

The performance and potential of the Australasian Health Star Rating system: a four-year review using the RE-AIM framework

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Unhealthy diets – high in salt, harmful saturated and trans fats, added sugar and energy – are a leading cause of death and disability globally.¹ Australia has some of the highest obesity rates in the world: nearly two-thirds of Australian adults and one in four children are overweight or obese. Unprecedented availability and aggressive marketing of processed and pre-packaged foods and beverages are a key driver of obesity and diet-related conditions including high blood pressure, heart disease, type 2 diabetes and dental caries.² Obesity is estimated to cost Australia more than \$8.6 billion annually.³

Interpretive front-of-pack nutrition labels (FoPL) are recommended by the World Health Organization (WHO) as an evidence-based policy to promote healthier diets.^{4,5} These types of labels use nutrient profiling to assess the nutritional quality of individual foods and display this in a simplified, visual form. There is growing evidence that FoPL have potential to improve nutrition literacy, guide consumer choice and incentivise industry to improve their product formulations.^{6,7} While not a complete source of dietary advice, FoPL is recognised by WHO as a helpful tool to use in conjunction with interventions aimed at improving the overall nutritional quality of diets.⁸ At least 16 government-endorsed schemes in various formats are operating in over 23 countries.⁹ This proliferation of formats has prompted the international food

Abstract

Objective: The Health Star Rating (HSR) is a front-of-pack nutrition labelling system, implemented voluntarily in Australia and New Zealand since 2014. Our aim was to evaluate HSR's performance.

Method: We used data from peer-reviewed publications and government-commissioned monitoring and evaluation, websites and communiqués to evaluate HSR's performance between June 2014 and October 2018 using the RE-AIM (Reach, Efficacy, Adoption, Implementation and Maintenance) framework.

Results: Thirty-three peer-reviewed publications, 21 government and three independent reports informed the assessment. Awareness and trust in HSR was increasing, though campaign reach remained low. Consumers liked, could understand and use the HSR logo, though effects on purchasing were largely unknown. The algorithm was the focus of a formal review. HSR was present on 20–28% of products but biased to those that scored better (HSR \geq 3.0). Necessary stakeholders were mostly engaged.

Conclusions: A substantial body of work supports continuation and strengthening of HSR. Reasonable refinements to HSR's star graphic and algorithm, action to initiate mandatory implementation, and strengthened HSR governance present the clearest opportunities for improving public health impact.

Implications for public health: Development and implementation of government-led front-of-pack nutrition labelling systems have the potential to improve public health, while engaging a diverse set of stakeholders.

Key words: food labelling, nutrition, food policy, health star rating, obesity

standards agency, the Codex Alimentarius Commission, to commence work developing further international guidance on FoPL.¹⁰

In June 2014, Australia and New Zealand adopted a voluntary FoPL in the form of the Health Star Rating system (HSR) following a lengthy process of development involving federal, state and territory governments in collaboration with industry, public health

and consumer groups.¹¹ In short, HSR aims to “provide convenient, relevant and readily understood nutrition information and/or guidance on food packs to assist consumers to make informed food purchases and healthier eating choices”.¹² Its developers also recognised that the system should aim to be aligned with existing health strategies and guidelines, and provide incentives for

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improvements to the healthiness of the food supply.¹³

The HSR System has three components: an underlying algorithm, the label graphic and an accompanying education campaign.

The algorithm assigns a rating from 0.5 (least healthy) to 5.0 stars (most healthy) in ten half-star increments, assessing both 'risk' components (total energy, total sugars, saturated fat, sodium) and 'positive' components of food (fibre, fruit, vegetable, nut and legume content (FVNL) and in some cases, protein). It derives from an existing model used to regulate health and nutrient content claims in both countries, embedded in the *Australia New Zealand Food Standards Code*.¹⁴ It was adapted for HSR in consultation with Food Standards Australia New Zealand (FSANZ) and technical and nutrition experts, including industry representatives.^{15,16}

Where they elect to utilise the system, food manufacturers are responsible for correct and accurate use of government guidance

material specifying how to display one of several permitted variants of the HSR graphic.¹⁷ No fee or charge is payable to any party for HSR use, with manufacturers bearing the cost of updating their own packages. Roll-out has been accompanied by government-funded education campaigns specific to each country.

At its adoption, Australian and New Zealand Food Ministers agreed HSR would remain voluntary for five years, and subject to a two-year review of progress.¹⁸ They later agreed the system would be subject to a comprehensive formal review, due to be delivered by mid-2019.¹⁹

The aim of this study was to evaluate the extent to which the HSR had achieved its objectives since implementation and to contribute recommendations on how its public health impact may be enhanced. This evaluation was independent and separate from the formal review commissioned by government.

Methods

We evaluated HSR with the RE-AIM framework, a method widely used to assess the public health impact of health promotion programs.^{20,21} The five dimensions of the framework (Reach, Efficacy, Adoption, Implementation and Maintenance) are particularly appropriate for evaluating the implementation of population health policy, allowing assessment of both the process and outcomes. In Table 1 we define metrics for evaluating each of the RE-AIM dimensions as they apply to implementation of HSR.

Data sources and criteria for inclusion

We conducted the evaluation using two sources of information:

- Government-issued information on HSR implementation (e.g. official websites, communiqués, monitoring reports and commissioned research)

Table 1: Operationalising the RE-AIM Framework for evaluation of the HSR system.

Dimension	Description	Definition in context	Metrics for assessment	Data sources identified through search (n) ^a
Reach	Proportion, and representativeness of the target population that participates in the policy	Extent to which the Australian and New Zealand population has access to HSR	Fraction of population that: <ul style="list-style-type: none"> • Is aware of the HSR system (unprompted and prompted) • Trust HSR • Has been exposed to the HSR campaign 	Government-commissioned nationally representative surveys on awareness, understanding and use (12) Government-commissioned campaign evaluations (10)
Efficacy	Extent to which the policy has delivered outcomes in the target population	Extent to which HSR is guiding consumers towards healthier choices	<p><i>Efficacy of HSR label graphic</i></p> <ul style="list-style-type: none"> • Consumer understanding and use • Impact on choice and purchasing • Impact in driving industry reformulation <p><i>Efficacy of HSR algorithm</i></p> <ul style="list-style-type: none"> • Alignment with current nutrition, medical and behavioural sciences literature (content validity) • Alignment with other health and nutrition policies (construct validity) • Alignment with health outcomes (predictive validity) <p><i>Efficacy of HSR campaign</i></p> <ul style="list-style-type: none"> • Consumer understanding • Impact on call to action 	Independent, peer-reviewed research: RCTs, randomized online surveys, choice experiments, focus groups, cross-sectional examination of food supply (28) Government-commissioned nationally representative surveys (11) Government-commissioned reports on alignment with other policies and reformulation (2) Government-commissioned campaign evaluations (10) Independent report benchmarking HSR against international best practice (2)
Adoption	The degree to which the necessary settings have been engaged in the policy	Degree to which HSR is operating as an Australian and New Zealand governments initiative in partnership with industry, public health and consumer groups	<p><i>Representation of each stakeholder in governance structures for HSR implementation</i></p> <p><i>Stakeholder analysis of involvement, interest, power and impact of HSR on each actor</i></p>	Government websites: HSR; Food Regulation; AusTender, Department of Health (Aus), Ministry of Primary Industries (NZ) Government-commissioned media analysis (1) Website and reports of the Independent Reviewer
Implementation	Extent to which the policy actually has been implemented as intended in the real world	Extent to which HSR has actually been implemented as intended including the number of products displaying HSR and compliance of labels with HSR guidance materials	<p><i>Uptake of HSR on product labels</i></p> <ul style="list-style-type: none"> • Number of products displaying, proportion of food supply • HSR status of those displaying • Number of manufacturers displaying HSR <p><i>Compliance of labels displayed with HSR Guidance materials</i></p>	Independent, peer-reviewed research, cross-sectional examination of food supply (5) Government-commissioned monitoring and evaluation reports (6)
Maintenance	How the policy is sustained over time and is evaluated	Initiatives, implemented as a direct consequence of HSR, designed to enforce and sustain the intervention and monitor its effects	<p><i>HSR governance</i></p> <ul style="list-style-type: none"> • Dedicated funding sources • Monitoring and evaluation mechanisms • Enforcement mechanisms, including anomaly and dispute processes and other mechanisms to ensure compliance, transparency and accountability 	Government websites: HSR; Food Regulation; AusTender Department of Health (Aus), Ministry of Primary Industries (NZ) Government-issued communiqués and budget papers Reports of the independent reviewer (2)

Notes:

a: Data sources may cover more than one outcome or RE-AIM dimension e.g. reports which consolidate data on general HSR awareness, and operation of the HSR campaign

- Secondary data from peer-reviewed and grey literature (e.g. reports produced by industry, consumer or public health stakeholders).

All materials were publicly available and obtained using a systematic search strategy outlined in Supplementary Appendix 1.

We limited our search to materials produced after HSR's adoption and, given our focus on implementation, excluded any materials published about HSR's development before and after this date. We also excluded materials concerning use of HSR in other jurisdictions and settings (e.g. on labels in other countries, or on foods or products for which it wasn't intended). We focused on original analysis, and therefore excluded commentaries and editorials that repeated information already included through original research. To keep the exercise manageable, we excluded individual media items, but included summary media analysis released by government. We included materials published up to and including 1 October 2018.

Extraction and coding of data

We created a database of materials on HSR implementation. For each item, we extracted standard information including: author(s), title, date and place of publication, type of publication (e.g. peer-reviewed research, government-commissioned report) and jurisdiction covered (Australia and/or New Zealand). We also extracted information on study design, population and/or data relied upon to assist in evaluating the strength of the evidence obtained. Finally, we coded materials by component of the HSR System reviewed (algorithm, label and/or education campaign), outcome evaluated (awareness, understanding, use, uptake, alignment with existing policies), and relevant RE-AIM dimension. This database is included in Supplementary Appendix 1.

Analysis

Outcomes of the literature review were summarised by each RE-AIM dimension and synthesised where possible in tables and figures to provide an overall view of the degree to which each dimension has been achieved. To evaluate Adoption, we also adapted a stakeholder analysis approach used by Brugha and Varvasovszky,²² using findings of the literature review and consultation among the authors to assign

a rating to the average interest, influence and position of key HSR stakeholders, and impact of HSR implementation on them. Our findings for all dimensions combined were used to assess HSR's overall achievement of its objectives, and to make recommendations on where its public health impact could be improved.

Results

We identified 33 relevant peer-reviewed publications, 21 government-commissioned and three independent reports, most of which contained quantitative data relevant to one or more of the RE-AIM dimensions of Reach, Efficacy and Implementation: see Supplementary Appendix 1. Adoption and Maintenance were primarily assessed through information provided by the Australian and New Zealand governments through websites and communiqués, facilitating analysis of stakeholder engagement in HSR's current operation, governance and funding.

Reach

Reach was assessed by the proportion of the population that were aware of HSR, trust it, and had been exposed to the education campaign.

HSR awareness had been evaluated in nine nationally representative surveys in Australia and three in New Zealand.²³⁻³⁴ They suggested low, but consistently improving, unprompted awareness (3% April 2015,

to 21% July 2018), and steadily increasing prompted awareness of the HSR system (33% April 2015 to 84% July 2018) (Figure 1). Females, younger people, those with higher education, higher income and normal weight were consistently more likely to be aware of HSR.

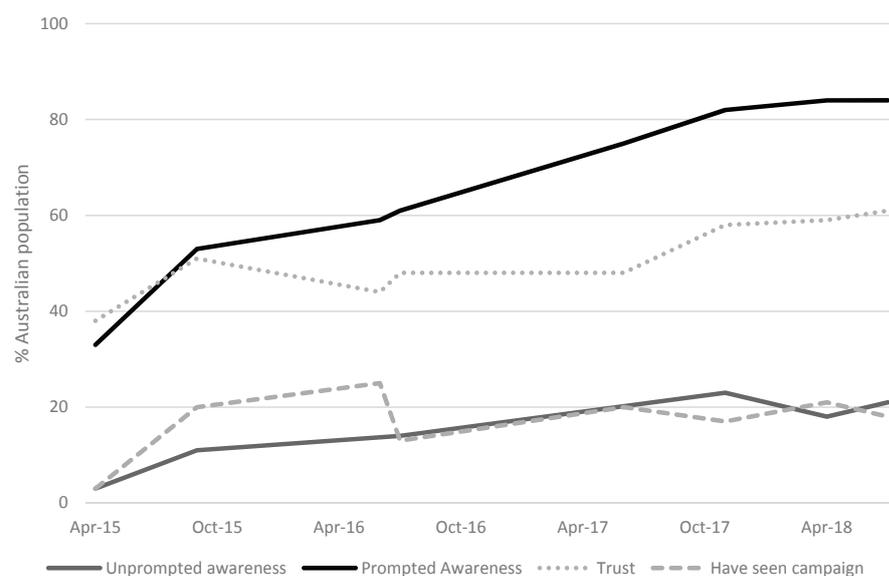
In Australia, these surveys showed that trust in HSR among the total population had steadily increased from 38% in April 2015 to 61% in July 2018²³⁻³¹ (Figure 1). In New Zealand, trust was 39% in January 2017,³³ and steady at 40% in June 2018.³⁴

Ten of these surveys evaluated exposure to the education campaign. Australia's campaign ran over four waves between 2014 and 2017 with eight surveys conducted up until July 2018 showing campaign recognition fluctuating between 13 and 25% (Figure 1).²⁴⁻³¹ Evaluators noted funding was 'modest' compared to other government and private sector campaigns.²⁵ In New Zealand, reported recognition rose from 12% in December 2016 to 45% in June 2018 following addition of television to the marketing mix.^{33,34}

Efficacy

Efficacy was assessed by the extent to which HSR was guiding consumers towards healthier choices. HSR's efficacy had been the subject of more than 29 peer-reviewed research papers and 15 government-commissioned reports covering performance of one or more of the HSR's three components: the label graphic, underlying

Figure 1: Unprompted awareness of HSR, prompted awareness of HSR, trust in HSR and exposure to the HSR campaign in Australia.



Note:

Data is provided from the date of the first availability in Australia (April 2015).

algorithm, and accompanying education campaign.

Twenty-six papers and reports had assessed the efficacy of the HSR graphic, including two randomised controlled trials (RCTs), seven randomised choice experiments, eleven nationally representative surveys, three intercept surveys, two focus group studies, and one policy analysis paper.

HSR 'star' graphic

Understanding and use: Most research identified the HSR graphic as easy to understand and use. The HSR star logo was found to be more likely to be understood and to influence product selection than the Nutrition Information Panel (NIP),^{35,36} health and nutrient content claims,³⁷⁻⁴⁰ and alternative FoPL designs including the Multiple Traffic Light (MTL)^{35,36,38,41} and industry-preferred Daily Intake Guide.^{35,36,38,41-44} Several studies confirmed these results in children.^{40-42,44} These experimental findings were consistent with government-commissioned monitoring surveys, where between two-thirds and three-quarters of consumers consistently self-reported HSR was easy to understand and use.²³⁻³⁴

Two New Zealand studies (one intercept survey and one online experiment) produced disparate findings^{45,46} though both were conducted shortly after HSR adoption, using label designs different from the HSR graphic used in practice. In 2018, the intercept survey was repeated with an updated label, producing results more consistent with other findings on consumer understanding and use.⁴⁷

No experiments had assessed use and understanding of HSR's 'energy icon only' variant of the label, which displayed only kilojoule (and not star rating) information. In government surveys, only 1% of consumers found it easy to understand and use.²⁶

Choice and purchasing: Consumers consistently self-reported being influenced by HSR when shopping^{23-31,33,34,37,48} but studies assessing HSR's impact on choice and real world purchases were less clear.

Several studies inferred a shift towards purchasing of more healthy food or beverage choices when compared to no FoPL,^{43,49} and suggested that HSR remained a significant attribute in driving product choice even when there were co-existing health claims^{39,40} or other forms of nutrition information and marketing on the label.⁵⁰ In the disparate New

Zealand studies noted above, HSR was shown to be ineffective in influencing unprompted consumer choice between two breakfast cereals^{46,47} and consumers made similar purchases using HSR and MTL.⁴⁵ Randomised controlled trials examining the impact of FoPL in the real world identified no effect of HSR on the healthiness of food purchases,^{35,36} despite participants' stated preference for the HSR label format.

Ability to incentivise reformulation: Several companies reported HSR was guiding reformulation activities⁵¹ but only two papers systematically assessed HSR's impact on reformulation across the food supply.^{52,53} Research in New Zealand found small but statistically significant favourable changes in mean energy density, sodium and fibre in HSR labelled products compared with their composition prior to adoption of HSR.⁵² In Australia, these methods were replicated and used to model cost-effectiveness, with researchers determining HSR a cost-effective strategy for delivering food reformulation under both voluntary and mandatory implementation scenarios.⁵³

HSR algorithm

Thirteen peer-reviewed publications and two government reports assessed the performance of the HSR algorithm using different validation methods.^{54,55}

Alignment with current scientific literature (i.e. content validity): Food components included in the algorithm were largely consistent with those in government-led FoPL elsewhere.⁵⁶⁻⁵⁸ HSR's components 'to limit' were the four most common elements reported in FoPL globally: energy (used in 41% of systems), sodium (43%), saturated fat (35%) and total sugars (41%).⁵⁶ Not all FoPL contained 'positive' components. Those used in HSR (FVNL, fibre and protein) were used in several other FoPL elsewhere,⁵⁷ but lack of transparency in FVNL and fibre values relied upon to calculate HSR, and changes to the 'tipping point' for determining eligibility to receive protein points were raised by public health and consumer stakeholders as concerns in the five-year review.⁵⁹

Two papers focused on incorporating added or free sugars into HSR^{60,61} to accord with evidence-based recommendations of Australian and New Zealand food-based dietary guidelines and updated WHO Guidelines on Sugars Intake.⁶² A 2017 audit suggested added or free sugars were included in 14% of FoPL globally.⁵⁶ Treatment

of sugars was being considered in the five-year review.⁵⁹

Alignment with existing policies and other measures of healthiness (i.e. construct validity): We identified eight studies that assessed alignment between HSR and the Australian Dietary Guidelines (ADGs). This work consistently found that healthy 'core' or 'Five Food Group' (FFG) foods received higher HSRs on average (HSR 3.7-4.0) than 'discretionary' foods (HSR 1.9-2.5).^{61,63-68}

The two papers focused on added sugars demonstrated that alignment with the ADGs could be improved by incorporating added sugars into the HSR algorithm.^{60,61}

Three papers and one government report attempted to specify overall alignment with the ADGs. Two large cross-sectional examinations of the food supply calculating HSRs for all products (n=34,000; 65,600) regardless of whether they displayed HSR, found between 82-87% of products had HSRs corresponding with a pre-defined 'appropriate' range for core or discretionary using a cut-point of HSR 3.5 (i.e. core foods scored equal or above this and discretionary foods below this).^{63,65} Two smaller studies (n=1,269; 3,940) reviewed the algorithm using information from labels on which HSR was displayed. The findings of these studies highlighted that between 39-57% of discretionary foods displayed a HSR \geq 2.5, assessed by the study authors as an unacceptable 'pass' mark.^{64,67} Each of these works highlighted HSR 'outliers', attributed in some cases to the algorithm and in others to imprecise definitions of unhealthy food.⁶³ Recommendations made for improving the algorithm including its treatment of sugar, protein, juices, and unpackaged fruits and vegetables were being considered in HSR's five-year review.^{59,61}

HSR alignment with Australia and New Zealand's existing health claims legislation was found to be good at a cut-point of HSR \geq 3.5; with 97.3% of products over this threshold eligible to display a health claim.⁶⁹ While HSR was explicitly designed to focus on packaged and processed foods,¹¹ there is increasing international interest in the impact of industrial food processing on health, particularly the association between high levels of consumption of ultra-processed foods (UPF) and poor diets.⁷⁰ Three papers assessed HSR against the NOVA food classification system.^{67,71,72} In a sample of dairy foods, HSR correctly classified milks, but not yoghurt and cheeses, based on degree

of processing.⁷² In a sample of supermarket own-brand foods voluntarily displaying HSR (n=3,940), unprocessed and minimally processed foods had a higher mean (HSR 4.4) than processed (HSR 3.5) or UPF (HSR 2.5), however, 55% of UPF displayed a HSR \geq 2.5, assessed by the authors as a failure to fall below a designated cut-off of HSR 2.0.⁶⁷ A summary of submissions to the five-year review acknowledged stakeholder comments on degree of processing,⁷³ but at the time of writing the independent reviewer had determined it was outside the reasonable scope of the review.⁵⁹

Alignment with health outcomes (i.e. predictive validity): No papers were identified that assessed the ability of the HSR algorithm to predict health outcomes, reported as the strongest method for assessing the validity of nutrient profile models.^{54,72}

HSR Campaign

Eight government-commissioned surveys in Australia and two in New

Zealand evaluated the performance of the HSR campaign.^{24-31,33,34} The majority of respondents reported that they understood campaign messages, though Australian evaluation noted some persistent confusion.^{24,25,27} In both countries, those who had seen the campaign self-reported higher awareness, trust, understanding and use of the HSR, and consistently reported carrying out at least one behavioural objective of the campaign with around two-thirds self-reporting they had purchased a new product because of its HSR.^{24,25,27,33,34}

Adoption

Adoption was measured as the degree to which the necessary stakeholders engaged in HSR implementation. Available data were used to map HSR governance structures (Figure 2) and summarise involvement of each stakeholder (Table 2). Stakeholder analysis was conducted through iterative consultation among the authors, assessing the average level of interest, influence

and position of each stakeholder in HSR implementation, and HSR implementation's resulting impact on them (Table 2).

Key stakeholders with high interest and a supportive position included the Australian (Commonwealth, State and Territory) and New Zealand governments, each of whom contributed funding and together retained ultimate decision-making power on the future of the system through voting rights exercised in the Ministerial Forum on Food Regulation (Forum). Decisions by politicians in the Forum are supported by the work of senior government officials in the Food Regulation Standing Committee (FRSC). In New South Wales, State Government integrated HSR into its food procurement criteria in schools and hospitals.⁷⁴ Despite this formal influence, media analysis up to 2016 noted government representatives rarely participated in public commentary on HSR implementation.⁷⁵

Food manufacturers and retailers have high interest and influence, though their

Table 2: Assessment of average interest, influence and position of stakeholders involved in HSR implementation, and impact of HSR on them.

Stakeholder	Characteristics	Interest in HSR	Influence/Power	Position*	Impact of HSR on stakeholder
	Involvement in the issue				
Australian Commonwealth Government	Participate in Trans-Tasman Food Regulatory Committees with remit over HSR Host FoPL Secretariat – primary public point of contact Facilitate government coordination – e.g. chair Jurisdictional Group and TAG Run Australian education and awareness campaign Administer tender for HSR monitoring and evaluation in Australia and overall Contribute funding to support implementation	High	High	Supportive	Medium
New Zealand Government	Participate in Trans-Tasman Food Regulatory Committees with remit over HSR Contribute funding to support implementation, including NZ specific campaign Coordinate and manage NZ HSRAG Coordinate and collate NZ monitoring and evaluation	High	Medium	Supportive	Medium
Australian State and Territory Governments	Participate in Trans-Tasman Food Regulatory Committees with remit over HSR Selected representatives on HSRAC and TAG Contribute funding to support implementation, including campaign Consider integration of HSR into State-based policies e.g. school canteen guidelines	Medium	Medium	Supportive	Low
Food manufacturers and retailers	Formal representation on HSRAC, TAG and NZ HSRAG Responsibility to voluntarily apply HSR on products Provide in-store placement of HSR campaign materials (retailers)	High	High	Somewhat supportive	High
Public health community	Formal representation on HSRAC, TAG and NZ HSRAG Conduct and publish research on HSR efficacy and implementation Build awareness of HSR among peers, patients and public in Australia and globally Advocate for improvements to HSR to improve public health impact	Medium	Medium	Somewhat supportive**	Medium
Consumer groups	Formal representation on HSRAC and NZ HSRAG Conduct and publish consumer research on HSR efficacy and implementation Build awareness of HSR with consumers and consumer organisations globally Advocate for improvements to HSR to improve consumer utility	Medium	Medium	Somewhat supportive	Medium

Notes:

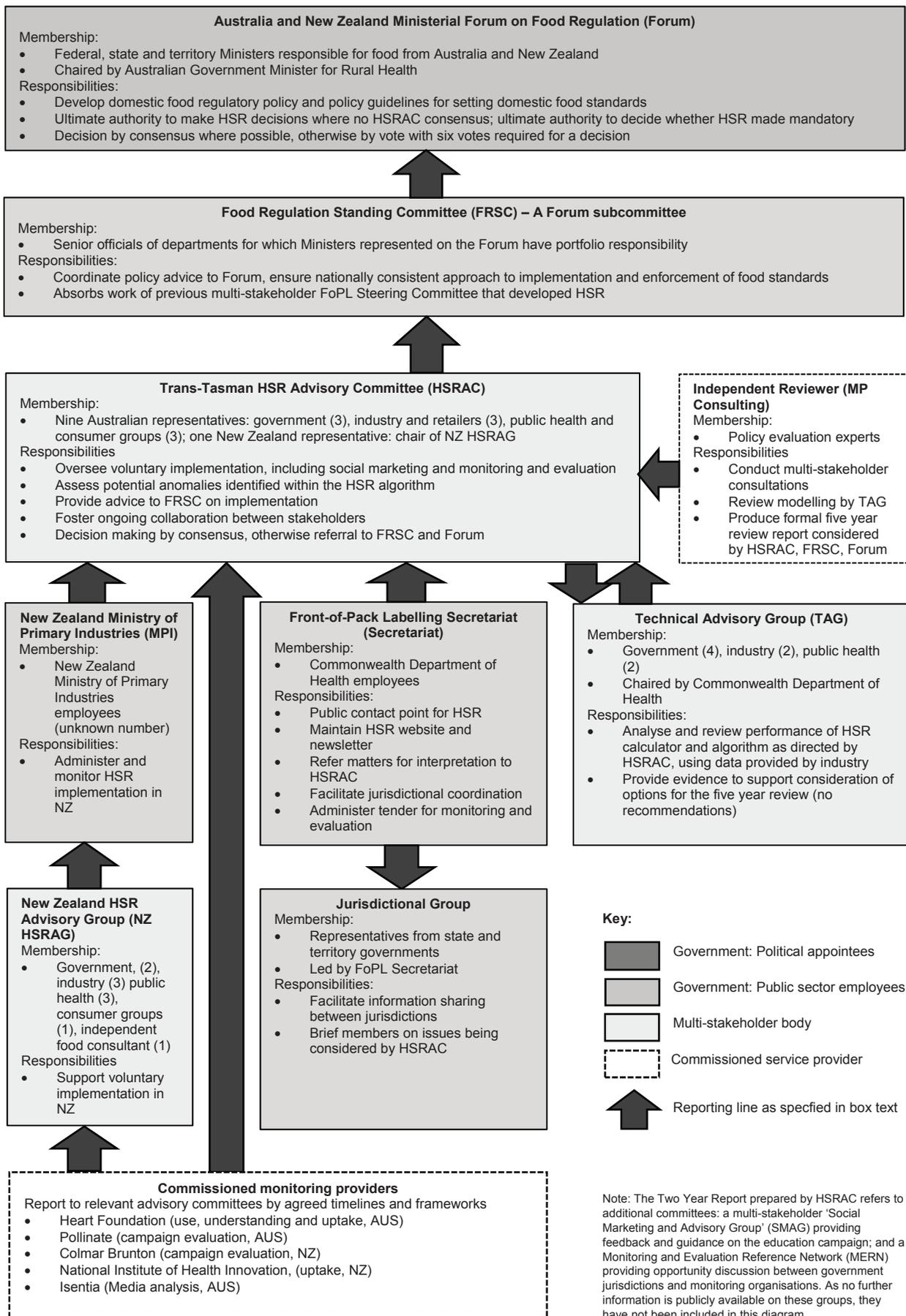
Key to abbreviations used:

HSR, Health Star Rating; FoPL, Front-of-Pack Label; NZ, New Zealand; TAG, Technical Advisory Group; NZ HSRAG New Zealand Health Star Rating Advisory Group; HSRAC, Health Star Rating Advisory Committee

*Possible values for position include: supportive, somewhat supportive, somewhat opposed and opposed

**While the majority of papers, policy statements, submissions and media representations from this group were generally supportive, a small number of vocal opponents were noted

Figure 2: Health Star Rating system governance.



participation on HSR governance committees was limited to those below the governmental Forum and FRSC. In HSR's voluntary form, their power comes primarily from agreeing to apply HSR to product labels. Given the potential business impact of mandatory labelling requirements, peak industry bodies had indicated their support for HSR, conditional on it remaining voluntary.⁷⁶ Media analysis found industry the most frequently cited stakeholder conveying favourable messages about HSR, including that it helps promote products, drives innovation and that industry were acting to introduce it.⁷⁵

Health and consumer groups participated in HSR governance committees. On the trans-Tasman Health Star Rating Advisory Committee (HSRAC) they had combined numbers equal to industry. They influenced and supported implementation by conducting independent research and disseminating information to their own networks, interest groups and the wider public. Common messages conveyed by these groups in media analysis were that HSR could be an effective tool to communicate with consumers, but also that it was being used by industry in ways that favoured their own interests.⁷⁵ In formal consultations and policy statements, health and consumer groups broadly indicated their support for HSR while advocating for it to be strengthened, made mandatory and complemented with other nutrition policies.^{73,77-82}

Implementation

Implementation was measured by the extent to which HSR was appearing on labels as intended, assessed by both commissioned monitoring and independent publications involving cross-sectional examination of the food supply.

Uptake

Uptake had been examined in five peer-reviewed publications^{64,67,71,83,84} and six government-commissioned reports^{23,31,85-88} covering both Australia and New Zealand. Results indicated uptake was increasing, with government issuing a communiqué in June 2018 that HSR had been displayed on 10,333 products in Australia and over 3,900 in New Zealand.⁸⁹ Studies that examined proportionate uptake suggested HSR was on between 20-28% of eligible products in the Australian food supply in 2017.^{31,83,87} Uptake remained lower in New Zealand, at

20.9% in 2018.⁸⁸ Only ten per cent of new products entering the Australian market between June 2014 and June 2017 chose to display HSR.⁶⁴ In Australia, more than 118 manufacturers were using HSR in 2018, but large retailers Coles, Woolworths and Aldi were together responsible for more than half of all uptake.^{31,83} Uptake was skewed towards products that scored at the upper end of the five-star spectrum.^{31,67,83,85,88} More than 50% of uptake was on UPF foods.^{67,71}

Compliance

Government-commissioned monitoring suggested at least 90% of HSR labels complied with Style Guide formatting requirements, with errors predominantly of a minor technical nature^{23,31,86} or related to poor legibility.⁸⁵ Official monitoring also suggested >90% accuracy of HSR values, with incorrect calculations more frequently under-reporting, rather than over-stating HSR, usually by 0.5 stars.^{23,31,87} Independent research raised issues concerning inconsistent use of the 'energy icon only' variant of HSR, particularly on low-scoring non-dairy beverages.^{83,84}

Maintenance

Maintenance was assessed by measures taken by stakeholders to sustain HSR over time. Data available directly from government websites detailed HSR governance structures, complaints mechanisms, frameworks for monitoring and evaluation, and funding committed.

Governance structures

Figure 2 illustrates the governance of HSR in its voluntary status as at October 2018. The trans-Tasman government bodies of the Forum and FRSC retained ultimate decision-making power on the operation and continuance of HSR. Underneath this, implementation was overseen by the HSRAC, whose remit was to foster ongoing collaboration between government, industry, public health and consumer groups. HSRAC coordinated the HSR education campaign, as well as monitoring and evaluation of the system, reporting outcomes to the Forum and FRSC. HSRAC also received matters submitted through HSR complaint mechanisms for decision making by consensus. Where consensus could not be reached, matters were referred to the Forum and FRSC. Ancillary support was provided by the FoPL Secretariat (Secretariat) in the Australian

Commonwealth Department of Health. The Secretariat acted as public contact point, maintaining the website and newsletter. They also led a Jurisdictional Group, facilitating information sharing on HSR between Australia's states and territories. In New Zealand, HSR implementation was administered by the Ministry of Primary Industries (MPI), who received advice from their own multi-stakeholder Health Star Rating Advisory Group (HSRAG).

Legal analysis suggested the Australian Commonwealth Government possessed the requisite authority to make HSR mandatory if desired.⁹⁰

Complaint mechanisms

Potential algorithm anomalies can be submitted to HSRAC for consideration; by October 2018 there had been 21 submissions, two of which (tinned vegetables and dairy desserts) were determined to meet the specific definition of 'anomaly', warranting follow up action.¹¹ An additional dispute resolution procedure exists for challenging HSRs on individual products, though to date no disputes appear to have been registered.¹¹ Outside these processes, HSRAC has dealt with concerns surrounding HSR implementation in an ad hoc manner. For example, 'the form of the food – as prepared' rules in the HSR Style Guide were subject to a formal public consultation, additional modelling and additional industry proposals before ultimate referral to the Forum for resolution. The process took more than 18 months, with compliance not required by industry until after 2019.¹¹

Monitoring and evaluation framework

Conduct of monitoring in Australia was tendered to the National Heart Foundation shortly after implementation.⁹¹ It included regular reports on consumer awareness and use, as well as label implementation, consistency, and nutrient status of products carrying HSR.¹¹ Similar activities occurred in New Zealand, coordinated by MPI with input from academic research organisations.^{85,88} Regular monitoring of uptake and use was supplemented with commissioned evaluation of the education campaign^{24,25,27,33,34} and HSR coverage in media.⁷⁵

In 2016, HSRAC issued a combined two-year monitoring report compiling data from this work.⁵¹ Following this, planning commenced for a formal five-year review. An independent reviewer (MP Consulting) was appointed by

tender,⁵⁹ and a voluntary multi-stakeholder Technical Advisory Group (TAG) created with specific remit to analyse performance of the HSR algorithm and provide technical input.¹¹ The review involved several rounds of written and face-to-face consultation. Feedback consolidated and reported online noted the main concerns raised, namely that some products high in sugar, fat and salt could carry a high rating.⁷³ Results of TAG modelling attempted to provide solutions and were published online with a calculator to test the implications of preferred options on products.⁹² Recommendations on long-term maintenance of HSR, including whether the system should be made mandatory⁹⁰ were to be provided in a report for consideration first by HSRAC and then FRSC to inform a decision by Forum Ministers on the future of HSR in mid-2019.¹¹

Funding commitments

Comprehensive information on HSR funding was difficult to obtain due to its federated, trans-Tasman structure. Budget documents recorded \$5.3 million committed by Australia's Commonwealth government to HSR for the period 2016-2019, noting continued involvement and endorsement of government was critical to HSR's independence.⁹³ Tender databases suggested it distributed about \$2 million on monitoring and evaluation services, and about \$2.3 million up to October 2018 on campaign development and evaluation.⁹¹ This did not

include costs of media buy: in 2017, phase four of the campaign alone had a media buy of \$2.2 million.⁹¹ Specific contributions or spending by state and territory governments or by New Zealand for HSR related activities were not publicly available and were not included in this sum. It is not clear what resources would be made available for sustaining HSR after delivery of the review report in 2019.

Conclusions

More than four years since voluntary implementation commenced, a significant body of evidence supports continuation and strengthening of HSR. Our systematic analysis points to key areas where HSR's public health impact can be enhanced (see Box 1).

Awareness and trust were reported as increasing, though unprompted awareness remained modest given HSR's position as a key pillar of both countries' responses to addressing the huge burden of diet-related disease. Lower awareness among Australians who were overweight, live in rural areas or experience socioeconomic disadvantage suggests opportunity to improve HSR's utility among these groups. Successful targeted efforts in New Zealand with 'priority' groups suggest similar attention in Australia would be important to address ongoing health inequities.

Exposure to the HSR campaign remained disappointing. While evaluators suggested

campaign funding was 'modest', it made up a significant proportion of total spend on HSR. Monitoring suggested most people were aware of HSR from 'seeing it on pack', making it arguably more cost-effective for government to focus on increasing HSR uptake, rather than further spending on awareness campaigns.

The bulk of peer-reviewed and government-commissioned research focused on HSR's efficacy. The 'star' graphic was shown to be well-liked by consumers, and superior in utility to the industry-preferred DIG. To maximise the utility of a single FoPL, the DIG and its variants (i.e. Treatwise, energy icon variant of HSR) should now be formally retired. Innovation in FoPL formats worldwide suggest opportunities for strengthening HSR's graphic design further. Evidence-based features to enhance visibility and consumer utility such as incorporation of colour (for example, France's Nutriscore⁹⁴ or the MTL), written government endorsement (as in Chile⁹⁵ and Singapore⁹⁶) and Canada's proposed rules for positioning FoPL in a uniform pack position away from health claims⁹⁷ provide inspiration for future research and updates to the HSR Style Guide (Box 1).

HSR's efficacy also depends on its underlying algorithm providing an accurate representation of the healthiness of food. Substantial attention has been placed on the performance of the HSR algorithm, predominantly through content and construct validity assessments that show its similarities with other nutrient profiling algorithms and tend to support its performance as a reasonable, albeit imperfect, tool to assess nutritional quality. Differences in methodologies and 'cut-points' have led to variations in results that highlight challenges in assessing alignment with other measures of healthiness without pre-defined indicators by which to measure 'success', e.g. a HSR threshold or band of scores appropriate to delineate 'healthy' from 'unhealthy' or minimally processed from ultra-processed foods. Despite these differences, broadly consistent recommendations have emerged for strengthening algorithm alignment with existing health policies (Box 1).

Our assessment also highlighted that the HSR algorithm has not been subject to more robust forms of validation. HSR is not unique in this respect: a recent systematic review found only 10% of nutrient profile models being used in government-led nutrition

Box 1: Recommendations for improving HSR's public health impact.

Reasonable refinements to improve efficacy

- Strengthen utility of the 'star' graphic by considering standardised colour, size and placement, specifying separation from health claims, ending concurrent use of non-interpretive labels (e.g. Daily Intake Guide, Treatwise, 'energy icon only' variant)
- Implement HSR algorithm improvements to reflect findings of existing research: incorporate added sugars, strengthen treatment of sodium, review treatment of protein, consider treatment of fresh fruit and vegetables including unpackaged
- Conduct further high level validation studies to explore link between the HSR of foods, healthier diets, and health outcomes

Responsive regulatory action to improve uptake

- Clear targets with specified timelines (e.g. 80% eligible products within two years of 2019 review completion) and commitment by Forum to make mandatory on specified date where sufficient progress not demonstrated
- Improve transparency and accountability of uptake monitoring through use of regularly updated, publicly available branded food composition database

Strengthen government leadership to improve HSR governance

- Renewed and unambiguous public commitment and funding to continue HSR beyond five year review
- Increased public visibility of government leadership at ministerial level
- Authority and resource delegated to FSANZ to provide independent technical advice
- Renewed Terms of Reference for multi-stakeholder involvement, controlling for conflicts of interest, particularly in technical functions such as algorithm review and determining anomalies
- Improve transparency of multi-stakeholder committees and public consultations, e.g. agendas and minutes, individual submissions publicly available
- Reform complaint mechanisms to improve utility, provide expeditious resolution of reasonable concerns raised by all stakeholders, including consumers
- Integrate HSR into other government-led nutrition policies e.g. procurement for public settings, criteria for marketing to children, fast food menu labelling
- Situate and support HSR within a comprehensive policy framework e.g. National Obesity or Nutrition Strategy

policies have been subject to 'predictive' validity testing to assess associations with health outcomes, e.g. weight gain or cancer risk.⁵⁸ The most frequently validated of these is the United Kingdom (UK) Ofcom model, from which HSR originated.^{55,58} Results of studies assessing its performance in UK and French cohorts have found prospective associations with health outcomes in most,⁹⁸⁻¹⁰³ but not all studies.¹⁰⁴ While recognising the significant commonalities between both algorithms, further high-level validation could usefully assess any prospective association between HSR, healthier diets and health outcomes in Australasian populations. It could also assess whether variations in HSR's design (e.g. creation of extra dairy categories) have impacted these associations.

While refinements to increase efficacy are important, analysis of implementation suggests they are unlikely to drive improvements in impact unless accompanied by radically increased uptake. During its development in 2013, Forum Ministers agreed HSR would remain voluntary subject to there being 'consistent and widespread' uptake, otherwise a mandatory approach would be required.¹⁰⁵ Even without performance indicators, it is arguable that uptake of less than one-third of eligible products (mostly those that score well), justifies review of HSR's voluntary status. Mandatory FoPL are increasing globally, including recent initiatives in Mexico, Iran, Chile, Sri Lanka, Peru, Uruguay and Israel.¹⁰⁶ Our findings highlight wide support from consumer and public health stakeholders, but not industry, to make HSR mandatory in Australasia. If a mandatory HSR is not yet politically feasible, a 'responsive regulatory' approach provides interim suggestions for how uptake must necessarily be enhanced to improve HSR's utility to consumers¹⁰⁷ (Box 1).

The relative engagement and differential power held by HSR stakeholders (Table 2 and Figure 2) provide insights into how HSR's governance can be enhanced. While HSR is a multi-stakeholder initiative, government retains ultimate responsibility for HSR decision-making and funding. Absence of government comment in media analysis suggests opportunity for greater visible leadership from government Ministers, for example, in reiterating government endorsement of HSR and communicating positive changes for consumers emanating from the five-year review.

Low uptake by industry (particularly on less healthy products), despite their public endorsement of HSR supports review of the Terms of Reference for their engagement. This should take into account increasing global awareness of the need to prevent and manage conflicts of interest in the development of national nutrition policies.¹⁰⁸ Notably absent from governance arrangements outlined in Figure 2 are Food Standards Australia New Zealand (FSANZ) who have the expertise and independence to conduct many of the functions performed voluntarily by HSRAC and the TAG to date. While a renewed HSRAC may have a role in continuing to promote multi-stakeholder collaboration in implementation, delegation of greater technical authority to FSANZ to administer and validate the algorithm, monitor uptake, and assess compliance using publicly available branded food composition data, could mitigate real or perceived commercial conflicts of interest in HSR's governance and facilitate its progressive integration into the formal food regulatory system.

Linkages between HSR and other health policies, as done by NSW in procurement standards, or by countries like Chile in linking FoPL with restrictions on marketing to children,⁹⁵ provide opportunities to further the utility of HSR. Strategically situating and supporting HSR within a comprehensive policy framework such as a National Obesity Strategy will enhance synergies with existing and future interventions to address diet-related disease.

This paper used a systematic approach to synthesising a growing body of heterogeneous material on HSR's implementation and efficacy. The strength of the evidence obtained is importantly limited in several areas by study design, the scope of the analyses done and the magnitude of the projects completed. Further investment in high-quality research will provide better insight into the most likely effects of HSR on health outcomes, and how best to maximise them through both technical enhancements and improvements in implementation. Analysis of industry compliance with the HSR algorithm was limited by lack of transparency surrounding some food components (e.g. benefits obtained from Fruit, Vegetable Nut and Legume (FVNL) content) as companies are not required to display the relevant data on the label. Our governance assessment was to some degree limited by reliance on public

information, e.g. no available minutes of HSRAC or TAG meetings.

Implications for public health

Adoption of HSR in 2014 placed Australia and New Zealand among a small but growing number of countries using FoPL as one tool to promote healthier diets. Four years since implementation commenced, available evidence supports the continuation and strengthening of HSR.

As the formal five-year review draws to a close in 2019, reasonable refinements to HSR's star graphic and algorithm, action to initiate mandatory implementation and strengthened governance – particularly through renewed, visible government leadership – present the clearest opportunities to enhance HSR's public health impact.

References

1. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair-Rohani H, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: A systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2224-60.
2. Stuckler D, McKee M, Ebrahim S, Basu S. Manufacturing epidemics: The role of global producers in increased consumption of unhealthy commodities including processed foods, alcohol, and tobacco. *PLoS Med*. 2012;9(6):e1001235.
3. PricewaterhouseCoopers. *Weighing the Cost of Obesity: A Case for Action*. Sydney (AUST): PWC; 2015.
4. World Health Organization. *'Best Buys' and Other Recommended Interventions for the Prevention and Control of Noncommunicable Diseases, Updated (2017) Appendix 3 of the Global Action Plan for the Prevention and Control of Non-Communicable Diseases 2013-2020*. Geneva (CHE): WHO; 2017.
5. World Health Organization. *Implementation Plan of the WHO Commission on Ending Childhood Obesity*. Geneva (CHE): WHO; 2017.
6. Volkova E, Mhurchu CN. The influence of nutrition labeling and point-of-purchase information on food behaviours. *Curr Obes Rep*. 2015;4(1):19-29.
7. Vyth EL, Steenhuis IH, Roodenburg AJ, Brug J, Seidell JC. Front-of-pack nutrition label stimulates healthier product development: A quantitative analysis. *Int J Behav Nutr Phys Act*. 2010;7(1):1.
8. World Health Organization. *Nutrient Profiling*. Geneva (CHE): WHO; 2010.
9. World Cancer Research Fund International. *WCRF International Food Policy Framework for Healthy Diets: NOURISHING*. London (UK): WCRF; 2019.
10. Codex Alimentarius Commission Committee on Food Labelling. *Report of the Codex Committee On Food Labelling (Forty-fourth Session)*; 2017 Oct 16-17; Ascunson, Paraguay. Rome, Italy: Food and Agriculture Organisation of the United Nations; 2018.
11. Australian Government Department of Health. *The Health Star Rating System* [Internet]. Canberra (AUST): Front-of-Pack Labelling Secretariat; 2018 [cited 2019 May 2]. Available from: <http://healthstarrating.gov.au/>
12. Front-of-Pack Labelling Project Committee. *Objectives and Principles for the Development of a Front-of-pack Labelling (FOPL) System Endorsed 11 May 2012*. Canberra (AUST): Australian Government Department of Health; 2018.

13. Australia New Zealand Food Regulation Ministerial Council. *Front of Pack Labelling Policy Statement*. Canberra (AUST): Food Regulation Secretariat Australian Government; 2009.
14. *Food Standards Australia New Zealand Act 1991* (Cth). Australia New Zealand Food Standards Code – Standard 1.2.7 – Nutrition, Health and related Claims.
15. Australian Government Food Regulation Secretariat. *Food Regulation Activities. Front-of-Pack Labelling Committee and Working Group Meetings* [Internet]. Canberra (AUST): Australian Government Department of Health; 2016 [cited 2016 Nov 21]. Available from: <http://foodregulation.gov.au/internet/fr/publishing.nsf/Content/frontofpackcommittee>
16. Health Star Rating Technical Advisory Group. *Five Year Review of the HSR System - Technical Paper, History and Development of the Health Star Rating Algorithm*. Canberra (AUST): Front-of-Pack Labelling Secretariat Australian Government Department of Health; 2018.
17. Health Star Rating Advisory Committee. *Health Star Rating System Style Guide*. 4th ed. Version 5. Canberra (AUST): Front-of-Pack Labelling Secretariat Australian Government Department of Health; 2017.
18. Australian Department of Health. *Media Release: Health Star Rating System on Track*. Canberra (AUST): Front-of-Pack Labelling Secretariat; 2014 June 27.
19. Australia and New Zealand Ministerial Forum on Food Regulation. *Media Release: Communiqué of Outcomes from the Australia and New Zealand Ministerial Forum on Food Regulation Meeting held on 20 November 2015*. Canberra (AUST): Front-of-Pack Labelling Secretariat Australian Government Department of Health; 2015 November 20.
20. Glasgow RE, Vogt TM, Boles SM. Evaluating the public health impact of health promotion interventions: The RE-AIM Framework. *Am J Public Health*. 1999;89(9):1322-7.
21. Jilcott S, Ammerman A, Sommers J, Glasgow REJAoBM. Applying the RE-AIM Framework to assess the public health impact of policy change. *Ann Behav Med*. 2007;34(2):105-14.
22. Varvasovszky Z, Brugha R. A stakeholder analysis. *Health Policy Plan*. 2000;15(3):338-45.
23. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System – Year 1*. Melbourne (AUST): Heart Foundation; 2015.
24. Pollinate Research. *Health Star Rating System Campaign Evaluation Report 2015*. Canberra (AUST): Front-of-Pack Labelling Secretariat Australian Government Department of Health; 2015 September.
25. Pollinate Research. *Health Star Rating System: Campaign Evaluation Report 2016*. Canberra (AUST): Front-of-Pack Labelling Secretariat Australian Government Department of Health; 2016.
26. National Heart Foundation of Australia. *Report on Monitoring the Implementation of the Health Star Rating System - Area of Enquiry 2 - Consumer Awareness and Ability to Use the HSR System Correctly*. Melbourne (AUST): Heart Foundation; 2016 July.
27. Pollinate Research. *Health Star Rating System Campaign Evaluation Report 2017*. Canberra (AUST): Front-of-Pack Labelling Secretariat Australian Government Department of Health; 2017 June.
28. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System: Key Findings for Area of Enquiry Two – Consumer Awareness and Ability to Use the Health Star Rating System Correctly – November 2017*. Melbourne (AUST): Heart Foundation; 2017.
29. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System: Key Findings for Area of Enquiry 2 - Consumer Awareness and Ability to Use the Health Star Rating System Correctly - April 2018*. Melbourne (AUST): Heart Foundation; 2018.
30. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System: Key Findings for Area of Enquiry 2 - Consumer Awareness and Ability to Use the Health Star Rating System Correctly - July 2018*. Melbourne (AUST): Heart Foundation; 2018.
31. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System in the First Two Years of Implementation: June 2014 to June 2016*. Melbourne (AUST): Heart Foundation; 2017.
32. Colmar Brunton. *Health Star Rating Monitoring and Evaluation*. Wellington (NZ): Health Promotion Agency; 2016.
33. Colmar Brunton. *Health Star Rating Monitoring and Evaluation Year One Follow Up Research Report*. Wellington (NZ): Health Promotion Agency; 2017.
34. Colmar Brunton. *Health Star Rating Monitoring and Evaluation: Year 2 Follow Up Research Report*. Wellington (NZ): Health Promotion Agency; 2018.
35. Neal B, Crino M, Dunford E, Gao A, Greenland R, Li N, et al. Effects of different types of front-of-pack labelling information on the healthiness of food purchases—a randomised controlled trial. *Nutrients*. 2017;9(12):1284.
36. Ni Mhurchu C, Volkova E, Jiang Y, Eyles H, Michie J, Neal B, et al. Effects of interpretive nutrition labels on consumer food purchases: The Starlight randomized controlled trial. *Am J Clin Nutr*. 2017;105(3):695-704.
37. Riley MD, Bowen J, Krause D, Jones D, Stonehouse W. A survey of consumer attitude towards nutrition and health statements on food labels in South Australia. *Foods Health Dis*. 2016;6(12):809-21.
38. Talati Z, Pettigrew S, Dixon H, Neal B, Ball K, Hughes C. Do health claims and front-of-pack labels lead to a positivity bias in unhealthy foods? *Nutrients*. 2016;8(12):787.
39. Russell CG, Burke PF, Waller DS, Wei E. The impact of front-of-pack marketing attributes versus nutrition and health information on parents' food choices. *Appetite*. 2017;116:323-38.
40. Talati Z, Pettigrew S, Hughes C, Dixon H, Kelly B, Ball K, et al. The combined effect of front-of-pack nutrition labels and health claims on consumers' evaluation of food products. *Food Qual Prefer*. 2016;53:57-65.
41. Talati Z, Pettigrew S, Ball K, Hughes C, Kelly B, Neal B, et al. The relative ability of different front-of-pack labels to assist consumers discriminate between healthy, moderately healthy, and unhealthy foods. *Food Qual Prefer*. 2017;59:109-13.
42. Pettigrew S, Talati Z, Miller C, Dixon H, Kelly B, Ball K. The types and aspects of front-of-pack food labelling schemes preferred by adults and children. *Appetite*. 2017;109:115-23.
43. Talati Z, Pettigrew S, Kelly B, Ball K, Neal B, Dixon H, et al. Can front-of-pack labels influence portion size judgements for unhealthy foods? *Public Health Nutr*. 2018;21(15):2776-81.
44. Talati Z, Pettigrew S, Kelly B, Ball K, Dixon H, Shilton T. Consumers' responses to front-of-pack labels that vary by interpretive content. *Appetite*. 2016;101:205-13.
45. Maubach N, Hoek J, Mather D. Interpretive front-of-pack nutrition labels. Comparing competing recommendations. *Appetite*. 2014;82:67-77.
46. Hamlin R, McNeill L. Does the Australasian "Health Star Rating" front-of-pack nutritional label system work? *Nutrients*. 2016;8(6):327.
47. Hamlin R, McNeill L. The impact of the Australasian "Health Star Rating" front-of-pack nutritional label, on consumer choice: A longitudinal study. *Nutrients*. 2018;10(7):906. pii: E906.
48. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System: Key Findings for Area of Enquiry Two – Consumer Awareness and Ability to Use the Health Star Rating System Correctly*. Melbourne (AUST): Heart Foundation; 2017.
49. Billich N, Blake MR, Backholer K, Cobcroft M, Li V, Peeters AJA. The effect of sugar-sweetened beverage front-of-pack labels on drink selection, health knowledge and awareness: An online randomised controlled trial. *Appetite*. 2018;128:233-41.
50. Scrinis G, Parker C. Front-of-pack food labeling and the politics of nutritional nudges. *Law Policy*. 2016;38(3):234-49.
51. Health Star Rating Advisory Committee. *Two Year Progress Review Report on the Implementation of the Health Star Rating System - June 2014 - June 2016*. Canberra (AUST): Public Health Association Australia; 2017.
52. Mhurchu CN, Eyles H, Choi YH. Effects of a voluntary front-of-pack nutrition labelling system on packaged food reformulation: The Health Star Rating System in New Zealand. *Nutrients*. 2017;9(8):918.
53. Mantilla Herrera AM, Crino M, Erskine HE, Sacks G, Ananthapavan J, Mhurchu CN, et al. Cost-effectiveness of product reformulation in response to the health star rating food labelling system in Australia. *Nutrients*. 2018;10(5). pii: E614.
54. Townsend MS. Where is the science? What will it take to show that nutrient profiling systems work? *Am J Clin Nutr*. 2010;91(4):1109S-15S.
55. Cooper SL, Pelly FE, Lowe JB. Construct and criterion-related validation of nutrient profiling models: A systematic review of the literature. *Appetite*. 2016;100:26-40.
56. World Health Organization. *Global Nutrition Policy Review 2016-2017*. Geneva (CHE): WHO; 2018.
57. Kanter R, Vanderlee L, Vandevijvere S. Front-of-package nutrition labelling policy: Global progress and future directions. *Public Health Nutr*. 2018;21(8):1399-408.
58. Labonté M-E, Poon T, Gladanac B, Ahmed M, Franco-Arellano B, Rayner M, et al. Nutrient profile models with applications in government-led nutrition policies aimed at health promotion and noncommunicable disease prevention: A systematic review. *Adv Nutr*. 2018;9(6):741-88.
59. MP Consulting. *Five Year Review of the Health Star Rating System - Navigation Paper*. Canberra (AUST): Front-of-Pack Labelling Secretariat Australian Government Department of Health; 2018.
60. Menday H, Neal B, Wu JHY, Crino M, Baines S, Petersen KS. Use of added sugars instead of total sugars may improve the capacity of the health star rating system to discriminate between core and discretionary foods. *J Acad Nutr Diet*. 2017;17(12):1921-30.e11.
61. Peters SA, Dunford E, Jones A, Ni Mhurchu C, Crino M, Taylor F, et al. Incorporating added sugar improves the performance of the health star rating front-of-pack labelling system in Australia. *Nutrients*. 2017;9(7):701.
62. World Health Organization. *Guideline: Sugars Intake for Adults and Children*. Geneva (CHE): WHO; 2015.
63. Jones A, Rådholm K, Neal B. Defining 'unhealthy': A systematic analysis of alignment between the Australian dietary guidelines and the Health Star Rating System. *Nutrients*. 2018;10(4):501.
64. Lawrence M, Dickie S, Woods J. Do nutrient-based front-of-pack labelling schemes support or undermine food-based dietary guideline recommendations? Lessons from the Australian Health Star Rating System. *Nutrients*. 2018;10(1):32.
65. Dunford E, Cobcroft M, Thomas M, Wu J. *Technical Report: Alignment of the NSW Healthy Food Provision Policy with the Health Star Rating System*. Sydney (AUST): State Government of New South Wales Ministry of Health; 2015.
66. Carrad AM, Louie JCY, Yeatman HR, Dunford EK, Neal BC, Flood VM. A nutrient profiling assessment of packaged foods using two star-based front-of-pack labels. *Public Health Nutr*. 2016;19(12):2165-74.
67. Pulker C, Trapp G, Scott J, Pollard CJN. Alignment of supermarket own brand foods' front-of-pack nutrition labelling with measures of nutritional quality: An Australian perspective. *Nutrients*. 2018;10(10). pii: E1465.
68. Wellard L, Hughes C, Watson WL. Investigating nutrient profiling and Health Star Ratings on core dairy products in Australia. *Public Health Nutr*. 2016;19(15):2860-5.
69. Dunford E, Huang L, Peters S, Crino M, Neal B, Ni Mhurchu CJN. Evaluation of alignment between the health claims Nutrient Profiling Scoring Criterion (NPS) and the Health Star Rating (HSR) nutrient profiling models. *Nutrients*. 2018;10(8). pii: E1065.
70. Monteiro CA, Cannon G, Moubarac J-C, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr*. 2018;21(1):5-17.
71. Pulker CE, Scott JA, Pollard CMJPhn. Ultra-processed family foods in Australia: nutrition claims, health claims and marketing techniques. *Public Health Nutr*. 2018;21(1):38-48.

72. Cooper S, Pelly F, Lowe JB. Assessment of the construct validity of the Australian Health Star Rating: A nutrient profiling diagnostic accuracy study. *Eur J Clin Nutr.* 2017;71(11):1353-1359.
73. MP Consulting. *Report on Submissions to the Five Year Review of the Health Star Rating System.* Canberra (AUST): Australian Government Department of Health; 2017.
74. NSW Ministry of Health. *Healthy Food and Drink in NSW Health Facilities for Staff and Visitors Framework.* Sydney (AUST): State Government of New South Wales; 2017.
75. Isentia Insights. *Media Analysis Report July 2014 - June 2016 SA Health Star Rating.* Adelaide (AUST): State Government South Australia Department of Health; 2016.
76. Australian Food and Grocery Council. *Submission to Senate Select Committee Inquiry into the Obesity Epidemic.* Canberra (AUST): AFGC; 2018.
77. Obesity Policy Coalition. *Submission to the Senate Select Committee into the Obesity Epidemic in Australia - July 2018.* Canberra (AUST): Australian Government Department of the Senate; 2018.
78. Obesity Policy Coalition. *Tipping the Scales: Australian Obesity Prevention Consensus.* Melbourne (AUST): OPC; 2017.
79. CHOICE. *Submission to Select Senate Committee Inquiry into the Obesity Epidemic - July 2018.* Sydney (AUST): CHOICE; 2018.
80. Public Health Association of Australia. *Submission to the Senate Select Committee Enquiry into the Obesity Epidemic - July 2018.* Canberra (AUST): PHAA; 2018.
81. Sacks G for the Food-EPI Australia Project Team. *Policies for Tackling Obesity and creating Healthier Food Environments: Scorecard and Priority Recommendations for Australian Governments.* Melbourne (AUST): Deakin University; 2017.
82. Vandevijvere S, Mackay S, Swinburn B. Measuring and stimulating progress on implementing widely recommended food environment policies: The New Zealand case study. *Health Res Policy Syst.* 2018;16(1):3.
83. Jones A, Shahid M, Neal B. Uptake of Australia's Health Star Rating System. *Nutrients.* 2018;10(8):997.
84. Brownbill AL, Braunack-Mayer A, Miller CJHPJoA. Health star ratings: What's on the labels of Australian beverages? *Health Promot J Austr.* 2019;30(1):114-18.
85. NZ Ministry for Primary Industries. *Health Star Rating: Monitoring Implementation at Year Two.* MPI Technical Paper No.: 2017/09. Wellington (NZ): Government of New Zealand; 2017.
86. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System: Key Findings for AOE1 - Consistency in Implementation of the Health Star Rating (HSR) System with the HSR Style Guide - June 2016 to June 2017.* Melbourne (AUST): NHF; 2017.
87. National Heart Foundation of Australia. *Report on the Monitoring of the Implementation of the Health Star Rating System: Key Findings for AOE1 - Assessment of the Health Star Rating (HSR) Displayed on Pack Using the HSR Calculator - June 2016 to June 2017.* Melbourne (AUST): NHF; 2017.
88. NZ Ministry for Primary Industries. *The Health Star Rating System in New Zealand 2014-2018 System Uptake and Nutrient Content of Foods by Health Star Rating Status.* Wellington (NZ): Government of New Zealand; 2018.
89. Australia New Zealand Ministerial Forum on Food Regulation. *Communique of Outcomes from the Ministerial Forum on Food Regulation 29 June 2018.* Canberra (AUST): FSANZ; 2018.
90. Brennan M. Is the Health Star Rating System a Thin Response to a Fat Problem: An Examination of the Constitutionality of a Mandatory Front Package Labelling System. *Notre Dame Law Rev.* 2015;17(5):86.
91. AusTender. *Australian Government's Procurement Information System.* Canberra (AUST): Government of Australia; 2018.
92. Matthews Pegg Consulting. *Matthews Pegg Consulting: HSR System Enhancements.* Canberra (AUST): MPConsulting; 2018.
93. Australian Department of Health. *Budget 2016-2017.* Canberra (AUST): Government of Australia; 2016.
94. Santé Publique France. *Nutri-Score Corporate Graphic Charter.* Saint-Maurice Cedex (FRA): Public Health France; 2018.
95. Corvalán C, Reyes M, Garmendia ML, Uauy R. Structural responses to the obesity and non-communicable diseases epidemic: The Chilean Law of Food Labeling and Advertising. *Obes Rev.* 2013;14:79-87.
96. Singapore Health Promotion Board. *Healthier Choice Symbol.* Singapore (SIN): HPB; 2018.
97. Health Canada. *Regulations Amending Certain Regulations Made Under the Food and Drugs Act (Nutrition Symbols, Other Labelling Provisions, Partially Hydrogenated Oils and Vitamin D).* Ontario (CAN): Government of Canada; 2018.
98. Deschasaux M, Julia C, Kesse-Guyot E, Lécuyer L, Adriouch S, Méjean C, et al. Are self-reported unhealthy food choices associated with an increased risk of breast cancer? Prospective cohort study using the British Food Standards Agency nutrient profiling system. *BMJ Open.* 2017;7(6):e013718.
99. Donnenfeld M, Julia C, Kesse-Guyot E, Méjean C, Ducrot P, Péneau S, et al. Prospective association between cancer risk and an individual dietary index based on the British Food Standards Agency Nutrient Profiling System. *Br J Nutr.* 2015;114(10):1702-10.
100. Julia C, Ducrot P, Lassale C, Fézeu L, Méjean C, Péneau S, et al. Prospective associations between a dietary index based on the British Food Standard Agency nutrient profiling system and 13-year weight gain in the SU.VI. MAX cohort. *Prev Med.* 2015;81:189-94.
101. Masset G, Scarborough P, Rayner M, Mishra G, Brunner EJ. Can nutrient profiling help to identify foods which diet variety should be encouraged? Results from the Whitehall II cohort. *Br J Nutr.* 2015;113(11):1800-9.
102. Adriouch S, Julia C, Kesse-Guyot E, Ducrot P, Péneau S, Méjean C, et al. Association between a dietary quality index based on the food standard agency nutrient profiling system and cardiovascular disease risk among French adults. *Int J Cardiol.* 2017;234:22-7.
103. Adriouch S, Julia C, Kesse-Guyot E, Méjean C, Ducrot P, Péneau S, et al. Prospective association between a dietary quality index based on a nutrient profiling system and cardiovascular disease risk. *Eur J Prev Cardiol.* 2016;23(15):1669-76.
104. Mytton O, Frouhi N, Scarborough P, Lentjes M, Luben R, Rayner M, et al. Association between intake of less healthy foods defined by the UK's nutrient profile model and cardiovascular disease: A population-based cohort study. *PLoS Med.* 2018;15(1):e1002484.
105. Legislative and Governance Forum on Food Regulation. *Final Communique 27 June 2014.* Canberra (AUST): Australian Government Food Regulation Secretariat; 2014.
106. World Cancer Research Fund International. *Building Momentum: Lessons on Implementing a Robust Front-of-pack Food Label.* London (UK): WCRF; 2019.
107. Magnusson R, Reeve B. Food reformulation, responsive regulation, and "regulatory scaffolding": Strengthening performance of salt reduction programs in Australia and the United Kingdom. *Nutrients.* 2015;7(7):5281-308.
108. World Health Organization. *Safeguarding Against Possible Conflicts of Interest in Nutrition Programmes: Draft Approach for the Prevention and Management of Conflicts of Interest in the Policy Development and Implementation of Nutrition Programmes at Country Level.* Geneva (CHE): WHO; 2017.

Supporting Information

Additional supporting information may be found in the online version of this article:

Supplementary Appendix 1: Search strategy and database.