Counteracting noncommunicable diseases with front-of-pack nutritional labels' informativeness: an inquiry into the effects on food acceptance and portions selection

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Abstract

Purpose – Front-of-pack nutritional labels have been extensively studied to support consumers in making healthier and more informed food choices. However, existing research has gathered conflicting evidence about which category of label, nutrient-specific or summary labels, is more effective. As a result, the European Union has postponed its decision on selecting a unified label to collect additional information. This study specifically focusses on individuals with noncommunicable diseases, an overlooked yet relevant segment of consumers who can significantly benefit from the proper use of nutritional labels in their self-care.

Design/methodology/approach – In a sequence of three studies grounded in the front-of-pack acceptance model and focussing on customers with specific noncommunicable diseases, the authors examined the different effects of the NutrInform Battery and Nutri-Score on food acceptance and portion selection. This research involved the use of structural equation modelling and ANOVA and was conducted with a cumulative sample of 2,942 EU adults, residing in countries with or without previous exposure to nutritional labels.

Findings – The results suggest that among individuals with noncommunicable diseases, nutrient-specific labels are perceived as more useful and easier to use. They also generate a better attitude towards the usage of nutritional labels and are more effective in nudging those consumers towards a proper selection of portions.

Social implications – The results provide valuable insights into how front-of-pack nutritional labels can impact the food choices of individuals with noncommunicable diseases and have implications for public health policies.

Originality/value – Investigation of the effects of NutrInform Battery and Nutri-Score on consumers with noncommunicable diseases, an area currently under-researched.

Keywords Front-of-pack nutritional labels, Noncommunicable disease, NutrInform Battery, Nutri-Score, Food acceptance, Portion selection
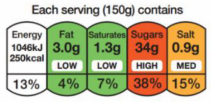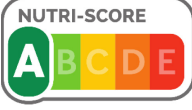
Paper type Research paper

1. Introduction

Obesity and overweight are major public health concerns that have been on the rise globally in recent decades (WHO, 2021). To address this issue, institutions have implemented various measures aimed at reverting this trend. Among them, extensive efforts have been dedicated to support the introduction of front-of-pack nutritional labels, a proven tool to nudge customers towards healthier and more informed food choices (Egnell *et al.*, 2018a; Mazzù *et al.*, 2021; Julia *et al.*, 2022; Zlatevska *et al.*, 2019; Maesen *et al.*, 2022; Ikonen *et al.*, 2020), extensively studied globally (Mazzonetto *et al.*, 2022; da Silva *et al.*, 2022; Schwalb Helguero *et al.*, 2023) and a fundamental lever recognized by the European Union "*From-farm-to-fork*" strategy. While the European Union aims to identify a single label that can be adopted by all Member States, over the last few years, local governments have implemented different typologies of nutritional labels, clustered in nutrient-specific and summary labels by a recent European Union taxonomy (European Union Commission, 2020; see Table 1).

Front-of-pack nutritional labels belonging to these categories have been extensively studied and confronted by researchers to identify the best option to support European Union consumers towards healthier diets (Egnell *et al.*, 2018a, b; Talati *et al.*, 2018; Mazzù *et al.*, 2021; Mazzù *et al.*, 2022b; Pettigrew *et al.*, 2023). However, given the inconsistent outcomes of past research (Mazzù *et al.*, 2022b; Werle *et al.*, 2022) and the lack of consensus among member

Taxonomies		Examples
Nutrient-Specific Labels: Front-of-pack Nutritional Labels that provide detailed information about certain nutrients (fat, saturates, sugars, salt, and energy value) with an objective description of the quantities contained in the food	• **Numerical Labels**: non-interpretative (non-evaluative) labels, providing numerical information on the content of four nutrients (fat, saturates, sugars, salt) and on the energy value, as well as on how much this represents as a percentage of the daily reference intake	• **NutrInform Battery**
	• **Colour-Coded Labels**: labels providing numerical information on the content of four nutrients (fat, saturates, sugars, salt) and on the energy value, as well as on how much this represents as a percentage of the daily reference intake. Colours are used to classify those nutrients as "low" (green), "medium" (amber) or "high" (red)	• **Multiple Traffic Light**
Summary Labels: Front-of-pack Nutritional Labels that provide a synthetic assessment of the product's overall nutritional healthfulness that is sometime the result of an algorithmic computation	• **Endorsement Logos**: labels providing a synthetic appreciation of a product's overall nutritional value through a positive (endorsement) logo that is applied only to foods that comply with nutritional criteria	• **Keyhole logo**
	• **Graded Indicators**: labels providing a synthetic appreciation of a product's overall nutritional value through a "graded indicator" that provides graded information on the nutritional quality of foods that is applied on all food products	• **Nutri-Score**

Source(s): Credits – own elaboration

Table 1.
EU Taxonomy and example of front-of-pack-labels

states and stakeholders, the European Union has postponed its decision on which unified front-of-pack nutritional labels to adopt to gather more evidence on the relative effectiveness of summary vs nutrient-specific labels (Morrison, 2022).

In this context, while front-of-pack nutritional labels were originally conceived to prevent the growth of obesity and overweight, their use might be even more beneficial to a significant part of the European Union population, which might be attentive to the intake of specific nutrients (Muzzioli *et al.*, 2022). Among these, individuals suffering from noncommunicable diseases, such as diabetes and cardiovascular diseases. In the past, limited attention has been devoted to confronting front-of-pack nutritional labels for this relevant part of the population [1], which could have a significant advantage from the correct use of them. Thus, as consumers with noncommunicable diseases often require specific dietary regimes to manage their conditions (Lowe *et al.*, 2013), they could benefit from the additional help granted by these labels in making healthier and more informed food choices (Egnell *et al.*, 2022). This paper then aim at contributing to the stream of research that benchmark, among European Union individuals, the performance of nutrient-specific and summary labels on attitudes and behaviours, with a specific focus on people affected by diagnosed noncommunicable diseases. The remainder of this paper provides an overview of the extant literature, methodology, research, general discussion, conclusions and remarkable implications for decision-makers.

2. Theoretical background and hypothesis development

Past research showed that when consumers decide between different portion sizes, they are impacted by front-of-pack nutritional labels, as well as costs, the ability of the food to satisfy hunger and the enjoyment provided by the food (Cornil and Chandon, 2016; Hagen *et al.*, 2017; Liu *et al.*, 2019). Some authors, specifically, argued the potential to support dietary choices also of individuals with noncommunicable diseases. In fact, summary labels proved to be effective systems in helping consumers make healthier food choices and nutrient-specific labels in managing their nutrient intake (Egnell *et al.*, 2022; Lewis *et al.*, 2009; Post *et al.*, 2010). Other studies have investigated the impact of such labels on product selection (Egnell *et al.*, 2018b) and have found that nutrient-specific labels can be difficult to interpret and time-consuming, whereas summary labels provide additional evaluation through features such as colour coding (Egnell *et al.*, 2018c; Talati *et al.*, 2018; McCrickerd *et al.*, 2020).

However, limited evidence is available that confronts nutrient-specific and summary labels on the behavioural side, and specifically on their impact on the food portions selected by individuals with noncommunicable diseases. As a result, it remains unclear which type of front-of-pack nutritional label would be the best for individuals with noncommunicable diseases, and which would also be superior from a public policy perspective.

In the past, among the different constructs and theoretical models used to benchmark the performances of the labels, the front-of-pack acceptance model investigated whether consumers find the labelling systems useful and easy to use and whether they form favourable attitudes and intentions towards healthier food options (Mazzù *et al.*, 2022a).

This model identifies a direct relationship between perceived usefulness and perceived ease of use as significant predictors of attitudes towards front-of-pack nutritional labels and behavioural intention. Thus, the greater the perceived usefulness and ease of use of the front-of-pack nutritional labels, the higher their acceptance, leading consumers to make healthier and more informed choices. While extant research has shown that nutritional labels have a significant impact on in-store purchases providing consumers with information about the nutrients (Hawley *et al.*, 2013), front-of-pack acceptance model clarified how these labels function as a decision support system while food shopping, serving as a reference model for this research.

Individuals with noncommunicable diseases often require ongoing care to maintain their wellbeing; the use of supportive tools for food selection, such as digital health technologies (Parth *et al.*, 2021), mobile health applications (Lowe *et al.*, 2015) and front-of-pack nutritional labels can significantly help individuals with noncommunicable diseases better manage their choices. Indeed, the labels usage is affected by various factors, as their perceived usefulness (Mazzù *et al.*, 2022a). Individuals who perceive a product or service as useful are more likely to adopt and use it, particularly when managing chronic conditions such as noncommunicable diseases (Holden and Karsh, 2009). However, prior literature on noncommunicable diseases did not reveal how perceived usefulness affects attitude if it differs across consumers with and without noncommunicable diseases and for NutrInform Battery and Nutri-Score. To this end, we contend that.

H1. Perceived usefulness positively influences the attitude towards the front-of-pack nutritional labels of consumers with noncommunicable diseases.

H2. Perceived usefulness is greater for consumers with noncommunicable diseases than consumers without noncommunicable diseases.

H3. Perceived usefulness of consumers with noncommunicable diseases is greater for NutrInform Battery than Nutri-Score.

Similarly, perceived ease of use is a key factor in determining user acceptance of front-of-pack nutritional labels. Perceived ease of use (Davis, 1989) has been widely used to predict user behaviour in various fields, including healthcare-technology (Rasul *et al.*, 2023) and the use of technology-based interventions aimed at promoting healthy behaviours and preventing noncommunicable diseases. Studies that examined the relationship between perceived ease of use and front-of-pack nutritional labels use found that it was positively associated with perceived usefulness and consumers' intention to use the labels (Mazzù *et al.*, 2022a). Similarly, they found that consumers' perceived ease of use was positively associated with their ability to use labels to make healthier food choices. For the latter, we posit that perceived ease of use does not change between consumers with and without noncommunicable diseases. Subsequently.

H4. Perceived ease of use positively influences perceived usefulness of consumers with noncommunicable diseases.

H5. Perceived ease of use positively influences attitudes towards the front-of-pack nutritional labels of consumers with noncommunicable diseases.

In addition, as ease of use is a factor strictly related to the label and not to the health situation of an individual, we predict that.

H6. Perceived ease of use does not vary between consumers with and without noncommunicable diseases.

Finally, as the extant literature shows a significant difference in perceived ease of use between NutrInform Battery and Nutri-Score, we postulate that this relationship also holds in the case of noncommunicable diseases consumers.

H7. Perceived ease of use of consumers with noncommunicable diseases is greater for NutrInform Battery than Nutri-Score

Moreover, attitudes and behavioural intentions have been studied in relation to promoting healthy behaviours and preventing noncommunicable diseases. Medina-Molina and Perez-Gonzalez (2021) found that consumers' intention to use front-of-pack nutritional labels was positively associated with their ability to use the labels to make healthier food choices, and

that attitude towards the front-of-pack nutritional labels was positively associated with their actual use of the labels. Consistent with prior studies, we extend previous findings to the noncommunicable diseases literature and contend that.

H8. Attitude towards the front-of-pack nutritional labels positively influences behavioural intention of consumers with noncommunicable diseases.

H9. Attitudes towards front-of-pack nutritional labels are greater for consumers with noncommunicable diseases than for consumers without noncommunicable diseases.

H10. Attitude towards the front-of-pack nutritional labels is higher for NutrInform Battery than Nutri-Score.

Moreover, we hypothesized that an increased level of informativeness is beneficial to individuals with noncommunicable diseases in driving their behaviour to lower the level of intake of nutrients considered negative for their specific health condition. We then posit that front-of-pack nutritional labels with higher degrees of informativeness, such as the NutrInform Battery, report higher degrees of appropriate behavioural intention vs Nutri-Score for consumers with noncommunicable diseases. Thus.

H11. The behavioural intention of consumers with noncommunicable diseases is lower for NutrInform Battery than Nutri-Score, in the presence of nutrients considered negative for the specific health condition.

Finally, other studies have shown that front-of-pack nutritional labels performance is consistent in diverse countries on multiple constructs (e.g. Hughes *et al.*, 2023; Ho *et al.*, 2022; Mazzù *et al.*, 2021; Egnell *et al.*, 2018a). When applied to European Union consumers with noncommunicable diseases, we contend that the effects of front-of-pack nutritional labels on perceived usefulness, perceived ease of use, attitude and behavioural intention do not vary by country. Hence,

H12. The country effect does not influence the perceived usefulness, perceived ease of use, attitude, or behavioural intention of consumers with noncommunicable diseases.

In our research we drawn on front-of-pack acceptance model (see Figure 1) as a theoretical framework that aims to understand how consumers interpret and respond to the information
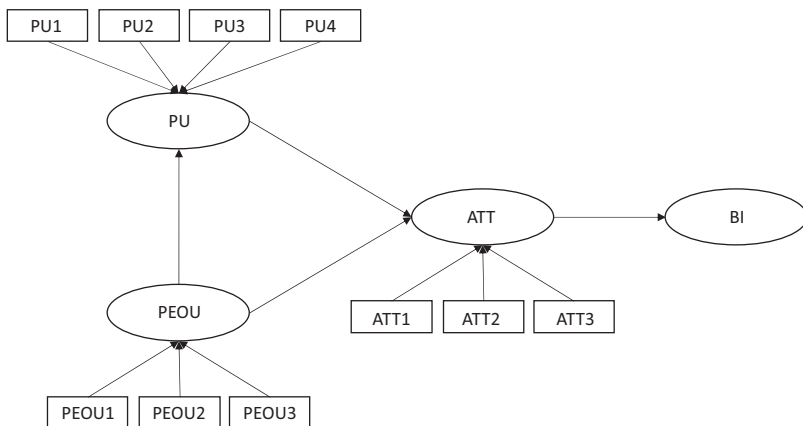
Figure 1.
Front-of-pack
acceptance model

Source(s): Own elaboration

presented on front-of-pack nutritional labels. The model assesses the perceived usefulness and ease of use of such labels and examines their effects on consumers' attitudes and behavioural intentions related to food choices, thus exploring how consumers perceive the information provided by front-of-pack nutritional labels, and whether they find it useful in making informed decisions about food products. It also examines the ease of use of front-of-pack nutritional labels, focussing on factors such as the clarity and comprehensibility of the label design and content. Additionally, the model investigates how consumers' attitudes towards front-of-pack nutritional labels are influenced by their perception of the labels' usefulness and ease of use. The behavioural intentions component of the model explores consumers' intention of acting based on the information provided by front-of-pack nutritional labels. This can include intentions to choose healthier food options, modify portion sizes, or alter dietary habits based on the guidance provided by the labels.

While other studies (Egnell *et al.*, 2018c; Talati *et al.*, 2018; McCrickerd *et al.*, 2020; Mazzù *et al.*, 2022a) have previously focussed on healthy consumers, this research contributes to the literature by focussing on consumers who have been diagnosed with noncommunicable diseases.

To this end, we collected data through Prolific platform, a trustworthy international web panel provider that upholds high recruitment standards as well as a high response rate, reliability and replicability of studies (Palan and Schitter, 2018). The sample includes European Union consumers who self-declared, when they originally registered to Prolific platform, to suffer of at least one noncommunicable disease. Thus, in our methodology, we did not convey any direct questions on the respondents' health status through the questionnaire.

In order to test our hypotheses, we utilized a sequence of three studies. In the first study, we tested whether the front-of-pack acceptance model can be applied in contexts with consumers with noncommunicable diseases to explain the acceptance of front-of-pack nutritional labels (Study 1a, test H1, H4, H5 and H8), and whether different degrees of acceptance exist between groups of consumers with and without noncommunicable diseases (Study 1b, test of H2, H6 and H9), highlighting which group can benefit more from front-of-pack nutritional labels utilization.

In the second study, we focussed on consumers with noncommunicable disease only and explored their reaction to different front-of-pack nutritional labels, testing H3, H7, H10 and H11. Specifically, we first focussed on individuals who self-registered as suffering from heart-related issues (Study 2a), considering the situation where noncommunicable diseases consumers are exposed to foods with a high level of the most critical nutrient for the specific illness, to understand the differential effects of NutrInform Battery vs Nutri-Score vs the absence of labels, in terms of perceived usefulness, perceived ease of use, attitude towards the label and behavioural intention. Subsequently, in Study 2b, with a similar design, we focussed on consumers with diabetes and considered the opposite situation where a critical nutrient is not present in the tested food.

Lastly, Study 3 extends the validity of the results of Study 2, testing H12 and investigating whether significant differences exist between consumers with noncommunicable diseases living in countries with different degrees of front-of-pack nutritional labels exposure. The following part includes a detailed description of the methodology for each study.

3. Study 1

Study 1 seeks to (1) examine the applicability of the front-of-pack acceptance model in consumer contexts involving individuals with non-communicable diseases to understand the acceptance of front-of-pack nutritional labels (Study 1a) and (2) explore potential variations in the acceptance of front-of-pack nutritional labels among consumer groups with and without

noncommunicable diseases, shedding light on which group may derive greater advantages from utilizing these labels (Study 1b).

3.1 Study 1a

3.1.1 Methods. We recruited 675 primary European Union grocery shoppers through Prolific of which 281 self-declared suffering from heart issues or diabetes and 394 who self-declared themselves as not suffering from noncommunicable diseases (hereafter referred also as "healthy consumers") when originally registering on the platform. No direct questions on the respondents' health status were delivered through the questionnaire. The respondents' countries were selected based on the absence of previous extensive exposure to front-of-pack nutritional labels in the market.

To compare the behaviour of consumers with and without noncommunicable diseases, after randomly showing information about front-of-pack nutritional labels, both groups were subject to the same set of questions and exposed to two different front-of-pack nutritional labels: the NutrInform Battery and the Nutri-Score.

All participants were asked to answer questions regarding perceived usefulness, perceived ease of use, attitude and behavioural intention (Table 2).

3.1.2 Results. We leveraged on structural equation modelling to test whether front-of-pack acceptance model can be extended to consumers with and without self-declared noncommunicable diseases. The response set was analysed to evaluate the reliability, validity and overall fit of the structural model. A decomposition test was conducted using the bootstrap method with 5,000 samples and 95% confidence interval. In this study we first tested the reliability and validity of the scales. To measure reliability, we used Cronbach's alpha to assess the internal consistency of the scale and its inter-relatedness of items. Confirmatory factor analysis (CFA) was then performed to evaluate the discriminant and convergent validity of the constructs while controlling for their effects. Finally, we evaluated the fit of the structural equation model, which tested the validity of the latent constructs and the relationships between them. We also ran a multigroup analysis to compare the indices

| Construct(s)	Item(s)	Author
Perceived usefulness (PU)	Food front-of-pack label give (will give) me access to useful food purchase information Food front-of-pack label are (will be) very beneficial to me Using food front-of-pack label improves my food purchase Using food front-of-pack label gives me greater control over my food purchase	Mazzù *et al.* (2022a, 2022c)
Perceived ease of use (PEOU)	My interaction with the food front-of-pack label is easy for me to understand Overall, I find the food front-of-pack label easy to use It is easy to learn how to use food front-of-pack label for food purchase	Mazzù *et al.* (2022a, 2022c)
Attitude towards using (ATT)	I am positive about the front-of-pack label t for food purchase The use of the front-of-pack label for food purchase is a good idea It makes sense to use the front-of-pack label for food purchase	Mazzù *et al.* (2022a, 2022c)
Behavioural intention (BI)	Select the intake portion to express the desired consumption	Cornil and Chandon (2016)

Source(s): Credits – own elaboration

among groups and assess the applicability of front-of-pack acceptance model to consumers with (without) noncommunicable diseases.

CFA proved that the front-of-pack acceptance model was appropriate for both conditions. In both healthy respondents' sample (χ^2 = 114.471, p = 0.000, GFI = 0.937, CFI = 0.982, NFI = 0.970, SRMR = 0.025, RMSEA = 0.070) and noncommunicable diseases sample (χ^2 = 197.260, p = 0.000, GFI = 0.966, CFI = 0.925, NFI = 0.919, SRMR = 0.0229, RMSEA = 0.079) all indices indicated a good fit to the data. Both samples had high reliability and validity, with factor loadings above 0.70. Further, convergent validity suggests that all loadings accurately measure the construct (λ > 0.70 and SMC>0.50) while also being distinct from each other (average variance extracted is higher than SMC).

The specified structural model was found to have a high fit (χ^2 = 116.827, p = 0.000, GFI = 0.936, CFI = 0.982, NFI = 0.970, SRMR = 0.029, RMSEA = 0.070) for the sample without noncommunicable diseases. The results showed significant relationships between all variables, with perceived ease of use positively affecting perceived usefulness and attitude towards using front-of-pack nutritional labels, and perceived usefulness affecting attitude towards using front-of-pack nutritional labels, in turn affecting behavioural intention. Also sample with noncommunicable diseases showed a high model fit (χ^2 = 172.912, p = 0.000, GFI = 0.962, CFI = 0.925, NFI = 0.918, SRMR = 0.0264 and RMSEA = 0.079). Like the other sample, all relationships were significant. Attitude was partially mediating the effect of perceived usefulness on behavioural intention (Figure 2).

The results of the measurement invariance among the two groups showed that the configural invariance model for the groups demonstrated an accep*table* fit. In the configural model, all parameters were estimated for both the calibration and validation groups simultaneously, meaning that no parameters were restricted to being equal across groups. This multigroup model produced a χ^2 = 598.072 with 98 degrees of freedom and served as a reference for comparison with subsequent models. In the second tested model, measurement weights and all factor loadings were constrained to be equal across groups, assuming no variance in how constructs were formed. In the subsequent models, structural weights, covariances and residuals, all beta, covariances and residuals were constrained to be equal across groups, assuming no variance in how the relationships between constructs were formed. The fact that the delta of CFIs never exceeded the cut-off value of 0.01 across all models suggests that the model is invariant across the two groups of individuals with and
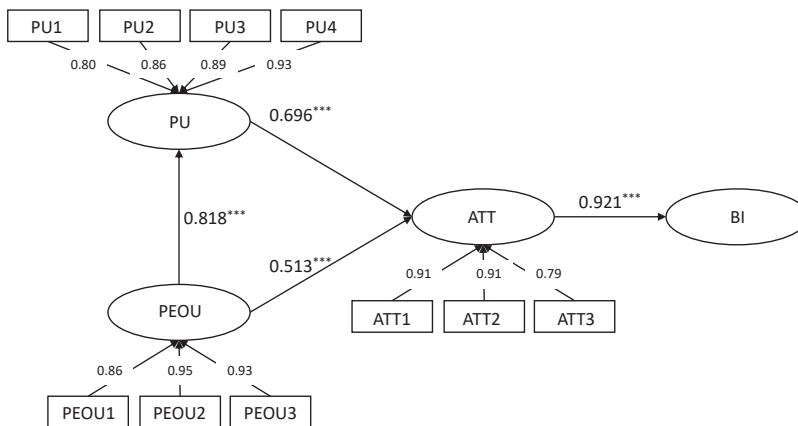
Source(s): Own elaboration

without noncommunicable diseases (Table 3). In conclusion, all factor loadings, structural paths, factor covariances, factor residual variances, and measurement error variances operate similarly across both calibration and validation samples.

3.2 Study 1b

3.2.1 Methods. We recruited 542 respondents ($N_{\text{WithNoncommunicablediseases}}$ = 245; $N_{\text{WithOUTNoncommunicablediseases}}$ = 297), living in countries that had not yet officially implemented any nutritional labels system. The present design allowed us to test whether some labelling systems are more important than others in terms of perceived usefulness, perceived ease of use and attitude towards using front-of-pack nutritional labels.

Consumers with and without noncommunicable diseases were exposed to the same pre-validated scales after randomly reading generic information about front-of-pack nutritional labels. We then calculated the mean differences between consumers with and without noncommunicable diseases.

All participants were asked to respond to the same items presented in Study 1a.

3.2.2 Results. To test whether significant mean differences existed among the groups, we performed Analysis of Variance (ANOVA). Subsequently, we compared the means of the groups using the Bonferroni post hoc test. We also assessed the reliability of the scales using Cronbach's alpha.

One-way ANOVA revealed differences between the groups on perceived usefulness ($F(1,541)$ = 2.674; $p < 0.01$) and attitude towards the label ($F(1,541)$ = 4.673; $p < 0.031$). However, the mean difference in terms of perceived ease of use was not significant ($p > 0.05$), indicating that both clusters had the same level of ease of use for the label. The post-hoc comparison highlighted that noncommunicable diseases consumers perceived front-of-pack nutritional labels as more useful ($M_{\text{Noncommunicable diseases}}$ = 4.93 vis-a-vis M_{healthy} = 4.87) and had a higher attitude towards front-of-pack nutritional labels ($M_{\text{Noncommunicable diseases}}$ = 5.42 vis-a-vis M_{healthy} = 5.32), whereas they reported similar perceived ease of use ($M_{\text{Noncommunicable diseases}}$ = 5.91; M_{healthy} = 5.82).

4. Study 2

After having understood the relevance of front-of-pack nutritional label for consumers with noncommunicable diseases, in Study 2 we benchmarked the differential effectiveness of two different labels in supporting them towards healthier and more informed food choices in absence of previous exposure to Nutritional labels.

4.1 Study 2a

4.1.1 Methods. The sample is composed of 258 European Union primary grocery shoppers with heart-related issues, living in countries where front-of-pack nutritional labels are not widely available.

Model	X^2	df	CFI	RMSEA (95% CI)	ΔCFI
Unconstrained	67,547	66	0.921	0.046 (0.041–0.051)	<0.01
Measurement weights	138,808	78	0.919	0.045 (0.041–0.051)	<0.01
Structural weights	179,513	81	0.919	0.044 (0.041–0.050)	<0.01
Structural covariances	189,074	82	0.918	0.044 (0.040–0.049)	<0.01
Structural residuals	190,836	86	0.917	0.045 (0.040–0.049)	<0.01
Measurement residuals	598,072	98	0.916	0.045 (0.039–0.047)	<0.01
Source(s): Credits – own elaboration					

Table 3.
Multi-group analysis –
measurement
invariance

Three manipulations were utilized: (1) NutrInform Battery with a high level of the specific nutrient (i.e. salt = 67%), (2) Nutri-Score with the symbol "D" and (3) a control group without any label (Appendix Figure A1). We decided to manipulate salt because it is a nutrient carefully considered by individuals affected by heart-related issues (Frisoli *et al.*, 2012; Strazzullo *et al.*, 2009). The stimuli were designed using nutrient levels of real products (Ham with a high salt level). The three manipulations allowed us to observe whether consumers with noncommunicable diseases limit in a different way the consumption of critical products when exposed to different labels or in absence of a label.

All participants were asked to respond to the same items presented in Study 1.

4.1.2 Results. To determine whether significant mean differences existed among the groups, we conducted an ANOVA and subsequently compared the groups using the Bonferroni post-hoc test. Additionally, we evaluated the scale's reliability by using Cronbach's alpha.

A one-way ANOVA revealed the main effects of our manipulation on perceived ease of use $(F(1,257) = 9.724; p < 0.001)$, perceived usefulness $(F(1,257) = 17.258; p < 0.001)$, attitude towards the label $(F(1,257) = 9.529; p < 0.001)$ and behavioural intention $(F(1,257) = 2.720; p < 0.05)$. The post-hoc comparison highlighted that respondent, when exposed to salty products, perceived the NutrInform Battery as more useful $(M_{NutrInform \, Battery-HighNutrients} = 5.65$ vs $M_{Nutri-Score} = 4.95$ vs $M_{Control} = 4.29)$, easy to use $(M_{NutrInform \, BatteryHighNutrients} = 5.93$ vs $M_{Nutri-Score} = 5.62$ vs $M_{Control} = 5.17)$ and had a higher attitude $(M_{NutrInform \, BatteryHighNutrients} = 5.85$ vs $M_{Nutri-Score} = 5.41$ vs $M_{Control} = 4.99)$. As for the behavioural intention, respondents with noncommunicable diseases intended to consume fewer high-risk foods when exposed to NutrInform Battery $(M_{NutrInform \, Battery-HighNutrients} = 3.97)$ vs Nutri-Score $(M_{Nutri-Score} = 4.40)$ vs control group $(M_{Control} = 5.40)$ (Appendix Figure A2). Subsequently, H3, H7, H10 and H11 are not rejected.

4.2 Study 2b

4.2.1 Methods. The sample was composed of 476 individuals with diabetes living in countries where front-of-pack nutritional labels are not widely available. Selected products were cookies with low sugar levels (manipulation shown in Appendix Figure A1).

Consumers were randomly exposed to three different conditions: (1) a NutrInform Battery with a low level of nutrients (i.e. Sugar = 0%); (2) a Nutri-Score with the symbol "A" and (3) the control group without any label. We manipulated sugar because it is a nutrient considered by individuals affected by diabetes (Teng *et al.*, 2021; American Diabetes Association, 2019). Consistent with Study 2a, nutritional labels and nutrient levels allowed us to observe intentional behaviour of consumers with noncommunicable diseases when exposed to different front-of-pack nutritional labels.

All participants were asked to respond to the same items presented in Study 1.

4.2.2 Results. We performed an Analysis of Variance (ANOVA) to assess whether there were significant differences among the groups. Subsequently, we compared the groups using the Bonferroni post-hoc test. In addition, we assessed the reliability of the scales by using Cronbach's alpha.

Results. One-way ANOVA revealed a significant effect of our manipulation on perceived ease of use $(F(1,475) = 18.199; p < 0.001)$, perceived usefulness $(F(1,475) = 40.1165; p < 0.001)$, attitude $(F(1,475) = 21.818; p < 0.001)$ and behavioural intention $(F(1,475) = 10.733; p < 0.001)$. The post-hoc comparison highlighted that respondent perceived the NutrInform Battery as more useful $(M_{NutrInform \, BatteryLowNutrients} = 5.38$ vs $M_{Nutri-Score} = 4.94$ vs $M_{Control} = 3.83)$, easy to use $(M_{NutrInform \, BatteryLowNutrients}:5.74$ vs $M_{Nutri-Score} = 5.77$ vs $M_{Control} = 4.91)$ and had a higher attitude towards the NutrInform Battery $(M_{NutrInform \, BatteryLowNutrients} = 5.50$ vs $M_{Nutri-Score} = 5.29$ vs $M_{Control} = 4.46)$. As for the behavioural intention, respondents with

noncommunicable diseases consumed less low-risk foods when exposed to Nutri-Score ($M_{Nutri-Score}$ = 5.00) than the NutrInform Battery ($M_{NutrInform\ BatteryLowNutrients}$ = 5.30). The control group scored a mean of $M_{Control}$ = 4.43. Consistent with our predictions, perceived usefulness, perceived ease of use and attitude towards the label were higher in the presence of front-of-pack nutritional labels than in the control group, and the NutrInform Battery was perceived as more useful, easy to use and with greater attitude towards the label. As for behavioural intention, the desired portion intake was higher for consumers who had seen the NutrInform Battery than for those exposed to Nutri-Score and control. Post-hoc comparison revealed that the difference between the Nutri-Score and Control Group was not significant (M_{diff} = 0.57; $p > 0.05$), whereas the NutrInform Battery significantly differed from the Nutri-Score (M_{diff} = 0.30; $p < 0.001$) and Control (M_{diff} = 0.87; $p < 0.001$) (Appendix Figure A2).

5. Study 3
Study 3 builds upon the findings of Study 2 and aims to validate them further by examining whether difference exists in terms of attitudes and behaviours among consumers with noncommunicable diseases residing in countries with different levels of exposure to front-of-pack nutritional labels.

5.1 Methods
We recruited 991 European primary grocery shoppers with noncommunicable diseases of which 578 in countries with front-of-pack nutritional labels exposure and 413 in countries without exposure.

Individuals responded to same set of items after being exposed in a randomized order to either NutrInform Battery or Nutri-Score manipulation. We used the same manipulation as in Study 1a.

Measures. All participants were asked to respond to the same items presented in Study 1.

5.2 Results
To assess differences among the groups, we performed an Analysis of Variance (ANOVA) test by using country exposure, manipulation and interaction as independent variables. Subsequently, we compared the groups using the Bonferroni post-hoc test. In addition, we assessed the reliability of the scales by using Cronbach's alpha.

One-way ANOVA revealed a significant effect of front-of-pack nutritional labels manipulation on perceived ease of use ($F(1,990)$ = 20.772; $p < 0.001$), perceived usefulness ($F(1,990)$ = 48.668; $p < 0.001$), attitude ($F(1,990)$ = 25.853; $p < 0.001$) and behavioural intention ($F(1,990)$ = 23.827; $p < 0.001$). The post-hoc comparison highlighted results comparable to those of previous studies.

As for country exposure, the ANOVA did not reveal a significant difference across the groups of the categorical variable, indicating that significant mean differences between countries with and without prior exposure are not reported. Moreover, the results do not report a significant interaction between front-of-pack nutritional labels and exposure, indicating that front-of-pack nutritional labels exerts an effect on the Dependent Variables regardless of country.

6. Discussion
In the current debate, originated by the "*From-Farm-to-Fork*" strategy on which Front-of-Pack label might better support European Union consumers towards healthier and more informed food choices, this research aims to provide additional evidence related to the

response of consumers with noncommunicable diseases when exposed to nutritional labels. By focussing on NutrInform Battery and Nutri-Score, two of the most studied and most debated labels developed in recent years by scholars and policy-makers, this research, drawing on front-of-pack acceptance model, shows how consumers with noncommunicable diseases interpret and respond to the information presented on front-of-pack nutritional labels. Specifically, Study 1 shows how consumers with noncommunicable diseases perceive front-of-pack nutritional labels as useful as compared to other individuals, and relevant to their specific health conditions. Also, respondents with noncommunicable diseases have similar levels of ease of use when it comes to front-of-pack nutritional labels, suggesting that there is no difference in the comprehension and potential utilization of front-of-pack nutritional labels in decision-making processes of different types of individuals.

More in detail, Study 1a indicates that the front-of-pack acceptance model was appropriate for both healthy respondents and consumers with non-communicable diseases, confirming that perceived ease of use positively influences perceived usefulness and attitude towards using front-of-pack nutritional labels, while perceived usefulness influences attitude, which in turn affects behavioural intention. Moreover, the mediating effects of attitude on the relationship between perceived usefulness and behavioural intention were found to be positive, indicating that attitude partially mediated the effect of perceived usefulness on behavioural intention. Thus, H1, H4, H5 and H8 were not rejected, extending the findings of the current literature, and indicating that the front-of-pack acceptance model can be applied to explain the acceptance of front-of-pack labels from consumers with diagnosed noncommunicable.

Moreover, Study 1b shows that consumers with noncommunicable diseases have more positive attitudes towards front-of-pack nutritional labels usage compared to healthy individuals, likely stemming out from the recognition of the importance of nutritional labels as a tool that supports their self-care and their dietary requirements. Specifically, it reveals that those consumers consider front-of-pack nutritional labels to be more useful and develop a greater attitude towards them, whereas there are no significant differences in terms of perceived ease of use. Hence, H2, H6 and H9 are not rejected. This finding advances the outcomes of previous studies (Mazzù et al., 2022a) showing how noncommunicable diseases consumers accept front-of-pack nutritional labels in assisting them towards healthier food choices.

We also observed that individuals with noncommunicable diseases exhibit higher behavioural intentions related to front-of-pack nutritional labels usage, implying that those individuals are more likely to act upon the information provided by nutritional labels and make food choices that align with their health needs. Thus, consumers are less likely to accept nutritional labels they perceive as less useful and easy to use.

The second set of studies uncovers the differential effects of different labels on consumers reaction, contributing to the literature by offering a comprehensive reading of the antecedents of the front-of-pack nutritional labels acceptance and showing the higher effectiveness of NutrInform Battery in supporting consumers with noncommunicable diseases during the selection of products.

Specifically, Study 2a uncovers the varying effects of different front-of-pack nutritional labels on consumers' ability to select appropriate food alternatives based on their health conditions. Results reveal that perceived usefulness, perceived ease of use and attitude differ significantly across the manipulated levels. Additionally, the NutrInform Battery was perceived as more useful, easy to use and led to a better attitude. Results confirm that conditions without front-of-pack nutritional labels are associated with higher degrees of portion intake of critical nutrients and show that NutrInform Battery has a lower consumption than the Nutri-Score, indicating its ability to better inform consumers when exposed to potentially perilous foods. This finding contributes to existing literature (Egnell et al., 2018c; Talati et al., 2018; McCrickerd et al., 2020) by suggesting that different front-of-pack nutritional labels formats may have varying levels of effectiveness to consumers, a

relevant factor in implementing labelling policies. The NutrInform Battery format better informs consumers about potentially unhealthy food choices, leading to more controlled propensity towards portion intake. Thus, for individuals with noncommunicable diseases, exposure to NutrInform Battery, which provides more detailed nutrient composition information, leads to the selection of smaller portions of products with nutrients that pose a risk to their specific health condition compared to Nutri-Score and the no-label alternative.

Coherently, the opposite results were observed in Study 2b. Consumers with noncommunicable diseases exposed to products that do not contain harmful nutrients for their specific health condition are less secure to consume such products when either exposed to Nutri-Score (with the green symbol "A") or no-front-of-pack nutritional labels vs the case when they are exposed to the NutrInform Battery (with specific nutrient level = 0%). This suggests that consumers are possibly more confident in the usage of the product in the presence of nutrient-specific labels than in their absence when the product is healthy. The results highlight the greater ability of NutrInform Battery to orientate the propensity of consumers towards a more informed selection of food products. Evidence indicates not only that the NutrInform Battery is perceived as more useful, easy to use and generates a higher attitude among consumers compared to the Nutri-Score, but also underscore the importance of considering the specific design and information provided by front-of-pack nutritional labels in relation to consumers' health conditions and prefer a higher degree of information provided to consumers.

Finally, Study 3 investigates whether the effects of front-of-pack nutritional labels differ in countries with prior exposure to labelling systems compared to those without such exposure. Results show that, for consumers with noncommunicable diseases, the differences observed in Studies 1 and 2 do not vary significantly as a function of consumers' prior exposure to front-of-pack nutritional labels, thus generalizing the applicability of the findings in terms of perceptions, attitudes and behavioural intentions across various geographical contexts, implying that nutritional labels can have consistent effects on individuals with noncommunicable diseases across different countries, regardless of prior exposure.

This paper makes a theoretical contribution to the literature by presenting a model that considers differences across European territories and offer evidence that should be considered to identify an approach that allows countries to implement a harmonized front-of-pack nutritional labels options.

Findings suggest relevant implications for scholars, managers and policymakers. On one side, researchers should further explore how this specific segment can proficiently utilize front-of-pack nutritional labels to select appropriate dietary requirements that can protect their health status. On the other side, firms should consider how to improve the communication available on the packaging and how to integrate relevant nutritional information that might be visible and useful to those customers, especially in the absence of Nutritional labels. Finally, policymakers should consider how information relevance and priority differ among different customer groups, and whether some groups should be prioritized in terms of nutritional communication, consequently selecting the most effective front-of-pack nutritional label.

The study is not exempt from limitations. While the sample focus on a relevant segment, it may not represent the entire population of individuals with noncommunicable diseases. Further, the study provides insights into the effects of two labels, disregarding the analysis of other alternatives. Future research could then extend the understanding of the impact of nutritional labels on other vulnerable populations and explore methods to make labels more effective for noncommunicable diseases groups. Additionally, while some studies have shown that front-of-pack nutritional labels influence immediate food choices, it is unclear whether these effects are sustained over time. This research primarily examines the immediate effects of front-of-pack nutritional labels on food acceptance and portion selection, while it does not assess the long-term impact of such labels on dietary behaviour, health outcomes, or sustained adherence to healthier food choices. Future research should also examine if a combination of front-of-pack

nutritional labels (Mazzù *et al.*, 2023) might further improve the outcomes to the benefit of consumers with noncommunicable diseases and observe the effects of nutritional labels on portions' selection in real shopping or consumption contexts.

7. Conclusion

The recognition of the importance of front-of-pack nutritional labels in promoting healthier and more informed food choices extends to individuals with noncommunicable diseases, a significant customer group in the European Union. This research highlights how those customers rely on nutritional labels as a tool to make healthier and more informed food choices. Among the tested labels, their preference leans towards the NutrInform Battery for guiding portion selection and reducing the likelihood of selecting potentially riskier alternatives.

Note

1. About 60mn people, aged 25 years and over, suffers from diabetes in the European Region (https://www.who.int/europe/health-topics/diabetes#tab=tab_1); About sixty million people are living with Cardio-Vascular Diseases in the European Union, and 13mn new cases of Cardio-Vascular Diseases are diagnosed in the region every year. Even in the absence of a global pandemic, Cardio-vascular diseases are the leading cause of death in the European Union (https://www.efpia.eu/about-medicines/use-of-medicines/disease-specific-groups/transforming-the-lives-of-people-living-with-cardiovascular-diseases/).

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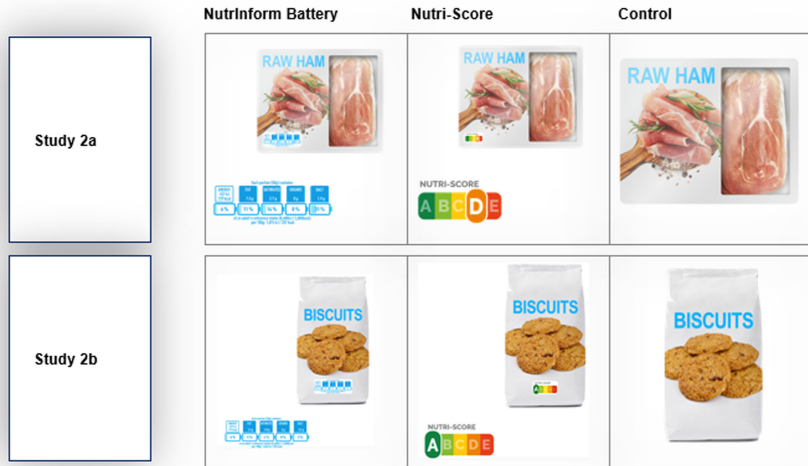
Appendix

Figure A1.
Manipulation of
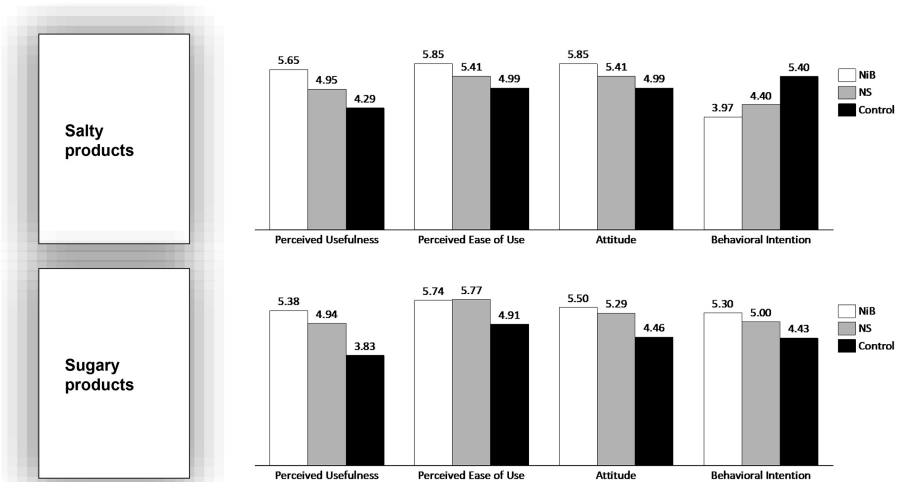studies 2a and 2b

Source(s): Own elaboration

Figure A2.
Mean differences
between NutrInform
battery, Nutri-Score
and control group
across variables of
FOPAM by salty and
by sugary products

Source(s): Own elaboration

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