Effectiveness of numeric energy menu labelling and alternative formats and/or content: a rapid evidence review update.

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Executive Summary

Under an existing program of work funded by the NSW Ministry of Health, the Physical Activity Nutrition Obesity Research Group (PANORG) at the University of Sydney has undertaken an updated rapid evidence review on the effectiveness of NEML and alternative formats and/or content. This work updates a previous review conducted by PANORG in 2016. The findings of the review will support the evidence base for ongoing effective implementation of menu labelling.

Overall summary of evidence

Compared to the rapid evidence review commissioned in 2016, there was a larger number of systematic reviews published as well as studies from real world settings. Overall, findings were mixed, reflecting the diversity of contexts and outcomes in real world settings. However, the updated review found increased evidence for a positive impact of NEML on ‘energy/item selected, ordered, purchased’, and generally positive outcomes in real world settings. The evidence for alternate menu labelling formats and/or content, in population subgroups, and in children, adolescents and/or their parents, was either inconsistent or limited in terms of the number of reviews and individual studies. A number of gaps in the available evidence were identified.

Main findings

The literature review was focussed on five research questions and the main findings in relation to these questions are presented here. A range of outcomes were considered including: consumer awareness of numeric energy labels/daily reference value (DRV), consumer understanding/knowledge, reported use of NEML, energy/item selected, ordered or purchased, energy/item consumed, product reformulation/innovation, overall diet, physical activity and body mass index.

What is the effectiveness (including cost-effectiveness) of menu labelling (numeric energy content +/- DRV)?

What can we learn from studies conducted in real world settings?

- Overall, the evidence from 11 reviews and 21 individual studies was mixed in relation to outcomes most commonly examined, and the evidence was limited for other outcomes.
- Based on available evidence, there was moderate awareness of NEML and modest self-reported use of NEML.
- Effectiveness was most commonly assessed using ‘energy/item selected, ordered, or purchased’; while findings were mixed, half of the reviews and individual studies assessing this outcome reported a positive impact.
- There was limited and inconclusive evidence for the impact of NEML on overall diet and product reformulation/innovation.
- There was also a lack of studies that assessed the effectiveness of NEML with the inclusion of a DRV statement.

Evidence from real world settings for the effectiveness of NEML:

- 6 reviews and 16 individual studies involved real world settings only, and 5 reviews and one individual study included a mix studies from real world and laboratory settings.
- Findings from reviews were mixed across all outcomes, however, relatively more reviews reported positive outcomes.
- Findings from individual studies indicated that NEML had a positive impact across a range of outcomes.
- Most reviews and individual studies conducted in artificial or laboratory settings reported positive effects of NEML on ‘energy/nutrients selected, ordered, or purchased’ or ‘calories ordered/consumed’.
Are there alternative formats for menu labelling with energy alone, which have been shown to be effective (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?

**NEML and addition of traffic light labelling, physical activity calorie equivalent (PACE) labelling, or health start rating:**
- The evidence from five reviews and three laboratory/online studies that assessed alternative formats for menu labelling with energy alone was inconsistent, with some evidence showing alternative formats were effective compared to NEML alone, but there were also mixed findings, and findings indicating no differences between NEML and the addition of alternative label formats.
- The evidence was limited due to quality concerns (expressed by authors of reviews) and the small number of studies.

**NEML compared to PACE menu format:**
- One systematic review and three studies comparing NEML to PACE menu label formats did not find any differences in energy purchased or ordered across the different formats.

Are there menu labelling approaches which have been shown to be effective that have included (a) other nutrients and/or (b) overall healthiness (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?
- The evidence was limited due to a small number of studies identified relating to different menu labelling approaches that have included other nutrients and/or overall healthiness.

How are the above 3 questions (effectiveness, formatting, reformulation) influenced by consumer socioeconomic status and age group?
- The combined evidence from reviews and individual studies was inconclusive.
- There was limited consistent evidence from reviews on the influence of socioeconomic status, age, gender, age, and ethnicity/race on the effectiveness of NEML.
- Individual studies tended to show that suggested that individuals that are educated, female or White are more likely to notice and use menu labelling to inform food choices.
- There were few or no studies that examined the influence of socioeconomic status and other factors on formatting (two studies) or reformulation (no studies).

What does the evidence in children and adolescents show?
- Based on a small number of relevant reviews and studies, this rapid review found mixed and inconclusive evidence in relation to NEML effectiveness in children.

Conclusions and implications
Compared to the previously commissioned review, the updated rapid evidence review provides more evidence from reviews and a greater number of studies conducted in real world settings to support a potential impact of NEML on ‘energy/item selected, ordered, or purchased’. The evidence from real world settings captures the complexity of food choices in the real world compared to simulated/laboratory settings, so these findings are valuable for policy makers. The evidence for the effectiveness of other menu labelling approaches is currently lacking, more research is required before considering changes to current menu labelling formats in Australia. Further investigation is needed to capture the complexity of what affects food choices in the real world.

There is a need for further high-quality research to provide more definite evidence on the effectiveness of NEML and alternate, potentially more visually appealing and easier to understand formats/content, in real world settings, in children, adolescents and/or their parents, and among population subgroups according to socioeconomic status, demographic and other factors such as weight status.
More information is needed about the impact of NEML and alternate formats/content, both in the short and longer term on dietary intake over multiple meals and days and in different types of settings and food outlets, as well as on consumer behaviour related to online ordering platforms.
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1. Background

1.1 Introduction

The increasing prevalence of overweight and obesity requires public health interventions to promote healthier diets at a population level. In Australia and other countries, numeric energy menu labelling was introduced to enable people to make healthier food choices in the outside-of-home environment where food labelling (such as nutrition and ingredient information) is not available.

In 2010, New South Wales (NSW) was the first Australian jurisdiction to introduce kilojoule (kJ) labelling legislation, requiring all major fast food outlets to display kJ information for standard menu items at the point of sale. Evaluation of the NSW legislation showed increased customer understanding of average daily energy intake and a reduction in kJ purchased.

Fast food menu labelling schemes have now been introduced in several Australian states, including the Australian Capital Territory, Victoria, Queensland and South Australia. At the August 2019 meeting of the Ministerial Forum on Food Regulation, Ministers agreed that nationally consistent menu labelling, by developing a food regulatory measure under the Australia New Zealand Food Standards Code, would be desirable for the food industry, public health organisations, and governments.

Worldwide, more countries are implementing mandatory or voluntary menu labelling initiatives. The effectiveness of menu labelling has been examined by several systematic reviews to date, most often including studies in mixed settings, with a majority of studies simulating the restaurant environment or conducted in controlled laboratory environments. The evidence from these reviews has been mixed.

In 2016, NSW Health commissioned a rapid evidence review on the effectiveness of numeric energy menu labelling (NEML) and potential alternative formats and/or content showing mixed findings. As the effectiveness of menu labelling may increase with time due to repeated customer exposure, and with a growing number of studies in real life settings assessing the implementation of menu labelling legislation or regulations, it is important to review the research evidence on an ongoing basis, to support decisions that inform policy development and implementation of menu labelling.

This updated rapid evidence review was undertaken by the Physical Activity Nutrition Obesity Research Group (PANORG). Its findings will support the evidence base for ongoing effective implementation of menu labelling.

1.2 Report format

This report is presented in sections and structured as follows:
Section 2 outlines the aim and research questions addressed;
Section 3 describes the methods used;
Section 4 provides the research questions addressed with relevant evidence synthesised for each;
Section 5 compares how the evidence has changed since the previous rapid evidence review was commissioned in 2016; and
Section 6 summarises the evidence in relation to the research questions and provides a discussion, conclusions and implications.
Appendices include the search strategy, flow diagram, and tables summarising the data in relation to the different research questions and outcomes addressed.
1.3 Abbreviations and glossary

AOR  Adjusted odds ratios.
BA   Before-and-after studies.
BC   British Columbia.
BMI  Body mass index. A measure of weight adjusted for height, calculated as weight (kg) divided by the square of height (m^2).
CBA  Controlled before-and-after studies.
CI   Confidence interval.
CS   Contextual statement. Also referred to as contextual information. When accompanying NEML, this statement provides contextual information about energy.
DRV  Daily reference value. A daily reference value for energy helps put the energy content of menu items into context in comparison to daily energy requirements, and appears in statements such as ‘The average adult daily energy intake is 8700 kJ’.
FFR  Fast food restaurants.
HSR  Health star rating.
IDP  Informed Dining Program.
ITS  Interrupted time series.
kj   Kilojoules. Divide kilojoules by 4.184 to derive calories (4.184 kJ=1 calorie).
Lab  Laboratory.
ML   Menu labelling. Displaying nutrition information on menus or menu boards at point of purchase.
MVPA Moderate-to-vigorous physical activity.
NEML Numeric energy menu labelling. Menu labelling with energy content (kilojoules or calories).
NI   Nutrition information.
NIP  Nutrition Information Panel.
NL   Nutrition label/labelling.
NPS  Nutrient profiling score.
OR   Odds ratio.
PA   Physical activity.
PACE Physical activity calorie equivalent. This type of menu labelling posts the amount of physical activity needed to expand the kilojoules/calories in foods/beverages.
POP  Point-of-purchase.
QE   Quasi-experimental.
RCT  Randomised controlled trial.
Real world Studies in “real world” settings are studies that have been conducted in “real life” as opposed to simulated or laboratory settings. For example, real world studies may relate to implementation of NEML legislation in fast food or sit-down restaurants.
RDI  Recommended dietary intake.
SD   Standard deviation.
SES  Socioeconomic status.
SR  Systematic review.
SSB  Sugar-sweetened beverages.
TLL  Traffic light labelling. Foods/beverages are labelled with symbols that are red, amber, or green to enable consumers to make healthier choices based on the amount of energy and/or selected nutrients.
T2DM  Type 2 diabetes mellitus.
UK  United Kingdom.
US  United States.

**Note:** Abbreviations presented in the glossary may be used in the body of the report, the summary tables (Appendices 3-7) and/or complementary Technical Reports 1 and 2 (provided separately to the report).
2. **Aim**

2.1 **Purpose and audience for the review**

In 2016, the NSW Ministry of Health commissioned a rapid review on the effectiveness of NEML and potential alternative formats and/or content. The purpose of the current rapid evidence review is to provide an overview and update of the evidence since 2016. The findings will support the evidence base for ongoing effective implementation of menu labelling.

2.2 **Research questions to be addressed**

**Question 1:** What is the effectiveness (including cost-effectiveness) of menu labelling (numeric energy content +/- daily reference value [DRV])? What can we learn from studies conducted in real world settings?

**Question 2:** Are there alternative formats for menu labelling with energy alone, which have been shown to be effective (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?

**Question 3:** Are there menu labelling approaches which have been shown to be effective that have included (a) other nutrients and/or (b) overall healthiness (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?

**Question 4:** How are the above 3 questions (effectiveness, formatting, reformulation) influenced by consumer socioeconomic status and age group?

**Question 5:** What does the evidence in children and adolescents show?
3. Methods

A program logic model depicting how kJ menu labelling policy may lead to various outcomes of interest including consumer awareness, understanding and use of numeric energy menu labelling, and lower kJ purchases, an improved overall diet, lower prevalence of overweight and obesity, and ultimately improved overall health is presented in Figure 1 (presented at the end of this section).

3.1 Review type

We used a rapid evidence review to provide an assessment of the evidence related to the research questions outlined in section 2.2. Rapid reviews synthesise research evidence efficiently in a short timeframe to inform policy making. Systematic methods are followed, however these may not delve into the level of detail of traditional systematic reviews, due to a tight timeframe.6

3.2 Search strategy

The electronic databases MEDLINE, SCOPUS and PsycInfo were searched for relevant studies from January 2016 until September 2020, using medical subject headings and keyword search terms. The search strategy was adapted for specific databases. An example of the search strategy used for MEDLINE via Ovid is included in Appendix 1. Google and Google Scholar were searched for grey literature using the following set of search terms: “effect impact kilojoule calorie menu labelling”.

3.3 Outcomes of interest

- Consumer awareness of kJ labels and of DRV
- Improved consumer understanding or knowledge of energy and/or kJ alone and/or in context of DRV
- Reported use of kJ by consumers when making purchase choices
- Energy/nutrient(s)/item selected
- Energy/nutrient(s)/item ordered
- Energy/nutrient(s)/item purchased
- Energy/nutrient(s)/item consumed later in the day/24 hours/overall diet
- Energy/healthy meals sold
- Revenue/transactions per month
- Reformulation – reduced energy content of pre-existing menu items (by item size or nutrient content)
- Product innovation – introduction of (new) lower-energy menu options
- Physical activity
- Weight/body mass index (BMI)

3.4 Inclusion criteria

- Publication details:
  - English language
  - Publications from 2016 onwards
- Study types:
  - Qualitative
  - Cross-sectional
  - Randomised controlled experiments
  - Pre-test/post-test
  - Natural experiments with or without control (quasi-experimental)
Randomised controlled trial (RCT)
Systematic reviews/meta-analyses

- **Settings**
  - Quick service restaurants
  - Sit-down restaurants (including fine dining)
  - Cafeterias (e.g. workplaces, hospitals, universities)
  - Survey
  - Simulated/laboratory

- **Interventions**
  - Menu board labelling (numeric or interpretive) for individual nutrients (including energy +/- DRV) and/or overall healthiness of menu items
  - Printed menu labelling (numeric or interpretive) for individual nutrients (including energy +/- DRV) and/or overall healthiness of menu items

- **Populations (but not restricted to the following):**
  - Adults were our population of interest, however children, adolescents and/or parents were also included
  - Socioeconomic status (SES)
  - Age
  - Gender
  - Ethnicity/race
  - Weight/weight management behaviours

### 3.5 Exclusion criteria

Evidence relating to:

- Restaurant certification schemes
- Labelling on packaged foods (back/side-of packet nutrition information panel, front of pack labelling, nutrient claims) – including consumer preferences for display of particular nutrients on front of pack and misleading claims, or choice labelling experiments where there is no apparent link to menu boards/menus
- Multi-component schemes (e.g. menu labelling combined with increased availability and promotion – including choice architecture; particularly in retail setting) unless impact of menu labelling component specifically measured
- Shelf-labels
- Vending machines
- Non-restaurant retail setting
- Correct understanding of energy by consumers generally (i.e. not in relation to energy menu labelling or contextual guidance)
- Nutrition education and literacy more generally
- Consumer attitudes/preferences (only)
- Consumer intention to use menu labelling (only)
- Ethics of menu labelling

### 3.6 Screening

Two authors (BN, JT) independently screened the abstracts and titles of records identified through the systematic and grey literature searches. Any disagreement or uncertainty as to study eligibility was resolved through discussion. The same authors independently screened the full texts of potentially eligible articles and discussed any disagreement or uncertainty until consensus was reached. A flow chart of studies identified for this review is presented in Appendix 2.
3.7 Data extraction

Three reviewers (BN, JT, CR) shared the data extraction due to time constraints. Key information from each review or study was summarised and tabulated (Technical Reports 1 and 2). Any uncertainty was discussed by all three reviewers and resolved. Data were extracted into two main tables, one comprising only reviews and meta-analyses (Technical Report 1), and another comprising other types of studies (Technical Report 2). Information extracted for systematic reviews included: publication information (first author, year), population/setting/number of studies/country/study design, intervention/outcomes addressed, main findings/conclusions and additional comments. Information extracted for other types of studies included: publication information (first author, year), study aim, study design/setting/characteristics, intervention/description of the study, outcomes addressed/measurement methods, main findings/conclusions, and additional findings/comments. In addition, tables summarising the data in relation to the different research questions and outcomes addressed were created (Appendices 3-7).

Due to the rapid nature of the evidence review, a quality appraisal of included studies was not undertaken. Quality concerns expressed by authors of reviews were noted.

3.8 Differentiation between real world and laboratory/online settings

Studies in real world settings are studies that have been conducted in “real life” as opposed to simulated, hypothetical online or laboratory settings. For example, studies in real world settings may relate to implementation of NEML legislation in fast food or sit-down restaurants, studies involving various types of food outlets (e.g. worksite cafeterias) in real world settings, or studies involving population-based surveys asking about NEML in real-world settings. Laboratory/online settings involve artificial, simulated or hypothetical scenarios. Mixed settings included both real world and laboratory/online settings.
Figure 1. Program logic model.
4. **Review findings**

4.1 **Search results**

The initial search identified 333 papers. A search for grey literature added three additional records. Following removal of duplicates and abstract screening, 291 papers underwent full-text review. Of these, 58 were considered eligible for the rapid evidence review. The PRISMA flow chart is presented in Appendix 2.

4.2 **Study characteristics**

Overall, there were 14 systematic reviews (of which seven included a meta-analysis), one rapid review of systematic reviews, and one overview of systematic reviews (detailed in Technical Report 1). Of these, four focused on adults only, nine also included children/adolescents, and one review related to children, adolescents and/or their parents. Except for four reviews that included studies from the United States (US) only, the remaining reviews included studies from multiple high-income countries. Eleven reviews included studies from mixed settings and three were based on studies conducted in real world settings.

Our searches also retrieved 42 individual studies (detailed in Technical Report 2), including cross-sectional (n=12), quasi-experimental (n=6), between subject designs (n=5), randomised experiments (n=5), natural experiments (n=3), RCTs (n=3), field experiments/experimental (n=4), qualitative (n=2), interrupted time series (n=1), and controlled before-and-after study (n=1). The majority of studies were conducted in the US (n=28), followed by Australia (n=4), Canada (n=4), the United Kingdom (n=3), Brazil (n=1), Spain (n=1), and Denmark (n=1). Most studies were conducted in real world settings (n=24), or in an online/hypothetical/laboratory environment (n=18), and two studies included sub-studies in mixed settings (n=2).

4.3 **Summary of findings**

Findings have been summarised based on research questions addressed and outcomes examined (Appendices 3-7), starting with the outcome most distal to the intervention as per the logic model presented in Figure 1. Several studies reported more than one outcome.

4.3.1 **What is the effectiveness (including cost effectiveness) of menu labelling (numeric energy content +/- DRV)? What can we learn from studies conducted in real world settings?**

Overall, 33 studies (11 reviews, 21 individual studies) examined the effectiveness of NEML in relation to outcomes of interest, with 17 of these studies (9 reviews, 8 individual studies) reporting several outcomes (Appendix 3). Most studies measured effectiveness using ‘energy/item/nutrients purchased, selected, ordered, or sales/revenue data’ (11 reviews, 14 individual studies), and some measured ‘energy/item/nutrient consumption’ (6 reviews), NEML awareness (2 reviews, 6 individual studies), understanding/knowledge (2 reviews, 2 individual studies), use (1 review, 6 individual studies), product reformulation/innovation (4 reviews, 1 individual studies), overall diet (2 individual studies), physical activity (1 individual study), and/or BMI (1 individual study).

**Outcome: BMI/weight**

Only one individual study provided evidence for the effectiveness of NEML on BMI or weight outcomes.$^7$ This cross-sectional study using surveillance data (2004-12) found that mandatory NEML laws implemented...
in chain restaurants in New York jurisdictions resulted in a 1.5% reduction in BMI and a 12% lower risk in obesity. The impact was similar across the BMI distribution, but appeared larger in lower income individuals, particularly lower income minorities. The reduction in weight was estimated to be 1.23 kg (95% confidence interval [CI]: 0.36, 2.10), based on an energy imbalance between intake and expenditure of 45 calories per day for a year.

Outcome: overall diet and physical activity
In the same individual study, mandatory NEML laws did not have a significant impact on the daily consumption of fruit and vegetables, alcohol, or physical activity. However, the surveillance data used to determine dietary behaviours only accounted for approximately 15% of total energy intake. In a second study by the same researcher, using US surveillance data (2002-12), local and state mandatory NEML restaurant laws led to a 1.2% drop in the number of survey respondents reporting drinking alcohol in the past month compared to jurisdictions without NEML laws.

Outcome: menus offered by retailers, product reformulation or innovation
The evidence for the impact of NEML regulation on restaurant menu offerings, product reformulation or innovation is limited due to modest changes or mixed findings being reported, and a small number of studies. A meta-analysis of the efficacy of the mandatory NEML legislation in 2018 in the US examined the effect of calorie disclosure on calories offered by retailers on their menus, revealing a reduction in calories (-15 calories) across menu items. It was unclear if this reduction in calories was a result of product reformulation or innovation, or a change in menu items offered. A 2017 systematic review, also conducted in the US, indicated that healthier restaurant offerings may be related to recent menu labelling regulations. However, findings were inconclusive due to the small number of studies, lack of comparison sites, and heterogeneity between studies. Similarly, another systematic review identified only two US studies that reported mixed findings as to the impact of menu labelling law on restaurants providing healthier offerings. A systematic review investigating the effect of policy interventions targeting the food environment reported modest reformulation changes by regulated chain restaurants in the US. An intervention study at an Australian university food outlet assessing the impact of NEML in young adults found that three out of seven new meals that were introduced were higher energy than their original counterparts.

Outcome: energy/item/nutrient consumption
The evidence provided by six reviews as to the impact of NEML on ‘energy, items, or nutrients consumed’ was mixed and inconclusive. The authors of four of these reviews noted concerns about the poor quality of some studies included in their reviews.

Based on findings from meta-analyses, two reviews reported a reduction in calories consumed: one found a mean reduction of 115 calories (95% CI: 99.5, 130.9) ordered/consumed in laboratory settings, and another found that energy consumed was reduced by 100.2 calories (95% CI: 54.0, 146.6) in a mix of real world and experimental/laboratory settings. However, the findings reported by Littlewood (2016) related to energy menu labelling accompanied by contextual or interpretive guidance in some studies.

Two reviews found mixed or inconclusive findings. One was an overview of systematic reviews aiming to determine the efficacy of population-wide type 2 diabetes mellitus or obesity prevention initiatives at the macroenvironment level, which involved a mix of real world and laboratory studies for menu labelling studies. The other was a systematic review of calorie labelling restaurant interventions that also included both real world and laboratory studies.
Three reviews indicated that there was no effect of NEML on energy/nutrients consumed.\textsuperscript{4,13,16} One of these reviews was based on a meta-analysis of studies conducted in laboratory settings.\textsuperscript{13} Another review included a mix of real world and a majority of laboratory settings.\textsuperscript{16} The third review examined the impact of restaurant menu labelling on calories/nutrients consumed in real world settings.\textsuperscript{4}

Outcome: energy/item/nutrient selected, ordered, purchased or sales/revenue data

The outcome predominantly examined was ‘energy/item/nutrient selected, ordered, purchased or related sales/revenue transaction data’. The evidence from reviews and studies was mixed. However, half of the reviews and individual studies found a positive impact of NEML on this outcome, with the remainder showing mixed findings, or no effect.

Out of the 11 reviews that examined this outcome, five reported a reduction in energy (kilojoules or calories) selected/ordered/purchased,\textsuperscript{3,4,10,13,15} five reported mixed findings,\textsuperscript{5,9,10,14,17} and three reported no effect.\textsuperscript{4,11,16} Reductions in ‘energy/nutrients selected, ordered, or purchased’ were observed in real world settings such as restaurants, fast food outlets, cafés,\textsuperscript{3,13,15} and non-chain food outlets that voluntarily implemented NEML,\textsuperscript{10} as well as in laboratory settings.\textsuperscript{3,4,15} Reviews reporting mixed findings or no effect also involved real world,\textsuperscript{4,5,10,11,17} laboratory settings or a mix of these.\textsuperscript{9,14,16} One meta-analysis suggested that reductions may be more effective in sit-down restaurants, artificial settings, and for lunch meals.\textsuperscript{3} A systematic review reported that while diverse menu labelling formats including NEML were effective in both cafeteria and restaurant settings, they appeared to be more effective in cafeterias.\textsuperscript{4} No differences by study design were reported in the meta-analysis.\textsuperscript{3}

Out of the 14 individual studies that assessed this outcome, half reported a reduction in energy selected/ordered/purchased,\textsuperscript{12,18-23} four found mixed findings,\textsuperscript{24-27} two no changes,\textsuperscript{28,29} and in one qualitative study that involved focus groups, young Australian adults suggested that NEML could help make lower energy choices.\textsuperscript{30} The seven studies reporting positive effects of NEML included quasi-experimental studies,\textsuperscript{19,20,23} field, experimental and laboratory studies,\textsuperscript{12,18,21} and a natural experiment.\textsuperscript{22} More than half of these studies were conducted in real world settings,\textsuperscript{12,19,20,22} and some were a mix real world and laboratory studies,\textsuperscript{18} or conducted in lab/simulated/hypothetical settings.\textsuperscript{21,23} A Canadian quasi-experimental study found that a mandatory NEML policy had greater effectiveness on calories ordered than a voluntary policy where customers had to request nutrition information, or no policy.\textsuperscript{20} In terms of findings in the longer term, one quasi-experimental longitudinal study found that the reduction in calories purchased in large fast food chains following NEML implementation diminished over a one-year follow-up.\textsuperscript{19} A natural experiment evaluating the long-term effect of voluntary NEML in McDonald restaurants, showed that adult purchases had fewer calories over time.\textsuperscript{29}

Among individual studies reporting mixed findings, healthier sides and beverages but not entrées were selected in fast food restaurants by NEML users in one cross-sectional study;\textsuperscript{24} NEML increased the likelihood of lower energy food selection in participants with high but not low self-control in an online study,\textsuperscript{25} less calories were ordered when linear pricing (price per unit is consistent across different portion sizes) was used in another online study, however, no effect was seen with non-linear pricing (price per unit is lower for larger portion sizes);\textsuperscript{26} and NEML decreased the probability of selecting higher energy meals in a questionnaire but did not influence actual purchase behaviour in a field experiment.\textsuperscript{27}

In one of the two individual studies that did not find any effect, one study was a stepped wedged RCT in a cafeteria that assessed menu labelling in multiple formats, however, the effects of NEML alone could not
be assessed.\textsuperscript{28} The other study was a natural experiment examining McDonald’s restaurants with and without NEML.\textsuperscript{29}

**Outcome: NEML use**

While findings from one review and six individual studies were varied, most of the evidence in real world settings points towards modest use of NEML in real world settings. One review found that the proportion of consumers reporting NEML use in chain restaurants was much below the proportion aware of the NEML present.\textsuperscript{11} A study in a university food outlet also showed that a small proportion of students noticing NEML were using it.\textsuperscript{12} Findings from other studies included: a small share of customers both noticing and using NEML information in fast food restaurants;\textsuperscript{29} a greater likelihood for patrons of restaurants with NEML to use the information than participants having to request the information;\textsuperscript{31} an increase in NEML usage over time in a nationally representative sample (from 8\% to 18\% in fast food restaurants, and 8\% to 14\% in sit-down restaurants between 2007 and 2013);\textsuperscript{32} and based on surveys, >50\% reporting noticing NEML also reported using this information.\textsuperscript{33,34}

**Outcome: NEML knowledge/understanding**

Findings from two systematic reviews in real world settings and two individual studies examining the impact of NEML were mixed. In one review, there was an increase in knowledge of the energy content of fast food menu items in two out of nine studies.\textsuperscript{10} In the other review, evidence was limited to one study in which consumers were able to estimate calories in purchased items, however estimation understanding of recommended dietary intake did not improve post-NEM implementation.\textsuperscript{11}

A few months after NEML legislation in one Canadian province, most participants in this province and those in control provinces incorrectly estimated calories of a popular fast food item.\textsuperscript{35} In an Australian natural field experiment stemming from differences in menu labelling laws across different states, the caloric content of meals were better estimated by consumers of quick casual restaurant chains with NEML than by consumers of restaurants without NEML, and with more frequent visits to restaurants with NEML.\textsuperscript{22}

**Outcome: NEML awareness**

Overall, awareness of NEML across study designs appeared to be moderate. Two systematic reviews in real world settings assessed awareness of NEML, with one review finding increased awareness of the energy content of fast food menu items in two out of nine studies,\textsuperscript{10} and the other review describing awareness levels that ranged between 38\% and 76\% depending on the study.\textsuperscript{11}

Out of the six individual studies assessing this outcome, five were conducted in real world settings. One natural experiment in the US showed that a small percentage of customers of a popular fast food restaurant noticed NEML.\textsuperscript{29} In a Canadian quasi-experimental design, customer awareness of energy information was greater in restaurants with NEML than in restaurants where nutrition information had to be requested.\textsuperscript{31} In another natural experiment using population representative data from the US, NEML awareness increased over time in restaurants, from 20\% to 42\% in fast food restaurants and from 16\% to 32\% in sit-down restaurants.\textsuperscript{32} A quasi-experimental study found greater awareness in a Canadian province with mandatory NEML compared to other provinces with a voluntary policy or no policy.\textsuperscript{20} In an Australian study in a university food outlet, 30\% of respondents to an intercept survey were aware of NEML.\textsuperscript{12} In a population-based survey conducted in the US, 53\% of participants reported noticing energy information when buying a meal or a snack in restaurants.\textsuperscript{33}
**NEML and inclusion of a DRV statement**

Only one review and one individual study specifically compared the effectiveness of NEML when a DRV statement was added. The systematic review considered several studies where NEML and a DRV statement was used. However, findings were not consistent and the effects of adding DRV could only be isolated from one study, in which a higher reduction in energy selected was seen in the NEML plus DRV condition compared to NEML only. In an experimental study at a large US university campus, adding a DRV compared to NEML only did not have any impact on the intention of university student to select lower calorie foods.

**What can we learn from studies conducted in real world and other settings?**

Studies examining the effectiveness of NEML were mainly conducted in real world settings (6 reviews, 16 individual studies). Remaining studies included a laboratory/online/simulated environment (2 reviews, 4 individual studies), or involved a mix of real world and laboratory/online/simulated settings (5 reviews, 1 individual study).

In the reviews examining studies conducted in real world settings only, findings were varied for different outcomes, ranging from positive, mixed to no effect. For example, reductions in ‘energy/nutrients selected, ordered, or purchased were reported’. There was less evidence for an impact of NEML on healthier offerings made by retailers due to mixed findings, beverage calories per transaction and total sales, food choices, food purchases, and understanding/knowledge. Some reviews did not find any effect of NEML on energy ordered/consumed or on purchasing behaviour.

Most reviews conducted in a laboratory/artificial environment showed positive effects of NEML in terms of reductions in calories ordered/consumed and reductions in ‘energy/nutrients selected, ordered, or purchased’. One review found no effect on energy consumed.

Due to mixed findings or no effect shown in reviews including studies from real world and laboratory/online settings, the evidence from these reviews does not support positive impact on these outcomes: calories ordered/purchased, calories consumed, product reformulation, or no effect for calories purchased or consumed.

Individuals studies conducted in real world settings mostly reported a positive impact of NEML such as: reduction in BMI/obesity, reduction in alcohol intake, higher awareness and use compared to no NEML, higher awareness and use over time, greater influence of a mandatory compared to a voluntary NEML policy on awareness and use, and reduction in calories ordered. A smaller number of studies found mixed findings, or no effect or changes in calories purchased or on lifestyle behaviours.

For individual studies conducted in laboratory/online settings, most showed positive effects such as: reasonable awareness and/or use of NEML, better estimation of meal caloric content, high intention to select lower energy meals, lower selection of higher energy meals, and reduction in calories ordered. Two studies reported mixed findings while another study did not find a difference in caloric estimation of a popular fast food item between a province with mandatory NEML and a control province.
4.3.2 Are there alternative formats for menu labelling with energy alone, which have been shown to be effective (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?

Relevant data from reviews and individual studies related to this research question are summarised in Appendix 4.

NEML and addition of traffic light labelling (TLL), physical activity calorie equivalent (PACE) labelling, or health star rating (HSR)

The evidence provided by five reviews and three laboratory/online studies that assessed alternative formats for menu labelling with energy alone is mixed. A rapid review of systematic reviews indicates that contextual or interpretive guidance may increase the effectiveness of NEML. The evidence from remaining reviews and studies is limited mostly due to the small number of studies.

Three reviews were based on a small number of studies, and authors of one review expressed the need for higher quality studies. While three reviews encompassed adult and child populations, findings reported here were only based on included studies conducted in adults, or a majority of adult studies.

One review, focussing on real world settings only, examined the impact of menu labelling (NEML alone and NEML plus TLL), compared to no menu labelling. This review found a reduction of 47 calories in energy purchased, although this was based on a meta-analysis of three RCTs in adults and the separate effects of both menu conditions could not be assessed. The authors deemed the three RCTs to be of poor quality.

The other four reviews included studies from real world and lab/experimental settings. One of these reviews revealed a reduction in energy ordered/consumed of 67 calories with contextual labels (TLL, PACE or DRV) compared to NEML alone, based on three studies in college students. A systematic review of reviews also reported a reduction in energy consumed based on three systematic reviews including 36 primary studies; the findings from a systematic review conducted in adults were similar to those of the other reviews involving adults and children. For the two other reviews, the evidence was mixed in relation to the addition of TLL or PACE for calories purchased and consumed.

Amongst other studies in laboratory/online settings, a randomised repeated measures crossover design revealed lower calorie fast food selections when either TLL or PACE were added to NEML, compared to NEML alone. Higher attention was also given to visual menu formats, in particular PACE, compared to NEML alone. However, there was no difference between menu formats for beverages. In an online study in which university students were randomised to either NEML, NEML plus PACE, or no menu labelling conditions, there were no differences between conditions as to total calories ordered overall, or in the burger, salad, or dessert categories. Participants in the NEML condition ordered sides with more calories than other conditions. The addition of HSR to NEML, compared to NEML or HSR or no menu labelling, on fast food restaurant menus in a between-subject online study did not change the mean caloric content of meals selected. Participants in the NEML plus HSR condition did select healthier meals than those in other menu conditions based on nutrient profiling scores.

NEML compared to PACE menu format

One systematic review and four individual studies compared NEML to the PACE menu labelling. All quantitative studies consistently showed that there was no difference between both types of labelling for the various outcomes examined. In the systematic review and meta-analysis comprising studies from mixed settings, no difference in calories ordered was observed between NEML and PACE, or by type of settings.
An interrupted time series cohort study in three worksite cafeterias did not find significant differences in either self-reported or objectively measured physical activity between participants exposed to NEML or PACE labels.\textsuperscript{41} Similarly, while both NEML and PACE menu labelling led to reductions of about 40 calories purchased at lunch time, there were no differences between both conditions in a quasi-experimental study in worksite cafeterias.\textsuperscript{42} One randomised experiment in laboratory settings comparing NEML plus DRV and PACE menu formats, did not report any differences in calories ordered overall or from specific foods, nor in macronutrient intake in Hispanic participants.\textsuperscript{43} In an Australian qualitative study, young adults involved in focus groups suggested that posting PACE could help enable healthier choices and could be easier to understand than NEML.\textsuperscript{30}

4.3.3 Are there menu labelling approaches which have been shown to be effective that have included (a) other nutrients and/or (b) overall healthiness (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?

This research question more specifically relates to outcomes that decrease intake of particular nutrients or that improve overall healthiness of food choices, rather than decreasing the energy content of foods. Two studies examined sodium labelling approaches in laboratory/online settings, however the evidence was limited due to the small number of studies. Six studies, predominantly in real world settings, focused on various menu labelling approaches aiming to improve overall healthiness. As these studies explored different menu labelling approaches, the evidence presented for individual approaches is not conclusive. (Appendix 5).

Individual nutrients: sodium

One study assessed menu labelling with sodium in addition to NEML in laboratory/online settings.\textsuperscript{44} This online study compared customer food choices from a casual dining restaurant menu when participants were randomised to four different menu labelling formats: no nutrition information, NEML only, NEML plus numeric sodium content, NEML plus a warning symbol for sodium greater than 2,300 mg. The addition of numeric sodium content to NEML was associated with selection of meals lower in sodium content than meals from the NEML only or no nutrition information menu. This was only observed for participants who believed that lower sodium, lower calorie, healthier foods are tastier. Participants with the opposite taste belief ordered meals with higher sodium content. The NEML plus warning symbol for high sodium content did not change the sodium content of meals selected compared to other conditions, regardless of taste belief.\textsuperscript{44}

Another online study examined the impact of different sodium labelling formats on restaurant menus including: no labelling, numeric sodium menu labelling, sodium icons, and sodium TLL.\textsuperscript{45} Reductions of about 3-5% in average sodium ordered was reported for all menu labelling formats in three experiments, but these were not significant. In a well powered experiment within that study, traffic light and stop sign warning labels compared to controls helped to decrease sodium ordered. Warning labels helped to increase sodium content knowledge and health risk perceptions.

Overall healthiness

One systematic review and five individual studies were conducted in real world settings. While the menu/nutrition labelling approaches employed were varied, all studies found positive outcomes suggesting that approaches about overall healthiness of foods may be promising. A systematic review found that qualitative menu labelling, such as healthy symbols or TLL, promoted healthier choices than quantitative labelling in cafeterias (e.g. NEML, nutrient content).\textsuperscript{5} In two cross-sectional studies, nutrition labels were
placed on sneeze guards or near food items in university dining halls.\textsuperscript{46,47} The labels described the dish title, serving size, calories, grams of fat, carbohydrates, and protein. In one study, half of participants were aware of labels and one fifth used these. Findings did not change over time or based on placement.\textsuperscript{46} In the other study, label users compared to non-label users made healthier choices, more qualitative in nature (types of foods selected) than quantitative (amount of food).\textsuperscript{47} In another study in a self-service restaurant in Brazil, >50% of participants chose healthier choices after reading dish nameplates with TLL for energy and sodium content, portion size information, and an ingredients list.\textsuperscript{48} In a field experiment in a cafeteria, graphical signposting improved the nutrient content of purchases and reduced total calories ordered compared to a nutrition information panel and no nutrition label.\textsuperscript{49} The nutrition graph depicted values of fibre and protein per calorie in a two dimensional plot alongside a target box of dietary recommendations for these nutrients. Finally, in the only online study simulating a canteen environment, TLL with either caloric content or carbon emission led to lower caloric and lower carbon emission meals chosen.\textsuperscript{50}

\textbf{4.3.4 How are the above 3 questions (effectiveness, formatting, reformulation) influenced by consumer socioeconomic status and age group?}

Overall, 26 studies investigated whether the effectiveness of menu labelling is influenced by SES, demographic factors and/or other factors (Appendix 6). The majority of studies were conducted in real world settings, while the remaining studies were in either mixed or laboratory settings. Studies included eight reviews (two in the real world, six in mixed settings), nine experimental studies (five in the real world, four laboratory), and nine observational, cross-sectional, or secondary data analyses in real world settings. The combined evidence from reviews and individual studies provided inconclusive evidence as to the influence of SES and other factors on NEML effectiveness.

\textbf{Socioeconomic status}

The majority of studies (one overview of systematic reviews, 5 reviews, 13 individual studies) examined SES, income and/or education level, with most individual studies showing positive effects of NEML with higher levels of education and income. The evidence from reviews including mostly low-moderate quality studies (as reported by authors of these reviews) suggested that there was no differential effect by SES, or was mixed.

Nine individual studies reported differential effects by SES/income/education level. Three studies showed a positive effect of a higher income on menu labelling awareness and/or use,\textsuperscript{32,34} and reduction of calories over a one-year follow up.\textsuperscript{19} Four studies reported positive findings in lower income individuals: an interrupted time series study found that strength training increase was higher in low income participants exposed to NEML in worksite cafeterias;\textsuperscript{41} secondary analyses of the impact of mandatory NEML on body weight was greater in low income individuals;\textsuperscript{7} and individuals with higher food insecurity were more likely to notice and use menu labelling.\textsuperscript{20} Five studies showed a positive effect of higher education on menu labelling awareness and/or use,\textsuperscript{32-34,51} and choosing healthier options.\textsuperscript{52}

One overview of systematic reviews, two reviews, and four individual studies did not find NEML effectiveness to be influenced by SES. An overview of systematic reviews in mixed settings,\textsuperscript{14} two systematic reviews in mixed and real world settings did not observe any differences by SES\textsuperscript{10,15} as well as a quasi-experimental study which found no effect on NEML awareness and use.\textsuperscript{31} One RCT in simulated online settings\textsuperscript{53} and a cross-sectional survey\textsuperscript{52} did not find any differences of effects by education level on energy ordered\textsuperscript{53} or healthier food selections in males.\textsuperscript{52} Three systematic reviews,\textsuperscript{11,54,55} one of which was in children and adolescents,\textsuperscript{54} and one cross-sectional survey,\textsuperscript{27} reported mixed or inconsistent findings in relation to NEML use,\textsuperscript{11,55} food choices,\textsuperscript{54} and actual purchases.\textsuperscript{55}
Age
The influence of age on the effectiveness of NEML was assessed in 10 studies, of which three were systematic reviews.\textsuperscript{10,15,40} The evidence was mixed, with more studies not finding differential effects by age:

- Two reviews,\textsuperscript{10,15,40} one RCT,\textsuperscript{43} and four other studies found no effect of age\textsuperscript{21,49,52} on various outcomes of interest,\textsuperscript{10} energy/meal selected or purchased,\textsuperscript{15,27} the lack of differences between NEML plus DRV and PACE on calories ordered,\textsuperscript{43} and the lack of impact of PACE on calories ordered.\textsuperscript{40}
- A natural experiment and a population-based cross-sectional survey showed positive effects of younger age on NEML awareness and/or use.\textsuperscript{32,34}

Other factors: gender, ethnicity/race, weight/weight management behaviours

Gender
Differential effects by gender were examined in 17 studies (5 reviews, 12 individual studies), with more than half showing favourable effects in women. However, either no effect or mixed findings were reported in the reviews.

- Ten individual studies demonstrated positive effects in women, compared to men, for menu labelling awareness,\textsuperscript{46} use,\textsuperscript{20,21,33,51} and healthier/calorie selections.\textsuperscript{3,27,52}
- Men were more influenced/impacted by mandatory menu labelling laws for alcohol intake compared to men in jurisdictions without these laws.\textsuperscript{8}
- Two reviews and one randomised study found no effect of gender on total calories selected/ordered,\textsuperscript{10,43} and no gender differences in the lack of impact of PACE on calories ordered.\textsuperscript{40}
- Three reviews reported mixed or inconsistent findings on menu labelling awareness\textsuperscript{15,54} and use among men and women.\textsuperscript{11}

Ethnicity/race
The effectiveness of menu labelling in relation to ethnicity/race was reported in 10 studies, of which three were reviews.\textsuperscript{10,11,15} Most studies described a significant effect of ethnicity, with more positive outcomes described in Whites compared to other ethnicities:

- One systematic review and five individual studies showed a significant effect of ethnicity:
  - Whites compared to other minorities were more likely to notice NEML\textsuperscript{10,20,33,51} use it,\textsuperscript{34} and to be less affected than minorities by menu labelling laws on alcohol intake.\textsuperscript{8}
  - One natural experiment found that NEML use was more likely in non-Hispanic Blacks and Hispanics than non-Hispanic Whites.\textsuperscript{32}
- Two systematic reviews and a population-based cross-sectional survey found no effect on NEML awareness or use,\textsuperscript{15,33} and energy selected/ordered/purchased.\textsuperscript{10}
- One systematic review did not find consistent findings for menu labelling use.\textsuperscript{11}

Weight/weight management behaviours
The evidence for an influence of BMI on NEML effectiveness is mixed, however with more studies showing that it has no effect. Only two individual studies examined weight management behaviours, showing greater use of menu labelling.

- Findings from two systematic reviews, two RCTs, and two other individual studies were mixed for the influence of BMI:
  - One systematic review\textsuperscript{15} and two RCTs\textsuperscript{21,43} found no influence of BMI on menu labelling use,\textsuperscript{15} purchase intentions,\textsuperscript{21} or total calories ordered.\textsuperscript{43}
  - Findings were not consistent in one systematic review undertaken in children, adolescents and/or their parents.\textsuperscript{54}
  - A natural experiment found that individuals with a higher BMI were more likely to notice and use NEML in fast food and sit-down restaurants.\textsuperscript{32}
Awareness and use of nutrition labels in university dining halls were related to being overweight/obese and previous nutrition classes were predictors of awareness and/or use.46

Two cross-sectional surveys, one predominantly in a female sample, found that menu labelling use/considerations was associated with dieting/dieters.33,56

4.3.5 Children, adolescents, parents

Eight reviews and five individual studies involved children, adolescents and/or their parents (Appendix 7). Seven systematic reviews included a mix of studies conducted in adult and/or children populations,3,9,10,13,16,17,55 mostly with very few papers included in children, adolescents and/or their parents, and some included studies overlapping between reviews. One systematic review focused only on children, adolescents and/or their parents.54 Three reviews were in real world settings,13,17,55 and the remaining five included mixed settings.3,9,10,16,54

Except for one laboratory study,57 four studies were conducted in real world settings,29,58-60 with one study being qualitative.60

Effectiveness of NEML

Based on the few papers related to children, adolescents and/or their parents from the systematic reviews including a mix of adults and children populations, and systematic reviews involving children, adolescents and/or their parents only, the evidence was mixed:

- In a systematic review identifying 11 studies in children, adolescents and/or their parents, NEML appeared to be effective in influencing children, adolescents and/or their parents in ordering less calories in artificial settings. The evidence was unclear for the effectiveness of NEML and NEML legislation in real world settings.54
- Effect of NEML legislation:
  - Reduction in calories ordered and calories offered by food outlet retailers, with no significant effect by age;3
  - Increased awareness but no effect on calories purchased in adolescents from low income neighbourhood in one study61 included in one systematic review;55
- Mixed findings for beverage calories per transaction and total sales/revenue,17 and energy selected/ordered;9
- No effect of menu labelling on calories ordered/consumed.16

Findings were also mixed based on individual studies:

- A natural experiment assessing the impact of NEML on McDonald restaurant menus reported:
  - An increased probability of adolescents noticing NEML in intervention compared with control restaurants;
  - No effect on calories purchased in adolescents or children; however, over time there were less calories in purchases for children in both intervention and control restaurants.29
- A quasi-experimental study in school children 8-11 years of age did not find any effect of NEML on energy purchased.59
- A qualitative study involving focus groups with high-school students found that students were knowledgeable about NEML, but few were aware of NEML and few used the information. If NEML was to be used, then adolescents suggested adding the DRV statement.60
NEML and inclusion of contextual/interpretive guidance

There was a lack of studies in children, adolescents and/or their parents investigating this research question.

- One systematic review found unclear evidence as to the effectiveness of including contextual or interpretive guidance in addition to NEML, with four included studies not finding any difference in total calories/fat ordered between NEML and NEML plus contextual/interpretive guidance.54
- In a qualitative study among adolescents of high school age, participants suggested the addition of PA labels or other simpler forms of labelling that used bolder eye-catching colours.60

Menu labelling approaches that have included other nutrients and/or overall healthiness

The evidence is limited by the number of studies that have examined different approaches:

- Energy and fat labelling compared to no nutrition labelling on children’s menus in a restaurant at a country club did not have an effect on total energy and fat purchased by families. However, in the Nutrition Price Bargain (nutritional value in dollars) menu fewer unhealthy combinational calories and more healthy à la carte calories were purchased relative to the baseline menu. These findings were based on one interrupted time series study62 included in two systematic reviews.9,13
- In one randomised experiment in children63 included in a systematic review,9 a healthy heart symbol next to healthier items on a McDonald’s menu led to less calories ordered, while menu labelling with energy and fat content had no effect.
- An online experimental auction where parents randomised to different menu conditions had to bid on four McDonald’s happy meals showed that parents in the NEML plus a daily reference contextual statement plus sodium information condition made lower bids than parents in the no nutrition information condition, suggesting that menu posting with both calories and sodium may help lower parents’ demand of less healthy foods.57 More parents in menu conditions where numeric energy and/or sodium were present were able to correctly estimate the highest energy/sodium meal.
- During a phased intervention of TLL and cartoon labelling with washout periods (time between interventions) in a children hospital café, less unhealthy purchases were made during the TLL phase, whereas cartoon labelling of healthier items was associated with more unhealthy purchases.58

5. How has the evidence changed between the rapid evidence review commissioned in 2016 and the updated review?

The rapid evidence review commissioned in 2016 and this updated rapid evidence review share the following similarities:

- The predominant measure of effectiveness was ‘energy/item selected, ordered or purchased’;
- There was mixed evidence for the effectiveness of NEML on ‘energy/item selected, ordered, or purchased’;
- The research literature lacks evidence about the impact of NEML on overall diet;
- There was no consistent evidence for differential effects of NEML by population subgroup (e.g. SES, age);
- Studies included in reviews were heterogeneous;
- There are limitations on the generalisability of studies conducted in simulated conditions.

The findings of the updated review are different from the previous review in the following ways:

- The evidence for the effectiveness of NEML on ‘energy/item selected, ordered, or purchased’ was based on a greater number of systematic reviews;
• Despite mixed findings, there was greater support from reviews and individual studies for a positive impact of NEML on ‘energy/item selected, ordered, purchased or sales/revenue data’;
• While the evidence from reviews in real world settings was mixed, more reviews reported positive outcomes; this finding was also supported by individual studies that mostly reported a positive effect of NEML;
• In contrast to the 2016 rapid evidence review, reviews relating to alternative formats to NEML alone were identified by our searches and these reviews included studies conducted in real world settings (in the 2016 rapid evidence review, only field and laboratory studies were found);
• There were an insufficient number of studies, compared to the previous review, in relation to the third research question;
• Through the search strategy, the updated review attempted to capture evidence on newer, online modes of ordering and consuming food; however, there were no studies identified that examined these online modes;
• Finally, the updated review specifically assessed the evidence relating children, adolescents and/or their parents.

It should be noted that there was a slight overlap in studies between both rapid evidence reviews, with some later papers arising from the same study.\textsuperscript{7,15,49}

6. Discussion

6.1 Addressing the research questions (overall summary of evidence)

Overall, we found a large number of relevant systematic reviews and a range of other studies that have been published since 2016, to include in this updated rapid evidence review. The majority of the evidence gathered addressed the research question about NEML effectiveness, particularly in relation to ‘energy selected, ordered, or purchased’. For other research questions, and in children, adolescents and/or their parents, the evidence was more limited in terms of the number of reviews and other studies addressing these.

Findings are presented separately for reviews and individual studies, with more weight given to higher quality evidence from systematic reviews and meta-analysis, and evidence supported by a larger number of reviews and/or individual studies. However, findings should be interpreted with caution due to methodological and quality concerns raised in certain reviews and individual studies, and the heterogeneity of studies.

6.1.1 What is the effectiveness (including cost effectiveness) of menu labelling (numeric energy content +/- DRV)? What can we learn from studies conducted in real world settings?

Interest in the effectiveness of menu labelling appears to be increasing among researchers with a substantial increase in studies published since the previous 2016 review. The focus of outcomes measured continues to be on ‘energy/item selected, ordered or purchased’ and the number of systematic reviews has increased. The body of evidence is now largely supportive of a positive impact of NEM on this outcome, but it is important to keep in mind that some studies and reviews published since 2016 still provide findings that are not consistent with this overall trend. The evidence for the impact on nutrients consumed was less conclusive despite six reviews measuring this outcome. Very few studies examined the impact of adding a DRV statement to NEM with conflicting findings within the one systematic review and individual study identified.
Studies reported that the proportion of those exposed to NEML that are aware of it ranges from 20% to 76% indicating that many different factors may be at play. Over time, awareness of NEML often increased but the evidence indicates that awareness is often around 50% or less indicating room for improvement.

Only three studies have investigated the effectiveness of NEML on weight/BMI (one), or overall diet (two) so while impact on weight appeared to be positive conclusions cannot be drawn from these limited findings. The studies of impact on diet were US population-based policy impact studies by the same author and more such studies would provide better information on impact of NEML policies.

Overall, studies that investigated mandatory policies indicated that such policies tend to be effective across a range of outcomes.

There were limited studies investigating the effectiveness of NEML on energy (kilojoules/calories) offered or product reformulation. There was also little consistency in the findings with some showing modest reductions in calories and others no change or even an increase in caloric content of meals offered.

NEML might be expected to have an impact on consumers’ knowledge of the energy content of food offered or purchased but the findings from the limited number of studies completed to date, many in fast food environments, indicate that this does not occur consistently. Clearly more evidence is needed. It also appears that the impact of NEML may vary depending on the type of food outlet, with some indications that they may have more impact in cafeterias and sit-down restaurants.

No studies were found on the impact of NEML on online food delivery/ordering or on cost-effectiveness of NEML.

Most studies that explored the impact of NEML were conducted in real world settings. Despite mixed findings across all the outcomes examined in this review, there was a tendency for real world studies of the impact on ‘energy/nutrients selected, ordered or purchased’ to have positive findings. Studies of NEML in laboratory/simulated/online settings also tended to show a positive impact on many of the outcomes examined.

Despite the need for more studies for particular outcomes, NEML appears to be effective in influencing some changes in consumer behaviour but it is unclear whether overall consumer knowledge is improved. Whether there are also associated changes in energy content of foods offered or weight status is unclear from the existing evidence. Awareness of the menu labelling, and a decision to use the information, appear to be important for behaviour change but awareness levels were generally found to be moderate. Some studies suggested that education campaigns or programs may be needed to increase the understanding and use of NEML.

6.1.2 Are there alternative formats for menu labelling with energy alone, which have been shown to be effective (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?

There is currently no strong evidence that alternative formats for NEML, including TLL, PACE, HSR and DRV are effective in changing consumer behaviour. Findings from a rapid review of systematic reviews indicates that adding contextual or interpretive guidance such as TLL and PACE may improve the effectiveness of NEML on energy content of food ordered.
6.1.3 Are there menu labelling approaches which have been shown to be effective that have included (a) other nutrients and/or (b) overall healthiness (and which also support the policy objective of providing consistent, standardised and clear nutrition information)?

The evidence from a small number of studies and for individual approaches was not conclusive. Findings from two individual studies that tested the addition of information about sodium content to NEML found this tended to reduce the sodium content of food ordered but this strategy may be more salient for those with positive attitudes to sodium reduction.

The review identified several studies that used a variety of different menu labelling approaches indicating healthiness of the food available with the findings generally indicating they were effective in influencing consumers to choose foods with reduced calories or better nutrient content. One systematic review covering 38 studies concluded that qualitative menu labelling (healthy symbols, TLL) was more effective than quantitative NEML and another individual study supported this finding but clearly more evidence to confirm this is needed. As is the case for NEML, awareness and self-reported use of the menu labelling appears to predict changes in consumer behaviour.

6.1.4 How are the above 3 questions (effectiveness, formatting, reformulation) influenced by consumer socioeconomic status and age group?

A large number of studies examined differences in effectiveness of NEML by SES, age or other sociodemographic indicators and most of these were conducted in real world settings. Across six reviews and 13 other individual studies, findings for SES differences were not consistent with some studies finding better impacts for high SES groups, others no difference between SES groups, and some finding better impacts for low SES groups.

On balance, reviews and studies investigating differences in impact of NEML by age for various outcomes found no significant differences. While the majority of individual studies examining differences by gender found a more positive impact for women for several outcomes, the five reviews reported inconsistent findings for the effect of gender on calories selected/ordered or awareness and reported use of menu labelling. Across three reviews and seven individual studies, findings sometimes demonstrated no effect or an inconsistent effect of ethnicity on several outcomes, but others tended to show that Whites were more likely to be aware of and use NEML.

The majority of reviews and studies identified found no influence of BMI on consumer selection and purchasing behaviours. Awareness and reported use of NEML may however be higher in individuals with higher BMI or engaging in dieting, but the evidence is limited.

6.1.5 Children, adolescents, parents

Several reviews and individual studies involved children, adolescents or their parents but fewer studies examined children or adolescents alone. Overall, the evidence from eight reviews and five individual studies, most of which were in real world settings, was found to be either mixed or insufficient depending on the research question addressed. There is no clear evidence on the value of using additional contextual or interpretative guidance around NEML for children and adolescents or their parents. There is some limited evidence that other menu labelling approaches may positively impact children’s or parents’ food choices.
**Need for further evidence**

The updated rapid evidence review highlights a need for further high-quality studies investigating:

- The effectiveness of NEML and alternate, potentially more visually appealing and easier to understand formats/content, in real world settings;
- The effectiveness of NEML and alternate formats/content for children, adolescents and/or their parents;
- The effectiveness of NEML and alternate formats/content in population subgroups relating to SES, demographic and other factors;
- The impact of NEML and alternate formats/content on dietary intake over multiple meals and days;
- The impact of NEML and alternate formats/content by settings and food outlets;
- The effectiveness of NEML on online ordering platforms;
- The long-term effectiveness of NEML and alternate formats/content.

**Conclusions and implications**

Compared to the previously commissioned review, the updated rapid evidence review provides more evidence from reviews and a greater number of studies conducted in real world settings to support a potential impact of NEML on ‘energy/item selected, ordered, or purchased’. The evidence from real world settings captures the complexity of food choices in the real world compared to simulated/laboratory settings, so these findings are valuable for policy makers. Nevertheless, this complexity also contributes to inconsistency in study findings so more studies are needed to clarify effectiveness of NEML in particular contexts and for a variety of outcomes, and to identify what other factors are affecting food choices.

On balance, the evidence from this review indicates that NEML is effective in influencing consumer selection, ordering or purchasing, while the evidence for the effectiveness of other menu labelling approaches is currently lacking. While the addition of other menu labelling options to NEML shows promise for increasing effectiveness, more studies are needed.

Of concern, is the lack of consistent evidence for awareness and self-reported use of NEML as this is critical for ensuring impact on purchasing behaviour. There appears to be little research addressing how awareness could be increased, including through education campaigns. Similarly, the evidence for the impact of NEML on overall diet or weight is limited or inconsistent so no firm conclusions can be drawn.

It will be important to conduct further research on the impact of NEML on different sociodemographic groups, including those addressing weight issues, but there is no clear evidence of concerning trends for different SES groups in the current literature. The impact of NEML and other menu labelling options on food choices in all age groups, and especially among children and adolescents, needs further investigation.
References


30. Allman-Farinelli M, Rahman H, Nour M, Wellard-Cole L, Watson WL. The role of supportive food environments to enable healthier choices when eating meals prepared outside the home: findings from focus groups of 18 to 30-year-olds. Nutrients. 2019;11(9):13.


56. Courtney AL, PeConga EK, Wagner DD, Rapuano KM. Calorie information and dieting status modulate reward and control activation during the evaluation of food images. PLoS ONE. 2018;13(11).


Appendices

Appendix 1: Search Statement (Medline via Ovid)

1. Fast foods/ OR Fast food*.mp
2. Quick service.mp
3. Restaurants/ OR Restaurant*.mp
4. Cafe*.mp
5. Cafeteria*.mp
6. Canteen*.mp
7. Food court*.mp
8. Food service*.mp
9. Food outlet*.mp
10. ((Food OR eating) adj2 establishment*).mp
11. Point of purchase*.mp OR point-of-purchase*.mp OR point of selection.mp OR point-of-selection.mp
12. (Online adj5 (food deliver*)).mp
13. (Online adj5 (food order*)).mp
14. Take away*.mp OR takeaway*.mp OR take-away*.mp
15. Take out*.mp OR takeout*.mp OR take-out*.mp
16. Uber Eats.mp
17. Menulog.mp
18. Deliveroo.mp
19. 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 10 OR 11 OR 12 OR 13 OR 14 OR 15 OR 16 OR 17 OR 18
20. ((menu OR nutrition* OR calorie OR energy OR kilojoule* OR kJ) adj2 (label* OR post* OR information OR symbol* OR logo* OR icon* OR format* OR approach*)).mp
21. Food labelling/
22. 20 OR 21
24. Aware*.mp
25. Understand*.mp
26. Energy intake/ OR Nutrients/ OR Food preferences/ OR Choice behavior/ OR Consumer behavior/ OR ((energy OR calorie* OR food* OR item* OR meal* OR nutrient* OR kilojoule OR kJ) adj3 (order* OR select* OR consum* OR purchas* OR choice* OR intake* OR sold OR sale* OR sell*)).mp OR eating behavio?r*.mp
27. Portion size/ OR portion* size*.mp
28. Purchase intent*.mp
29. Reformulat*.mp
30. Body mass index/ OR body weight/ OR Obesity/ OR Body mass index.mp OR BMI.mp OR weight.mp OR obesity.mp
31. Healthiness.mp
32. 23 OR 24 OR 25 OR 26 OR 27 OR 28 OR 29 OR 30 OR 31
33. 19 AND 22 AND 32
34. limit 33 to (english language and humans and yr="2016 -Current")
Appendix 2: PRISMA flow diagram

Records identified through database searching (n = 333)

Additional records identified through other sources (n = 3)

Records after duplicates removed (n = 291)

Records screened by title and abstract (n = 291)

Records excluded (n = 201)

Full-text articles excluded, with reasons (n = 32):
- Wrong outcome (n = 12);
- Wrong study design (n = 7);
- Multi-component intervention (n = 6);
- Not about NEML (n = 6);
- NEML and front-of-pack labelling assessed together (n = 1)

Full-text articles assessed for eligibility (n = 90)

Studies included in rapid evidence review (n = 58)
Appendix 3: Tabulation of relevant reviews and individual papers relating to research question 1

(Papers are organised alphabetically by year, with the most recent first).

<table>
<thead>
<tr>
<th>First author, publication year</th>
<th>Study setting</th>
<th>Types of outlets</th>
<th>Intervention/ description of study</th>
<th>Awareness</th>
<th>Understanding/ knowledge</th>
<th>Use</th>
<th>Selection/ ordering/ purchase of kj/item/ nutrients/ sales/revenue</th>
<th>Consumption of calories/item/ nutrients</th>
<th>Calories offered by retailers/ product reformulation or innovation</th>
<th>Overall diet</th>
<th>PA</th>
<th>BMI/ weight</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>Von Philipsborn 2019&lt;sup&gt;17&lt;/sup&gt;</td>
<td>Real world</td>
<td>Chain restaurants, cafés</td>
<td>- Mandatory NEML - No NEML</td>
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<td></td>
<td></td>
<td></td>
<td>Based on one ITS, two CBA studies</td>
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<tr>
<td>Crockett 2018&lt;sup&gt;13&lt;/sup&gt;</td>
<td>Real world</td>
<td>Restaurants</td>
<td>- NEML/ NEML + TLL - No NEML</td>
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<td></td>
<td>Reduction in energy purchased</td>
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<td></td>
<td>Meta-analysis based on three RCTS; findings supported by two ITS studies at low risk of bias</td>
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<td></td>
<td>Lab</td>
<td>- NEML/NL on multiple items - No NEML /no NL</td>
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<td></td>
<td>No effect on energy consumed</td>
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<td></td>
<td>Meta-analysis based on eight RCTs</td>
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<tr>
<td>Roberts 2018&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Mix of real world and lab</td>
<td>Restaurants, cafeterias</td>
<td>- ML - No ML</td>
<td></td>
<td></td>
<td>Mixed findings as to calories ordered</td>
<td>Mixed findings as to calories consumed</td>
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<td>Based on 12 SRs. Author concerns as to quality of evidence; some studies lacking control group</td>
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<tr>
<td>Zlatevska 2018&lt;sup&gt;3&lt;/sup&gt;</td>
<td>Mix of real world and online/ artificial</td>
<td>Restaurants</td>
<td>- Mandatory NEML - No NEML</td>
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<td>Reduction in calories selected. Reduction may be stronger in sit-down restaurants, artificial settings, and for lunch meals</td>
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<td>First author, publication year</td>
<td>Study setting</td>
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<td>Intervention/ description of study</td>
<td>Awareness</td>
<td>Use</td>
<td>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
<td>Consumption of calories/item/ nutrients</td>
<td>Calories offered by retailers/ product reformulation or innovation</td>
<td>Overall diet</td>
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<tr>
<td>Wright 2018&lt;sup&gt;16&lt;/sup&gt;</td>
<td>Mix of real world and experimental/ lab</td>
<td>- NEML/NL - Control or comparison</td>
<td>No effect for calories selected/ ordered</td>
<td>No effect for calories consumed</td>
<td>No difference by study design</td>
<td>Based on three SRs (two examined NEML specifically) including a majority of lab studies and some real world studies</td>
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<td>Bleich 2017&lt;sup&gt;9&lt;/sup&gt;</td>
<td>Mix of real world and simulated/lab</td>
<td>Restaurants, cafeterias - NEML - No NEML</td>
<td>Mixed/ inconclusive findings for calories purchased</td>
<td>Mixed/ inconclusive findings</td>
<td>Inconclusive findings for product reformulation /innovation</td>
<td>Lack of strong designs Some studies did not have control/ comparison groups. Included studies not appraised for quality</td>
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<td>Cantu-Jungles 2017&lt;sup&gt;4&lt;/sup&gt;</td>
<td>Real world</td>
<td>Restaurants - NEML - Control</td>
<td>No effect on calories/nutrients ordered/ consumed</td>
<td>No effect on calories/ nutrients ordered/ consumed</td>
<td>Range of study designs</td>
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<td>Lab</td>
<td>- NEML - Control</td>
<td>Reduction in calories ordered/ consumed</td>
<td>Reduction in calories ordered/ consumed</td>
<td>Range of study designs Based on meta-analysis</td>
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<td>Fernandes 2017&lt;sup&gt;5&lt;/sup&gt;</td>
<td>Real world</td>
<td>Restaurants, cafeterias - ML - No ML</td>
<td>Mixed findings, with 65% studies finding partial influence</td>
<td>ML included several formats Some studies lacked a control group</td>
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<td>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
<td>Consumption of calories/item/ nutrients</td>
<td>Calories offered by retailers/ product reformulation or innovation</td>
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<td>Hillier-Brown 2017[10]</td>
<td>Real world</td>
<td>Restaurants, cafeterias</td>
<td>Impact of mandatory NEML law</td>
<td>Mixed (2/9 studies found increased awareness and knowledge)</td>
<td>Mixed (2/9 studies found increased awareness and knowledge)</td>
<td>Mixed findings. Most studies did not find effects of mandatory law on food purchases</td>
<td>Mixed/inconclusive</td>
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<td>Real world Non-chain food outlets</td>
<td>Impact of voluntary nutrient labelling</td>
<td>Mixed (2/9 studies found increased awareness and knowledge)</td>
<td>Reduction in energy and nutrient purchases</td>
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<td>Author states some studies were poor quality</td>
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<td>Sisnowski 2017[11]</td>
<td>Real world</td>
<td>Restaurants</td>
<td>Impact of NEML</td>
<td>Varied by location and study</td>
<td>Much lower than proportion noticing ML</td>
<td>No effect on purchasing behaviour</td>
<td>Modest changes</td>
<td>No reduction in frequency of restaurant visits</td>
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<td>Based on one moderate quality study (author stated)</td>
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<td>Littlewood 2016[15]</td>
<td>Mix of real world and experimental</td>
<td>Restaurants, cafés, cafeterias</td>
<td>- NEML - No NEML</td>
<td>Reduction in energy ordered in real world and lab settings</td>
<td>Reduction in calories consumed</td>
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<td>In some studies, NEML was accompanied by contextual/ interpretive guidance</td>
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<td>Most studies had a control group. Based on meta-analysis</td>
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<td>Mix of real world and experimental</td>
<td>Restaurants, cafés, cafeterias</td>
<td>- NEML + DRV - NEML</td>
<td>Enhanced reduction in energy selected with NEML + DRV</td>
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<td>Allman-Farinelli 2019</td>
<td>Real world</td>
<td>Eating out</td>
<td>Actionable suggestions for NEML</td>
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<tr>
<td>Dallas 2019</td>
<td>Real world and lab</td>
<td>Restaurant</td>
<td>- NEML on left side of menu - NEML on left side of menu - No NEML</td>
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<td>Based on one study Could not isolate effects of DRV in other studies</td>
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<td>Petimar 2019a</td>
<td>Real world</td>
<td>Fast food restaurants</td>
<td>Pre-vs post-implementation of NEML</td>
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<tr>
<td>Petimar 2019b</td>
<td>Real world</td>
<td>Fast food restaurants</td>
<td>McDonald restaurants with or without NEML</td>
<td>Small percentage noticed and used NEML</td>
<td>Small percentage noticed and used NEML</td>
<td>No changes in actual/estimated calories purchased</td>
<td>Less calories purchased over time for adult purchases and purchases made for children</td>
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<td>Vanderlee 2019</td>
<td>Real world</td>
<td>Restaurants</td>
<td>- NEML - NI available upon request - No NI</td>
<td>Participants in NEML noticed energy information more</td>
<td>Participant s in NEML more likely to report using NI than other conditions</td>
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<td>Consumption of calories/item/ nutrients</td>
<td>Calories offered by retailers/ product reformulation or innovation</td>
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<td>Vasiljevic 2019&lt;sup&gt;28&lt;/sup&gt;</td>
<td>Real world</td>
<td>Worksite cafeterias</td>
<td>Energy labelling (multiple formats including NEML)</td>
<td>No effect on daily energy purchased</td>
<td>No effect on daily energy purchased</td>
<td>Stepped wedge RCT</td>
<td>Unable to assess effects of NEML alone</td>
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<td>Feng 2018&lt;sup&gt;12&lt;/sup&gt;</td>
<td>Real world</td>
<td>Fast food, sit down restaurants</td>
<td>NEML awareness and use between 2007-13</td>
<td>Increase over time</td>
<td>Increase over time</td>
<td>Natural experiment</td>
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<td>Goodman 2018&lt;sup&gt;20&lt;/sup&gt;</td>
<td>Real world</td>
<td>Quick service and sit down restaurants</td>
<td>Comparison between provinces with mandatory, voluntary or no NEML policy</td>
<td>Higher awareness in province with mandatory than provinces with voluntary or no policy</td>
<td>More influence of mandatory than voluntary or no policy on food ordered</td>
<td>QE pre-post with control group</td>
<td>Little support for effectiveness of voluntary policies</td>
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<td>Kellershohn 2018&lt;sup&gt;15&lt;/sup&gt;</td>
<td>Online survey</td>
<td>Fast food item</td>
<td>Pre- and post mandatory NEML legislation in one province and a control province</td>
<td>Most participants could not estimate the caloric content of a popular fast food item within ±10%</td>
<td>No differences between provinces at baseline and post-3 months,</td>
<td>Cross-sectional</td>
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<td>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
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<tr>
<td>Larson 2018&lt;sup&gt;33&lt;/sup&gt;</td>
<td>Survey</td>
<td>Restaurant</td>
<td>Population-based survey Half noticed calorie information</td>
<td>Of those that noticed calorie information, 62% used it</td>
<td>only difference at post-6 months</td>
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<td>Gruner 2017&lt;sup&gt;24&lt;/sup&gt;</td>
<td>Real world</td>
<td>Fast food restaurants - NEML users - Non-users</td>
<td>Healthier sides and beverages selected by NEML users; no difference for lower energy entrees</td>
<td>Cross-sectional</td>
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<td>Restrepo 2017a&lt;sup&gt;7&lt;/sup&gt;</td>
<td>Real world</td>
<td>Chain restaurants - Mandatory NEML law - No mandatory law</td>
<td>No impact on daily consumption of fruit and vegetables or alcohol</td>
<td>Cross-sectional</td>
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<td>Restrepo 2017b&lt;sup&gt;8&lt;/sup&gt;</td>
<td>Real world</td>
<td>Restaurants - Mandatory NEML law - No mandatory law</td>
<td>Reduction in reported alcohol consumption in past month with ML laws</td>
<td>Cross-sectional</td>
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<td>Rising 2017&lt;sup&gt;25&lt;/sup&gt;</td>
<td>Online/ hypothetical</td>
<td>NEML or no NEML with or without self-control</td>
<td>ML increased likelihood of choosing lower calorie food options among those with high self-control, but not among those</td>
<td>2x2 between subjects</td>
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<td>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
<td>Consumption of calories/item/ nutrients</td>
<td>Calories offered by retailers/ product reformulation or innovation</td>
<td>Overall diet</td>
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<tr>
<td>Haws 2016&lt;sup&gt;26&lt;/sup&gt;</td>
<td>Online/ hypothetical</td>
<td>- Linear pricing, NEML - Linear pricing, no NEML - Non-linear pricing, NEML - Non-linear pricing, no NEML</td>
<td></td>
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<td>Less calories ordered with linear pricing; more participants chose healthier full portions than half unhealthy portions</td>
<td>With non-linear pricing, NEML had no effect on calories ordered, with larger portion sizes favoured</td>
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<td>2x2 between subjects design</td>
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<tr>
<td>Lee-Kwan 2016&lt;sup&gt;34&lt;/sup&gt;</td>
<td>Survey</td>
<td>Prevalence of NEML use</td>
<td>Of those noticing NEML, &gt;50% reported moderate-frequent NEML use; 43% reported never using it</td>
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<td>Cross-sectional</td>
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<tr>
<td>Loureiro 2016&lt;sup&gt;27&lt;/sup&gt;</td>
<td>Questionnaire and real world</td>
<td>Fast food</td>
<td>Impact of NEML</td>
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<td>Lower probability of selecting high energy meals in the questionnaire No significant impact on actual purchase</td>
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<td>Questionnaire and follow-up randomised field experiment</td>
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<td>First author, publication year</td>
<td>Study setting</td>
<td>Types of outlets</td>
<td>Intervention/ description of study</td>
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<td>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
<td>Consumption of calories/item/ nutrients</td>
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<td>Roseman 2016&lt;sup&gt;21&lt;/sup&gt;</td>
<td>Experimental/ hypothetical</td>
<td>- NEML (absence, presence) - DRV (absence, presence) - Subjective nutrition knowledge</td>
<td>NEML (vs no NEML) and subjective nutrition knowledge had a positive impact on intention to select lower calorie foods, while DRV (vs no DRV) did not</td>
<td>Nearly 1/3 were aware of NEML</td>
<td>Only 5% of those aware of NEML used it</td>
<td>Some falls in sales of higher energy items</td>
<td>3/7 meals reformulated were higher energy</td>
<td>Australian intervention study University students Findings relating to social marketing not reported here</td>
<td>Natural field experiment</td>
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<tr>
<td>Roy 2016&lt;sup&gt;22&lt;/sup&gt;</td>
<td>Real world food outlet</td>
<td>- NEML only - NEML + social marketing</td>
<td>Better estimation of meal caloric content at restaurants with NEML than no NEML. Better estimation with more frequent visits to restaurants with NEML</td>
<td>Higher energy meals selected by patrons from restaurants with NEML than those without NEML, potentially due to prior consumer beliefs on meal nutrition content</td>
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<td>Seenisavan 2016&lt;sup&gt;22&lt;/sup&gt;</td>
<td>Real world Quick chain restaurant</td>
<td>Restaurants with NEML vs no NEML</td>
<td>Better estimation of meal caloric content at restaurants with NEML than no NEML. Better estimation with more frequent visits to restaurants with NEML</td>
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<td>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
<td>Consumption of calories/item/ nutrients</td>
<td>Calories offered by retailers/ product reformulation or innovation</td>
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<td>Stran 2016²¹</td>
<td>Simulated</td>
<td>Mock dining room</td>
<td>Fast food menu with NEML vs menu without NEML</td>
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<td>Less calories ordered from menu with NEML than menu without NEML</td>
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<td>QE</td>
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Abbreviations: BMI=body mass index; BRFSS=Behaviour Risk Factor Surveillance System; CBA=controlled before-and-after study; DRV=daily reference value; ITS=interrupted time series; kJ=kilojoules; lab=laboratory; ML=menu labelling; NEML=numeric energy menu labelling; NL=nutrition labelling/labels; PA=physical activity; QE=quasi-experimental; RDI=recommended dietary intake; SR=systematic reviews.
Appendix 4: Tabulation of relevant reviews and individual papers relating to research question 2

(Papers are organised alphabetically by year, with the most recent first).

<table>
<thead>
<tr>
<th>First author, publication year</th>
<th>Study setting</th>
<th>Types of outlets</th>
<th>Intervention/ description of study</th>
<th>Awareness</th>
<th>Use</th>
<th>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</th>
<th>Consumption of calories/item/ nutrients</th>
<th>Calories offered by retailers/ reformulation</th>
<th>Overall diet</th>
<th>PA</th>
<th>BMI/ weight</th>
<th>Comments</th>
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<tbody>
<tr>
<td>REVIEWS</td>
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<tr>
<td>Christoph 2018</td>
<td>Mix of real world and lab</td>
<td>Cafeterias, quick service outlets, convenience stores, vending machines</td>
<td>- Contextual labels (TLL/PACE/ DRV) - NEML</td>
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<td>Higher reduction in calories ordered/consumed with contextual labels compared to NEML</td>
<td>Higher reduction in calories ordered/consumed with contextual labels compared to NEML</td>
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<tr>
<td>Crockett 2018</td>
<td>Real world</td>
<td>Restaurants</td>
<td>- NEML/ NEML + TLL - No NEML</td>
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<td>Reduction in energy purchased</td>
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<td>Seyed-hamzeh 2018</td>
<td>Mix of real world and lab</td>
<td>Restaurants</td>
<td>- PACE - NEML</td>
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<td>No difference in calories ordered between conditions. No effect by setting</td>
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<tr>
<td>Wright 2018</td>
<td>Mix of real world and experimental/lab</td>
<td>- NEML + contextual info - Control or comparison</td>
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<td>Reduction in calories consumed</td>
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<tr>
<td>Bleich 2017</td>
<td>Mix of real world and simulated/lab</td>
<td>Restaurants, cafeterias</td>
<td>- Modified NEML (TLL, PACE) - No labels</td>
<td></td>
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<td>Mixed/inconclusive findings for calories purchased</td>
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<tr>
<td>Fernandes 2017</td>
<td>Real world</td>
<td>Restaurants, cafeterias</td>
<td>- Qualitative ML (e.g. healthy food symbols, TLL)</td>
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<td>Qualitative ML appeared more effective in promoting healthy eating</td>
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Based on a small number of studies

Meta-analysis based on 3 RCTS; findings supported by 2 ITS studies at low risk of bias

2 studies in real world settings, rest online or simulated

Only few studies

ML included several formats
<table>
<thead>
<tr>
<th>First author, publication year</th>
<th>Study setting</th>
<th>Types of outlets</th>
<th>Intervention/ description of study</th>
<th>Awareness</th>
<th>Understanding/ knowledge</th>
<th>Use</th>
<th>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</th>
<th>Consumption of calories/item/ nutrients</th>
<th>Calories offered by retailers/ reformulation</th>
<th>Overall diet</th>
<th>PA</th>
<th>BMI/ weight</th>
<th>Comments</th>
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<tr>
<td>Littlewood 2016&lt;sup&gt;14&lt;/sup&gt;</td>
<td>Mix of real world and experimental</td>
<td>Restaurants, cafés, cafeterias</td>
<td>- NEML + TLL - No ML</td>
<td>Higher in NEML + TLL</td>
<td>Higher in NEML + TLL</td>
<td>Mixed findings</td>
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<td>Some studies lacked a control group</td>
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<tr>
<td>Mix of real world and experimental</td>
<td>Restaurants, cafés, cafeterias</td>
<td>- NEML + PACE - No ML</td>
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<td>Mixed findings</td>
<td>Mixed findings</td>
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<td>Based on small number of studies</td>
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<td>INDIVIDUAL STUDIES</td>
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<tr>
<td>Allman-Farinelli 2019&lt;sup&gt;30&lt;/sup&gt;</td>
<td>Real world</td>
<td>Eating out</td>
<td>Actionable suggestions for alternate approaches to NEML</td>
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<td>Listing nutrients or PACE may enable healthier choices</td>
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<td>Qualitative study</td>
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<td>Deery 2019&lt;sup&gt;41&lt;/sup&gt;</td>
<td>Real world</td>
<td>Cafeterias</td>
<td>- PACE - NEML</td>
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<td></td>
<td>Modest but not statistically significant increases in self-reported and objective PA in PACE group compared to NEML group</td>
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<tr>
<td>Niven 2019&lt;sup&gt;39&lt;/sup&gt;</td>
<td>Online</td>
<td>Fast food restaurant</td>
<td>- No NEML - NEML - HSR - NEML + HSR</td>
<td>Good proportion understood kJ and HSR; no difference between conditions</td>
<td>Mean kJ content of meals selected did not differ by ML condition Healthier meals selected in NEML + HSR condition than NEML or HSR only (based on NPS)</td>
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<td>Between-subjects design</td>
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<td>Intervention/ description of study</td>
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<td>Selection/ ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
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<td>Calories offered by retailers/ reformulation</td>
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<td>Viera 2019&lt;sup&gt;12&lt;/sup&gt;</td>
<td>Real world</td>
<td>Worksite cafeterias - Energy labelling (near food) - PACE</td>
<td>Both conditions led to reduction in calories purchased at lunchtime No difference between conditions</td>
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<td>QE</td>
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<tr>
<td>Kim 2018&lt;sup&gt;17&lt;/sup&gt;</td>
<td>Lab</td>
<td>Fast food menu - NEML - NEML + TLL - NEML + PACE</td>
<td>Higher visual attention with NEML + PACE than other conditions Healthier food (lower calorie) selections in NEML + PACE and NEML + TLL than NEML only No difference between conditions for beverages</td>
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<td>Randomised, repeated measures crossover design</td>
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<tr>
<td>Lee 2016&lt;sup&gt;18&lt;/sup&gt;</td>
<td>Online</td>
<td>- No ML - NEML only - NEML + PACE</td>
<td>No difference between conditions in calories ordered No difference between conditions in burger, salad or dessert categories Calories ordered in the sides category was higher in NEML only than in NEML + PACE and no ML Mostly no impact on exercise attitudes, perceptions and intentions</td>
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<td>Randomised experiment</td>
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<tr>
<td>Shah 2016&lt;sup&gt;19&lt;/sup&gt;</td>
<td>Lab</td>
<td>- No NL - NEML + DRV/meal - PACE</td>
<td>No difference in calories ordered between conditions</td>
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<td>Randomised experiment</td>
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<td>Consumption of calories/item/ nutrients</td>
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<td>No effect of NEML + DRV/meal or PACE on calories ordered, % energy from macronutrients, and calories ordered from specific foods</td>
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Abbreviations: HSR=Health Star Rating; ITS, interrupted time series; kJ=kilojoules; lab=laboratory; ML=menu labelling; NEML, numeric energy menu labelling; NL=nutrition labelling/labels; NPS=nutrient profiling score; PA=physical activity; PACE=physical activity calorie equivalent labelling; QE=quasi-experimental; TLL=traffic light labelling.
Appendix 5: Tabulation of relevant reviews and individual papers relating to research question 3

(Papers are organised alphabetically by year, with the most recent first).

<table>
<thead>
<tr>
<th>First author, publication year</th>
<th>Study setting</th>
<th>Types of outlets</th>
<th>Intervention/ description of study</th>
<th>Awareness</th>
<th>Understanding/ knowledge</th>
<th>Use</th>
<th>Selection/ Ordering/ purchase of kJ/item/ nutrients/ sales/revenue</th>
<th>Consumption of calories/item/ nutrients</th>
<th>Calories offered by retailers/ reformulation</th>
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<td>Fernandes 2017</td>
<td>Real world</td>
<td>Restaurants, cafeterias</td>
<td>- Qualitative ML (e.g. healthy food symbols, TLL)</td>
<td>Qualitative ML</td>
<td>Qualitative ML appeared more effective in promoting healthy eating</td>
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<td>- Quantitative ML</td>
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<tr>
<td>Musicus 2019</td>
<td>Online</td>
<td>Restaurant</td>
<td>- No sodium ML</td>
<td>Sodium warning labels compared to none associated with increased knowledge of meal sodium content</td>
<td>All conditions led to reduction in average sodium ordered; these were not significant in 3 experiments Reduction in sodium ordered with traffic light and stop sign warnings compared to controls in well powered experiment</td>
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<td>- Sodium ML</td>
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<td>- Sodium icons (stop sign)</td>
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<tr>
<td>Osman 2019</td>
<td>Online</td>
<td>Canteen</td>
<td>- Single TLL (with energy content or carbon emissions)</td>
<td>TLL led to positive shifts towards meals with lower caloric content and lower carbon emissions</td>
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<td>- Dual TLL (with both energy content and carbon emissions)</td>
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</tbody>
</table>

ML included several formats Some studies lacked a control group
Four sequential, randomised controlled experiments
Between-subject CBA
<table>
<thead>
<tr>
<th>First author, publication year</th>
<th>Study setting</th>
<th>Types of outlets</th>
<th>Intervention/ description of study</th>
<th>Awareness</th>
<th>Use</th>
<th>Selection/ Ordering/ purchase of kJ/item/ nutrients/ sales/revenue</th>
<th>Consumption of calories/item/ nutrients</th>
<th>Calories offered by retailers/ reformulation</th>
<th>Overall diet</th>
<th>PA</th>
<th>BMI/ weight</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byrd 2018(^a)</td>
<td>Online</td>
<td>Casual dining restaurant menu</td>
<td>- No NI - NEML only - NEML + numeric sodium - NEML + warning symbol for sodium &gt;2,300 mg</td>
<td>High proportion aware of NEML</td>
<td>1/3 used NEML when they saw it</td>
<td>NEML + numeric sodium led to higher/lower selection of sodium content than NEML only or no NI conditions, depending on taste intuition</td>
<td>NEML + warning symbol for sodium did not differ in meal sodium content from other conditions</td>
<td></td>
<td></td>
<td></td>
<td>Between-group DRV statement included at bottom of menus</td>
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<tr>
<td>Mazocco 2018(^a)</td>
<td>Real world</td>
<td>Self-service restaurant</td>
<td>Dish nameplates using TLL for ED and sodium content, portion size info and ingredients list</td>
<td>&gt;50% changed for better food choices after reading nameplates</td>
<td></td>
<td></td>
<td></td>
<td>Interven-tional study</td>
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<tr>
<td>Christoph 2017(^a)</td>
<td>Real world</td>
<td>University dining halls</td>
<td>- NL near food items, including dish title, serving size, calories, grams of fat, carbohydrates, and protein - No NL</td>
<td></td>
<td></td>
<td>Labels users made healthier choices, more qualitative than quantitative, than non-label users</td>
<td></td>
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<td></td>
<td>Cross-sectional</td>
<td></td>
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</tr>
<tr>
<td>Christoph 2016(^a)</td>
<td>Real world</td>
<td>University dining halls</td>
<td>NL placed on either sneeze guards or near food in different</td>
<td>Nearly half were aware of NL. Did not vary by placement</td>
<td>One fifth used NL Did not vary by</td>
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<td></td>
<td>Cross-sectional</td>
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<tr>
<td>First author, publication year</td>
<td>Study setting</td>
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<td>Selection/ Ordering/ purchase of kJ/item/ nutrients/ sales/revenue</td>
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<td>Calories offered by retailers/ reformulation</td>
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<tr>
<td>Pratt 2016^9</td>
<td>Real world</td>
<td>Cafeteria</td>
<td>Signposted food at POP using a nutritional graph, NIP or no NL</td>
<td>or over time</td>
<td>placement or over time</td>
<td>Graphical signposting improved nutrient content of purchases and reduced total calories ordered compared to NIP and no NL</td>
<td>NIP had no effect compared to baseline</td>
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<td>Findings from field experiment</td>
</tr>
</tbody>
</table>

Abbreviations: CBA, controlled before-and-after study; ED, energy density; info, information; kJ=kilojoules; ML=menu labelling; NEML, numeric energy menu labelling; NL=nutrition labelling/labels; NIP=nutrition information panel; POP=point of purchase; TLL=traffic light labelling.
Appendix 6: Tabulation of relevant reviews and individual papers relating to research question 4

(Papers are organised alphabetically by year, with the most recent first).
<table>
<thead>
<tr>
<th>Study design</th>
<th>Study setting</th>
<th>Types of outlets</th>
<th>Intervention/ description of study</th>
<th>Awareness</th>
<th>Understanding/ knowledge</th>
<th>Use</th>
<th>Selection/ordering, purchase of kJ/item/ nutrients/ sales/revenue</th>
<th>Consumption of calories/item/ nutrients</th>
<th>Calories offered by retailers/ reformulation</th>
<th>Overall diet</th>
<th>PA</th>
<th>BMI/ weight</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roberts 2018</td>
<td>Mix of real world and lab</td>
<td>Evaluation of population-wide T2DM or obesity prevention initiatives</td>
<td></td>
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<td></td>
<td>No impact of SES or demographics in conditions with POP prompts, ML, or multicomponent interventions</td>
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<tr>
<td>Seyedhamzeh 2018</td>
<td>Mix of real world and lab</td>
<td>Various settings, including restaurants and schools</td>
<td>Evaluate effect of PACE labelling and calorie-only labelling on health behaviour</td>
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<td></td>
<td>PACE labelling results in small, non-significant reduction in calories ordered, with no difference between age, sex, or BMI</td>
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<tr>
<td>Zlatevska 2018</td>
<td>Mix of real world and lab</td>
<td>Restaurants</td>
<td>To evaluate the impact of mandatory calorie disclosure on reducing restaurant-based food calorie consumption</td>
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<td></td>
<td>NEML results significantly fewer calories selected in females</td>
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<tr>
<td>Hillier Brown 2017</td>
<td>Real world</td>
<td>Food outlets selling ready-to-eat meals to eat in, to take away or to be delivered (e.g. cafés, restaurants)</td>
<td>Any intervention aiming to change food outlet practices to promote healthier menu food offerings including mandatory and voluntary calorie labelling</td>
<td></td>
<td></td>
<td></td>
<td>There is some evidence indicating that awareness of NEML is highest among women and Caucasian, higher SES (income and education) and older adults</td>
<td></td>
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<td></td>
<td>Mostly low-moderate quality studies (author stated)</td>
</tr>
<tr>
<td>Sacco 2017&lt;sup&gt;24&lt;/sup&gt;</td>
<td>Mix of real world and lab</td>
<td>Cafeterias, restaurants</td>
<td>Analysis of actual or intended food purchasing decisions or consumption behaviour</td>
<td>Some differences in ML among youth by gender, weight status, and SES; however, findings are inconsistent</td>
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<tr>
<td>Sisnowski 2017&lt;sup&gt;11&lt;/sup&gt;</td>
<td>Mix of real world and lab</td>
<td>Any</td>
<td>To evaluate outcomes of policies targeting the reduced consumption of energy dense foods and drinks</td>
<td>Among ML users, uptake varied by sub-population, with some studies differing by income, others by race, or by gender. No consistent findings to support results</td>
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<tr>
<td>Littlewood 2016&lt;sup&gt;15&lt;/sup&gt;</td>
<td>Mix of real world and lab</td>
<td>Restaurants, cafés, cafeterias</td>
<td>Variances in BMI, ethnicity, age and SES did not impact effectiveness of ML. Females more aware of ML than males in two studies, but no difference in another two studies</td>
<td>PACE more effective with younger consumers of normal weight – may be irrelevant to those who do not exercise</td>
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<tr>
<td>Sarink 2016&lt;sup&gt;13&lt;/sup&gt;</td>
<td>Mix of real world and lab</td>
<td>Cafeterias, restaurants</td>
<td>Analysis of awareness, understanding and use of ML; purchase and consumption with ML; and energy balance/BMI with ML</td>
<td>Self-reported/intended ML use generally more favourable in low than high SES</td>
<td>Majority of studies investigating actual purchase outcomes found no impact of NEML for low SES, but result may be due to overall lack of effectiveness of</td>
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</tbody>
</table>
**OTHER TYPES OF STUDIES**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Setting</th>
<th>Type of Study</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marty 2020</td>
<td>Simulated online restaurant</td>
<td>Survey on food purchase intention based on NEML and DRV present vs not present, and increased availability of healthier options vs reduced availability</td>
<td>NEML had no effect on energy ordered in either high/low SES</td>
</tr>
<tr>
<td>Deery 2019</td>
<td>Real world Work cafeteria - PACE - NEML (also coloured, TLL)</td>
<td>RCT The effect after increased availability of healthier food did not differ between low and high SES. Main measure of SES was education level</td>
<td>Significant increase in resistance exercise in the lowest income group in NEML condition, and non-significant increases in higher income groups in the PACE conditionITS cohort study</td>
</tr>
<tr>
<td>Petimar 2019a</td>
<td>Real world Fast food restaurant chains</td>
<td>Comparison of transaction data from pre-ML laws compared to post</td>
<td>The impact of ML on reducing calories ordered diminished faster in low SES than high SES</td>
</tr>
<tr>
<td>Study</td>
<td>Type</td>
<td>Participants</td>
<td>Procedure</td>
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<tr>
<td>Roseman 2019</td>
<td>Real world University cafeteria</td>
<td>Participants exposed to one of 4 different sample menus. - with or without calorie information (NEML) on menu - with or without DRV on bottom right of menu</td>
<td>Nutrition knowledge impacted on intention to select lower calorie items</td>
</tr>
<tr>
<td>Vanderlee 2019</td>
<td>Real world Sit-down restaurants</td>
<td>Exit surveys in 2012, 2015 and 2017 asking customers outside restaurants about their awareness of labelling and self-reported use of menu labels/Informed Dining Program (IDP, nutrition information on request)</td>
<td>ML information resulted in significant association with awareness compared to IDP. No significant impact of SES on use of nutrition information.</td>
</tr>
<tr>
<td>Courtney 2018</td>
<td>Lab</td>
<td>Dieting and non-dieting participants viewed images of food with and without calorie information</td>
<td>Calorie information reduced reward system activation and increased control system activation, also observed in dieters</td>
</tr>
<tr>
<td>Feng 2018</td>
<td>Real world Restaurants (fast food and sit-down)</td>
<td>Survey on use of ML</td>
<td>High school graduates, having a higher income, being female, Non-Hispanic Blacks and Hispanics more likely to use ML than Non-Hispanic</td>
</tr>
<tr>
<td>Study</td>
<td>Setting</td>
<td>Population</td>
<td>Methodology</td>
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<tr>
<td>Goodman 2018&lt;sup&gt;20&lt;/sup&gt;</td>
<td>Real world</td>
<td>Restaurants (fast food and sit-down)</td>
<td>Cross-sectional survey. Comparison between mandatory calorie labelling policy and no formal control</td>
</tr>
<tr>
<td>Larson 2018&lt;sup&gt;19&lt;/sup&gt;</td>
<td>Real world</td>
<td>Restaurants</td>
<td>Survey on noticing and use of NEML</td>
</tr>
</tbody>
</table>
Restrepo 2017b | Real world | Restaurants | Analyse the effect of mandatory restaurant ML laws on alcohol use | Men (3.2%), and minorities (4.8%) estimated to be more affected by ML policy on alcohol consumption than women and non-Hispanic Whites, respectively | Secondary data analyses

Christoph 2016 | Real world | University dining hall | Label users - Non-label users | 22% used labels; more women than men notice ML | Greater % of label-users selected healthier choices

Lassen 2016 | Real world | Fast food restaurants | Survey on meal selection and purchase intentions based on 4 hypothetical menus | Female, higher education, more likely to select healthier option | Cross-sectional

Lee Kwan 2016 | Real world | Fast food and chain restaurants | Cross-sectional survey | Female, higher education, and higher income, younger, white ethnicity more likely to use ML | Cross-sectional population-based survey

Loureiro 2016 | Real world | Fast food restaurant | Survey on food purchase intention and | Mixed effects for selection of meals | Cross-sectional
<table>
<thead>
<tr>
<th>Study</th>
<th>Setting</th>
<th>Location</th>
<th>Methodology</th>
<th>Findings</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oh 2016</td>
<td>Real world</td>
<td>Restaurants</td>
<td>Trends identified in weighted logistic and linear regression models on use of ML in dining out</td>
<td>More women reported using calorie information when ordering</td>
<td>Cross-sectional study. Data collected after law passed, but before final rules and regulations were confirmed.</td>
</tr>
<tr>
<td>Pratt 2016</td>
<td>Real world</td>
<td>University cafe</td>
<td>Investigating effect of graphically or numerically presented nutrition information on nutrient recall and purchasing behaviour</td>
<td>No impact of age, weight, BMI, nutrition knowledge, or sex on recall of nutrient info</td>
<td>Women ordered fewer calories than men. Women ordered fewer calories, reflecting significant difference in body weight between men and women in the study. Limitation: all participants highly educated (university students).</td>
</tr>
<tr>
<td>Shah 2016</td>
<td>Lab</td>
<td>Mock restaurant</td>
<td>Select a meal from one of 3 randomly assigned menus: - No food labels - NEML and DRV - PACE + rank-ordered by PACE (separate menus for male and female bodies)</td>
<td>No difference between menu options in total calories ordered</td>
<td>Randomised study. No effect of gender, age, BMI.</td>
</tr>
</tbody>
</table>

Abbreviations: BMI=body mass index; DRV=daily reference value; IDP=Informed Dining Program; ITS=interrupted time series; kJ=kilojoules; lab=laboratory; ML=menu labelling; NEML=numeric energy menu labelling; PA=physical activity; PACE=physical activity calorie equivalent labelling; POP=point-of-purchase; SES=socioeconomic status; T2DM= type 2 diabetes mellitus.
<table>
<thead>
<tr>
<th>Study design</th>
<th>Population</th>
<th>Study setting</th>
<th>Types of outlets</th>
<th>Intervention/ description of study</th>
<th>Awareness</th>
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<th>Selection/ Ordering/ purchase of kJ/item/ nutrients/ sales/revenue</th>
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<th>Overall diet</th>
<th>PA</th>
<th>BMI/ weight</th>
<th>Comments</th>
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<tr>
<td>REVIEWS</td>
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<tr>
<td>Von Philipsborn 201917</td>
<td>Adults, adolescents and children</td>
<td>Real world</td>
<td>Chain restaurants, cafés</td>
<td>- Mandatory NEML - No NEML</td>
<td></td>
<td></td>
<td>Mixed findings for beverage calories/ transaction and total sales/ revenue</td>
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<td>Based on one ITS, two CBA studies</td>
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<tr>
<td>Crockett 201813</td>
<td>Adults or children</td>
<td>Real world</td>
<td>Restaurants</td>
<td>- NEML - NEML + fat information - Healthy symbols - Nutrition bargain price - No nutrition information</td>
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<td>No effect on total calories or fat purchased, but significant shifts in purchasing healthier meals from combination meals</td>
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<td></td>
<td>Based on one ITS study</td>
</tr>
<tr>
<td>Zlatevska 20183</td>
<td>Adults and children menus</td>
<td>Mix of real world and online/ artificial</td>
<td>Restaurants</td>
<td>- Mandatory NEML - No NEML</td>
<td></td>
<td></td>
<td>Reduction in calories selected Reduction may be stronger in sit-down restaurants, artificial settings, and for lunch meals. No difference in effect by age</td>
<td>Reduction in calories offered No difference in effect by age</td>
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<td>Based on a few studies</td>
</tr>
<tr>
<td>Wright 201816</td>
<td>Adults or children</td>
<td>Mix of real world and experiment -tal/lab</td>
<td>Restaurants</td>
<td>- NEML/NL - Control or comparison</td>
<td></td>
<td></td>
<td>No effect for calories ordered</td>
<td>No effect for calories consumed</td>
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<td></td>
<td>Based on one systematic review in adults and children</td>
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<tr>
<td>Sacco 201714</td>
<td>Children, adolescents</td>
<td>Mix of real world and</td>
<td>- NEML - Other ML conditions</td>
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<td>Findings for effectiveness of</td>
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<td>Lab studies suggest that ML may</td>
</tr>
<tr>
<td>Study design</td>
<td>Population</td>
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<tr>
<td>and/or parents</td>
<td>experimental/lab</td>
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<td></td>
<td>NEML differed by settings</td>
<td>Unclear whether other ML conditions are more effective compared to NEML</td>
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<td>reduce calories for children and adolescents but real-world studies are less supportive</td>
</tr>
<tr>
<td>Bleich 2017</td>
<td>Adults, adolescents and children</td>
<td>Mix of real world</td>
<td>Restaurants, cafeterias</td>
<td>- Modified NEML (TLL, PACE)</td>
<td>- No labels</td>
<td></td>
<td>Mixed/ inconclusive findings for calories purchased</td>
<td>No changes in calories purchased</td>
<td></td>
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<td></td>
<td>Three studies included children/ adolescents</td>
</tr>
<tr>
<td>Sarink 2016</td>
<td>Adolescents from low income neighbourhoods</td>
<td>Real world</td>
<td>Restaurants</td>
<td>Before and after mandatory NEML introduction</td>
<td>Increase in awareness following mandatory NEML introduction</td>
<td></td>
<td>No changes in calories purchased</td>
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<td>Based on one study</td>
</tr>
</tbody>
</table>

**OTHER TYPES OF STUDIES**

<p>| Petimar 2019  | Adults, adolescents and parents/guardians of children                        | Real world                      | Fast food restaurants | McDonald restaurants with or without NEML | Small percentage noticed and used NEML |     | No changes in actual/estimated energy purchased | Less energy purchased over time for purchases made for children | Natural experiment |
|              |                                                                           |                                 |                  |                            |                                        |     |                                       |                           |                           |
| Whitt 2017   | Parents and children                                                        | Real world                      | Children’s hospital café | Phased intervention: - TLL - Washout - Cartoon labelling (of healthy items only) - Washout |                                        |     | Lowest purchases of unhealthy foods in the TLL period compared with baseline | Cartoon labelling was associated with more |                           |                           |</p>
<table>
<thead>
<tr>
<th>Study design</th>
<th>Population</th>
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<th>Comments</th>
</tr>
</thead>
</table>
| Hobin 2016<sup>17</sup> | Parents | Online | Menu boards replicating McDonald meals | - No NI 
- NEML only 
- NEML + DRV CS 
- NEML + sodium + DRV CS 
- NEML + sodium using traffic lights + DRV CS | More parents in the 4 menu conditions providing calories were able to correctly identify the highest calorie meal and more parents in the two conditions providing sodium information were able to correctly identify the meal with the highest sodium content | Lower bids for parents in NEML + sodium + DRV CS compared to parents in no NI | No differences among other ML formats | | | | | Experimental auction where participants had to bid on four Happy Meals |
| Williams 2016<sup>19</sup> | School children aged 8-11 years | Real world | Food kiosks near cafeteria | - First stage: NEML 
- Second stage: Multimedia intervention | No effect of NEML | | | | QE study | Significant effect of a three hour multimedia intervention |
<p>| Evans 2015&lt;sup&gt;20&lt;/sup&gt; | Adolescents of high school age | Public location | Eating out | Focus groups | Low ML awareness | Low ML use | | | | | Suggestions for effective ML included adding PACE or simple graphics with bold colours |</p>
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Abbreviations: BMI, body mass index; CBA, controlled before-and-after study; CS=contextual statement; DRV=daily reference value; kJ=kilojoules; lab=laboratory; ML=menu labelling; NEML, numeric energy menu labelling; NI=nutrition information; NL=nutrition labelling; PA=physical activity; PA=physical activity calorie equivalent labelling; QE=quasi-experimental.