



Multiple traffic light front-of-pack label and their influence on students' dietary behaviors

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Abstract

Prevalence of overweight and obesity is on the rise among children and adolescents. Compared to 2011, a 4-fold increase in prevalence of overweight and obesity was observed in 2024 with an estimated pool of prevalence of 24.0%. Evidence suggests that effective food labels help consumers to make quick and easy decisions on healthy and less healthy products based on the key nutrients such as sodium, fat, saturated fat, and sugar content. Currently, no reviews have been published on multiple traffic light (MTL) food labels as a tool used to prevent obesity among students. This review focuses on dietary behavior among students when exposed to MTL and includes an analysis of 19 papers by authors from around the world. The analysis showed that a more salient type of food label called MTL demonstrated to be superior in perceived healthfulness of food products and purchased intention compared to other food labels used among students. Therefore, educational institutional should be the primary setting in promoting healthy eating behaviors which is recognized in reducing obesity risks due to time spent in first 2 decades of their life.

Keywords: Acceptance. Food label. Obesity. Multiple traffic light.

Introduction

Obesity is a significant, preventable cause of death worldwide, with its prevalence increasing not only among adults but also children and adolescents [1]. In Malaysia, the prevalence of childhood obesity is

particularly concerning. According to the National Health Morbidity Survey (NHMS) 2011, the obesity rate among children aged 5 to 17 years was 6.1%. This rate rose significantly in subsequent years, reaching 11.9% in 2015, 14.8% in 2019 and 24.0% in 2024 [2,3]. Among adolescents aged 13 to 17 years, obesity prevalence increased from 13.3% [4] to 14.3% in 2022 [5]. In the university student population, obesity rate increased from 17.6% in 2019 [6] to 25.4% in 2024 [7]. Therefore, it is evident that childhood obesity has been one of the greatest threats to public health, putting children and adolescents at risk of poor health persistent into adulthood. The widespread availability of energy-dense and processed foods high in refined carbohydrates and fats contributes significantly to this issue [8]. Obesity is associated with an increased risk of several health problems, including type 2 diabetes mellitus, insulin resistance, heart disease, high blood pressure, and metabolic syndrome [9].

Monitoring students' growth within educational settings is essential as it plays a key role in addressing obesity, given their extensive and continuous engagement with students during their formative years [10]. During critical developmental stages, students spend a substantial amount of time in schools, universities, and colleges, consuming a significant portion of their daily energy intake in these settings [11]. Consequently, the time spent in educational environments can significantly influence their dietary patterns. Adolescents often underestimate the long-term consequences of their health choices, believing

they can change their habits later. However, the stress associated with university life, including academic pressures and time management challenges, reduces the likelihood of students practicing healthy eating habits [12]. A cluster randomized controlled trial among Australian students revealed that the most frequently ordered foods in their canteens were high in salt, sugar, fat, and saturated fat, such as pizza, processed chicken, and hot dogs [13]. Therefore, implementing strategies to promote healthy eating and nutrition within schools, colleges, and universities would be beneficial [14,15]. Targeting nutrition education and experiences in educational institutions is advantageous, as it can shape lifelong behaviors [16].

Governments in many countries align with World Health Organization (WHO) guidelines by mandating nutrition information on packaged foods and menu labels, particularly in schools, to support healthy eating policies consistent with national dietary guidelines [17]. The Nutrition Facts Panel (NFP) is a widely used format for providing nutritional information, appearing on both Front-of-Pack (FOPL) and Back-of-Pack labels (BOPL) [18]. Several nutrition labeling formats have been introduced worldwide, including Guideline Daily Amounts (GDA), Multiple Traffic Light (MTL), Chilean Warning Labels, red Warning labels, 5-Color Nutrition Label, Health Star Rating (HSR), and Healthy Choice labels. Extensive research indicated that these nutritional labels significantly influence consumers' food choices at the point of purchase [19,20]. However, several factors can limit the effective use of this information, including time constraints, comprehension challenges, and competing priorities such as taste, price, promotions, or habitual preferences. Therefore, simplifying nutrition labels has been proposed as a key strategy to combat obesity, aiming to reduce cognitive load and enhance the likelihood that consumers will consider nutritional information when making purchase decisions [21].

Research indicates that interpretive nutritional labels, which use color-coding to highlight nutrient levels (green for low, yellow/amber for medium, and red for high), offer greater clarity. For example, MTL food labels provide more accurate assessments of a product's healthfulness compared to reductive labels [18]. Simplified food labeling, such as using colors to indicate food choices, helps consumers make healthier selections because the color cues are easily understood [22]. Color-coded labels effectively enhance consumer attention and reduce the time needed to interpret nutritional information on food products [23]. Table 1 shows the cut-off used for traffic light food label for a usual food serving based on the criteria from UK Food Standards Agency [24].

Table 1. Cut-offs used for traffic light food label.

Nutrient	GDA	Low (Green) <7.5% GDA	Moderate (Yellow)	High (Orange) >20% GDA
Energy (kcal)	2000	150	150 – 500	400
Fat(g)	70	≤5.25	5.25 – 14	≥14
Saturated fat (g)	20	≤1.5	1.5 – 4	≥4
Sugar (g)	60	≤4.5	4.5 – 12	≥12
Salt (g)	6	≤0.45	0.45 – 1.2	≥1.2

Source: [24].

The current existing literature has primarily focused on exposure of MTL among adults with a positive impact on dietary quality and purchase intentions [18,23,25] but limited reviews and research have synthesized this evidence among students [26,27]. Therefore, this review aimed to provide an overview of recent investigations related to MTL food label on purchasing behavior and consumption to address childhood obesity.

Methods

Three electronic databases were used to search for relevant papers published in English: PubMed, The Cochrane Library, and Wiley Online Library from August 2024 to October 2024. The search was using Patient/Problem, Concept, and Context (PCC), in which the patient would be children, adolescents or students. The concept would be MTL food label or MTL nutrition label and the context used was schools, school canteens, universities or universities cafeteria. The review focused exclusively on studies involving human subjects, and terms related to various diseases were excluded where possible, except for obesity. The keywords used for the search were "front of pack labelling", "traffic light menu label", "traffic light food label", "children", "adolescent", "student", "school", "canteens", "universities", "college", "cafeteria", "understanding", "acceptance", "knowledge", "attitude", and "purchasing". Record retrieval was limited to studies published between January 2012 and December 2024. These publication dates were chosen to ensure strong evidence supports this study as this was the first review done on students. The aim was to address the research questions of Malaysian educational institutions should emphasize Multiple Traffic Light (MTL) food label among students and how this label influences their product perception, purchasing behavior and consumption.

A set of eligibility criteria was established to guide publication selection, ensuring alignment with the defined research question. Publications were only included in the analysis if it provided information on multiple traffic light food or menu label among students particularly school, and university and college students, if it provided on the perception,

understanding and acceptance of students on this label and if there are any significant changes on students point of purchase post exposure of this label. Eligibility criteria required the articles retrieved to be in English language and full text articles were provided for analysis. Publications that reported information on MTL food labels among adult consumers were excluded. Publications were also excluded if the MTL exposure on participants were a pilot studies and study protocol. Publication on findings providing parameter relating to student's perception, interpretation and food choice selection were chosen.

Comparison of MTL with Other Food Labels

Food labels used globally can be categorized into two types: reductive and interpretive. Reductive labels present straightforward nutritional information with minimal guidance. On the other hand, interpretive labels also provide nutritional details but use color coding to convey the healthiness of the food. Interpretive labels can be further divided into nutrient-specific labels like MTL, which highlight individual nutrients, and summary indicators such as NutriScore, which give an overall assessment of the product's nutritional quality [28].

A more salient type of food label is MTL. This label categorizes foods based on their content of sugar, fat, and sodium: red indicates foods that should be consumed infrequently, yellow (or amber) suggests moderate consumption, and green signifies foods that can be consumed regularly [26]. Food labels that provide evaluative information, like the traffic light food label, have been found to outperform other types of labels in terms of perceived healthfulness and purchase intentions among students [29].

Two studies revealed that while most consumers are aware of GDA, they seldom use them due to the complexity of the nutritional information presented. HSR, Warning Labels, MTL, and the Healthy Choice Logo were found to be easier to understand [30]. The findings indicate that directive and semi-directive labels, such as Warning Labels, HSR, and MTL, are more effective at guiding consumers toward healthier food choices compared to the nondirective GDA. These labels also influence consumers' emotions, as children showed less frequent use of positive emotion emojis on foods displaying these labels [31].

Similarly, a study in a children's hospital retail food venue found that traffic light food labeling significantly decreased the purchase of unhealthy food items, whereas cartoon labeling increased the purchase of unhealthy items [32]. A study comparing font sizes on food labels found that nutrition fact tables with large fonts for calories improved calorie recall (p

< 0.001). When small fonts were used, MTL labels were most effective in improving calorie recall ($p < 0.01$). This finding aligns with other research, indicating that traffic light food labels are effective at capturing attention and increasing consumers' understanding of nutrient levels in food products [33]. Therefore, improving the visibility and design of labels can enhance the effectiveness of calorie labeling, making it more noticeable and easier to interpret on packaged foods [34].

A study involving university students on nutrition labeling for college menus and prototype design revealed that students identified five key nutrients: calories, sodium, sugar, fat, and carbohydrates to be color-coded using a traffic light system. This suggests that students are interested in color-coded food labels, which could positively influence their selection of healthier foods [35]. In three experimental studies conducted at various universities, two found that traffic light food labels were more effective than nutrition tables and the GDA in distinguishing between more and less healthful foods. Traffic light food label effectively communicated the healthfulness of products across and within categories. When assessing products individually, traffic light food labels helped participants accurately judge the healthfulness of both less healthy and healthy food items ($p < 0.05$) [36,37].

In another experimental study with primary and secondary students, participants were exposed to sugar reduction claims and traffic light food label on three dairy products: yogurt, chocolate-flavored milk, and vanilla dessert. The sugar reduction claim resulted in a slight but significant increase in the children's and adolescents' expected liking of these products ($p < 0.01$). When the sugar reduction claim was combined with the traffic light food label, it further boosted their expected liking and influenced their product selection ($p < 0.01$) [38]. In an online survey, students were presented with pictorial examples and asked to rate the usefulness of the labels. They then evaluated the traffic light food label and found them to be understandable, with an average score of 5.9 out of 7 on a Likert scale. Color coding promoted healthier food choices compared to text-based nutrition declarations [39]. In another study, using a randomized crossover method, students were exposed to both traffic light food label and GDA. Their selections were significantly lower in total energy ($p < 0.001$), sugar ($p < 0.001$), fat ($p < 0.01$), saturated fat ($p < 0.01$), and salt ($p < 0.001$) with traffic light food label compared to the GDA system. Traffic light food label helped students identify healthy and less healthy foods more accurately, aligning their choices with dietary recommendations [24].

The Impact of MTL Food Label on Children's Behaviors

MTL nutrition information influenced meal choices and energy intake by providing clear, color-coded information. This made it easier for students to identify healthier food options, which led to healthier meal choices and a reduction in overall energy intake. Exposure to MTL labels significantly reduced body mass index (BMI) in children over a 10-week period. Therefore, MTL food and menu labels are considered highly effective for addressing childhood obesity, with long-term studies showing sustained benefits over a 10-year period [40].

Research on 81 adolescents aged between 14 to 16 years indicated that MTL food label helped them identify healthier products better than labels without color coding. Participants showed greater ability in choosing food items with fewer calories and lower levels of total fat, saturated fat, sugar, and salt [24]. In a follow-up study among university students exposed to MTL labels for one week, the students demonstrated improved healthy diet choices and became more conscious of other nutritional ingredients such as protein, which were not listed on the MTL labels [41]. Similarly, a study involving 790 Australian adults by Kelly et al. revealed that users of MTL labels were five times more effective at identifying healthier products compared to those using non-color-coded labels [42].

Moreover, a study comparing children's responses to text labels with and without color-coding, as well as colored and non-colored facial icons, found that color-coding and/or colored facial icons significantly enhanced the accuracy and speed of selecting both healthy and less healthy food products ($p < 0.001$) [43], while a study conducted in a pediatric ward found that children were 1.75 times more likely to choose healthier, green-labeled foods and 0.65 times less likely to choose red-labeled foods when exposed to child-friendly menu labeling [44]. Traffic light food label also found to evoked feelings of guilt among children when selecting red-labeled foods [32].

Two randomized controlled trials, one involving school children and another with university students, highlighted the impact of color-coded food labels. In one study, the mean proportion of primary school children who ordered and purchased their lunch online from the green category was significantly higher in the intervention group (51.21%) compared to the control group (37.93%) ($p < 0.001$). Conversely, the proportion of red-labeled foods purchased was significantly lower in the intervention group (1.21%) compared to the control group (11.11%) ($p < 0.001$) [13]. Similarly, a study among Japanese university students found that

those in the labeled group were significantly more likely to choose healthy meals and were more aware of other nutritional components not listed on the label, such as protein and dietary fiber, compared to the unlabeled group [28]. This study provided strong evidence supporting the effectiveness of a consumer-behavior intervention using color coding food labels among students.

In contrast, two other intervention studies conducted on university students and children/adolescents found no significant changes in the proportion of red foods ordered ($p > 0.20$) and green foods ordered ($p > 0.40$) among university students exposed to labels [45]. Among primary and secondary school students exposed to traffic light food label, most understood the information on the labels, but there were no significant changes in their purchasing and consumption behaviors. However, health-conscious adolescents used the labels when selecting products [46]. Another study involving dieters and non-dieters discovered that non-dieters understood and utilized the information on traffic light food label, which influenced their perception based on the "stop" and "go" logic of the color-coding. In spite of that, dieters did not adopt the color cues as readily, focusing more on the cost of consumption, which led to a lower health quality evaluation [47].

Nevertheless, a cross-sectional mixed-method study highlighted potential concerns with traffic light food labels contributing to the development of eating disorders among university students. Although 60% of students found the traffic light food label helpful and 57% used them a few times a week ($p < 0.001$), 16% reported developing eating disorders, and 47% felt that these labels might worsen existing eating disorders ($p < 0.001$). The labels led some students to restrict their food intake to alter their body shape or weight, potentially increasing the risk of eating disorders [48].

Short Term vs. Long Term Effectiveness of MTL Food Label

Research in Ecuador on the purchase of carbonated soft drinks showed that the initial implementation of MTL labels did not significantly reduce purchases of high-sugar soft drinks. However, over time, there was a marked decrease in the purchase of high-sugar drinks and an increase in the purchase of low and no-sugar alternatives once MTL labels were displayed on product contents [49]. In contrast to a finding among children in a pediatric ward, the purchase effect of green-labelled foods diminished over time, and after eight meals. The proportions of red and green-labeled food orders were

similar. This suggests that child-friendly menu labels are effective in the short term for encouraging healthy eating [44]. Meanwhile, among university students, a survey revealed that 58% of students used traffic light food label at least a few times per week, and 73% wanted the labels to continue in their college cafeterias [45].

Nutrition Literacy as a Ket Mediator in Effectiveness of MTL Food Label

The effectiveness of MTL food label varied among different subgroups of students. For example, students with higher literacy levels were more likely to understand and effectively use the MTL food label compared to those with lower health literacy levels. This suggests that while MTL food labels are beneficial, their impact can be enhanced with targeted educational efforts to improve nutritional literacy among all student subgroups [50]. Among university students it was also found that these students required minimal prior knowledge to understand the nutrition labels, with no significant differences in psychological stress during food selection [41]. A quasi-experimental study revealed that students exposed to traffic light food labels showed improved comprehension of nutrition labels compared to those exposed to nutrition fact tables [23].

The MTL system is designed to be simple and easy for consumers to understand at the point of purchase. Despite this, studies have shown that health literacy can significantly impact the understanding of MTL labels among parents and their children. Parental health literacy plays a crucial role in maintaining their children's healthy body weight. Parents with higher health literacy are better at estimating portion sizes, understanding nutrition labels, and comprehending growth charts [51]. The World Health Organization (WHO) defines health literacy as the cognitive and social skills that influence an individual's motivation and ability to access, understand, and use information to promote and maintain good health. In Malaysia, the overall health literacy levels are categorized as follows: sufficient health literacy (40.7%), limited health literacy (35%), and excellent health literacy (24.3%) [2].

Conclusion

MTL represents a prominent form of food labeling that effectively enhances perceived healthfulness and purchase intentions for healthier food and beverages, particularly among students. Evidence suggests that exposure to MTL significantly reduces overall calorie intake in children compared to non-color-coded labels. Although its influence on children's purchase intentions may diminish over time, university students continue to

demonstrate strong support for its implementation in cafeterias. Given its intuitive design, MTL is more likely to be comprehended and utilized even among individuals with lower levels of nutritional literacy.

Limitation

As of all the papers, sociodemographic demographic background of the subjects was not included. Besides, subject's socio-economic status was also not determined in each of the publications. This was somewhat a limiting factor as some publications identified that lower socio-economic subjects tend to purchase more on higher calories food ignoring the health label displayed on food products. The reason of the frequent purchase on higher calories, salt, sugar, sodium and fat foods is due to cheaper prices, and they are readily available in their convenience stores. Information on nutrition literacy among Malaysian students is somewhat limited to be used as guidance in its acceptability and suitability on MTL being implemented to Malaysian students.

CrediT

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