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Nudging healthier choices through menu labelling

By

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Abstract

In our rapid and constantly changing food environment, access to unhealthy food is continually growing, particularly meals prepared outside the home. The excessive intake of foods high in fat, salt and sugar increases the risk of lifestyle-related diseases such as stroke, diabetes, and some cancers. Although current strategies such as nutrition education and packaged food labelling are commonplace, there is a need to address the intake of food consumed in the out of home dining setting, which has seen rapid growth due to the increased popularity of food delivery services during the Covid-19 pandemic. As such, the current thesis focuses on encouraging healthier food choices in out of home dining scenarios by way of menu labelling.

The thesis consists of five chapters. Chapter One is a general introduction and highlights the importance of encouraging healthier food choices in an increasingly unhealthy food environment, with particular emphasis on meals prepared and/or consumed outside the home. The use of labelling as a nudge (where choice architecture encourages specific behaviours without limiting options) is discussed. The concept of evaluative labels that help consumers interpret information, and descriptive labels that provide only factual information is also introduced to provide insight into the scope of the thesis. Chapter Two consists of a systematic review and meta-analysis that examines the current research on menu labelling in the out of home dining context. The meta-analysis revealed that overall, labelling nudged healthier choices (Cohen's $d = 0.13$, $p = .001$). When split by labelling type, descriptive/factual calorie labels did not reach statistical significance ($d = .07$, $p = .12$), while labels that helped consumers interpret information had a small significant nudge effect ($d = .15$, $p = .001$).

Chapter Three presents an experimental study (Study 3) where participants attended an in-person laboratory experiment that compared the effects of two types of evaluative labelling, namely traffic light labelling and a healthy tick symbol, against a no information control. Participants viewed one of three café style menus and made a hypothetical meal order. Study 3 found that menu labelling did not affect the overall proportion of healthy foods chosen within a meal. However, when

separated by category, a healthy tick label (green circle with a white tick mark) nudged a healthier choice of main. Chapter Four consists of two follow-up studies (Studies 4 and 5) that were conducted online. These studies examined the use of red and green labels both alone and in combination, with the goal of understanding the influence of different traffic light colours in nudging healthier meal choices. When the legend was present, any form of labelling was found to significantly lower the number of unhealthy food and drinks compared to the no information control. However, this nudging effect was non-significant when the legend was removed in Study 5. Across all three experimental studies, the role of dietary restraint and nutrition knowledge as a moderating factor was inconsistent with their effects. The final chapter is a general discussion that summarises the findings of the meta-analysis and experimental studies, along with the theoretical insights and practical implications of the results. The strengths and limitations of the thesis are also discussed, along with recommendations for future research examining the use of nudging labels to promote healthier choices.

Overall, the results of the thesis show some support for the use of evaluative and interpretive labelling and highlight the strength of providing interpretive elements alongside nutrition information. However, a key limitation of the thesis is that the current literature pool is limited in scope, and largely focused on the use of calorie labelling and consumption. As such, more research is needed to help support the current findings, and to also address identified gaps in the literature.

Declaration

I certify that this thesis:

1. does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university

2. and the research within will not be submitted for any other future degree or diploma without the permission of Flinders University; and

3. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Signed: Cherie Sim

Date: 20/7/2023

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Chapter 1: General introduction

Chapter overview

The main goal of this thesis is to contribute to research on encouraging healthier food and drink choices through nudging. This introductory chapter aims to present the layout of the thesis, with each chapter written up as individual stand-alone manuscripts with the eventual goal of publication. The present chapter (Chapter 1) will introduce the importance of nudging healthier food choices in an increasingly unhealthy food environment. In particular, a brief understanding of the current use of labelling as a nudging strategy will be provided, followed by an overview of the specific approaches in out of home dining labelling, the focus of the present thesis. Additional personal factors which might influence the effectiveness of menu labelling (e.g., dietary restraint, nutrition knowledge) will also be briefly discussed. Finally, a brief summary of the thesis and research goals will be presented.

The changing global food environment and health concerns

Worldwide and particularly in Western or high socio-economic-status countries, increases to global food supply have helped ease world hunger. While greater access to food is beneficial in reducing cases of malnutrition causing death and disease, there is a double edged sword to the increased access to food as it may lead to overconsumption of some nutrients (Masters et al., 2022). In particular, the increased access and affordability of food has led to a growing majority of diets high in fats and sugar but lower in fibre, described by Popkin and Gordon-Larsen (2004) as a global dietary convergence on a ‘Western diet’.

Within USA and Australia, for every $1 spent on food approximately 33% is spent on services associated with dining out of home (Suncorp Group, 2020; Martin, 2023). Beyond an increased access to such unhealthy processed food in settings such as supermarkets, globalisation has also been accompanied by the convenience of dining out of home, with the spread of fast-food restaurants alongside urbanisation (Mendez & Popkin, 2004). Although the Covid-19 pandemic reduced the amount of dining out in restaurants and fast-food outlets, this was accompanied by an increase in consumers ordering takeaway foods and delivery (Conway et al., 2020). This increased demand has led to food delivery services expanding to meet consumers' needs, thereby further increasing the accessibility to food prepared outside the home (Partridge et al., 2020). The global food delivery market is estimated to have tripled between 2017 and 2021, and current forecasts show that this trend only continues to grow (Ahuja et al., 2021). The growth and access to an unhealthy food environment has been shown to increase the risk of unhealthy diets, where proximity to fast-food outlets was associated with lower dietary quality when individuals are faced with food insecurity (Van der Velde et al., 2022).

The increased consumption of unhealthy food and convergence on the 'Western diet' is associated with health risks such as obesity and noncommunicable diseases (e.g., diabetes and stroke). The World Health Organisation (2022) estimated that noncommunicable diseases account for 70% of the world's deaths and highlighted the large burden placed on healthcare systems, alongside affecting an individual's quality of life. Unhealthy diets play a large role in the increased risk of this burden (WHO, 2022). However, diet is a modifiable lifestyle factor that has potential for intervention, and has been the subject of an increasing field of research looking to mitigate the effects of malnutrition by overconsumption.

Interventions and nudging

As countries work toward addressing the negative effects of urbanisation and unhealthy food consumption, there is a need for research to support scientific knowledge and policy making. Several interventions have already been implemented (e.g., education, governmental policies). One common and well-established strategy is education, with nine out of ten countries implementing school health and nutrition programs (UNESCO et al., 2023). Common curriculum programs include physical and nutrition education within schools, with programs more likely to be implemented at primary rather than secondary education levels. Notably, about 76% of countries include education content on healthy diets to prevent overweight and obesity, highlighting the widespread need for healthier eating to be encouraged in most countries. Due to the variability of diets and food cultures, many countries have developed their own systems recommending a culturally appropriate version of a healthy diet (UNESCO et al., 2023).

However, other interventions share a commonality across countries. One is the use of a sugar tax, which is implemented in over 80 countries (Australian Medical Association, 2023). A similar taxation for junk food or foods high in fat has also been implemented in countries such as Denmark, Hungary, and Mexico (Grout et al., 2022). |Reviews for the use of a sugar tax show support for the implementation with projected reductions in obesity and improvements in heart health, and suggest that the benefits would be greater for individuals from lower income groups (Backholer et al., 2016; Park & Yu., 2019). However, the evidence supporting food taxes is more mixed; while some reviews show tentative support (Powell & Chaloupka, 2009; Afshin et al., 2017), others highlight unintended consequences, such as a fat tax reducing the consumption of saturated fat, but increasing salt intake instead (Mytton et al., 2007; Smith et al., 2018). However, despite the goal of increasing population health, an emerging critical voice against such policies is that they limit personal freedom of choice, and accuse governments of being overbearing in its policies (Barnhill et al., 2014).

An alternate approach is the use of nudging, where choices are encouraged, but not forbidden. Thaler and Sunstein (2009, p.6) introduced nudging in their book as “any aspect of choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic intentions”. In contrast to a tax on sugar or fat content in which the financial costs might be pushed on to customers, nudging maintains freedom of choice, but makes the healthier option either more appealing or more easily accessible. As conceptualised by Cadario and Chandon (2019) in their meta-analysis, nudges were divided into three categories: cognitively oriented nudges, affectively oriented nudges, and behaviourally oriented nudges.

The current thesis aims to narrow the focus on the first category of cognitively oriented nudges. This category was further divided into three groups: descriptive nutritional labelling, evaluative nutritional labelling. and visibility enhancements. The use of nutrition labelling was chosen as the topic of this thesis due to the recent trend in governmental policies, which have mandated the use of calorie labelling within certain dining scenarios (e.g., chain fast-food restaurants). Such policies were introduced as early as 2006 in the U.S.A and as recently as 2022 in the U.K. (Swartz et al., 2011; Yeo, 2022). As such, there has been an increased interest in the use of labelling, which warrants research to help support the creation and implementation of these policies.

Current research on labels

The most prominent and widespread use of labels is that on packaged foods, with the WHO (2022) estimating that over 90 countries have mandatory provision of nutrition information on pre-packed products. A common example of such labelling is the nutrition fact panel on the back of boxes. With packaged food labelling being introduced as early as 1973 in the USA, there has been an established history of research and reviews on the use and effectiveness of packaged food labelling (Boon et al., 2010).

Despite the widespread use of packaged food labelling that highlights the nutritional value of a food product, reviews have found mixed evidence of their effectiveness.

Anastasiou et al.'s (2019) systematic review found inconsistent support for the use of food labels, noting that fact panels showed some association with improved diets, but insufficient support for other forms of labelling such as ingredient lists or serving sizes. Another review by Shangguan et al., (2019) found stronger support for food labelling, with multiple benefits such as reduced fat and energy intake. Of particular interest for research is the use of alternate types of labels, namely interpretive labels which help consumers interpret nutritional information. An example of such a label is the U.K. traffic light system, where nutritional information is presented with red, amber or green colours to indicate the amount of fat/sugar/salt per portion, or per 100 grams (NHS, 2022). Another common example is the Australian Heart Foundation Tick introduced in 1989 where a logo with a red circle and a white tick mark was used on food packaging to highlight healthier choices (The Heart Foundation, 2023). Several meta-analyses have shown support for the use of such interpretive elements to help consumers interpret information and select healthier choices(Temple & Fraser, 2014; Hawley et al., 2012).

These use of interpretive elements to help consumers better understand nutrition information was identified by Candario and Chandon (2019) in their meta-analysis and described as 'evaluative' labelling. This is in contrast to 'descriptive' nutritional labelling, where information such as calorie counts or ingredient lists that provide factual information with no relative values (e.g., daily intake guidelines) or further interpretation are provided.

Within their meta-analysis, Cadario and Chandon compared the use of evaluative and descriptive nudges used in a mix of settings including grocery stores, cafeterias and eateries. The results of their meta-analysis showed that evaluative labelling had a larger effect size of nudging healthier food choices (e.g., choosing a healthy option over an unhealthy option, or a reduced intake of unhealthy food) than descriptive labelling. Although these results show promise for the use of evaluative labels, there is a need for further research and a better understanding of labelling and its nudging effects. As highlighted above, with an increased consumption of food prepared outside the home, there is a need to specifically examine the use of labelling in out of home dining scenarios. As such, the goal of this thesis is to expand on the concepts introduced in Cadario and Chandon's review, with a specific focus on the use of descriptive versus evaluative labelling in an out of home dining scenario.

Out of home dining labels

As highlighted above, there has been increased access and demand for food prepared and consumed outside the home. As such, there is a need to examine the use of labelling on menus and other food sources such as online ordering menus. At present, a widely used format of menu labelling is calorie labelling, which was enforced via policies as early as 2006 in New York, U.S.A., and has grown to include other countries such as Australia and the U.K. (Swartz et al., 2011; NSW Government Food Authority, 2013; Vadiveloo et al., 2011; Yeo, 2022).

As calorie labelling is the most widely used and mandated format, there have been multiple studies, reviews and meta-analyses examining its effectiveness in reducing the total kcal consumed or ordered. A common outcome from these meta-analyses is that calorie labelling often has a positive nudge in reducing the overall calories ordered/consumed, but that this effect is not statistically significant (Cecchini & Warin, 2015; Nikolaou et al., 2015; Sinclair et al., 2014). Another analysis by Long et al. (2014) found a significant reduction in calories ordered or purchased when calorie labelling was implemented across a pool of 19 studies. However, when studies were grouped by setting, studies in restaurants showed a non-significant effect of calorie labelling, while studies conducted in non-restaurant settings such as laboratory experiments continued to have a significant nudge effect of reduced calories ordered/consumed.

Similar to the issue of packaged food labelling having limited success with descriptive labelling, reviews have suggested that the inclusion of additional interpretive elements may improve the effectiveness of menu labelling (Littlewood et al., 2015; Sinclair et al., 2014). An example of such interpretive labelling to accompany declarative calorie counts is the Physical Activity Calorie Equivalent (PACE), where the number of minutes of walking or running to burn the number of calories is provided in the label (Daley et al. 2020). Other examples of evaluative menu labelling include the use of ‘high’ or ‘low’ labels for specific macronutrients such as salt or fats, or the inclusion of traffic light colours to indicate the healthiness of a product. With the wide range of evaluative and interpretive labels, there is a need to consolidate and summarise the current field of research in both laboratory and field experiments. Chapter 2 of this thesis aims to do so in the meta-analysis, alongside comparing the nudge effects of descriptive and evaluative labelling.

Moderating factors

Following the meta-analysis, three experimental studies were conducted to compare various evaluative labelling systems. Alongside the comparison of these labels, individual factors were also examined. Two factors were chosen to examine their possible interaction effects with menu labelling, nutrition knowledge and dietary restraint. Based on previous research, it was hypothesized that these two personal factors would influence a participant’s likelihood of choosing a healthier food or drink when presented with a labelled menu.

The first factor nutrition knowledge can be defined as an individual’s knowledge of food and nutritional values. Previous research has shown an association between higher nutrition knowledge and better-quality dietary intake such as increased fruit and vegetable consumption (Spronk et al., 2014). This correlation was expanded upon by a model proposed by Miller and Cassidy (2015), whose review paper suggests that individuals with higher nutrition knowledge are more likely to accurately understand and make decisions based on nutrition labels. Their review analysed the impact of nutrition knowledge on packaged food labels. The studies in this thesis aimed to see if the results can also be applied to menu labelling.

A downside of the association between nutrition knowledge and label use is that declarative or factual labels may not be easily interpreted by consumers with low nutrition knowledge. Previous research has shown that too much information can lead to confusion and a lack of proper use of packaged food labels (Cowburn & Stockley, 2005). As such, there is an opportunity for interpretative labels to reduce the demand on nutrition knowledge, helping individuals who have lower nutrition knowledge make healthier meal choices. As such, it is possible that evaluative labelling may be more effective for individuals with lower nutrition knowledge.

The second individual factor examined in this thesis is dietary restraint, which is the intention and cognitive goal to lose or maintain weight by regulating food intake (Herman & Polivy, 1980). Various menu labelling studies have hypothesized that high dietary restraint would lead to healthier food choices in line with dieting goals (Sharma et al., 2011; Sonnenburg et al., 2013). Additionally, a study by Jacob et al. (2020) found that cognitive restraint was positively associated with self-reported label use. In a study by Girz et al. (2012) restraint affected their participants choice of meal (between pasta and salad) regardless of labelling, but no interaction effect was detected with the calorie labels used in their study.

However, at present there is no conclusive body of research that indicates a clear link between dietary restraint and behavioural food intake in response to nudging. As suggested by Bublitz et al. (2010), the continuous cognitive regulation of food intake can be interrupted, leading to lapses in diets or overconsumption. Dietary restraint has also been identified as a risk factor for binge eating, often due to a loss of control and associated all-or-nothing thinking and overeating (Linardon, 2018). As such, the use of menu labelling for restrained eaters may occasionally have the opposite effect, where a failed or lapsed dieter may actively choose unhealthy items based on menu labelling as a form of overconsumption. The experimental studies of the present thesis aimed to examine potential interaction effects of menu labelling and dietary restraint in the light of current conflicting evidence.

Overview of the thesis

In summary, the current food environment is a factor contributing to increased access to unhealthy food, with an associated escalating global obesity rate and health risks. The use of labelling nudges can help encourage healthier food choices without expressively forbidding options, which might be a more acceptable policy than food taxes or bans. Although nutritional labelling of packaged food has long been established, meta-analyses and reviews suggest that the inclusion of interpretive elements can help consumers better understand and utilise such labelling. This use of interpretive elements can also be translated to menu labelling, which is a growing field of research due to the increased access to food prepared outside the home.

As such, the overall aim of the thesis is to contribute to the field of knowledge regarding labelling use in the out of home dining context. With this goal in mind, the remainder of the thesis consists of a meta-analysis, three experimental studies and an overall general discussion. The meta-analysis (Chapter 2) gathers and summarises the current published research that tests the effectiveness of evaluative and interpretive labels relative to descriptive labels.

Chapters Three and Four present three experimental studies which examine the use of evaluative labels on a cafe style menu. Chapter Three describes a study which compares the use of multi-coloured traffic light labels and a healthy tick label option to a no information control. Chapter Four is comprised of two studies where only red and green labels are used to allow for an examination of approach versus avoidance nudges. The fifth and final chapter is a general discussion of the overall thesis results and their broader implications.

References

Afshin, A., Penalvo, J. L., Del Gobbo, L., Silva, J., Michaelson, M., O'Flaherty, M., ... & Mozaffarian, D. (2017). The prospective impact of food pricing on improving dietary consumption: a systematic review and meta-analysis. *PloS one*, *12*(3), e0172277.

Ahuja, K., Chandra, V., Lord, V., & Peens, C. (2021). Ordering in: The rapid evolution of food delivery. *McKinsey & Company*, *22*.

Anastasiou, K., Miller, M., & Dickinson, K. (2019). The relationship between food label use and dietary intake in adults: A systematic review. *Appetite*, *138*, 280-291.

Australian Medical Association. (2023, January 20). *Time for Australia to join 85 countries and jurisdictions taxing sugary drinks*. Australian Medical Association. https://www.ama.com.au/media/time-australia-join-85-countries-and-jurisdictions-taxing-sugary-drinks

Authority, N. F. (2013). Evaluation of kilojoule menu labelling. *Silverwater: NSW Government*.

Backholer, K., Sarink, D., Beauchamp, A., Keating, C., Loh, V., Ball, K., ... & Peeters, A. (2016). The impact of a tax on sugar-sweetened beverages according to socio-economic position: a systematic review of the evidence. *Public health nutrition*, *19*(17), 3070-3084.

Barnhill, A., King, K. F., Kass, N., & Faden, R. (2014). The value of unhealthy eating and the ethics of healthy eating policies. *Kennedy Institute of Ethics Journal*, *24*(3), 187-217.

Boon, C. S., Lichtenstein, A. H., & Wartella, E. A. (Eds.). (2010). *Front-of-package nutrition rating systems and symbols: Phase I report*. National Academies Press.

Bublitz, M. G., Peracchio, L. A., & Block, L. G. (2010). Why did I eat that? Perspectives on food decision making and dietary restraint. *Journal of Consumer Psychology*, *20*(3), 239-258.

Cadario, R., & Chandon, P. (2019). Effectiveness or consumer acceptance? Tradeoffs in selecting healthy eating nudges. *Food policy*, *85*, 1-6.

Cecchini, M., & Warin, L. (2016). Impact of food labelling systems on food choices and eating behaviours: a systematic review and meta-analysis of randomized studies. *Obesity reviews*, *17*(3), 201-210.

Conway, M. W., Salon, D., da Silva, D. C., & Mirtich, L. (2020). How will the COVID-19 pandemic affect the future of urban life? Early evidence from highly-educated respondents in the United States. *Urban Science*, *4*(4), 50.

Cowburn, G., & Stockley, L. (2005). Consumer understanding and use of nutrition labelling: a systematic review. *Public health nutrition*, *8*(1), 21-28.

Daley, A. J., McGee, E., Bayliss, S., Coombe, A., & Parretti, H. M. (2020). Effects of physical activity calorie equivalent food labelling to reduce food selection and consumption: systematic review and meta-analysis of randomised controlled studies. *J Epidemiol Community Health*, *74*(3), 269-275.

Grout, L., Mizdrak, A., Nghiem, N., Jones, A. C., Blakely, T., Mhurchu, C. N., & Cleghorn, C. (2022). Potential effect of real-world junk food and sugar-sweetened beverage taxes on population health, health system costs and greenhouse gas emissions in New Zealand: a modelling study. *BMJ Nutrition, Prevention & Health*, *5*(1), 19.

Hawley, K. L., Roberto, C. A., Bragg, M. A., Liu, P. J., Schwartz, M. B., & Brownell, K. D. (2013). The science on front-of-package food labels. *Public health nutrition*, *16*(3), 430-439.

Heart foundation tick: The Heart Foundation. Heart Foundation Tick. (n.d.). https://www.heartfoundation.org.au/bundles/healthy-living-and-eating/heart-foundation-tick

Herman, C. & Polivy, J.(1980) Restrained eating. *Obesity. Philadelphia: Saunders*.

Jackson, S. E., Llewellyn, C. H., & Smith, L. (2020). The obesity epidemic–Nature via nurture: A narrative review of high-income countries. *SAGE open medicine*, *8*, 2050312120918265.

Jacob, R., Drapeau, V., Lamarche, B., Doucet, É., Pomerleau, S., & Provencher, V. (2020). Associations among eating behaviour traits, diet quality and food labelling: a mediation model. *Public health nutrition*, *23*(4), 631-641.

Linardon, J. (2018). The relationship between dietary restraint and binge eating: Examining eating-related self-efficacy as a moderator. *Appetite*, *127*, 126-129.

Littlewood, J. A., Lourenço, S., Iversen, C. L., & Hansen, G. L. (2016). Menu labelling is effective in reducing energy ordered and consumed: a systematic review and meta-analysis of recent studies. *Public health nutrition*, *19*(12), 2106-2121.

Long, M. W., Tobias, D. K., Cradock, A. L., Batchelder, H., & Gortmaker, S. L. (2015). Systematic review and meta-analysis of the impact of restaurant menu calorie labeling. *American journal of public health*, *105*(5), e11-e24.

Martin, A. (2023). USDA ERS - Food Prices and Spending. Usda.gov. https://www.ers.usda.gov/data-products/ag-and-food-statistics-charting-the-essentials/food-prices-and-spending/

Masters, W. A., Finaret, A. B., & Block, S. A. (2022). The economics of malnutrition: Dietary transition and food system transformation. *Handbook of agricultural economics*, *6*, 4997-5083.

Mendez, M. A., & Popkin, B. M. (2004). Globalization, urbanization and nutritional change in the developing world. *eJADE: electronic Journal of Agricultural and Development Economics*, *1*(853-2016-56106), 220-241.v

Miller, L. M. S., & Cassady, D. L. (2015). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, *92*, 207-216.

Mytton, O., Gray, A., Rayner, M., & Rutter, H. (2007). Could targeted food taxes improve health?. *Journal of Epidemiology & Community Health*, *61*(8), 689-694.

NHS. (2022, September 16). *Food labels*. NHS choices. https://www.nhs.uk/live-well/eat-well/food-guidelines-and-food-labels/how-to-read-food-labels/

Nikolaou, C. K., Hankey, C. R., & Lean, M. E. J. (2015). Calorie-labelling: does it impact on calorie purchase in catering outlets and the views of young adults?. *International Journal of Obesity*, *39*(3), 542-545.

Noncommunicable diseases. (2019, June 12). WHO | World Health Organization. https://www.who.int/health-topics/noncommunicable-diseases

Park, H., & Yu, S. (2019). Policy review: Implication of tax on sugar-sweetened beverages for reducing obesity and improving heart health. *Health Policy and Technology*, *8*(1), 92-95.

Partridge, S. R., Gibson, A. A., Roy, R., Malloy, J. A., Raeside, R., Jia, S. S., ... & Redfern, J. (2020). Junk food on demand: a cross-sectional analysis of the nutritional quality of popular online food delivery outlets in Australia and New Zealand. *Nutrients*, *12*(10), 3107.

Popkin, B. M., & Gordon-Larsen, P. (2004). The nutrition transition: worldwide obesity dynamics and their determinants. *International journal of obesity*, *28*(3), S2-S9.

Powell, L. M., & Chaloupka, F. J. (2009). Food prices and obesity: evidence and policy implications for taxes and subsidies. *The Milbank Quarterly*, *87*(1), 229-257.

Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., ... & PRICE, F. (2019). A meta-analysis of food labeling effects on consumer diet behaviors and industry practices. *American journal of preventive medicine*, *56*(2), 300-314.

Sharma, S., Wagle, A., Sucher, K., & Bugwadia, N. (2011). Impact of point of selection nutrition information on meal choices at a table-service restaurant. *Journal of foodservice business research*, *14*(2), 146-161.

Sinclair, S. E., Cooper, M., & Mansfield, E. D. (2014). The influence of menu labeling on calories selected or consumed: a systematic review and meta-analysis. *Journal of the Academy of Nutrition and Dietetics*, *114*(9), 1375-1388.

Smith, E., Scarborough, P., Rayner, M., & Briggs, A. D. (2018). Should we tax unhealthy food and drink?. *Proceedings of the Nutrition Society*, *77*(3), 314-320.

Sonnenberg, L., Gelsomin, E., Levy, D. E., Riis, J., Barraclough, S., & Thorndike, A. N. (2013). A traffic light food labeling intervention increases consumer awareness of health and healthy choices at the point-of-purchase. *Preventive medicine*, *57*(4), 253-257.

Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *British journal of nutrition*, *111*(10), 1713-1726.

Swartz, J. J., Braxton, D., & Viera, A. J. (2011). Calorie menu labeling on quick-service restaurant menus: an updated systematic review of the literature. *International Journal of Behavioral Nutrition and Physical Activity*, *8*, 1-8.

Taillie, L. S., Busey, E., Stoltze, F. M., & Dillman Carpentier, F. R. (2019). Governmental policies to reduce unhealthy food marketing to children. *Nutrition reviews*, 77(11), 787-816.

Temple, N. J., & Fraser, J. (2014). Food labels: a critical assessment. *Nutrition*, *30*(3), 257-260.

The cost of keeping up with food trends. Suncorp Group. (2020, December 8). https://www.suncorpgroup.com.au/news/news/cost-of-food-trends-australia

UNESCO, UNICEF, WFP (2023) *Ready to learn and thrive: school health and nutrition around the world*

Vadiveloo, M. K., Dixon, L. B., & Elbel, B. (2011). Consumer purchasing patterns in response to calorie labeling legislation in New York City. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 1-9.

Van der Velde, L. A., Zitman, F. M., Mackenbach, J. D., Numans, M. E., & Kiefte-de Jong, J. C. (2022). The interplay between fast-food outlet exposure, household food insecurity and diet quality in disadvantaged districts. *Public Health Nutrition*, 25(1), 105-113.

World Health Organization. (2022). *Nutrition labelling: policy brief*. World Health Organization.

Yeo, G. S. (2022). Is calorie labelling on menus the solution to obesity?. *Nature Reviews Endocrinology*, *18*(8), 453-454.

Chapter 2 (Study 1): A systematic review and meta-analysis of nudging labels in an out of home dining context

Abstract

With the rapid spread of globalisation, there is an increased access and intake of unhealthy food high in excess fats, sugars and salt. One source of such unhealthy food is meals consumed outside the home (e.g., fast-food restaurants). Recent public health policies have intervened by enforcing mandatory calorie labelling in chain restaurants. However, there is a need to examine the use of a variety of labels in the out of home context. As such, this meta-analysis compared descriptive (factual) and evaluative (interpretive) labels, and aimed to summarise the current research on labels that help consumers interpret information. Six databases (CINHAL, Cochrane Trials, Medline, Proquest, PsycInfo and Scopus) were searched for articles examining labelling nudges in the out of home context. A final total of 39 articles were included in the meta-analysis, which provided 43 studies and 89 effect sizes. An overall effect of labelling nudging healthier choices was found (Cohen's $d = 0.13$, $p = .001$). Mixed effect analysis revealed that descriptive labelling had a small but non-significant effect ($d = .07$, $p = .12$), while evaluative labelling had a statistically significant nudging effect ($d = .15$, $p = .001$). When groups of studies were compared, calorie labelling that was presented in combination with either traffic lights ($d = .28$, $p = .005$) or physical activity equivalents ($d = .18$, $p = .008$) was shown to significantly nudge healthier choices. Additionally, labelling nudges were shown to be effective in fast-food settings ($d = .17$, $p < .001$) and restaurants ($d = .13$, $p = .006$), but not cafeterias ($d = .10$, $p = .38$). The present results show support for the use of evaluative labelling nudges in the out of home dining context alongside current declarative labels. However, more information is needed to draw firmer conclusions due to the variability across studies in this field.

Introduction

Noncommunicable diseases such as stroke and diabetes account for 70% of global deaths (WHO, 2021). A major cause of these diseases is an increased consumption of unhealthy food, i.e., food that contains excess fat, sugar, and salt (Popkin et al., 2021; WHO, 2021). Access to such unhealthy food has rapidly increased as globalisation and urbanisation spread. This signals an increasing need to target and encourage healthier consumption worldwide (Popkin et al., 2021).

With increased access to ready-to-eat food and meals prepared outside the home, there has been a growing interest in encouraging healthier choices in the out of home dining context. In Australia, the average adult has been recorded to visit quick service restaurants (e.g., fast food joints) 4.8 times a month (Roy Morgan Research, 2021). Because of increased demand due to the COVID-19 pandemic, restaurants and other food services have increased their delivery range, and access to unhealthy foods high in fats, sugars, and salt prepared outside the home only continues to grow (Patridge et al., 2020).

There are a variety of approaches that attempt to address the consumption of unhealthy food (Kumanyika et al., 2022). These include strategies such as nutrition education programs, increasing access to healthy foods, and food labelling (Bowen et al., 2015). Other approaches include financial incentives such as a sugar-sweetened beverage tax, or a restriction on the advertising of foods considered unhealthy (Chung et al., 2022; Fernandez & Raine, 2019). However, a criticism of governmental policies that restrict choice via limiting sales or increasing costs through taxation is that they are overbearing and impinge upon an individual’s freedom (Barnhill, 2014).

One solution could be to implement nudging policies instead where healthy choices are encouraged but unhealthy ones are not explicitly forbidden. Nudging is defined by Thaler and Sunstein (2009, p.6) as “any aspect of choice architecture that alters people’s behavior in a predictable way without forbidding any options or significantly changing their economic intentions”. The main benefit of nudging is the lack of behavioural restriction, which produces less resistance, as choices and decisions remain under the consumer’s control. In a meta-analysis by Cadario and Chandon (2019), which examined cognitive, affective, and behavioural oriented nudges across a mix of settings (e.g., grocery stores, cafeterias, eateries), healthy eating nudges were effective in reducing unhealthy eating, with an estimated reduction of about 124 kilocalories per day. Additionally, their analysis found no significant differences between effect sizes when of results when foods were selected or ordered, in contrast with studies that assessed the amount actually consumed as the outcome. As such the following meta-analysis will consider both measures of selection and consumption under the same outcome measure.

One approach to nudging a healthier diet is adapting the well-established use of packaged food labelling - which was introduced as early as 1973 in the USA - into the out of home dining context (Boon, 2010). Food labelling is a suitable nudge as it aims to inform the customer of the contents and nutrient information of the food, but does not limit a consumer’s choice. In contrast to packaged food labelling, menu labelling policies are relatively recent, being introduced to the U.S.A. in 2010, Australia in 2012, and the U.K. in 2022 (Swartz et al., 2011; NSW Government Food Authority, 2013; Yeo, 2022). To date, menu labelling policies have largely been calorie-focused, and have a mixed body of support. While several meta-analyses have found reductions in overall calories ordered, the results are often not statistically significant (Cecchini & Warin, 2015; Nikolaou et al., 2015; Sinclair et al., 2014).

The current meta-analysis builds on the previous meta-analysis by Cadario and Chandon (2019) by targeting the out of home dining context. As highlighted above, there has been an established field of research within packaged food labelling (used in stores and supermarkets), and a growing need to address foods consumed out of home. This meta-analysis narrows the scope of nudging specifically to cognitively oriented nudges, which includes two types of labelling : descriptive labelling and evaluative labelling (Cadario & Chandon). Labelling methods such as ingredient lists and nutrient declarations are often descriptive in nature, where values and facts are stated with no further information. In contrast, evaluative labelling helps consumers interpret facts or nutrient values of the food items. An example of descriptive versus evaluative labelling is the use of the descriptive label ‘contains 100 calories’ compared to the evaluative exercise label ‘25 minutes of walking to burn 100 calories’. While both labels state the same information, evaluative and interpretive labels provide additional context to help nudge consumers to make healthier choices.

In addition to the type of nudge (descriptive vs evaluative), it is also important to consider the food setting. In contrast to packaged food labels at the supermarket, where food choices are often made for future consumption, out of home dining labels focus on helping customers make choices about foods they are likely to eat immediately. The incorporation of interpretive elements from evaluative labelling into restaurant menus has been supported by the Australian Chronic Disease Prevention Alliance (ACDPA; 2011) in their statement addressing nutrition labelling. As such, this review aims to scope the current research of labelling nudges in the out of home dining context. This includes food service locations targeting immediate consumption. As suggested by Cohen and Babey (2012), a large number of factors play a role in decision making in both restaurants and supermarkets. While some factors are similar between both settings (e.g., variety and presence of labels), others are specific to each location, such as wait staff behaviour in restaurants and advertising of branded packaged products in supermarkets. Research into evaluative labelling on packaged foods may not directly translate to the out of home labelling context. With ever increasing access to food prepared outside the home, it is important to examine the potential of both descriptive and evaluative labelling beyond packaged foods.

As mentioned earlier, the current field of menu labelling is largely focused on calorie labelling, which is the most commonly used and investigated system (Littlewood et al., 2015; Long et al., 2015, Swartz et al.,2011; Sinclair et al. 2014). Although some papers analysed in this review will include calorie labelling as their intervention, the review's main focus is on the analysis of the interpretive element used (e.g., walking distance needed to burn calories). Another review by Shangguan et al. (2019) had a similar scope of examining the impact of both packaged and menu/point of purchase labelling on consumer choices, but the current review will focus solely on comparing the impact of evaluative and interpretive labelling relative to descriptive labelling within the menu context. Similarly, other reviews that have examined the out of home dining context have often included a compilation of nudges such as proximity and placements (Arno et al., 2016; Broers et al., 2017; Cadario and Chandon, 2019). Although these nudges have shown some promise, the current study aims to purely focus on labelling as is it easily implemented across various contexts regardless of dining scenario. As such, the current study aimed to contribute to the field of nudging by examining the application of labels that helped consumers interpret information. Although previous reviews and meta-analyses have explored the topics of labelling, and nudging healthier choices, to the author's knowledge this is the first meta-analysis to examine the use of interpretive evaluative labels within the specific context of out of home dining.

To the author's knowledge, no review has specifically examined and contrasted descriptive and evaluative labelling methods. In line with the premise of nudging that making healthier choices should be easy and simple, the present meta-analysis aims to assess the effectiveness of evaluative and interpretive labelling in comparison to descriptive labelling in the out of home dining situation. Although grouping and comparing types of labelling was incorporated into Cadario and Chandon's (2019) review, their focus was on field studies and the examination of a broader range of nudges. They also did not include odds ratios or sales data. In contrast, the current meta-analysis aims to examine and compare the current scope of evaluative labelling specifically for out of home dining services/scenarios designed to help consumers interpret nutritional information. In particular, it aims to summarise the evidence on evaluative labelling, and contribute to the field by contrasting it to the currently established research on descriptive calorie labelling.

Methods

The Preferred Reporting Items for Systematic Review and Meta-Analyses guidelines (PRISMA; Page et al., 2012) was used to guide the meta-analysis process. The review was registered with the Open Science Framework on 30 May 2020, with the code GFH78 (https://osf.io/gfh78)

Search strategy

The initial search strategy was developed in consultation with a Flinders University academic librarian. The final search strategy was based on a combination of key terms, synonyms and phrases relating to nudging intervention, out of home dining, menu labelling and food choices (see Appendix A for the full list of terms). The initial search was conducted on 25 August 2020 and included the following databases: CINHAL, Cochrane Trials, Medline, Proquest, PsycInfo and Scopus. A second follow-up search was conducted using the same search strategy on 12 May 2023 to update the pool of papers and ensure any new articles would be included.

Eligibility criteria

For inclusion, studies had to examine a labelling approach that helped customers interpret nutritional information, included on the menu, display or food items, and not only available on request or via an additional step (e.g., information only on restaurant website). Studies designs required Randomised Control Trials or pre- and post- test phases of baseline and intervention. Lastly, the settings required participants to make either an actual or hypothetical meal choice for consumption in an out of home dining setting or menu (e.g., cafeteria, restaurant, fast food outlet). Studies were excluded if they examined packaged foods (e.g. cereal boxes), the use of labels on only drinks, or combined labelling with other nudges or interventions (e.g. both a pricing and labelling nudge implemented at the same time).

Inclusion screening

Covidence, an online systematic review website, was used to manage the screening process. The papers were first uploaded, and duplicates were removed. Title and abstract screening were completed by two independent reviewers, and papers that met the eligibility criteria were moved to full text screening to ensure they met inclusion/exclusion criteria. Following full text screening, quality assessment was undertaken by two independent reviewers. Any disagreements at each stage were discussed between the reviewers, and a third reviewer was approached for conflicts or uncertainties. The additional studies collected in the second search were also reviewed via Covidence and followed the same process of title and abstract screening, followed by full text screening, quality assessment and data extraction. Forward and backward hand searching was also conducted with the reference lists of the included studies and any additional studies were entered directly into the full text screen phase.

Data extraction and Quality Assessment

Data extraction was completed using Microsoft Excel. The number of participants, experimental setting, labels used, and outcome measures were entered into Table 1. The Quality Assessment process used the Mixed Methods Appraisal Tool to evaluate each study's quality and risk of bias (Hong et al., 2018). Quality Assessment was completed for each full text article by two independent reviewers. Each study was then assigned a 1-to-5-star rating based on the percentage of quality criteria met. Different criteria were used for each category of study (e.g., qualitative randomised vs non-randomised studies), including questions such as the appropriateness of measures used and the reporting of complete outcome data.

Table 1.

Studies included in the meta-analysis

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
Allan et al., 2015	UK Public	NA	Field study RCT	Academic hospital coffee shop	1) No information control 2) Rank ordered calories	Sales data, proportion of high vs low calorie purchases	4
Boonme et al., 2014	USA University students	230 (40%)	Laboratory RCT	Fast food	1) No information control 2) Heart-icon only 3) Nutrition information only	Odds ratio of healthy/unhealthy choice	3
Carbonneau et al., 2015	Canada Public	141 (100%)	Field study RCT	Lab provided meals for 10 days	1) No information control 2) Low-fat label 3) Calorie label	Kcal consumed	3
Dodds et al., 2014	Australia Parents	329 (83.3%)	Laboratory RCT	Fast food	1) No information control 2) Calorie only 3) Single traffic light (based on energy, sugar, fats, salt)	Kcal ordered, both children's and adults' meal	5
Dowray et al., 2014	USA University employees	802 (88%),	Laboratory RCT	Fast food	1) No information control 2) Calorie only 3) Calorie +walking time 4) Calorie +walking distance	Kcal ordered	4

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
Ebneter et al., 2013	USA Undergraduate women	175 (100%)	Laboratory RCT	Taste-rating task for a new type of M&M's	1) Low-fat-labelled with caloric information 2) Low-fat-labelled without caloric information 3) Regular-fat-labelled with caloric information 4) Regular-fat-labelled without caloric information	Kcal consumed	4
Erdem et al., 2022	UK Public	172 (41.1%)	Field study Pre and post intervention cohort	Restaurant on campus	1) No information control 2) Pace + traffic light	Kcal ordered	2
Feldman et al., 2015	USA Students	424 (51.65)	Laboratory RCT	University cafeteria	1) No information control 2) Multiple traffic light (calories, sodium, sugar, total fat, and carbohydrate)	Odds ratio of healthy/unhealthy choice	2
Giazitzi, 2022	Greece Public	437 (72.8%)	Laboratory Repeated measures	Traditional Greek restaurant	1) No information control 2) Calories only 3) Icon (nutritionally balanced mark)	Kcal ordered	3
Hammond et al., 2013	Canada Public	635 (55.8%)	Laboratory RCT	Fast food	1) No information control 2) Calorie only 3) Single traffic light (calories) 4) Multiple traffic light (calorie, fat, sodium, and sugar)	Kcal consumed	4
James et al., 2015	USA Students	300 (55.67%)	Laboratory RCT	Fast food menu	1) No information control 2) Calorie + guideline daily amount 3) Exercise (brisk walking)	Kcal consumed	4

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
Julia, 2021	France Staff	2063 (NA)	Field study Matched groups pre and post	Staff restaurants in the same company	1) No information baseline 2) Nutri-Score label: graded and coloured front of pack label	Kcal ordered	3
Kerins et al., 2016	Ireland Public	NA	Field study Quasi-experimental pretest–posttest design	Mixed: Four restaurants, three café/coffee shops and one pub restaurant/bar	1) No information baseline 2) A heart healthy icon: e.g. Cholesterol Friendly, Diabetes Friendly	Sales data: % of healthy items sold	2
Kim et al., 2018	USA University students	95 (54.73%)	Laboratory randomized, repeated measures crossover	Fast food	1) Control: calories only 2) Calories + traffic light 3) Calories + minutes to run	Kcal ordered	4
Lee &Thompson, 2016	USA Undergraduat e students	643 (76%)	Laboratory RCT	Fast food	1) No nutrition information label 2) Calorie count only label 3) Calorie count + walking distance	Kcal ordered	4
Lee & Lee, 2018	South Korea Parents	1980 (50.2%)	Laboratory RCT	Mixed: fast-food or family restaurant	1) No information control 2) Low-calorie symbol besides the lowest calorie item within each category 3) Numeric value (per portion: calories (kcal), sugar (g), protein (g), saturated fat (g), and sodium (mg),) 4) Both low-calorie symbol and numeric value (symbol + numeric)	Kcal ordered for child	4
Levin et al., 1996	New Mexico Staff	NA	Field study	Worksite cafeteria	1) No information baseline 2) Icon/symbol: heart-shaped labels	% of healthy entrée sales	5

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
			Repeated measures, comparison group, quasi-experimental design				
Liu et al., 2012	USA Public	419 (69.5%)	Laboratory RCT	Restaurant menu-dinner	1) No Calories 2) Calories + RDI 3) Calories + rank order + RDI 4) Calories + rank order + RDI + green or red circles	Kcal ordered	4
McCann et al., 2013	North Ireland University	47 (48.9%)	Laboratory Repeated measures design with a fixed sequence of treatment	Lunch served from lab; Food was repeated; label was manipulated	Multiple traffic lights of energy and fat content of meals 1) Green 2) Amber 3) Red	Megajoules consumed	4
Musicus et al., 2019	USA Public	4234 (NA)	Laboratory RCT	Restaurant menu	1) No information control 2) Icon: red stop sign 3) Traffic light sodium label	Sodium ordered	4
Niven et al., 2019	Australia Public	1007 (54%)	Laboratory RCT	Menu boards	1) No information control 2) Kilojoule only 3) Health Star Rating only 4) kilojoule and HSR	Kilojoules ordered	5
Oliveria et al., 2018	Brazil University undergraduates	223 (45.29%)	Field study Cross-sectional, parallel-group cluster RCT	Restaurant weekday lunch	1) No information control 2) Traffic light + guideline daily amounts	% of healthy items chosen	5

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
					3) Ingredients list plus highlighted symbols (e.g. contains gluten, organic).		
Olstad et al., 2015	Canada Public	NA	Field study Cohort pre post design	Recreation and sport facility concession	1) No information baseline 2) Single traffic light	% of healthy items chosen	3
Platkin et al., 2014	USA Students	62 (100%)	Laboratory RCT	Fast food	1) No information control 2) Calories only 3) Calories + exercise equivalents	Kcal ordered	3
pratt et al., 2016	USA Public	362 (58.84%)	Field study Cohort pre post	Café	1) No information control 2) Graphical display 3) Nutrition facts panels	Kcal ordered	3
Prowse, 2020	Canada Parents	998 (50.4%)	Laboratory RCT	Restaurants	1) No information control 2) Calories Only 3) Calories + Contextual Statement (CS – mention of daily guidelines) 4) Calories, Sodium + CS 5) Calories and Sodium in Traffic Lights + CS	Kcal ordered	4
Reale et al., 2016	UK University	84 (48.8%)	Laboratory RCT	Restaurant	1) Calorie only 2) Calorie+ low calorie icon 3) Calorie in TL colours	Kcal ordered	4
Reynolds et al., 2022	UK Staff	NA	Field study Step wedge intervention with baseline, pre, and post measures	Worksite cafeteria	1) No information control baseline 2) Physical activity calorie equivalent (walking minutes)	Kcal ordered	5

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
Roberto et al., 2010	USA Public	295 (50.17%)	Laboratory RCT	Menu items from 2 restaurants	1) Control 2) Calories 3) Calories + recommended daily intake	Kcal consumed	5
Roy & Alassadi, 2021	New Zealand University	NA	Field study Comparison group, quasi-experimental	2 comparison campus food outlets	1) Control outlet 2) Ticks added to healthy choice on intervention outlet	Sales data, proportion of healthy items sold	3
Sato et al., 2013	USA Staff	NA	Field study quasi-experimental study	Hospital cafeteria offering 2 entrees (1 healthy, 1 regular)	1) No information baseline 2) Graphic pie chart (daily percentage of calories, fat, and sodium)	Sales data proportion picked healthier choice	4
Stacey et al., 2021	Australia Parents	NA	Field study cluster RCT	Lunch orders for students in kindergarten to year six placed via a mobile device.	1) Control: no change to current traffic lights 2) Intervention tailored feedback pie graph showing proportion of ‘everyday’, ‘occasional’, and ‘caution’ items	Odds ratio of healthy/unhealthy choice	3
Stutts et al., 2011	US Children	236 (NA)	Laboratory Experimental condition is a between-subjects factor and restaurant is a within-subjects factor	Fast food	1) Nutrition information (calories and fat grams) 2) Symbol/icon: Heart healthy	Kcal ordered	3

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
Thorndike et al., 2012	USA Staff	NA	Field study Cohort baseline vs intervention	Hospital cafeteria	1) No information baseline 2) Single traffic light label	% of healthy items sold	4
Vanepps et al., 2016	USA Staff	249 (60%)	Laboratory RCT	Lunch menu ordered online	1) No information control 2) Calories 3) Traffic light 4) Traffic light+ calories	Kcal ordered	3
Vanepps et al., 2021	5 studies 1) University campus 2-5) Public online participants	1) 509 (49%f) 2) 1803 (59%f) 3)2437 (54% f) 4) 3002 (52%f) 5) 3010 (52% f)	Laboratory RCT	Study 1) sandwich and drink 2 - 5) restaurant menu	Study 1: calorie only or aggregated traffic light Study 2: calories only, calorie aggregation or traffic light aggregation Study 3: control, calories, calorie aggregation, or traffic light aggregation Study 4: calories only, and 4 interventions: 2 (format: numeric vs. traffic light) × 2 (aggregation type: continuous vs. discrete) Study 5: calories only, traffic light aggregations, emoji symbol aggregation	Kcal ordered	1)2 2-5) 3
Viera & Antonelli, 2015	USA Parents	823 (72%)	Laboratory RCT	Fast food	1) No information control 2) Calories only 3) Calories + exercise time 4) Calories + exercise distance	Kcal ordered for child's meal	3

Author(s)	Country Sample source	N (% female)	Study design	Setting	Labelling conditions	Outcome measure	Quality assessment
Viera et al., 2017	USA Employees	414 (778%)	Field study Cohort study, baseline vs interventions	Three worksite campus cafeterias	1) Calories only 2) Physical activity calorie expenditure	Kcal ordered	4
Whitt et al., 2017	USA Public	4440 (NA)	Field study Cohort study Baseline and traffic light	Children's hospital cafe	1) Baseline 2) Single traffic light	% of healthy items sold	3
Yepes et al., 2014	Switzerland Students	126 (62%)	Laboratory RCT	restaurant	1) No information control 2) Calories only 3) Calorie + graphic summary, 4) Single traffic-light 5) Single traffic-light + graphic summary 6) Single traffic light + calories	Kcal ordered	3

Data analysis

Data analyses were conducted using the Comprehensive Meta-Analysis (CMA) program version 4. Following Borenstein (2019), random effects analysis was used for the total overall analysis and mixed effects analyses were used for analysing effect sizes of subgroups. For studies that tested multiple interventions against a single control group, a similar approach to Sinclair et al.'s (2014) meta analysis was used, where studies were coded so that each intervention condition was compared separately against the control. For example, Dodds et al. (2014) tested three menus: control, calorie labels and a traffic light menu. The data for each intervention group was entered as a separate study to allow for a comparison of two effect sizes (1. control vs calorie labels, and 2. control vs traffic light menus). To prevent overrepresentation of multiple sample groups, the number of participants in the control group was divided by the number of interventions and rounded down to the nearest whole number.

The majority of studies that reported the energy ordered or consumed used the unit of Kilocalories (Kcal), and studies that reported outcomes in units of Kilojoules or Megajoules were converted to Kcal. Cohen's d was calculated for each study regardless of outcome measure (calories/ odds ratio).Additionally, studies were grouped based on the type of experimental design, where laboratory studies included online participation or participants being invited to separate dining setting, while field studies collected data from participants physically dining where food is usually provided (e.g. restaurant, cafeteria). The menus used were also categorised based on the types of food offered (e.g. fast food vs restaurant menus)The effect sizes presented in the meta-analysis results below use the standardized difference in means or Cohens' *d* reported alongside the 95% confidence interval. To assess heterogeneity of effect sizes Cochran's Q and the I^2 statistics were used (Cochran, 1954;

Higgins & Thompson, 2002). Egger's regression test was used to test for publication bias, along with examination of the funnel plot asymmetry.

Results

Study selections and coding

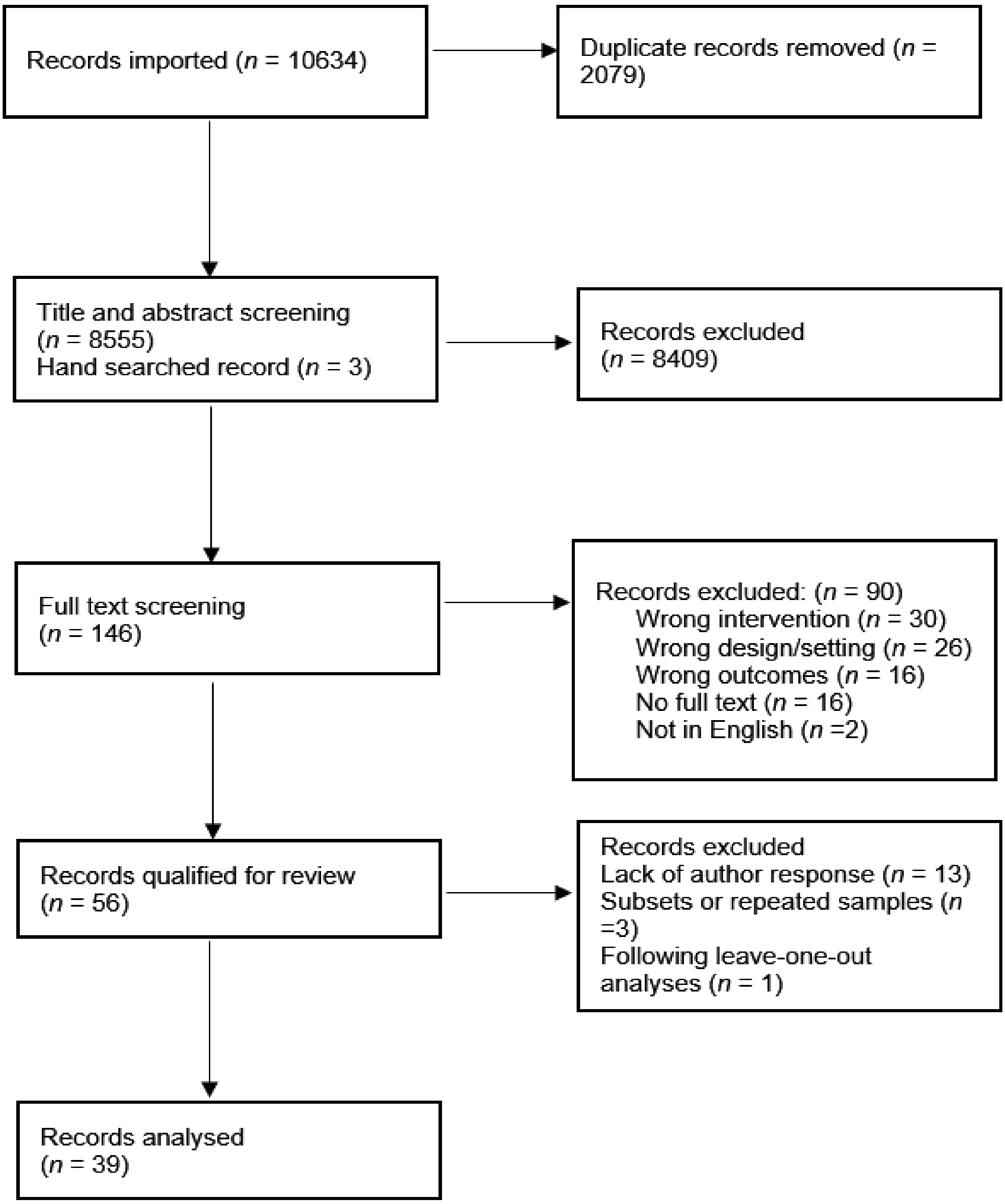
Overall, 10,634 articles were entered into Covidence for review. Following title and abstract screening, along with additional hand searched studies, 146 articles qualified for full text screening. Of these, 90 articles were excluded due to reasons including wrong interventions (n = 30; e.g. manipulating visibility or availability), wrong design or setting (n = 26), wrong outcomes (n = 16), no full text found (n = 16) or not published in English (n = 2) (see Figure 1).

As such, 56 articles qualified for inclusion; three articles (Levy et al., 2012; Thorndike et al 2019; Veira et al., 2019) were subsets or follow-ups of an original study sample (Thorndike et al., 2012; Viera et al., 2017) and were excluded from the analysis to prevent duplication and over-representation of their samples. Of the articles that qualified for inclusion, 22 did not include all of the data needed for meta-analysis. As such, email requests for missing data were sent to either the first author or the corresponding author of these studies, with a second follow-up email request if no response was received. A total of 13 authors did not respond with the requested data and their articles were excluded.

In total, 40 articles qualified for the final meta-analysis. One article (Vanepps et al., 2021) contained multiple studies, for a total of 44 studies. The coding of intervention conditions against the control condition in each study resulted in a total of 91 effect sizes for analysis. Following a leave one out analysis to identify outliers, a single study (Musiscus et al., 2019) with two effect sizes was noted as an outlier, and notably affected the Cohen's *d* scores. As such, the study and two associated effect sizes were excluded from further analyses. Due to the formatting of the CMA program, 1 effect size was not calculated due to the *p* result being larger than .5. Additionally, 3 studies (5 effect sizes) employed a pre and post matched groups design. As the authors did not report the pre/post correlation, a value of 0 was entered into CMA to prevent an over-representation of effect sizes. The final analyses were based on a total of 39 articles with 43 studies, and 88 effect sizes.

Figure 1.

PRISMA flowchart



Study characteristics

Thirteen studies collected anonymous data, often as sales, and did not report all sample characteristics. Overall, 34 out of 43 studies reported sample sizes, which ranged from 47 – 4,440 with a mean of 948.74 (*SD* = 1181.39). For gender, 31 studies reported the gender ratios; 3 studies recruited only female participants, while the other studies recruited all genders. In those studies, females represented between 40% - 62% for 21 studies, while 7 studies reported a majority female participant group ranging from 69% - 88% (see Table 1). Most studies (n = 16) recruited participants from the general public (e.g., online research portals or convenience sampling of customer sales), 14 studies recruited participants from a university setting (both staff and students), 7 studies examined staff in a workplace context, 5 studies only recruited parents, and 1 study recruited children as participants.

Studies were most commonly from the USA (*n* = 23), followed by Canada and the UK (*n* = 4 each), Australia (*n* = 3), along with one study each from Brazil, France, Greece, Ireland, Northern Ireland, New Mexico, New Zealand, South Korea and Switzerland. Studies were conducted either in laboratories (*n* = 26) or in field study (*n* = 17) settings. The setting of most studies was either a restaurant (n = 12) or fast-food outlets/menus (*n* = 11). The remaining studies included 9 cafeteria settings (5 workplaces, 2 hospitals, 2 student), 4 laboratory provided meals/food, 2 studies with mixed settings (more than one scenario examined within the study design), 2 cafes, and 3 others (university outlet, coffee shop and concession stand). Most studies (*n* = 32) measured kilocalories consumed or ordered, while 11 studies analysed odds ratios or the event rate of the healthier choices being picked, often through sales data. Of the 88 effect sizes, 24 examined descriptive labelling (calories only), while 64 examined evaluative and interpretive labelling, which were categorised in 8 groups (see Table 2 below for the breakdown of labels).

Table 2.

Number of effect sizes in each labelling category

Label type	Number of effect sizes
Descriptive calorie labelling	23
calorie + exercise (time/physical activity equivalent to burn calories)	8
calorie + icon (e.g. low/high calorie symbol)	4
calorie + other (e.g. ranking)	8
calorie + traffic lights	6
icon/symbol/other (e.g. low fat symbol, rankings)	20
Traffic lights + other	19

Outliers and publication bias

A visual examination of the funnel plot (Figure 2) shows a skew of effect sizes towards the left direction, which corresponds to Eggers regression test for publication bias that was statistically significant, $p = .04$. This suggests the possibility of publication bias within the current group of studies included in the meta-analysis and as such, results should be interpreted with caution.

Figure 2.

Funnel plot of Cohen's d plotted against standard error

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Descriptive vs evaluative labelling

The analysis of the remaining effect sizes using the random model showed that the average effect size of menu labelling nudges was small, but significant, $d = 0.13$ CI (.05, .22), $p = .001$, with an associated Z-value of 3.23 ($p = .001$), which allows for the conclusion that the mean effect size is greater than zero. When assessing heterogeneity, Cochran's Q (87) was 26701.69, $p < .001$, which suggests that the true effect size varies across the studies. The I^2 statistic was 99.67, which indicated that the true effect of nudging would likely be very similar to the observed effect size of the meta-analysis.

The studies were then grouped by type of labelling, descriptive or evaluative/interpretive, to allow for a comparison between the effect sizes. Mixed effect models show that descriptive labelling did not have a significant effect of nudging, $d = .06$ CI (-.02 .15), $p = .15$, while evaluative/interpretive labelling resulted in a small but significant effect size *d* = .16 CI (.06, .25), *p* = .001. When testing for heterogeneity between the subgroups, *Q* (1) = 2.12, *p* = .15, the estimated effect sizes did not significantly differ between the two groups, and the spread of effect sizes was roughly equal between descriptive and evaluative/interpretive labels.

Figure 3.

Histogram of studies included in the meta-analysis

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Subgroups by intervention

As the studies were entered as effect sizes to compare an intervention label to a control setting, the effect sizes could be categorised based on intervention. A total of 7 groups of label interventions were found, and effect sizes were grouped into subgroups for comparison. Table 3 below summarises the effect size standard difference in means for each subgroup of study. Testing for heterogeneity, Q (6) = 6.52, p = .04, revealed that the effect sizes were significantly different between groups, suggesting that the variability between results could be based on labelling intervention. From Table 3, it can be seen that the effect sizes were only significant for studies that incorporated calories with another form of labelling (e.g., exercise, traffic lights). In contrast, the nudge effect of other interventions alone did not reach statistical significance.

Table 3.

Results of analysis of subgroup based on labelling method used

Label condition	Number of effect sizes	Cohens' *d*	SE	CI lower	CI upper	Z-value	*p*
Calories only	23	.06	.04	-.02	.15	1.43	.15
Calories + exercise	8	.21	.08	.05	.37	2.58	.01
Calories + icon	4	.20	.21	-.22	.62	.92	.36
Calories+ Traffic lights	6	.21	.08	.05	.37	2.56	.01
Calories + other	8	.21	.06	.09	.32	3.58	<.001
Traffic lights	19	.14	.11	-.07	.35	1.30	.19
Icons or symbols	20	.09	.06	-.03	.21	1.53	.13

Subgroup based on out of dining setting

Studies and their effect sizes were then grouped by type of dining setting to examine if the out of home scenario affected the influence of nudging. Studies were classified into one of four scenarios: restaurant, cafeteria, fast-food, or other. Testing for heterogeneity between the subgroups, Q (3) = 8.43, p = .04, revealed that the effect sizes significantly differed between the four groups, suggesting that the variability of effect sizes might be attributed to dining condition. As seen in Table 4, nudging was statistically significant when applied to the fast-food and restaurant settings, but was not significant in other conditions.

Table 4.

Results of analysis of subgroup based on dining setting

Dining condition	Number of effect sizes	Cohens' *d*	SE	CI lower	CI upper	Z-value	*p*
Fast food	32	.19	.03	.13	.25	6.04	<.001
Restaurant	31	.12	.05	.02	.22	2.37	.02
Cafeteria	11	.10	.11	-.12	.32	.87	.39
Other	14	.04	.04	-.04	.12	.96	.34

Subgroup by laboratory or field study setting

Studies were grouped by experimental setting (laboratory vs field study) to allow for a comparison between the two groups. Mixed effect models show that field studies showed a nonsignificant effect of nudging, d = .05 CI (-.11, .21), p = .54, while studies in laboratories revealed a small but significant effect, d = .15 CI (.10, .20), p < .001. Testing for heterogeneity between the subgroups, Q (1) = 1.32, p = .25, revealed that the effect sizes did not significantly differ between the two groups, which suggests lower variability of the effect sizes of groups between the two experimental settings.

Subgroups by type of labelling and experimental setting

The final analysis aimed to assess if a combination of labelling type (descriptive, evaluative/interpretive) and experimental setting (laboratory, field study) would have different effects of nudging. As seen in Table 5 below, the most common form of labelling tested was evaluative/interpretive labels in a laboratory setting, which showed a significant effect of nudging. However, descriptive labelling tested in laboratories did not reach statistical significance. Field studies were also non significant. . However, there is a notable difference in the number of studies comparing the conditions with a larger number in favour of evaluative/interpretive labelling. This limits the conclusions that can be drawn from the testing of descriptive labelling, particularly in a field study context. Testing for heterogeneity between the subgroups, Q (3) = 5.26, p = .15, revealed that the effect sizes did not significantly differ between the four groups, which suggests lower variability of the effect sizes between groups.

Table 5.

Results of analysis of subgroup based on labelling type and experimental setting

Label condition	Number of effect sizes	Cohens' *d*	SE	CI lower	CI upper	Z-value	*p*
Lab – descriptive	20	.08	.05	-.02	.18	1.49	.14
Lab - evaluative/interpretive	47	.19	.04	.12	.26	5.32	<.001

Field study-descriptive	3	.02	.13	-.24	.27	.13	.90
Field study - evaluative/interpretive	18	.06	.09	-.12	.23	.64	.52

Quality assessment

Out of the 43 studies, 22 were assessed to be of high quality at 4 (*n* = 16) or 5 (*n* = 6) stars (see Appendix B). The most common rating was 3 stars (*n* = 17), which indicated medium quality. The remaining four studies were rated at 2 stars (Erdem et al., 2022; Feldman et al., 2015; Kerins et al., 2016; Vanepps et al., 2021 study 1). As recommended by Hong et al., (2018), the studies with lower methodological quality were still included in the analysis.

Discussion

Summary of results

The present meta-analysis aimed to examine the current literature on the use of evaluative labelling in the out of home dining context in comparison to the nudging effects of descriptive calorie labelling. A total of 39 articles were included in the meta-analysis, and a total of 88 effect sizes were analysed across the studies included. The analysis of the effect sizes revealed a small but significant effect of menu labels nudging healthier choices such as fewer calories ordered, or an increased chance of ordering a healthy item.

The group of studies were then further divided to examine various factors such as type of labelling, dining setting, and comparisons between laboratory and field study settings. When the types of labelling were compared, evaluative/interpretive labelling was found to have a statistically significant effect, while descriptive labelling had a smaller effect size and was not statistically significant. The results are similar in direction to those found in Cadario and Chandon's (2019) review where evaluative nudges (d =.17) had a larger effect size than descriptive nudges (d = .10). The positive but nonsignificant effect of descriptive calorie labelling fits with previous meta-analyses that have examined its impact and also found it to not be significant (Cecchini & Warin, 2015; Nikolaou et al., 2015; Sinclair et al., 2014). Notably, Cadario and Chandon's review excluded laboratory or online studies, and required studies to report specific outcome measures (weight or energy ordered/consumed). In contrast, the present meta-analysis included laboratory studies and consumption intentions, such as sales data and odds ratios of healthy choices made. It is possible that the wider scope of studies increased the variability of outcomes, leading to smaller effect sizes found in the present meta-analysis.

The present study also explored the types of labelling used across different subgroups. Among studies that examined the use of calorie labelling, the use of exercise equivalent labels, traffic light labelling and other formats alongside calorie signposting were found to be statistically significant. Labels that used calories only, or calories with an associated icon (e.g., heart healthy label, or low-calorie label) did not show statistically significant effects of nudging. As the additional labels were paired with a calorie count, most studies used the total number of calories ordered or consumed as the outcome, which might not reflect the true benefit of non-calorie focused labels such as a low sugar or high fibre icon which does not related to the calorie count.

Other labelling nudges, such as the use of traffic light labelling or icons/symbols showed a non-significant effect. The significant effect of additional interpretive elements (exercise or traffic lights) is in line with previous studies and suggests that the inclusion of additional data alongside descriptive calorie labelling can nudge consumers to make healthier choices (Temple & Fraser, 2014; Hawley et al., 2012). It is possible that consumers are already familiar with the reporting of calorie counts, and the inclusion of information that helps with their understanding (exercise equivalents and traffic lights) helps make the common label more noticeable and easier to interpret. In contrast, other logos or traffic lights without the calorie count may be unfamiliar to consumers, and they may place less importance on such labels.

The dining scenario was also found to impact the effectiveness of labelling nudges. Among these, the most common scenarios were either a fast-food (36.36%) or restaurant (35.23%) context, where a small but statistically significant effect of nudging was found. The use of labels in the other settings and cafeterias were not found to have a statistically significant effect of nudging healthier choices. A possible explanation for the nonsignificant effect could be the lack of research in these other settings, as there were fewer than 10 studies (or 11 effect sizes) that examined a scenario outside of the fast-food or restaurant context. The high variability and lack of conclusive support limits the generalisability of applying labelling nudges in additional scenarios and suggests that more research is needed in other settings

Finally, laboratory studies were compared to studies conducted as field studies within dining venues. Although both groups showed positive effects of nudging, studies conducted within laboratories were statistically significant, while field studies did not show a significant effect of nudging. This highlights a common difficulty in verifying the potential external validity from controlled laboratory experiments in field studies, where there are often many external variables that are difficult to control (Mitchell, 2012). The experimental settings were then further split into groups based on the labelling type tested (descriptive or evaluative) to allow for a closer examination of labelling type. Evaluative/interpretive labelling had larger effect sizes than descriptive labelling, but only reached statistical significance when tested in laboratory settings. However, the proportion of effect sizes testing descriptive labelling in a laboratory setting was overrepresented (53.41%) and further research is required to gather evidence for labelling in other settings, particularly field study experiments.

Implications

Taken together the current results show additional support for the growing body of research for the use of evaluative labelling relative to descriptive labels. However, not all evaluative/interpretive labelling formats were found to be significantly effective. Within the context of additional interpretive elements to calorie labelling, a similar result to Daley's et al. (2020) meta-analysis was noted, where Physical Activity Calorie Equivalent (PACE) labelling (evaluative/interpretive) was associated with fewer calories being ordered or consumed relative to descriptive calorie labelling. In the current meta-analysis, PACE and traffic light labels were found to have a statistically significant impact on nudging healthier choices either through reduced calories or increased odds of healthier choices. This is in line with previous research and shows support for the use of additional interpretive elements (Temple & Fraser, 2014; Hawley et al., 2012). The group of 'other labels' was also statistically significant, but this consisted of a mix of interventions, including ranked order calories, or provision of the daily recommended intake, and the small number of studies within each group may limit the generalisability of the results. However, not all interpretive labels were found to significantly improve choices, and the use of an additional icon (e.g., heart healthy logo) did not appear to help consumers reduce the number of calories ordered or eaten. The main limitation of these non-calorie based interpretive labels is that their effectiveness may not be captured when calories ordered/consumed was assessed as the outcome, as the attempts to nudge a healthier choice may not align with a lower calorie count.

Outside of calorie labelling, when used by themselves, traffic light labels, or labels that used icons or symbols did not reach statistical significance. However, there was a lack of consensus among studies on how these labels should be applied. While some studies (Thorndike et al., 2012; Whitt et al., 2017) applied an overall single colour label, other studies presented individual values of fats, salts, and sugars with corresponding colour coded values similar to the U.K. traffic light front of pack labelling (Hammond et al., 2013). This high variability in the presentation of information, even with the commonality of traffic light colour labelling makes the evaluation of the label and comparisons between studies difficult. A similar issue in the high variability of icons used (low fat, heart healthy, country specific labels) may also contribute to the non-significant effects reported in the analysis.

Another barrier to the generalisability of the current meta-analysis was the heterogeneity found among the effect sizes. This heterogeneity could indicate the presence of moderators. Common moderators include age and gender, but the wide variability in the collected studies and lack of reported sample characteristics in some articles meant that moderation analysis was not possible in the current meta-analysis. The grouping and testing of studies by labelling, menu conditions and laboratory conditions show some potential moderators, as effects may be limited to certain groups. However, there could be other moderators not assessed within the analysis or reported studies, such as an individual's nutrition knowledge or interest in dieting, which might affect how much they notice or understand labels (Miller & Cassidy, 2015; Vyth et al., 2011).

When the dining scenarios were compared, the two most commonly tested settings, fast-food (n = 32) and restaurants (n = 31), showed significant effects of labels nudging consumers to make healthier choices. This result also tentatively suggests that nudging may have a larger effect in fast-food outlets compared to restaurants. However, this could be a reflection of current policy trends, where fast-food chains are usually targeted by policy mandates in countries such as Australia and the USA to display calorie information.

Due to these policies, there may be a larger body of research, along with a more standardised approach to the types of labels used in the fast-food environment (often calorie focused). Additionally, research into the default meals provided at fast-food restaurants show that a large majority (97% – 99%) exceed recommended calorie and sodium guidelines (Vercammen et al., 2019). As such, a small effect of nudging may be enough to influence a larger health outcome. In contrast, restaurants may not be as highly regulated by current mandates. In addition, the wider range of food types served in restaurants lends itself to a larger variability in the use and effectiveness of labels which might have led to the smaller effect size observed in the current meta-analysis. Within other scenarios (e.g., cafeteria, lab-based meals, cafes), labelling showed a non-significant effect of nudging. However, the number of studies of these additional settings was small (less than 10), and more research into these additional out of home dining situations is needed for more conclusive evidence.

When laboratory studies were compared to field study experiments, there was a notable difference in the effect size and significance value. The results are similar to Long et al.'s (2015) meta-analysis, where the effects of calorie labelling were found to be significant in studies conducted online or in a laboratory, but non-significant when studies were conducted in restaurants. When the settings were further grouped by type of labelling, evaluative/interpretive labelling showed a statistically significant nudge effect within laboratory settings, but descriptive labelling was only approaching statistical significance ($p = .11$). As the current meta-analysis aimed to focus on evaluative labelling, research studies that only tested calorie labelling with no evaluative/interpretive comparison were not included in the analysis. As such, it is possible that the present pool of effect sizes that test descriptive calorie labelling is only a subsection of the larger pool in Long et al.'s meta-analysis, which likely reflects more accurate insight into purely descriptive calorie label research.

However, the additional disparity of significance and effect sizes between laboratory and field studies highlight issues of translating research into the practical field. While the laboratory studies allow for the control of extraneous factors, it is possible that other factors in real life settings are limiting the replicability of results. A common limitation among several studies was the recruitment of a university student population, which may not accurately reflect the effects of nudging when applied to the general public. Additional variables such as hunger and pricing may also play a role in affecting food choices beyond the nudging effect of labels. As such, more field studies are required, and rigorous testing of such variables may help isolate and identify other influences to help support the effects of nudging labels.

Although the current results show a small effect size, the use of labelling, and in particular the inclusion of traffic lights or physical activity calorie equivalent labels alongside calories is an easily implemented nudge. Although the effect size may be small, across a large population it can generate a noticeable benefit in improving healthy choices. As mentioned in the Introduction, the use of a nudge that does not restrict or forbid choices could reduce the resistance some individuals may have. The present study also highlights the large amount of variability in both the labelling methods and results, and thus requires a larger body of research examining non-calorie based labelling to allow for more definitive conclusions to be drawn.

Limitations

A key limitation of this meta-analysis is the large emphasis on studies conducted in relatively wealthy nations, with almost half the articles included being based in the USA. This places an emphasis on a largely Western diet and may be indicative of the research trends of obesity prevention specific to the North American continent (Arno & Thomas, 2016). This may limit the ability to generalise the results of the review to a more global or international context. Similar to the large focus on Western diets, there is an overemphasis (32 out of 43 studies) on calories as an outcome measure. While some studies have included measures such as fat or salt content ordered, there were not enough studies to conduct an analyses on these nutrient levels. This limits the conclusions that can be drawn on nudges that do not specifically target calorie reduction such as heart healthy icons which might be lower in fat but not overall calories. As such there needs to be a larger pool of studies that examine other outcomes such as odds ratio of making a healthier choice.

Another limitation is the number of studies in each subgroup, particularly when specific labelling formats were compared (less than 10 effect sizes for evaluative/interpretive nudges combined with calories). As recommended by Borenstein (2019), subgroups should have sizes of 20 or above to allow for meaningful comparisons. As such, the conclusions drawn from the meta-analysis are tentative and require further research to provide supporting or diverging evidence.

An additional note was the quality of the included studies. Based on the MMAT, approximately 50% of the studies included were of high (4 or 5 stars) methodological quality, while the most common rating (40%) was 3 stars (medium quality). These ratings reflect that most research in the field is currently of medium to high quality, and while the conclusions drawn from the results are tentative, the research methodology of experiments appeared to be at least modestly adequate. A common theme noticed during the quality assessment was the lack of details about how participants were randomised to conditions, which led to a lower rating among the studies. An aim of future research could be more specific reporting on how participants were randomised, specifically stating the use of blind allocation or technological support (e.g., online survey randomiser).

Within the field of labelling, there is also large variability in the use of labels from study to study, limiting both the understanding and generalisability of the results. As an example, studies such as those by Stacey et al. (2021) and Olstad et al. (2014) both based their traffic light colour coding on specific state or country guidelines. Within recent years, large bodies such as the European Union have suggested harmonised labelling formats

(Peonides et al., 2022). Although this suggestion is targeted at front of pack labels, packaged food labelling research is closely related to the growing out of home dining research field.

Conclusion

This was the first meta-analysis to specifically compare different methods of labelling used specifically in an out of home dining context. At present, the current results show support for menu labelling, with a small but significant effect of nudging healthier choices when evaluative/interpretive labelling is used, compared to a nonsignificant effect of descriptive calorie labelling. The comparison of labelling types showed support for the use of physical activity labels and traffic light labelling alongside calorie labelling, but found that other types of labels did not have a statistically significant nudge effect. When subgroups were compared, nudging via labelling appeared to be effective in certain contexts such as fast-food and laboratory settings, but not in others. As the field of research into out of home labelling continues to grow, there is a need for more formats of labelling to be tested, along with research focused on determining the most effective methods to advise governmental policies targeting healthier eating.

References

Allan, J. L., Johnston, M., & Campbell, N. (2015). Snack purchasing is healthier when the cognitive demands of choice are reduced: A randomized controlled trial. *Health Psychology*, *34*(7), 750.

Bates, S., Reeve, B., & Trevena, H. (2020). A narrative review of online food delivery in Australia: Challenges and opportunities for public health nutrition policy. *Public Health Nutrition*, 1-11.

Bezerra, I. N., Curioni, C., & Sichieri, R. (2012). Association between eating out of home and body weight. *Nutrition reviews*, *70*(2), 65-79.

Boonme, K., Hanus, B., R. Prybutok, V., A. Peak, D., & Ryan, C. (2014). Visual information influences consumer fast-food choices. *Nutrition & Food Science*, *44*(4), 279-293.

Carbonneau, E., Perron, J., Drapeau, V., Lamarche, B., Doucet, É., Pomerleau, S., & Provencher, V. (2015). Impact of nutritional labelling on 10-d energy intake, appetite perceptions and attitudes towards food. *British Journal of Nutrition*, *114*(12), 2138-2147.

Choi, M. K., Lee, Y. K., Heo, Y. R., Hyun, T., Lyu, E. S., Park, H., ... & Bae, Y. J. (2019). Association between the frequency of dining out and the risk of obesity, diabetes mellitus, and dyslipidemia among Korean adults. *Ecology of food and nutrition*, *58*(6), 560-574.

Chung, A., Zorbas, C., Riesenberg, D., Sartori, A., Kennington, K., Ananthapavan, J., & Backholer, K. (2022). Policies to restrict unhealthy food and beverage advertising in outdoor spaces and on publicly owned assets: A scoping review of the literature. *Obesity Reviews*, *23*(2), e13386.

Dodds, P., Wolfenden, L., Chapman, K., Wellard, L., Hughes, C., & Wiggers, J. (2014). The effect of energy and traffic light labelling on parent and child fast food selection: a randomised controlled trial. *Appetite*, *73*, 23-30.

Dowray, S., Swartz, J. J., Braxton, D., & Viera, A. J. (2013). Potential effect of physical activity based menu labels on the calorie content of selected fast food meals. *Appetite*, *62*, 173-181.

Ebneter, D. S., Latner, J. D., & Nigg, C. R. (2013). Is less always more? The effects of low-fat labeling and caloric information on food intake, calorie estimates, taste preference, and health attributions. *Appetite*, *68*, 92-97.

Erdem, S. (2022). Investigating the effect of restaurant menu labelling on consumer food choices using a field experiment. *British Food Journal*, *124*(11), 3447-3467.

Feldman, C. H., Hartwell, H., Brusca, J., Su, H., & Zhao, H. (2015). Nutrition information and its influence on menu choice within higher education establishments. *British Food Journal*, *117*(4), 1399-1410.

Fernandez, M. A., & Raine, K. D. (2019). Insights on the influence of sugar taxes on obesity prevention efforts. *Current nutrition reports*, *8*, 333-339.

Giazitzi, K., Chrysanthakopoulou, V., & Boskou, G. (2022). A Hypothetical Tavern Menu for the Evaluation of Calorie Selection through Menu Labelling. *Foods*, *11*(11), 1624.

Hammond, D., Goodman, S., Hanning, R., & Daniel, S. (2013). A randomized trial of calorie labeling on menus. *Preventive medicine*, *57*(6), 860-866.

Hong QN, Pluye P, Fàbregues S, Bartlett G, Boardman F, Cargo M, Dagenais P, Gagnon M-P, Griffiths F, Nicolau B, O'Cathain A, Rousseau M-C, Vedel I. Mixed Methods Appraisal Tool (MMAT), version 2018. *Registration of Copyright (#1148552*), Canadian Intellectual Property Office, Industry Canada.

James, A., Adams-Huet, B., & Shah, M. (2015). Menu labels displaying the kilocalorie content or the exercise equivalent: effects on energy ordered and consumed in young adults. *American Journal of Health Promotion*, *29*(5), 294-302.

Julia, C., Arnault, N., Agaësse, C., Fialon, M., Deschasaux-Tanguy, M., Andreeva, V. A., ... & Hercberg, S. (2021). Impact of the front-of-pack label nutri-score on the nutritional quality of food choices in a quasi-experimental trial in catering. *Nutrients*, *13*(12), 4530.

Kerins, C., Cunningham, K., Finucane, F. M., Gibson, I., Jones, J., & Kelly, C. (2017). Effects of an icon-based menu labelling initiative on consumer food choice. *Perspectives in public health*, *137*(1), 45-52.

Kim, E., Tang, L. R., Meusel, C., & Gupta, M. (2018). Optimization of menu-labeling formats to drive healthy dining: An eye tracking study. *International Journal of Hospitality Management*, *70*, 37-48. Kim, E., Tang, L. R., Meusel, C., & Gupta, M. (2018). Optimization of menu-labeling formats to drive healthy dining: An eye tracking study. *International Journal of Hospitality Management*, *70*, 37-48.

Kumanyika, S., Jeffery, R. W., Morabia, A., Ritenbaugh, C., & Antipatis, V. J. (2002). Obesity prevention: the case for action. *International journal of obesity*, 26(3), 425-436.

Lee, K., & Lee, Y. (2018). Parents' meal choices for their children at fast food and family restaurants with different menu labeling presentations. *Nutrition Research and Practice*, *12*(3), 243-250.

Lee, M. S., & Thompson, J. K. (2016). Exploring enhanced menu labels' influence on fast food selections and exercise-related attitudes, perceptions, and intentions. *Appetite*, *105*, 416-422.

Levin, S. (1996). Pilot study of a cafeteria program relying primarily on symbols to promote healthy choices. *Journal of Nutrition Education*, *28*(5), 282-285.

Liu, P. J., Roberto, C. A., Liu, L. J., & Brownell, K. D. (2012). A test of different menu labeling presentations. *Appetite*, *59*(3), 770-777.

McCann, M. T., Wallace, J. M., Robson, P. J., Rennie, K. L., McCaffrey, T. A., Welch, R. W., & Livingstone, M. B. E. (2013). Influence of nutrition labelling on food portion size consumption. *Appetite*, *65*, 153-158.

Mitchell, G. (2012). Revisiting truth or triviality: The external validity of research in the psychological laboratory. *Perspectives on Psychological Science*, *7*(2), 109-117.

Musicus, A. A., Moran, A. J., Lawman, H. G., & Roberto, C. A. (2019). Online randomized controlled trials of restaurant sodium warning labels. *American journal of preventive medicine*, *57*(6), e181-e193.

Niven, P., Morley, B., Dixon, H., Martin, J., Jones, A., Petersen, K., & Wakefield, M. (2019). Effects of health star labelling on the healthiness of adults' fast food meal selections: an experimental study. *Appetite*, *136*, 146-153.

NSW Government Food Authority. (2013). Evaluation of kilojoule menu labelling. *NSW Food Authority*. Available from:http://www.foodauthority.nsw.gov.au/

Oliveira, R. C., Fernandes, A. C., da Costa Proença, R. P., Hartwell, H., Rodrigues, V. M., Colussi, C. F., & Fiates, G. M. (2018). Menu labelling and healthy food choices: a randomised controlled trial. *British Food Journal*, *120*(4), 788-803.

Olstad, D. L., Vermeer, J., McCargar, L. J., Prowse, R. J., & Raine, K. D. (2015). Using traffic light labels to improve food selection in recreation and sport facility eating environments. *Appetite*, *91*, 329-335.

Partridge, S. R., Gibson, A. A., Roy, R., Malloy, J. A., Raeside, R., Jia, S. S., ... & Redfern, J. (2020). Junk food on demand: a cross-sectional analysis of the nutritional quality of popular online food delivery outlets in Australia and New Zealand. *Nutrients*, *12*(10), 3107.

Platkin, C., Yeh, M. C., Hirsch, K., Wiewel, E. W., Lin, C. Y., Tung, H. J., & Castellanos, V. H. (2014). The effect of menu labeling with calories and exercise equivalents on food selection and consumption. *BMC obesity,* 1(1), 1-7.

Pratt, N. S., Ellison, B. D., Benjamin, A. S., & Nakamura, M. T. (2016). Improvements in recall and food choices using a graphical method to deliver information of select nutrients. *Nutrition Research*, *36*(1), 44-56.

Prowse, R. J., Lee, K. M., Chen, E., Zuo, F., Hammond, D., & Hobin, E. (2020). Testing the efficacy of and parents' preferences for nutrition labels on children's menus from a full-service chain restaurant: results of an online experiment. *Public Health Nutrition*, *23*(10), 1820-1831.

Reale, S., & Flint, S. W. (2016). The impact of menu label design on visual attention, food choice and recognition: An eye tracking study. *Journal of Sensory Studies*, *31*(4), 328-340.

Reynolds, J. P., Ventsel, M., Hobson, A., Pilling, M. A., Pechey, R., Jebb, S. A., ... & Marteau, T. M. (2022). Evaluation of physical activity calorie equivalent (PACE) labels' impact on energy purchased in cafeterias: A stepped-wedge randomised controlled trial. *PLoS Medicine*, *19*(11), e1004116.

Roberto, C. A., Larsen, P. D., Agnew, H., Baik, J., & Brownell, K. D. (2010). Evaluating the impact of menu labeling on food choices and intake. *American journal of public health*, *100*(2), 312-318.

Roy, R., & Alassadi, D. (2021). Does labelling of healthy foods on menus using symbols promote better choices at the point-of-purchase?. *Public Health Nutrition*, *24*(4), 746-754.

Sato, J. N., Wagle, A., McProud, L., & Lee, L. (2013). Food label effects on customer purchases in a hospital cafeteria in Northern California. *Journal of Foodservice Business Research*, *16*(2), 155-168.

Stacey, F., Delaney, T., Ball, K., Zoetemeyer, R., Lecathelinais, C., Wolfenden, L., ... & Wyse, R. (2021). A cluster randomized controlled trial evaluating the impact of tailored feedback on the purchase of healthier foods from primary school online canteens. *Nutrients*, *13*(7), 2405.

Stutts, M. A., Zank, G. M., Smith, K. H., & Williams, S. A. (2011). Nutrition information and children's fast food menu choices. *Journal of Consumer Affairs*, *45*(1), 52-86.

Swartz, J. J., Braxton, D., & Viera, A. J. (2011). Calorie menu labeling on quick-service restaurant menus: an updated systematic review of the literature. *International Journal of Behavioral Nutrition and Physical Activity*, *8*, 1-8.

Thorndike, A. N., Sonnenberg, L., Riis, J., Barraclough, S., & Levy, D. E. (2012). A 2-phase labeling and choice architecture intervention to improve healthy food and beverage choices. *American journal of public health*, *102*(3), 527-533.

VanEpps, E. M., Downs, J. S., & Loewenstein, G. (2016). Calorie label formats: using numeric and traffic light calorie labels to reduce lunch calories. *Journal of Public Policy & Marketing*, *35*(1), 26-36.

VanEpps, E. M., Molnar, A., Downs, J. S., & Loewenstein, G. (2021). Choosing the light meal: Real-time aggregation of calorie information reduces meal calories. *Journal of Marketing Research*, *58*(5), 948-967.

Vercammen, K. A., Frelier, J. M., Moran, A. J., Dunn, C. G., Musicus, A. A., Wolfson, J. A., & Bleich, S. N. (2019). Calorie and nutrient profile of combination meals at US fast food and fast casual restaurants. *American journal of preventive medicine*, *57*(3), e77-e85.

Viera, A. J., & Antonelli, R. (2015). Potential effect of physical activity calorie equivalent labeling on parent fast food decisions. *Pediatrics*, *135*(2), e376-e382.

Viera, A. J., Tuttle, L., Olsson, E., Gras-Najjar, J., Gizlice, Z., Hales, D., ... & Ammerman, A. (2017). Effects of physical activity calorie expenditure (PACE) labeling: study design and baseline sample characteristics. *BMC Public Health*, *17*, 1-8.

Whitt, O. R., Jilcott Pitts, S. B., Rafferty, A. P., Payne, C. R., & Ng, S. W. (2018). The effects of traffic light labelling versus cartoon labelling on food and beverage purchases in a children's hospital setting. *Pediatric obesity*, *13*(4), 265-268.

World Health Organization. (2022). *Nutrition labelling: policy brief*. World Health Organization.

Yeo, G. S. H. (2022, June 9). *Is calorie labelling on menus the solution to obesity?*. Nature News. https://www.nature.com/articles/s41574-022-00705-3

Yepes, M. F. (2015). Mobile tablet menus: attractiveness and impact of nutrition labeling formats on millennials' food choices. *Cornell Hospitality Quarterly*, *56*(1), 58-67.

Appendix

Appendix A search strategy

Cochrane	
Menu labelling component	(((nutrition* OR nutrient*) NEAR/4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*)) OR (("recommended dietary allowance*" OR "guideline daily amount*" OR "nutrient reference value*" OR "nutrient daily value*") NEAR/4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*)) OR ((fat* OR salt OR sodium OR calorie* OR kilojoule* OR sugar*) NEAR/4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*)) OR ((menu) NEAR/5 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*)) OR ("traffic light*" OR "heart-healthy tick" OR "heart healthy tick" OR "heart symbol") OR ((health*) NEAR/2 ((choice* OR heart) NEAR/3 (tick* OR symbol*))) OR ((keyhole) NEAR/4 (Sweden)) OR (("star rating") NEAR/4 (australia*)))
Outcome component	(((food* OR menu* OR dish* OR drink* OR beverage*) NEAR/5 (preference* OR habit* OR behavior* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR behaviour*)) OR ((health*) NEAR/4 (preference* OR habit* OR behavior* OR behaviour* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR lifestyle* OR weight* OR diet)))
Out of home dining setting	(("fast food") OR (restaurant* OR cafe* OR "catering buffet" OR bistro OR bar* OR canteen* OR cafeteria* OR "dinner hall*" OR "dining area*" OR "dining room*" OR mess OR eatery OR mess OR buffet* OR bistro* OR "eating place*") OR ((food OR meal) NEAR/2 (services* OR fast OR convenience OR "ready prepared" OR "ready to eat" OR "ready-to-eat")))
Scopus	
Menu labelling component	(TITLE-ABS-KEY ((nutrition* OR nutrient*) W/4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*))) OR (TITLE-ABS-KEY (("recommended dietary allowance*" OR "guideline daily amount*" OR "nutrient reference value*" OR "nutrient daily value*") W/4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*))) OR (TITLE-ABS-KEY ((fat* OR salt OR sodium OR calorie* OR kilojoule* OR sugar*) W/4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*))) OR (TITLE-ABS-KEY ((menu) W/5 (label* OR sign* OR symbol* OR sticker* OR icon

	* OR "traffic light*" OR numeric*))) OR (TITLE-ABS-KEY ("traffic light*" OR "heart-healthy tick" OR "heart healthy tick" OR "heart symbol")) OR (TITLE-ABS-KEY ((health*) W/2 ((choice* OR heart) W/3 (tick* OR symbol*)))) OR (TITLE-ABS-KEY ((keyhole) W/4 (sweden))) OR (TITLE-ABS-KEY (("star rating") W/4 (australia*))))
Outcome component	((TITLE-ABS-KEY ((food* OR menu* OR dish* OR drink* OR beverage*) W/5 (preference* OR habit* OR behaviour* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR behavior*))) OR (TITLE-ABS-KEY ((health*) W/4 (preference* OR habit* OR behavior* OR behaviour* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR lifestyle* OR weight* OR diet))))
Out of home dining setting	((TITLE-ABS-KEY ("fast food")) OR (TITLE-ABS-KEY (restaurant* OR cafe* OR "catering buffet" OR bistro OR bar* OR canteen* OR cafeteria* OR "dinner hall*" OR "dining area*" OR "dining room*" OR mess OR eatery OR mess OR buffet* OR bistro* OR "eating place*")) OR (TITLE-ABS-KEY ((food OR meal) W/2 (services* OR fast OR convenience OR "ready prepared" OR "ready to eat" OR "ready-to-eat"))))
Psych Info	
Menu labelling component	9 or/1-8 8 (star rating adj4 australia*).tw,id. 7 (keyhole adj4 Sweden).tw,id. 6 (health* adj2 (choice* or heart) adj3 (tick* or symbol*)).tw,id. 5 (traffic light* or heart-healthy tick or heart healthy tick or heart symbol).tw,id.

	4 (menu adj5 (label* or sign* or symbol* or sticker* or icon* or traffic lig ht* or numeric)).tw,id. 3 ((fat* or salt or sodium or calorie* or kilojoule* or sugar*) adj4 (label* or sign* or symbol* or sticker* or icon* or traffic light* or numeric)).tw,i d. 2 ((recommended dietary allowance* or guideline daily amount* or nutr ient reference value* or nutrient daily value*) adj4 (label* or sign* or sy mbol* or sticker* or icon* or traffic light* or numeric*)).tw,id. 1 ((nutrition* or nutrient*) adj4 (label* or sign* or symbol* or sticker* or icon* or traffic light* or numeric)).tw,id.
Outcome componen t	15 or/10-14 14 (health* adj4 (preference* or habit* or behavio?r* or choice* or deci sion* or decid* or inclin* or lik* or choos* or select* or pick* or order* or nudg* or lifestyle* or weight* or diet)).tw,id. 13 ((food* or menu* or dish* or drink* or beverage*) adj5 (preference* or habit* or behavio?r* or choice* or decision* or decid* or inclin* or lik* or choos* or select* or pick* or order* or nudg* or behavio?r*)).tw,id. 12 decision making/ or exp choice behavior/ 11 preferences/ 10 food preferences/ or exp diets/ or eating attitudes/
Out of home dining setting	21 9 and 15 and 20 20 or/16-19 19 fast food.tw,id. 18 ((food or meal) adj2 (services* or fast or convenience or "ready pre pared" or "ready to eat" or "ready-to-eat")).tw,id.

	17 (restaurant* or cafe* or catering buffet or bistro or bar* or canteen* or cafeteria* or dinner hall* or dining area* or dining room* or mess or eatery or mess or buffet* or bistro* or eating place*).tw,id. 16 fast food/
Proquest	
Menu labelling componen t	(((nutrition* OR nutrient*) NEAR/4 (label* OR sign* OR symbol* OR sticker* OR icon * OR "traffic light*" OR numeric*)) OR (("recommended dietary allowance*" OR "gu ideline daily amount*" OR "nutrient reference value*" OR "nutrient daily value*") N EAR/4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR num eric*)) OR ((fat OR salt OR sodium OR calorie* OR kilojoule* OR sugar*) NEAR/4 (lab el* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*)) OR ((menu) NEAR/5 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light* " OR numeric*)) OR ("traffic light*" OR "heart-healthy tick" OR "heart healthy tick" OR "heart symbol") OR ((health*) NEAR/2 ((choice* OR heart) NEAR/3 (tick* OR sym bol*))))
Outcome componen t	noft(((food* OR menu* OR dish* OR drink* OR beverage*) NEAR/5 (preference* OR habit* OR behavior* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR behaviour*)) OR ((health*) NEAR/4 (preference* OR habit* OR behavior* OR behaviour* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR lifestyle* OR weight* OR diet)))
Out of home dining setting	noft(("fast food") OR (restaurant* OR cafe* OR "catering buffet" OR bistro OR bar* OR canteen* OR cafeteria* OR ("dinner hall") OR ("dining area" OR "dining areas") OR ("dining room" OR "dining rooms") OR mess OR eatery OR mess OR buffet* OR bistro* OR ("eating place" OR "eating places")) OR ((food OR meal) NEAR/2 (services* OR fast OR convenience OR "ready prepared" OR "ready to eat" OR "ready-to-eat")))
Medline	

Menu labelling component	1. Food Packaging/ and (label* or sign* or symbol* or sticker* or icon* or traffic light* or numeric*).tw,kw. 2. Product Labeling/ and (label* or sign* or symbol* or sticker* or icon* or traffic light* or numeric*).tw,kw. 3. ((nutrition* or nutrient*) adj4 (label* or sign* or symbol* or sticker* or icon* or traffic light* or numeric*)).tw,kf. 4. ((recommended dietary allowance* or guideline daily amount* or nutrient reference value* or nutrient daily value*) adj4 (label* or sign* or symbol* or sticker* or icon* or traffic light* or numeric*)).tw,kf. 5. ((fat* or salt or sodium or calorie* or kilojoule* or sugar*) adj4 (label* or sign* or symbol* or sticker* or icon* or traffic light*)).tw,kf. 6. (menu adj5 (label* or sign* or symbol* or sticker* or icon* or traffic light* or numeric*)).tw,kf. 7. (traffic light* or heart-healthy tick or heart healthy tick or heart symbol).tw,kf. 8. (health* adj2 (choice* or heart) adj3 (tick* or symbol*)).tw,kf. 9. (keyhole adj4 Sweden).tw,kf. 10. (star rating adj4 australia*).tw,kf. 11. or/1-10
Outcome component	12. exp Food Preferences/ or exp Food Habits/ or exp Feeding Behavior/ or exp Eating/ or exp Diet/ or exp Choice Behavior/ 13. (intak* or consume or consumes or consumption or consumed or eat* or diet*).tw,kf. 14. ((food* or menu* or dish* or drink* or beverage*) adj5 (preference* or habit* or behavio?r* or choice* or decision* or decid* or inclin* or lik* or choos* or select* or pick* or order* or nudg* or behavio?r*)).tw,kf.

	15. (health* adj4 (preference* or habit* or behavio?r* or choice* or decision* or decid* or inclin* or lik* or choos* or select* or pick* or order* or nudg* or lifestyle* or weight* or diet)).tw,kf. 16. or/12-15
Out of home dining setting	17. food services/ or restaurants/ 18. (restaurant* or cafe* or catering buffet or bistro or bar* or canteen* or cafeteria* or dinner hall* or dining area* or dining room* or mess or eatery or mess or buffet* or bistro* or eating place*).tw,kw. 19. ((food or meal) adj2 (services* or fast or convenience or "ready prepared" or "ready to eat" or "ready-to-eat")).tw,kf. 20. fast food.tw,kw. 21. or/17-20 22. 11 and 16 and 21 23. exp animals/ not humans.sh. 24. 22 not 23
CINHAL	
Menu labelling componen t	S18 S13 OR S14 OR S15 OR S16 OR S17 S17 TI ((health* N4 (preference* OR habit* OR behaviour* OR behavior* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR lifestyle* OR weight* OR diet))) OR AB ((health* N4 (preference* OR habit* OR behaviour* OR behavior* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR lifestyle* OR weight* OR diet))) S16 TI (((food* OR menu* OR dish* OR drink* OR beverage*) N5 (preference* OR habit* OR behavior* OR behaviour* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg*))) OR AB (((food* OR menu* OR dish* OR drink* OR beverage*) N5 (preference* OR habit* OR behavior* OR behaviour* OR

	choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg*))) S15 (MH "Decision Making") S14 (MH "Diet+") S13 (MH "Food Preferences") OR (MH "Food Habits") OR (MH "Eating Behavior") S12 S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 S11 TI ("star rating" N4 australia*) OR AB ("star rating" N4 australia*) S10 TI (keyhole N4 Sweden) OR AB (keyhole N4 Sweden) S9 TI ((health* N2 ((choice* OR heart) N3 (tick* OR symbol*)))) OR AB ((health* N2 ((choice* OR heart) N3 (tick* OR symbol*)))) S8 TI (("traffic light*" OR "heart-healthy tick" OR "heart healthy tick" OR "heart symbol")) OR AB (("traffic light*" OR "heart-healthy tick" OR "heart healthy tick" OR "heart symbol")) S7 TI ((menu N5 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric))) OR AB ((menu N5 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric))) S6 TI (((fat OR salt OR sodium OR calorie* OR kilojoule* OR sugar*) N4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric))) OR AB (((fat OR salt OR sodium OR calorie* OR kilojoule* OR sugar*) N4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric))) S5 TI (((nutrition* OR nutrient*) N4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric))) OR AB (((nutrition* OR nutrient*) N4 (label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric))) S4 TI ((("recommended dietary allowance*" OR "guideline daily amount*" OR "nutrient reference value*" OR "nutrient daily value*") N4 (label* OR sign* OR symbol* OR sticker* OR icon* OR “traffic light*” OR numeric*))) OR AB

	((("recommended dietary allowance*" OR "guideline daily amount*" OR "nutrient reference value*" OR "nutrient daily value*") N4 (label* OR sign* OR symbol* OR sticker* OR icon* OR “traffic light*” OR numeric*))) S3 S1 AND S2 S2 TI ((label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*)) OR AB ((label* OR sign* OR symbol* OR sticker* OR icon* OR "traffic light*" OR numeric*)) S1 (MH "Food Packaging") OR (MH "Food Labeling")
Outcome component	S18 S13 OR S14 OR S15 OR S16 OR S17 S17 TI ((health* N4 (preference* OR habit* OR behaviour* OR behavior* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR lifestyle* OR weight* OR diet))) OR AB ((health* N4 (preference* OR habit* OR behaviour* OR behavior* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg* OR lifestyle* OR weight* OR diet))) S16 TI (((food* OR menu* OR dish* OR drink* OR beverage*) N5 (preference* OR habit* OR behavior* OR behaviour* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg*))) OR AB (((food* OR menu* OR dish* OR drink* OR beverage*) N5 (preference* OR habit* OR behavior* OR behaviour* OR choice* OR decision* OR decid* OR inclin* OR lik* OR choos* OR select* OR pick* OR order* OR nudg*))) S15 (MH "Decision Making") S14 (MH "Diet+") S13 (MH "Food Preferences") OR (MH "Food Habits") OR (MH "Eating Behavior")
Out of home	S24 S19 OR S20 OR S21 OR S22 OR S23 S23 TI "fast food" OR AB "fast food"

dining setting	S22 TI (((food OR meal) N2 (services* OR fast OR convenience OR "ready prepared" OR "ready to eat" OR "ready-to-eat"))) OR AB (((food OR meal) N2 (services* OR fast OR convenience OR "ready prepared" OR "ready to eat" OR "ready-to-eat"))) S21 TI ((restaurant* OR cafe* OR "catering buffet" OR bistro OR bar* OR canteen* OR cafeteria* OR "dinner hall*" OR "dining area*" OR "dining room*" OR mess OR eatery OR mess OR buffet* OR bistro* OR "eating place*")) OR AB ((restaurant* OR cafe* OR "catering buffet" OR bistro OR bar* OR canteen* OR cafeteria* OR "dinner hall*" OR "dining area*" OR "dining room*" OR mess OR eatery OR mess OR buffet* OR bistro* OR "eating place*")) S20 (MH "Fast Foods") OR (MH "Food, Commercially Packaged") S19 (MH "Restaurants") OR (MH "Food Services") OR (MH "Menu Planning")

Appendix B

Study quality analysis based on the Mixed Methods Appraisal Tool

	Criteria based on Mixed Methods Appraisal Tool																								
Studies	1.1	1.2	1.3	1.4	1.5	2.1	2.2	2.3	2.4	2.5	3.1	3.2	3.3	3.4	3.5	4.1	4.2	4.3	4.4	4.5	5.1	5.2	5.3	5.4	5.5
Allan et al., 2015	1	0	1	1	1																				
Boonme et al., 2014	0	0	1	1	1																				
Carbonneau et al., 2015	0	0	1	1	1																				
Dodds et al., 2014	1	1	1	1	1																				
Dowray et al., 2014	0	1	1	1	1																				
Ebneter et al., 2013	0	1	1	1	1																				
Erden et al., 2022	0	0	1	1	1																				
Feldman et al., 2015	0	0	1	1	0																				
Giazitzi, 2022						0	1	0	1	1															
Hammond et al., 2013	0	1	1	1	1																				
James et al., 2015	0	1	1	1	1																				
Julia, 2021						1	1	1	0	0															
Kerins et al., 2016						0	1	0	0	1															
Kim et al., 2018	0	1	1	1	1																				
Lee &Thompson, 2016	0	1	1	1	1																				
Lee & Lee, 2018	0	1	1	1	1																				

Levin et al., 1996						1	1	1	1	1					
Liu et al., 2012	0	1	1	1	1										
McCann et al., 2013						1	1	1	0	1					
Musicus et al., 2019	1	0	1	1	1										
Niven et al., 2019	1	1	1	1	1										
Oliveria et al., 2018	1	1	1	1	1										
Olstadet al., 2015						1	1	1	0	0					
Platkin et al., 2014	0	1	0	1	1										
pratt et al., 2016						1	1	0	0	1					
Prowse, 2020	0	1	1	1	1										
Reale et al., 2016	0	1	1	1	1										
Reynolds et al., 2022						1	1	1	1	1					
Roberto et al., 2010	1	1	1	1	1										
Roy & Alassadi, 2021						1	1	0	0	1	1	1	1	0	1
Sato et al., 2013															
Stacey et al., 2021	1	0	1	1	0										
Stutts et al., 2011	0	0	1	1	1										
Thorndike et al., 2012						1	1	1	0	1					
Vanepps et al., 2016	0	0	1	1	1										
Vanepps et al., 2021 (1)	0	0	0	1	1										
Vanepps et al., 2021 (2)	0	0	1	1	1										
Vanepps et al., 2021 (3)	0	0	1	1	1										

Vanepps et al., 2021 (4)	0	0	1	1	1					
Vanepps et al., 2021 (5)	0	0	1	1	1					
Viera & Antonelli, 2015	0	0	1	1	1					
Viera et al., 2017						1	1	1	1	1
Whitt et al., 2017						1	1	0	0	1

Chapter 3 (Study 2) : Comparison of traffic light system and healthy tick symbol for nudging out of home dining food choices

Abstract

Encouraging healthier eating choices through nudging has the benefit of decreasing lifestyle related disease and tackling the public health concern of noncommunicable diseases globally. The use of menu labelling can aid to make the food choice decision process easier. The present study compared the effects of two labelling styles: traffic light colours and a healthy tick symbol, on food and drink choices made in a hypothetical café order. Volunteers (*n* = 181) attended a laboratory testing session where they were randomised to view one of three menus: traffic light (food and drinks were colour coded into red/amber/green), healthy tick (healthier food/drink choices labelled) or control (no information). After making a meal selection (main, drink and dessert), participants completed surveys assessing nutrition knowledge and dietary restraint. Although the proportion of healthy choices for the total overall meal ordered did not vary by condition, participants who viewed the healthy tick menu were more likely to select a healthy main compared to those in the control condition. Additionally, the nudge to choose a healthy main was significantly stronger for participants high in dietary restraint and/or low in nutrition knowledge. The present research helps contribute to the developing field of using nudges to encourage healthier eating in out of home dining contexts.

Introduction

Noncommunicable diseases such as diabetes, heart disease, strokes and cancer are a growing public health concern. According to the World Health Organization, collectively these diseases are responsible for approximately 70% of deaths worldwide (WHO, 2021). The WHO has identified several factors that increase the risk of death by noncommunicable diseases, such as physical inactivity and in particular an unhealthy diet.

The contemporary food environment with its increased access to unhealthy foods, i.e., those high in sugar, salt, and fat, is a major contributor to poor eating habits (Popkin, 2021). One easily accessible source of unhealthy foods is out of home dining, which has increased over the years. Financially, the proportion of Australian household food budgets spent on meals away from home increased from 31% to 34% between 2009/2010 to 2015/2016 with consumers choosing to spend money on food services over food products (Hogan, 2018). More recent research in 2020 revealed that the average Australian (aged 14 and above) made 4.8 visits to quick service restaurants in the span of four weeks (Roy Morgan Research, 2021). Such statistics highlight the importance of evaluating food choices made while eating food prepared outside the home to inform interventions to encourage healthier eating.

Various approaches to encourage healthier out of home dining include strategies such as reducing portion sizes of meals and adjusting prices to reflect the healthiness of foods (e.g., sugar tax). Another approach, and the focus of the present study, is the use of labelling to encourage healthier choices. There is a large body of research that has examined the use of food and nutrient labels on packaged products (e.g., Campos et al. 2011; Croker et al., 2020; Feteira-Santos et al., 2020), but its application to menus in out of home dining is less widely researched (Cadario & Chandon 2019; Holdswoth & Haslam, 1998). One type of labelling approach for out of home dining is the Menu Label Scheme, introduced in 2011 by the

Australian Federal Government. Under this scheme, major fast-food providers are required to display the kilojoule count of their menu items with the goal of helping consumers make healthier decisions. Although a 2013 evaluation by the New South Wales government showed that the scheme combined with supporting public education resulted in a decrease in median kilojoules purchased (Authority, 2013), other research suggests that the labelling scheme has not had an impact on the overall number of calories ordered by consumers (Wellard-Cole, 2018). The conflicting results suggest the need for further research on different approaches to understand how to make menu labelling more effective.

One improvement suggested by the Australian Chronic Disease Prevention Alliance (ACDPA) is to include an interpretive element to assist customers to understand the nutritional content of menu items (ACDPA, 2011). In contrast to providing calorie counts or information about nutrients (i.e., descriptive labelling), interpretive elements such as symbols and colours (i.e., evaluative labelling) can help consumers understand the nutritional information of food. Examples of evaluative labelling are the United Kingdom's (UK) traffic light system and the Australian Health Star Rating system. These are standardised labelling systems that have an interpretive angle (traffic light colours and stars, respectively) that provide clear and simple information about a food item's nutritional content. In so doing, such evaluative labelling aims to make nutrition information more accessible to the consumer.

Evaluative labelling, such as the UK's traffic light system, was initially developed for packaged food and products (i.e., front-of-package labelling). In particular, the UK Food Standards Agency have an established system where the nutritional values of packaged products are categorised and colour coded according to set criteria with red indicating high amounts, amber moderate amounts, and green low amounts of fat, sugar and salt (Department of Health, 2016). A review by Song et al. (2021) found that front-of-package colour coded labels such as the UK traffic light labelling system can successfully encourage consumers to choose healthier products. A benefit of the traffic light system is the presentation of colours alongside information which provide a heuristic for the consumer to quickly process the healthiness of the food (Drescher et al., 2014). More recently, the system has been used in out-of-home dining situations to identify healthy items on menus. Specifically, a few studies have adapted the traffic light system into a single overall measure based on criteria including fat and caloric content, and the inclusion of a healthy main ingredient (e.g., fruit, vegetable, whole grains lean protein), and have found some support for its application in a hospital cafeteria setting (Levy et al. 2012; Sonnenberg, et al., 2013; Thorndike, et al., 2012). In particular, Sonnenberg et al. (2013) found that participants who noticed the labelling system were more likely to make a healthier purchase. Other studies, which included additional nudges (increased visibility and access to healthy food) alongside traffic light labelling reported increased purchases of healthy (green) items in a cafeteria setting (Levy et al. 2012; Thorndike, et al., 2012).

Other examples of evaluative/interpretive labelling systems that identify healthier choices on menus for consumers include Singapore's Healthier Dining Programme and Sweden's Keyhole label. These systems use established symbols (i.e., food pyramid logo and keyhole symbol with a green background, respectively) to identify healthier food options within menu categories (e.g., mains, desserts) based on their caloric and nutritional content (Larsson et al., 1999; Seah et al., 2022). Research is currently mixed in relation to the success of these initiatives. Two studies set in Sweden and the Netherlands found no support for the use of country specific healthier option labels, the Swedish keyhole label in an industry company lunch restaurant and Dutch Choices Nutrition logo in worksite cafeterias, respectively (Thunstrom & Nordstrom, 2011; Vyth, et al., 2011). However, other studies have found moderate to strong support for the use of such labels (e.g., a 'heart healthy' label) in an upscale

US table service restaurant serving Indian food to adult consumers (Sharma et al., 2011) and the Swedish keyhole label applied in a Danish hospital employee canteen (Lassen et al., 2014), with results including increased sales of items identified as healthy and reductions in calories consumed. The conflicting results highlight the need for further research.

Evaluative and interpretive labelling is in line with the concept of nudging, which is defined by Thaler and Sunstein (2009, p.6) as "any aspect of choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic intentions". Evaluative and interpretive labelling allows consumers to apply heuristics or rules of thumb during the decision-making process. As research has shown that the decision-making processes involving food are often unconscious, providing summarised or simplified information makes it is easier for consumers to compare products quickly, and effectively identify the healthier product (Wansink & Sobal, 2007).

Personal factors such as dietary restraint and nutrition knowledge may moderate the effects of menu labelling on food choices. Dietary restraint is a measure of an individual's intention to regulate their food intake to lose weight or avoid gaining weight (Herman & Polivy, 1980). Vyth et al.'s (2011) study found a non-significant impact of a healthy label in a cafeteria setting, and suggested that the non-significant nudge was due to a majority of participants (66%) reporting low intentions to eat healthier, which likely correlated with lower measures of dietary restraint.. Other studies have also suggested that such food labelling would only be noticed by, and appeal to consumers who are concerned about their diets and healthy eating, which is an indicator of high dietary restraint (Sharma et al., 2011; Sonnenburg et al., 2013). In addition, systematic reviews suggest that high nutrition knowledge is associated with better dietary intake and increased usage and understanding of food labels (Miller & Cassidy 2015; Spronk et al., 2014). The review by Miller and Cassidy (2015) highlighted the interaction between an individual's knowledge and the attention and understanding of nutrient labels, where high nutrition knowledge was correlated with increased reported label use.

Thus, the aim of the present study was to further investigate the effect of evaluative labelling on healthier menu choices. To this end, we compared two evaluative labels, healthy symbol (a green tick) and traffic light labelling against an unlabelled control condition. It was hypothesized that the labelling conditions (healthier choices indicated by a tick or green traffic light circle) would encourage participants to select healthier items from the menu than the no label condition. As previous research has shown that consumers place greater emphasis on avoiding items labelled red rather than choosing items labelled green (Hieke & Wilczynski, 2011; Sacrborough et al., 2015), it was further hypothesized that the traffic light labelling system would discourage participants from selecting an unhealthy (labelled with a red circle) item compared to the control condition. In addition, personal factors such as dietary restraint and nutrition knowledge were anticipated to interact with the evaluative labels to affect menu choices Specifically, it was predicted that participants who are concerned about their food intake (high in dietary restraint) would be more likely to choose a healthier option in the labelling conditions, as healthier choices are more in line with their food intake goals. Likewise, it was predicted that participants with high nutrition knowledge would be better able to understand the labelling systems, which would increase their likelihood of making healthier food choices.

Method

Participants

A total of 181 participants (132 women and 49 men) were recruited through the Flinders University SONA (Psychology research participation system) website. The research study was approved by the Flinders Human Research Ethics Committee (HREC number: 8382). Power calculations estimated that a sample size of 156 was required to detect medium effects for 2 degrees of freedom with an alpha of .05 and 80% power using a chi square analysis (Cohen, 1992). A medium effect size was predicted based on previous studies by Thorndike et al. (2015). Participants were either first-year undergraduate Psychology students who took part for course credit (n = 122) or volunteers from the wider student community who received a small reimbursement (n = 59). Participants were 17 to 69 years old (M = 22.90; SD = 6.89). The majority ethnic group was Non-Indigenous Australians (38.1%), with the remaining participants identifying themselves as Asian (27.6%), European (19.3%), Multi-ethnic (4.4%), Indigenous Australians (0.6%) or Other (9.9%).

Eligibility criteria for participants included: 1) should like most foods, 2) have no food intolerances, allergies, or special dietary requirements (e.g., vegan, vegetarian), and 3) not experience colour blindness. Participants were expected to like most foods and not have food allergies or intolerances as these factors could influence their food choices. Participants were screened for colour blindness due to the use of the colour coded traffic light scheme. To standardize hunger levels, participants were requested to eat or drink something two hours before the study and then refrain from doing so (water excepted) until after the testing session.

Design

The study used a between-subjects design with participants randomly assigned to one of the three labelling conditions (Control, Healthy tick, Traffic light), subject to equal numbers per condition. The dependent variable was food choice (percentage of red, amber, or green foods chosen).

Materials

Menus

The menus were printed on A3 sheets of paper and laminated for durability (see Figure 1 and Appendix A for larger sizes). Menu items consisted of coloured photographs of foods and beverages, with the name of the item printed underneath the image. Items were presented on both the left and right hand sides of the menu. The menu consisted of three sections (mains, desserts, and drinks), with six items in each section. The control menu displayed only the images and labels of each food and drink. The healthy tick menu identified two healthy items from each section (main, desserts, drinks) by displaying a small green circle containing a white tick next to the food/drink item. The traffic light menu presented a small red, amber, or green circle next to each food/drink item, with two items per colour for each menu section. The bottom left corner of the menu displayed a box that contained either a neutral logo (control menu) or a legend explaining the labelling system of the healthy tick or traffic light logos.

The 18 final menu items were selected through a pilot study. For the pilot, 25 food and beverage options were selected based on objective nutritional values (fat, sugar, and salt) to range from healthy to unhealthy. To objectively evaluate the healthiness of the food and drink items, the UK ‘Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets' was used to classify the foods and beverages into three colour categories (red, amber, and green) based on their nutritional values (see Appendix B). Items classified as red had three or more red values both per portion and per 100 grams. Items classified as amber had at least two amber values per 100 grams category and two or fewer red values both per portion and per 100 grams. Finally, items classified as green had at least two green values per 100 grams and no red values neither per portion nor per 100 grams. The nutritional content of the final 18 menu items can be seen in Appendix C. Nutritional values were sourced from Calorie King Australia (https://www.calorieking.com/au/en/) and NutritionX (https://www.nutritionix.com/).

Figure 1.

Three versions of the café menu, one for each of the labelling conditions

Control menu	Healthy tick menu	Traffic light menu
Content removed due to copyright restrictions	Content removed due to copyright restrictions	Content removed due to copyright restrictions

To evaluate the subjective healthiness ratings of food, a brief Qualtrics survey was completed by 27 volunteers (6 men, 18 women, 3 other or preferred not to disclose) aged 20 – 84 years (*M* = 29.48, *SD* = 14.87), who viewed a variety of images for the 25 food and drink options. A total of 127 food and beverage images were sourced from the internet and all images were cropped and/or resized to allow for a standardized presentation in the final menu. Each image was presented one at a time and participants were asked to first write down the name of the food/beverage to ensure that the items were recognisable and representative of the presented food/beverage. They then rated the healthiness ("How healthy is the food/drink in the picture?") and likelihood of ordering the food/beverage ("How likely are you to order this item for a sit down meal in a café setting?") on 9-point Likert scales ranging from 1 (not at all healthy; not at all likely) to 9 (extremely healthy; extremely likely).

To fit the traffic light categorisation, the final 18 menu items were selected to best fit the three groups: healthy (green), unhealthy (red), or average (amber), both objectively (nutritional information) and subjectively (perceived healthiness). Pairwise comparisons were made between colour categories on perceived healthiness and likelihood of ordering for each food category (mains, desserts, drinks). Across all food categories, green-coded food items were rated significantly higher (ps $< .05$) in perceived healthiness than red-coded food items. Food items in the amber category were significantly different in some (but not all) pairwise comparisons, but as a middle category between two extremes, differences were non-essential for the study. There were no significant differences in likelihood of ordering between the colour categories of each menu group (ps $> .05$). Additionally, all items had a concept agreement of 95% or above, except for the brownie (91.30%), chia pudding (90%) and chai latte (91.66%). Descriptive statistics for the final menu items are shown in Appendix D.

Dietary restraint

To assess dietary restraint, the Revised Restraint Scale (Herman & Polivy, 1980) was used (see Appendix E). This 10-item self-report measure asks participants to respond to questions related to their dieting concerns and behaviour (e.g., ‘How often are you dieting?’). Items are rated on 4- or 5-point scales, which are scored from 0 to 3 or 0 to 4. Total scores range from 0 to 35, where higher scores indicate higher degrees of dietary restraint. A pre-established cut off score was used to categorise participants into restrained (15 and above) and unrestrained (14 or below) eater groups. The scale has previously shown good internal consistency (Cronbach’s $\alpha = .82$) and test-retest reliability ($r = .95$; Allison, Kalinsky, & Gorman, 1992). Internal consistency in the present sample was acceptable ($\alpha = .77$).

Nutrition knowledge

To assess nutrition knowledge the Consumer Nutrition Knowledge Scale (CoNKS) was used (Dickson-Spillmann et al., 2011; see Appendix F). Participants are presented with 20 items (e.g., ‘The same amount of fat and sugar contains equally many calories’) and respond by selecting ‘True’, ‘False’ or ‘Don’t know’. Each correct answer scores 1 point, with a maximum score of 20. There are no penalties for incorrect or ‘Don’t know’ responses. Participants were categorised into high and low nutrition knowledge groups based on a median split. The CoNKS has been shown to have acceptable internal consistency (Cronbach’s $\alpha = .73$) and acceptable convergent validity ($r = .67$) with the established General Nutrition Knowledge questionnaire (Dickson-Spillmann et al., 2011; Parmenter & Wardle, 1999). Internal consistency in the present sample was acceptable ($\alpha = .66$).

Demographic and background information

Participants reported demographic information including age, gender, and ethnicity. They also reported the last time they ate or drank anything other than water (to the nearest 15 min.). Finally, participants rated their current hunger and thirst levels on 100 mm visual analogue scales ranging from ‘not hungry/thirsty at all’ to ‘extremely hungry/thirsty’. Hunger (M = 46.82, SD = 23.04) and thirst (M = 53.17, SD = 20.64) ratings were around the mid-point of the scale.

Procedure

The study was conducted in the Flinders University Food Research Laboratory, where participants were informed that the study investigated food choices from a menu, while the exact manipulation was kept concealed. Participants were tested individually or in pairs in separate cubicles in a single session of approximately 15 minutes. All questionnaires were administered using Qualtrics software. Participants first completed a pre-decision survey to collect demographic information and to check that they met the screening criteria, including when they last ate or drank anything other than water. Next, participants were presented with the menu according to their randomly assigned allocation. Participants were randomly assigned to a condition based on order of participation, with the first participant viewing a control menu, the second a healthy tick menu, and the third the traffic light menu, before repeating the cycle of menus again. They were instructed to imagine that they were selecting items for a meal at a café and to then enter their choice of a main dish, dessert, and drink. After recording their selections, participants were asked to provide a brief reason for each of their choices. Participants then completed the measures of dietary restraint and nutrition Finally, the researcher measured participants’ height and weight to calculate BMI (kg/m^2).

One participant declined to have their height and weight measured, and was excluded from BMI analyses.

Results

Characteristics of the Sample

A series of one-way ANOVAs were conducted to compare the three conditions (control, healthy tick, traffic light) at baseline. Across groups, there were no significant differences in BMI, hunger ratings, thirst ratings, nutrition knowledge or dietary restraint (all *p*s > .05, see Table 1 for means and SDs). There was, however, a significant difference between groups for age, F (2,178) = 3.39, p = .04, but Bonferroni post hoc tests showed no significant pair-wise group differences (p values ranged from .06 - .08). A 3x2 chi square analysis revealed that gender significantly differed between groups, with significantly fewer men in the healthy tick condition, X^2 (2, 181) = 6.63, p = .03. As such, gender was controlled for in subsequent analyses.

Table 1.

Means (and standard deviations) or counts for participant characteristics by condition

	Control	Healthy Tick	Traffic Light	Total
Gender Male	20	9	20	49
Gender Female	41	51	40	132
Age	21.05 (2.74)	23.82 (9.44)	23.85 (6.55)	22.9 (6.89)
Hunger	46.74 (22.53)	45.13(24.01)	48.6 (22.82)	46.82 (23.04)
Thirst	55.62 (18.68)	55.25 (21.59)	51.58 (21.66)	53.17 (20.64)
Nutrition knowledge	12.03 (2.691)	12.73 (3.55)	11.3 (3.32)	12.02 (3.31)
Dietary restraint score	14.95 (6.1)	15.5 (6.39)	15.6 (5.35)	15.35 (5.94)
Restrained eaters	33	31	35	99
Unrestrained eaters	28	29	25	82

	Control	Healthy Tick	Traffic Light	Total
BMI	23.36 (4.85)	23.8 (5.1)	24.28 (5.17)	23.81 (5.02)
Low Nutrition Knowledge	33	26	40	99
High Nutrition Knowledge	28	34	20	82

A series of correlational analyses showed that dietary restraint scores were positively correlated with BMI (r = .44, p < .01). Hunger and thirst ratings were also positively correlated with each other (r = .33, p < .01).

The effect of labelling condition on healthy choices

To examine the effect of labelling condition on the total number of green (healthiest) food and drinks picked, the percentage of green items chosen was calculated for each participant, ranging from 0% (no green items) to 100% (all 3 items picked were the healthiest options). A One-way ANOVA was conducted with condition as a grouping variable and controlling for gender, which revealed the groups did not significantly differ in the percentage of green healthy choices F (2,178) = 0.82, p = .43, η_p^2 = .01. The mean proportion of healthy choices in the Healthy tick condition was 41.66 (*SD*= 25.02), the mean percentage for the Traffic light condition was 35.00 (*SD*= 27.73), and the control condition had a mean percentage of 35.52 (*SD*= 26.43) green choices.

Similarly, to investigate the effect of labelling condition on the number of red (unhealthiest) choice made, another one-way ANOVA compared the total percentage of red choices across conditions, again controlling for gender. The results revealed no significant differences between groups on the proportion of unhealthy choices F (2, 177) = 1.37, p = .25, η_p^2 = .02. The mean proportion of unhealthy choices in the Healthy tick condition was 34.44

(*SD*= 38.80), the mean percentage for the Traffic light condition was 38.89 (*SD*= 39.38), and the control condition had a mean percentage of 47.54 (*SD*= 41.93) red choices.

The moderating role of dietary restraint

To examine the moderating role of dietary restraint, a series of two-way ANOVA factorial analyses were conducted, with labelling condition (control, healthy tick, traffic lights) and dietary restraint (restrained, unrestrained) as grouping variables, controlling for gender. Total percentages of healthiest (green) and unhealthiest (red) choices were analysed separately as outcomes. There was no significant main effect of dietary restraint on the total percentage of either green or red choices, and no significant interactions between condition and restraint (see Table 2).

Table 2.

Number, Mean and standard deviations of percentage of green choices

	Control	Healthy tick	Traffic lights
Main effect of restraint on green choices	F (1, 180) = .01, p = .92, η_p^2 <.01		
Interaction between restraint and condition	F (2, 180) = .03, p = .97, η_p^2 <.01		
Restrained	34.34 (24.27)	38.71 (24.49)	32.38 (27.40)
Unrestrained	36.90 (29.17)	44.82 (25.63)	38.66 (28.35)
Total	35.52 (26.43)	41.66 (25.02)	35.00 (27.73)
Main effect of restraint on red choices	F (1, 180) < .01, p = .99, η_p^2 <.01		
Interaction between restraint and condition	F (2, 180) = .06, p = .94, η_p^2 <.01		
Restrained	46.46 (43.25)	34.41 (34.41)	40.00 (40.26)
Unrestrained	48.81 (41.06)	34.48 (10.32)	37.33 (38.87)
Total	47.54 (41.93)	34.44 (38.80)	38.89 (39.38)

The moderating role of nutrition knowledge

Similarly, a series of two-way factorial ANOVAs was used to compare the main and interaction effects of nutrition knowledge on the total percentage of healthiest (green) and unhealthiest (red) choices. Gender was controlled during the analyses, and labelling condition (control, healthy tick, traffic lights) and nutrition knowledge (low, high) were the grouping variables. As can be seen in Table 3, no main effects or interaction effects between nutrition knowledge and condition were found.

Table 3.

Means and standard deviations by condition and knowledge level

	Control	Healthy tick	Traffic lights
Main effect of knowledge on green choices	F (1, 180) = .64, p = .43, η_p^2 = .004		
Interaction between knowledge and condition	F (2, 180) = 1.14, p = .32, η_p^2 = .01		
Low nutrition knowledge	37.37 (26.03)	47.43 (25.25)	33.33 (28.24)
High nutrition knowledge	33.33 (27.22)	37.25 (24.29)	38.33 (27.09)
Total	35.52 (26.43)	41.66 (25.02)	35.00 (27.73)
Main effect of knowledge on red choices	F (1, 180) = 2.36, p = .13, η_p^2 = .02		
Interaction between knowledge and condition	F (2, 180) = 0.36, p = .70, η_p^2 = .004		
Low nutrition knowledge	46.46 (39.91)	25.64 (35.66)	35.0 (39.19)
High nutrition knowledge	48.81 (44.89)	41.17 (40.25)	46.66 (39.59)
Total	47.54 (41.93)	34.44 (38.80)	38.89 (39.38)

The effect of labelling condition on choices from individual menu categories

To investigate the effect of labelling condition on choices from individual sections of the menu (main/dessert/drink) while controlling for gender, a series of 3x3x2 (condition x chosen item colour x gender) Chi Square tests of independence were conducted. However, all results for both genders were non-significant across all sections ($p > .05$). As such, the results for the combined full samples were used.

There was a significant effect of labelling condition on the distribution of mains chosen across colours (green, amber, red). Compared to the control condition, participants in the Healthy Tick option were significantly ($p < .05$) more likely to choose one of the healthiest main dishes, and significantly less likely to choose one of the unhealthiest main dishes. However, there was no significant difference in the healthiness of main choices for participants in the Traffic Light condition compared to either the Control or Healthy Tick condition. No significant effects of labelling condition on the colour of chosen drinks and desserts were found (see Table 4).

Table 4.

Number and percentage of choices from each menu section per condition

	Control	Healthy Tick	Traffic Light
Mains	X^2 (4, 181) = 11.19, p = .03, Cramer's V = .18		
Red mains	31 (50.8%)*	16 (26.66%)*	20 (33.33%)
Amber mains	15 (24.59%)	13 (21.66%)	16 (26.66%)
Green mains	15 (24.59%)*	31 (51.66%)*	24 (40%)
Total mains	61 (100%)	60 (100%)	60 (100%)
Desserts	X^2 (4, 181) = 5.46, p = .24, Cramer's V = .12		

	Control	Healthy Tick	Traffic Light
Red desserts	28 (45.9%)	23 (38.3%)	25 (41.7%)
Amber desserts	12 (19.7%)	20 (33.3%)	22 (36.7%)
Green desserts	21 (34.4%)	17 (28.3%)	13 (21.7%)
Total desserts	61 (100%)	60 (100%)	60 (100%)
<u>Drinks</u>	X^2 (4, 181) = 2.46, *p* = .65, , Cramer's V = .08		
Red drinks	20 (32.8%)	28.3% (17)	15 (25%)
Amber drinks	12 (19.7%)	26.7% (16)	19 (31.7%)
Green drinks	47.5% (29)	45% (27)	26 (43.3%)
Total drinks	61 (100%)	60 (100%)	60 (100%)

Note *Indicates a subset of condition categories where column proportions differ significantly at the .05 level

Dietary restraint as a moderator for individual menu section choices

To examine the role of dietary restraint as a moderator, a series of 3x3x2 (condition x colour of item chosen x dietary restraint) chi square analyses were conducted for each section of the menu (main/dessert/drink). Compared to the control condition, restrained eaters in the Healthy Tick condition were significantly more likely to choose one of the healthiest main dishes (green options). No other significant differences were found. For unrestrained eaters, no significant differences were found for choices of mains. The remaining menu sections (desserts and drinks) did not show a significant interaction between labelling condition and dietary restraint (see Table 5).

Table 5.

Summary of main, dessert and drink choices and percentage by dietary restraint and labelling condition

	Control	Healthy tick	Traffic lights
Unrestrained	X^2 (1,82) = 3.11, p = .54, Cramer's V = .14		
Green main	10 (35.71%)	15 (51.72%)	10 (40%)
Amber main	5 (17.86%)	6 (20.69%)	7 (28%)
Red main	13 (46.43%)	8 (27.59%)	8 (32%)
Total main	28 (100%)	29 (100%)	25 (100%)
Restrained	X^2 (1,99) = 10.39, p = .03, Cramer's V = .23		
Green main	5 (15.15%)*	16 (51.61%)*	14 (40%)
Amber main	10 (30.30%)	7 (22.58%)	9 (25.71%)
Red main	18 (54.55%)	8 (25.81%)	12 (34.29)
Total main	33 (100%)	31 (100%)	35 (100%)
Unrestrained	X^2 (1,82) = 1.83, p = .77, Cramer's V = .15		
Green desserts	9 (32.14%)	10 (34.48%)	7 (28%)
Amber desserts	5 (17.86%)	8 (25.59%)	8 (32%)
Red desserts	14 (50%)	11 (37.93%)	10 (40%)
Total desserts	28 (100%)	29 (100%)	25 (100%)
Restrained	X^2 (1,99) = 4.88, p = .30, Cramer's V = .16		
Green desserts	12 (36.36%)	7 (22.58%)	6 (17.14%)
Amber desserts	7 (21.21%)	12 (38.71%)	14 (40%)
Red desserts	14 (42.42%)	12 (38.71%)	15 (42.86%)
Total desserts	33 (100%)	31 (100%)	35 (100%)
Unrestrained	X^2 (1,82) = 1.21, p = .88, Cramer's V = .09		
Green drinks	12 (42.86%)	14 (48.28%)	12 (48%)
Amber drinks	7 (25%)	7 (24.14%)	8 (32%)
Red drinks	9 (32.14%)	8 (28.59%)	5 (20%)

	Control	Healthy tick	Traffic lights
Total drinks	28 (100%)	29 (100%)	25 (100%)
Restrained	X^2 (1,99) = 2.76, *p* = .60, , Cramer's V = .18		
Green drinks	17 (51.52%)	13 (41.94%)	14 (40%)
Amber drinks	5 (15.15%)	9 (29.03%)	11 (31.43%)
Red drinks	11 (33.33%)	9 (29.03%)	10 (28.57%)
Total drinks	33 (100%)	31 (100%)	35 (100%)

Note: *indicates a subset of condition categories where column proportions differ significantly at the .05 level

Nutritional knowledge as a moderator for individual menu section choices

To test the moderating effect of nutritional knowledge on each section (mains/desserts/drinks) of the menu a series of 3x3x2 (condition x colour of item choice x nutrition knowledge) chi square analyses were conducted. Similar to dietary restraint, a significant interaction effect was only found within the mains section. Specifically, participants with low nutrition knowledge in the healthy tick condition were significantly more likely to choose a healthy main dish, and significantly less likely to choose an unhealthy main dish compared to the Control condition. These effects of labelling condition were not found for participants with high nutrition knowledge. The remaining sections of the menu (desserts and drinks) did not show a significant interaction between labelling condition and nutrition knowledge (see Table 6).

Table 6.

Summary of main, dessert and drink choices and percentage by nutrition knowledge and menu condition

	Control	Healthy tick	Traffic lights
Low knowledge	X^2 (1,99) = 15.13, p = .004, Cramer's V = .28		
Green mains	6 (18.18%)*	17 (65.38%)*	15 (37.5%)
Amber mains	9 (27.27%)	5 (19.23%)	11 (27.5%)
Red mains	18 (54.55%)*	4 (15.38%)*	14 (35%)
Total mains	33 (100%)	26 (100%)	40 (100%)
High knowledge	X^2 (1,82) = 1.56, p = .82, Cramer's V = .10		
Green mains	9 (32.14%)	14 (41.18%)	9 (45%)
Amber mains	6 (21.43%)	8 (23.53%)	5 (25%)
Red mains	13 (46.43%)	12 (35.29%)	6 (30%)
Total mains	28 (100%)	34 (100%)	20 (100%)
Low knowledge	X^2 (1,99) = 3.21, p = .52, Cramer's V = .13		
Green desserts	11 (33.33%)	8 (30.77%)	9 (22.5%)
Amber desserts	8 (24.24%)	10 (38.46%)	17 (42.5%)
Red desserts	14 (42.42%)	8 (30.77%)	14 (35%)
Total desserts	33 (100%)	26 (100%)	40 (100%)
High knowledge	X^2 (1,82) = 2.95, p = .57, Cramer's V = .13		
Green desserts	10 (35.71%)	9 (26.47%)	4 (20%)
Amber desserts	4 (14.29%)	10 (29.41%)	5 (25%)
Red desserts	14 (50%)	15 (44.12%)	11 (55%)
Total desserts	28 (100%)	34 (100%)	20 (100%)
Low knowledge	X^2 (1,99) = 6.23, p = .18, Cramer's V = .18		
Green drinks	20 (60.61%)	12 (46.15%)	16 (40%)
Amber drinks	3 (9.09%)	8 (30.77%)	12 (30%)
Red drinks	10 (30.30%)	6 (23.08%)	12 (30%)
Total drinks	33 (100%)	26 (100%)	40 (100%)
High knowledge	X^2 (1,82) = 3.51, p = .47, Cramer's V = .15		

	Control	Healthy tick	Traffic lights
Green drinks	9 (32.14%)	15 (44.12%)	10 (50%)
Amber drinks	9 (32.14%)	8 (23.53%)	7 (35%)
Red drinks	10 (35.71%)	11 (32.35%)	3 (15%)
Total drinks	28 (100%)	34 (100%)	20 (100%)

Note: *indicates a subset of condition categories where column proportions differ significantly at the .05 level

Discussion

The present study aimed to compare various menu labelling systems, with a traffic light system and healthy tick symbol compared to a control condition where no health information was provided. The results revealed that menu labelling only nudged consumers to make healthier main item choices (not desserts or drinks), and that the effect of this nudge was particularly pronounced for participants high in dietary restraint or low in nutrition knowledge.

When looking at the effects of the different label types on menu choices overall no significant effect of menu labelling was found. The average composition of healthy or unhealthy items (calculated by the percentage of green or red items ordered for the meal as a whole) did not significantly differ by labelling condition. Although these results suggest a lack of support for the use of menu labelling, a further analysis of individual meal categories suggests the possibility of labelling impacting parts of a meal order. In particular, when analysing the effects of menu labelling for the individual menu categories, a significant effect was found for mains choices, but not drink and dessert choices. Participants who saw the healthy tick labelling were more likely to choose a healthy main (marked by a green tick) compared to the control condition. They were also more likely to avoid an unhealthy choice of main dish. These results are somewhat consistent with the findings by Ellison et al. (2013) in which an effect of menu labelling was only found within the mains (entrees) section, and not within the drinks and side dishes. In their study, participants who were presented with an interpretive menu label (traffic lights) alongside a calorie count ordered significantly fewer mains calories than participants who saw only the declarative menu labelling (calorie count only) or no menu labelling (control condition). Ellison et al. suggested that individuals may choose a healthy main, and through a licensing effect (where individuals come up with reasons for indulgence), choose an unhealthy dessert and/or drink with the justification that they are eating a healthy main meal. As desserts and drinks are often additional or discretionary choices to a meal in the out of home dining context, consumers may place more importance on choosing a healthy main dish compared to desserts and drinks.

While past research has found support for the use of traffic light labelling in out of home dining contexts, the current results suggest that such labelling may not have as large an effect as a healthy tick symbol on menus (Levy et al. 2012; Sonnenberg et al., 2013; Thorndike et al., 2012). Although Ellison et al. (2013) did find support for the use of traffic light labelling, they did so in combination with the provision of calorie counts.

In addition to the main effects of menu labelling on the choice of main meal, the personal factors of dietary restraint and nutrition knowledge were also found to interact with menu condition, moderating the healthiness of main chosen. Specifically, compared to the control condition, restrained eaters who were presented with a healthy tick symbol were observed to approach healthier options (order a healthy main) and avoid unhealthy options (less likely to order an unhealthy main), with a significantly lower number of red mains chosen. In contrast, unrestrained eaters did not significantly differ in the healthiness of the main item chosen in either label condition. These results are in line with previous research, where individuals with high dietary consciousness were more likely to be influenced by menu labelling to make healthier choices (Schaumberg et al., 2016). In contrast to unrestrained eaters, for restrained eaters healthier choices are in line with their dieting goal of eating less, and/or eating more healthily.

Additionally, nutrition knowledge was also found to have a moderating role. Specifically, participants who had low nutrition knowledge and viewed the healthy tick label were more likely to order a healthy main item, compared to the no label control condition. This was not the case for participants with high nutrition knowledge. Notably, the current results contrast with past research where it has been reported that individuals high in nutrition knowledge are more likely to use labels, and therefore pick healthier choices than individuals with low knowledge (Miller & Cassady, 2015). However, Miller and Cassady's review focused on the use of labels on packaged food, which is often descriptive information without an evaluative/interpretive element (e.g., nutrition panel). In contrast, the present study examined the use of evaluative labels on menus. It is possible that the simplicity of the healthy tick labelling format removes the need for prior nutrition knowledge for the labelling to be effective.

Implications and applications

The present results show the effectiveness of the use of a healthy tick symbol to nudge healthier main choices, particularly among restrained eaters and those with low nutrition knowledge. The study contributes to the support of nudging where positive choices are encouraged through a simple symbol and the choice is made easier for consumers. In contrast to the traffic light system, where information is presented for every item on the menu, the healthy tick option may make the decision easier as it highlights and features the healthiest choices from the menu. This allows the consumer to easily and immediately focus their attention on the healthiest choices, and potentially allow for individuals with low nutrition knowledge to make a quick choice, as heuristics play a large role in food choices being made quickly and simply (Schulte-Mecklenbeck et al, 2013).

On a practical scale, the results show support for the application of healthy tick labelling within the out-of-home dining setting. Such a simple labelling format is easy for individuals lower in nutrition knowledge to interpret, and helps highlight healthier choices for consumers concerned about their dietary intake. An additional benefit is the relative ease it would be for food establishments to implement such a labelling system, as this can be accomplished with simple stickers or quick additions to menu layouts. Overall, this study adds to the growing body of research in support of the use of nudges to encourage healthier choices in out of home dining settings.

One limitation of this study was the use of a university population, with a majority of participants being female and young adults. As such the sample had an uneven distribution of genders across conditions. Notably, previous research has shown that women tend to have higher concerns about dieting and weight control compared to men and are thus likely to score higher for dietary restraint (Slof-Op't Landt et al., 2017), which was found to be a significant moderator in the current study. As such, it might be possible that the effects of menu labelling may be less effective for men. Future studies could usefully examine the impact of labelling on a wider general population and the generalisability of such results across genders. An additional limitation of the menu was the use of an imagined choice instead of examining actual meal consumption, which is based on the assumption that participants would consume the whole meal ordered. Although previous research has shown that effect sizes between food selection and consumption in such nudging studies are not significantly different, the use of imagined choices does not capture the full detail of consumption (Cadario & Candon, 2019). Lastly, the current results are limited to the use of a café specific menu from the modest selection provided to participants. This limits the generalisation of results to actual café settings, which likely have a larger selection of food and drink items.

Overall, the present study contributes to the field of menu labelling and shows support for the use of labelling to help nudge consumers to make healthier choices, at least for the selection of mains. The use of a healthy tick symbol appears to have been effective in encouraging consumers to choose a healthier main. Such a simple labelling format is easy for individuals lower in nutrition knowledge to interpret, and helps highlight healthier choices for consumers concerned about their dietary intake. Further research could usefully encourage food service establishments and policymakers to adopt a nudging approach to encourage healthier choices within the population, and thus help ease the disease burden of health complications that arise from poor diets.

References

Allison, D. B., Kalinsky, L. B., & Gorman, B. S. (1992). A comparison of the psychometric properties of three measures of dietary restraint. *Psychological assessment*, *4*(3), 391.

Australian Chronic Disease Prevention Alliance. (2011, May). *Position Statement on Nutrition Labelling on Restaurant Menus*. Diabetes Australia | Support for people living with diabetes. https://www.diabetesaustralia.com.au/wp-content/uploads/Position-Statement-on-Nutrition-Labelling.pdf

Australian Institute of Health and Welfare 2017. Impact of overweight and obesity as a risk factor for chronic conditions: Australian Burden of Disease Study. Australian Burden of Disease Study series no.11. Cat. no. BOD 12. BOD. Canberra: AIHW.

Authority, N. F. (2013). Evaluation of kilojoule menu labelling. *Silverwater: NSW Government*.

Cadario, R., & Chandon, P. (2019). Effectiveness or consumer acceptance? Tradeoffs in selecting healthy eating nudges. *Food policy*, *85*, 1-6.

Campos, S., Doxey, J., & Hammond, D. (2011). Nutrition labels on pre-packaged foods: a systematic review. *Public health nutrition*, *14*(8), 1496-1506.

Cohen, J. (1992). Statistical power analysis. *Current directions in psychological science*, *1*(3), 98-101.

Croker, H., Packer, J., Russell, S. J., Stansfield, C., & Viner, R. M. (2020). Front of pack nutritional labelling schemes: a systematic review and meta-analysis of recent evidence relating to objectively measured consumption and purchasing. *Journal of Human Nutrition and Dietetics*, *33*(4), 518-537.

Department of Health. (2016). *Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets*. https://www.food.gov.uk/sites/default/files/media/document/fop-guidance_0.pdf

Dickson-Spillmann, M., Siegrist, M., & Keller, C. (2011). Development and validation of a short, consumer-oriented nutrition knowledge questionnaire. *Appetite*, *56*(3), 617-620.

Drescher, L. S., Roosen, J., & Marette, S. (2014). The effects of traffic light labels and involvement on consumer choices for food and financial products. *International journal of consumer studies*, *38*(3), 217-227.

Ellison, B., Lusk, J. L., & Davis, D. (2013). Looking at the label and beyond: the effects of calorie labels, health consciousness, and demographics on caloric intake in restaurants. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 1-9.

Feteira-Santos, R., Fernandes, J., Virgolino, A., Alarcão, V., Sena, C., Vieira, C. P., ... & Santos, O. (2020). Effectiveness of interpretive front-of-pack nutritional labelling schemes on the promotion of healthier food choices: a systematic review. *JBI Evidence Implementation*, *18*(1), 24-37

Herman, C. & Polivy, J.(1980) Restrained eating. *Obesity. Philadelphia: Saunders*.

Hieke, S., & Wilczynski, P. (2012). Colour Me In–an empirical study on consumer responses to the traffic light signposting system in nutrition labelling. *Public health nutrition*, *15*(5), 773-782.

Hogan, L. (2018) *Food demand in Australia: trends and issues 2018*. Australian Bureau of Agricultural and Resource Economics and Sciences, Australian Government

Holdsworth, M., & Haslam, C. (1998). A review of point-of-choice nutrition labelling schemes in the workplace, public eating places and universities. *Journal of Human Nutrition and Dietetics*, *11*(5), 423-445.

Larsson, I., Lissner, L., & Wilhelmsen, L. (1999). The 'Green Keyhole'revisited: nutritional knowledge may influence food selection. *European journal of clinical nutrition*, *53*(10), 776-780.

Lassen, A. D., Beck, A., Leedo, E., Andersen, E. W., Christensen, T., Mejborn, H., ... & Tetens, I. (2014). Effectiveness of offering healthy labelled meals in improving the nutritional quality of lunch meals eaten in a worksite canteen. *Appetite*, *75*, 128-134.

Thaler,R. H., Sunstein, C.R. (2008) Nudge: Improving decisions about health, wealth, and happiness. Leonard, T. C.

Levy, D. E., Riis, J., Sonnenberg, L. M., Barraclough, S. J., & Thorndike, A. N. (2012). Food choices of minority and low-income employees: a cafeteria intervention. *American journal of preventive medicine*, *43*(3), 240-248.

McDonald's, KFC, Hungry Jack's & Domino's Pizza are Australia's favorite restaurants - Roy Morgan Research. (2021, May 24). Www.roymorgan.com. https://www.roymorgan.com/findings/mcdonalds-kfc-hungry-jacks-dominos-pizza-are-australias-favorite-restaurants

Miller, L. M. S., & Cassady, D. L. (2015). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, *92*, 207-216.

Noncommunicable diseases. (2019, June 12). WHO | World Health Organization. https://www.who.int/health-topics/noncommunicable-diseases

Popkin, B. M., Barquera, S., Corvalan, C., Hofman, K. J., Monteiro, C., Ng, S. W., ... & Taillie, L. S. (2021). Towards unified and impactful policies to reduce ultra-processed food consumption and promote healthier eating. *The Lancet Diabetes & Endocrinology*, *9*(7), 462-470.

Scarborough, P., Matthews, A., Eyles, H., Kaur, A., Hodgkins, C., Raats, M. M., & Rayner, M. (2015). Reds are more important than greens: how UK supermarket shoppers use the different information on a traffic light nutrition label in a choice experiment. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 1-9.

Schaumberg, K., Anderson, D. A., Anderson, L. M., Reilly, E. E., & Gorrell, S. J. C. O. (2016). Dietary restraint: what's the harm? A review of the relationship between dietary restraint, weight trajectory and the development of eating pathology. *Clinical Obesity*, *6*(2), 89-100.

Schulte-Mecklenbeck, M., Sohn, M., de Bellis, E., Martin, N., & Hertwig, R. (2013). A lack of appetite for information and computation. Simple heuristics in food choice. *Appetite*, 71, 242-251.

Seah, S. S. Y., van Dam, R. M., Tai, B. C., Tay, Z., Wang, M. C., & Rebello, S. A. (2022). An evaluation of the healthier dining programme effects on university student and staff choices in Singapore: A cluster-randomized trial. *Food Policy*, *107*, 102211.

Sharma, S., Wagle, A., Sucher, K., & Bugwadia, N. (2011). Impact of point of selection nutrition information on meal choices at a table-service restaurant. *Journal of foodservice business research*, *14*(2), 146-161.

Slof-Op‘t Landt, M. C., van Furth, E. F., van Beijsterveldt, C. E., Bartels, M., Willemsen, G., de Geus, E. J., ... & Boomsma, D. I. (2017). Prevalence of dieting and fear of weight gain across ages: a community sample from adolescents to the elderly. *International journal of public health*, *62*(8), 911-919.

Song, J., Brown, M. K., Tan, M., MacGregor, G. A., Webster, J., Campbell, N. R., ... & He, F. J. (2021). Impact of color-coded and warning nutrition labelling schemes: A systematic review and network meta-analysis. *PLoS medicine*, *18*(10), e1003765.

Sonnenberg, L., Gelsomin, E., Levy, D. E., Riis, J., Barraclough, S., & Thorndike, A. N. (2013). A traffic light food labeling intervention increases consumer awareness of health and healthy choices at the point-of-purchase. *Preventive medicine*, *57*(4), 253-257.

Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *British journal of nutrition*, *111*(10), 1713-1726.

The Nielsen Company. (2016). *What's in our food and on our mind; Ingridient and dining-out trends around the world*. https://www.nielsen.com/

Thorndike, A. N., Sonnenberg, L., Riis, J., Barraclough, S., & Levy, D. E. (2012). A 2-phase labeling and choice architecture intervention to improve healthy food and beverage choices. *American journal of public health*, *102*(3), 527-533.

Thunström, L., & Nordström, J. (2011). Does easily accessible nutritional labelling increase consumption of healthy meals away from home? A field experiment measuring the impact of a point-of-purchase healthy symbol on lunch sales. *Food Economics-Acta Agriculturae Scandinavica, Section C*, *8*(4), 200-207.

Vyth, E. L., Steenhuis, I. H., Heymans, M. W., Roodenburg, A. J., Brug, J., & Seidell, J. C. (2011). Influence of placement of a nutrition logo on cafeteria menu items on lunchtime food choices at Dutch work sites. *Journal of the American Dietetic Association*, *111*(1), 131-136.

Wellard-Cole, L., Goldsbury, D., Havill, M., Hughes, C., Watson, W. L., Dunford, E. K., & Chapman, K. (2018). Monitoring the changes to the nutrient composition of fast foods following the introduction of menu labelling in New South Wales, Australia: an observational study. *Public Health Nutrition*, *21*(6), 1194-1199.

Appendix

Appendix A

Larger versions of the menus for the Control, Healthy tick and Traffic light menus

Mains

Image/content removed due to copyright restrictions
Spaghetti & meatballs

Image/content removed due to copyright restrictions
Fried rice

Image/content removed due to copyright restrictions
Baked salmon

Image/content removed due to copyright restrictions
Burger

Image/content removed due to copyright restrictions
Pizza

Image/content removed due to copyright restrictions
Salad

Image/content removed due to copyright restrictions

THE CORNER CAFÉ

Desserts

Image/content removed due to copyright restrictions
Fruit salad

Image/content removed due to copyright restrictions
Pancakes

Image/content removed due to copyright restrictions
Cake

Image/content removed due to copyright restrictions
Chia pudding

Image/content removed due to copyright restrictions
Brownie

Image/content removed due to copyright restrictions
Fruit tart

Drinks

Image/content removed due to copyright restrictions
Water

Image/content removed due to copyright restrictions
Chai

Image/content removed due to copyright restrictions
Hot chocolate

Image/content removed due to copyright restrictions
Iced mocha

Image/content removed due to copyright restrictions
Cappuccino

Image/content removed due to copyright restrictions
Tea

Mains

Image/content removed due to copyright restrictions
Spaghetti & meatballs

Image/content removed due to copyright restrictions
Fried rice

Image/content removed due to copyright restrictions
Baked salmon

Image/content removed due to copyright restrictions
Burger

Image/content removed due to copyright restrictions
Pizza

Image/content removed due to copyright restrictions
Salad

The healthy tick

Look out for this symbol for healthier choices low in fat, sugar or salt.

Desserts

Image/content removed due to copyright restrictions
Fruit salad

Image/content removed due to copyright restrictions
Pancakes

Image/content removed due to copyright restrictions
Cake

Image/content removed due to copyright restrictions
Chia pudding

Image/content removed due to copyright restrictions
Brownie

Image/content removed due to copyright restrictions
Fruit tart

Drinks

Image/content removed due to copyright restrictions
Water

Image/content removed due to copyright restrictions
Chai

Image/content removed due to copyright restrictions
Hot chocolate

Image/content removed due to copyright restrictions
Iced mocha

Image/content removed due to copyright restrictions
Cappuccino

Image/content removed due to copyright restrictions
Tea

Mains

Image/content removed due to copyright restrictions
Spaghetti & meatballs

Image/content removed due to copyright restrictions
Fried rice

Image/content removed due to copyright restrictions
Baked salmon

Image/content removed due to copyright restrictions
Burger

Image/content removed due to copyright restrictions
Pizza

Image/content removed due to copyright restrictions
Salad

The traffic lights

Red = High in fat, sugar, and/or salt

Amber = Moderate in fat, sugar, and/or salt

Green = Low in fat, sugar, and/or salt

Desserts

Image/content removed due to copyright restrictions
Fruit salad

Image/content removed due to copyright restrictions
Pancakes

Image/content removed due to copyright restrictions
Cake

Image/content removed due to copyright restrictions
Chia pudding

Image/content removed due to copyright restrictions
Brownie

Image/content removed due to copyright restrictions
Fruit tart

Drinks

Image/content removed due to copyright restrictions
Water

Image/content removed due to copyright restrictions
Chai

Image/content removed due to copyright restrictions
Hot chocolate

Image/content removed due to copyright restrictions
Iced mocha

Image/content removed due to copyright restrictions
Cappuccino

Image/content removed due to copyright restrictions
Tea

Appendix B

Guidelines for UK Front of Pack Traffic Light labelling

Guidelines for colour coding the nutritional values of food items

	Green	Amber	Red /100g	Red /portion
Fat	≤ 3.0g/100g	> 3.0g to ≤ 17.5g/100g	> 17.5g/100g	> 21g/portion
Saturated Fat	≤ 1.5g/100g	> 1.5g to ≤ 5.0g/100g	> 5.0g/100g	> 6.0g/portion
Sugar	≤ 5.0g/100g	> 5.0g to ≤ 22.5g /100g	> 22.5g/100g	> 27g/portion
Salt	≤ 0.3g/100g	> 0.3g to ≤ 1.5g/100g	>1.5g/100g	>1.8g/portion

Guidelines for colour coding the nutritional values of drink items

	Green	Amber	Red /100g	Red /portion
Fat	≤ 1.5g/100ml	> 1.5g to ≤ 8.75g/100ml	> 8.75g/100ml	>10.5g/portion
Saturated Fat	≤ 0.75g/100ml	> 0.75g to ≤ 2.5g/100ml	> 2.5g/100ml	> 3g/portion
Sugar	≤ 2.5g/100ml	> 2.5g to ≤ 11.25g/100ml	> 11.25g/100ml	> 13.5g/portion
Salt	≤ 0.3g/100ml	>0.3g to ≤0.75g/100ml	> 0.75g/100ml	> 0.9g/portion

Appendix C

Nutritional value of final items included in Study 2 menu

		Per portion				Per 100g			
	Grams / portion	fat	Satu-rated fat	salt	sugar	fat	Satu-rated fat	salt	sugar
Mains									
Burger	257	29	13.1	0.96	8.3	11.28	5.10	0.38	3.23
Pizza	357	35.7	18	1.97	9.9	10	5.04	0.55	2.77
Spaghetti & meatball	350	25	9.1	0.79	6.3	7.14	2.6	0.226	1.8
Fried rice	336	18.8	6	1.51	16.1	5.60	1.79	0.45	4.79
Grilled salmon	100	15.5	4.3	0.05	0	15.5	4.3	0.05	0
Salad	400	1	0	0.22	5.4	0.25	0	0.06	1.35
Desserts									
Brownie	50	12.8	6.1	0.26	17.7	25.6	12.2	0.512	35.4
Chocolate cake	100	39	28	0.06	30.4	39	28	0.061	30.4
Pancake	83	6.6	3.7	0.07	3.3	7.95	4.46	0.08	3.98
Fruit tart	100	7.1	4.4	0.09	14.2	7.1	4.4	0.09	14.2
Fruit salad	200	0.4	0	0.03	15	0.2	0	0.014	7.5
Chia pudding	115	3	2.2	0.03	3.3	2.61	1.91	0.03	2.87
Drinks									
Iced mocha	355	14.1	7.8	0.07	21	3.97	2.20	0.02	5.92
Hot chocolate	293	10.8	7.3	0.10	29.3	3.69	2.49	0.03	10
Cappuccino	220	7	4.6	0.08	9	3.18	2.09	0.04	4.09
Chai latte	237	3.3	1.9	0.05	21	1.39	0.80	0.02	8.86
Black tea	250	0	0	0.00	0	0	0	0	0
Water	200	0	0	0.00	0	0	0	0	0

Appendix D

Descriptive ratings and statistics from the pilot study of menu items

		Healthiness	Likelihood of ordering	Concept agreement
Mains	Category			
Burger	Red	2.64 (1.53)	6.10 (2.59)	100%
Pizza	Red	2.05 (1.25)	5.27 (2.91)	100%
Spaghetti & meatball	Amber	4.26 (1.36)	6.00 (2.56)	100%
Fried rice	Amber	5.04 (1.54)	5.70 (2.29)	95.65%
Grilled salmon	Green	7.52 (1.23)	6.25 (2.95)	100%
Salad	Green	7.86 (0.79)	7.00 (2.05)	100%
Desserts				
Brownie	Red	1.57 (0.79)	5.35 (2.23)	91.30%
Chocolate cake	Red	1.84 (1.03)	5.08 (2.12)	100%
Pancake	Amber	3.95 (1.59)	5.59 (2.26)	100%
Fruit tart	Amber	3.96 (1.77)	5.18 (2.61)	95.65%
Fruit salad	Green	8.14 (0.86)	6.00 (2.61)	100%
Chia pudding	Green	6.50 (1.87)	5.95 (2.56)	90%
Drinks				
Iced mocha	Red	1.72 (0.74)	5.17 (2.98)	96%
Hot chocolate	Red	2.12 (0.97)	5.20 (3.00)	100%
Cappuccino	Amber	4.00 (2.14)	6.14 (3.47)	100%
Chai latte	Amber	3.95 (1.99)	4.75 (3.04)	91.66%
Black tea	Green	6.87 (1.69)	5.83 (3.01)	100%
Water	Green	8.76 (0.90)	8.88 (0.33)	100%
Average ratings across sections				
Unhealthy (red)		1.99 (.38)	5.36 (0.37)	97.83%
Average (amber)		4.28 (.63)	5.70 (0.65)	97.33%
Healthy (green)		7.61 (.83)	6.65 (1.17)	98.33%

Appendix E

Revised Restraint Scale (Herman & Polivy, 1980)

Appendix F

Consumer Nutrition Knowledge Scale (Dickson-Spillmann, Siegrist, Keller, 2011)

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Chapter 4 (Studies 3 and 4) : Use of red and green labels and explanatory legends to nudge healthier choices from a café style menu

Abstract

With increasing access to unhealthy foods, it is important to encourage healthier eating to address climbing rates of lifestyle-related disease worldwide. The present studies investigated using red and green labels to encourage healthier decisions from a mock café style menu with both healthy and unhealthy food and drink choices. Three labelling conditions: 1) red only (unhealthy labels), 2) green only (healthy labels), 3) both red and green labels were compared to a no information control. Participants were randomized (using Qualtrics) to one of these four conditions and selected a main, dessert and drink before completing measures of dietary restraint and nutrition knowledge. Study 3 tested labelling with an explanatory legend. Study 4 tested if nudging was still effective without an explanation, along with assessing if participants noticed and understood the labels.

In Study 3 any label condition encouraged overall healthier choices. Labelling increased the likelihood of healthy mains, but not desserts and drinks. Neither nutrition knowledge nor dietary restraint interacted with labelling to affect choices. Study 4 found no significant effect of labelling nor an interaction with dietary restraint. An isolated moderation effect of nutrition knowledge was noted when the green only label was compared to the control. Participants reported noticing and understanding the red and green labels more than the red only and green only labels.

Both studies support labelling for healthier choices, but an explanatory legend is needed. Dietary restraint did not interact with labelling to affect healthier choices, which highlights the applicability of simple colour labelling for general populations.

Introduction

As globalisation increases, there has been a corresponding increase in trends such as access to unhealthy foods, that is those high in fat, sugar and salt (Popkin & Gorden-Larsen 2004). This is one of the causes of the growing trend of unhealthy diets, along with an associated increased risk of health concerns such as diabetes and high blood pressure (Popkin et al., 2021; WHO, 2021). As such, there is a pressing need for policies and interventions to address unhealthy food choices and consumption.

Various strategies to encourage healthier eating range from campaigns such as the Australian "Go for 2 & 5" marketing campaign promoting healthier diets (2 servings of fruit and 5 servings of vegetables per day), to financial incentives such as the introduction of a sugar tax to make drinks with added sugar more expensive (Pollard et al., 2008; Jones et al, 2021). However, governmental policies encouraging healthier eating have occasionally been criticized for being overbearing or restrictive (Barnhill et al., 2014). An alternative approach to such polices which are designed to restrict choices is the use of nudging. Nudging is defined as "any aspect of choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic intentions" (Thaler and Sunstein, 2009, p.6).

An example of trying to encourage healthier food choices without restricting options includes the use of food labels, which aim to inform consumers about the content of food. This is often seen on packaged food products, most commonly through the use of a nutrition fact panel. There has also been an increase in labelling within food service establishments, such as the provision of calorie labels which was introduced in Australia in 2011. Although calorie labelling has been in use by major Australian fast-food providers, research has shown mixed support for its use in promoting healthier eating (Authority, 2013; Wellard-Cole, 2018).

A drawback of labelling is the need for the consumer to have the required knowledge to interpret the labels, such as understanding the daily recommended calorie intake or the ability to compare the information presented on two similar products. This is because labels are often declarative in nature, where information is stated factually; in contrast, evaluative labelling aims to help consumers interpret information (Cadario & Chandon, 2019). An example of declarative versus evaluative labelling for sugar content can be seen in the use of a Food Nutrition Panel providing the sugar content in grams versus the Chilean warning system which uses a black octagonal label on a bottled drink that says ‘high in sugar’. While both labels inform the customer about the sugar content of the drink, the warning system has an additional interpretative element (using a stop sign shape and text warning) to help nudge the consumer away from selecting the beverage for consumption.

The present studies aimed to examine the use of evaluative labelling through the use of red and green labels to help promote the avoidance and approach of foods, respectively. The colours are based on the traffic light system, and their associated ‘stop’ and ‘go’ connotations which have been found to extend to automatic avoidance and approach behaviours towards food (Bouhassoun et al., 2022; Rohr et al., 2015). The use of traffic light labelling has already been established for packaged foods in the United Kingdom where the calorie, fat, sugar and salt content of food and drinks is evaluated and labelled from to healthiest (green) to unhealthiest (red), with amber as a middle category (British Nutrition Foundation, 2022; Sacks et al., 2009). The present study aimed to apply a simplified version, leaving out the amber category to better examine the approach and avoidance of foods. Previous research conducted by Scarborough et al. (2015) examining the UK traffic light labelling concluded that participants were more concerned about avoiding red coloured labelled food than approaching green labelled food. As such, it was predicted that a menu that only labelled red (unhealthy) foods would have a stronger effect on encouraging healthier choices over a menu that only identified healthy foods with a green label.

Although labelling usually aims to target the general population, previous research has shown that personal individual factors can influence the usage and understanding of labels. Nutrition knowledge, or an individual's understanding of food content and nutritional values has been shown to increase the use and understanding of food information panels (Miller & Cassidy 2015; Spronk et al., 2014). The present study sought to reduce the importance of nutrition knowledge by using evaluative labelling (colours rather than a declarative information panel). It was expected that while individuals with high nutrition knowledge might be more likely to notice the labelling, the use of an evaluative or interpretive system does not require high nutrition knowledge to be effective.

An additional personal factor is dietary restraint, which is defined as the cognitive process or intention of restricting the intake of food to maintain or reduce body weight (Herman & Polivy, 1980). Previous research has shown that higher dietary restraint was positively associated with self-reported food label use (Jacob et al., 2020). Other field studies have also suggested that such food labelling would appeal to customers high in dietary restraint, as the ability to identify healthy food or avoid unhealthy food to better control weight loss or maintenance is in line with restrained eaters' goals (Sharma et al., 2011; Sonnenburg et al., 2013). Similarly, the present study predicted that restrained eaters would be more likely to notice and be influenced by the menu labelling compared to unrestrained eaters.

Thus, the present research examined the use of colour labelling (green and red) in a café style menu, along with the potential moderating factors of nutrition knowledge and dietary restraint. Study 3 examined the use of three labelling types (red only, green only, red and green) against a control with no labelling information. The different labels were designed to examine the differing avoidance and approach effects of labelling, where the red only and green only labels would help isolate the approach and avoidance effects, respectively. Based on previous research it was predicted that the avoidance effect of red labels would be more effective than the approach effect of healthy green labels. As such it was further hypothesised that while all conditions with menu labelling would encourage healthier food and drink choices, the red only and red and green label conditions would have the largest impact in reducing unhealthy choices.

The menus in each of the conditions in Study 3 included a legend explaining the labelling system. As an extension, Study 4 examined the use of the labelling without such a legend. In so doing, it aimed to examine whether the use of simple red and green circles can nudge healthier food choices. If successful, this could support the use of a simplified system and would support nudging healthier choices through minimal and simple cues.

For both studies, it was predicted that participants high in nutrition knowledge would be able to more effectively understand and utilise the labelling systems, and be more likely to select healthier choices compared to participants with low nutrition knowledge. Similarly, it was hypothesised that dietary restraint would interact with the menu labelling system, whereby restrained eaters would be more likely than unrestrained eaters to make healthier choices.

Study 3 methods

Participants

Participants were recruited through the Flinders University psychology research participation system or the online research platform Prolific. The research study was approved by the Flinders University Human Research Ethics Committee (HREC number: 8382). To be eligible for participation, individuals had to: 1) like most foods, 2) not report specific dietary requirements, or have food allergies/intolerances, and 3) not experience colour blindness. These criteria were set to ensure that participants would be able to view the label colours, and food choices would not be influenced by special dietary needs. A hardware criteria was set where participants were requested to only use desktop or laptop computers to enable the landscape format of the menu to be displayed at optimal size, as a mobile phone screen would be too small for the details to be shown clearly.

Calculations estimated that to detect medium effects with an alpha of .05 and 80% power, a sample size of at least 484participants was needed for 3 degrees of freedom using a chi square analysis (Cohen, 1992). A medium effect size was predicted based on previous studies by Thorndike et al. (2015). A total of 580 participants were recruited for the study. However, several participants were excluded due to declining to continue beyond the consent screen (n=10), incomplete survey data (n=5), not meeting all inclusion criteria (n=35), or attempting the survey on an incompatible device (n=17), resulting in a final sample of 513 participants. Of these, 204 participants completed the study for course credit and 309 participants received a small monetary compensation for their participation.

Participants ranged in age from 17 to 80 years, with a mean age of 28.28 (*SD* = 11.76). A majority of participants were Non-Indigenous Australians (48.1 %), with the remaining participants identifying themselves as European (23.8%), Asian (19.9%), multi-ethnic (3.5%), Indigenous Australians (0.6%) or other (4.1%). The majority of participants identified as female (58.1%), with 40.9% male, and 1% chose ‘other’ or ‘prefer not to disclose’. Two participants reported heights that were statistical outliers based on tests of normality and were excluded from the calculation of BMI (kg/m^2).

Design

Participants were randomly assigned to one of four labelling conditions (control, red only, green only, red and green), with the Qualtrics survey system set to randomise numbers equally across conditions. The dependant variable was the healthiness of food and drink choices from a café style menu (number of red versus green choices).

Materials

Menu items.

The selection of food and drink items for the menu was based on a pilot study. To best represent a range of café type foods, a total of 25 food and beverage items were selected. As part of the pilot study, these food and drink items were evaluated both on their objective and subjective healthiness.

To assess the objective healthiness, each item’s nutritional value was estimated based on online resources from Calorie King Australia and NutritionX. These values were then assessed against the UK traffic light labelling guidelines (‘Guide to creating a front of pack (FoP) nutrition label for pre-packed products sold through retail outlets’), which assess the fat, sugar and salt content of each item. The guidelines evaluate each item on two separate values: per portion and per 100 grams and assigns a colour category (red, amber, and green) for each level of fat, sugar and salt. Based on these values of fat, sugar and salt, the food and drinks were classified into three different categories: red (unhealthy), amber (neutral), or green (healthy). For the purpose of this study, only items that were unhealthy (red) or healthy (green) were considered for use. The final food and drink items that were classified as healthy had at least two green values per 100 grams. In contrast red (unhealthy) items had three or more red values both per portion and per 100 grams (see Appendix A).

Following the objective evaluation, subjective item healthiness was assessed through a pilot survey. A collection of 127 images were sourced from the internet to represent a range of common food and beverage items. The images were then resized to allow for consistent presentation, and set up in a Qualtrics survey. The survey was completed by 27 volunteers (18 women, 6 men and 3 other/preferred not to disclose). The mean age of participants in the pilot study was 29.48 (*SD* = 14.87) and ranged from 20 to 84 years.

After viewing each image of food or drink, participants were asked to write down the name of the food or beverage item. This ascertained how recognisable the items were to participants. Participants were then asked to rate on 9-point Likert scales their perceived healthiness of the item shown (1: not at all healthy; 9: not at all likely), and their likelihood of ordering the food or drink item (1: extremely unlikely; 9: extremely likely).

Based on the findings from the pilot study, the final menu consisted of 18 items, selected to best fit the categories of healthy and unhealthy from both objective (nutritional value) and subjective (pilot study perceived healthiness) data. Across all food categories, green-coded food items were rated significantly higher in perceived healthiness than red-coded food items ($p < .05$). No significant difference in likelihood of ordering was found between the red and green items ($p > .05$). Additionally, all items had a concept agreement of 90% or above, except for yoghurt (86.36%). Nutrient ratings and descriptive statistics for the final menu items are shown in Appendices B and C, respectively.

Menu layout.

All four menus (control, red only, green only, red and green) were presented in a landscape format, with the online survey set to display the menus within a maximised screen. All menus contained the same 18 food items, divided into 3 sections (mains, desserts and drinks), with 6 items in each section. The menu was set up with an equal number of healthy and unhealthy items, and thus each section consisted of 3 healthy (green) and 3 unhealthy (red) choices.

All items were presented simultaneously on a single menu sheet, with mains presented on the left half, and desserts and drinks presented on the right half. The bottom left section of the menu contained a box. In the control condition, the box simply displayed the café logo and name; in the experimental conditions, it displayed a legend explaining the corresponding labelling system.

The control condition only displayed the images and name of each food and drink item. In the green only condition, a small green circle was displayed next to the healthy food and drink items. In the red only condition, a small red circle next was displayed next to the unhealthy food and drink items. In the red and green condition, a small green circle was displayed next to the healthy food and drink items and a small red circle next was displayed next to the unhealthy ones (see Figure 1, see Appendix D for larger sizes).

Figure 1.

Four versions of the café menu in Study 3, one for each label condition

Control	Red only
Image/content removed due to copyright restrictions	Image/content removed due to copyright restrictions
Green only	Red and green
Image/content removed due to copyright restrictions	Image/content removed due to copyright restrictions

Nutrition knowledge.

Nutrition knowledge was assessed using the Consumer Nutrition Knowledge Scale (Dickson-Spillmann et al. 2011; see Appendix E). The scale consists of 20 statements (e.g., ‘A scoop of chocolate ice cream is just as healthy as a scoop of lemon sorbet’) which participants respond to by selecting ‘True’, ‘False’ or ‘Don’t know’. Each correct response scored 1 point, and the final total scores ranged from 0 to 20. Participants were not penalised for incorrect or ‘don’t know’ responses. Previous studies have found the scale to have acceptable convergent validity with the General Nutrition Knowledge questionnaire ($r = .67$), alongside acceptable internal consistency (Cronbach’s $\alpha = .73$; Dickson-Spillmann et al., 2011). Adequate internal consistency ($\alpha = .75$) was found in the present study.

Dietary restraint.

Dietary restraint was assessed using the Revised Restraint Scale (Herman & Polivy, 1980; see Appendix F). The scale contains 10 items regarding dieting concerns and behaviours (e.g., ‘Would a weight fluctuation of 2 kg (5lb) affect the way you live your life?’), which participants respond to on 4- or 5- point scales. Total scores range from 0 to 35. Participants are categorised as unrestrained (score of 14 or less) or restrained (score of 15 or more) eaters based on established cut off scores. Previous studies have shown the scale to have good test-retest reliability along with good internal consistency (Cronbach’s $\alpha = .82$; Allison, et al., 1992). The internal consistency in the present study was good ($\alpha = .80$).

Procedure

The study was completed online, via the Qualtrics survey system. Participants were first presented with the study information and asked for their consent to participate. Demographic information was then collected to ensure they met screening criteria.

Participants who met the pre-screening criteria were next asked to indicate to the nearest 15 minutes when they last ate or drank, along with ratings of hunger and thirst on 100 mm visual analogue scales (0 “not at all hungry/thirsty” to 100 “extremely hungry/thirsty”). Both hunger (M = 37.35, SD = 25.38) and thirst (M = 47.63, SD = 22.84) were below the mid-point of the scale. The time since participants last ate ranged from 0 minutes to 24 hours and 45 minutes, with a mean time of 2 hours and 30 minutes (SD = 147.54 minutes [2 hours 27 minutes]).

Following that, participants were instructed to imagine themselves choosing a meal at a café where they would be asked to select a main dish, a dessert and a drink. Participants were then shown the version of the menu based on their randomly assigned group. They made their choice by clicking on the image/name of each item. They then responded to an open-ended question asking for a brief reason for each food or drink choice. Finally, participants completed the measures of nutrition knowledge and dietary restraint and reported their height and weight.

Study 3 Results

Sample characteristics

Table 1 shows demographic information and other sample characteristics for each of the four groups. Groups were compared using various one-way ANOVAs or Chi-square tests. At baseline, all groups were comparable on all variables except for thirst ($p < .05$). When participants were compared based on source (Prolific or SONA research pool), the SONA participants significantly younger than the Prolific participants, had a larger representation of female participants, and also scored higher on nutrition knowledge, which was likely due to the nature of the participant pool (first year psychology students). However, both groups were equally randomised across all 4 conditions. In addition, nutrition knowledge was positively correlated with dietary restraint status ($r = .18$, $p \leq .01$), and negatively correlated with the total number of unhealthy items ($r = -.11$, $p \leq .05$).

Table 1.

Means (and standard deviations) or counts for participant characteristics by condition

	Control	Red	Green	Red and Green	Total
N	128	130	128	127	513
Gender Male	40 (31.25%)	55 (42.31%)	58 (45.31%)	57 (44.88%)	210 (40.9%)
Gender Female	86 (67.19%)	74 (56.92%)	68 (53.13%)	70 (55.12%)	298 (58.1%)
Gender Other	1 (0.78%)	1 (0.77%)	1 (0.78%)	0	3 (0.6%)
Gender Prefer not to disclose	1 (0.78%)	0	1 (0.78%)	0	2 (0.4%)
Age (years)	27.54 (11.42)	28.31 (11.40)	28.13 (11.60)	29.15 (12.67)	28.28 (11.76)

	Control	Red	Green	Red and Green	Total
BMI (kg/m^2)	24.88 (5.10)	24.87 (5.94)	24.97 (4.98)	24.74 (5.43)	24.87 (5.36)
Hunger	39.59 (24.41)	39.89 (15.57)	35.07 (24.35)	34.81 (26.96)	37.36 (25.38)
Thirst	48.02 (21.74)	44.25 (22.51)	53.03 (23.07)	45.28 (23.27)	47.63 (22.84)
Nutrition knowledge	11.80 (3.72)	11.38 (3.50)	11.20 (3.56)	12.32 (3.80)	11.67 (3.66)
Restrained eaters	64	57	56	65	242
Unrestrained eaters	64	73	72	62	271

Effect of labelling on meal choices

To analyse the overall healthiness of meal choice, the total number of unhealthy options chosen for the meal was calculated for each participant with final scores ranging from zero to three. A one-way ANCOVA was used to compare the average total number of red choices across conditions, while controlling for thirst, F (3, 508) = 2.18, p = .04, η_p^2 = .02. Pairwise comparisons showed that all conditions with a label differed significantly from the control group, but the various labels did not differ significantly from each other. Participants in the control condition ordered a higher number of red (unhealthy) items (M = 1.60, SD = 0.93) than those in the red only (M = 1.31, SD = 0.88, p = .01), green only (M = 1.33, SD = 0.98, p = .02), and red and green (M = 1.28, SD = 0.89 p = .007) conditions.

Moderating roles of nutrition knowledge and dietary restraint

To examine the role of nutrition knowledge, a moderation analysis through the PROCESS macro for SPSS (Hayes, 2017) was conducted with condition as the predictor, nutrition knowledge scores as the moderator, thirst as a covariate and the total number of red choices as the dependent outcome. The overall model was significant F (8, 505) = 2.45, p = .01 r^2 = .037. However, this appeared to be due to the main effect of condition; there was no significant main effect of nutrition knowledge, b = -.031, 95% CI [-.074, .012], t = -1.41, p = .16, nor an interaction for any level of the labelling condition when compared to the control menu (p values range from .26 to .88).

To examine the moderating effect of dietary restraint, a 4 (control, red only, green only, red and green) by 2 (restrained, unrestrained) ANCOVA was conducted with thirst as a covariate. There was no significant main effect of dietary restraint, nor a significant dietary restraint and condition interaction (see Table 2).

Table 2.

Results of 4 (menu condition) by 2 (restraint status) ANCOVA

	Control	Red only	Green only	Red and Green
Overall model	F (3, 512) = 1.49, p = .16, η_p^2 = .02			
Main effect of restraint on red choices	F (1, 512) =.61, p = .43, η_p^2 = .001			
Interaction between restraint and condition	F (3, 180) = .37 p = .77, η_p^2 = .002			
Restrained	1.58 (.94)	1.19 (.85)	1.32 (.97)	1.29 (.91)
Unrestrained	1.63 (.93)	1.40 (.89)	1.33 (.99)	1.27 (.87)
Total	1.60 (.93)	1.31 (.88)	1.33 (.98)	1.28 (.89)

Effect of labelling on individual menu sections

To examine the effect of labelling condition on each individual section of the menu (mains, desserts and drinks), a series of chi square tests of independence were conducted. A significant effect of labelling condition was found for the choice of main, X^2 (3, 513) = 9.65, p = .02, φ = .14, whereby participants in the control condition were more likely to choose a red main than those in the three labelling conditions ($p \geq .05$). The analyses for desserts, X^2 (3, 513) = 2.22, p = .53, φ = .07, and drinks, X^2 (3, 513) = 3.15, p = .37, φ = .08, did not show any statistically significant differences between conditions (see Table 3).

Table 3.

Percentage of red choices for each section by condition

	Control	Red only	Green only	Red and green
Main	68%	50.8%	53.9%	52.8%
Dessert	64.8%	57.7%	57%	57.5%
Drinks	27.3%	22.3%	21.9%	18.1%

Nutritional knowledge as a moderator for individual menu section choices

To examine the effect of nutrition knowledge as a moderating factor in the effect of menu condition on individual menu choices (main, desserts and drinks), a series of binary logistic regressions were run. The main effects of condition, nutrition knowledge and the interaction between the two were included in the regression. For the analysis of drink choice, thirst was controlled for by entering it as an additional variable in the analysis.

As can be seen in Table 4, there was only a significant interaction for desserts; however, statistical analyses showed that each menu labelling condition did not significantly differ from the control condition when compared via dummy coding (*p* values ranged from .13 to .20).

Dietary restraint as a moderator for individual menu section choices

To examine the effect of dietary restraint as a moderating factor between menu condition and the choice of each main, dessert or drink, a series of binary logistic regressions were run. The variables of condition, dietary restraint, and an interaction between the two were included in the regression. For the analysis of drink choice, thirst was controlled by entering the factor as an additional variable. As shown in Table 5, there were no significant interaction effects with dietary restraint for any section of the menu.

Table 4.

Summary of results for binary logistic regressions of nutrition knowledge on meal section choice

	Mains	Desserts	Drinks
Overall model	χ2(7) = 16.47, *p* =.02, Cox & Snell R^2 = .03	χ2(7) = 13.06, *p* =.07, Cox & Snell R^2 = .03	χ2(8) = 10.41, *p* =.24 Cox & Snell R^2 = .02
Main effect of condition	*W* (3) = 2.72, *p* = .44	*W* (3) = 8.80, *p* = .03	*W* (3) = 2.19, *p* = .54
Main effect of nutrition knowledge	B = -.09, *SE* = .06, Wald's χ2 (1) = 2.61, *p* =.11	B = .005, *SE* = .05, Wald's χ2 (1) = .01, *p* =.91	B = -.07, *SE* = .05, Wald's χ2 (1) = 1.95, *p* =.16
Interaction between condition and nutrition knowledge	*W* (3) .90, *p* = .83	*W* (3) 9.62, *p* = .02	*W* (3) 1.59, *p* = .66

Table 5.

Summary of results for binary logistic regressions of dietary restraint on meal section choice

	Mains	Desserts	Drinks
Overall model	χ2(7) = 13.32, *p* = .07 Cox & Snell R^2 = .03	χ2(7) = 5.39, *p* = .61 Cox & Snell R^2 = .01	χ2(8) = 8.30, *p* = .41 Cox & Snell R^2 = .02
Main effect of condition	*W* (3) = 6.83, *p* = .077	*W* (3) = 2.03, *p* = .57	*W* (3) = 3.50, *p* = .32,
Main effect of restraint	B = -.51, *SE* = .38, Wald's χ2 (1) = 1.75, *p* =.19, z = -1.32	B = .21, *SE* = .37, Wald's χ2 (1) = .31, *p* =.58	B = .11, *SE* = .40, Wald's χ2 (1) = .07, *p* =.79
Interaction between condition and restraint	(3) .87, *p* = .83	*W* (3) 2.96, *p* = .40.	*W* (3) = 2.60, *p* = .46

Study 3 Discussion

Study 3 aimed to compare the effectiveness of using red and/or green coloured circles to nudge healthier menu choices. Three labelling conditions of red only, green only, and red and green labels were contrasted with a no label control. Results showed an effect of labelling whereby all three labelling conditions had significantly lower mean scores of total orders of unhealthy items ordered compared to the control menu condition. However, there were no significant differences between the three labelling conditions, indicating that neither the approach (green) nor avoid (red) labelling seemed to be significantly stronger. This contradicts past research by Sacrborough et al. (2015) who found that the avoidance of red labels had a stronger effect than the approach effect of green labels.

When meal choices were analysed separately by menu section, there was a significant effect of menu labelling for mains, but not for desserts and drinks. This effect is in line with past research by Ellison et al., (2013) and Prowse et al., (2020), who found similar effects of labelling on their participants' choice of mains, but not on additional choices such as desserts, drinks or sides.

Neither nutrition knowledge nor dietary restraint interacted with labelling conditions to affect choices for either the overall meal or individual menu sections. By contrast, previous studies examining packaged food labelling have found factors such as nutrition knowledge to play a role in decision making (Miller & Cassidy 2015). Perhaps the use of a simplified nudge, compared to the more complex information typically found on packaged foods may have reduced the importance of nutrition knowledge as a moderator here.

Based on the results of Study 3, Study 4 was designed to investigate if the effects of colour coded labelling could be further simplified. As such, the explanatory legend was removed from the labelled menus, leaving only the coloured circles within the menu as the sole indicators of health.

Study 4 Methods

Participants

Participants were recruited from the online research platform prolific or the Flinders University research participation system, with the same inclusion and exclusion criteria as in Study 3. The research study was approved by the Flinders University Human Research Ethics Committee (HREC number: 8382). Calculations estimated that to detect medium effects with an alpha of .05 and 80% power, 484 participants was needed for 3 degrees of freedom using a chi square analysis (Cohen, 1992). A medium effect size was predicted based on previous studies by Thorndike et al. (2015).. A total of 533 volunteers signed up for the study, with 490 participants completing the survey and receiving either course credit (*n* = 44) or a small monetary compensation (*n* = 446). Participants were excluded due to declining to continue (*n* = 5), having an incomplete survey (*n* = 6), not meeting all the criteria (*n* = 29), or attempting the survey on an incompatible device (*n* = 4).

The majority of participants identified their ethnicity as Non-Indigenous Australian (47.8%), followed by Asian (24.3%) and European (18.8%); the remaining participants indicated that they were multi-ethnic (3.5%), Indigenous Australian (1%), or 'other' (4.7%). The age range of the sample was 18 to 81 years (*M*= 31.26, *SD* =12.35). The majority of the participants were female (55.51%), with 42.86% males, and 1.63% indicating 'other' for their gender.

The heights of three participants and weights of five participants were excluded due to being statistical outliers for tests of normality, and all eight were excluded from the calculation of BMI (kg/m^2). One Revised Restraint Scale score was missing, and SPSS functions were used to replace the missing value with the mode response for that question. Both hunger (*M* = 33.91, *SD* = 25.76) and thirst (*M* = 46.89, *SD* = 23.90) ratings were below the mid-point of the scale. The time since participants last ate ranged from 0 minutes to 24 hours and 45 minutes, with a mean time of 2 hours and 47 minutes (*SD* = 217.38 minutes [3 hours 37 minutes])

Design, materials and procedure

Design, materials, randomisation, and procedure were the same is in Study 3, except for a change in the menu labelling legend and the addition of several questions. In all conditions, the menu now displayed the neutral café logo in the bottom left corner. However, in the experimental conditions (red only, green only, red and green), the menu still displayed the corresponding red or green circle next to each item, but no legend explaining the labelling system (see Figure 2; see Appendix G for larger sizes).

Figure 2.

Four versions of the café menu in Study 4, one for each label condition

Control	Red only
Image/content removed due to copyright restrictions	Image/content removed due to copyright restrictions
Green only	Red and green
Image/content removed due to copyright restrictions	Image/content removed due to copyright restrictions

A few questions were also added to the survey, asking all participants if they noticed any information on the menu after they made their meal selection. Following that, participants who viewed a menu with a labelling system were specifically asked if they noticed any coloured circles on the menu and were presented with a free response question asking them what they believed the circles represented. As previous research has shown that individuals are more likely to avoid red labels in contrast to approaching green ones (Scarborough et al., 2015), we predicted that: 1) participants would be less likely to notice the green labels in the green only condition compared to red labels in the red only condition, and 2) participants would be less likely to correctly identify the meaning of the labels in the green only condition compared to both the red only and red and green conditions.

Study 4 Results

Sample characteristics

Table 6 shows the descriptive statistics for sample characteristics for each labelling condition. A series of chi-square tests or one-way ANOVAs showed no significant group differences on any sample characteristics at baseline (*p*s > .05). Similar to Study 3, nutrition knowledge scores were positively correlated with dietary restraint status ($r = .13$, $p \leq .01$), and were also negatively correlated with the total number of unhealthy items ordered ($r = -.11$, $p \leq .05$). When participants were compared based on source (Prolific or SONA research pool), no significant differences were found for variables such as restraint status and the outcome of total number of unhealthy choices. Although the SONA pool was significantly younger than the Prolific participants, and had a larger representation of female participants, this was due to the nature of the participant pool (first year psychology students). Both participant pools were equally randomised across all conditions.

Table 6.

Means (and standard deviations) or counts for participant characteristics by condition

	Control	Red	Green	Red and Green	Total
N	120	123	122	125	490
Gender Male	57 (47.5%)	56 (45.53%)	47 (38.52)	50 (40%)	210 (42.86%)
Gender Female	60 (50%)	66 (53.66)	74 (60.66%)	72 (57.6%)	272 (55.51%)
Gender Other	3 (2.5%)	1 (0.81)	1 (0.82%)	3 (2.4%)	8 (1.63%)
Age	31.0 (13.28)	30.10 (10.55)	32.06 (11.81)	31.90 (13.56)	31.26 (12.35)

	Control	Red	Green	Red and Green	Total
BMI	25.41 (5.88)	26.60 (7.14)	25.37 (5.60)	25.21 (5.63)	25.65 (6.10)
Hunger	32.89 (26.41)	33.88 (24.67)	32.35 (26.10)	36.42 (25.96)	33.91 (25.76)
Thirst	45.13 (25.59)	49.76 (22.47)	45.64 (22.50)	46.99 (24.90)	46.89 (23.90)
Nutrition knowledge	12.12 (3.92)	11.89 (3.61)	12.07 (3.54)	11.55 (3.58)	11.90 (3.66)
Restrained eaters	49	56	50	60	215
Unrestrained eaters	71	67	72	65	275

Effect of labelling on meal choices

A one-way ANOVA comparing the effect of menu condition on the average total number of red choices showed no significant overall effect, F (3, 489) = .58, p = .63, η^2.= .004 Follow up analyses revealed that the pairwise comparisons of each group (red only M = 1.63, SD = .97, green only M = 1.66, SD = .91, red and green M = 1.53, SD = .89) to the control condition (M = 1.55, SD = 1.02) were non-significant (p = 1.00).

Moderating role of nutrition knowledge

A moderation analysis examining the role of nutrition knowledge in the effect of labelling condition on the total number of red choices showed that the overall model was non-significant R^2 = .03 F (7, 481) = 1.90, p = .07 (see Table 7). The interaction between menu condition and nutrition knowledge was also non-significant. However, a significant interaction effect was found when the green only condition was compared in isolation to the control condition. As can be seen in Figure 3, all conditions showed a lower number of red choices as nutrition knowledge increased. However, this trend in the green only label condition was significantly larger than the control condition.

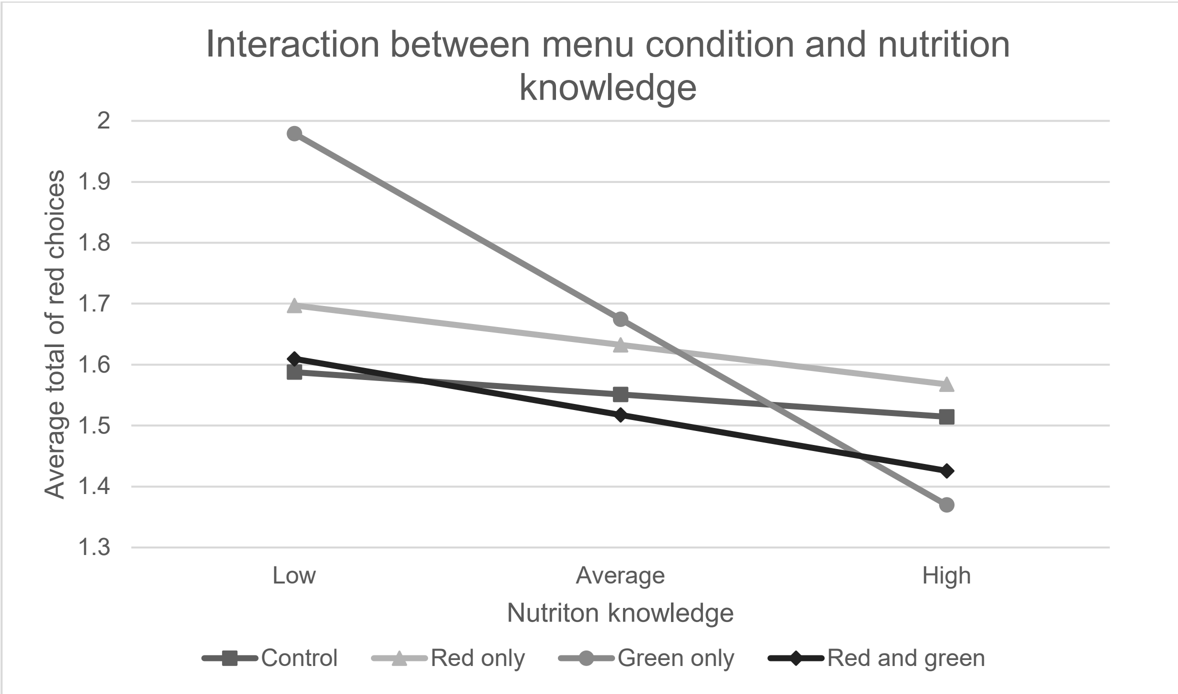
Table 7.

Moderation analysis of condition and nutrition knowledge on the total number of red choices

	β	*se*	*t*	*p*	*CI*
Red only	.08	.12	.68	.50	-.16, .32
Green only	.13	.12	1.07	.29	-.11, .37
Red and green	-.03	.12	-.27	.79	-.27, .21
Interactions with nutrition knowledge	-.01	.02	-.42	.68	-.05, .03
Red only * NK	-.01	.03	-.22	.83	-.07, .06
Green only *NK	-.07	.03	-2.04	.04	-.13, -.003
Red and green *NK	-.01	.03	-.43	.67	-.08, .05

Figure 3.

Interaction between menu condition and nutrition knowledge on the total number of red choices



Moderating role of dietary restraint

A 4 (control, red only, green only, red and green) by 2 (restrained, unrestrained) ANOVA examining the moderating effect of dietary restraint showed that there was no significant main effect of dietary restraint, nor a significant dietary restraint and condition interaction (see Table 8).

Table 8.

Descriptive statistics of menu condition x dietary restraint ANOVA

	Control	Red only	Green only	Red and Green
Overall model	F (7,489) = .57, p = .78, η_p^2 = .01			
Main effect of restraint on red choices	F (1,489) = 1.96, p = .16, η_p^2 = .004			
Interaction between restraint and condition	F (3, 489) = .08, p = .97, η_p^2 = .001			
Restrained	1.61 (.91)	1.73 (.98)	1.70 (.89)	1.60 (.79)
Unrestrained	1.51 (1.09)	1.55 (.96)	1.64 (.94)	1.46 (.97)
Total	1.55 (1.02)	1.63 (.97)	1.66 (.91)	1.53 (.89)

Effect of labelling on individual menu sections

A series of chi square tests of independence examining the effect of labelling condition on each individual section of the menu showed no significant effects for mains, X^2 (3, 490) = 1.03, p = .80, φ = .05, desserts, X^2 (3, 490) = 5.08, p = .17, φ = .10, or drinks, X^2 (3, 490) = .64, p = .89, φ = .04 (see Table 9).

Table 9.

Percentage of red choices for each section by condition

	Control	Red only	Green only	Red and green
Main	60%	63.9%	65.9%	64.8%
Dessert	60.8%	69.7%	67.5%	57.6%
Drinks	34.2%	32.8%	30.1%	30.4%

Nutrition knowledge as a moderator for individual menu section choices

A series of binary logistic regressions examining the moderating role of nutrition knowledge in the effect of menu condition on individual menu choices (main, desserts and drinks), showed that the overall models were non-significant, as were the interactions with nutrition knowledge.

Dietary restraint as a moderator for individual menu section choices

A series of binary logistic regressions examining restraint as a moderating factor in the effect of menu condition on individual menu choices (main, desserts and drinks) showed that the overall models for each section were non-significant. In addition, for both mains and drinks, there was no significant interaction between condition and dietary restraint. However, dietary restraint appeared to be a significant predictor of the healthiness of dessert choice, although the interaction between dietary restraint and labelling condition was non-significant. A follow up chi-square test showed significant differences in the likelihood of choosing an unhealthy dessert. Although an unhealthy dessert choice was more popular regardless of dietary restraint, (70.2% for restrained eaters, 58.9% for unrestrained eaters), the likelihood of choosing an unhealthy choice was higher for restrained (40.4%) compared to unrestrained (17.8%) eaters.

Table 10.

Summary of results for binary logistic regressions of nutrition knowledge on meal section choice

	Mains	Desserts	Drinks
Overall model	$\chi 2(7) = 8.12$, *p* = .27, Cox & Snell $R^2 = .02$	$\chi 2(7) = 8.67$, *p* = .28, Cox & Snell $R^2 = .02$	$\chi 2(7) = 15.59$, *p* = .03, Cox & Snell $R^2 = .03$
Main effect of condition	Wald's $\chi 2$ (3) = 4.25, *p* = .24	Wald's $\chi 2$ (3) = 3.10, *p* = .38	Wald's $\chi 2$ (3) = 6.64, *p* = .08
Main effect of Nutrition knowledge	B = -.04, *SE* = .05, Wald's $\chi 2$ (1) = .54, *p* = .46	B = .05, *SE* = .05, Wald's $\chi 2$ (1) = 1.15, *p* = .28	B = -.06, *SE* = .05, Wald's $\chi 2$ (1) = 1.36, *p* = .24
Interaction between condition and nutrition knowledge	Wald's $\chi 2$ (3) = 4.36, *p* = .23	Wald's $\chi 2$ (3) = 3.51, *p* = .32	Wald's $\chi 2$ (3) = 6.29, *p* = .10

Table 11 .

Summary of results for binary logistic regressions of dietary restraint on meal section choice

	Mains	Desserts	Drinks
Overall model	$\chi 2$ (7) = 1.05, *p* = .99, Cox & Snell $R^2 = .002$	$\chi 2$ (7) = 13.65, *p* = .06, Cox & Snell $R^2 = .03$	$\chi 2$ (7) = 2.77, *p* = .91, Cox & Snell $R^2 = .006$
Main effect of condition	Wald's $\chi 2$ (3) = .44, *p* = .93	Wald's $\chi 2$ (3) = 2.52, *p* = .47	Wald's $\chi 2$ (3) = 2.36, *p* = .50
Main effect of restraint	B = -.06, *SE* = 0.38, Wald's $\chi 2$ (1) = .02, *p* = .88	B = .78, *SE* = .40, Wald's $\chi 2$ (1) = 3.84, *p* = .05	B = -.27, *SE* = .40, Wald's $\chi 2$ (1) = .46, *p* = .50
Interaction between condition and dietary restraint	Wald's $\chi 2$ (3) = .03, *p* = .99	Wald's $\chi 2$ (3) = .1.34, *p* = .72	Wald's $\chi 2$ (3) = .2.09, *p* = .55

Awareness and understanding of labelling

All participants in a labelling condition (*n* = 370) were asked if they noticed any information on the menu, of which 25.14% (*n* = 93) correctly indicated that they noticed circles on the menu. A 3 (condition) by 2 (noticed) chi square was conducted which showed that the rate of noticing was different between groups, X^2 (2, 370) = 12.69, *p* = .002. The green condition was noted to have significantly lower rates of the labelling being noticed compared to the red and green condition. The red only condition did not significantly differ in the rate of noticing compared to the red and green condition or the green only condition.

All participants were also asked for the meaning of the labels, with 28.9% (*n* = 107) correctly noting that they indicated health, 21.95% (*n* = 81) assuming it indicated other reasons (e.g., dietary requirements, availability, chef recommendations), and 49.2% (*n* = 182) saying that they did not know. A 3 (condition) by 2 (meaning correct) chi square indicated that the red and green condition was significantly more likely to have correctly understood the labels compared to the red only and green only conditions, X^2 (2, 370) = 37.63, *p* < .001.

Table 12.

Distribution of noticing and meaning across labelled conditions

	Red only	Green only	Red and green
Noticing			
Noticed circles	30 (24.39%)	19 (15.57%)	44 (35.2%)
Did not notice circles	93 (75.61%)	103 (84.43%)	81 (64.8%)
Meaning/understanding			
Correctly guessed meaning	19 (15.45%)	27 (22.13%)	61 (48.8%)
Incorrect meaning	104 (84.55%)	95 (77.86%)	64 (51.2%)

Study 4 Discussion

Study 4 aimed to examine if the effectiveness of menu labelling found in Study 3 would hold if the legend explaining the labels were removed from the experimental menus. In contrast to Study 3, there was no effect of menu labelling condition on meal choices, neither for the total meal ordered nor for the individual menu sections (mains, desserts, and drinks).

Nutrition knowledge was found to be a significant moderator when analysing its effect across total meal choices, but was not found to interact significantly when individual menu sections were analysed separately. Specifically, across all three experimental groups, a higher nutrition knowledge was associated with a lower mean total of unhealthy dishes ordered. This effect was significantly larger only when participants saw a green only menu label compared to the control condition. The other two labelled menu conditions (red only, and red and green) did not significantly differ from the control. A possible explanation for the isolated effect of the green only menu condition could be the minimal information presented, requiring participants to have higher nutrition knowledge to effectively interpret the green circle without context and benefit from the labelling system. In contrast, for participants with lower nutritional knowledge the green circle may not have provided them with sufficient information as they may not have associated its colour with healthiness. The second personal factor of dietary restraint did not moderate the effect of the menu labelling on the healthiness of choices made, neither for total meal orders nor individual menu sections. However, dietary restraint was found to have a main effect on dessert choices, where restrained eaters were more likely to select an unhealthy dessert compared to unrestrained eaters.

Lastly, participants in the red and green condition were more likely to notice the labelling than those in the green only condition, with the red only condition not significantly differing from the other two. In terms of understanding the meaning of the labels, the red only condition showed the lowest accuracy, which could be because participants assumed the label indicated something other than health (e.g., availability). In contrast the red and green label menu showed the highest accuracy, as participants would be able to compare the two groups of labelled food, with the contrast in healthiness between the for the red and green labels providing additional context.

General Discussion

The present research aimed to investigate the use of a simplified colour labelling system (green and red) on a café style menu. Both red and green labels were tested separately (red only and green only) and in combination (red and green) against a control menu with no information/label. Individual factors of nutrition knowledge and dietary restraint were examined as potential moderators of the effect of menu label on the healthiness of food and drinks chosen. Both studies used the same labelling system, but Study 4 removed the use of an explanatory legend, to test if the nudging effect would still be present when only coloured circles used. Overall, the results of Study 3 show support for the use of any combination of red and green colour labels to nudge healthier eating, while Study 4 highlights the need for an explanatory legend for the nudge to be impactful.

When overall meal choices were analysed, Study 3 revealed that any form of labelling led to a significantly lower number of unhealthy food and drinks chosen when compared to a control menu with no information. This effect of menu labelling was not present in Study 4. The lack of significant differences between the three experimental conditions in Study 3 suggests that both approach and avoidance strategies are equally effective. This differs from previous research by Sacrborough et al. (2015) which found that participants were more concerned with avoiding red coded labels than approaching green coloured values. However, their study focused on the use of the UK traffic light labelling, which involved analysis and decision making of three different colours (red, amber, and green) four different values (fat, saturated fat, sugar and salt). Instead, the present study used a single overall indicator of health and the simplified labelling could potentially reduce the cognitive demands of comparing different macronutrients and their associated colour values.

When the meal choices were analysed for each of the menu sections separately (mains, desserts and drinks), a significant effect of menu labelling was found in Study 3 for participants' choice of main, but no significant effects on desserts and drinks. The control condition had a significantly higher percentage of unhealthy choices of main in contrast to the labelling conditions. No significant effect of labelling on individual menu sections was found in Study 4. The isolated effect of labelling only affecting mains in Study 3 has been noted in some previous research (e.g., Ellison et al., 2013; Prowse et al., 2020). In particular, Ellison et al. (2013) found that participants who viewed a labelling condition (traffic lights and calorie count) ordered significantly fewer calories for their mains than participants who saw only the declarative menu labelling (calorie count only) or no menu labelling (control condition). Similarly, Prowse et al. (2020), who examined the use of calorie and sodium labelling, found a significant reduction of entrée sodium content for participants exposed to calories and sodium information, with no significant difference in sodium ordered for overall meals, or sides, desserts and beverages separately. It is possible that the isolated effect on the choice of mains in Study 3 could reflect a licensing effect, whereby participants allow themselves to indulge in their choice of dessert and drinks after choosing a healthy main (Ellison et al., 2013). Participants potentially placed more importance on their choice of main, and viewed desserts and drinks as discretionary choices which are more vulnerable to the licencing effect.

In both studies, nutrition knowledge was significantly correlated with healthier meal choices, irrespective of labelling. This is supported by previous research which shows an association between healthier eating and increased nutrition knowledge (Spronk et al., 2014). Nutrition knowledge was not a significant moderator in Study 3. However, in Study 4, when the green only label condition was compared to the control condition, nutrition knowledge appeared to moderate the relationship between menu labelling and the total number of unhealthy choices across the meal. In contrast to the red only and red and green conditions, the green only condition encouraged significantly healthier choices when nutrition knowledge was high, compared to the control condition. Although all conditions provided limited information, it appeared that the green only circles were associated with approach or healthier choices for individuals high in nutrition knowledge. Meanwhile, the red only condition was more prone to misinterpretation, and the more easily understood red and green condition did not require high nutrition knowledge to interpret the labelling nudges. Similarly, it is possible that in Study 3, the use of the explanatory legend helped to reduce the importance of nutrition knowledge, and that the moderating effect could only be noticed in Study 4 when minimal information is provided, and participants must rely on their own personal knowledge

Across both studies, dietary restraint was not a significant moderator. However, in Study 4 there was a main effect of dietary restraint whereby higher dietary restraint was associated with fewer unhealthy dessert choices regardless of labelling condition. This sole finding for desserts suggests that individual factors such as dietary restraint are more strongly associated with discretionary choices than mains and drinks. However, more research into the field is required to understand potential decision differences between meal components in relation to dietary restraint.

In Study 4, participants in the red and green condition were significantly more likely to notice the labelling than those in the green only condition, with those in the red only condition not differing from the other two. In contrast to the hypothesis that red labels would be more likely to be noticed compared to green ones, it appears that the presentation of both colours is required for participants to significantly notice the labels. Notably, the red and green only condition was shown to have the largest percentage of participants noticing and understanding the red and green labels. It appears that the use of both red and green colours and their association with the traffic light system when presented together enables participants to better compare healthy versus unhealthy food and drinks.

One limitation was that the studies were conducted online, with the use of hypothetical meal choices instead of measuring actual consumption. Although this allows for the collection of a larger sample due to less demand on resources, hypothetical choices assume that participants plan to consume the whole meal ordered. This may not capture details such as participants who plan to order an unhealthy item, but compensate by eating a smaller portion. A second limitation of the study is the limited generalisability of the menu, as a small selection of items specific to a café style setting was chosen. Based on the current results, a future study examining a wider range of food and drink choices within an actual café setting could help test the applicability of the present research.

The findings of the present studies have some important theoretical and practical implications. Theoretically, nudging has the potential to encourage healthier choices, but as demonstrated by the present set of results, an explanatory context is needed for it to be effective for menu choices. In addition, nutrition knowledge was generally associated with healthier meal choices. However, nutrition knowledge was only found to have an interacting effect with labelling in a specific limited information context (green only labels with no legend). With regards to the effect of colour as a nudge, the present research contradicts Sacrborough et al. (2015) which suggested that red was a stronger avoidance nudge than the approach of green. Instead, all labelling methods did not significantly differ from each other. However, when red and green labels are presented together, they appear to be more noticeable and accurately interpreted than red or green labels individually. The results of both studies would suggest that the use of both red and green labels may be the most efficient as they are noticeable, easily interpreted, and effective in encouraging healthier menu choices.

Practically, the application of a simplified colour coded system should be relatively easy to implement. There is a need for future research to further expand on the use of colour coded labelling in the out of home dining context as the field develops separately from the established front of pack labelling systems. In addition, governmental polices should also include public education programs to improve the general populations' level of nutrition knowledge, as this will help support overall choices in hand with labelling programs. An additional benefit of nutritional labelling is that it encourages food providers to reformulate their items to meet healthier criteria, increasing the overall nutritional value of foods offered. Effective nudging, in combination with other factors can help promote healthier diets and reduce the burden of non communicable diseases and their associated health risks. In summary, the present research examined the application of red and green labels in the context of a café style menu. Results show that menu labelling has the potential to encourage healthier choices and highlight the need for an explanatory legend alongside coloured labels for the nudge to be effective. Overall, the research contributes to the growing field of using labelling in the out of home dining context as a way of encouraging people to make better nutritional choices to reduce their risk of obesity and disease.

References

Allison, D. B., Kalinsky, L. B., & Gorman, B. S. (1992). A comparison of the psychometric properties of three measures of dietary restraint. *Psychological assessment*, *4*(3), 391.

Authority, N. F. (2013). Evaluation of kilojoule menu labelling. *Silverwater: NSW Government*.

Barnhill, A., King, K. F., Kass, N., & Faden, R. (2014). The value of unhealthy eating and the ethics of healthy eating policies. *Kennedy Institute of Ethics Journal*, *24*(3), 187-217.

Bouhassoun, S., Naveau, M., Delcroix, N., & Poirel, N. (2022). Approach in green, avoid in red? Examining interindividual variabilities and personal color preferences through continuous measures of specific meaning associations. *Psychological Research*, 1-11.

Cadario, R., & Chandon, P. (2019). Which healthy eating nudges work best? A meta-analysis of field experiments. *Marketing Science*, *39*(3), 465-486.

Dickson-Spillmann, M., Siegrist, M., & Keller, C. (2011). Development and validation of a short, consumer-oriented nutrition knowledge questionnaire. *Appetite*, *56*(3), 617-620.

Ellison, B., Lusk, J. L., & Davis, D. (2013). Looking at the label and beyond: the effects of calorie labels, health consciousness, and demographics on caloric intake in restaurants. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 1-9.

Herman, C. & Polivy, J.(1980) Restrained eating. *Obesity. Philadelphia: Saunders*.

Jacob, R., Drapeau, V., Lamarche, B., Doucet, É., Pomerleau, S., & Provencher, V. (2020). Associations among eating behaviour traits, diet quality and food labelling: A mediation model. *Public health nutrition*, *23*(4), 631-641.

Jones, A., Wu, J. H., & Buse, K. (2021). UK's sugar tax hits the sweet spot. *bmj*, *372*.

Looking at labels - British Nutrition Foundation. (n.d.). Www.nutrition.org.uk. https://www.nutrition.org.uk/putting-it-into-practice/food-labelling/looking-at-labels/

Looking at labels. British Nutrition Foundation. (2022, February). Retrieved April 25, 2023, from https://www.nutrition.org.uk/putting-it-into-practice/food-labelling/looking-at-labels/

Miller, L. M. S., & Cassady, D. L. (2015). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, *92*, 207-216.

Noncommunicable diseases. (2019, June 12). WHO | World Health Organization. https://www.who.int/health-topics/noncommunicable-diseases

Pollard, C. M., Miller, M. R., Daly, A. M., Crouchley, K. E., O'Donoghue, K. J., Lang, A. J., & Binns, C. W. (2008). Increasing fruit and vegetable consumption: success of the Western Australian Go for 2&5® campaign. *Public health nutrition*, *11*(3), 314-320.

Popkin, B. M., & Gordon-Larsen, P. (2004). The nutrition transition: worldwide obesity dynamics and their determinants. *International journal of obesity*, *28*(3), S2-S9.

Popkin, B. M., Barquera, S., Corvalan, C., Hofman, K. J., Monteiro, C., Ng, S. W., ... & Taillie, L. S. (2021). Towards unified and impactful policies to reduce ultra-processed food consumption and promote healthier eating. *The Lancet Diabetes & Endocrinology*, *9*(7), 462-470.

Prowse, R. J., Lee, K. M., Chen, E., Zuo, F., Hammond, D., & Hobin, E. (2020). Testing the efficacy of and parents' preferences for nutrition labels on children's menus from a full-service chain restaurant: results of an online experiment. *Public Health Nutrition*, *23*(10), 1820-1831.

Rohr, M., Kamm, F., Koenigstorfer, J., Groeppel-Klein, A., & Wentura, D. (2015). The color red supports avoidance reactions to unhealthy food. *Experimental psychology*.

Sacks, G., Rayner, M., & Swinburn, B. (2009). Impact of front-of-pack 'traffic-light'nutrition labelling on consumer food purchases in the UK. *Health promotion international*, *24*(4), 344-352.

Scarborough, P., Matthews, A., Eyles, H., Kaur, A., Hodgkins, C., Raats, M. M., & Rayner, M. (2015). Reds are more important than greens: how UK supermarket shoppers use the different information on a traffic light nutrition label in a choice experiment. *International Journal of Behavioral Nutrition and Physical Activity*, *12*(1), 1-9.

Sharma, S., Wagle, A., Sucher, K., & Bugwadia, N. (2011). Impact of point of selection nutrition information on meal choices at a table-service restaurant. *Journal of foodservice business research*, *14*(2), 146-161.

Sonnenberg, L., Gelsomin, E., Levy, D. E., Riis, J., Barraclough, S., & Thorndike, A. N. (2013). A traffic light food labeling intervention increases consumer awareness of health and healthy choices at the point-of-purchase. *Preventive medicine*, *57*(4), 253-257.

Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *British journal of nutrition*, *111*(10), 1713-1726.

Wellard-Cole, L., Goldsbury, D., Havill, M., Hughes, C., Watson, W. L., Dunford, E. K., & Chapman, K. (2018). Monitoring the changes to the nutrient composition of fast foods following the introduction of menu labelling in New South Wales, Australia: an observational study. *Public Health Nutrition*, *21*(6), 1194-1199.

Appendix

Appendix A

Guidelines for UK Front of Pack Traffic Light labelling

Guidelines for colour coding the nutritional values of food items

	Green	Amber	Red /100g	Red /portion
Fat	≤ 3.0g/100g	> 3.0g to ≤ 17.5g/100g	> 17.5g/100g	> 21g/portion
Saturated Fat	≤ 1.5g/100g	> 1.5g to ≤ 5.0g/100g	> 5.0g/100g	> 6.0g/portion
Sugar	≤ 5.0g/100g	> 5.0g to ≤ 22.5g /100g	> 22.5g/100g	> 27g/portion
Salt	≤ 0.3g/100g	> 0.3g to ≤ 1.5g/100g	>1.5g/100g	>1.8g/portion

Guidelines for colour coding the nutritional values of drink items

	Green	Amber	Red /100g	Red /portion
Fat	≤ 1.5g/100ml	> 1.5g to ≤ 8.75g/100ml	> 8.75g/100ml	>10.5g/portion
Saturated Fat	≤ 0.75g/100ml	> 0.75g to ≤ 2.5g/100ml	> 2.5g/100ml	> 3g/portion
Sugar	≤ 2.5g/100ml	> 2.5g to ≤ 11.25g/100ml	> 11.25g/100ml	> 13.5g/portion
Salt	≤ 0.3g/100ml	>0.3g to ≤0.75g/100ml	> 0.75g/100ml	> 0.9g/portion

Appendix B

Nutritional value of final items included in Study 3 and 4 menu

	Per portion					Per 100g			
	Grams/ portion	fat	Satu-rated fat	salt	sugar	fat	Satu-rated fat	salt	sugar
Mains									
Burger	257	29	13.1	.96	8.3	11.28	5.10	.38	3.23
Pizza	357	35.7	18	1.97	9.9	10	5.04	.55	2.77
Fish and chips	250	34	9.9	0.37	2.5	13.6	3.96	.15	1
Sandwich	211	18.5	2.6	482	9.8	8.77	1.23	.23	4.64
Grilled salmon	100	15.5	4.3	.05	0	15.5	4.3	.05	0
Salad	400	1	0	.22	5.4	.25	0	.06	1.35
Desserts									
Brownie	50	12.8	6.1	0.26	17.7	25.6	12.2	.51	35.4
Chocolate cake	100	39	28	0.06	30.4	39	28	.06	30.4
Tiramisu	174	44	25	0.02	21	25.29	14.37	.09	12.07
Yoghurt	200	.3	0.2	99	32	.15	0.1	.05	16
Fruit salad	200	.4	0	0.03	15	.2	0	.01	7.5
Chia pudding	115	3	2.2	0.03	3.3	2.61	1.91	.03	2.87
Drinks									
Iced mocha	355	14.1	7.8	0.07	21	3.97	2.20	.02	5.92
Hot chocolate	293	10.8	7.3	0.10	29.3	3.69	2.49	.03	10
Ice cream float	300	5.7	3.8	113	43.4	1.9	1.27	.04	14.47
Juice	200	0	0	0	11	0	0	.003	5.5
Black tea	250	0	0	.00	0	0	0	0	0
Water	200	0	0	.00	0	0	0	0	0

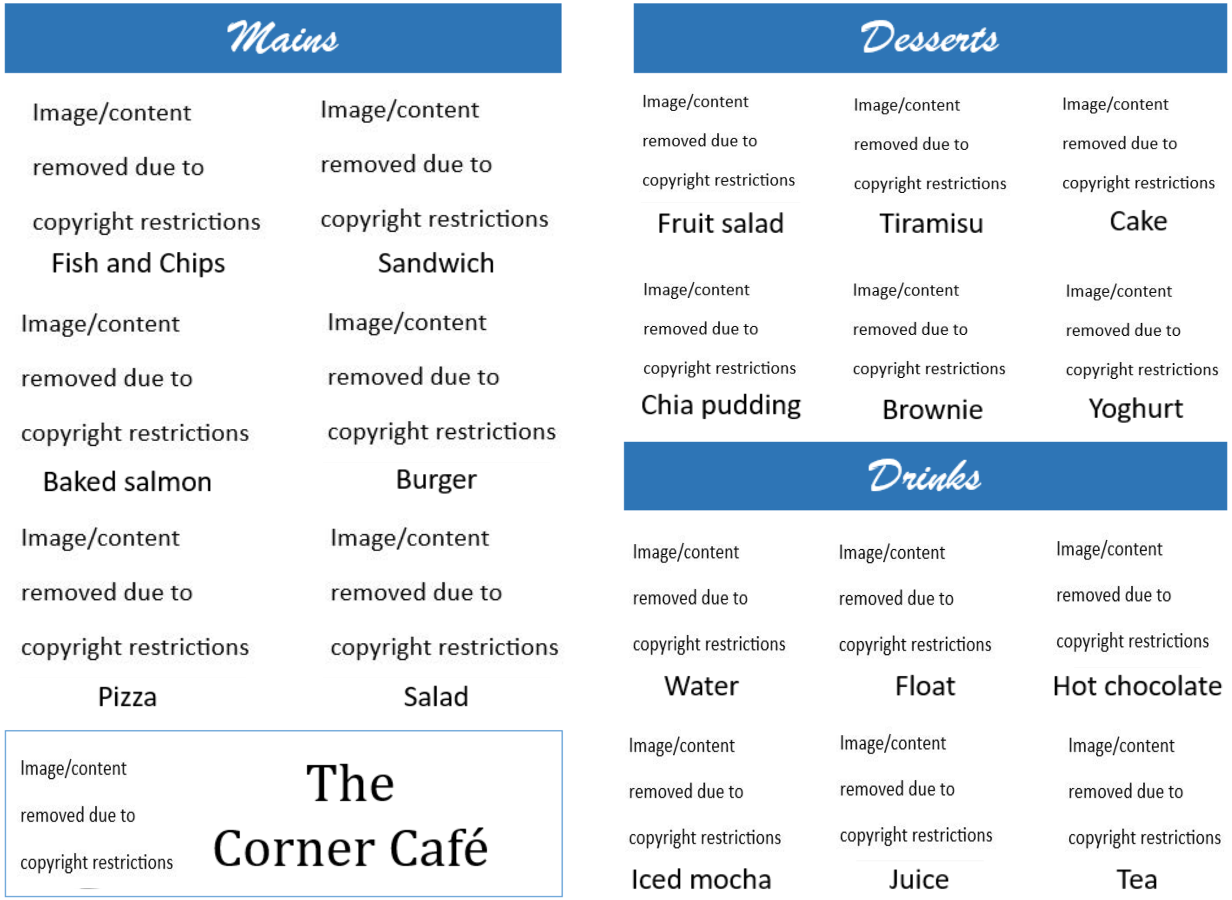
Appendix C

Descriptive ratings and statistics from the pilot study of menu items

		Healthiness	Likelihood of ordering	Concept agreement
Mains	Category			
Burger	Red	2.64 (1.53)	6.10 (2.59)	100%
Pizza	Red	2.05 (1.25)	5.27 (2.91)	100%
Fish and chips	Red	2.45 (1.22)	4.45 (2.58)	95.45%
Sandwich	Green	6.12 (1.05)	6.23 (1.67)	92%
Grilled salmon	Green	7.52 (1.23)	6.25 (2.95)	100%
Salad	Green	7.86 (0.79)	7.00 (2.05)	100%
Desserts				
Brownie	Red	1.57 (0.79)	5.35 (2.23)	91.30%
Chocolate cake	Red	1.84 (1.03)	5.08 (2.12)	100%
Tiramisu	Red	1.87 (.92)	4.48 (2.76)	92%
Yoghurt	Green	5.41 (1.90)	5.14 (2.32)	86.36%
Fruit salad	Green	8.14 (0.86)	6.00 (2.61)	100%
Chia pudding	Green	6.50 (1.87)	5.95 (2.56)	90%
Drinks				
Iced mocha	Red	1.72 (0.74)	5.17 (2.98)	96%
Hot chocolate	Red	2.12 (0.97)	5.20 (3.00)	100%
Ice cream soda float	Red	1.83 (1.44)	3.42 (2.65)	100%
Juice	Green	6.17 (1.78)	5.87 (2.18)	100%
Black tea	Green	6.87 (1.69)	5.83 (3.01)	100%
Water	Green	8.76 (0.90)	8.88 (0.33)	100%
Average ratings across sections				
Unhealthy (red)		2.01 (.35)	4.95 (0.75)	97.19%
Healthy (green)		7.04 (1.10)	6.35 (1.07)	96.48%

Appendix D

Larger versions of the menus for Study 3



Mains

Image/content removed due to copyright restrictions

Fish and Chips

Image/content removed due to copyright restrictions

Sandwich

Image/content removed due to copyright restrictions

Baked salmon

Image/content removed due to copyright restrictions

Burger

Image/content removed due to copyright restrictions

Pizza

Image/content removed due to copyright restrictions

Salad

The red circle

Foods marked with a red circle are high in fat, sugar, and/or salt

Desserts

Image/content removed due to copyright restrictions

Fruit salad

Image/content removed due to copyright restrictions

Tiramisu

Image/content removed due to copyright restrictions

Cake

Image/content removed due to copyright restrictions

Chia pudding

Image/content removed due to copyright restrictions

Brownie

Image/content removed due to copyright restrictions

Yoghurt

Drinks

Image/content removed due to copyright restrictions

Water

Image/content removed due to copyright restrictions

Float

Image/content removed due to copyright restrictions

Hot chocolate

Image/content removed due to copyright restrictions

Iced mocha

Image/content removed due to copyright restrictions

Juice

Image/content removed due to copyright restrictions

Tea

Mains

Image/content removed due to copyright restrictions

Fish and Chips

Image/content removed due to copyright restrictions

Sandwich

Image/content removed due to copyright restrictions

Baked salmon

Image/content removed due to copyright restrictions

Burger

Image/content removed due to copyright restrictions

Pizza

Image/content removed due to copyright restrictions

Salad

The green circle

Foods marked with a circle are low in fat, sugar, and/or salt

Desserts

Image/content removed due to copyright restrictions

Fruit salad

Image/content removed due to copyright restrictions

Tiramisu

Image/content removed due to copyright restrictions

Cake

Image/content removed due to copyright restrictions

Chia pudding

Image/content removed due to copyright restrictions

Brownie

Image/content removed due to copyright restrictions

Yoghurt

Drinks

Image/content removed due to copyright restrictions

Water

Image/content removed due to copyright restrictions

Float

Image/content removed due to copyright restrictions

Hot chocolate

Image/content removed due to copyright restrictions

Iced mocha

Image/content removed due to copyright restrictions

Juice

Image/content removed due to copyright restrictions

Tea

Mains

Image/content removed due to copyright restrictions

Fish and Chips

Image/content removed due to copyright restrictions

Sandwich

Image/content removed due to copyright restrictions

Baked salmon

Image/content removed due to copyright restrictions

Burger

Image/content removed due to copyright restrictions

Pizza

Image/content removed due to copyright restrictions

Salad

The coloured circles

Red = Foods high in fat, sugar, and/or salt

Green = Foods low in fat, sugar, and/or salt

Desserts

Image/content removed due to copyright restrictions

Fruit salad

Image/content removed due to copyright restrictions

Tiramisu

Image/content removed due to copyright restrictions

Cake

Image/content removed due to copyright restrictions

Chia pudding

Image/content removed due to copyright restrictions

Brownie

Image/content removed due to copyright restrictions

Yoghurt

Drinks

Image/content removed due to copyright restrictions

Water

Image/content removed due to copyright restrictions

Float

Image/content removed due to copyright restrictions

Hot chocolate

Image/content removed due to copyright restrictions

Iced mocha

Image/content removed due to copyright restrictions

Juice

Image/content removed due to copyright restrictions

Tea

Appendix E

Revised Restraint Scale (Herman & Polivy, 1980)

Appendix F

Consumer Nutrition Knowledge Scale (Dickson-Spillmann, Siegrist, Keller, 2011)

Appendix G

Larger versions of the menus for Study 4

Mains

Image/content removed due to copyright restrictions Fish and Chips	Image/content removed due to copyright restrictions Sandwich
Image/content removed due to copyright restrictions Baked salmon	Image/content removed due to copyright restrictions Burger
Image/content removed due to copyright restrictions Pizza	Image/content removed due to copyright restrictions Salad

Image/content removed due to copyright restrictions

The Corner Café

Desserts

Image/content removed due to copyright restrictions Fruit salad	Image/content removed due to copyright restrictions Tiramisu	Image/content removed due to copyright restrictions Cake
Image/content removed due to copyright restrictions Chia pudding	Image/content removed due to copyright restrictions Brownie	Image/content removed due to copyright restrictions Yoghurt

Drinks

Image/content removed due to copyright restrictions Water	Image/content removed due to copyright restrictions Float	Image/content removed due to copyright restrictions Hot chocolate
Image/content removed due to copyright restrictions Iced mocha	Image/content removed due to copyright restrictions Juice	Image/content removed due to copyright restrictions Tea

Mains

Image/content removed due to copyright restrictions Fish and Chips	Image/content removed due to copyright restrictions Sandwich
Image/content removed due to copyright restrictions Baked salmon	Image/content removed due to copyright restrictions Burger
Image/content removed due to copyright restrictions Pizza	Image/content removed due to copyright restrictions Salad

Image/content removed due to copyright restrictions

The Corner Café

Desserts

Image/content removed due to copyright restrictions Fruit salad	Image/content removed due to copyright restrictions Tiramisu	Image/content removed due to copyright restrictions Cake
Image/content removed due to copyright restrictions Chia pudding	Image/content removed due to copyright restrictions Brownie	Image/content removed due to copyright restrictions Yoghurt

Drinks

Image/content removed due to copyright restrictions Water	Image/content removed due to copyright restrictions Float	Image/content removed due to copyright restrictions Hot chocolate
Image/content removed due to copyright restrictions Iced mocha	Image/content removed due to copyright restrictions Juice	Image/content removed due to copyright restrictions Tea

Mains

Image/content removed due to copyright restrictions

Fish and Chips

Image/content removed due to copyright restrictions

Sandwich

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Baked salmon

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Burger

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Pizza

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Salad

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The Corner Café

Desserts

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Fruit salad

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Tiramisu

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Cake

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Chia pudding

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Brownie

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Yoghurt

Drinks

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Water

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Float

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Hot chocolate

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Iced mocha

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Juice

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Tea

Chapter 5: General Discussion - Overview

The present thesis aimed to examine the use of labelling, and in particular evaluative labelling, in the out of home dining context, and its effectiveness in nudging healthier food choices. The thesis included four studies described across three chapters, along with an introduction and discussion chapter. Chapter One was an introductory chapter to the thesis, highlighting the current state of research in the field along with the scope and relevance of the thesis' topic. Chapter Two (Study 1) discussed the process and findings of a systematic review and meta-analysis, reviewing the current scope of published literature on the impact of evaluative versus descriptive labelling on food choices and/or consumption. A series of experiments (one laboratory and two online) were then conducted to test the impact of different evaluative labels on café style menus. Specifically, Chapter Three comprised an in-person experimental laboratory study (Study 2) comparing the effects of traffic light labelling and a healthy tick symbol against a no information control. Chapter Four consisted of two online experimental studies (Studies 3 and 4) that examined the specific use of red and green labels separately to better understand the associated approach or avoidance behaviours associated with traffic light colours. This final Discussion chapter will summarise the findings of the included studies, alongside discussing the implications of the body of work presented in this thesis. Lastly, the limitations of the thesis will be discussed, together with recommendations for future research and policy making in the field of nudging labels to promote healthier eating behaviour.

Summary of Findings

Chapter 2 (Study 1) – Systematic Review and Meta-analysis

Study 1 was a meta-analysis examining the current literature on evaluative/interpretive labelling relative to descriptive labelling. The study aimed to contribute to the field of nudging by examining the application of labels that helped consumers interpret information. Although previous reviews and meta-analyses have explored the topics of labelling, and nudging healthier choices, to the author's knowledge Study 1 was the first meta-analysis to examine the use of interpretive evaluative labels within the specific context of out of home dining. The goal of the meta-analysis was to examine the field of literature on the application of such evaluative labels, whereas previous analyses have only examined descriptive calorie labelling (Littlewood et al., 2015; Long et al., 2015, Swartz et al.,2011; Sinclair et al. 2014), or a mix of different nudges such as placement and priming (Arno & Thomas, 2016; Broers et al., 2017; Cadario and Chandon, 2019).

The meta-analysis scoped literature from six online databases, and the final analyses were based on 39 articles, which included 43 studies, for a total of 88 effect sizes. The main comparison was between factual descriptive labels (e.g., calorie labelling) and evaluative/interpretive labels that help consumers interpret nutritional information. Overall, the effect of descriptive labelling was small (d = .07) and not statistically significant, indicating that while descriptive calorie labelling influenced healthier choices, there was a lack of statistical evidence for conclusive support. In contrast, evaluative/interpretive labelling was shown to have a significant effect on healthier food choices, along with a larger effect size (d = .13). Taken together these findings suggest that evaluative labelling with interpretive elements may be a more effective and potentially more reliable nudge than descriptive labelling.

Further analyses allowed for comparisons between groups of labelling. Within the descriptive labelling group of calorie labels, labels that only reported calories, or calories with an additional icon (e.g., heart healthy) had a small or even negative effect that did not reach statistical significance. In contrast, the inclusion of exercise equivalent labels and traffic lights alongside calorie counts resulted in a larger nudging effect, which was statistically significant. These additional interpretive elements served their purpose in informing consumers or helping them make the healthier choice easier. The findings also suggest that perhaps a combination of labelling nudges is needed in order to consistently impact upon food choices.

Additional analyses of specific subgroups of evaluative labelling showed mixed effects. Two groups of labels (traffic light labelling and icons/symbols that were not calorie count based) did not show statistically significant effect of nudging. A possible explanation for the lack of statistical support could be the wide variety of interventions and outcomes used across studies. In contrast to calorie labelling, which has been standardised through policies and the use of a common outcome measure such as kilocalories (kcal), traffic light labels and icons often represent a variety of health goals (e.g., heart healthy, low sodium, low in fats), and research studies target different outcome measures such as proportion of sales or odds ratios in contrast to the concrete measure of kcal ordered/consumed. Often there was also variation between studies regarding the implementation of traffic light labels based on dietary criteria or country specific recommendations. As such, the current field of research into evaluative labelling requires more studies and a larger pool of results to allow for conclusive evidence to be drawn.

The meta-analysis in Chapter Two also compared studies based on the dining and experimental settings used. Out of the 88 effect sizes analysed, fast-food outlets and restaurant settings were the most common (n = 32 and 31, respectively). Both settings were found to have statistically significant effects of nudging. In contrast, cafeterias and other dining settings had fewer studies (n = 11 and 14, respectively). and labelling was not found to be statistically significant. . The fast-food setting also had the largest effect size (Cohen's d = .17) compared to the other scenarios (d =.13 - .03) However, this may reflect the high calorie items served in fast-food outlets, where meals often exceed dietary guidelines (Vercammen et al., 2019). In contrast, cafeterias and other settings such as cafes often serve a wider range of food, and the variability of both products and labelling methods may contribute to smaller or nonsignificant findings in these settings. Lastly, the final quarter of studies consisted of various scenarios such as laboratory provided meals and café settings, each with less than five studies examining each scenario. This small number of studies highlights an avenue for further research which was targeted in the subsequent experimental studies (Chapters Three and Four).

Finally, the results from the meta-analysis showed that laboratory settings were more likely to produce a significant effect of nudging, while field studies had a smaller effect size that was not statistically significant. This highlights a common issue in psychology, where the effect sizes found in laboratories are often different to those found in field studies (Mitchell, 2012). This is likely due to the presence of external factors difficult to control outside of a laboratory setting, such as food prices, social influences over ordering, and other dining specific situations. For example consumers may choose a healthier option to appear more socially desirable when dining in groups, or choose meals based on pricing, with lower consideration towards health. Experiments conducted in laboratories often involved a single participant, and instructions to choose a meal with a larger imagined budget, or no financial limit, with the goal to control for such external factors Although there is appeal in exclusively conducting field studies to ensure better generalisability or research, laboratory settings allow for potential moderating factors to be identified and analysed. Several studies in the meta-analysis examined potential social and demographic factors such as age and income status, but due to the small pool of studies it was difficult to draw definite conclusions. It is possible that other factors have yet to be analysed, such as interest in dieting and nutrition knowledge, which may influence how consumers notice and interact with labelling nudges (Miller & Cassidy, 2015; Vyth et al., 2011). These factors were examined in the experimental studies of the thesis (Chapters Three and Four).

Chapter Three (Study 2) – Comparison of traffic light system and healthy tick symbol for nudging out of home dining food choices

Based on the results of the meta-analysis, the experimental studies (Chapters Three and Four, Studies 2-4) were developed to help address possible gaps in the current research. The first was an identified lack of studies examining dining scenarios outside of restaurants and fast-food outlets. As such, a café style menu was chosen to explore the potential effects of labelling in a fairly casual food setting without the limitations of typical fast-food menu items. Second, as a majority of previous studies focused on calorie labelling, there was a need for labels that focused on other measures of health beyond calories. Lastly, the experimental studies aimed to assess if personal factors, such as nutrition knowledge and dietary restraint might interact with menu labelling as moderators.

Study 2 (Chapter Three) aimed to compare and contrast two evaluative systems, traffic light labelling, and a healthy tick symbol against a no information control. University students participated in a laboratory experiment where they were randomized to view one of three café menus and asked to make a hypothetical meal selection. The outcome measure was the healthiness of their chosen food and drinks. Personal factors of dietary restraint and nutrition knowledge were also measured to test for interaction effects with nudging labels.

Although the overall composition of meals did not appear to be significantly affected by menu labelling, analysis of individual meal categories suggested that labelling impacted parts of the meal order. In particular, menu labelling, and specifically the healthy tick label, nudged participants to choose a healthier main. In contrast, dessert and drink choices appeared to be unaffected by the labelling nudges. It was suggested that consumers may place more importance on choosing a healthy main dish compared to desserts and drinks, with similar results seen other research studies (Ellison et al., 2013; Prowse et al., 2020). It was also suggested that a healthy tick symbol may be more effective than seeing all colours of the traffic light system, or that perhaps a simplified version of the traffic light system would be worth exploring.

Study 2 also examined the effect of the different types of evaluative labelling nudges in relation to the personal moderating factors of dietary restraint and nutrition knowledge. It was anticipated that participants who were concerned about their food intake (high in dietary restraint) would be more likely to choose a healthier option in the labelling conditions, and that participants with high nutrition knowledge would be better able to understand the labelling systems, which would increase their likelihood of making healthier food choices. Dietary restraint was found to interact with the healthy tick menu condition, where participants who were restrained eaters were more likely to choose healthier mains and avoid unhealthy mains, while the nudge effect of the healthy tick was not found for participants low in dietary restraint. Interestingly, the opposite effect was found in relation to nutrition knowledge. It was actually those with low nutrition knowledge who made healthier choices in response to the healthy tick nudge. This moderating effect of healthy tick labelling was not found when comparing individuals with high nutrition knowledge between the control and healthy tick group and suggests the effectiveness of a simple evaluative nudge for individuals with low nutrition knowledge. This will be discussed more below after summarising the findings from Studies 3 and 4.

Chapter Four (Studies 3 and 4) - Use of red and green labels and explanatory legends to nudge healthier choices from a café style menu

Based on the results of Study 2 showing the impact of a simple healthy tick over the full traffic light system, Studies 3 and 4 were designed to examine the effects of a simplified version of the traffic light system focused on red or green labels only. Based on previous research, the colours red and green and their associated meanings ‘stop’ and ‘go’ can be extrapolated to approach and avoidance effects for foods (Bouhassoun et al., 2022; Rohr et al., 2015). It was anticipated that the simplified traffic light (red and green, without amber) would allow for a better understanding of nudging consumers either towards healthier foods, or away from unhealthy choices. As such, to examine the impact of the two colours red and green on healthy food choices from a menu, Studies 3 and 4 tested them separately and in combination across three conditions (red only, green only, red and green) against a no information control. In contrast to the laboratory study which recruited only a student population (Study 2), Studies 3 and 4 included a wider range of participants recruited from the general public via the research platform Prolific. Similar to Study 2, participants were asked to make a hypothetical café meal selection and completed measures of nutrition knowledge and dietary restraint.

Study 3 showed that being exposed to any of the labelling conditions (red only, green only, red and green) led to significantly healthier choices compared to the control group. However, there were no differences between the different types of labelling. Although the red and green (combined) condition had the lowest mean number of unhealthy items chosen, it was not statistically different from the red only and green only conditions. Similar to Study 2, a significant effect of labelling on the choice of main was observed, whereby participants who viewed any labelling condition were significantly more likely to choose a healthy main compared to the control condition. No nudging effects of labelling were found for the desserts and drinks sections. In contrast to Study 2, neither nutrition knowledge nor dietary restraint moderated the effect of labelling on the food or drinks chosen.

Study 4 was designed to test if the nudging effects of Study 3 could be replicated if the explanatory legend was removed, for a subtler labelling nudge. Study 4 used the same menu and labelling format of Study 3, but instead all versions of the menus used the neutral café logo placeholder from the control condition in place of the explanatory legend. In contrast to Study 3, Study 4 did not find any significant effect of menu labelling on the food and drink choices, both across the overall meal choice, and within specific meal sections (mains, drinks, or desserts). This suggests that at present, an explanatory legend is required for participants to effectively understand

and apply the use of coloured labelling, despite the implicit association of red and green with ‘stop’ and ‘go’. Relating back to the meta-analysis, it is possible that a similar reasoning is behind the significant effect of calorie labels with traffic lights, compared to the non-significant effect of traffic light labelling alone. The inclusion of traffic lights in addition to calories gave consumers enough context to understand the labelling effectively, whereas traffic light labelling alone might not have enough explanatory context within the other studies outside of calorie labelling.

In contrast to the findings of Study 3, Study 4 found that nutrition knowledge interacted with the green only condition. While higher nutrition knowledge was correlated with a higher total number of healthy items ordered across all conditions, the moderating effect of the green only condition meant that participants who saw a green only menu were even more likely to choose healthy items over unhealthy options compared to the no information control. This effect was smaller and not significant when comparing the red only and red and green conditions to the control. The second personal moderator of dietary restraint was not found to interact with any of the labelling conditions.

Finally, Study 4 included additional questions asking participants if they noticed the labels, and what they assumed the labels meant. When comparing the labelled conditions, the red and green condition was more likely to be noticed (35%) compared to the green only condition (15%), while the red only condition did not significantly differ in being noticed (24%) from the other two (red and green, and green only). The results also indicated that the red and green condition was significantly more likely to be correctly interpreted compared to the red only and green only conditions. In Littlewood et al.’s (2015) review, studies in which 70% of participants or less noticed menu information reported no statistically significant changes. In contrast, studies where 70% or more of participants noticed the labelling reported statistically significant impacts of menu labelling (e.g., reduced kcal orders). The low rate of noticing the labels in Study 4 could potentially explain the lack of significant findings in contrast to Studies Two and Three, where the explanatory legend likely made the labels more noticeable to participants. A similar result was seen a recent study by Kay et al., (2023) where the nudge of including drinks (soft drinks or plain water) within the context of Instagram images revealed that nudges that were too subtle did not effectively encourage healthier drink choices. This suggests the need for menu labelling to generate at least a certain level of awareness to be an effective nudge.

Discussion of Experimental Studies

Across all three experimental studies, a mix of results were found that show varying levels of support for labelling nudges. A possible explanation for the variability in results across studies could be the small effect size noted in the meta-analysis (Chapter 2, Study 1). Evaluative/interpretive labelling for traffic light and symbols was found to have a 95% confidence interval of the true effect size that ranged from small to medium (-.05 to .34), while pairwise comparison cohen's d for the experimental studies ranged from (.02 to .24). While overall labelling nudges appeared to be positive in both the meta-analysis and the experimental studies, the variability of the true effect size could also be seen in the present studies, showing inconsistent support across different measures (e.g., overall meal choices versus individual meal components).

A commonality between Studies 2 and 3 was a significant effect of labelling on the choice of mains. This isolated effect of nudging on mains has been noted in previous research (Ellison et al., 2013). In Ellison et al.'s study, participants who viewed a labelling condition of traffic lights and calorie count were found to order fewer calories in their mains compared to a descriptive menu with only calorie labels. This isolated effect of nudging on mains could reflect the presence of a licensing effect, whereby nudging only impacts the main choice, as consumers view their choice of desserts and drinks as discretionary, and thus less likely to be influenced by labels.

In terms of moderators, nutrition knowledge was found to correlate with healthier meal choices outside of labelling condition. This fits with previous research. For example, Spronk et al. (2014) found an association between healthier eating such as a higher intake of fruit and vegetables and a lower intake of sweetened drinks alongside increased nutrition knowledge. In Study 4, nutrition knowledge was found to interact with labelling condition when participants viewed a green only label compared to a no information control, where the likelihood of selecting a healthier option was higher when they had higher nutrition knowledge. It is possible that without a legend in Study 4, participants with higher nutrition knowledge were able to correctly guess that the green only label indicated healthier choices. In contrast, in Study 2, healthy tick labelling (green circle with a white tick mark) was found to nudge consumers with low nutrition knowledge into making healthier choices. It appears that easily interpreted information is needed for consumers with lower nutrition knowledge, whereas labels with no context (e.g. green circle only) required higher nutrition knowledge to guess or interpret the meaning of unclear labels. The two opposing effects found in Studies 2 and 4 highlight that more research is required to properly understand the influence of nutrition knowledge on food choices when differing levels of information are provided to consumers.

The second individual factor that was explored, dietary restraint, was only found to have a moderating role in Study 2, where restrained eaters were significantly more likely to choose a healthy main when exposed to a healthy tick option compared to the control condition. Furthermore, higher dietary restraint was actually associated with more unhealthy dessert choices in Study 4. The experimental studies originally predicted that restrained eaters would be more likely to make healthier choices when presented with an evaluative menu label as they are more concerned with limiting or maintaining their food intake. There are several potential explanations for the lack of moderation by dietary restraint in Studies 3 and 4. First, it should be noted that the moderation was found for a healthy tick (Study 2), but not in relation to the traffic light system used in either Studies 2, 3, or 4. Thus, there may be something about the specific type of evaluative labelling that impacts restrained eaters. It is also possible that restrained eaters may be concerned with specific indicators of nutrition knowledge (e.g., fat content vs calorie count) that was not captured by the single label icon used in the studies. The result for study 4 also shares similarities to Girz et al. (2012), where restraint was to affect food choice, but did not interact with labelling.

Another possible explanation is that the measure of dietary restraint, the Revised Restraint Scale focuses largely on the cognitive process, or how occupied an individual is with their desired weight and food intake (Herman & Polivy, 1980). However, this may not immediately translate into a behavioural measure of food intake. In a study by Lowe and Timko (2004), restrained eaters were found to score consistently higher on measures of cognitive restraint but also showed more weight cycling, which was an indicator of unsuccessful eating control. As such, the cognitive measure of dietary restraint used in the current set of studies in this thesis may not be a pure measure of active behavioural dieting. As described by Bublitz et al. (2010), "(…) restrained eaters are not always active dieters but consumers actively dieting are utilizing restraint." The lack of significant results highlights that another measure of dieting cognition and behaviours may allow for a better understanding of the nudging effects of labels. A potential alternative measure is the Three factor eating questionnaire (Stunkard & Messick., 1985) which similarly assesses cognitive restraint. A measure developed by Leske et al. (2017) for their study also shows promise, where the questions focused more on behaviours, such as increasing intake for specific body weight/shape goals (e.g., high protein diet) alongside questions about restricting intake. Alternatively, a self-report measure of dieting status may be sufficient to help assess the potential influence of nudging labels. Examples include a yes or no response to "Are you currently on a diet to lose weight?" (Tiggemann, 2000) or the 7-point Likert response (ranging from definitely not to definitely) to "I am currently dieting" in Leske et al's (2017) studies may be enough to assess an individuals current dieting behaviour or intent.

Strengths and Limitations

Overall, the aim of the thesis was to both examine and contribute to the field of menu labelling nudges, with a focus on evaluative/interpretive labels and their use in an out of home dining context. However, various limitations restrict the generalisability of the current research. A key limitation of the meta-analysis was that effect sizes for descriptive (calorie) labels were only included in the analysis if the research study also examined evaluative labelling. This was done to focus on and allow for comparisons with evaluative labelling. However, the effect size and conclusions drawn about descriptive labelling may not accurately reflect the current field of research that may have focused on descriptive labelling alone. Although the results show similarities with other studies that reported a positive but nonsignificant effect (Cecchini & Warin, 2015; Nikolaou et al., 2015; Sinclair et al., 2014), the results of descriptive labelling were meant to be examined in comparison to evaluative/interpretive labels.

A second limitation of the meta-analysis was the over-representation of fast-food and restaurant settings, which limits the generalisability of the results, and further highlights the need for more research in the field of out of home dining. Finally, the current focus on calorie counts within the literature meant that traffic light and icon/symbol studies were compiled into groups, which did not allow for a closer understanding of their effects. This limits the insight gained from the results. For example, both an approach ‘heart healthy’ icon and an avoid ‘high sodium’ warning sign were collapsed into the same group for the analysis, as there were not enough studies to allow for comparisons. As research on the field continues to grow, it is hoped that more studies purely focusing on evaluative and interpretive labelling as a standalone would allow for a larger and more representative pool, better understanding of other food settings (e.g. cafeterias) and eventually have enough studies to separately analyse specific types of labelling in future meta-analyses.

Each experimental study also had specific strengths and limitations. In terms of participants, Study 2 exclusively recruited a university student population, with a larger female representation

(73%) and younger age (~23 years). In comparison, Studies 3 and 4 comprised a majority of participants from a research recruitment website, resulting in a more equal gender balance (55% – 58%) and older age (~28 and ~31 years, respectively). However, all participants from both research pools were equally randomly allocated across conditions, which aimed to control for such factors across the conditions. Additionally, sample sizes were calculated for main effects, and the study was underpowered to examine interaction effects. Although studies 3 and 4 aimed to capture a representative Australian general population, there may be limits on the generalisability of a sample obtained from Prolific. Future studies can test to see if the results found are replicable with a larger sample size.

In addition, Study 2 was conducted in a laboratory where participants were given physical menus to make their meal choices, while Studies 3 and 4 were delivered online with participants viewing a full screen image. Both the use of the laboratory setting and online menus are limited in their ability to replicate the menu of actual café setting. It is hoped that future research can replicate such labelling formats and menus within a field study, which would help increase research validity. The laboratory set-up of Study 2 allowed for better control of factors such as hunger, as participants were given explicit instructions to fast two hours before participating in the lab. While the online format of Studies 3 and 4 allowed for a larger recruitment pool that is more representative of a general Australian sample, the diversity in participant and situational factors such as hunger, thirst, time of day and distractions were beyond the author's control. While this improves the generalisability of the results, it also introduces potential variables that cannot be isolated or controlled.

For the experimental studies (Chapters Three and Four), the choices participants made were hypothetical, which assumes that participants had planned to consume their whole selection, and ignores other potential factors such as pricing. It is possible that participants may have ordered an unhealthy item, with a plan to only partially consume it. However, in the meta-analysis by Cadario and Chandon (2019), no significant differences were found when the effect sizes of selection and consumption were compared, thus selection orders may prove to be an acceptable measure. Additionally, future research could potentially offer participants a chance of actually consuming their meal ordered (e.g., a random draw for a meal vouchers of their order) to improve ecological validity.

An additional limitation was the lack of attention checks within the online studies. As the original research was conducted in-person with participants attending a laboratory, the survey did not include online safeguards such as attention checks. These checks were then left out for the following studies to ensure a similar methodology across the surveys. However, a benefit of the Prolific platform involves their stringent signup and monitoring measures for participant quality. Additionally, all free text responses were checked by the author. Future research could benefit from adding both attention checks and questions asking participants their guesses of the studies' research goals, to help control for demand effects. The final limitation shared across the studies was the use of a limited menu . The menu was pilot tested and developed to have a range of items across a scale of healthiness, but to represent each section evenly, a limited menu (six options per meal category) was used The final menus only consisted of 18 total items, which limits the range of customer choices and might not be applicable to an actual café setting that often have many more options available. Future studies could consider using menus that provide consumers more options to increase the validity of the results.

Lastly, a limitation shared across chapters was the lack of adjustments to the significance levels for multiple testing. The lack of Bonferroni adjustments to the analyses has increased the risk of false positives. Future analyses that attempt to replicate results of expand on the research should consider including the relevant statistical adjustments to reduce the risk of false positive errors.

Implications and future research

Despite these limitations of the research, the results provide much insight and potential avenues for future research. In particular, the meta-analysis (Chapter Two, Study 1) results support previous reviews that suggest evaluative/interpretive labelling is better than descriptive labelling (Cadario & Chandon, 2019; Daley et al.,2020). The current evidence also shows support for the use of evaluative labelling in both fast-food and restaurant settings. There also appears to be difficulty translating lab research into real world settings, as seen by the difference in effectiveness between laboratory and field studies. However, as mentioned above, there is a large focus on calorie labelling and associated evaluative/interpretive labels (e.g., physical activity equivalents) and an inconsistent application of other evaluative labels such as traffic lights and icons, which future research can help to address. The experimental studies within this thesis aimed to help contribute to our understanding of labelling nudges, but the field of menu labelling is continually developing and has many avenues to explore. In contrast to packaged food, menus and out of home dining services include a wide range of settings and scenarios. At present, the current field has largely focused on calorie labelling and reduction. However, the use of alternative evaluative/interpretive formats has the potential to nudge consumers with specific dietary goals. An example is a study by Pechey et al., (2020) where labels on packaged snacks included a warning about specific diseases such as cancer or type 2 diabetes similar to labels used in the tobacco industry. The use of specific labels may be more salient for individuals who are at risk of such health concerns, and thus nudge healthier choices within at at-risk population.

Another issue worth exploring is the inconsistency between studies in the application of traffic light and icon labels. As mentioned in the meta-analysis (Chapter Two), the application of traffic light labels was highly variable. There was a mixture of studies that applied different criteria (e.g., calorie ranges versus macronutrient content) to how items were colour coded with traffic lights. Additionally, some studies simplified information by providing only a single coloured label, with other studies providing separate colours for each value of the food (e.g., fat, sugar, salt). As research continues within the field of both packaged food and menu labelling, it is hoped that there will be enough studies to allow for a comparison between the use of single against multi-component traffic light labels. The use of symbols and icons also share the same methodological concern, where there has yet to be a large enough pool of research to compare different types of labels (e.g., heart healthy versus low fat). This knowledge is essential to help both the scientific field and policymakers in identifying labels with stronger nudge effects.

The results of the experimental studies in this thesis also highlight inconsistencies in nudging affecting overall healthiness of meals (only found in study 2) and the choice of main (significant nudges in studies 2 and 3, but not 4)(. This suggests that there might be a difference in the decision making process of single choices compared to multicomponent meals. Within the field, substitution nudges have been explored and have shown tentative success, but could not be captured in the current meta-analysis due a difference in interventions compared to labelling (Policastro et al., 2017; Taufik et al., 2022). Such nudges often rely on changes to the environment such as making the healthier option the default choice, or consumers being prompted to make healthier swaps. These types of nudges were defined by Cadario and Chandon (2019) as a behaviourally oriented convenience enhancements and are very different from cognitively oriented nudges. However, the use of nudging healthier substitutes such as offering a healthy choice as the default option can definitely play a complementary role to menu labelling in encouraging healthier out of home dining and has room for exploration.

When moderators were examined across studies, dietary restraint was found to be inconsistent and only influential in relation to the healthy tick label. Future research should examine if other measures of dieting and dietary restraint may interact with nudging, and if specific labels appeal to specific groups of dieters (e.g., successful versus unsuccessful) and non-dieters. In contrast, nutrition knowledge showed some tentative moderating effects across both types of evaluative labels tested. As discussed above, there appear to be opposing effects of nutrition knowledge based on the level of information provided to participants. However, nutrition knowledge was overall correlated with healthier choices across studies regardless of condition. As such, education programs and raising awareness about the importance of healthy eating would benefit the larger population regardless of what labelling nudges are applied. Governmental policies supporting such education programs across a range of ages and food settings should be encouraged to help improve population consumption of healthy foods.

As discussed, menu labelling can be considered an agreeable nudge as it encourages healthier choices without limiting consumers. However, there is an additional benefit to menu labelling where companies or restaurants may actually reformulate their products in response to menu labelling. For example, within the field of packaged food, the introduction of the Health Star Rating system in Australia and New Zealand shows tentative evidence of products being reformulated to be healthier (e.g., reduced calories and sodium, increased fibre) (Ni Mhurchu et al., 2017; Morrison et al., 2019). Similarly, a cross-sectional study by Theis and Adams (2019) found that UK restaurant chains that voluntarily provided menu labelling had items with less fat and salt than restaurants without menu labelling. As such, beyond the effect of nudging consumers to make healthier choices, menu labelling can also support healthy eating by encouraging reformulation of recipes and products served in out of home dining settings.

Conclusion

To summarise, the present thesis aimed to contribute to the current research field of menu labelling, and specifically out of home dining labels, and the field of nudging. With the increasing burden of unhealthy diets and noncommunicable diseases, the use of labelling as a nudging intervention that targets healthier eating has the potential to improve the quality of life for the general public without explicitly forbidding options. The thesis first examined the current scope of labelling, with a focus on labels that help consumers interpret nutritional information (i.e., evaluative/interpretive labelling as opposed to descriptive labelling). Following a meta-analysis, three experimental studies were conducted to help address identified gaps in the literature.

The overall results of the meta-analysis (Chapter Two, Study 1) and experimental studies (Chapters Three and Four; Studies 2, 3, and 4) show tentative support for the use of labelling, and specifically interpretive evaluative labelling over descriptive labelling that only provides information without interpretation. However, both the meta-analysis and experimental studies revealed areas that require further research to better understand labelling nudges and their effects on consumers. Among these include the need for further studies focusing on labels outside of calorie labelling, and a better understanding of how dieting behaviours, and nutrition knowledge might interact with labelling nudges to affect food choices.

To conclude, labelling nudges show tentative effectiveness for encouraging healthier food choices. As research progresses, nudging is a continually developing field that has many opportunities to further progress and refine our understanding of food choices and eating behaviours. With the ever-increasing accessibility to unhealthy foods in the modern food environment, it is important for this subject to continue to gain traction and support from the various scientific fields to help reduce the burden of unhealthy eating on population health and wellbeing.

References

Arno, A., & Thomas, S. (2016). The efficacy of nudge theory strategies in influencing adult dietary behaviour: a systematic review and meta-analysis. *BMC public health*, *16*(1), 1-11.

Bouhassoun, S., Naveau, M., Delcroix, N., & Poirel, N. (2023). Approach in green, avoid in red? Examining interindividual variabilities and personal color preferences through continuous measures of specific meaning associations. *Psychological Research*, *87*(4), 1232-1242.

Broers, V. J., De Breucker, C., Van den Broucke, S., & Luminet, O. (2017). A systematic review and meta-analysis of the effectiveness of nudging to increase fruit and vegetable choice. *The European Journal of Public Health*, *27*(5), 912-920.

Bublitz, M. G., Peracchio, L. A., & Block, L. G. (2010). Why did I eat that? Perspectives on food decision making and dietary restraint. *Journal of Consumer Psychology*, *20*(3), 239-258.

Cadario, R., & Chandon, P. (2019). Which healthy eating nudges work best? A meta-analysis of field experiments. *Marketing Science*, *39*(3), 465-486.

Cohen, J. (1992). Statistical power analysis. *Current directions in psychological science*, *1*(3), 98-101.

Daley, A. J., McGee, E., Bayliss, S., Coombe, A., & Parretti, H. M. (2020). Effects of physical activity calorie equivalent food labelling to reduce food selection and consumption: systematic review and meta-analysis of randomised controlled studies. *J Epidemiol Community Health*, *74*(3), 269-275.

Ellison, B., Lusk, J. L., & Davis, D. (2013). Looking at the label and beyond: the effects of calorie labels, health consciousness, and demographics on caloric intake in restaurants. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 1-9.

Herman, C. & Polivy, J.(1980) Restrained eating. *Obesity. Philadelphia: Saunders*.

Kay, E., Kemps, E., Prichard, I., & Tiggemann, M. (2023). Instagram-based priming to nudge drink choices: Subtlety is not the answer. *Appetite*, *180*, 106337.

Leske, S., Strodl, E., & Hou, X. Y. (2017). Predictors of dieting and non-dieting approaches among adults living in Australia. *BMC Public Health*, *17*, 1-18.

Leske, S., Strodl, E., & Hou, X. Y. (2017). Predictors of dieting and non-dieting approaches among adults living in Australia. *BMC Public Health*, *17*, 1-18.

Littlewood, J. A., Lourenço, S., Iversen, C. L., & Hansen, G. L. (2016). Menu labelling is effective in reducing energy ordered and consumed: a systematic review and meta-analysis of recent studies. *Public health nutrition*, *19*(12), 2106-2121.

Long, M. W., Tobias, D. K., Cradock, A. L., Batchelder, H., & Gortmaker, S. L. (2015). Systematic review and meta-analysis of the impact of restaurant menu calorie labeling. *American journal of public health*, *105*(5), e11-e24.

Lowe, M. R., & Timko, C. A. (2004). What a difference a diet makes: Towards an understanding of differences between restrained dieters and restrained nondieters. *Eating Behaviors*, *5*(3), 199-208.

Miller, L. M. S., & Cassady, D. L. (2015). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, *92*, 207-216.

Miller, L. M. S., & Cassady, D. L. (2015). The effects of nutrition knowledge on food label use. A review of the literature. *Appetite*, *92*, 207-216.

Mitchell, G. (2012). Revisiting truth or triviality: The external validity of research in the psychological laboratory. *Perspectives on Psychological Science*, *7*(2), 109-117.

Morrison, H., Meloncelli, N., & Pelly, F. E. (2019). Nutritional quality and reformulation of a selection of children's packaged foods available in Australian supermarkets: Has the Health Star Rating had an impact?. *Nutrition & dietetics*, *76*(3), 296-304.

Ni Mhurchu, C., Eyles, H., & Choi, Y. H. (2017). Effects of a voluntary front-of-pack nutrition labelling system on packaged food reformulation: The health star rating system in New Zealand. *Nutrients*, *9*(8), 918.

Nikolaou, C. K., Hankey, C. R., & Lean, M. E. J. (2015). Calorie-labelling: does it impact on calorie purchase in catering outlets and the views of young adults?. *International Journal of Obesity*, *39*(3), 542-545.

Pechey, E., Clarke, N., Mantzari, E., Blackwell, A. K., De-Loyde, K., Morris, R. W., ... & Hollands, G. J. (2020). Image-and-text health warning labels on alcohol and food: potential effectiveness and acceptability. *BMC Public Health*, *20*, 1-14.

Policastro, P., Palm, T., Schwartz, J., & Chapman, G. (2017). Targeted calorie message promotes healthy beverage consumption better than charity incentive. *Obesity*, 25(8), 1428-1434.

Prowse, R. J., Lee, K. M., Chen, E., Zuo, F., Hammond, D., & Hobin, E. (2020). Testing the efficacy of and parents' preferences for nutrition labels on children's menus from a full-service chain restaurant: results of an online experiment. *Public Health Nutrition*, *23*(10), 1820-1831.

Rohr, M., Kamm, F., Koenigstorfer, J., Groeppel-Klein, A., & Wentura, D. (2015). The color red supports avoidance reactions to unhealthy food. *Experimental Psychology*.

Sinclair, S. E., Cooper, M., & Mansfield, E. D. (2014). The influence of menu labeling on calories selected or consumed: a systematic review and meta-analysis. *Journal of the Academy of Nutrition and Dietetics*, *114*(9), 1375-1388.

Spronk, I., Kullen, C., Burdon, C., & O'Connor, H. (2014). Relationship between nutrition knowledge and dietary intake. *British journal of nutrition*, *111*(10), 1713-1726.

Stunkard, A. J., & Messick, S. (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of psychosomatic research*, *29*(1), 71-83.

Swartz, J. J., Braxton, D., & Viera, A. J. (2011). Calorie menu labeling on quick-service restaurant menus: an updated systematic review of the literature. *International Journal of Behavioral Nutrition and Physical Activity*, *8*, 1-8.

Taufik, D., Bouwman, E. P., Reinders, M. J., & Dagevos, H. (2022). A reversal of defaults: Implementing a menu-based default nudge to promote out-of-home consumer adoption of plant-based meat alternatives. *Appetite*, 175, 106049.

Theis, D. R., & Adams, J. (2019). Differences in energy and nutritional content of menu items served by popular UK chain restaurants with versus without voluntary menu labelling: A cross-sectional study. *PLoS One*, *14*(10), e0222773.

Tiggemann, M. (2000). Dieting and cognitive style: The role of current and past dieting behaviour and cognitions. *Journal of Health Psychology*, *5*(1), 17-24.

Vercammen, K. A., Frelier, J. M., Moran, A. J., Dunn, C. G., Musicus, A. A., Wolfson, J. A., & Bleich, S. N. (2019). Calorie and nutrient profile of combination meals at US fast food and fast casual restaurants. *American journal of preventive medicine*, *57*(3), e77-e85.

Vyth, E. L., Steenhuis, I. H., Heymans, M. W., Roodenburg, A. J., Brug, J., & Seidell, J. C. (2011). Influence of placement of a nutrition logo on cafeteria menu items on lunchtime food choices at Dutch work sites. *Journal of the American Dietetic Association*, *111*(1), 131-136.