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BMJ Open

Randomised controlled trial in an experimental online supermarket testing the effects of front-of-pack nutrition labelling on food purchasing intentions in a low-income population

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ABSTRACT

Background The Nutri-Score, a front-of-pack nutrition label, has been adopted in 2017 in France but its impact on low-income populations is unknown, and they are more at risk of having unhealthy diets. The present study assessed the effects of the Nutri-Score on the nutritional quality of purchasing intentions among low-income individuals, compared with the current French labelling situation: references intakes (RIs) and no label, using a three-arm parallel-group randomised controlled trial.

Methods Low-income active adults from the NutriNet-Santé cohort (household income below €1200/month) were asked to perform a shopping task in an experimental online supermarket after being randomised in one of the three conditions (Nutri-Score, RIs or no labelling). The main outcome was the overall nutritional quality of the virtual shopping cart, assessed with the French-modified Food Standards Agency Nutrient Profiling System (FSAm-NPS), and secondary outcomes were the nutrient content of the shopping carts. 524 subjects were randomised, and 336 included in the analyses.

Results The Nutri-Score resulted in the highest overall nutritional quality of the shopping cart, as reflected by a FSAm-NPS score (1.86 (SD 3.59) points) significantly lower (reflecting higher nutritional quality) than the RIs (3.21 (SD 4.14) points, p≤0.05) but not significantly lower than no label (2.60 (SD 3.09) points, p=0.3). The Nutri-Score also resulted into significantly lower contents in calories and saturated fatty acids in the shopping cart, compared with the RIs only (p≤0.05).

Conclusion The implementation of the front of pack nutrition label Nutri-Score, adopted in France and in different European countries, appears to have the potential to encourage purchasing intentions of foods from higher nutritional quality among low-income individuals, compared with the RIs label promoted by food manufacturers.

Trial registration number: NCT02769455

Strengths and limitations of this study

- The present study is a three-arm randomised controlled trial investigating the effect of the Nutri-Score front-of-pack nutrition label compared with the reference intakes and no label.
- The trial recruited low-income individuals from the French NutriNet-Santé cohort study.
- Participants were invited to simulate grocery shopping on an experimental online supermarket as if they were in their usual supermarket.
- The overall nutritional quality and nutrient content of the shopping carts were then compared across the three arms to assess potential differences between the Nutri-Score and control groups.

INTRODUCTION

Low-income populations present higher risk to have less healthy diets,[1] and to be affected with chronic diseases.[2] As dietary energy density is inversely associated with products price, low-income families are more likely to consume cheaper product with higher energy-density and poor nutritional content.[3–6] Nutritional information displayed on food packages has been originally identified as a tool to help consumers make more informed food choices.[7 8] However, the nutrition facts panel in the back of packages has been shown to be difficult to read and understand by consumers, particularly in vulnerable populations.[7]

Front-of-pack nutrition labels (FoPLs) simplifying the nutritional information have been identified to promote healthier food choices at the point-of-purchase.[9–11] The various formats include purely informative labels displaying only numerical information, and interpretive schemes providing guidance to interpret the nutritional quality of foods using colours, texts or symbols. It has been shown that interpretive FoPLs were better understood by consumers than purely

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informative formats,[7] especially among vulnerable populations with a lower socioeconomic status.[12] Among the many factors involved in food choices at the point of purchase, price has been identified as one of the key drivers along with healthiness,[13] and even more so in disadvantaged groups.[14] In the absence of nutritional knowledge or information, purchasing healthier foods is therefore challenging in low-income groups,[13] and lower prices for energy-dense and nutritionally low foods may partially drive observed inequalities in nutrition between low and high socioeconomic groups.[15 16]

In France, the Nutri-Score, a summary, colour-coded and graded FoPL, has been adopted in October 2017 by the French government, considering specifically the needs of vulnerable populations regarding nutritional information, in order for the policy to have the potential to reduce social inequalities in health and nutrition.[17] Food manufacturers adopting the Nutri-Score are required to apply the system on all their prepacked food products. However, given the European Union regulation 1169/2011, the Nutri-Score remains a voluntary system, and manufacturers have the right to use other FoPLs that are in accordance with the regulation (eg, the nutrient-specific scheme reference intakes (RIs), disseminated on a voluntary basis by food manufacturers since 2005). Therefore, in the French market, consumers can find products with no FoPL, products labelled with the Nutri-Score or with the RIs. Although the Nutri-Score has demonstrated a positive effect on the nutritional quality of purchases in the general French population[12] and students,[18] no study has specifically assessed its effect on intentional or real purchasing behaviours among low-income populations for whom the use of FoPLs may be challenging. In this context, the present study aimed at investigating the impact of the Nutri-Score compared with the label already implemented by industrialists in France (namely, the RIs) and a no-labelling on consumer's purchasing intentions, among adults of working age (30–50 years of age except retired people and students) with low incomes.

MATERIALS AND METHODS

The methodology of the trial is described in details in the online supplementary file and is summarised below.

Study design and intervention

A three-arm randomised controlled trial embedded in the NutriNet-Santé cohort study was conducted using an experimental supermarket in 2016.

Experimental online supermarket

Purchasing intentions were measured on an experimental online supermarket, similar to supermarkets used in other trials,[12 18] with a food offer representative of products commonly sold in French grocery stores, including unpacked and prepacked foods. The experimental supermarket was developed in order to resemble real online supermarkets existing in France. Participants were asked to perform one grocery-shopping task as if they were in their usual supermarket. No specific instruction was provided to the participants regarding the duration of the shopping task, the amount to spend nor the number of persons or days for which they were invited to simulate purchases. No training or guidance was given to the participants. After completing the shopping task, participants were invited to validate their shopping cart, but no payment was involved. Participants were randomly allocated to one of the three following arms: (1) the Nutri-Score arm, where this summary and graded FoPL was affixed on the front of all prepacked foods and beverages, (2) the RIs arm, where this nutrient-specific FoPL was affixed on the front of all prepacked foods and beverages or (3) the no label arm, where no FoPL was affixed on front of food packages. Each arm therefore corresponded to a distinct supermarket environment, where the only difference resided in the presence of the FoPLs tested on the front of the package or no label.

Experimental arm

The experimental arm consisted in the Nutri-Score affixed on the front of all prepacked foods products. The Nutri-Score indicates the overall nutritional quality of foods and beverages, using a 5-colours scale associated with letters—from dark green (A) to dark orange (E) for products. The Nutri-Score providing an overall assessment of the nutritional quality of a food product is based on the Food Standards Agency nutrient profiling system, adapted by the French High Council of Public Health (FSAm-NPS).[19] The FSAm-NPS scores foods considering the food composition in unfavourable (energy, saturated fatty acids (SFA), sugars, sodium) to which up to +10 points are allocated each, and favourable elements (protein, fibre, fruits, vegetables, legumes and nuts) to which up to −5 points are allocated each. The overall FSAm-NPS score ranges between −15 (healthier) and +40 points (less healthy), and has no specific unit.

Control arms

The first control arm consisted in the RIs applied on prepacked foods, a nutrient-specific format displaying numerical information on the amount of energy, fats, SFA, sugars and sodium in gram per portion, and their contribution to the reference intakes.[20] The second control arm of the trial did not include any label on front-of-package.

An example of a food included on the experimental supermarket, with the different front-of-package labelling situations depending on the arm, is displayed in figure 1.

Participants and public involvement

Individuals were recruited among the NutriNet-Santé cohort, an ongoing web-based observational cohort study launched in France in 2009, and composed of adult volunteers.[21] The NutriNet-Santé cohort includes participants aged 18+ years (range 18–85 years). Participants

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Figure 1 Example of a product in the no label arm (A), Nutri-Score arm (B) and references intakes arm (C).

in the NutriNet-Santé study are requested to complete at baseline and yearly during the follow-up a set of questionnaires including sociodemographic, anthropometrics, lifestyle, diet, physical activity and health data. They may be contacted at any point in time to participate in additional questionnaires or ancillary protocols.

An email was sent to volunteers from the NutriNet-Santé cohort, who potentially met the eligibility criteria of this specific trial, based on sociodemographic data (ie, aged 30–50 years, employment status—excluding students and retired participants—household income and composition) collected from their last questionnaire in the NutriNet-Santé study. The email indicated the objectives and the funding of the trial, its procedure and the legal rights of participants. Participants were invited to give their electronic consent and were complete an inclusion questionnaire to verify eligibility criteria. Data were therefore collected on sex, age, occupational activity and monthly income. Participants were also invited to provide information on grocery shopping frequency, including online grocery shopping frequency, back-of-pack nutritional information reading frequency and to self-estimate their nutritional knowledge. No incentive was provided to the participants. The monthly income was calculated per household unit, and participants with an income above €1200/month were excluded—corresponding approximately to individuals from the first two deciles of the income distribution in France.[22] Eligible participants were thus active adults, aged between 30 and 50 years, with an income per household unit below €1200/month and engaged in grocery shopping. Individuals answering that they were never responsible of grocery shopping for their households were considered ineligible, given that their purchasing intentions on the experimental online supermarket would not reflect potential real purchasing behaviours. To be included, participants had to have completed and validated their shopping cart and exited the online supermarket. Potential exclusions from the analytical study sample after randomisation involve technical issues (eg, software or hardware incompatibility) or loss to follow-up.

A priori calculations for sample size were made based on existing evidence on the effects of front-of-pack labels on purchases with the following hypotheses: an effect size of 0.2 with power 90%, considering a two-sided 0.02 nominal type I error rate to account for the three-arm design. To allow detecting the hypothesised effect, a sample size of 652 participants per arm (1956 in total) was projected. Given the non-respondent rate, 524 individuals were randomised and 336 participants were included in the analyses.

Randomisation and blinding

Computerised randomisation was performed using random block method with permuted blocks of 3, 6, 9 and 12. The randomisation list was accessible only to the independent statistician and the computer programmer who developed the online supermarket. The nature of the intervention did not allow for blinding; however, participants were blinded of the hypotheses. Participants were just informed that the experimental online supermarket aimed to investigate the role of determinants of purchasing behaviours or to test some public health measures.

Outcomes

The primary outcome was the overall nutritional quality of the foods within the shopping cart, using the mean of the FSAm-NPS score across all foods and beverages in the cart, computed for 100 g, and ranging between −15 and +40 points (no unit) for each food in the shopping cart. Lower FSAm-NPS scores are reflecting higher nutritional quality of the food purchases. Secondary outcomes were the content of the shopping cart in energy (kcal), SFA (g), sugars (g), sodium (mg), fibres (g), fruits and vegetables (percentage, %) and proteins (g), for 100 g of the cart.

Statistical analyses

The primary outcome was compared between the three arms using one-way analysis of variance, and pairwise comparisons were then carried out using Tukey's method to account for multiple testing. In order to avoid multiple testing of secondary outcomes, variables were compared using a serial gatekeeping strategy, in which outcomes were prioritised.[23] The gatekeeping strategy order was elaborated considering the relative importance of the various nutrients to health (unfavourable elements first, in particular energy and SFA) and the results of previous studies assessing FoPL effects on the nutritional quality of food purchases.[12 24] To limit the number of tests, the gatekeeping procedure specifies that when the comparison across the three arms for a component is not considered statistically significant (ie, $p \leq 0.05$), the comparison of secondary outcomes is stopped.[23] Secondary outcome variables were therefore prioritised in the following order[18]: (1) energy, (2) SFA, (3) sugars, (4) sodium, (5) fibres, (6) fruits and vegetables, (7) proteins. Analyses were performed considering all foods on the experimental supermarket, including also non-labelled items (ie, raw products such as fruits, vegetables, meat and poultry). Then, sensitivity analyses were computed (i) considering labelled products only and (ii) using multiple

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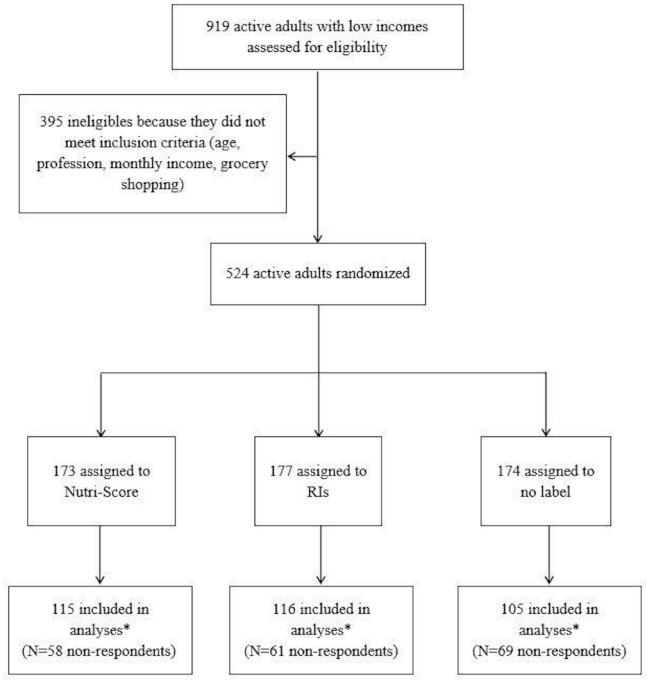


Figure 2 Flow diagram of the randomised controlled trial. *Subjects who validated their online shopping cart and did not encounter technical issues.

imputations on outcomes to take into account the non-respondent rate.

Descriptive analyses of the composition of the shopping cart in the different food categories were performed in order to investigate the differences in the distribution of food groups choices across the three randomisation arms. The number of products selected (mean percentage and SE) were examined across arms (no testing) to assess whether modifications in terms of food categories purchases occurred. Then, the contributions of the different food groups to the nutrient amounts in the shopping carts were calculated and expressed a mean percentage and SE.

All tests were two-sided, and a p value ≤0.05 was considered significant. Analyses were carried out with SAS software (V.9.4; SAS Institute).

RESULTS

Characteristics of participants

From July 2016 to May 2017, 919 subjects were recruited, 524 were eligible and randomly assigned to one of the three arms, and finally 336 participants validated a shopping cart and were included in the analyses (115 in the Nutri-Score arm, 116 in the RIs arm and 106 in the no label arm). The flow diagram of the study is presented in figure 2.

The trial included 87% of women, 19% with a university postgraduate degree, 65% with an income per household unit between €800/month and €1200/month and had a mean age of 41.3 (SD 5.9) years (table 1). Regarding purchasing habits, 66% declared always doing their grocery shopping and 60% reported having already purchased online once. Fifteen per cent declared always read the nutrition facts panel and 5% had a high self-estimated nutrition knowledge level. Sociodemographic, lifestyle characteristics and purchasing habits were globally similar between the three arms. According to the flow diagram, 35.9% of low-income adults were randomised but did not complete the study; however, while non-respondents might have some small differences on some sociodemographic characteristics compared with respondents, this was not significantly different between the three arms (interaction term between the arm and the sociodemographic characteristics not statistically significant to model the probability of not responding (online supplemental table 1).

Outcomes

Results for primary and secondary outcomes are shown in table 2. The mean (SD) FSAm-NPS score of the shopping cart was 1.86 (3.59) points in the Nutri-Score arm, 2.60 (3.09) points with no label and 3.21 (4.14) points with the RIs. The FSAm-NPS score was significantly lower for the Nutri-Score compared with RIs with a mean difference of −1.35 (95% CI −2.48 to −0.22) (relative difference of −42.0%, p=0.01), reflecting a higher overall nutritional quality of the shopping carts in the Nutri-Score group. However, no statistically significant difference was observed between the Nutri-Score and no label (−0.73 (95% CI −1.89 to 0.42), relative difference of −28.4%, p=0.3), nor between the RIs and no label (0.61 (95% CI −0.54 to 1.77), relative difference of+23.5%, p=0.4).

The Nutri-Score resulted in statistically significant lower contents in calories and SFA, compared with the RIs only. Similar trends were observed compared with no label, but differences were not statistically different. No significant difference between the RIs and no label was observed. Differences in sugars contents of shopping carts were not significant overall and comparisons of following secondary outcomes were stopped.

When analyses considered the FSAm-NPS score of labelled products only, no significant difference of shopping carts' FSAm-NPS scores between the three arms was observed (online supplemental table 2). Nevertheless, similar results for secondary outcomes were found. Consistent results were observed in analyses using multiple imputations (online supplemental tables 3 and 4); however, differences between arms were lower and comparisons were no longer statistically significant, except the lower score in the Nutri-Score arm compared with the RIs in the main analyses considering all products (online supplemental table 3).

In the Nutri-Score arm, participants tended to buy more products from the fruits and meat categories and less cheeses, sweet biscuits and sweetened beverages (online supplemental table 5). The average percentages of unpacked products purchased by participants were 25.8%±17.5% in the no label arm, 25.6%±17.5% in the RIs arm and 32.1%±27.6% in the Nutri-Score arm. The

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Table 1 Individual characteristics of included people in the randomised trials, France, 2017 (n=336)

	Nutri-Score	Reference intakes	No label	Total
Total, N	115	116	105	336
Sex, n (%)				
Men	12 (10.4)	15 (12.9)	18 (17.1)	45 (13.4)
Women	103 (89.6)	101 (87.1)	87 (82.9)	291 (86.6)
Age, years, mean (SD)	41.0 (5.9)	41.6 (6.0)	41.2 (5.9)	41.3 (5.9)
Occupational activity				
Primary	13 (11.3)	24 (20.7)	19 (18.1)	56 (16.7)
Secondary	26 (22.6)	23 (19.8)	25 (23.8)	74 (22.0)
University, undergraduate degree	43 (37.4)	55 (47.4)	39 (37.1)	137 (40.8)
University, postgraduate degree	31 (27.0)	13 (11.2)	22 (21.0)	66 (19.6)
Missing data	2 (1.7)	1 (0.9)	0	3 (0.9)
Monthly income per household unit* (€), n (%)				
<400	5 (4.3)	7 (6.0)	2 (1.9)	14 (4.2)
400–800	33 (28.7)	37 (31.9)	33 (31.4)	103 (30.6)
800–1200	77 (67.0)	72 (62.1)	70 (66.7)	219 (65.2)
Grocery shopping frequency, n (%)				
Always	83 (72.2)	78 (67.2)	62 (59.0)	223 (66.4)
Often	28 (24.3)	30 (25.9)	32 (30.5)	90 (26.8)
Sometimes	4 (3.5)	8 (6.9)	11 (10.5)	23 (6.8)
Online grocery shopping, yes n (%)	66 (57.4)	74 (63.8)	61 (58.1)	201 (59.8)
Online grocery shopping frequency, n (%)				
At least one time per week	12 (18.2)	12 (16.2)	7 (11.4)	31 (15.4)
One or two times per month	14 (21.2)	19 (25.7)	22 (36.1)	55 (27.4)
One time every 2 or 3 months	16 (24.2)	16 (21.6)	7 (11.5)	39 (19.4)
One or two times per year	11 (16.7)	18 (24.3)	19 (31.2)	48 (23.9)
Less than one time per year	13 (19.7)	9 (12.2)	6 (9.8)	28 (13.9)
Perceived nutritional knowledge, n (%)				
High	8 (7.0)	7 (6.0)	10 (9.5)	25 (7.4)
Intermediate	63 (54.8)	63 (54.3)	64 (61.0)	190 (56.6)
Low	41 (35.6)	40 (34.5)	29 (27.6)	110 (32.7)
No	3 (2.6)	6 (5.2)	2 (1.9)	11 (3.3)
Nutrition facts reading frequency, n (%)				
Always	18 (15.7)	13 (11.2)	20 (19.0)	51 (15.2)
Often	56 (48.7)	50 (43.1)	51 (48.6)	157 (46.7)
Sometimes	38 (33.0)	45 (38.8)	29 (27.6)	112 (33.3)
Never	3 (2.6)	8 (6.9)	5 (4.8)	16 (4.8)

*One household unit is attributed for the first adult of the household, 0.5 unit for other persons aged 14 years or older and 0.3 unit for children under 14 years of age.

percentage contributions of food groups to nutrient intakes in the overall shopping carts are presented in online supplemental table S6 (only for nutrients where a difference between arms was observed in the main analyses). Therefore, the lower calorie and SFA contents of the shopping carts in the Nutri-Score arm compared with the RIs would be related to lower purchases of dairy products, cheeses and sweetened biscuits.

DISCUSSION

The results suggested that the Nutri-Score significantly resulted in a higher overall nutritional quality of purchasing intentions, and lower contents in energy and SFA, compared with the RIs (with a reduction of 42.0% in FSAm-NPS, of 11.5% in energy and 27.8% in SFA contents for 100 g of the shopping cart). Similar trends were observed compared with no label but differences

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Table 2 Overall nutritional quality, energy and nutrient content for 100 g of the shopping cart, France, 2017 (n=336)

	Nutri-Score	Reference intakes	No label		Nutri-Score versus no label		Nutri-Score versus reference intakes		Reference intakes versus no label	
	N=115	N=116	N=105	P value**	Mean difference††	P value‡‡	Mean difference††	P value‡‡	Mean difference††	P value‡‡
Overall nutritional quality (FSAm-NPS score/100 g)	1.86 (3.59)	3.21 (4.14)	2.60 (3.09)	**0.02**	−0.73 (−1.89 to 0.42)	0.3	−1.35 (−2.48 to −0.22)	**0.01**	0.61 (−0.54 to 1.77)	0.4
Calories (kcal/100 g)	172.49 (71.41)	194.73 (80.64)	194.08 (56.36)	**0.03**	−21.59 (−44.02 to 0.84)	0.06	−22.25 (−44.12 to −0.38)	**0.05**	0.66 (−21.73 to 23.04)	1.0
Saturated fatty acids (g/100 g)	2.93 (2.12)	4.06 (5.16)	3.84 (2.1)	**0.04**	−0.91 (−2.02 to 0.19)	0.1	−1.13 (−2.21 to −0.05)	**0.04**	0.21 (−0.89 to 1.32)	0.9
Sugars (g/100)	7.83 (3.68)	7.81 (6.09)	6.98 (3.53)	0.3	0.85 (−0.62 to 2.32)	0.4	0.02 (−1.41 to 1.46)	1.0	0.83 (−0.64 to 2.29)	0.4
Sodium (mg/100 g)	191.09 (136.72)	219.56 (130.04)	239.27 (223.53)							
Fibre (g/100 g)	1.74 (1.25)	1.73 (1.01)	1.82 (0.95)							
Fruits and vegetables (%)	33.95 (23.68)	25.09 (15.68)	28.15 (16.08)							
Proteins (g/100 g)	6.79 (3.07)	6.82 (2.39)	7.82 (3.19)							

*P-value from one-way ANOVA; p-value≤0.05 wasconsidered significant (bold values in the table).
†Mean difference (95% Confidence Interval)
‡P-value using Tukey's test to correct for multiple comparisons.
FSAm-NPS, Food Standards Agency Nutrient Profiling System modified by the High Council for Public Health.

were not statistically significant. No significant difference was observed between no label and the RIs. Moreover, in the two arms with a FoPL, and particularly in the Nutri-Score group, modification in food categories choices were observed, with more raw unpacked products purchased (corresponding mainly to fruits and meat).

Several studies investigated the effect of FoPLs on the nutritional quality of real or virtual purchases, but results varied according to the labels. While interpretive FoPLs have been shown to a have a potential positive effect on the nutritional quality of consumers' choices,[12 24–31] purely informative labels such as the RIs did not demonstrate such effect.[12 24 28 30] However, to our knowledge, no study investigated the impact of FoPLs on purchases among underprivileged populations specifically. A few randomised trials in the general population performed stratified analyses according to socioeconomic status showing that the positive effects of some labels on purchases were not equitably distributed in the trial population.[28 30] In the experimental economy trial by Crosetto *et al*, investigating the effects on nutritional quality of purchases using the FSAm-NPS score as an outcome measure, the Nutri-Score was associated with a reduction in FSAm-NPS score of −2.766 (0.619, p<0.001) points compared with a situation with no labelling in the overall trial sample, and −2.584 (1.064, p<0.05) in the low-income group. For other labels, however, the effects were no longer significant in low-income groups (eg, −1.513 (0.619) points, p<0.05 in FSAm-NPS score in the overall trial sample vs −1.104 (1.046) points, not significant in the low-income group for the British traffic lights label).

In our trial, the Nutri-Score demonstrated a greater effect compared with the RIs only. These findings are consistent with studies which observed higher performance of summary labels to improve food choices.[10 12 28 32–36] It has been demonstrated that the summarised and graded format of Nutri-Score was favourably perceived and understood, including among low-income consumers.[12 37] In contrast, the RIs would require a higher cognitive workload, and could lead to confusion on nutritional terms, especially since lower-income individuals are more likely to have lower nutrition knowledge.[7 9 10 12 38 39] Moreover, the use of intuitive colours such in the Nutri-Score has been demonstrated to be well recognised and understood, with the green associated with a 'go' signal and red with 'stop',[40] while monochrome formats such as the RIs do not capture attention of consumers[41] and are more difficult to process.[10 12 33 42] In addition, the Nutri-Score resulted in lower contents in calories and SFA in the composition of items in the sopping cart compared with the RIs. Hence, this would suggest that even if the RIs provide more detailed information on the nutritional content of the food product, it may not translate into less calories and SFA purchases. Our findings are consistent with other studies which observed a positive impact of interpretive labels such as the warning symbol, the Nutri-Score or its previous format, on energy and fats intakes of purchases.[12 18 25] When analyses were restricted to labelled

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items only, the differences between the Nutri-Score and the RIs regarding the overall nutritional quality of the shopping carts were no longer significant. However, the content in energy and SFAs of the items in the shopping cart were still significantly lower. This finding would suggest that the effects observed in the Nutri-Score arm are associated with both changes in choices of labelled products, but more importantly to modifications in food groups choices towards non-labelled raw products, such as fruits and meat.

Nevertheless, it is important to notice that the improvement nutritional quality of purchasing intentions observed in the Nutri-Score arm was statistically significant compared with the RIs only, but only trends were observed compared with no label. The positive effect of the Nutri-Score compared with no label on food purchases has been demonstrated in previous studies.[12] Our non-significant results might be related to a lack of statistical power which prevented us from detecting small differences. Indeed, in the present trial, the number of recruited participants was far lower than the target number. Also, the high number of non-respondents may have led to participation bias. Indeed, the literature has suggested that protocols often do not achieve their objective regarding the recruitment of some specific populations, such as low-income individuals, considered as hard-to-reach populations. In our case, some constraints regarding time commitment and the duration of the shopping task might partly explain the non-respondents rate.[43] Moreover, the trial involved voluntary participants, and given the sociodemographic characteristics of participants, they may have greater interest and knowledge in nutrition than general low-income population. Thus, participants in no label arm might have made healthier choices than the overall population and the effects of FoPLs in comparison could have been underestimated. However, the positive effect of the Nutri-Score compared with the RIs among low-income population remains an important insight given that the RIs are still applied on many foods on the French and on the European market, and is part of the current debates of FoPL harmonisation in Europe.

Strengths of the study pertained in the inclusion of a specific subpopulation, difficult to access to conduct research and for which additional evidence is still required. Moreover, the randomised controlled design at the individual level resulted in comparable groups allowing accurate estimations of the labels' impact. Finally, the experiment was conducted on an experimental online supermarket, similar to actual online grocery shopping conditions, with a range of different products, brands and the use of real packaging. However, limitations should be acknowledged. First, as it has been discussed above, the high non-respondents rate may have prevented us from highlighting some potential small differences. Second, participants were volunteers recruited from an online cohort study, and therefore most probably had a higher level of digital literacy compared with the overall low-income population. The higher proportion of subjects who declared doing often their grocery shopping online than the French average may be an indicator of this specific issue. Generalisation of our results to more vulnerable populations, with lower levels of digital and health literacy should be performed with caution. Third, despite the diversity of the food offer proposed on the supermarket, the number of products was somewhat limited, and some participants may not have found their usual product and chose foods they would not buy in real shopping situation. In addition, the trial investigated purchasing intentions rather than actual purchases. Nevertheless, it has been suggested that virtual purchasing behaviours of individuals could be good predictors of real behaviours.[44] Complementary studies could be conducted in real-life settings and include a larger sample of low-income individuals.

To conclude, the present study is the first providing data on the effect of the Nutri-Score on low-income adults purchasing intentions. The Nutri-Score, with its colour-coded and graded summary format, would have a beneficial effect on the global nutritional quality of food purchases among low-income consumers, compared with the RIs already implemented and supported worldwide by many food manufacturers. Moreover, it has been shown that the nutrient profiling system underlying the Nutri-Score was associated with decreased risks of chronic diseases[12] and that the Nutri-Score, through a simulation study, could decrease the mortality by nutrition-related chronic diseases by improving the healthiness of food choices and consumptions.[45] These elements are particularly important given that low-income groups are more at risk to have unhealthy diets and a higher burden of chronic diseases, but less likely to understand and use nutritional information on food packages.

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Contributors ME, CJ and IB wrote the statistical analysis plan, analysed the data and drafted and revised the paper. SP, PD, MT, PG, CB, RP, PR, SH and EK-G analysed the data and critically revised the paper for important intellectual content. SH and CJ designed data collection tools, implemented the study, monitored data collection for the whole study and critically revised the draft paper for important intellectual content. All authors, external and internal, had full access to all of the data (including statistical reports and tables) in the study and can take responsibility for the integrity of the data and the accuracy of the data analysis. All authors have read and approved the final manuscript.

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Ethics approval The study was approved by the Institutional Review Board of Inserm (IRB Inserm n°IRB0000388 FWA00005831) and the National Commission for Data Protection and Liberties (CNIL n°909216), and registered at: https://clinicaltrials.gov/ct2/show/NCT02769455. Electronic consent was obtained from all participants. The NutriNet-Santé study is conducted according to the Declaration of Helsinki guidelines, approved by the IRB of Inserm (n°0000388FWA00005831) and the National Commission for Data Protection and Liberties (n°908450/n°909216), and registered at: https://clinicaltrials.gov/ct2/show/NCT03335644.

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