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Unpacking the Impact of Nutri-Score on Consumer Choices in Italy: Evidence From a Menu Planning Experiment

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ABSTRACT

Overnutrition is a major public health concern, and front-of-pack labels (FOPLs) have been introduced to support healthier food choices. Within the European Union, the coexistence of multiple voluntary schemes across Member States has fuelled the policy debate on a harmonized mandatory FOPL. In this context, Nutri-Score (NS) is among the most extensively studied interpretive labels, yet evidence remains limited on how it affects meal composition and cross-category substitution. We investigate these issues through an online within-subject experiment with 202 Italian consumers, who completed a menu-planning task first without (R1) and then with NS information (R2). The display of NS shifted choices toward healthier options, with the strongest effects at the extremes of the scale: selections of NS D products decreased substantially in the Proteins and Fats macro-category (−20.8%), whereas NS A choices increased (+17.3%). Beyond product-level shifts, NS altered meal composition strategies, increasing the frequency of "healthy–healthy" combinations and reducing "healthy–unhealthy" pairings. Improvements were often achieved through category switching rather than within-category substitutions, particularly in Proteins and Fats, where consumers reduced cheese choices (−9.0%) and increased plant-based alternatives (+10.4%). These findings confirm NS effectiveness in guiding healthier choices in a meal-planning context, while highlighting potential side effects of simplified ratings and limited within-category variability, including category avoidance with implications for dietary diversity and affected sectors.

1 | Introduction

Overnutrition affects 24.1% of adults worldwide, making the promotion of healthier diets a key public health priority (World Health Organization 2020). As detailed nutritional information can be difficult to interpret (Miller and Cassady 2015), front-of-pack labels (FOPLs) have been developed to encourage healthier and more informed choices. Currently, several types of FOPLs coexist within the European Union (EU) (Storcksdieck Gennat Bonsmann et al. 2020) differing in the way nutritional information is communicated to consumers. On the one hand, the nutrient-specific labels report detailed information on selected nutrients and include numerical schemes. Examples include the NutrInform Battery, adopted in Italy, and the Multiple Traffic Light system, a color-coded scheme used in countries such as Spain and Portugal. On the other hand, summary labels provide an overall nutritional assessment through simplified visual cues, either in the form of endorsement logos, such as the Keyhole symbol used in Scandinavian countries, or graded indicators, such as the Nutri-Score (NS), first introduced in France in 2017 and now widely adopted across several EU countries (Hercberg et al. 2021).

Given the coexistence of multiple nationally adopted schemes, the European Commission's harmonization effort involves selecting a single FOPL among those already implemented across

Member States to be applied uniformly throughout the EU. Among the existing schemes adopted, NS is one of the most extensively studied systems and has been shown to be effective in improving consumers' ability to identify healthier products and promoting healthier food choices (Drewnowski 2022; Pettigrew et al. 2023; Schlarbaum et al. 2022). It applies a five-tier, color-coded scale (from A, dark green, to E, red) that aggregates favorable (e.g., fruits and vegetables, fibers, protein, nuts, rapeseed, and olive oil) and unfavorable (e.g., calories, fat, sugars, and salt) nutrient components, for 100 g product, to derive an overall nutritional score for each product (Hercberg et al. 2021). However, its simplicity presents both advantages and limitations: Although it enhances usability and facilitates consumer understanding, it has also been criticized for oversimplifying complex nutritional information (Delhomme 2021; Fialon et al. 2022).

Key concerns regarding the label include (i) its initial unfavorable evaluation of certain fat sources, such as olive oil; (ii) the calculation of the score according to population-level nutritional priorities, which may not adequately reflect the relative importance of specific nutrients for individuals with noncommunicable diseases or other condition-specific dietary needs (Mazzù et al. 2023; Teng et al. 2021); (iii) its reliance on a standardized 100 g reference quantity rather than realistic serving sizes; (iv) and its potential to influence consumer choices across product categories (Stiletto et al. 2023).

Although the first issue has been partially addressed through revisions to the algorithm, the second reflects an intrinsic characteristic of the scheme, as a single FOPL cannot be tailored to the specific nutritional needs of different individuals or population subgroups. With regard to the remaining limitations, NS evaluates foods on the basis of their nutritional composition per 100 g and in isolation, without accounting for the frequency of consumption or the broader dietary context in which foods are consumed. As a result, the label provides information at the product level but does not capture how foods are combined, substituted, or integrated within real dietary pattern (Graham et al. 2023). This product-based approach may therefore influence consumer choices not only within product categories but also across categories, particularly when consumers seek to replace lower rated products with alternatives perceived as nutritionally superior. The use of a standardized 100 g reference quantity may indeed fail to reflect realistic consumption patterns of some products or product categories, potentially discouraging the selection of nutrient-dense foods that receive unfavorable scores despite typically being consumed in smaller amounts (Van Der Bend et al. 2022). For example, under the 2021 algorithm, 95.3% of cheeses were rated D or E, despite recommended serving sizes of 20–50 g (European Commission 2025), suggesting a more limited nutritional impact in real consumption contexts. Although recent revisions have partially mitigated this issue, no cheeses have yet been assigned a positive NS grade (A or B) (Hafner and Pravst 2024).

In this context, although the effects of NS on within-category product comparisons have been extensively studied, its influence on cross-category decision-making remains underexplored, particularly in contexts where consumers combine multiple products, such as meal planning (Cerf et al. 2024). When an entire category is rated poorly, consumers may struggle to identify healthier options within it, potentially shifting toward other product categories (Stiletto and Trestini 2022). Although NS guidelines specify that comparisons should be made within categories, they also allow cross-category comparisons when products are "comparable" in use or purchase conditions (Hercberg et al. 2021). In practical terms, from the NS guidelines perspective, this implies that cheeses might be replaced with other protein sources, thereby enabling the selection of nutritionally more favorable products.

This definition of "comparability" is generic enough to accommodate a wide array of consumer behaviors. Given the heterogeneity in consumer preferences, what is considered "comparable" may therefore vary across individuals. As a result, this behavior-based approach produces categories that are neither clearly defined nor mutually exclusive and, therefore, do not necessarily align with traditional food classification systems based on intrinsic product characteristics, which rely on clearly bounded and non-overlapping categories to ensure coherent and meaningful categorization (European Food Safety Authority (EFSA) 2015). Thus, the NS definition of "comparability" allows the substitution or exclusion of entire food categories as defined in traditional classifications. Such shifts may have unintended consequences, including nutritional imbalances due to the loss of category-specific nutrients and a reduction in dietary diversity (European Dairy Association 2023). In addition, such exclusion could generate significant economic repercussions for specific product sectors.

Despite these concerns, as anticipated, limited attention has been given to how NS influences switching across product categories. Existing research has primarily examined within-category choices (e.g., Ducrot et al. 2015; Julia et al. 2016), whereas real-world decisions involve simultaneous choices across multiple products and categories, such as in shopping basket composition (Caputo and Lusk 2022; Neill and Lahne 2022) or meal planning (Rahamat et al. 2022; Chandon and Cadario 2023). The present study aims to address this gap by examining how NS influence consumers' preferences in meal composition. This aligns with the recent study by Abou Jaoudé et al. (2022), which examined the meal preferences of French students in a canteen setting. The research explores whether NS stimulates consistency strategies (e.g., selecting a combination of healthy dishes) or compensation strategies (e.g., balancing healthy and unhealthy dishes) in meal composition. Besides expanding the sample beyond students, our study introduces a novel approach by examining category-switching behavior to assess the potential impact of the NS label across different products categories. Specifically, we aim to understand how the nutritional information provided through the NS label influences consumer choices in a menu planning context (Objective 1), investigating whether its presence induces consumers to select products from different categories (Objective 2).

2 | Conceptualization of NS Effects on Consumer Choices

The aim behind the creation of the NS label was to improve consumer nutritional choices. Several classifications of the factors affecting food choices have been proposed in the literature (Chen and Antonelli 2020; Fernqvist et al. 2024; Martinsen-Brannon 1989). However, for the purpose of contextualizing our study, a convenient simplification of these categorizations might consider three levels of factors: (i) individual (e.g., personal characteristics, attitudes, values, and motivations), (ii) product (i.e., product attributes), and (iii) environment (e.g., social context, shopping environment, cultural norms). This classification helps us in clarifying three possible ways in which NS can affect consumer food choices.

In this perspective, the nutritional quality of food is a product level attribute. However, this attribute is not explicitly revealed to consumers, qualifying it as a credence attribute (Nelson 1970). Consumers can nonetheless form expectations about the nutritional quality of food. This can be done using their own knowledge and previous experience—individual level factors—or through the utilization of product cues (Grunert et al. 1996). In this respect, NS is expected to act as a cue that, if correctly interpreted, helps consumers to better infer the nutritional quality of a food product.

In addition, consumers are heterogeneous in the importance they attach to nutritional aspects in their food choices (Welk et al. 2025), whereas nutritional considerations are part of a usually broader set of criteria that consumers use in evaluating food choices (Fernqvist et al. 2024). The relative importance that consumers assigned to the nutritional attribute not only varies across individuals but may also change depending on the decision-making context (Bordalo et al. 2013). The NS label, placed in a visible position on the package, can act as a stimulus for consumers, bringing nutritional information to the attention, and thus leading consumers to increase the weight they associate with nutritional considerations within their set of food choice criteria.

Although these effects can be expected for every FOPL, the simplicity and the color coding of the NS further add to its potential effectiveness. These elements are in fact capable of exerting a nudging effect on consumers (Mazzù et al. 2023), guiding them toward choices that are signaled as "better" (green color, letter A).

These three potential NS effects—namely, signaling product nutritional quality, increasing individual nutritional sensitivity, nudging consumers—lead us to expect, on average, an increase in the choices of products signaled as healthier by the NS when the NS label is displayed.

However, this average effect possibly hides heterogenous consumer strategies, especially when the single choice is not performed in isolation, but it is rather a constituent of a set of multiple choices aimed at filling a food basket. In these situations, the individual, on the basis of their attention to and attitudes toward nutritional aspects of food, may optimize the nutritional quality not at the product level, but at the basket (or meal) level. (Optimization has to be intended not as the maximization of the nutritional quality. Rather, in a neoclassical economics sense, it consists in finding the optimal level of nutritional quality that maximizes the utility associated with the product/meal/basket [where utility is affected by multiple products, consumer and context characteristics].) This optimization would entail two steps: (i) the choice of the optimal nutritional level; (ii) the choice of the food items that allow the individual to reach the desired nutritional level, with this choice being shaped and constrained by consumers' general preferences for specific foods. This opens the way to multiple consumer strategies in creating their basket, where heterogeneity stems from (i) different consumer nutritional preferences and (ii) different possible combinations for attaining similar nutritional levels.

In this respect, the NS can be expected to exert on strategies the effects detailed above for single-product choices. Specifically, the NS can (i) allow consumers to build strategies on more precise nutritional information, (ii) increase the weight consumer give to nutritional quality in strategy selection criteria, and (iii) nudge toward healthier single-product selections.

3 | Data and Methods

3.1 | Structure of the Experiment

An online survey was administered to a convenience sample of 202 Italian consumers between September and October 2023. Adults aged over 18 years old who are responsible for the family food purchases were recruited through social media platforms. The questionnaire was structured in different sections: a menu planning task and a section devoted to collect respondents' sociodemographic characteristics, food-related motives, and attitudes toward nutrition labeling.

The menu planning task was organized as a within-subject experiment, where each participant performs the task two times. The first time (round 1—R1), respondents only see the products, without any nutritional information associated with them. The second time (round 2—R2), the NS was used to give respondents nutritional information about every product in the choice basket. Between the two rounds, basic information about the NS system was provided, including an explanation of the elements that contribute to a positive or a negative NS rating. The structure of the experiment is illustrated in Figure A1.

The choice basket included 13 products commonly found in the Italian food market, divided in two macro-categories: *Carbohydrates* sources, comprising the categories bread, pasta, and rice, and *Proteins and Fats* sources, comprising cheese, meat, fish, and plant-based alternatives. Products were selected to ensure the representation of different NS levels wherever feasible, while preserving the plausibility of the basket. NS diversity was limited in some categories (e.g., cheese, fish), and products with NS = E were excluded as they are mainly confined to sugar-rich segments (Bordalo et al. 2013). A summary of the products is reported in Table 1.

In performing each task, respondents were instructed to select only two products, one from each macro-category. To minimize hypothetical bias, the study was framed as a dinner-planning exercise, instructing participants to select foods as if they were shopping in a supermarket for their evening meal.

TABLE 1 | Products and categories used in the experiment.

	Carbohydrates			Proteins and fats	
Category	**Products**	**NS**	**Category**	**Products**	**NS**
Bread	Whole wheat sliced bread	A	Meat	Chicken breast	A
	White sliced bread	B		Veal meat	B
	Tomato and basil crostini	D		Cured ham	D
Pasta	Pasta	A	Cheese	Ricotta	C
	Potato gnocchi	B		Mozzarella	D
	Tortellini	C		Hard cheese	D
Cereals	Rice	A	Fish	Canned natural tuna	B
	Basmati rice	A		Fish sticks	B
	Cereals mix: rice, barley, and spelt	A		Smoked salmon	D
			Vegetable alternatives	Veggie burger	A
				Natural tofu	A
				Canned peas	A

Abbreviation: NS, Nutri-Score.

3.2 | Data Analysis

In line with our objectives, the analysis focused on two aspects related to how the NS information can affect dietary choices. First, we analyzed whether a change is observed, in R2, in the respondents' nutritional choice patterns (combination of *Carbohydrates* and *Proteins and Fats* products). To do so, following Abou Jaoudé et al. (2022), we estimated, separately for R1 and R2, a series of logit regressions (Equation 1), modeling the probability of choosing a given *Proteins and Fats* source given the choice of different *Carbohydrates* sources:

$$P_{ijk} = \frac{1}{1 + e^{\beta C_{ijk}}} \quad (1)$$

where P_{ijk} is a dummy variable indicating whether respondent i chose a *Proteins and Fats* product in the product category j and with NS level k. Similarly, C_{ijk} is a dummy variable for the choice of the specific *Carbohydrates* products. The comparison of the logit estimates associated with the specular regressions in R1 and R2 allowed us to understand how the probability of the different *Carbohydrates-Proteins and Fats* combinations changed after the provision of NS information.

As a second aspect, we investigated whether the probability of choosing specific product categories significantly changed after the provision of NS information. To do so, we compared the share of individuals choosing products within each category in R1 and R2. As the R1 and R2 samples are not independent, we assessed the statistical significance through the non-parametric McNemar's test, as commonly done for the comparison of proportions in paired samples. All the analyses are performed in R (version 4.5.0).

4 | Results

4.1 | Descriptive Statistics: Sample Characteristics and General Effects of the NS on Food Choices

The study involved 202 Italian participants, relatively younger and more educated than the national average, but similar for gender and income. Regarding dietary habits that influence nutritional choices, Italy has traditionally been characterized by a strong adherence to the Mediterranean diet (Ferro-Luzzi and Branca 1995). However, a gradual shift toward less healthy eating habits is often observed (Biasini et al. 2021), even if these patterns may be heterogeneous across different areas of the country (Scarsi et al. 2025).

Regarding food-related motives, measured through the Food Choice Questionnaire (single-item version proposed Onwezen et al. 2019), results indicated that the most important factor for participants was pleasurable sensations, followed by health, and convenience. Finally, attitudes toward nutrition labeling, as assessed by the Trust in Food Labels scale (Žeželj et al. 2012; $\alpha = 0.71$), showed that respondents are generally willing to consult and rely on nutrition labels to guide their food choices. At the same time, they reported that such labels are often difficult and time-consuming to interpret. This finding underscores both the relevance of nutrition labeling for consumers and the potential value of more accessible formats, such as FOPLs. Descriptive statistics of the sample are reported in Table 2.

Turning to the core of the study, namely, the impact of the NS on menu composition strategies, the results indicate that the NS is effective in guiding food choices toward healthier products, with the strongest effects observed for items positioned at the extremes of the NS scale (A and D ratings). Specifically, as reported in

TABLE 2 | Descriptive statistics of the sample including sociodemographics and attitudes toward dietary habits and food labels.

Sociodemographics		***N***	**%**
Gender	Male	87	43.1
	Female	115	56.9
Income	Much less than €2500	5	2.4
	Less than €2500	35	17.3
	Around €2500	63	31.2
	More than €2500	69	34.2
	Much more than €2500	30	14.9
Education	Mandatory school	41	20.3
	High school	43	21.3
	Bachelor's degree	52	25.7
	Master's degree	42	20.8
	Post graduation	24	11.9
		Mean	**Std. dev.**
Age (in years)		30.44	10.10
Food choice questionnaire—Onwezen et al. (2019)		**Mean**	**Std. dev.**
It is important to me that the food I eat on a typical day is:			
FCQ_1	Healthy	5.97	1.20
FCQ_2	Is a way of monitoring my mood	5.41	1.45
FCQ_3	Is convenient	5.49	1.48
FCQ_4	Provides me with pleasurable sensations	6.32	1.01
FCQ_5	Is natural	5.45	1.33
FCQ_6	Is affordable	5.30	1.31
FCQ_7	Helps me control my weight	5.13	1.54
FCQ_8	Is familiar	4.78	1.65
FCQ_9	Is environmentally friendly	5.33	1.40
FCQ_10	Is animal friendly	5.12	1.53
FCQ_11	Is fairly traded	5.08	1.49
Trust in food labels (α = 0.71)—Žeželj et al. (2012)			
LTU_1	The nutrition information on food labels is hard to interpret	4.20	1.78
LTU_2	Reading food labels takes more time than I can spend	4.13	1.99
LTU_3	Reading food labels makes it easier to choose foods	5.44	1.51
LTU_4	When I use food labels, I make better food choices	5.40	1.48
LTU_5	Using food labels to choose foods is better than just relying on my own knowledge about what is in them	5.51	1.49

Table 3, a significant reduction was found in the selection of products with negative NS values (e.g., D or C), accompanied by a corresponding increase in products with positive scores (A). This effect was particularly pronounced in the macro-category of *Proteins and Fats*, where the share of NS A products rose substantially (+17.3%), whereas choices of NS D products declined (−20.8%). For *Carbohydrates* sources, the shifts were more modest, likely because a large proportion of respondents (74.3%) had already selected the healthiest options in Round 1. Interestingly, 71.8% of those who had initially chosen the most favorable option under the control condition (R1) maintained this choice in the NS treatment (R2).

Looking more in detail toward how the NS influence consumer behaviors, Table 4 shows that only a small fraction of respondents worsened their NS class (2.5% for *Carbohydrates*; 7.1% for *Proteins and Fats*), whereas 48.0% (*Carbohydrates*) and 45.6% (*Proteins and Fats*) did not improve their NS level in the second round, suggesting that the label does not exert uniform effects across individuals.

TABLE 3 | Share of respondents choosing products across different nutritional classes in the two rounds.

	Round 1		Round 2		Diff. R2–R1	
	N	**%**	***N***	**%**	**%**	***p* value**
Carbohydrates						
Nutri-Score A	150	74.3	164	81.2	+6.9	0.008
Nutri-Score B	28	13.8	31	15.3	+1.5	0.677
Nutri-Score C	19	9.4	5	2.5	−6.9	0.001
Nutri-Score D	5	2.5	2	1.0	−1.5	0.371
Proteins and fats						
Nutri-Score A	77	38.2	112	55.5	+17.3	0.000
Nutri-Score B	43	21.3	46	22.8	+1.5	0.735
Nutri-Score C	7	3.4	11	5.4	+2.0	0.343
Nutri-Score D	75	37.1	33	16.3	−20.8	0.000

Note: Statistical significance of the observed differences between the two rounds is assessed through the McNemar's test.

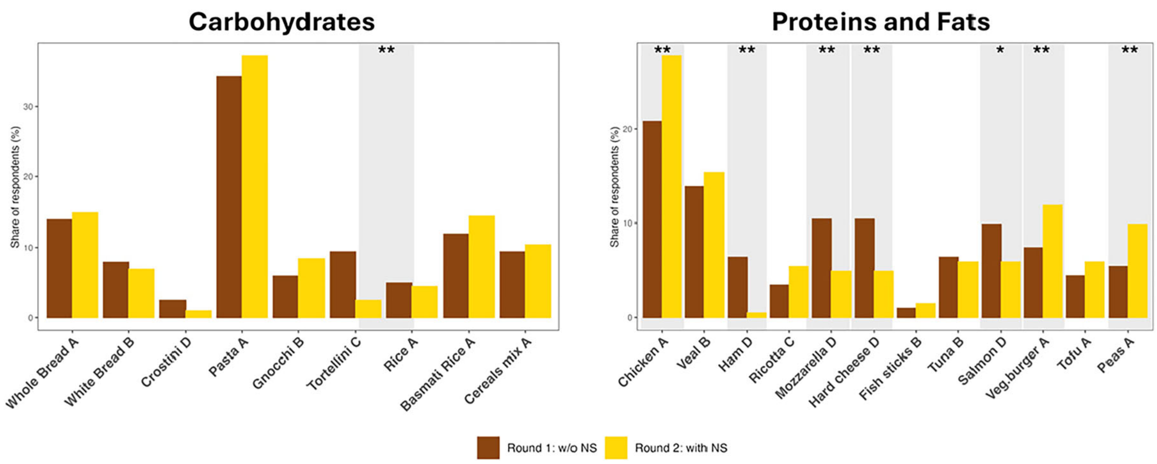

FIGURE 1 | Share of respondents choosing the different products in R1 (without NS) and R2 (with NS). Statistical significance of the observed differences between the two rounds is assessed through a McNemar's test. Asterisk (*) and double asterisks (**) indicate statistical significance at 10% and 5% level, respectively. NS, Nutri-Score.

In terms of individuals improving their nutritional choices, the pattern is different in the two macro-categories. In the case of *Proteins and Fats*, most respondents (33.6%) tend to change product category, whereas a smaller share displays a "within-category" improvement (17.6%). The opposite is observed in the case of *Carbohydrates*, where the number of individuals improving their nutritional choices selecting a product from the same category (44.0%) is higher than the number of respondents switching category (12.0%).

Moving to a finer scale, at the product level, the main change in the *Carbohydrates* macro-category between the two rounds concerns Tortellini (NS C), whose selection decreased under the NS information scenario (Figure 1). Variations in the choice of other products within this macro-category were negligible. By contrast, a more dynamic pattern emerges for *Proteins and Fats* sources. In this case, respondents reduced their selection of several NS D products, such as ham, mozzarella, and hard cheese, which showed significant declines in R2. These reductions were offset by an increased selection of healthier alternatives, including vegetable burgers, chicken, and peas.

4.2 | Meal Composition Strategies

To further investigate the role of the NS in shaping menu composition choices, we estimated a series of logistic regressions, one for each *Proteins and Fats* source × NS combination (e.g., Fish with NS = A, Meat with NS = A, etc.), in which the selection of the *Proteins and Fats* source × NS combination was modeled as a function of the *Carbohydrates* sources. To facilitate the visualization and interpretation of these patterns,

TABLE 4 | Evolution of choice patterns between round 1 (R1) and round 2 (R2).

	Consumers' choices in R1	*N*	Consumers' patterns in R2	*N*	(R2/R1) %
Carbohydrates	NS = A	150	Keep the best NS (=A)	145	96.7
	NS worse than A (NS = B;C;D)	50	Do not improve the NS	24	48.0
			Improve the NS within the category	22	44.0
			Improve the NS changing category	6	12.0
	NS better than D (NS = A;B;C)	197	Worsen the NS	5	2.5
Proteins and fats	NS = A	77	Keep the best NS (=A)	72	93.5
	NS worse than A (NS = B;C;D)	125	Do not improve the NS	57	45.6
			Improve the NS within the category	22	17.6
			Improve the NS changing category	42	33.6
	NS better than D (NS = A;B;C)	127	Worsen the NS	9	7.1
Total	NS = A	227	Keep the best NS (=A)	217	95.6
	NS worse than A (NS = B;C;D)	175	Do not improve the NS	81	46.3
			Improve the NS within the category	44	25.1
			Improve the NS changing category	48	27.4
	NS better than D (NS = A;B;C)	324	Worsen the NS	14	4.3

Note: The left panel shows consumers' choices in Round 1 (R1), whereas the right panel shows consumers' patterns in Round 2 (R2), conditional on the choices in R1. Accordingly, percentages in the last column (R2/R1) are computed using as denominator the number of respondents in each R1 choice (row-specific).
Abbreviation: NS, Nutri-Score.

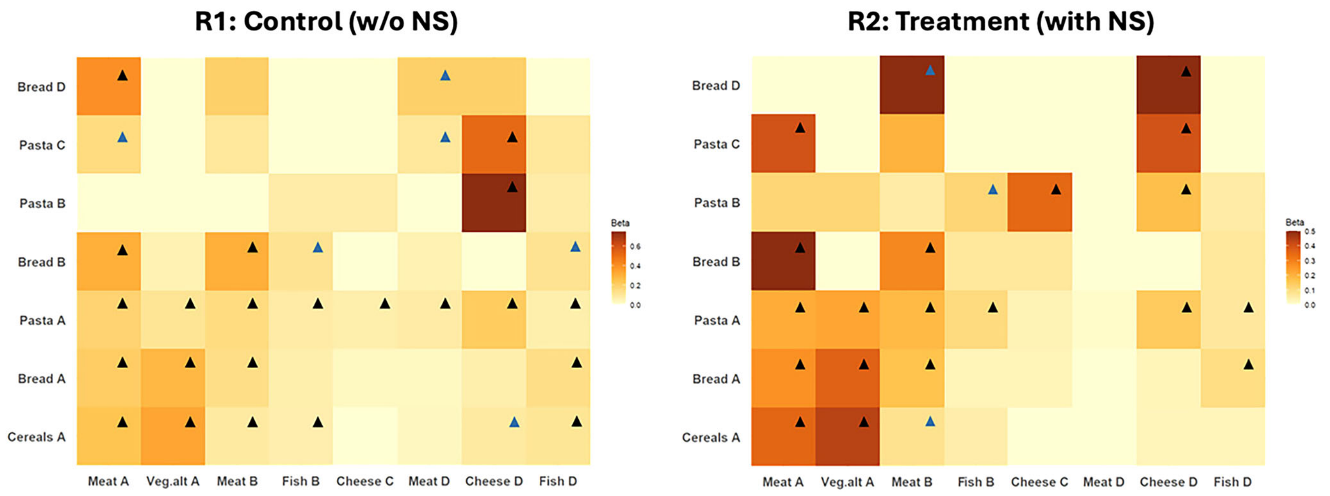

FIGURE 2 | Heatmap showing meal composition strategies in R1 (without NS) and R2 (with NS). Heatmaps depict respondents' meal composition strategies. The vertical axis represents the selected *Carbohydrates* source, whereas the horizontal axis represents the selected *Protein and Fat* source. Colors indicate the magnitude of the specific coefficients from the logistic regressions. Black and blue triangles indicate the statistical significance levels (respectively, 5% and 10%). NS, Nutri-Score.

the results are presented as heatmaps in Figure 2, whereas the corresponding numerical estimates are reported in Table A1. The heatmaps depict respondents' meal composition strategies, with *Carbohydrates* sources on the vertical axis and *Proteins and Fats* sources on the horizontal axis. Each cell represents the magnitude of the estimated coefficient from the logit regressions described in Equation (1). Darker colors correspond to a higher probability of selecting a specific *Proteins and Fats* source condition on the prior choice of a particular *Carbohydrates* source. Statistical significance levels are indicated by black (5%) and blue (10%) triangles. To illustrate, in R1, the probability of choosing mozzarella or hard cheese (category: cheese; NS = D) as the *Proteins and Fats* source is the highest when potato gnocchi (category: pasta; NS = B) were chosen as a *Carbohydrates* source.

The role of the NS in shaping meal composition strategies is revealed by the change in the color intensity in different parts of the heatmaps. To simplify, labeling as "healthy" those products with NS levels A and B and as "unhealthy" those products with NS levels C and D, we can identify four distinct regions on the map, corresponding to *Carbohydrates–Proteins and Fats* combinations: (i) healthy–healthy; (ii) healthy–unhealthy; (iii) unhealthy–healthy; (iv) unhealthy–unhealthy. The major changes stimulated by NS information appear in Regions i and ii. Specifically, the probability of observing combinations in the first region increases in R2. Conversely, there is a general decrease in the probability of observing combinations in the second region. This suggests that the NS drives individuals toward generally healthier diets, favoring "nutritional homogenization" patterns instead of "nutritional compensation" patterns. A further hint, despite feebler, of the prevalence of the homogenization stance is represented by the slight increase in the magnitude of the effect of the choice of *Carbohydrates* with NS levels C or D on the choice of cheese with NS level D. This evidence suggests in fact that the choice of this product, when NS information is available, remains mainly confined to those individuals that make generally unhealthy choices.

4.3 | NS Effect on Products' Categories

To achieve the second objective, thus assessing the impact of the NS label on different product categories, we compare the share of respondents choosing products within a given category in R1 and R2 (Table 5).

Results stressed a notable tendency among respondents to switch category, at least in some cases. Specifically, we observed a significant reduction in the selection of cheese products and a relevant increase in the choice of vegetable alternatives. By contrast, no significant change emerged for *Carbohydrates* sources. Two factors may explain this pattern. First, categories within the *Carbohydrates* macro-category comprise products with relatively similar NS levels. Second, only a small share of consumers selected products with negative NS grades in R1, thereby limiting the potential for nutritional improvement in this domain. For *Proteins and Fats* products, no substantial reductions were observed in categories characterized by high intra-category variability (e.g., meat), whereas more nutritionally homogeneous categories tended to be either penalized or favored depending on their NS level.

5 | Discussion

Although most previous studies on the NS have focused on single products or specific settings, evidence on its influence on broader meal composition strategies remains scarce. To address this gap, our study explores not only the nutritional quality of individual choices but also how NS shapes product combinations and category-level shifts in consumer behavior.

The key contribution of this article lies indeed in shifting the focus from isolated food choices to meal composition strategies. Existing research has largely assessed the NS within narrow product categories (most typically, breakfast cereals, as in Van Den Akker et al. 2022) or in real-world contexts such as university

TABLE 5 | Comparison of product selection shares by category in R1 and R2.

	R1		R2		Diff. R2–R1	
	N	**%**	***N***	**%**	**%**	***p* value**
Category: Carbohydrates						
Cereals	53	26.2	59	29.2	+3.0	0.181
Bread	49	24.3	46	22.8	−1.5	0.450
Pasta	100	49.5	97	48.0	−1.5	0.606
Category: Proteins and fats						
Meat	83	41.1	88	43.6	+2.5	0.473
Cheese	49	24.3	31	15.3	−9.0	0.001
Fish	35	17.3	27	13.4	−3.9	0.170
Vegetable alternatives	35	17.3	56	27.7	+10.4	0.000

Note: Statistical significance of the observed differences between the two rounds is assessed through the McNemar's test.

cafeterias, where interventions tend to target single dishes without considering how selections combine into meals (Mora-García et al. 2019). Yet, in typical grocery shopping situations, consumers rarely make isolated decisions but rather select a combination of ingredients and items to create meals (Hanemann and Morey 1992; Caputo and Lusk 2022).

Our work thus contributes to the emergent literature strain investigating the role of NS in more complex, meal-based scenarios (Julia et al. 2021; Abou Jaoudé et al. 2022). Consistent with previous findings on NS (Fuchs et al. 2022; Shin et al. 2023) and on other FOPLs (Lee et al. 2023), we confirm that the NS exerts a clear positive influence in guiding consumers toward products that, according to the NS algorithm, are healthier. Beyond this, however, we show that the presence of the label alters not only the single product choices but also the way products are combined into meals. In general, two patterns emerge. On the one hand, consumers tend to move toward baskets that are overall healthier, pairing a "healthy" Carbohydrates source with a "healthy" Proteins and Fats source. On the other hand, a minor share of consumers seems to remain consistent in their unfavorable choices, which are particularly evident when negatively labeled products, such as cheeses (NS = D), are involved.

This evidence suggests a "polarization" of food choices, which includes what Abou Jaoudé et al. (2022) labeled a "consistent" strategy, where respondents subsequently choose products with similar NS ratings. Conversely, we found no evidence of a "compensatory" strategy, described by the same authors, where consumers compensate negative NS levels of some products, including products with positive NS ratings in their basket. In our case, in fact, the initial heterogeneity, which included respondents with diversified nutritional choices, tends to disappear after displaying the NS.

The shift toward healthy-rated baskets is in line with the expectations about NS functioning, as illustrated in Section 2. From a behavioral economics perspective, in addition to giving information about the nutritional quality of food, NS reduces the consumers' cognitive effort, acting as a heuristic shortcut. Indeed, under bounded rationality conditions, when facing complex decisions—as, in our case, composing a meal—individuals tend to rely on heuristics rather than engaging in full analytical evaluations of the choices at hand (Kahneman 2003; Simon 1979). The visual structure of the NS makes its heuristic role even more important, as it makes nutritional quality information more immediately visible and easier to interpret, as common for informational nudges (Thaler and Sunstein 2008). In the frame of dual-process theory (Kahneman 2011), the NS label thus basically allows consumers to make their nutritional evaluations based on their "fast" cognitive system rather than on the "slow" system.

Concerning the consistency of some respondents in unfavorable nutritional choices, the pattern has also been observed in other studies (e.g., Dobrowolski et al. 2025) and may be the result of different factors. An explanation relates to stable taste preferences and hedonic motivations, which may dominate, for some consumers, over health considerations in food choices (Mai and Hoffmann 2012). When taste is the primary decision criterion, nutritional information, even when clearly presented, may carry limited weight in influencing behavior. An additional element might be the mistrust, by some individuals, in the NS system (Stiletto et al. 2024), which may reduce the perceived credibility of the label, weakening its effectiveness as a decision aid. Consumers who question the validity or fairness of the rating algorithm may be less willing to adjust their choices accordingly. Finally, misunderstanding or misinterpretation of the label (Stiletto and Trestini 2022) may prevent some individuals from using the information as intended.

The effectiveness of the NS in facilitating healthier choices for a large share of respondents, however, might also imply a simplified, categorical interpretation of nutritional quality. In this respect, Sprengholz et al. (2025) observe that, although NS is formally designed as a linear and equidistant scale, it is often interpreted by consumers as a psychological map that polarize foods into "good" and "bad" categories. Our results seem to validate this observation, as the impact of the NS was most pronounced at the extremes of the scale, with a substantial reduction in the selection of NS = D products (e.g., salmon, mozzarella, ham) and a corresponding increase in NS = A products (e.g., vegetable burgers, peas, chicken). This evidence is also in line with Dobrowolski et al. (2025), who maintain that consumers perceive substantial improvements only when changes in the NS are large (e.g., moving from C to A or from E to C), whereas small shifts between similar ratings have little impact on perceived healthiness.

This "simplification" is observed also when analyzing how the choices of different food categories change in response to the NS information. Indeed, when seeking to improve their nutritional choices, a considerable share of consumers switches categories, most notably trying to replace negative NS ratings (e.g., cheese) with positive ones (e.g., plant-based alternatives). This pattern is likely related to the intra-category differentiation of the NS ratings. Experimental evidence shows that, under NS, demand tends to decrease for categories systematically rated unfavorably (e.g., dairy, sweets, etc.), whereas it increases for better-rated alternatives (Egnell et al. 2022; Höhn et al. 2023). This interpretation is in line with the low share of category switches observed in the case of *Carbohydrates*, where two of the three categories display a good amount of NS variability. This suggests, as observed also by Egnell et al. (2021), that the role of NS is amplified in categories with high intra-category variability, where the label facilitates substitution toward healthier options.

Such category switching reflects a pragmatic use of the label by consumers but also exposes inefficiencies in the system, as it undermines the primary purpose of NS (viz., supporting comparisons within categories) as emphasized in the literature and in official communication on the label. (See, e.g., the NS information sheet, promoted by Santé Publique France, available at https://www.mangerbouger.fr/content/show/1499/file/DT05-115-24B%20T_NUTRISCORE_version%20sans%20reperes_juillet25_web_2.pdf.) The total abandonment of certain product categories, such as cheese, may also entail unintended consequences, including nutritional imbalances due to the loss of category-specific nutrients and a reduction in dietary diversity (European Dairy Association 2023). In addition, such exclusion could generate significant economic repercussions for specific food sectors.

In this respect, however, future studies should investigate whether the familiarity with the NS can affect this aspect of NS-based food choices. Julia et al. (2021), in a similar meal composition scenario, observed that the positive effects of NS on nutritional quality of meals emerged over time, suggesting a sort of learning process of individuals. In a similar vein, it is possible that individuals, getting more experienced about the NS, turn to within-category meal modifications as their strategy to improve the meal nutritional quality.

A further aspect on which future research could work is the comparison, also in a meal composition perspective, of different nutritional labels. Such comparisons are common in the investigation of the ability of nutritional label to promote healthy choices (Egnell et al. 2018; Pettigrew et al. 2023; Talati et al. 2019), but they remain mostly confined to single-product selection scenarios. Although the NS appears to perform better than other labels in these contexts, investigations considering the choice of a whole meal can assess whether this performance is maintained also in more complex situations.

6 | Implications and Conclusions

This study expands the literature on the NS by showing that its influence extends beyond single-product choices to broader meal composition strategies. Our results confirm that the label promotes healthier decisions, particularly by discouraging the selection of products with unfavorable ratings and encouraging shifts toward the best rated alternatives. These effects are most pronounced in the *Proteins and Fats* macro-category, whereas they remain weaker for *Carbohydrates*, where most consumers had already selected the healthiest option in the first round. Importantly, part of the nutritional improvement is driven by category switching, with consumers abandoning cheese in favor of plant-based options. Yet, the NS proves most effective at the extremes of the scale, discouraging the selection of poorly rated products (D) and fostering preferences for highly rated ones (A). This dynamic tends to reinforce category switching, particularly in product groups with limited intra-category variability. Although it effectively nudges consumers toward healthier dietary patterns, its current design may also generate undesired distortions in consumer behavior and negative economic effects for some product categories.

At the same time, some limitations of the present study should be acknowledged, some of which are intrinsic in its exploratory nature. First, the analysis is based on a small convenience sample, which is characterized by a lower age and a higher education level than the overall Italian population. This might have some effects on the results, as young consumers (Andreeva et al. 2022) as well as more educated consumers (Mazzù et al. 2023; Talati et al. 2019) tend to display a higher understanding of food labels. In addition, being the sample collected among Italian consumers, the results are likely dependent on the specific national context and its dietary habits.

As a further limitation, the study relies on a hypothetical choice setting, which may not fully capture real-life purchasing behavior, whereas the scope of products included in the experiment was necessarily limited. An example in this respect was the exclusion of products with NS level E. Although the exclusion was considered acceptable due to the very low occurrence of this NS category in most market categories, future research should address these limitations. It appears therefore desirable to expand the range of food categories and test the persistence of NS effects in longitudinal or field settings.

Author Contributions

Conceptualization: Alice Stiletto and Samuele Trestini. Data curation: Alice Stiletto. Formal analysis: Alice Stiletto and Leonardo Cei. Investigation: Alice Stiletto, Archana Singh, and Samuele Trestini. Methodology: Alice Stiletto, Leonardo Cei, and Samuele Trestini. Resources: Samuele Trestini. Supervision: Samuele Trestini. Visualization: Alice Stiletto, Leonardo Cei, and Samuele Trestini. Writing – original draft: Alice Stiletto and Leonardo Cei. Writing – review and editing: Alice Stiletto, Leonardo Cei, Archana Singh, and Samuele Trestini.

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Ethics Statement

This study received an ethical waiver from Department of Land, Environment, Agriculture and Forestry (TESAF), University of Padova (Ethical Request No. 2024_14).

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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TABLE A1 | Food choice strategies (logistic regression outputs).

	Meat A		Veg.alt A		Meat B		Fish B		Cheese C		Meat D		Cheese D		Fish D	
Round 1																
Cereals A	0.245	***	0.340	***	0.094	**	0.075	**	0.000		0.038		0.094	*	0.113	***
Bread A	0.214	***	0.286	***	0.143	**	0.071		0.036		0.036		0.071		0.143	**
Pasta A	0.188	***	0.116	***	0.159	***	0.087	***	0.072	***	0.087	***	0.217	***	0.072	**
Bread B	0.313	***	0.063		0.313	***	0.125	*	0.000		0.063		0.000		0.125	*
Pasta B	0.000		0.000		0.000		0.083		0.083		0.000		0.750	***	0.083	
Pasta C	0.158	*	0.000		0.105		0.000		0.000		0.105	*	0.526	***	0.105	
Bread D	0.400	**	0.000		0.200		0.000		0.000		0.200	*	0.200		0.000	
Round 2																
Cereals A	0.356	***	0.441	***	0.085	*	0.051		0.000		0.000		0.034		0.034	
Bread A	0.267	***	0.367	***	0.167	**	0.033		0.033		0.000		0.033		0.100	**
Pasta A	0.213	***	0.227	***	0.187	***	0.107	***	0.040		0.013		0.147	***	0.067	**
Bread B	0.500	***	0.000		0.286	***	0.071		0.071		0.000		0.000		0.071	
Pasta B	0.118		0.118		0.059		0.118	*	0.353	***	0.000		0.176	**	0.059	
Pasta C	0.400	**	0.000		0.200		0.000		0.000		0.000		0.400	***	0.000	
Bread D	0.000		0.000		0.500	*	0.000		0.000		0.000		0.500	**	0.000	

Note: Asterisk (*), double asterisks (**), and triple asterisks (***) indicate statistical significance at 10%, 5%, and 1% level, respectively.

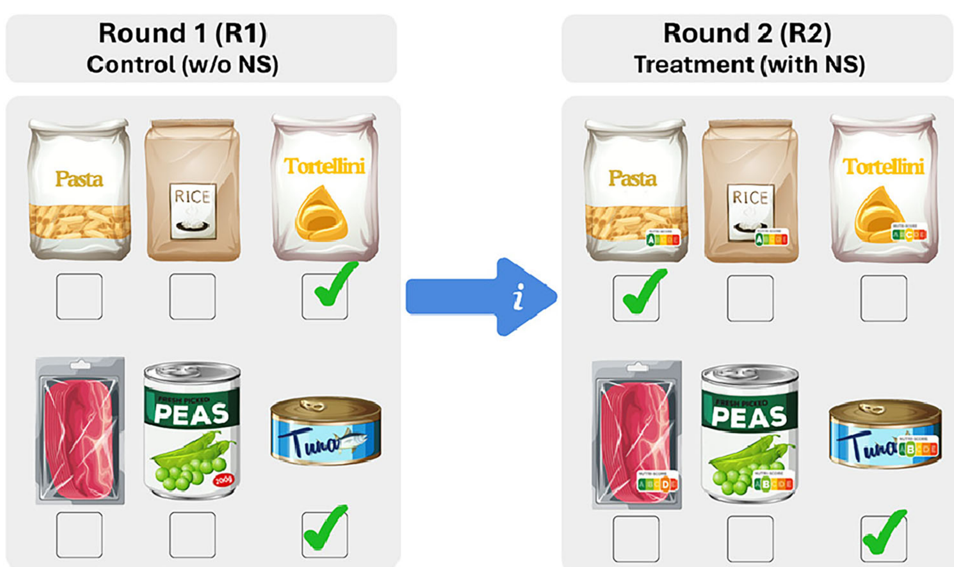

FIGURE A1 | Structure of the meal composition tasks. In the experiment, respondents had to choose one *Carbohydrates* source (first line) and one *Protein and Fat* source (second line), selecting from different products across various categories. Their preferences were recorded before (R1) and after (R2) the NS informational treatment. Between the two rounds, respondents were provided with information about NS to level their knowledge on the topic.