; and (iii) identify	Public locations (post offices, health-care centres or municipal offices)	Non-health professional adults	34% 18–24 years 20% 25–34 years 18% 35–44 years 13% 45–54 years 15% 55	36% male 64% female BMI not reported

Table 1. Food label serving size information scoping review summary of included studies

Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
			symbols on labels.			years +	
Vermeer et al. (2010) The Netherlands	Experimental, non-randomised, no control group	168	2 photographed labelling formats (control vs. small/medium/large) x participants' intended soft drink size choice (control vs. 14, 18, or 24 oz).	3 fast food restaurants (6 occasions)	Adults	M = 26 SD = 10.3	50% male 50% female 19% overweight or obese (BMI)
Vermeer et al. (2011) The	2-arm experimental trial (between-	101	Portion size and caloric guidance for daily amounts labelling (second evening) x	Cinema	Adults	M = 50 SD = 12.4	26% male 74% female

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Table 1. Food label serving size information scoping review summary of included studies

Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
Netherlands	subject design with a control group)		No label control (first evening). Choice of five portion sizes (200, 250, 400, 500 and 750 millilitre cups) vs control (only cup sizes (ml) displayed).				33% overweight or obese (BMI)
Zhang (2014) USA	Repeat cross sectional surveys	16,048	Consumer understanding and usage of serving size information on Nutrition	Community	Adults	NR	NR

Table 1. Food label serving size information scoping review summary of included studies

Meta-data	Study characteristics				Sample characteristics		
Authors (year) Country	**Study type & design**	**Sample size**	**Description of study arms/conditions**	**Study setting**	**Participant**	**Age**	**Gender ratio; weight status**
			Facts in 3 large national repeat measures surveys that contained similar questions on serving size meaning.				

Note. BMI = body mass index (kilograms/height in metres^2); BOP = Back of Pack; FOP = Front of Pack; NR = not reported

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Participants

Studies recruited adult volunteers from the general public (k = 10) or University students (k = 4). All but one sample [48] were mixed gender with a greater proportion of female participants relative to males. The average participant age per sample ranged from 19 years [36] to 50.4 years (Vermeer 2011). Of the eight studies that reported weight status, four reported the percentage of the study sample who were classified as overweight or obese based on body mass index (BMI) measures [36, 45-47], with a range of 19 – 33% and average of 24.5% of sample above the health weight range. Four studies reported mean BMI, which ranged from 21.5 to 28.5 with an average of 25.3 [37, 39, 44, 48]. The remaining six studies did not report weight status. None of the studies excluded individuals from participating based on this criterion.

Study designs

Various study designs were employed to answer respective research questions, with experimental studies involving between two and 10-arm designs. A non-randomised experimental design was used in six studies, of which five had no control group [36-38, 40, 45] and one had a control group [46]. An experimental survey design (random allocation, no control group) was used in three studies [39, 41, 47]. A randomised controlled trial (RCT) design was chosen for two studies, including a 3-arm RCT [44] and a 4-arm RCT [48]. A cross sectional design was used in three studies, with two being single time-point studies [42, 49] and one repeat cross sectional [43].

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Test conditions, comparator conditions and measurement of consumer attitudes and behaviours

All fourteen studies involved consumers reporting on serving size information on food packaging, in a paper-based [40], interviewer administered [49] or online survey [37, 39, 41, 47], using food models [37-38, 42] or displayed in food outlets [36, 45-46]. Of these studies, six studies specifically investigated BOP nutrition facts and serving size labelling [37, 39-40, 43, 47-48], five investigated FOP and BOP nutrition facts and servings size labelling [38, 41-42, 44, 49], two investigated percentage of daily needs based on a national food guidance system, in addition to serving size labelling [45-46] and one investigated serving size in relation to whether consumers used nutrition facts labels routinely [36]. Seven included studies specifically used discretionary foods in their studies [38-40, 45-48], five studies involved both discretionary and core foods [36-37, 41-42, 44] and two studies involved use of generic food labels [43, 49].

Consumer attitudes (including understanding, beliefs and concerns) about nutrition facts and serving sizes on existing labels were investigated in two studies [39, 41]. Mohr et al (2012) further investigated the influence of health framing on consumer perception [41]. Eight studies investigated consumer understanding of proposed or modified relative to existing NFL and serving size information [37-38, 40, 42-44, 47, 49].

Consumer behaviours in relation to existing nutrition facts labelling and serving size information was investigated in two studies [36, 39]. Seven studies investigated consumer behaviours in relation to proposed or modified relative to existing NFL and serving sizes [37-

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309 [38, 42, 44-46, 48]. Mohr et al (2012) also investigated the influence of health framing on

310 purchasing intention [41].

311

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	**Food type**	**Label type**	**Main findings - Attitudes**	**Main findings - Behaviour**	**Implications**
Christoph and Ellison (2017) USA	Buffet lunch	Nutrition facts label, SS label Both DF and CF	no data available	Nutrition label users selected more fruit, vegetables, beans (legumes), less potatoes, refined grains, fried foods, foods with added sugar (all $p <$ 0.05)	In buffet setting, labelling influences food choice (selecting different foods) rather than food quantity (selecting more or less food).
Dallas et al (2015) USA	**Study 1**: Chicken Veg. Soup; **Study 2**: Choc chip cookies; **Study 3**:	BOP nutrition facts label, SS label	78% believed SS related to how much food can or should be consumed in one sitting as part of a healthy diet.	Modified (larger amount) label (vs. current) led consumers to serve themselves 41% more cookies; serve 27% more cheese	Increased serving sizes may lead people who use this information as a reference to serve more food to themselves and others. *NB. In Study 1 researchers used*

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
	Crackers; **Study 4**: Lasagne	Both DF and CF		crackers to another person; buy 43% more lasagne for others and divide a lasagne into 22% larger slices.	*the term serving size for what is usually defined as portion size (usual consumption)*
Hydock et al. (2016) USA	**Study 1**: Pizza; Pasta; Fruit Loops; Sliced Cheese; Ham; **Study 2**: Macaroni cheese; Chili; Lasagne; Rice Snacks; Soup;	FOP and BOP nutrition facts label, SS label Mostly DF	Larger SS rated lower for health perceptions ($p < 0.05$) but more representative of portions ($p < 0.05$ all foods).	SS impacted on health perception ($p < .001$), estimated calories ($p < 0.05$) and guilt ($p < 0.05$). Consumers who viewed larger serving sizes (proposed) ate less confectionery than those presented with	Larger SS of DF considered less healthy but more representative of portion. Larger SS of DF caused consumers to anticipate greater consumption-related guilt and influenced estimation of calories portioned out. Larger SS of DF may help decrease consumption of foods

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
	Frozen Fish; **Study 3**: Confectionery			the current serving sizes ($p < 0.05$).	perceived as less healthy if nutrition information viewed.
Jones et al (2015) Canada	Chocolate milk; crackers	BOP nutrition facts label, SS label DF	**Study 1**: Nutrition label with per container or dual column better for correctly identifying energy content than per serving ($p < 0.01$). **Study 2**: No association between SS	No data available	Per container and dual column increased understanding of energy content compared to per serving. This may help decrease individual consumption of DF by influencing perceptions of food health. Font size and display order of same information did not influence correct energy

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
			display format and correct energy estimation. 62% preferred SS size format including servings per package.		estimation.
Lando et al (2012) USA	Frozen meal; crisps	BOP nutrition facts label, SS label DF	Single-serving per contained and dual-column formats performed better and scored higher on most outcome measures.	No data available	For products that contain 2 servings but usually consumed in single eating occasion, single-serving or dual-column labelling approach recommended.

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
Miller et al (2016) USA	Frozen pizza; snacks	BOP nutrition facts label, SS label DF	Overall accuracy was low (50–55%) across all age groups. Numeracy, nutrition knowledge and self-reported food label use supported accuracy, but did not influence age differences in accuracy. Detailed instructions improve accuracy, even for difficult comparisons in which	No data available	Accuracy limited by lack of consideration for multiple servings rather than too many columns to evaluate or numeracy skills.

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
			per serving and per package information is inconsistent. Accuracy is compromised by poorer numeracy (all ages) and poor attention skills and with less instructions (older adults).		

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
Mohr et al. (2012) USA	Frozen pizza; vegetable soup	FOP and BOP nutrition facts label, SS label CF and DF	Health framing manipulation reduced guilt about consumption (p <0.05) for consumers who were more concerned about their diet. People with high dietary concern are influenced more by health framing.	Health frame dietary concern affects purchase intention (p < 0.05) and guilt mediated the influence of health framing on purchase intention for participants with high concern (p < 0.05).	Prevention-focused health communication influenced participants towards selection of health-framed product whereas prompting to consider calories consumed influenced choice specifically towards listed calorie count. Health communication that encouraged participants to be diligent about their diet, but wary of health framing resulted in adjustment for serving sizes and selection of product with lowest negative nutrients.

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
Roberto et al (2012a) USA	Chocolate milk; waffles; spread; dressing; cereal bars; microwave popcorn; meat and veg soup	FOP and BOP nutrition facts label, SS label CF and DF	All 3 TL groups more accurate in calories-per-serving estimates compared with the symbol and no-label groups (all p < 0.001)	Symbol (and no label) perceived as healthier than any TL items (p < 0.001) but no differences in intention to purchase or perceived taste.	Additional information in relation to sugar, fat and salt can negatively influence perception relative to overall symbol.
Spanos et al (2015) Australia	Cheese pizza	BOP SS label DF	No data available	Labelling pizza with a higher number of servings decreased food intake relative to labelling the pizza with	Providing SS labelling on a food product can reduce the portion-size effect on consumer food intake.

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
				a lower number of servings ($p < 0.05$).	
Tal et al (2017) USA	Breakfast cereals	FOP food image (photo) and BOP nutrition facts label, SS label CF and DF	Portion size depictions on front of cereal boxes 64.7% larger than recommended portions on NFL.	Boxes that depicted exaggerated SS resulted in 17.8% more cereal portioned compared to boxes that depicted a single-size portion of cereal matching suggested SS and 42% more than suggested SS.	Biases in SS depicted on cereal packaging are prevalent and may lead to over-serving, which may consequently lead to overeating.

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
van der Merwe (2012) South Africa	Generic	FOP and BOP nutrition facts label, SS label	86% reported ability to locate label information and 97% could correctly identify symbols. 19% were able to correctly identify health/ nutrition claims allowed on labels. Front panel healthy product icon favourably received.	No data available	Respondents able to locate and manipulate label information, identify symbols and some nutrient content claims, but unable to identify some permissible health/nutrient claims and false claims.
Vermeer et al. (2010)	Regular soft drink	% needs,	No data available	Statistical trend for reference portion size	Reference portion size labelling may reduce large portion size

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
The Netherlands		serving size label		labelling increasing the likelihood to choose small sizes (OR 2.55).	preferences for specific DF.
Vermeer et al. (2011) The Netherlands	Regular soft drink	% needs, serving size label	No data available	Labelling neither stimulated participants to choose small portion sizes (OR = 0.75), nor dissuade participants to choose large portion sizes (OR = 0.51).	Portion size and caloric FGS labelling had no effect on soft drink (DF) intake.

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications
Zhang (2014) USA	Generic	BOP SS label	Majority of respondents misinterpreted the meaning of SS (Surveys 2 and 3). Women and obese individuals more likely to misinterpret SS meaning. A small subsample of participants expressed distrust of SS information.	Use of SS information (often or sometimes) increased from 54% to 64% from 1994 to 2008 (Survey 1). Women and obese individuals more likely to use SS often or sometimes.	The increasing use, widespread misunderstanding and distrust of SS indicates need for change to both NFL education and information.

Note. BOP = Back of Pack; CF = core foods; DF = discretionary choices; FGS = food guidance system; FOP = Front of Pack; NFL =

Table 2. Food label serving size information scoping review summary of findings and implications

Authors (yr) Country	Food type	Label type	Main findings - Attitudes	Main findings - Behaviour	Implications

nutrition facts label; OR = odds ratio; SS = serving size

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DESCRIPTION OF STUDY FINDINGS

The fourteen studies identified in this scoping review related to a range of research questions and hypotheses, but were consistent enough in study design study and primary outcome measures to consolidate into a set of study findings, as they related to attitudes and behaviours towards labelled serving size. Table 2 summarises the findings by study.

Consumer health perception (or attitudes towards) of labelled serving size

Consumer attitudes towards serving size labelling were measured in different ways in the six studies that reported on this influence. Hydock et al. (2016) reported that larger serving size decreased the products health perception ($p < 0.001$) and increased guilt associated with consumption ($p < 0.05$), but was perceived as more representative of portions typically consumed ($p < 0.05$ all foods) [38].

While 'traffic light' guidance systems were found by Roberto et al. (2012a) to be more accurate than a symbol, a 'Choices' symbol (or no label) were perceived as healthier than any traffic light items ($p < 0.001$) in the same study [44]. A front panel healthy product icon was also favourably received in a survey-based study by van der Merwe, et al. [49].

Two studies reported negative impacts or influences in relation to consumer perception of serving size labelling. In a study specifically related to health framing of labelling, Mohr et al. (2012) addressed the manipulation of serving size (and nutritional) information and reported that health framing reduced guilt of consumption ($p < 0.05$) for consumers who were more concerned about their diet [41]. In the open response

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section of a large national cross-sectional survey reported by Zhang et al. (2014), a small subsample of participants expressed distrust of serving size information [43].

Consumer understanding and interpretation of labelled serving size

In a cross-sectional survey by van der Merwe, et al. [49], 86% of participants reported having the ability to locate label information and 97% could correctly identify symbols. However, only 19% were able to correctly identify health or nutrition claims that are allowed on labels. Miller et al. (2017) identified that improved accuracy in serving size estimations was associated with higher numeracy, nutrition knowledge and self-reported food label use and enhanced by the provision of detailed instructions, even for difficult comparisons in which per serving and per package information was inconsistent [40]. Conversely, serving size estimation was compromised by poorer numeracy (all ages) and poor attention skills and with less instruction (older adults only) [40].

Three studies investigated consumer interpretation of labelled serving size and identified that consumers interpret serving size as a recommended serving rather than as a typical serving [37, 40, 43]. A discrepancy between understanding of serving size and portion size was reported by Dallas et al. (2015), with 78% of participants believing that serving size related to how much food can or should be consumed in one sitting as part of a healthy diet [37]. Zhang et al. (2014) reported that the majority of respondents across two cross-sectional studies (n = 16,280) misinterpreted the meaning of serving size, particularly women and obese individuals [43]. Reported accuracy in serving size interpretation was also low (50–55%) across all age groups in an experimental study by Miller et al. [40].

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In two studies that compared existing to modified versions of serving size labelling, Jones, et al. [47] reported that accuracy in calorie estimation was improved with a nutrition label that contained both per serving and either per-container or dual column information and Lando and Lo [39] reported improved accuracy with dual column information for more complex calorie estimation tasks. While there was no association between different serving size display formats (e.g., font size or order) and correct energy estimation in the study by Jones et al. (2015), the majority (62%) of participants preferred a serving size format that included servings per package [47].

In a study that investigated the influence of four Front of Pack labelling systems on estimation of calories per serving for the individual products, Roberto et al. (2012) found that three variations of a traffic light system all were more accurate for estimates of calories-per-serving compared with the symbol and no-label groups (all $p < 0.001$) [44]. In a study that investigated food image depiction on the front of packages, Tal et al. (2017) identified that portion size depictions, i.e., the image of the cereal bowl on cereal boxes were 64.7% larger than recommended portions on nutrition facts label [42].

Consumer behaviour in relation to labelled serving size

The behaviours exhibited by participants in the included studies in relation to labelled serving size were influenced by a range of factors including understanding of food labelling, health framing and intentional modification to labelling. Three studies reported that increased serving sizes resulted in increased portion sizes [37] found that viewing of modified (larger amount) serving sizes on labels relative to existing serving sizes led consumers to serve themselves 41% more cookies, serve 27% more cheese

crackers to another person, buy 43% more lasagne for others and divide a lasagne into 22% larger slices. Similarly, cereal boxes that depicted exaggerated serving sizes (i.e., a cereal bowl with a large portion on the package illustration) resulted in 17.8% more cereal being portioned compared to boxes that depicted a single-size portion and 42% more than the suggested serving size [42]. Spanos et al. (2015) reported that labelling pizza with a higher number of servings decreased food intake relative to labelling the pizza with a lower number of servings ($p < 0.05$) [48].

In contrast, consumers who viewed larger serving sizes ate less confectionery than those presented with the current serving sizes ($p < 0.05$) and reported that larger serving sizes increased estimated calories ($p < 0.05$) [38]. A statistical trend towards reference portion size labels increasing the likelihood to choose small sizes of soft drinks (OR 2.55) was reported by Vermeer, et al. [45], however a subsequent study, also by Vermeer et al. indicated that labelling neither stimulated participants to choose small portion sizes (OR = 0.75), nor dissuaded participants to choose large portion sizes (OR = 0.51) [46]. In a buffet meal consumption study conducted by Christoph and Ellison (2017), nutrition label users selected more fruit, vegetables, beans (legumes), less potatoes, refined grains, fried foods, foods with added sugar (all $p < 0.05$), but total consumption was not influenced by nutrition label use [36].

Health framing influenced behaviours as well as attitudes in the study by Mohr, et al. [41]. Health framing removed anticipated guilt associated with consuming calories, enabling consumers who were concerned about their diet to form stronger purchase intentions ($p < 0.05$). Although consumers in the study by Roberto et al. (2012) perceived a

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411 'Choices' symbol as healthier than any traffic light items ($p < 0.001$), this made no
412 differences in intention to purchase or perceived taste [44].
413
414 In other studies that related to serving size behaviours, Zhang et al. [43] reported that use
415 of serving size information (often or sometimes) increased from 54% to 64% between
416 1994 and 2008 in a large, nationally representative cross-sectional survey of 5,530
417 adults. Furthermore, in this study women and obese individuals were more likely to use
418 serving sizes often or sometimes [43].
419
420 **Definitions of serving size**
421 Different interpretations of serving and portion sizes were used across the studies. For
422 example, Dallas, et al. [37] reported that "*the correct definition of serving size is the amount*
423 *that people typically consume in one sitting"* and an "*incorrect definition of serving size is*
424 *the amount of the product that can or should be consumed in one sitting as part of a*
425 *healthy diet."* [37]. A further example of differing terminology was evident in the Tal et al.
426 study, which stated that "*portion size depictions on FOP of cereal boxes is 64.7% larger*
427 *than recommended portions on nutrition facts label."* [42]. The terminology used by Dallas
428 et al. [37] and Tal et al. [42] differ from each other and from all other included studies in
429 which serving size refers to the manufacturer-set amount listed in conjunction with
430 nutrition facts on labels and portion size being the commonly consumed amount. It
431 should also be noted that the study by Tal et al. [42] refers to portion size images in terms
432 of photographs of a cereal bowl, which is part of packaging design rather than a Front of
433 Pack label.
434

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Discussion

This scoping review was conducted with the aim to determine consumer understanding, perception and interpretation of serving size information on food labels and related behaviours (selection and consumption).

As ten out of the fourteen studies were conducted in North America, the results need to be contextualised to consider the change in serving size labelling legislation [29] in North America in May 2016, as most studies were conducted in the preceding four years or immediately after this time-point. These changes were intended to ensure that consumers were aware of the nutritional composition of foods they were consuming, using a more standardised and realistic food amount than previously indicated on serving size labels.

The majority of included studies for which weight status was measured involved predominantly participants with a healthy weight status. This is important as overweight and obesity have the potential to influence serving size attitudes and behaviours and therefore weight status of study populations needs to be accounted for. No included studies were conducted in natural, home environment so participants could not be completely blinded to study conditions. It would be useful for future studies on influences of serving size labelling on food choice and consumption to be conducted in point of sale and home settings, respectively. This is increasingly feasible in the current research environment with availability of technologies such as wearable cameras that can monitor behaviours [50].

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Therefore, the results of the scoping review are being discussed under in light of the rapidly changing food labelling landscape, different serving size legislation between countries, changes to labelling legislation within some countries during the timeframe of the scoping review search period (2010 and 2017), the possible implications of increasing or standardising serving sizes and the environments in which studies were conducted.

The results of this scoping review highlight some key points for consideration in relation to serving size labelling of food products and their relationship to usual consumption (portion size). Serving size was interpreted incorrectly or inaccurately and this was exacerbated by demographic characteristics. The finding of Miller et al. [40] that serving size estimation accuracy was enhanced by the provision of detailed instructions, even for difficult and inconsistent serving and per package information, provides an indication that improvements to consumer food label literacy are an important focus for serving size labelling. Overall, consumers interpreted recommended serving size information as indicative of nutrient consumption without following recommendations to inform portion size.

The scoping review identified that labelling a product with both serving size and dual column information (per serving and for the whole pack) was preferred by consumers [47]. This format is commonly used and widely accepted in food labelling [51] and has previously been reported to improve understanding by providing a contextual cue [52]. For this combination of labelling to be relevant and useful to consumers, appropriate serving size information against which to benchmark nutrient levels is necessary.

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Consumer attitudes about serving size related to both consumer perception of serving size information and perceptions about use and misuse or manipulation of serving size in the food industry. In general, perceptions of consumers could be influenced by manipulation or framing of serving size information, with evidence of demographic influences on susceptibility to misleading serving size information. Larger serving sizes were generally perceived as more realistic portions than recommended serving size and this was preferred by consumers over unrealistic serving sizes. This finding provides support for the changes to legislation such as those that have been implemented in North America [29], from the perspective of consumer approval and support.

The impact of serving size information on consumer portion size varied between studies and between study foods and whether these were considered discretionary or core foods. A study that provided images of soft drinks alongside reference portion sizes showed promising results in reducing portion size selection [45]. These findings suggest that different reference information or conditions may need to be applied to core and discretionary foods. Further investigation is also needed to explore the influence of health framing that results from the application of serving size information to other parts of Back of Pack and Front of Pack labelling.

While Front of Pack labelling was considered helpful to consumers, it performed better for tasks that related to product choice rather than serving size estimation. This is consistent with the intention of using a symbol or rating to indicate particular health features or overall 'health' value of a product. The relevance of Front of Pack labelling to serving size labelling could therefore be considered to assist in product selection, with

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Back of Pack serving size information subsequently used to inform how much to purchase and consume.

Conclusion

Consumers tend to interpret the labelled serving size as a recommended serving size rather than a typical portion size. To improve use and application of serving size labelling, it will be important for future studies to investigate the impact of labelled serving size on consumption of specific core foods and on discretionary foods. There is a need to determine, whether increasing consumer serving size literacy can help to overcome health framing of discretionary foods (e.g., a smaller serving size can increase perceived healthfulness and lead to increased intake, due to a lower calorie content per serving displayed on the pack) or whether other measures are required to offset the influence of health framing, particularly for susceptible consumer groups. Promising strategies to increase serving size literacy reported in the scoping review include comparative information on nutrition facts labels, realistic serving sizes and comparison to standard reference amounts, for example from national food guidance systems or use of international food volume units [33].

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Author Contributions

TB, DL and KvdH conceived and designed the study. KD, BM and TB conducted the searches, screened papers and abstracts, extracted and analysed the data and prepared the first draft of the manuscript. DL and KvdH also screened titles and abstracts of relevant records and provided input on the manuscript. Conflicts on study inclusion and exclusion were discussed and resolved among all authors.

Conflicts of Interest

Two of the authors [KVDH and DL] are employed at Nestec Ltd. The authors who are Nestec Ltd. employees have no conflicts of interest of any type with respect to this manuscript. The opinions expressed in this manuscript are those of the authors and do not necessarily reflect the views or recommendations of their respective affiliations. TB, KD and BM have no conflicts of interest.

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