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Molecular marketing, personalised information and willingness-to-pay for functional foods: Vitamin D enriched eggs

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Abstract

Increasingly, the health claims made by food products focus on the marketing of specific molecular enrichments. Research exploring consumers' willingness to pay (WTP) for health claims assumes that individuals hold perfect information on the benefits of the enrichment, and that their valuations depend solely on whether or not they need to improve their health. While health interventions are aimed at individuals at higher health risk, consumers may be unaware of the health risks that they face, limiting the effectiveness of a generic targeting strategy. Using an orthogonal experimental design, we explore the impact of two factors on the WTP for vitamin D enrichment in eggs: whether the information is person-specific or generic; and the presence of a health claim explaining the vitamin D enrichment. Results indicate that it is the provision of information, not the health claim, that influences WTP. Both generic and personalised information lead to similar increases in the WTP for vitamin D enrichment. While we only observe a direct effect of generic information on the WTP for vitamin D enrichment, personal information may also operate by increasing the perceived risk of vitamin D deficiency. Our results support the use of

personalised health information during the choice task as a means of increasing the sales of healthy products.

KEYWORDS
choice experiment, eggs, functional food, health claims, personalised marketing, vitamin D enrichment

JEL CLASSIFICATION
C25; D12; D91; I12; M31; Q18

1 | INTRODUCTION

Health claims are an important tool for manufacturers to communicate the benefits of food products in a competitive, differentiated marketplace (Domínguez Díaz et al., 2020). In recent years, the marketing of foods has become increasingly 'molecular', with new products often designed by adding specific molecules (e.g., omega-3 fatty acids, vitamins or minerals) to food products that are traditionally low in these micronutrients (Bogue et al., 2017; Cucick et al., 2020; Domínguez Díaz et al., 2020; Jones & Jew, 2016). Although such novel 'functional', 'biofortified' or 'enriched' foods are gathering interest in policy arenas due to their potential benefits for public health, there is limited consumer research on their reception. Previous research has focused on the impact of broad health claims on consumers' willingness to pay (WTP), purchase likelihood or product evaluations (Banovic et al., 2018; Hellyer et al., 2012; Jones & Jew, 2016; Pappalardo & Lusk, 2016; Szakály et al., 2019). This literature implicitly assumes that individuals hold perfect information on the likely benefits of the enrichment. However, consumers may be unaware of their health status (Cardon & Hendel, 2001), particularly at a micronutrient level, and may not recognise, or ignore, the potential benefits being offered by nutrient-enriched products. Other literature explores the impact of claims on risk perceptions (Chandon & Wansink, 2007; Chiou et al., 2009; Walker Naylor et al., 2009), but makes a limited contribution to consumers' valuations of the claims.

Current marketing techniques are increasingly interactive, with suppliers providing personalised information on products to target the needs of consumers (e.gArora et al., 2008; Khan et al., 2009; Nair et al., 2017; Zhang, 2011). Today, retailers have access to an unprecedented amount of information on their customers (e.g., from loyalty cards) which can be used to estimate a person's preferences and thus improve the targeting of products and increase profitability (Ghose & Huang, 2009; Nair et al., 2017). Personal data can also be used to identify metabotypes, defined as clusters of individuals who have similar metabolic profile, and predisposition to diseases (e.g., Brennan, 2017), and to identify their specific dietary needs, with a view to using marketing activities to improve public health. The success of such initiatives depends on the ability of markets to both supply products that improve health and to ensure that those consumers who would benefit from these products actually purchase them. However, unless individuals are aware of the need to supplement their diets, then the consumers most likely to purchase products that claim health benefits are those who are driven by risk aversion (Barreiro-Hurlé et al., 2010).

Improved targeting through the provision of personalised information can facilitate the matching of products to consumers with actual health needs. Our aim is to identify what information is most effective in encouraging the uptake of products fortified with vitamin D, a micronutrient in which a large proportion of the UK population is considered to be deficient (Miller et al., 2016; SACN, 2016). Here, information effectiveness is defined as the ability to

reach those individuals most in need of the information, specifically consumers at a high risk of vitamin D deficiency. The UK food sector has attempted to address vitamin D deficiency by increasing its availability through the enrichment of breakfast cereals, fat spreads and bread with vitamin D, and, more recently, by increasing vitamin D in eggs through adding it to chicken feed (Leeson & Caston, 2003; Mattila et al., 2004). However, little research has been done on the performance of these products in the marketplace.

We explore whether the provision of personalised, rather than generic information, increases the uptake of foods enriched with vitamin D by consumers who are likely to be deficient in this vitamin. We use a choice experiment (CE) to explore how preferences are affected by information on vitamin D status. First, experimental methods are used to manipulate the information consumers receive, with study participants receiving either personalised, generic or no information on their vitamin D status. Then a CE is used to measure individual WTP for vitamin D enrichment in eggs. This allows us to test whether the provision of tailored information on individual health status is an effective means of matching consumers with the most appropriate product within a choice set (see, e.g., Manski, 2018).

2 | VITAMIN D CONSUMPTION IN THE UK

Vitamin D plays an important role in the mineralisation of bones, ensuring long-term skeletal health (Holick, 2007; Prentice, 2008), and plays a protective role for a range of illnesses (see e.gHolick, 2007; Pfotenhauer & Shubrook, 2017; Prentice, 2008; Theodoratou et al., 2014). Vitamin D levels are monitored by measuring the concentration of 25-hydroxyvitamin D (or 25(OH)D) in the blood (Heaney, 2004; Holick, 2007). The human body can synthetise vitamin D naturally through exposure to sunlight, and through the consumption of food high in vitamin D (see Appendix S2, for more details). Public health guidelines suggest that serum levels of 25(OH)D below 25 nmol/l indicate a high risk of vitamin D deficiency, while levels above 50 nmol/l indicate a healthy status, and intermediate levels indicate a moderate risk of vitamin D deficiency (SACN, 2016). Vitamin D deficiency is a endemic problem (Cashman et al., 2016; Dobnig, 2011; Holick, 2008, 2010), affecting 20% of the UK population[1] (Calame et al., 2020; Hill, 2014; SACN, 2016). As a result, an increase in intake of vitamin D from the biofortification of food products could improve the quality of life of the UK population, decreasing long-term healthcare costs (Calvo & Whiting, 2013; Cashman & Kiely, 2016; Hayes & Cashman, 2016), provided that consumers value the enrichment and buy enriched products.

3 | PERSONALISED HEALTH INFORMATION AND CONSUMER BEHAVIOUR

3.1 | Uncertain health status and response to health information

Imagine a consumer i with observable health status H_i, and (unobservable) vitamin D status ξ_i. The consumer is considered vitamin D deficient if ξ_i is below a threshold $\bar{\xi}$; the individual cannot observe ξ_i (see also Cardon & Hendel, 2001 for a model where individuals have asymmetric information on their own health status), and estimates it as $\tilde{\xi}_i = \xi_i + b_i$, where b_i is a possibly non-zero (biased) estimation error (see Allcott & Sunstein, 2015). The consumer shops in a market with $j = 1,\ldots,J$ products; some are enriched with vitamin D, indicated as $D_j = 1$, and sold at a premium $c_j > 0$; others, indicated as $D_j = 0$, are not, and

[1]See also https://www.nutrition.org.uk/nutritioninthenews/new-reports/983-newvitamind.html

c_j =0. If $P(\tilde{\xi}_i > \bar{\xi}|D_j, H_i)$ is the subjective probability that a consumer will not be vitamin D deficient after consuming a product with characteristics D_j, and $U(D_j, \tilde{\xi}_i, c_j)$ is the utility of the consumer when choosing D_j and estimating $\tilde{\xi}_i$, the utility of the decision is (see Manski, 2018):

$$P(\tilde{\xi}_i > \bar{\xi}|D_j, H_i) \cdot U(D_j, \tilde{\xi}_i > \bar{\xi}, c_j) + [1 - P(\tilde{\xi}_i > \bar{\xi}|D_j, H_i)] \cdot U(D_j, \tilde{\xi}_i < \bar{\xi}, c_j) \quad (1)$$

Compared to Manski (2018), the treatment (purchase of vitamin D enriched eggs) and the health outcome are endogenous, because they originate from the same decision-maker: the consumer evaluates their own health status, and decides on the type of product to purchase. Following Equation (1), the consumer purchases the product enriched with vitamin D if:

$$\begin{aligned} &P(\tilde{\xi}_i > \bar{\xi}|D_j = 1, H_i) \cdot U(1, \tilde{\xi}_i > \bar{\xi}, c_j) + [1 - P(\tilde{\xi}_i > \bar{\xi}|D_j = 1, H_i)] \cdot U(1, \tilde{\xi}_i < \bar{\xi}, c_j) > \\ &P(\tilde{\xi}_i > \bar{\xi}|D_j = 0, H_i) \cdot U(0, \tilde{\xi}_i > \bar{\xi}) + [1 - P(\tilde{\xi}_i > \bar{\xi}|D_j = 0, H_i)] \cdot U(0, \tilde{\xi}_i < \bar{\xi}) \end{aligned} \quad (2)$$

that is, if choosing product D_j =1 yields a higher utility than choosing D_j =0.

In Equation (2), the consumer makes a choice based on an estimate of the vitamin D level, rather than the actual value, and on the subjective probability that the purchase will be effective. An extreme case would occur if the consumer believes that $\tilde{\xi}_i > \bar{\xi}$ if D_j =1 and $\tilde{\xi}_i < \bar{\xi}$ if D_j =0 with certainty; that is $P(\tilde{\xi}_i > \bar{\xi}|H_i, D_j = 1) = 1 P(\tilde{\xi}_i > \bar{\xi}|H_i, D_j = 0) = 0$ $U(1, \tilde{\xi}_i > \xi, c_j) = U(1, \tilde{\xi}_i > \bar{\xi}) - U(c_j)$, the probability of choosing the enriched product is:

$$U(1, \tilde{\xi}_i > \bar{\xi}) - U(0, \tilde{\xi}_i > \bar{\xi}) > U(c_j)$$

In this case, everyone will buy the supplement if the enrichment is valued more than the price premium, irrespective of the actual deficiency risk.

3.2 | Personalised health information and choice

From the perspective of the policy-maker, the bias $b_i = \tilde{\xi}_i - \bar{\xi}$ is problematic, because it can lead to suboptimal choices (see Allcott & Sunstein, 2015). This bias can be addressed by improving the ability to estimate, $\tilde{\xi}_i$, or by providing ξ_i, if known. Three main strategies can be used to improve the accuracy of $\tilde{\xi}_i$, (Arora et al., 2008). First, retailers and policy-makers can target all N consumers with the same message, calibrated to the average preference of the population, using a 'generic' one-size-fits-all approach which informs on the risks of vitamin D deficiency. Second, they can design a message that targets a more homogeneous cluster of $M<N$ consumers (in terms of relevant health preferences), using a 'segmented' approach (Lichtenstein et al., 1997; Onwezen et al., 2012), for instance targeting better-educated consumers with complex information, and less-educated consumers with more accessible information. Whilst reducing heterogeneity, segmentation retains variation in preferences within a segment and consumers may still differ significantly in their susceptibility to diseases (Brennan, 2017). Third, consumers can be provided with information that is designed specifically for each user, using a 'personalised' approach (Arora et al., 2008; Ghose & Huang, 2009; Nair et al., 2017; Zhang, 2011), providing them with ξ_i (or an unbiased and informed estimate). The personalisation increases the accuracy of $\tilde{\xi}_i$, increasing the marginal utility – and WTP – of D_j when the personal risk of vitamin D deficiency is high.

3.3 | The persuasive role of a claim

The choice of a vitamin D fortified option depends on the belief that this option is effective in addressing vitamin D deficiency, which is captured by the term $P\left(\tilde{\xi}_i > \bar{\xi} | H_i, D_j = 1\right)$, the subjective probability that the consumer is not vitamin D deficient if D_j =1. The presence of a health claim C_j may increase this probability by strengthening this belief. Research on linguistics[2] (Grewal et al., 1997) identifies three functions that explain the effectiveness of a claim: a *cognitive function*, where claims provide objective facts about a product that only require consumers to understand them (see also Williams, 2005); a *conative function*, as claims engage consumers by urging them to perform the activity promoted; and an *expressive function*, where the presence of the claim in itself induces consumers to explore the reasons that motivated the use of such a claim (Hilton, 1995; Hilton et al., 2018). Indeed, research evidence suggests that health claims provide information on product quality that enters the evaluative process of consumers (Kiesel & Villas-Boas, 2013; Kozup et al., 2003; Raghunathan et al., 2006; Walker Naylor et al., 2009). The subjective probability component can then be written as:

$$P\left(\xi_i > \bar{\xi} | H_i, D_j = 1, C_i = 1, c_j\right) > P\left(\xi_i > \bar{\xi} | H_i, D_j = 1, C_i = 0, c_j\right)$$

That is, the claim is expected to increase the perceived probability that vitamin D deficiency does not arise if D_j =1, compared to the absence of a claim.

4 | EXPERIMENTAL DESIGN

To test the impact of information type on consumer choices, we design an experiment using a 2 (claim vs. no claim) ×3 (no information vs. generic information vs. personalised information) between-respondent orthogonal design that manipulates two aspects: the specificity of information on vitamin D status; and the presence of a health claim.

4.1 | Information on vitamin D status

4.1.1 | Generic health information

Generic information was sourced from the National Health Service (NHS).[3] This text indicated that vitamin D deficiency is associated with specific factors (e.g., lifestyle, ethnicity), providing the same information to everyone. The exact text is provided in Appendix S1.

4.1.2 | Personalised health information

Personalised information refers to the provision of the level of vitamin D in the blood of the consumer, presented after the generic health information message. This information was estimated from the demographic, lifestyle and consumption information that consumers provided at the start of the survey detailed in Section 6. The information collected was entered automatically

[2]Jakobson (1960) presents more than three functions in his analysis of language, but we only focus on those discussed in Grewal et al. (1997), which more closely reflect the reality of labels and claims.

[3]https://www.nhs.uk/conditions/vitamins-and-minerals/vitamin-d/

into a JavaScript programme, which provided an estimate of the amount of serum 25(OH)D of the respondent, obtained using the parameters presented in Appendix S2, based on National Diet and Nutrition Survey (NDNS) data. Along with the estimated level of vitamin D in their blood, participants also received information on their risk of vitamin D deficiency, presented in Figure A1. At this point, respondents at high risk saw a *red* message saying:

> The level of Vitamin D in your blood is VERY LOW. You need to consider taking dietary supplements and eating more foods rich in vitamin D

Participants at intermediate risk saw a *yellow* message that read:

> The level of Vitamin D in your blood is A BIT LOW. You could consider taking dietary supplements and eating more foods rich in vitamin D

Finally, a person not at risk saw a *green* message reading.

> The level of Vitamin D in your blood is GOOD. There is no need for you to take dietary supplements.

This simple infographics approach to the presentation of risk information is based on the work of Spiegelhalter et al. (2011), while the cut-off points used existing guidelines on vitamin D levels (EFSA Panel on Dietetic products, 2014; Holick et al., 2011; SACN, 2016).

4.2 | Health claim

The second manipulation aimed to test the effect of a (legally valid) health claim. We used an 'enhanced function claim' that highlights the ability of vitamin D to keep bones and teeth healthy, designed to be short and informative (as recommended in Williams, 2005). Following the European Food Standards Agency (EFSA) definition of products high in vitamin D (EFSA Panel on Dietetic products, 2014), the claim states that the enriched egg 'Helps maintain normal bones and teeth'. This claim provides additional information by stating the benefits of the enrichment. By EFSA rules, this claim can be used by any food supplemented with vitamin D.

5 | MODELLING CONSUMER CHOICES

Our aim is to determine the impact of information on consumer WTP for vitamin D enrichment. As before, imagine a consumer i with observable health status H_i, and vitamin D status ξ_i. The market offers $j = 1,\ldots,J$ goods. Products differ in vitamin D content D_j, equal to 1 if the product is enriched with vitamin D (0 otherwise); other product characteristics $\underline{x}_j$; and price p_j. The consumer will choose by maximising the (indirect) utility function:

$$U = U(D_j, x_j, p_j)$$

Following Wensing et al. (2020), we use a Random Parameter Logit with Error Component (RPL-EC). In line with the choice modelling literature (Revelt & Train, 1998), the utility U_{ijn} consumer i obtains from option j in choice occasion n corresponds to:

$$U_{ijn} = V_{ijn} + \varepsilon_{ijn}$$

where V_{ijn} is the deterministic utility component, defined as $V_{ijn} = \alpha_{1i}D_{ijn} + \alpha_{2i}x_{ijn} + \delta p_{ijn}$, and ε_{ijn} is a random utility component. The resulting utility function is (Wensing et al., 2020):

$$U_{ijn} = ASC_j + \alpha_{1i}D_{ijn} + \alpha_{2i}x_{ijn} + \delta p_{ijn} + 1(\omega_{in}) + \varepsilon_{ijn} \tag{3}$$

In Equation (3), ASC_j refers to an alternative-specific constant (ASC) for the no-purchase option and the value option (see Section 6.3), which does not vary across consumers and choice occasions. The term $1(\omega_{in})$ refers to the error component, which is a binary operator equal to 1 for the two options that vary across time and consumers. Equation (3) captures individual preferences and tastes by using coefficients that vary across consumers as:

$$\begin{aligned} \alpha_{1i} &= \overline{\alpha}_1 + \beta G_i + \sigma_m \eta_{1i} \\ \alpha_{2i} &= \overline{\alpha}_2 + \sigma_m \eta_{2i} \end{aligned} \tag{4}$$

where m = 1, 2, and G_j is the experimental group of the respondent, which targets D_j only. The term σ_m is the standard error of the coefficient, while η is a random error. Compared to a simpler random parameter logit, the RPL-EC model is more effective at addressing the potential heteroscedasticity within individual choices: in each choice occasion, heteroscedasticity may arise because the options available for purchase correlate due to unobservable preferences for eggs that are common for each consumer; these preferences do not apply to the ASCs, which are different goods (Scarpa et al., 2007; Wensing et al., 2020). The RPL-EC model captures this heteroscedasticity by adding a dummy variable equal to 1 for all time-varying purchase options in the choice set (the term $1(\omega_{in})$ in Equation 3), obtaining a parameter with zero mean and a normally distributed random error.

From Equation (6), the *population WTP* for vitamin D can then be calculated as the trade-off between price and vitamin D enrichment, which can be used to estimate WTP as (e.gAlfnes et al., 2006; Rigby et al., 2010; Scarpa et al., 2007):

$$WTP_i = \frac{\partial p}{\partial D} = -\frac{\partial U/\partial D}{\partial U/\partial p} = -\frac{\alpha_{1i}}{\delta}$$

This measure of WTP is based on the population parameters α_{1i} and δ. Individual values of WTP can be estimated by simulation, conditioning the distribution of the parameter α_{1i} on the past choices of the consumer, obtaining the *conditional WTP* (see Train, 2009, chapter 11). Because the population WTP does not condition on past choices, the estimated value is not identical to the conditional WTP, but estimates are close if the model is correctly specified (Train, 2009, pp. 313–315).

The impact of the manipulation on WTP is then estimated using the three-equation seemingly unrelated regression:

$$WTP_i = \theta_0 + \theta_1 I_i + \theta_2 C_i + \theta_3 I_i C_i + \theta_4 PR_i + \theta_5 R_i + \theta_6 T_i + \theta_7 M_i + e_i \tag{6}$$

$$PR_i = \gamma_0 + \gamma_1 I_i + \gamma_2 C_i + \gamma_3 I_i C_i + \gamma_4 T_i + \gamma_5 M_i + w_i$$

$$R_i = \pi_0 + \pi_1 I_i + \pi_2 C_i + \pi_3 I_i C_i + \pi_4 T_i + \pi_5 M_i + \vartheta_i$$

$$T_i = \varphi_0 + \varphi_1 I_i + \varphi_2 C_i + \varphi_3 I_i C_i + \varphi_4 M_i + u_i$$

This system estimates the impact of the information main effect I_i, the claim main effect C_i, and their interaction on the estimated individual-level WTP_i, adjusting for personal characteristics M_i. In the second equation, the dependent variable PR_i corresponds to the

perceived risk of vitamin D deficiency (see Section 6.4.1); in the third equation, the dependent variable R_i refers to risk attitudes (see Section 6.4.2); and in the fourth equation, the dependent variable T_i is the time spent reading the information provided. Because of the presence of a control, this approach may remove the hypothetical bias of the choice experiment: as long as the bias is unrelated to the interventions, all groups have the same *average* hypothetical bias, which cancels out when estimating the difference in WTP between a treatment and the control.

6 | DATA

6.1 | Data collection and sampling strategy

The CE was conducted online, using the panel of the market research company Dynata (formerly ResearchNow). The exercise targeted around 300 respondents per group for the six experimental groups (1800 respondents in total) from the over 350,000 UK panellists available. The sample was chosen to be representative of the UK population for gender, age and region (North of England, Central England/Midlands, South of England, Wales, Scotland, Northern Ireland).[4] The survey started on 6 November 2017, and was completed on 21 November 2017. November was chosen for the survey because it is a month with low sunlight, therefore with a higher need for dietary integration of vitamin D.[5]

6.2 | Initial survey

Before the CE, participants were asked a range of questions on their food consumption (e.g., dairy products), lifestyle (e.g., physical activity, sunshine exposure), and biometric variables (e.g., body mass index, age). These variables mirrored those in Appendix S2, and questions were formulated exactly as those in the NDNS. This information was collected for everyone at the start of the questionnaire and was then used to estimate the vitamin D level of the respondent as indicated by the model in Appendix S2. Participants were unaware that their answers were being used to predict their vitamin D levels. The estimated vitamin D level was only shown to participants in the personalised information treatment.

6.3 | Choice-set design

In the CE, products differed across four dimensions: egg size (mixed, medium or large), production method (organic or free-range[6]), vitamin D enrichment (no or yes) and price[7] (£0.88, £1.22, £1.41, £1.78, £2.25). The study uses a mixed design, with each choice set consisting of four options: two options were obtained from the randomisation of the four attributes above using

[4]For age and gender quotas, see https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland. For regional quotas, see instead https://www.gov.uk/guidance/contacts-phe-regions-and-local-centres (please note that the NDNS merges London with the South region).

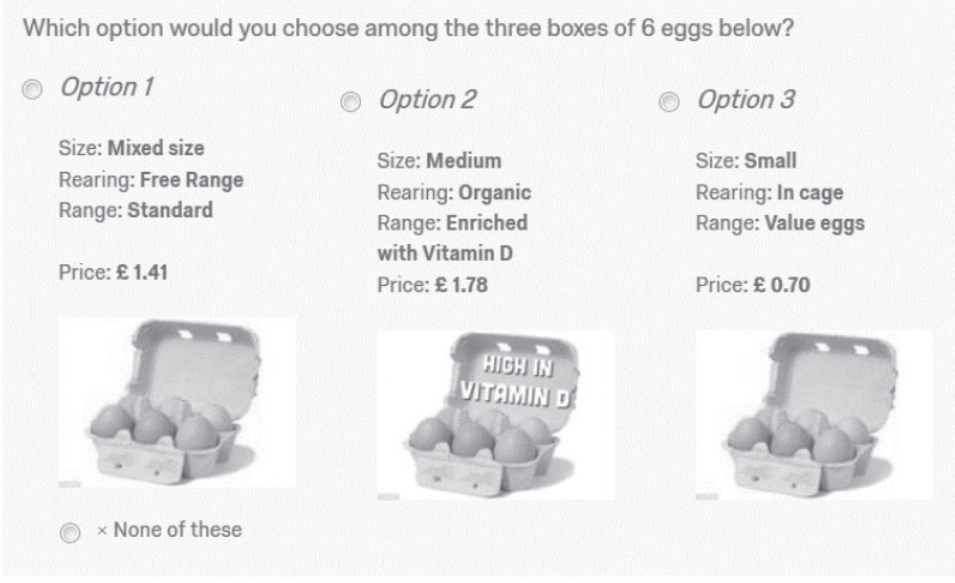
[5]See also https://www.nhs.uk/conditions/vitamins-and-minerals/vitamin-d/

[6]Apart from the value products, all remaining products in the market had either an organic or a free-range label.

[7]Prices reflected the distribution of the prices in the actual marketplace.

a blocked D-optimal design (Johnson et al., 2013), generated with the software Ngene (Choice Metrics); one fixed option was the value-range option (small size, reared in cage, sold at £0.70), which was the same for everyone in every choice occasion; and an opt-out option, where the consumers would spend nothing and receive no eggs (Figure 1). The design led to 10 blocks rotated across respondents in all treatment groups, with each participant facing a single block of 6 different choice sets. The 'claim' manipulations (explained below) used exactly the same 10 blocks and vitamin D enriched products carried a very visible claim, which stated 'Helps maintain normal bones and teeth' (Figure 2).

(a) Treatment with no claim



(b) Treatment with claim

FIGURE 1 Graphical representation of a choice card, with and without claim

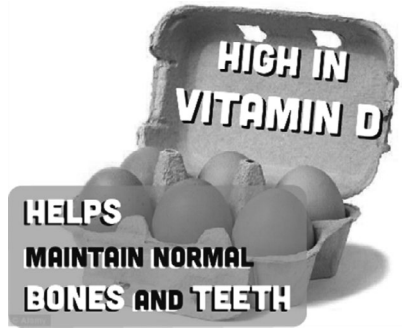


FIGURE 2 Graphical representation of the additional health claim

6.4 | Final survey questions

After the CE, consumers answered a final set of questions on their attitudes and beliefs. The full questionnaire can be found in the Appendix S1.

6.4.1 | Perceived risk of vitamin D deficiency

Participants reported their perceived risk of vitamin D deficiency by indicating how much they agreed with the statement *'I am at risk of Vitamin D deficiency'* using a scale from 0 to 100. This question works as a manipulation check, to determine whether participants perceive a higher risk of vitamin D deficiency when presented with information on the topic. To avoid making this question too salient, participants reported their agreement (on a 0–100 scale) to statements related to animal welfare *('I am concerned with the welfare of chickens'*), organic production (*'Organic products are not different from conventional ones'*), and price (*'Price is the main criteria I use when shopping for food'*). These four items were presented in a random order.

6.4.2 | Attitudes towards health risk

Attitudes towards health risk were collected using the scale of Weber et al. (2002, Appendix S2). Items were presented in a random order.

7 | RESULTS

7.1 | Descriptive characteristics of the sample

Table 1 reports the summary statistics of the six sub-samples. Compared to the NDNS sample (Table A2 in Appendix S2), participants in the CE are slightly younger, taller and heavier, and have slightly lower estimated levels of 25(OH)D. Sub-samples are not significantly different on any of the characteristics measured prior to the experiment. The statistical tests reported in Table 1 indicate that the experimental stimuli influenced the perceived vitamin D risk, which was measured after the CE, as well as affecting the time taken to read the vitamin D information page and the time taken for the CE. Interest in price, animal welfare and organic products, as well as risk attitudes, which were all measured after

TABLE 1 Characteristics of the sample, by experimental condition

Variable	Control	Generic	Personal	Claim	Generic +Claim	Personal +Claim	K-W χ^2
Estimated 25(OH)D (nmol/l)	38.1	37.7	37.6	39.4	39.8	37.5	6.4
Perceived vitamin D deficiency risk	41.7	44.3	50.2	38.5	43.5	51.8	52.9***
Age (years)	46.7	46.6	45.3	47.1	46.1	46.3	1.7
Weight (kg)	81.8	80.1	79.0	79.4	79.6	81.2	1.5
Height (cm)	170.6	171.1	170.6	171. 2	170.5	171.0	4.9
Time spent outside (h/week)	22.3	20.5	21.0	22.0	22.6	22.9	4.8
Skimmed milk[a]	0.8	0.8	0.7	0.8	0.7	0.8	1.7
Semi-skimmed milk[a]	1.1	1.1	1.1	1.2	1.1	1.1	5.2
Whole milk[a]	0.7	0.7	0.7	0.6	0.6	0.7	0.7
Yogurt, fromage frais, dairy desserts[a]	0.7	0.7	0.7	0.7	0.7	0.7	1.3
Cheddar cheese[a]	0.8	0.8	0.7	0.7	0.7	0.7	5.2
Cottage cheese[a]	0.3	0.3	0.3	0.3	0.3	0.3	1.7
Other cheese[a]	0.4	0.5	0.4	0.4	0.4	0.4	2.6
Butter[a]	2.7	2.9	2.5	2.3	2.7	2.9	1.8
Eggs[a]	0.7	0.7	0.7	0.7	0.7	0.7	0.6
Oily fish[a]	0.4	0.4	0.3	0.3	0.4	0.3	3.1
PUFA, margarines, other oils[a]	0.5	0.5	0.4	0.4	0.5	0.5	1.0
Reading time (seconds)	7.9	21.3	30.3	3.1	20.8	26.8	802.2***
Choice time (seconds)	25.9	18.1	19.2	25.8	15.4	18.7	13.1**
Male (%)	50.5%	48.0%	47.3%	53.4%	49.7%	47.3%	3.4
Vitamin D supplementation (%)	28.1%	34.3%	32.7%	30.0%	32.3%	30.5%	3.4
>3.5 h/week of physical activity (%)	77.9%	84.1%	75.5%	80.1%	82.6%	77.1%	10.4*
Asian ethnicity (%)	7.6%	11.6%	10.3%	6.8%	7.5%	6.9%	7.5
Vegan or vegetarians (%)	12.9%	12.3%	12.7%	10.7%	10.2%	14.9%	3.8
Skin colour: white (%)	92.1%	90.3%	93.0%	94.8%	92.9%	93.5%	4.9
Cigarettes – % None/day (mode)	71.9%	78.7%	70.6%	72.6%	72.0%	70.5%	6.5
Alcohol – 1–2/week (mode)	29.0%	25.6%	29.4%	28.7%	26.7%	27.3%	1.4
Observations	303	277	330	307	322	275	

Note: Significance is as follows: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

Abbreviation: K-W, Kruskal-Wallis.

[a]Value is in portions per day.

the experimental stimuli, did not differ across groups (see also Table A5 in Appendix S3). Table 2 shows that groups are also very similar in their estimated risk of vitamin D deficiency, based on their apparent diets and healthy living responses, with most participants (65–75%) in all groups being classified as medium risk.

7.2 | Perceived risk, blood 25(OH)D and health risk-taking attitudes

In this exercise, the blood level of 25(OH)D, which is inversely related to vitamin D deficiency, was estimated using the model presented in Appendix S2. The average estimates for each of the CE groups are shown in Table 1, which shows no significant differences between the groups. Participants also reported their perceived risk of vitamin D deficiency.

Health risk-taking attitudes (risk attitudes, for short) were measured using eight items from the refined risk behaviour scale, designed to reflect the likelihood of engaging in behaviours that have a significant risk to health—for example, not wearing a helmet when riding a motorcycle, or regularly eating high cholesterol foods (see study 3 in Weber et al., 2002). As in the original article, these eight items load into a single factor with a Principal Component Analysis (Table 3), and have a Cronbach's α greater than 0.7 ($\alpha = 0.74$ in this study, versus 0.77 in Weber et al., 2002). We use the Bartlett's factor score in the following analyses.

Table 4 indicates that risk attitudes are positively correlated to perceived risk in all treatments, except when personalised information is presented without a claim. Actual blood levels of 25(OH)D are unrelated to risk attitudes and perceived risk in all treatments, except when claim and personalised information appear jointly, and when a claim appears alone (only for perceived risk). These results indicate that, as expected, risk perceptions are primarily driven by attitudes, rather than actual vitamin D status, which is harder for individuals to identify.

TABLE 2 Proportion of participants by vitamin D deficiency risk class

	Risk class		
	Low	**Medium**	**High**
Control	16.2%	69.6%	14.2%
Generic	13.0%	74.7%	12.3%
Personal	14.5%	71.8%	13.6%
Claim	18.9%	70.7%	10.4%
Generic +Claim	18.9%	67.7%	13.4%
Personal +Claim	17.8%	65.5%	16.7%

Note: Low risk: serum levels of 25(OH)D > 50 nmol/l; Medium risk: serum levels of 25(OH)D between 25 and 50 nmol/l; High risk: serum levels of 25(OH)D < 25 nmol/l (SACN, 2016).

TABLE 3 Results from a principal component analysis on health risk-taking attitudes

Variable	Factor loading	Uniqueness
Buying an illegal drug for your own use	0.8131	0.3389
Consuming five or more servings of alcohol in a single evening	0.6623	0.5614
Engaging in unprotected sex	0.6846	0.5313
Exposing yourself to the sun without using sunscreen	0.6073	0.6312
Not wearing a seatbelt when being a passenger in the front seat	0.8110	0.3423
Not wearing a helmet when riding a motorcycle	0.7922	0.3724
Regularly eating high cholesterol foods	0.6075	0.6309
Walking home alone at night in a somewhat unsafe area of town	0.6862	0.5291

Note: the questions were asked on a 5-point scale (1 = Extremely unlikely; 5 = Extremely likely) 'For each of the following statements, please indicate the likelihood of engaging in each activity.'

TABLE 4 Spearman correlation between perceived risk, 25(OH)D, and risk-taking attitudes

Correlate 1	25(OH)D	Risk attitudes	Risk attitudes
Correlate 2	Perceived vit. D risk	Perceived vit. D risk	25(OH)D
Control	0.036	0.158***	−0.087
Generic	−0.045	0.248***	−0.071
Personal	−0.085	0.077	−0.055
Claim	−0.096*	0.122**	−0.089
Generic +Claim	−0.019	0.155***	0.069
Personal +Claim	−0.128**	0.196***	−0.108*

Note: Significance is as follows: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. 25(OH)D refers to the serum 25(OH)D levels estimated using the algorithm developed in Appendix S2.

7.3 | The impact of manipulations on perceptions and attitudes

The information provided to consumers may influence how consumers view themselves, and the relevance they give to specific attributes in their choice task. A series of ANOVAs (Table A5 in Appendix S3) finds a main effect of the personalised information on risk perception ($F = 15.69$; $p < 0.001$), with no other main or interaction effects. Time spent reading the vitamin D information (generic or personalised) shows a significant increase in the presence of generic and personalised vitamin D information,[8] with only a main effect. Conversely, health risk-taking attitudes are not significantly impacted by any manipulation. Interest in price, organic production and animal welfare show no main or interaction effects significant at $p < 0.05$.

7.4 | Consumer WTP for vitamin D enriched eggs

Table 5 presents the estimated parameter of the RPL-EC model, and Table 6 reports the estimated WTP for vitamin D fortification in eggs across the different treatments. The RPL-EC model includes: one dummy for mixed eggs, and one for large eggs[9] (baseline: medium eggs); one dummy for vitamin D fortification (baseline: standard eggs); and one dummy for free-range eggs (baseline: organic). The vitamin D dummy is interacted with the treatment group, to obtain group-level estimates; no other attribute was interacted because of the narrow focus on the experimental manipulations, which specifically targeted the vitamin D attribute, and had no influence on other attributes (see Section 7.3). Price enters the equation linearly as a fixed parameter: this step ensures the final distribution of WTP is the same as the distribution of the marginal utility of each attribute, so that consumers with higher WTP for an attribute are those who expect higher marginal utility from it.[10] In the estimation, we set the WTP for the value option, which has constant price and characteristics, equal to its price by imposing the constraint $-\frac{\alpha_{value}}{\delta} = 0.70$, whilst allowing the coefficient to vary across participants; this equal-

[8]Note the control group and the claim only group had no information, but they only saw a line of text saying 'Click on the arrows below to proceed'. This click allowed us to separate reading time and clicking time.

[9]Value eggs are all minimum weight eggs, and the WTP for this size is captured by the 'Value' coefficient.

[10]This restriction can be removed using a WTP-space estimator (Scarpa, Thiene, and Train 2008). We have preferred a preference space estimator because convergence is easier to achieve with the current dataset, where we have complex restrictions caused by the two alternative-specific constants.

TABLE 5 Estimated coefficients of the mixed logit model, by treatment

	Mean		SD (σ)	
	Coefficient	**SE**	**Coefficient**	**SE**
Price	−1.528***	0.082	–	–
Vitamin D - Control	0.044	0.117	1.291***	0.168
Vitamin D - Generic	0.335***	0.122	1.393***	0.159
Vitamin D - Personal	0.295***	0.097	1.074***	0.147
Vitamin D - Claim	−0.011	0.113	1.224***	0.141
Vitamin D - Generic +Claim	0.281**	0.118	−1.428***	0.158
Vitamin D - Personal +Claim	0.242*	0.142	1.677***	0.185
Size - Mixed	0.004	0.046	−0.003	0.064
Size - Large	0.404***	0.055	0.856***	0.102
Value Option	1.069	–	8.315***	0.742
Free-range	0.546***	0.049	−1.200***	0.066
No purchase	−4.313***	0.288	–	–
EC	–	–	4.859***	0.344
Observations	43536.00			
Wald $\chi^2(11)$	514.69***			
Log likelihood	−10202.50			

Note: Significance is as follows: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$. § = coefficient constrained to zero.

Abbreviation: EC, Error Component.

The SE of the Value option is zero because its WTP (the ratio of the Value option coefficient and the price coefficient) is constrained to 0.70.

ity constraint implies that the standard error of the mean effect equals zero. The 'no purchase' option is also modelled as an ASC. The Error Component is modelled by assigning a dummy equal to one to the two time-varying market options (all except the 'no purchase' and 'value' options), and constraining the coefficient of this dummy to zero (Scarpa et al., 2007; Wensing et al., 2020). Separate regressions by treatment can be found in Table A6 in Appendix S3. All estimates are based on 1000 Halton draws, with a burn-in phase of 15 draws.

Results in Table 5 indicate vitamin D biofortification is not valued significantly in the control group, with a WTP of around £0.03 (Table 6). The enrichment is significantly higher when either generic or personal information is presented, with a WTP for vitamin D of £0.22 and £0.19 per box of eggs, respectively (Table 6). The presence of a claim leads to a negative WTP not significantly different from zero. The addition of generic or personal information leads to a significant increase in utility, with a WTP of £0.18 and £0.16; indicating that the addition of a claim led to a small reduction in WTP. Results are very similar when doing separate regressions for each treatment (Table A6 in Appendix S3). Because total UK egg consumption in 2017 corresponded to 12,913 million eggs,[11] a vitamin D label provided without a claim and with generic information on vitamin D needs could add around £0.47 billion to the market. In terms of the other coefficients, consumers report a negative utility for price, and the no-purchase option, while assigning a positive utility to a free-range label and to large eggs only. Finally, the purchase of a value option (that is, of an egg with the characteristics of the value option) generates a higher utility than a no-purchase.

[11]https://www.egginfo.co.uk/egg-facts-and-figures/industry-information/data

TABLE 6 WTP for vitamin D enrichment, by treatment

	Population WTP		Conditional WTP		
Treatment	**Mean**	**SE**	**Mean**	**Median**	**SE**
Control	0.029	0.076	0.028	0.008	0.032
Generic	0.219***	0.081	0.211	0.195	0.038
Personal	0.193***	0.065	0.189	0.166	0.024
Claim	−0.007	0.074	0.007	−0.034	0.030
Generic +Claim	0.184**	0.077	0.185	0.136	0.036
Personal +Claim	0.159*	0.093	0.166	0.087	0.047

Note: Significance is as follows: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.
SE are estimated via the Delta methods.

Finally, Table 7 presents the estimates of Equation (6), testing the impact of the experimental stimuli on the individual-level WTP. Estimates refer to a seemingly unrelated regression with WTP, risk attitudes, perceived risk and the time spent on the vitamin D information page[12] as dependent variables. In this table, each equation is estimated first by regressing the endogenous variables on treatments only (column A); a second equation also adds the endogenous variables recursively, plus adding age, gender and the blocks of the choice experiment (column B). Results indicate that generic information increases the WTP for vitamin D by £0.16–0.18, while a personalised message increases this by £0.12–0.16. The claim does not affect the estimates, either independently or interacting with the main effects. WTP for vitamin D enrichment also decreases by £0.03 for each standard deviation increase in risk attitudes; increases by £0.02 for every 10 points increase in the perceived risk of vitamin D deficiency; and decreases with the age of the respondent.

Table 7 also indicates that personalised information influences WTP by increasing the perceived risk of vitamin D deficiency, which increases by about 8.5 points when personalised information is provided. Perceived risk is also lower in male and younger respondents. Risk attitudes are not influenced by the experimental stimuli and are lower for individuals who spent more time reading the vitamin D information, as well as for older and female respondents. Finally, the presence of generic and personalised information increases reading time by 13 and 22–23 seconds, respectively, with older people spending more time reading the information.

Figures 3a and b show a local polynomial regression linking WTP to the blood levels of 25(OH)D (panel a) and perceived risk (panel b). Figure 3a shows that in all groups where no information or generic information is provided, WTP is largely unrelated to the estimated blood levels of vitamin D. In both groups where personalised information is provided, the data shows a negative relationship between blood levels of vitamin D and WTP for those consumers identified as high risk (25(OH)D < 25), which becomes flat in the intermediate risk class; the slope becomes negative again in respondents with no risk of deficiency, but only if a claim is provided and, in the absence of a claim, WTP unexpectedly increases with the blood level of vitamin D. Figure 3b replicates these graphs linking WTP to perceived (rather than real) vitamin D deficiency risk. The relationship between these variables is relatively flat in all groups where information is not provided, with occasional peaks. All other groups show an upward-sloping line, particularly strong when personalised information is provided with a claim, particularly in individuals who have no risk of deficiency. Overall, these figures show that WTP in the baseline group is not driven by the blood level of vitamin D, but other health preferences. Generic

[12]For those who received no information, the information page was blank, and participants had to click a button to move forward, as in the other groups. As a result, time was greater than zero for all participants.

TABLE 7 SUR regression of WTP, risk attitudes and risk, by treatment

	WTP		Risk attitudes		Perceived risk		Info reading time	
	A	B	A	B	A	B	A	B
Intercept	0.028	0.158**	0.040	1.075***	41.726***	52.577***	7.892***	8.360**
SE	0.034	0.071	0.058	0.097	1.545	2.949	2.204	4.232
Claim	−0.021	−0.017	−0.058	−0.068	−3.179	−2.915	−4.787	−4.542
SE	0.048	0.048	0.082	0.071	2.178	2.159	3.107	3.099
Generic	0.184***	0.162***	−0.028	−0.002	2.592	2.306	13.422***	13.557***
SE	0.050	0.049	0.084	0.074	2.236	2.228	3.189	3.185
Claim × Generic	−0.005	−0.003	0.035	0.024	2.349	2.045	4.255	3.973
SE	0.069	0.068	0.116	0.102	3.099	3.076	4.420	4.418
Personalised	0.161***	0.121**	−0.016	−0.007	8.489***	8.008***	22.370***	22.654***
SE	0.048	0.048	0.080	0.071	2.140	2.152	3.053	3.046
Claim × Personalised	−0.002	−0.012	−0.020	0.009	4.749	4.676	1.290	0.685
SE	0.069	0.068	0.116	0.101	3.093	3.063	4.412	4.401
Risk attitudes		−0.034**						
SE		0.016						
Perceived risk		0.002***						
SE		0.001						
Info reading time		0.000		−0.001**		0.006		
SE		0.000		0.000		0.016		
Male		−0.036		0.517***		−2.770**		−1.032
SE		0.029		0.042		1.273		1.829
Age		−0.003***		−0.026***		−0.172***		0.152***
SE		0.001		0.001		0.036		0.052
Blocks	No	Yes	No	Yes	No	Yes	No	Yes
N	1814	1814						

TABLE 7 (Continued)

	WTP		Risk attitudes		Perceived risk		Info reading time	
	A	**B**	**A**	**B**	**A**	**B**	**A**	**B**
RMSE	0.596	0.585	1.006	0.877	26.894	26.581	38.365	38.187
R^2	0.018	0.056	0.001	0.241	0.029	0.051	0.062	0.070
χ^2	34.04***	106.87***	1.63	576.44***	53.27***	97.49***	118.98***	137.10***
Breusch-Pagan $\chi^2(6)$	125.19	91.05						
Log-likelihood	−21892.10	−21596.10						

Note: Significance is as follows: *$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

SE refer to robust standard errors. Risk attitudes are Bartlett scores from the factor analysis.

Model A only adjusts for treatments and blocks; Model B adds the endogenous variables to the main equation, plus the blocks.

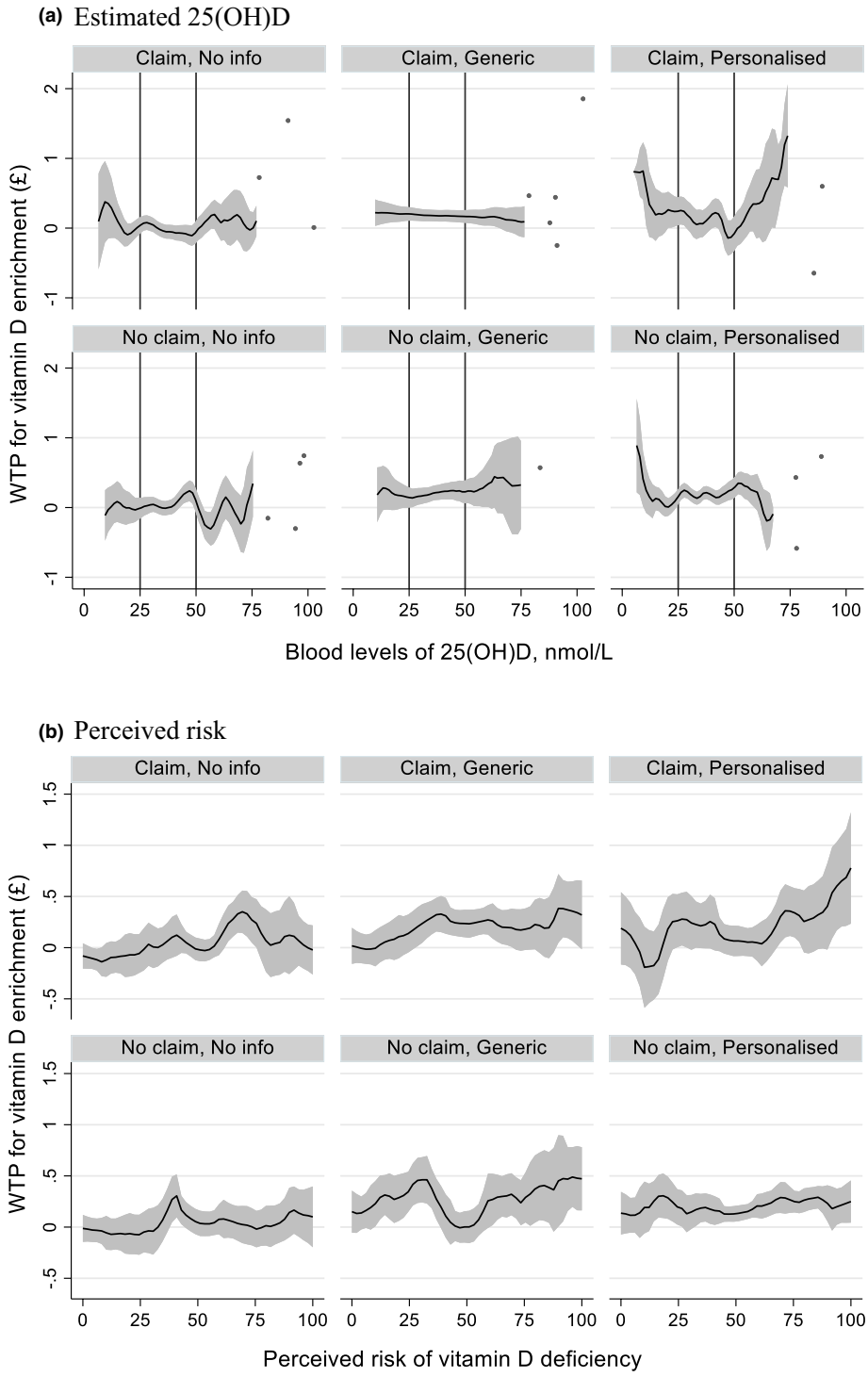


FIGURE 3 Local polynomial regression of 25(OH)D and WTP. (a) The graph refers to a local polynomial regression of degree zero, estimated separately for each treatment group. (b) The graph refers to a local polynomial regression of degree zero, estimated separately for each treatment group

Note: the graphs trim the top 1% of the distribution, because the low number of observations does not allow the estimation of the confidence intervals. Omitted observations are represented by the dots.

information improves the ability to reach consumers with an interest in vitamin D enrichment, although this information motivates consumers who more strongly perceive a risk, rather than those actually at risk. Personalised information is somewhat better at reaching consumers at high risk of vitamin D deficiency, as well as those consumers who perceive a higher risk.

8 | DISCUSSION

We explore the potential of personalised information and the use of claims to 'nudge' the WTP for vitamin D enrichment in eggs. Results indicate that personalised information on the importance of dietary vitamin D increases the perceived risk of vitamin D deficiency, which in turn increases the WTP for enriched products. Generic, as well as personalised, information is effective in increasing WTP, with the former leading to slightly higher estimated WTP. On the other hand, the presence of a claim has no impact on the decisions of the consumer, either as a main effect, or in combination with information. This section discusses the results in more detail, in light of existing literature on the impact of health claims.

8.1 | Personalised 'molecular' marketing, and consumer behaviour

Advances in food technology permit the improvement of the nutritional composition of food at the molecular level, allowing consumers to meet their nutritional needs and leading to improvements in public health nutrition (Bogue et al., 2017; Jones & Jew, 2016; Leng et al., 2017; Patch et al., 2004; Walker Naylor et al., 2009). This is the case with vitamin D deficiency, an endemic problem in the UK (Calame et al., 2020; Hill, 2014; SACN, 2016), which has led to vitamin D being increasingly added to foods. Our results show that, in the absence of any information about its usefulness, there is limited consumer interest in vitamin D enrichment in eggs. However, such enrichment has a significant value when consumers who consider themselves to be at risk of deficiency understand how additional dietary vitamin D can help them stay healthy. As a result, the introduction of information reveals a latent (stated) demand for products enriched with vitamin D. In other words, at least some consumers are sensitive to the issue of vitamin D deficiency and are willing to act on it by purchasing vitamin D enriched products if the market supplies them.

From a marketing perspective, biofortification in foods has led to marketing becoming increasingly 'molecular': products are differentiated through the addition of specific molecules with known health benefits, using claims to inform on the functional benefits to influence purchase likelihood (Chandon & Wansink, 2007; EFSA Panel on Dietetic products, 2014; Kaur et al., 2017; Walker Naylor et al., 2009; Williams, 2005). Our results show that the provision of information on the health benefits of vitamin D before their choice influences consumer WTP for vitamin D enriched eggs. The largest WTP increase occurs when generic information is provided, while personal information leads to a slightly smaller increase in WTP. However, if *on average* the provision of personalised information is as effective as the provision of generic information, the benefits of personalisation lie in a closer alignment between the purchase of biofortified eggs and low levels of vitamin D deficiency. This would improve the efficiency of the market, which more accurately matches products and consumers based on their health profiles. This should translate into long-term health benefits for those individuals more at risk, rather than those who are more risk averse.

Our study also shows that the presence of a claim on the label is not sufficient to influence purchase likelihood and WTP for vitamin D enrichment (as in Talati et al., 2018), either alone or interacting with the (generic or personal) vitamin D information provided to the consumer. Rather, the driver of behaviour is the perceived risk of vitamin D deficiency, and the claim

may only be useful in reminding consumers who are already aware of the problem about which products have higher levels of the required micronutrient. Undoubtedly, the lack of an impact of the claim on WTP may be driven in part by the complementarity of the two pieces of information: claims may remove the need for a lengthy product search (Roe et al., 1999), but add little or no additional information if consumers are already aware of the benefits of vitamin D. However, this explanation fails to explain why WTP does not increase when a claim appears alone. Rather, consumers may pay insufficient attention to health claims and therefore fail to consider the information contained in them when making their choices (as found in Annunziata & Mariani, 2019).

It should be noted that, in our sample, only around 15% of respondents received a red alert about their values of 25(OH)D, therefore few consumers had a strong motivation to buy vitamin D-enriched eggs in the choice experiment. This observation is consistent with research showing that marketing based on personalised information from which consumers perceive a direct benefit is effective in increasing sales (e.g., Ronteltap et al., 2008). At the same time, it hints that when personalised information is provided, consumers respond only to very high-risk scores (as found in Crosetto et al., 2020).

8.2 | How technology can help consumers make healthier choices

A key purpose of presenting health information on food labels is to help interested consumers identify the healthy option and purchase it (Andrews et al., 2011; Barreiro-Hurlé et al., 2010; Cowburn & Stockley, 2007; Gracia et al., 2009; Hieke & Taylor, 2012; Kiesel & Villas-Boas, 2013; Wills et al., 2009). Although the effectiveness of health labels is contingent on individuals holding information about their health needs (Annunziata & Mariani, 2019; Jones & Jew, 2016; Talati et al., 2018), labels provide 'average' information to the 'average' consumer in a market or in a market segment (Arora et al., 2008; Ghose & Huang, 2009). Providing information that is specific to an individual helps match products and consumers, potentially increasing the efficiency of the market. Crucially, consumers' preferences may not be active during the shopping task (Ariely et al., 2003; Ariely & Norton, 2008; Bettman et al., 1998), and need to be activated at the intention stage. Therefore, presenting relevant information when a choice is being made, and preferences are being constructed, is important in helping consumers make optimal consumption decisions.

The provision of personalised information is a marketing strategy that uses data science and technology to present consumers with personalised messages or products to facilitate the matching of services with customer needs (Arora et al., 2008; Ghose & Huang, 2009; Wedel & Kannan, 2016). In a heterogeneous market, personalisation makes it easier to reach target customers based on specific characteristics. Machine learning presents a promising approach to the public health problem associated with vitamin D deficiency: the availability of large datasets containing information on health outcomes and individual characteristics allows the identification of those individuals most likely to need treatment, therefore reducing the costs of an intervention (Athey, 2017; Kleinberg et al., 2015). Our study is a first step in this direction, demonstrating that the provision of personalised information on vitamin D status is sufficient to increase WTP for vitamin D supplementation. Greater accuracy in targeting can improve the ability to more closely cater to the actual health needs of consumers on the basis of their specific metabolic needs, a process known as metabotyping (see, for instance, Brennan, 2017). Metabotyping has the potential to increase the effectiveness of public health interventions by reaching those consumers who are in greater need of a change in behaviour. Our study suggests that these improvements can be reached with reasonably small computational resources that can automate information processing (Yadav & Pavlou, 2014).

9 | CONCLUSIONS

We explore how the provision of personalised rather than generic information, and the presence of health claims, influences consumer WTP for vitamin D enrichment in eggs. Results indicate that an increase in the specificity of the information results in an increase in the perceived risk of vitamin D deficiency and, consequently, in WTP for the vitamin D enrichment. Importantly, the research emphasises the importance of understanding information processing during the choice task, particularly in modern markets, where consumers and retailers can interact in various ways. These results support the idea that the design of the marketplace can influence what consumers buy, particularly online. We hope these insights will enrich the current social science literature on food biofortification by identifying better ways of communicating this information to consumers at the point of purchase.

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