

Research Paper

Cite this article: Calabro R, Kemps E, Prichard I, and Tiggemann M (2025). Healthy vending machines on campus: the effect of traffic light labelling on food and beverage choices. *Public Health Nutrition* 28: e68, 1–7. doi: [10.1017/S1368980025000229](https://doi.org/10.1017/S1368980025000229)

Received: 9 June 2024
Revised: 8 January 2025
Accepted: 10 February 2025

Keywords:

Vending machine; Food and beverage choices; Traffic light system; Increased healthy range; Campus study

Corresponding author:

Ryan Calabro;
Email: ryan.calabro@flinders.edu.au

Healthy vending machines on campus: the effect of traffic light labelling on food and beverage choices

Ryan Calabro¹ , Eva Kemps¹, Ivanka Prichard²  and Marika Tiggemann¹

¹Psychology, College of Education, Psychology and Social Work, Flinders University, Adelaide, Australia and ²Health & Exercise Sciences, College of Nursing and Health Sciences, Flinders University, Adelaide, Australia

Abstract

Objective: To investigate whether the introduction of healthy vending machines on a university campus could increase the proportion of healthy food and beverage purchases. **Design:** Four new healthy vending machines offering a wider range of healthier food and beverages were installed alongside existing machines. These new machines used traffic light colours to indicate nutritional value. A year after their installation, a traffic light text guide and colourful wrap were added to the new machines. χ^2 tests were used to assess significant differences in the sales of green (healthy), amber or red (unhealthy) items from healthy and existing vending machines across the 3 years (2021–2023). **Setting:** The study was conducted on a university campus where the new healthy vending machines were installed. **Participants:** Participants of this study were the consumers who purchased items from the vending machines on the university campus. **Results:** The results indicated a shift towards healthier purchases following the introduction of the healthy vending machines. The addition of the traffic light text guide and colourful wrap further reduced unhealthy purchases, although this change was small. Sales from the existing vending machines did not meaningfully decrease, and any reductions were more than replaced by sales from the new healthy vending machines. **Conclusions:** The study concluded that by providing healthier options and guiding consumers towards these options, the vending machine programme offers a promising pathway towards promoting healthier food and beverage choices from vending machines on university campuses.

Unhealthy dietary behaviours have become commonplace in many countries across the world, with significant shifts towards the consumption of foods and beverages that are high in sugar, fat, energy and salt but low in nutritional value^(1,2). This change in eating habits towards foods of poor nutritional value is contributing to a growing global health concern, namely, the rising incidence of non-communicable diseases such as CVD, type II diabetes, obesity and cancer. This underscores the urgent need for interventions to promote healthier dietary behaviours.

One acknowledged contributor to this rising incidence of non-communicable diseases is the widespread availability of food and beverages low in nutritional value and high in sugar, fat and salt (Baker et al., 2020). In the pursuit of promoting healthier dietary habits, it is important to pinpoint prevalent locations that disproportionately offer poor nutritional choices. Vending machines, as highlighted by Rozman *et al.*⁽³⁾, serve as a prime example of such settings. Vending machines represent an easy and convenient option for consumers in busy environments such as hospitals and universities. They also offer an effective target for intervention because of their small size and limited product selection, making it easier to change compared with cafés and other food retail outlets.

Of the various locations where vending machines are commonly found, universities can be considered a critical focus as the presence of vending machines has been found to contribute to unhealthy dietary choices and weight gain among students⁽⁴⁾. Much like other locations, vending machines on university campuses typically feature predominantly unhealthy options^(5–8), raising concerns about the potential impact on the dietary habits of students, who are primarily young adults. Addressing the poor nutritional options offered in this location is essential, as young adults are at a stage of life where lifelong dietary habits are often formed⁽⁹⁾. Therefore, creating an environment that promotes healthier dietary choices for students is imperative.

In response to the prevalence of unhealthy options in vending machines, various policies and programmes have been implemented to encourage healthier choices. These strategies typically involve increasing the availability of healthier options, providing health information about the options and enhancing the visibility and guidance towards healthier alternatives^(10–12). This has been achieved by using methods such as posters, branding, labelling and pricing changes for vending machines in various locations such as hospitals, universities, shopping centres and airports.

One effective strategy is to add healthier options and nutritional guides to vending machines, offering a practical alternative to banning unhealthy items. Kocken *et al.*⁽¹³⁾ found that

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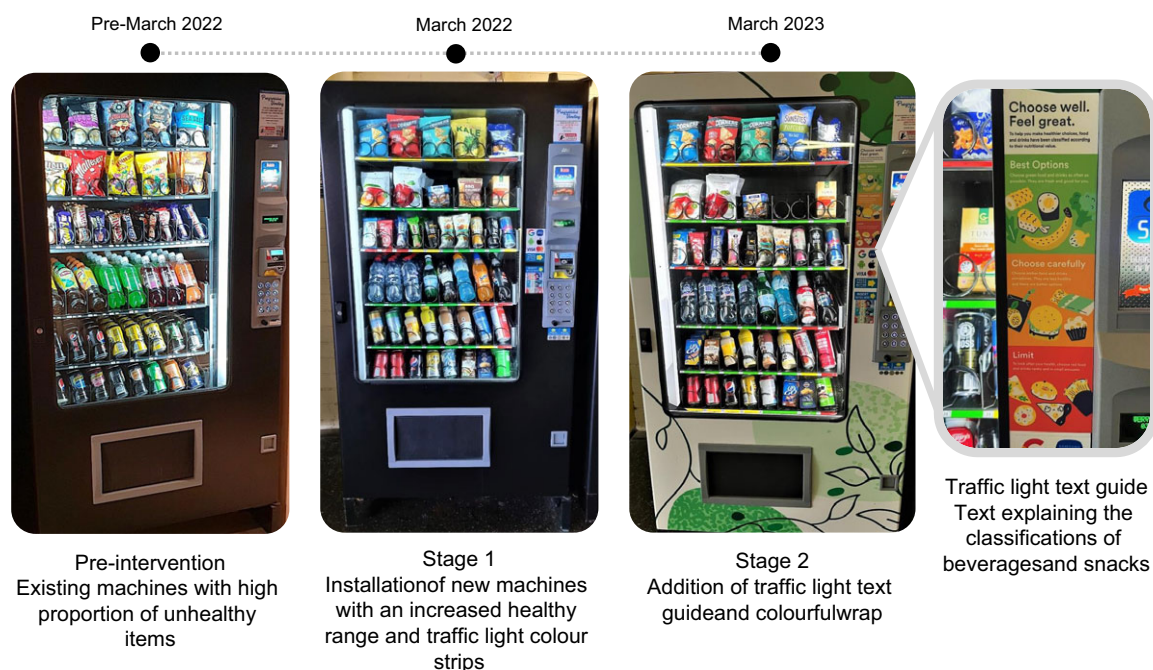


Figure 1. A timeline of the two stages of the healthy vending machine programme.

increasing lower-calorie foods in high school vending machines led to healthier choices without reducing sales. Similarly, Stamos *et al.*⁽¹⁴⁾ demonstrated that healthier beverage options and traffic light labelling significantly decreased sugar-sweetened beverage consumption in schools. To date, no studies have investigated the effectiveness of introducing new healthy vending machines alongside existing vending machines. Such a strategy would offer a way around the often-encountered barrier of potential reduced revenue^(15–17), whereby vending machine operators are understandably hesitant to replace popular (unhealthy) items in their machines with potentially less popular healthy items. However, adding more options via new machines and leaving the other options unchanged is less likely to affect revenue. Moreover, in not removing machines containing unhealthy choices, the consumer's liberty of choice is maintained as the option to choose the poorer nutritional items remains, but instead, an environment that encourages healthier choices is promoted. The present study investigated the effectiveness of a healthy vending machine programme, which involved installing new healthy vending machines on a university campus. The programme was rolled out in two stages. In the first stage, the new 'healthy' machines were installed alongside or near existing machines. A year later, a traffic light text guide and colourful wrap were added to the front of the machine. The present study investigated the effects of the installation of these new healthy vending machines on purchases of unhealthy and healthy food and beverages by analysing sales data across 3 years (2021–2023).

Method

Context

The study took place at Flinders University in South Australia, across the main campus (Bedford Park) and an auxiliary campus (Tonsley). The university is attended by thousands of students on a given day, with fewer students attending the smaller Tonsley

campus. The main campus has twenty vending machines and fourteen cafés, while the auxiliary campus has two vending machines and two cafés.

Healthy vending machines

The first stage of the healthy vending machine programme (March 2022) involved installing four healthy vending machines in high-traffic locations across the university campus (based on the sales data of the previous year). The new healthy vending machines featured an increased range of healthy food and beverages and correspondingly a reduced range of unhealthy items. Specifically, the machines were designed to have a high proportion of healthy food and beverages (40 %) and a low proportion of unhealthy food and beverages (20 %). Overall, the healthy machines consisted of 45 % healthy (green), 35 % amber and 20 % unhealthy (red) options, with slight variations in this composition across machines. The new machines also featured nutritional labelling in the form of red, amber and green strips under each item (see Fig. 1). The classification of items to colour was based on the FoodChecker system (see Table 1)⁽¹⁸⁾. FoodChecker is a service that allows food and beverages to be searched in an online database to find the colour classification set according to nutritional criteria. These criteria are based on the content of added sugar, energy, fat and salt, with green having the lowest and red having the highest of each (see Healthy Eating Advisory Service⁽¹⁸⁾ for more information).

The second stage of the healthy vending machine programme (March 2023) involved adding a written traffic light guide and wrapping the outside panels of the vending machines with an attractive design. The traffic light guide provided textual information via a poster near the card reader about the colour classifications within the machine, with the guide indicating that green means 'best choice', amber 'choose carefully' and red 'limit' (see Fig. 1). The wrap consisted of a green leafy design on a white background, designed to evoke freshness and health.

Table 1. Label text and classification of the food and beverages in the present study

Colour	Label text	Classification
Green	Best options Choose green food and drinks as often as possible. They are fresh and good for you.	Green items are: • good sources of important nutrients • lower in saturated fat, added sugar and/or salt • lower in energy (kilojoules) • higher in fibre
Amber	Choose carefully Choose amber food and drinks sometimes. They are less healthy, and there are better options.	Amber are items that: • can contribute to excess energy (kilojoule) intake • contain moderate amounts of saturated fat, added sugar and/or salt
Red	Limit To look after your health, choose red food and drinks rarely and in small amounts.	Red items are: • high in energy (kilojoules) • high in saturated fat, added sugar and/or salt • lacking in important nutrients such as fibre

All machines offered both food and beverages, consisting of approximately the same proportion of each (50 % food, 50 % beverages) for both healthy and existing machines, with some machines having slightly more beverage options (55 %) than food options (45 %). The items included in the existing vending machines included chips, lollies, noodles, muesli bars, chocolate, energy drink, soft drink, fruit juice, iced tea and iced coffee. The existing machines consisted on average of 6 % healthy (green), 12 % amber and 82 % unhealthy (red) options, with variations to this composition across machines. The items included in the new healthy vending machines included low-carb bars, soy chips, low-calorie cookies, fruit slices, cheese and crackers, popcorn snacks, tuna and crackers, nut mixes, sugar-free soft drinks, sugar-free iced tea and protein shakes. All vending machines were situated in high-traffic locations across the university campus, including outside and inside the central library, near the student hub and on the first floor of a multistorey student complex. The four healthy vending machines were installed in each of these locations, with no changes to any of the existing vending machines. The existing vending machines were standard plain black vending machines with no nutritional guide. The existing machines were chosen based on their close proximity to each of the newly installed healthy vending machines.

Data collection

Data were collected from seven vending machines (three existing, four new) in the first semester of two consecutive years (2022–2023) during the months of March, April, May and June. Sales data for the existing machines from the first semester of the previous year (2021) were also obtained. The data consisted of monthly sales reports that included the number of each item sold for each machine. The first semester was selected to minimise the impact of seasonal changes. Sales reports were only available from the vending machine supplier for the first semester for each of the 3 years. While this is a limitation, it carried the advantage of minimising the impact of seasonal changes throughout the year. The food and beverage purchases were categorised as green (healthy), amber or red (unhealthy) according to the FoodChecker system⁽¹⁸⁾.

Analysis

The sales data were analysed by calculating the total percentage of items sold per classification category (green, amber and red) for each machine. χ^2 tests were used where appropriate to test for significant differences in the proportion of items sold between the two groups of machines (existing *v.* new healthy). To investigate how the introduction of the new healthy vending machines affected the proportion of item category sales (green, amber, red), we compared the proportions of items sold per category (green, amber, red) for the existing (2021) *v.* existing and new healthy machines (2022). To investigate the effectiveness of the wrap and traffic light guide additions to the healthy vending machines, we compared the proportion of items sold per category (green, amber, red) from the first year when these new machines did not have these features (2022) to the subsequent year when they were added to the new machines (2023). Finally, to assess whether there was a reduction in sales from existing machines, we compared the total number of items sold from existing machines across the first semesters of the 3 years (2021–2023). Data were aggregated using Microsoft Excel⁽¹⁹⁾, and all analyses were conducted using the R Stats version 4.3.3⁽²⁰⁾ using an alpha value of 0.05.

Results

Healthy and unhealthy vending machine sales

To determine the effectiveness of the introduction of the healthy vending machines on healthy beverage and food purchases, the item sales from the first semester of the year the machines were installed (2022) were compared with the previous year's first semester (2021). The sales comparison includes seven vending machines (three existing, four new) for 2022 and three existing machines for 2021. A χ^2 test revealed a significant association between the introduction of healthy vending machines and the proportion of purchases of items from each category ($\chi^2 (2) = 1218.7$, $P < 0.001$), with a moderate effect size (Cramer's $V = 0.215$). Analysis of the changes for each category revealed that of all purchases made from the machines over each of the 4 months, the proportion of green items purchased increased by a range of 10–13 %, amber by 8–12 % and red decreased by 20–22 % (see Fig. 2), compared with the first semester of the previous year (2021).

For beverages specifically, a χ^2 test revealed a significant association between the introduction of healthy vending machines and the proportion of purchases of beverages from each category ($\chi^2 (2) = 837.71$, $P < 0.001$), with a moderate effect size (Cramer's $V = 0.239$). Analysis of the changes for each category revealed that of all beverage purchases made from the machines over each of the 4 months, the proportion of green beverages purchased increased by a range of 12–14 %, amber by 8–16 % and red decreased by 20–28 % (see Fig. 2), compared with the first semester of the previous year (2021).

For food specifically, a χ^2 test revealed a significant association between the introduction of healthy vending machines and the proportion of purchases of food from each category ($\chi^2 (2) = 557.31$, $P < 0.001$), with a moderate effect size (Cramer's $V = 0.219$). Analysis of the changes for each category revealed that of all food purchases made from the machines over each of the 4 months, the proportion of green food purchased increased by a range of 9–11 %, amber by 7–8 % and red decreased by 16–19 % (see Fig. 2), compared with the first semester of the previous year (2021).

As shown in Fig. 2, all category comparisons were significant, and this pattern did not change across food and beverage

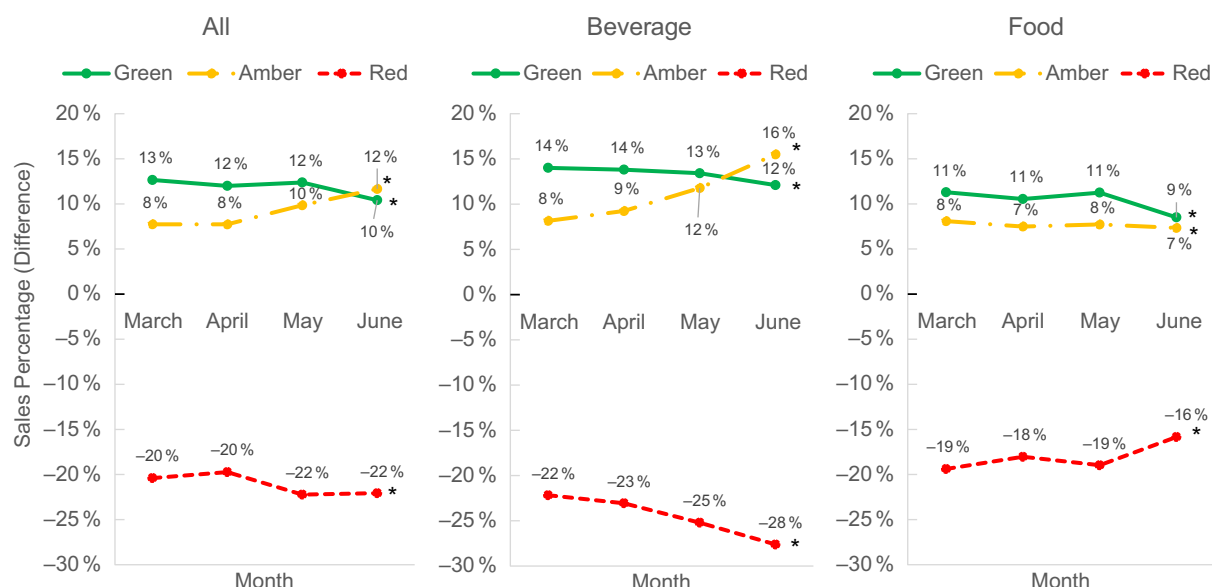


Figure 2. Stage 1: Difference in percentage of item sales per category (new + existing machines 2022 v. existing machines 2021). Note. *Indicates significant difference for the average of that category across the 4 months.

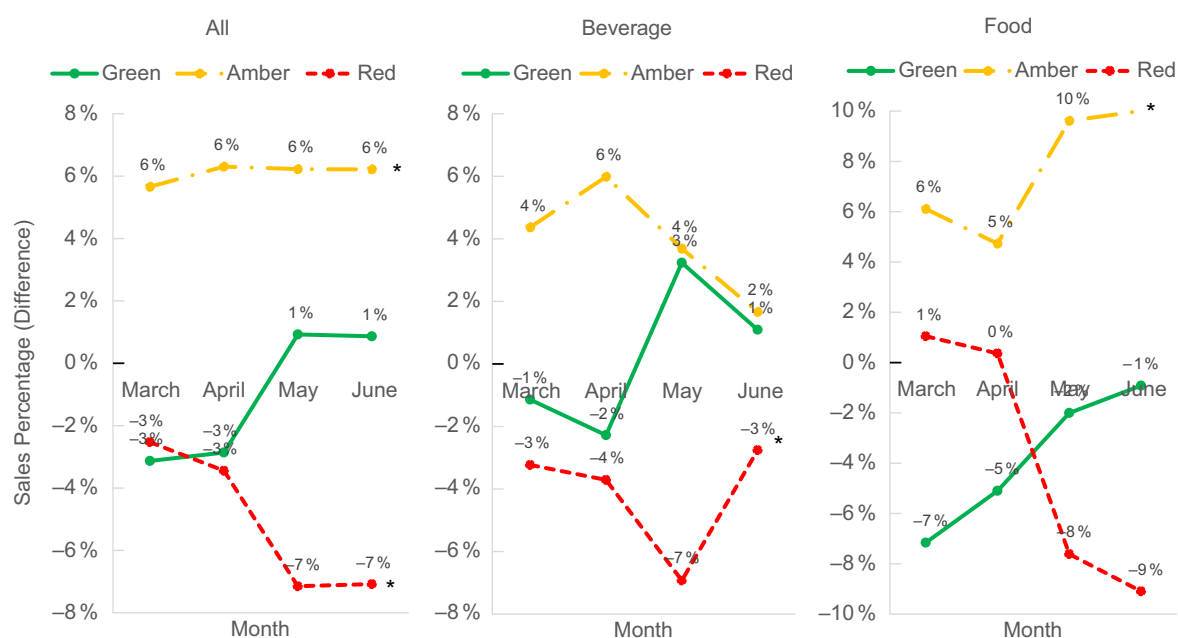


Figure 3. Stage 2: Change in percentage of item sales per category compared with stage 1 (new machines 2023 v. new machines 2022). Note. *Indicates significant difference for the average of that category across the 4 months.

purchases. However, on average, beverage sales seemed to have a slightly stronger increase in the proportion of green beverages sold and a slightly stronger decrease in the proportion of red beverages sold compared with food sales.

Effect of traffic light guide and colourful wrap

To determine the effectiveness of the addition of a traffic light text guide and colourful wrap to the healthy vending machines, the sales data of stage 2 (2023) and stage 1 (2022) were compared for the four new machines. A χ^2 test revealed a significant association ($\chi^2 (2) = 91.6$, $P < 0.001$), with a moderate effect size (Cramer's

$V = 0.071$). After the traffic light guide and colourful wrap were added (stage 2), for the proportion of all purchases made from the machines over each of the 4 months, red items decreased by a range of 3–7%, amber increased consistently by 6% and green ranged from a decrease of 3% to an increase of 1% compared with the previous year (see Figure 3).

For beverages specifically, a χ^2 test revealed a significant association between the addition of the traffic light guide and colourful wrap and the proportion of purchases of beverages from each category ($\chi^2 (2) = 53.35$, $P < 0.001$), with a moderate effect size (Cramer's $V = 0.072$). Analysis of the changes for each category revealed that of all beverage purchases made from the

As shown in Fig. 3, amber and red food and beverages were the comparisons that were significantly different. This pattern was different across beverages and food, whereby the only significant comparisons were for the proportion of red beverage sales and amber food sales. Based on these patterns, it appears that the addition of the traffic light guide and colourful wrap decreased the purchase of unhealthy (red) beverages more strongly and increased the purchase of amber food items more strongly.

In terms of overall product sales, the sales from existing machines appeared to reduce slightly from 2021 levels after the healthy vending machines were introduced in 2022 (10 762 *v.* 9062). However, the new healthy machines appear to have more than replaced this difference with sales totalling 7514 for 2022. The item sales from healthy machines after the introduction of the traffic light guide and colourful wrap also increased, from 7514 to 10 546, getting closer to the 11 685 sales from the existing machines. See Table 2 for a summary of the sales data.

The finding that healthy vending machines influenced purchasing behaviour towards healthier items highlights the importance of availability in a location such as a university campus when trying to encourage healthier eating behaviour. Without sufficient opportunity to choose healthy items, students may be choosing items that they do not necessarily want as a result of a lack of variety, which typically overrepresent those of poor nutritional value⁽⁵⁻⁸⁾. Moreover, previous research has reported that this style of intervention was the most favoured by students themselves^(21,22), with students requesting that more healthy options be provided in vending machines⁽⁴⁾.

Table 2. Summary of sales data for the existing and new vending machines across 3 years (2021–2023)

Vending machines	Green						Amber						Red						Total sales									
	Total			Beverage			Food			Total			Beverage			Food												
	n	%		n	%		n	%		n	%		n	%		n	%											
Existing 2021 (prior to any healthy machines)	1105	10.91 %		815	14.12 %		290	6.66 %		1071	10.58 %		966	16.73 %		105	2.41 %		7949	78.51 %		3992	69.15 %		3957	90.92 %		10 125
Existing 2022 (same year as healthy introduced)	543	6.26 %		422	9.05 %		121	3.02 %		928	10.7 %		801	17.19 %		127	3.17 %		7200	83.04 %		3438	73.76 %		3762	93.82 %		8671
Existing 2023 (same year as wrap and traffic light guide)	637	5.45 %		517	8.35 %		120	2.19 %		1640	14.04 %		1374	22.18 %		266	4.85 %		9408	80.51 %		4304	69.48 %		5104	92.97 %		11 685
New Healthy 2022 (healthier range and traffic light labels)	3133	41.7 %		2007	47.71 %		1126	34.05 %		2270	30.21 %		1659	39.43 %		611	18.48 %		2111	28.09 %		541	12.86 %		1570	47.48 %		7514
New Healthy 2023 (added wrap & traffic light text guide)	4302	40.79 %		2987	48.22 %		1315	30.22 %		3814	36.17 %		2676	43.2 %		1138	26.15 %		2430	23.04 %		531	8.57 %		1899	43.64 %		10 546

One year after the initial introduction of the healthy vending machines, a traffic light guide and a colourful wrap were added to the machines. This resulted in a slight decrease in red item (and to a smaller degree green) purchases and an increase in amber item purchases from these machines. The addition of the traffic light guide and wrap demonstrates an additional shift towards amber items, mainly shifting purchases away from red items. This is in line with previous research⁽²³⁾, which has suggested that consumers place greater emphasis on changes from 'amber' to 'red' compared with changes from 'green' to 'amber', which supports the idea that people pay more attention to avoiding less healthy (red) options than to choosing the most healthy (green) options. However, given that these changes were small and slightly unstable across machines and months sampled (especially for healthy items), this result should be interpreted with caution. Nevertheless, Stamos *et al.*⁽¹⁴⁾ who conducted a similar intervention to ours by increasing healthy options and introducing traffic lights also found that a decrease in the proportion of red beverage purchases was associated with a significant increase in purchases of amber beverages, indicating a shift towards healthier alternatives in response to their healthy vending machine intervention. The present results suggest that the addition of the traffic light guide and wrap influenced healthier item selections only slightly further.

In terms of the overall number of item sales, while there was a reduction in sales from the existing vending machines in the first year following the introduction of the healthy vending machines, the sales from the healthy machines more than made up for this slight reduction. Thus, the results suggest that introducing healthy vending machines alongside existing ones is a financially viable option for vending machine operators. It should be noted, however, that the addition of four new vending machines also increased overall exposure and access to products, contributing to the sales increase. The new machines appear to potentially shift original consumers' choices towards healthier options. In so doing, they provide further evidence that introducing healthy vending machines containing healthier options does not necessarily decrease revenue^(15–17). In addition, as this type of intervention has been shown to be supported by the general public⁽⁴⁾, vending machine operators could improve their public image by catering to these demands for healthier item options.

As a whole, the present results suggest that introducing healthy vending machines on university campuses can effectively steer individuals towards healthier food and beverage choices. This aligns with the principle of 'nudging', which seeks to subtly influence behaviour in a way that aligns with an individual's best interests, without removing their freedom of choice⁽²⁴⁾. The present findings add to the growing body of literature that has successfully used nudges to promote healthier food and beverage choices⁽²⁵⁾. Increasing the availability and visibility of healthier options can help shape dietary habits, particularly among young adults who are at a critical stage of life where lifelong dietary habits are often formed^(4,9). From a public health perspective, this approach could contribute to efforts aimed at combating the increasing prevalence of non-communicable diseases associated with poor dietary behaviours, such as diabetes, heart disease and obesity⁽²⁶⁾. Moreover, the present findings have important implications for policymakers in universities and similar settings. They suggest that offering healthier vending options in university settings can encourage consumers to make healthier choices with little impact on overall vending machine sales. This could encourage more institutions and organisations to adopt similar strategies, leading to widespread improvements in public health.

A notable strength of the present study is that it was conducted in the field and thus offers a high degree of ecological validity. However, this also introduced a number of challenges on account of practical requirements and restrictions imposed by the vending machine operator and the campus administration. Relatedly, one limitation of the present study was not being able to determine the individual effectiveness of the wider range of healthy items and the traffic light system implemented in the new healthy vending machines. However, previous research has found that the greatest shift toward healthier choices occurs when the two interventions are combined⁽²⁷⁾. Additionally, as an introductory programme, only a limited number of new healthy vending machines could be installed in selected high-traffic locations on campus. Thus, the sample of the existing vending machines for the data analysis was restricted to those in the immediate vicinity of the newly installed healthy vending machines. Furthermore, data were only obtained from 4 months across each of the 3 years, and thus greater changes might have been observed over a 12-month period for each of the years.

In conclusion, the introduction of healthy vending machines on a university campus demonstrated a significant shift in purchasing behaviour towards healthier food and beverage choices, without eliminating options for less healthy items. The addition of a traffic light guide and colourful wrap resulted in only a slight decrease in red item sales and an increase in amber item sales. Nonetheless, these additions likely enhanced the visibility and awareness of the healthier options. Importantly, the study suggests that integrating healthy vending machines alongside existing ones may not only cater to a new audience but also potentially encourage existing consumers to opt for healthier alternatives. Overall, this research underscores the importance of both providing healthy options and guiding consumer choices, highlighting the potential for such interventions to positively impact campus food environments and promote healthier eating behaviours among students.

Acknowledgements. We are grateful to Rachael Pollock and Jessica Hart for assistance with the field study and to Derek Haggart for providing the vending machine sales data.

Financial support. This research was supported under the Australian Research Council's Discovery Project funding scheme (project number DP180100545). The Australian Research Council had no role in the study design; the collection, analysis and interpretation of data; the writing of the manuscript; and the decision to submit the manuscript for publication.

Competing interests. There are no conflicts of interest.

Authorship. All authors contributed to the design of the study and writing of the manuscript. R.C. was responsible for obtaining sales data under the supervision of E.K. R.C. conducted the data analysis and wrote the first draft of the manuscript, with all other authors editing subsequent drafts of the manuscript. All authors have approved the final manuscript.

Ethics of human subject participation. The data used in this study were anonymised and aggregated, with no ability to identify individual purchasers or their specific purchases. As such, the study did not involve human subjects, and no personal or sensitive information was accessed or used. Therefore, the study did not require review or approval by an ethics committee.

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