Front-of-Pack Labeling and the Nutritional Quality of Students' Food Purchases: A 3-Arm Randomized Controlled Trial

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Objectives. To assess the effects of the Nutri-Score label (relative to the Reference Intakes label or no label) on the nutritional quality of students' food purchases.

Methods. A 3-arm randomized controlled trial was conducted in France in 2017; 2907 participants were randomized into 1 of the 3 study arms (Nutri-Score, Reference Intakes, no label) and invited to purchase groceries from an experimental Web-based supermarket. The main outcome was the overall nutritional quality of purchases, measured according to a modified version of the Food Standards Agency Nutrient Profiling System (FSAm-NPS/HCSP) score.

Results. The mean (±SD) FSAm-NPS/HCSP score was lower in the Nutri-Score group (2.02 ±3.56) than in the Reference Intakes group (2.69 ±3.44), reflecting higher nutritional quality; however, there was no significant difference between the Nutri-Score and no-label (2.45 ±3.28) groups or between the Reference Intakes and no-label groups. Shopping cart content was lower in calories and saturated fatty acids and higher in fruits and vegetables in the Nutri-Score arm than in the other arms.

Conclusions. The Nutri-Score label appeared to improve the nutritional composition of students' food purchases relative to the Reference Intakes label or no label. (*Am J Public Health.* 2019;109:1122–1129. doi:10.2105/AJPH.2019.305115)

See also Waterlander, p. 1067.

Front-of-pack nutrition labels, helping consumers identify the healthiness of foods, have been implemented in several countries.[1–5] In France, the Reference Intakes label, a nutrient-specific front-of-pack nutrition label, is used by some companies on prepackaged food products.[6] However, in October 2017, the Nutri-Score label was adopted by health authorities as the official French front-of-pack label[7] on a voluntary basis (because of European Union regulation[8]). The Nutri-Score is a graded and color-coded label that indicates whether a food product is relatively healthy in terms of nutritional quality (depicted as A and dark green) or less healthy (E and dark orange).

Although more than 110 food companies have pledged their support for the new measure, it remains voluntary and will coexist in French supermarkets with the Reference Intakes label and the absence of any label. Positive effects of front-of-pack labels have been shown in the general population, but evidence of their impact in vulnerable populations remains limited.

Among the various vulnerable populations, specific attention should be paid to students. During emerging adulthood, a transition period between the ages of 18 and 25 years, students are considered a vulnerable population with poor food choices at the point of purchase, an increased risk of weight gain, low levels of physical activity, and poor dietary habits.[9] These elements may be related to transitions toward increasing independence and autonomy in decision-making and financial responsibilities.[9]

The potential risk of carrying these poor dietary habits into adulthood[9] requires specific public health strategies. Evidence on the effectiveness of front-of-pack nutrition labels in younger populations is mixed,[10–15] with some studies showing that younger individuals are less likely to use these labels.[11–13] To our knowledge, however, very few studies have investigated the effects of front-of-pack nutrition labels among students.[16–19] The Nutri-Score label has been demonstrated to have a positive effect on the nutritional quality of food purchases of consumers[20,21] in the general population; again, however, no interventional study to date has been conducted to assess the impact of this label on purchasing intentions among students.

In this study, we sought to assess the effects of the Nutri-Score label on students' purchasing intentions through a comparison with current front-of-pack nutrition labeling

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practices in France (the Reference Intakes label and no label).

METHODS

A 3-arm randomized controlled trial was conducted between October 2016 and April 2017 to compare the effects of the different labeling practices (Nutri-Score, Reference Intakes, no label) on the overall nutritional quality of students' purchases. We used an experimental online supermarket with a large diversity of food products.

The randomization sequence was computer generated via a random block method with permuted blocks of size 3, 6, 9, and 12 (without stratification). Only the independent statistician and the computer programmer who developed the experimental online supermarket and the Web site had access to the randomization list.

Blinding of participants was not possible given the nature of the intervention. However, participants were unaware of the study hypotheses. Also, they were not informed of the study purpose or the labels being compared. They were informed only that the experimental online supermarket aimed to investigate the role of certain characteristics on purchasing behaviors or to test public health measures.

Participants

Eligible participants were students 18 to 25 years old who were studying in France and engaged in grocery shopping. Students were recruited through the National Conference of Presidents of University, which includes all French universities and higher education institutions. Deans who agreed to recruitment of students for this study sent a standardized e-mail inviting their students to participate and providing general information on the experimental supermarket platform and the task they would have to fulfill. Incentives were provided in the form of participation in a lottery. The e-mail contained a link to an information page detailing the study and its objectives (without mentioning the nature of the intervention), funding, procedures, legal rights of participants, and the fact that participants' personal data would be anonymized.

Participants provided electronic consent and were then redirected to an inclusion questionnaire in which eligibility criteria were verified. Students younger than 18 years or older than 25 years, students not currently studying, and students who never engaged in grocery shopping were excluded. Participants meeting the eligibility criteria were randomized into 1 of the 3 arms of the study.

Interventions

We created an experimental online supermarket that included 751 food items (each with details on name, price, and nutritional composition, along with a picture of the item) divided into 20 categories. Within a given food category, the food supply was a representative sample of the products commonly sold on French online supermarkets. For each food item, at least 2 different versions were proposed, including a national brand and a retailer's brand. Both prepackaged and raw products (e.g., fruit and vegetables, meat, poultry, and bread) were included.

Participants were asked to simulate their food purchases as if they were in their usual supermarket; no payment was required at the end. If participants could not find the product they were looking for, they were invited to select a similar product among the included items. According to trial arm, the items had a front-of-pack label (Nutri-Score or Reference Intakes label) or no label. However, labels were not present on raw products because these items are not subject to European mandatory nutrition labeling. Screenshots of the experimental supermarket are shown in Figure A (available as a supplement to the online version of this article at http://www.ajph.org).

The experimental arm of the trial focused on the Nutri-Score label affixed on food products. As noted, the Nutri-Score label is a summary graded label indicating the overall nutritional quality of a food product on a 5-color scale with a corresponding letter, from dark green (A) to dark orange (E).

The Nutri-Score label is based on the scoring of the Food Standards Agency Nutrient Profiling System, adapted to the French context by the High Council of Public Health (FSAm-NPS/HCSP).[22] The FSAm-NPS/HCSP score is calculated per 100 product grams and allocates positive points to unfavorable elements (energy [kJ], saturated fatty acids [g], sugars [g], and sodium [mg]; 0–10 points for each) and negative points to favorable elements (protein [g], fiber [g], and the content of fruits, vegetables, and nuts [%]; 0–5 points for each). Modifications of the underlying algorithm (described elsewhere[22]) were made for some of the food groups.

The study also included Reference Intakes and no-label arms. The Reference Intakes label shows the contribution of a portion of a product to a reference balanced diet of an average adult (2000 kcal) for the following nutrients: energy, lipids, saturated fatty acids, sugars, and sodium. In the control (no-label) arm, there was no nutrition label on the fronts of packages.

The experimental online supermarket included a central section with a rotating banner that displayed advertisements specifically developed for the study pertaining to health-related topics or—in the intervention arms—drawing awareness toward the label used. In each intervention arm, additional information on the computation and use of the label was available. In the control arm, the additional information Web page included guidelines on the proper conservation of fresh food products. An example of the 3 versions of a food product used in the different trial arms is shown in Figure 1.

Outcomes, Data, and Sample

The primary outcome was the overall nutritional quality of the shopping cart, assessed according to the cart's mean FSAm-NPS/HCSP score.[22] The shopping cart score was computed via the arithmetic mean of the FSAm-NPS/HCSP score (weighted on purchased quantity) for all foods and beverages in the cart; the score was calculated for 100 g of the overall shopping cart. The lower the score, the higher the nutritional quality. Secondary outcomes were, in order of importance, the content of the shopping cart (for 100 g) in terms of energy, saturated fatty acids, sugars, sodium, fiber, fruits and vegetables, and protein.

In the inclusion questionnaire, data were collected on various participant characteristics such as gender, age, educational level, housing, weekly food budget, nutrition knowledge (on a 4-item scale ranging from "I know a lot about nutrition" to "I don't know anything about nutrition"), grocery shopping

FIGURE 1—Example of a Product in the (a) Nutri-Score Arm, (b) Reference Intakes Arm, and (c) No-Label Arm: France, 2017

frequency (always, often, sometimes, or never), and frequency of online grocery shopping (always, often, sometimes, or never).

Sample size was calculated for the study to have a power of 90% to detect an effect size of 0.2 with a 0.02 type I error rate (to take into account the 3-arm design). We estimated a total sample size of 1956 participants, resulting in 652 participants per arm. To reach this final sample size while taking into account participants lost to follow-up, we randomized 2907 individuals and monitored the number of individuals validating their shopping cart.

Statistical Analyses

All of the participants who fulfilled the inclusion criteria and validated their shopping cart were included in our analyses. We used a one-way analysis of variance to compare the primary outcome between arms. We then computed post hoc pairwise comparisons using Tukey's test to account for multiple comparisons. A gatekeeping strategy was used to analyze secondary outcome variables compared in the following order:

1. Energy
2. Saturated fatty acids
3. Sugars
4. Sodium
5. Fiber
6. Fruits and vegetables
7. Protein

The gatekeeping strategy was elaborated taking into account the relative importance of the various nutrients to health (with unfavorable elements placed at the top of the list, particularly energy and saturated fatty acids) and the results of previous studies addressing the effects of front-of-pack labeling on the nutritional quality of food purchases.[23,24] When the comparison for a secondary outcome across the 3 arms was not statistically significant overall, no comparisons of subsequent secondary outcomes were conducted.

Our analyses took into account all food products in the experimental supermarket, including nonlabeled items. Our sensitivity analyses took into account only products labeled in the experimental supermarket and involved multiple imputations on missing outcomes (for all products and for labeled-only products). The balance of individual characteristics between arms was checked after randomization, and if an imbalance was observed, sensitivity analyses were performed with adjustment for the characteristic in question.

The composition of shopping carts across the different food categories was calculated as a percentage of the total number of products in the cart (mean ± standard error). All tests of significance were 2-sided, and a P value of .05 was considered significant. Analyses were carried out with SAS version 9.4 (SAS Institute, Cary, NC).

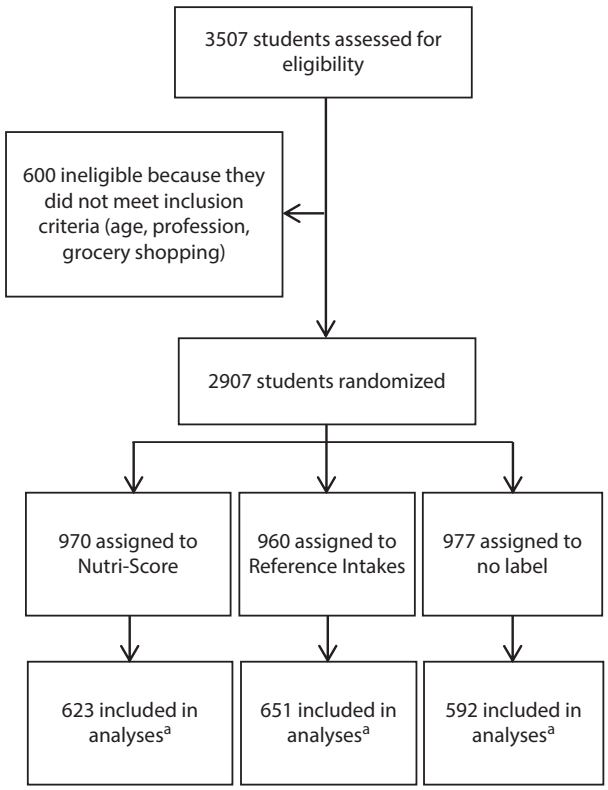
RESULTS

From October 2016 to April 2017, 3507 students from approximately 30 universities in France logged on to the system, 2907 were eligible and randomly allocated, and 1866 validated their shopping cart and were included in the analysis.

Characteristics of Participants

A total of 623 students were allocated to the Nutri-Score arm, 651 to the Reference Intakes arm, and 592 to the no-label arm. The study flow diagram is presented in Figure 2, and data on the individual characteristics of the participants are presented in Table 1. Seventy-three percent of the participants were women, and 60% had a university undergraduate degree; participants' average age was 20.4 ±1.9 years.

Regarding purchasing habits, 49% of participants responded that they always do their grocery shopping, 31% reported that they had shopped for groceries online, 39% reported that they spent less than 30€ per week on grocery shopping, and 58% usually received help from their family in the form of food supplies. Sociodemographic characteristics and purchasing habits were similar in the 3 trial arms with the exception of online grocery shopping frequency, which was lower in the no-label group. Overall, 35.8% of students were lost to follow-up; however, although the individual characteristics of



[a]Participants who validated their online shopping cart and did not encounter technical issues.

FIGURE 2—Flow Diagram of the Randomized Controlled Trial: France, 2017

nonrespondents may have been different than those of respondents, no significant differences between the 3 arms were found (Table A, available as a supplement to the online version of this article at http://www.ajph.org).

Outcomes

Results for the primary and secondary outcomes are reported in Table 2. Mean (±SD) FSAm-NPS/HCSP scores were 2.02 ±3.56 in the Nutri-Score group, 2.45 ±3.28 in the no-label group, and 2.69 ±3.44 in the Reference Intakes group ($P = .002$). The FSAm-NPS/HCSP score was lower in the Nutri-Score group (corresponding to higher nutritional quality) than in the Reference Intakes group (mean difference = –0.67; 95% confidence interval [CI] = –1.12, –0.21; $P = .002$), but there was no significant difference between the Nutri-Score and no-label groups (–0.43; 95% CI = –0.89, –0.03; $P = .07$) or between the Reference Intakes and no-label groups (0.23; 95% CI = –0.22, –0.69; $P = .5$).

All secondary outcomes differed significantly between groups. Pairwise comparisons revealed a lower shopping cart content of calories and saturated fatty acids and a higher content of fruits and vegetables in the Nutri-Score group than in the other 2 groups. In addition, the results showed a lower content of sodium and protein and a higher content of sugars in the Nutri-Score group than in the no-label group, as well as a lower content of fiber than in the Reference Intakes group. There were no significant differences between the Reference Intakes and no-label groups with respect to calories, saturated fatty acids, sodium, fiber, or fruits and vegetables; however, there were significantly higher levels of sugars and lower levels of protein in the Reference Intakes group than in the no-label group.

The results were similar in sensitivity analyses including only labeled products (Table B, available as a supplement to the online version of this article at http://www.ajph.org). Also, similar trends were observed with multiple imputations (Tables C and D, available as supplements to the online version of this article at http://www.ajph.org); however, differences were not significant between the 3 arms for sugars (or for sodium in sensitivity analyses including only labeled products), and no comparisons of subsequent secondary outcomes were conducted. The results were similar in sensitivity analyses adjusted according to online grocery shopping frequency (data not tabulated).

Table E (available as a supplement to the online version of this article at http://www.ajph.org) details the composition of shopping carts in terms of percentages among all food categories. Participants from the Nutri-Score group were more likely to purchase beverages, meat and poultry, canned fruit desserts, and especially fruits and less likely to purchase cream and eggs, cheese, dry goods, snacks, bread and pastries, and salty products. The mean percentages of non-labeled products purchased by participants were 24.5% ±16.5% in the no-label arm, 25.9% ±16.5% in the Reference Intakes arm, and 28.6% ±24.2% in the Nutri-Score arm. Thus, in the 2 arms in which labels appeared on prepackaged foods, and in particular in the Nutri-Score group, substitutions between food groups were observed, with more raw products (corresponding mainly to fruits and vegetables) purchased by the participants in both labeling arms.

DISCUSSION

This randomized controlled trial assessed the effects of the Nutri-Score label on the nutritional quality of food purchases among students. Our results suggest that the Nutri-Score label improves the overall nutritional quality of students' shopping cart, as reflected by a lower FSAm-NPS/HCSP score, relative to the Reference Intakes label. Also, the Nutri-Score label decreased shopping cart content in terms of calories, saturated fatty acids, sodium, fiber, and protein and increased fruit and vegetable content. By contrast, no overall differences between the Reference Intakes and no-label groups were observed, with the exception of sugars and protein.

Our study allowed the inclusion of a large sample of students, a population typically considered difficult to access in research investigations.[25] Our experimental supermarket seemed to be consistent with students'

TABLE 1—Characteristics of the Participants Included in the Randomized Controlled Trial, Overall and by Randomization Group: France, 2017

Characteristic	Nutri-Score	Reference Intakes	No Label	Total
Total, no.	623	651	592	1866
Gender, no. (%)				
Men	158 (25.4)	185 (28.4)	154 (26.0)	497 (26.6)
Women	465 (74.6)	466 (71.6)	438 (74.0)	1369 (73.4)
Age, y, mean ±SD	20.4 ±2.0	20.5 ±1.9	20.4 ±1.9	20.4 ±1.9
Educational level, no. (%)				
University undergraduate degree	382 (61.3)	384 (59.0)	361 (61.0)	1127 (60.4)
University postgraduate degree	241 (38.7)	267 (41.0)	231 (39.0)	739 (39.6)
Grocery shopping frequency, no. (%)				
Always	298 (47.8)	327 (50.2)	283 (47.8)	908 (48.7)
Often	187 (30.0)	173 (26.6)	171 (28.9)	531 (28.4)
Sometimes	138 (22.2)	151 (23.2)	138 (23.3)	427 (22.9)
Online grocery shopping, no. (%)	196 (31.5)	201 (30.9)	183 (30.9)	580 (31.1)
Online grocery shopping frequency, no. (%)				
≥1 time per wk	25 (12.8)	29 (14.4)	18 (9.8)	72 (12.4)
1 or 2 times per mo	48 (24.5)	41 (20.4)	31 (16.9)	120 (20.7)
1 time every 2 or 3 mo	45 (23.0)	53 (26.4)	31 (16.9)	129 (22.2)
1 or 2 times per y	43 (21.9)	49 (24.4)	66 (36.1)	158 (27.3)
<1 time per y	35 (17.9)	29 (14.4)	37 (20.2)	101 (17.4)
Weekly budget for grocery shopping, €, no. (%)				
<30	233 (37.4)	251 (38.6)	235 (39.7)	719 (38.5)
30–50	206 (33.1)	216 (33.2)	182 (30.7)	604 (32.4)
50–100	121 (19.4)	117 (18.0)	104 (17.6)	342 (18.3)
>100	63 (10.1)	67 (10.3)	71 (12.0)	201 (10.8)
Family assistance for food supplies, no. (%)	360 (57.8)	365 (56.1)	353 (59.6)	1078 (57.8)
Perceived nutritional knowledge level, no. (%)				
High	47 (7.5)	46 (7.1)	48 (8.1)	141 (7.6)
Intermediate	246 (39.5)	271 (41.6)	248 (41.9)	765 (41.0)
Low	297 (47.7)	302 (46.4)	264 (44.6)	863 (46.2)
No knowledge	33 (5.3)	32 (4.9)	32 (5.4)	97 (5.2)
Nutrition facts reading frequency, no. (%)				
Always	63 (10.1)	91 (14.0)	73 (12.3)	227 (12.2)
Often	218 (35.0)	236 (36.3)	208 (35.1)	662 (35.5)
Sometimes	270 (43.3)	247 (37.9)	234 (39.5)	751 (40.2)
Never	72 (11.6)	77 (11.8)	77 (13.0)	226 (12.1)
Virtual supermarket shopping cart, mean ±SD				
Total cost, €	47.6 ±31.4	49.6 ±39.2	46.7 ±30.1	48.0 ±34.0
No. of products	20.8 ±15.6	25.9 ±18.9	23.4 ±14.5	23.4 ±16.6
Overall nutritional quality (FSAm-NPS/HCSP) score (per 100 g)				
Median (minimum, maximum)	2.2 (–7.0, 23.0)	2.5 (–5.6, 22.0)	2.5 (–10.0, 15.0)	2.4 (–10.0, 23.0)
Range (interquartile range)	30.0 (4.5)	27.6 (4.3)	25.0 (4.1)	33.0 (4.3)

Note. FSAm-NPS/HCSP = Food Standards Agency Nutrient Profiling System/High Council of Public Health.

purchasing habits, and consequently it appears to be a relevant tool to investigate purchasing behavior in this population.[26] Moreover, the online aspect of the supermarket allowed multiple universities to be included and a randomized controlled trial to be conducted.

Reviews have suggested contrasting results regarding the effects of front-of-pack labels on food purchases and purchasing intentions.[4,27,28] Indeed, several studies have revealed an association between label use and improvements in the nutritional quality of

TABLE 2—Overall Shopping Cart Nutritional Quality, Energy, and Nutrient Content (per 100 g) per Trial Arm: France, 2017

	Study Arm, Mean ±SD				Nutri-Score vs No Label		Nutri-Score vs Reference Intakes		Reference Intakes vs No Label	
	Nutri-Score (n = 623)	Reference Intakes (n = 651)	No Label (n = 592)	P[a]	Mean Difference (95% CI)	P	Mean Difference (95% CI)	P	Mean Difference (95% CI)	P
Overall nutritional quality (FSAm-NPS/HCSP) score (per 100 g)[b]	2.02 ±3.56	2.69 ±3.44	2.45 ±3.28	.002	−0.43 (−0.89, 0.03)	.07	−0.67 (−1.12, −0.21)	.002	0.23 (−0.22, 0.69)	.5
Energy (kcal/100 g)	167.42 ±67.58	188.04 ±60.93	181.8 ±58.25	< .001	−14.38 (−22.79, −5.98)	< .001	−20.63 (−28.83, −12.42)	< .001	6.24 (−2.07, 14.56)	.2
Saturated fatty acids (g/100 g)	2.94 ±2.29	3.48 ±2.07	3.33 ±1.92	< .001	−0.39 (−0.68, −0.11)	.003	−0.54 (−0.82, −0.27)	< .001	0.15 (−0.13, 0.43)	.4
Sugars (g/100 g)	7.71 ±4.22	8.00 ±4.92	7.10 ±3.88	.001	0.61 (0.02, 1.20)	.04	−0.29 (−0.87, 0.28)	.5	0.90 (0.32, 1.48)	< .001
Sodium (mg/100 g)	192.08 ±121.36	204.41 ±105.23	210.15 ±105.50	.01	−18.07 (−33.01, −3.13)	.01	−12.33 (−26.92, 2.25)	.1	−5.74 (−20.52, 9.04)	.6
Fiber (g/100 g)	1.64 ±0.84	1.79 ±0.81	1.74 ±0.90	.005	−0.10 (−0.22, 0.01)	.09	−0.15 (−0.26, −0.04)	.004	0.05 (−0.06, 0.16)	.6
Fruits and vegetables (%)	33.70 ±22.21	28.99 ±16.08	28.72 ±16.71	< .001	4.98 (2.48, 7.47)	< .001	4.70 (2.26, 7.14)	< .001	0.27 (−2.19, 2.74)	> .99
Protein (g/100 g)	6.65 ±3.08	6.77 ±2.15	7.30 ±2.83	< .001	−0.65 (−1.01, −0.29)	< .001	−0.13 (−0.48, 0.23)	.7	−0.52 (−0.88, −0.16)	.002

Note. CI = confidence interval; FSAm-NPS/HCSP = Food Standards Agency Nutrient Profiling System/High Council of Public Health.
[a]From one-way analysis of variance; a *P* value of .05 was considered significant.
[b]A lower FSAm-NPS/HCSP score reflects higher nutritional quality.

purchases,[17,20,21,29,30] whereas others have not shown such an effect.[19,31,32] However, to our knowledge, very few studies have investigated the impact of front-of-pack labels on purchasing intentions among students specifically.[16–19] Although some investigations have shown that certain labels, including summary labels and nutrient-specific labels such as the Traffic Lights label, may help individuals identify healthier food products,[16–18] one study did not reveal an effect of the Traffic Lights label on food choices in college cafeterias.[19]

In our study, the different label formats had differing effects on the nutritional quality of food purchases. The Nutri-Score label had more of an effect on overall nutritional quality than did the Reference Intakes label. These findings can be explained by the format of the 2 labels tested. The Nutri-Score label uses colors to provide summarized information on the overall nutritional quality of foods. Such formats, which are less confusing and easier to read and understand, appear to be more efficient in influencing consumers' food choices. This is particularly important given that point-of-purchase decisions are made in a very short time period.[33] In particular, graded color-coded labels, and notably the Nutri-Score label, have been demonstrated to be more appropriate among individuals at low levels of education, nutrition knowledge, and income.[21] Thus, this type of format might be more appropriate and effective among students, who have lower levels of income but are increasing their level of education.

By contrast, the Reference Intakes format appeared to be less effective in encouraging healthier food choices, with no improvement of the nutritional quality of shopping carts in the Reference Intakes group relative to the no-label group. This finding might be explained by the label's nutrient-specific and monochrome format. Nutrient-specific labels may create decisional conflicts and entail prioritizing of nutrients.[34] Also, nutrient-specific labels that emphasize numeric information can be confusing to consumers, especially individuals with low educational levels and those of low socioeconomic status.[3,4,35]

Unlike the Reference Intakes label, the Nutri-Score label also led to lower cart content in terms of calories and saturated fatty acids. Thus, despite the fact that nutrient-specific formats provide more accurate information on food nutrient content, they do not encourage consumers to select products with lower caloric and saturated fatty acid content. The Nutri-Score effects we found are in line with studies showing that nutrition labels may encourage consumers to select foods with lower amounts of energy and fats.[17,20,21,23,29]

Relative to the other 2 formats, the Nutri-Score label was also associated with higher shopping cart content with respect to fruits, vegetables, and sugars and lower content with respect to sodium, protein, and fiber (these differences were not significant in analyses involving multiple imputations). Very few studies have examined associations between nutrition labels and the nutritional content of purchases, and these investigations have analyzed only a few nutrients. Our findings are in line with studies showing that front-of-pack labels, including notably the Traffic Lights label and the 5-Color Nutrition label (a previous graphical version of the Nutri-Score label), may encourage consumers to select products with less sodium.[21,29] However, our results are inconsistent with other studies indicating that front-of-pack labels may help individuals choose products with less sugar and more fiber.[5,23]

In our study, the lower protein content in the Nutri-Score group's shopping carts might be explained by the lower number of purchased cheese products, which are rich in protein, and the higher sugar content might be partly explained by the increased number of purchases in the canned fruit and

breakfast categories. Nevertheless, this effect on protein and sugars in the Nutri-Score group was also observed in the Reference Intakes group.

When analyses were restricted to labeled items, similar results were observed for FSAm-NPS/HCSP scores and for calories, saturated fatty acids, and sugars. However, given that the difference in sodium content was no longer significant, comparisons were discontinued. This reflects that the use of the Nutri-Score label probably entailed substitutions not only within food groups but also between food categories.

Limitations

Some limitations of our study should be acknowledged. First, the trial involved voluntary participants, and, given the sociodemographic characteristics of the participants, they may have greater interest in and knowledge regarding nutrition than do students overall. Moreover, our participants may use the Internet for grocery shopping more frequently than the French general student population. Thus, our control group participants may have made healthier food choices than the general population of students, and our label effects may have been underestimated. Second, despite the diversity of the food offered in the experimental supermarket, the number of products was limited, and some of the participants may not have found their usual product and selected foods they would not buy in a real shopping situation.

Third, the individual characteristics of nonrespondents may have been different than those of respondents; however, there were no significant differences between the 3 arms, resulting in nondifferential potential bias. Given the loss to follow-up rate, analyses were also performed with multiple imputations on missing outcomes; some differences in nutrient content between arms were no longer significant. Finally, because randomization took place at the participant level, potential bias caused by information sharing between students from different arms cannot be excluded. However, the trial involved multiple universities and small numbers of students from each, which may limit the magnitude of this bias. Moreover, such bias would have led to an underestimation of the differences between the 3 arms.

Conclusions

To our knowledge, our study is the first to assess the effects of the Nutri-Score label on the purchasing intentions of students, a population characterized by modification of dietary habits toward unhealthier food choices. This transition period represents a window of opportunity; assessing the impact of front-of-pack labels on the food purchasing habits of students is therefore essential. The Nutri-Score label, with its summarized and graded color-coded format, appears to be more effective than the Reference Intakes label in encouraging students to make food purchases of higher nutritional quality. AJPH

CONTRIBUTORS

M. Egnell, I. Boutron, and C. Julia originated the statistical analysis plan, analyzed the data, and drafted and revised the article. S. Péneau, P. Ducrot, M. Touvier, P. Galan, C. Buscail, R. Porcher, P. Ravaud, S. Hercberg, and E. Kesse-Guyot analyzed the data and critically revised the article for important intellectual content. S. Hercberg and C. Julia designed the data collection tools, implemented the study, monitored data collection, and critically revised the draft of the article for important intellectual content.

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CONFLICTS OF INTEREST

The authors declare no competing interests.

HUMAN PARTICIPANT PROTECTION

This study was approved by the institutional review boards of INSERM and the French National Commission for Data Protection. Electronic consent was obtained from each participant.

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