Do “no added sugar” labels impact sugar content estimation and healthiness perception? An experimental online study

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ABSTRACT

Nutritional labelling aims to promote informed food choices. This includes labels providing information about the nutrients and health-related qualities of a product. Little is known about their impact on product perceptions. Interestingly, despite of the lack of data, such claims are subject to heavy regulation in the European Union. Studies on the impact of nutrition and health labelling are hence urgently needed. This study thus investigated the impact of the “no added sugar” label on perceived healthiness and estimated sugar content. In this online experiment, 469 participants were randomly assigned to one of two conditions, viewing either products with the or without the “no added sugar” label. Eleven products from various categories were presented to the participants which rated them according to healthiness and estimated their sugar content. Nutrition knowledge and their responsibility for grocery shopping for others were considered. Independent samples t-tests revealed small and mostly non-significant differences between conditions for both perceived healthiness and estimated sugar content. No influence on the impact of the label by nutrition knowledge and

responsibility for grocery shopping were found. “No added sugar” labels seem to only have very small effects on consumers’ product perceptions, suggesting that they might play a minor role in guiding food choices. Furthermore, their effectiveness is largely unaffected by consumers’ nutritional knowledge or their shopping responsibility for others. This study is hence a first indication that some regulation of sugar claims, at least when it comes to buying decisions, is not justified.

Keywords: Nutrition Claim, Sugar Claim, front-of-pack (FOP) label, health perception, sugar content estimation

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

1. Introduction

Overconsumption of energy-dense foods has far-reaching consequences for people's health, as it can lead to obesity and corresponding secondary diseases such as diabetes mellitus type II, cardiovascular diseases and the formation of dental caries (World Health Organization, 2015). According to the World Health Organization (WHO), 39% of adults aged 18 and older are overweight and thus have elevated risk for a range of chronic conditions (World Health Organization, 2021). Especially excessive consumption of free sugars has been linked to weight gain and more widespread secondary diseases as well as dental caries (Moynihan and Kelly, 2014). In addition, overconsumption of foods high in free sugars could lead to a reduced intake of more nutrient-dense foods (Hauner et al., 2012; Malik et al., 2013). The WHO thus recommends limiting the daily intake of free sugars to no more than 10% of the daily energy intake; free sugars are defined as monosaccharides and disaccharides added to foods and beverages by manufacturers, cooks, or consumers, but also naturally occurring sugars in honey, syrup, fruit juices, and fruit juice concentrates (World Health Organization, 2015).

One of the reasons for the overconsumption of free sugars is food marketing; product packaging thereby acts as an important communication tool: Chandon (2013) describes the moment of purchase decision and the moment of consumption as “The Moments of Truth.” In both situations, packaging can have a decisive influence on eating behavior (Chandon, 2013; van Trijp and van der Lans, 2007). Labels presenting nutrition and health claims on food packaging are influential cues in this context (van Trijp and van der Lans, 2007). They may be used to help consumers make informed purchasing and consumption decisions (Hollands et al., 2017). In this respect they can be used as a tool to “nudge” people, helping them making better food choices (Purnhagen et al., 2016); however, they may also be misused as a marking tool, especially since health is an important food choice motive (Renner et al., 2012). Thus, regulations for the labelling of foods are needed for consumer protection.

In the EU, the Regulation (EC) No 1924/2006 (NHCR) regulates nutrition and health claims. It aims to harmonize “Member State regulation which relate to nutrition and health claims in order to ensure

the effective functioning of the internal market whilst providing a high level of consumer protection" (*NHCR*, 2006, art. 1 (1) L 404/13). To achieve that aim, it prohibits, among other targets, nutrition and health claims that are "false, ambiguous or misleading" (*NHCR*, 2006, art. 3 (a) L 404/14). It applies the principle of prohibition with reservation of permission, i.e., only claims that have been explicitly approved to comply with the regulation and are listed on specifically legally qualified lists may be used. For approved nutrition claims, the Annex to the NHCR provides such a list. The claims our study is subject to qualify as "nutrition claims." Nutrition claims include claims that state or imply that the food has a particular positive nutritional property. This property must result from either energy content, nutrients, or other substances that the food either contains in reduced or increased quantity, or not at all (*NHCR*, 2006, art. 2 (2) no. 4 L 404/14). Accordingly, labels referring to the sugar content of foods that imply nutritional or health benefits due to a reduced amount of sugar, including the label "no added sugar", belong to this category. Products may contain this label only if a product does "not contain any added mono- or disaccharides or any other food used for its sweetening properties" (*NHCR*, 2006, app. L 404/24). The legal definition of "added sugar" is therefore similar to the WHO definition of free sugars described above. Other legislation in the EU such as Directive 2001/111/EC relating to certain sugars intended for human consumption (*Directive 2001/111/EC*, 2002) were left out of the scope of our study as their inclusion would neither have altered the design nor the outcome of the study.

The available literature on the effectiveness of nutrition and health claims on food packaging on consumers' food choices produced mixed evidence. Some studies indicate the labels' effectiveness in promoting informed and healthy food choices (Kaur et al., 2017; Leathwood et al., 2007; Talati et al., 2017), but to a varying degree if one distinguishes different types of claims such as visual and textual claims (Purnhagen et al, 2016). On the other hand, some studies suggest that nutrition and health claims may have negative impact on product perceptions (Chandon, 2013; Oostenbach et al., 2019). For example, labeling might lead to the sugar content being underestimated, leading to a so-called health halo effect. This effect occurs when a single aspect that is difficult to assess is evaluated by the

consumer based on a simply formulated label (Chandon, 2013). Regarding the “no added sugar” label, Zühlsdorf et al. (2021) and Prada et al. (2021) found that products with this label were perceived to be healthier than products without the label, which may express a health halo effect. This effect may be amplified by consumers’ inability to estimate the sugar content correctly (Dallacker et al., 2018; König et al., 2019). Therefore, it is unclear whether real world consumers are indeed protected from misleading claims as we investigate in this study by the NHCR.

One important prerequisite for the consumers’ understanding of the “no added sugar” label is to correctly understand the term “added sugar”. In Tierney et al. (2017), only 4% of study participants could correctly identify ten or more substances from a list of thirteen variants of added sugars. Furthermore, honey, fruit juice, and fructose were identified as natural sugars rather than added sugars in 60% to 89% of cases, even though they are classified as added sugars as ingredients by WHO and in the NHCR (*NHCR*, 2006; Tierney et al., 2017; World Health Organization, 2015). The meaning of the “no added sugar” label thus may not be clear to consumers. This notion is supported by Zühlsdorf et al. (2021), who report that 64.5% of participants would rather by a product with the “no added sugar” label than without the label, so ignoring the fact that products with the “no added sugar” label may still contain high quantities of sugar (e.g., because of dried fruit in muesli). This may be caused by false consumer expectations regarding the sugar content and the nutritional value of the products. Indeed, Roe et al. (1999) showed that as soon as a nutrition or health claim are visible, consumers tend to ignore the nutritional information and make their product assessment based on the claim (Roe et al., 1999).

Furthermore, research suggest that nutrition knowledge is critical to understanding food claims (Barreiro-Hurlé et al., 2010; Howlett et al., 2008). For example, Chien et al. (2018) reported that mothers with lower knowledge about sugar were more likely to misinterpret nutrition and health claims such as “no added sugar.” In addition, there was a negative correlation between mothers'

knowledge about sugar and attitudes toward products with the claim of no added sugar (Chien et al., 2018)(see also Ares et al. (2008), for similar findings).

Finally, interest in labels may impact their understanding; this interest may differ among demographic groups (Grunert and Wills, 2007). For instance, parents who live with pre-teen children tend to have greater interest in labels than adults living without children (BEUC, 2005; Grunert and Wills, 2007). Parents may have greater interest in healthy foods due to the desire to protect their offspring. This notion is supported by Sah et al. (2021), who demonstrated that priming consumers for responsibility before making food choices had more pronounced effects on caregivers than on individuals who were responsible only for themselves (Sah et al., 2021).

Since product perceptions are an important driver of food choices, the present study experimentally tested the impact of "no added sugar" labels on sugar content estimation and generally healthiness perception of the products. Contrary to previous research that used made-up labels (Zühlsdorf et al., 2021), this study used real products sold in German supermarkets to increase external validity. Furthermore, nutrition knowledge and caregiving responsibilities were taken into account as potential moderators of the effect. Finally, we explored the consumers' label-related knowledge and understanding.

2. Methods

The study was preregistered on aspredicted.org prior to data collection (https://aspredicted.org/NP1_S49). Study materials and data are available from the project page on the Open Science Framework (OSF; https://osf.io/kpw7c/?view_only=dd149f87fd7d4504a17b653dee24b9a0).

2.1 Sample

The required sample size was determined using G*Power 3.1 (Faul et al., 2007). Based on König et al. (2019), a small to medium effect was assumed (d = 0.3); α was set to 0.025 due to two primary

outcome variables. For 80% power in independent samples t-tests, a sample size of $N = 426$ (group 1: $n_1 = 213$; group 2: $n_2 = 213$) was required.

Participants of this study had to be German-speaking adults, with a minimum age of 18 years. The recruiting took place from July until September 2021. Participants were recruited online, via social networks such as Instagram, Facebook and WhatsApp, through university accounts as well as personal contacts of the authors. In addition, pen-and-paper questionnaires were handed out to patients and accompanying persons at the gynecological outpatient clinic of a large university hospital. Additional study participants were recruited by distributing flyers at stores, libraries, and other public places.

2.2 Materials and Measures

2.2.1 Food Items

Eleven products that are representative of various food categories offered in standard grocery stores in Germany were selected for this study: blackberries (frozen), dates (dried), fruit yogurt, fruit muesli, oat milk, ketchup, fruit gum, sweet corn (canned), white chocolate granola bar, orange juice, chocolate. All products bear clearly visible the FOP label "*no added sugar*". The products were photographed and the label "*no added sugar*" was retouched using the GNU Image Manipulation Program 2.10.24 (Kimball et al., n.d.). See the OSF for all resulting images, https://osf.io/kpw7c/?view_only=dd149f87fd7d4504a17b653dee24b9a0.

2.2.2 Sugar content estimation

Furthermore, participants were asked to estimate the sugar content (natural and/or added) of the products in grams per 100 g product (c.f. König et al. (2019)).

2.2.3 Health perception

Participants rated all products on a six-point Likert scale: (1) very unhealthy, (2) unhealthy, (3) rather unhealthy, (4) rather healthy, (5) healthy and (6) very healthy.

2.2.4 Label-related knowledge

Ten sweetening substances were available for selection from the categories: Sugar and types of sugar, sweetening foods, sweeteners, and sugar substitutes (Zühlsdorf et al., 2021). The participants were asked which of the substances are prohibited in products with the label. Substances that are prohibited were household sugar, glucose-fructose syrup, fructose, honey, date powder, agave syrup, apple sweetener and stevia (stevioglycosides). Allowed substances were maltitol, stevia, xylitol, and erythritol.

2.2.5 Perception of the “no added sugar” label

In addition, the participants were asked to rate seven statements on a six-point Likert-Scale from (1) totally agree to (6) totally disagree. The statements are related to the perception of the label concerning its sugar content and during grocery shopping.

2.2.6 Demographic and anthropometric data

Participants were asked to indicate their gender (male/female/diverse), age, body weight and height, based on which body-mass index (BMI) was calculated.

2.2.7 Sugar consumption habits and consumption frequency

The participants were also asked about their diet and whether they agreed to the statement "*I try to eat less sweets/less sugar*" (Zühlsdorf et al., 2021). Furthermore, they were asked to indicate the consumption frequency of each product on a 6-point scale: (1) nearly every day, (2) several times a week, (3) once a week, (4) several times a month, (5) once a month or less, (6) never.

2.2.8 Nutrition knowledge

Nutrition knowledge was inferred from participants’ academic major or current occupation. On this basis, the participants were classified into having high, moderate, or low nutrition knowledge. Participants were classified as having high knowledge if their major or current occupation was in the field of nutritional sciences or health; as having moderate knowledge if their major is somewhat

related to the fields of nutrition or health; as having low knowledge if there is no connection to the fields of nutrition or health (see Supplementary Table S1 for examples).

2.2.9 Responsibility for grocery shopping for others

Participants were asked to indicate whether they co-habited with other persons (e.g., with a partner, with children) to differentiate between participants living alone and participants living with other people. If they indicated that they lived with other people, participants were asked to indicate the percentage (0% to 100%) by which they agreed with the statement "When I buy groceries, I also buy groceries for the other people living in my household." The survey of the living situation shows that especially people who live with a family including children, with a partner or with people in need of care often shop for the other people. The majority stated that they do this in more than 70% of the cases. People with a lot of shopping responsibility are accordingly classified as those who do 71% to 100% of the shopping for other people in their household.

2.3 Procedure

This experimental study used a between-subjects design. The online survey was created in Unipark (Tivian XI GmbH, 2021); in addition, a pen-and-paper version was provided. The study was approved by the ethics committee of the University of Bayreuth.

Participants provided informed consent by ticking a box on the first page of the survey. They then provided demographic and anthropometric data (gender, age, highest school leaving and vocational qualification, academic major and/or current occupation). Afterwards, participants were asked to provide information on their living situation and shopping responsibilities, as well as their eating behavior. Participants were then randomly assigned to one of the two experimental conditions: products with or without the “no added sugar” label. Participants in the online survey were randomized by the system; participants filling in a pen-and-paper questionnaire were randomized by having taken the top questionnaire from a stack of shuffled questionnaires that included either photos with or without the label. All food products were shown in a randomized order to prevent order

effects. In the online survey, the eleven food items were shuffled; participants filling in the pen-and-paper questionnaire received one of five different sequences. For each product, participants in both groups estimated the sugar content and indicated the perceived healthiness and consumption frequency. Finally, all participants answered a set of quiz questions about the "no added sugar" label.

2.4 Statistical Analysis

The missing values for the entire dataset ranged from 0% for gender and age to 2.13% for tertiary education and 10.67% of the values for major and occupation. The maximum of missing values regarding health perception was 0.43% (n = 2) for fruit gums and sweet corn. Concerning the sugar content estimations, all estimations above 100 g were declared implausible, as the sugar content of normal sugar is just 100 g of sugar per 100 g of product; implausible values were replaced with missing values. Further missing values resulted from the transfer of the paper questionnaire into digital form, since all answers describing the sugar content as little or very much, for example, and information such as 4-5 g for the sugar content were entered as missing values. Overall, the maximum of missing values regarding the sugar content estimations was at n = 10 (2.13%) for ketchup and orange juice.

JASP (JASP Team, 2020) was used for the statistical analysis. With a sample size of $N = 469$ ($n_{(label)} = 249$; $n_{(no\ label)} = 220$), the sample means can be assumed to be normally distributed (Bortz and Schuster, 2010, p. 86). Compatibility of printed and online questionnaire samples was tested by an independent samples Welch t-test. The test of a successful randomization of the label conditions was conducted using an independent samples Student t-test. For testing differences in sugar content estimations and healthiness perceptions between the two label conditions, independent samples t-tests were conducted; α was set to 0.025 due to two outcomes of interest. If the homogeneity of variance assumption was violated, Welch tests for conducted for the respective products (see Tables 1 and 5). For testing additional effects of nutrition knowledge, 2 *Condition* (label/ no label) x 3 *Knowledge* (low/ medium/ high) between-subjects ANOVAs were conducted. Fifty-three participants (11.30%) were excluded from these analyses due to unspecified job titles or academic major, resulting in a sample of $N = 416$. For testing additional effects of responsibility for grocery shopping, 2 Condition (label/ no

label) x 2 Responsibility (low/ high) between-subject ANOVAs were conducted. Perception of and knowledge about the “no added sugar” label was analyzed descriptively.

3. Results

3.1 Sample

*T*he sample includes 469 study participants (72.7% female, 27.1% male, 0.2% diverse) with ages ranging from 18 to 78 years (M = 34.66; SD = 13.03). The BMI of the sample ranged from 16.41 to 47.75 (M = 24.88; SD = 5.25). Eighty-two percent of participants participated in the online survey, and 18% completed the printed questionnaire. Welch t-Tests showed no significant group differences of age (t (240.9) = -1.96, p = 0.051, d = -0.19). Significant differences of gender composition (t (160.77) = 4.87, p < .001, d = 0.53,) and BMI (t (92.53) = 6.09, p < .001, d = 0.85) can be explained by the recruiting strategy regarding the printed questionnaire which was conducted exclusively at a gynecological outpatient clinic; group differences are thus likely caused by a high proportion of pregnant women in the pen-and-paper subsample.

The verification of the randomized assignment of the conditions shows a very similar demographic composition of the groups. Student t-tests showed no significant group differences regarding all tested variables including age, gender and BMI (ts[dfs ≥ 461] ≤ |1.13|, ps ≥ .26, ds ≤ |0.11|). Thus, randomization was successful.

More than two-thirds of the sample were high school graduates. The highest vocational qualifications most frequently reported were a university degree (39.0%) or vocational training/apprenticeship (28.8%). Regarding their current living situation, the majority (41.8%) stated that they live with their partner. Furthermore, 24.1% of the respondents lived with their family including one or more children and 19.6% lived alone.

Most respondents reported an omnivorous diet (78.7%), and 18% were either vegetarian or vegan. Of all participants 79.7% (3) tended to agree, (2) agreed or (1) fully agreed to pay attention to reduce their sugar consumption.

3.2 Consumption of the selected food items

Most participants consumed the individual products once a month or less or never (*Mdn* = 5). Only the frequency of consumption of fruit gums is lower than that (*Mdn* = 6).

3.3 Impact of the label on sugar content estimation

Estimations were similar for most products in both conditions (see Table 1). Sugar content estimation differed significantly for ketchup (*d* = -0.19) and chocolate (*d* = -0.38). In both cases, the estimated sugar content was lower for the product without the "no added sugar" label than for the product with the label. Differences were again small (Cohen, 1988). No significant differences were found for the remaining nine products.

Table 2 shows that only the sugar content of fruit gums and dates was underestimated, while the sugar content for the remaining nine products was overestimated ($p < .001$).

3.3.1 Influence of nutritional knowledge related to the label on sugar content estimations

In addition to the already established main effect of experimental condition ($F(1,409) = 15.11$, $p < .001$, $\eta_{p2} = 0.04$) on the assessment of sugar content in chocolate, no main significant effect was evident for the factor nutritional knowledge ($F(2,409) = 1.31$, $p = .271$) in an ANOVA. There also was no significant interaction between the factors ($F(2,409) = 1.06$, $p = .348$). Accordingly, the effect of the condition does not depend on nutritional knowledge. For all other products, the analysis of variance showed neither significant main effects nor interactions (see Table 3). The missing main effect of the label for ketchup, which was shown in the *t*-test, is due to the different calculation of the residual in a multifactorial analysis of variance.

3.3.2 Influence of the responsibility for grocery shopping relate to the label on sugar content estimations

Similarly, no consistent pattern emerged for a between-subjects ANOVA testing the effects of experimental condition and responsibility for grocery shopping for others on sugar content estimations. In addition to the already established main effect of condition for chocolate ($F(1,458) = 14.40$, $p < .001$, $\eta_{p2} = 0.03$), a significant main effect of responsibility for grocery shopping emerged for blackberries ($F(1,455) = 5.09$, $p = .025$, $\eta_{p2} = 0.01$). Participants who were responsible for grocery shopping for others estimated the blackberries to contain less sugar ($M = 18.05$, $SD = 15.67$) than participants who were not responsible for grocery shopping for others ($M = 21.62$, $SD = 16.18$). All other main effects as well as all interactions did not reach statistical significance (see Table 4 for a summary).

3.4 Impact of the label on healthiness perception

For most products, the healthiness perceptions with and without label were very similar; statistically significant differences were found for the granola bars ($d = 0.19$) and chocolate ($d = 0.38$) with small to medium effects (Cohen, 1988). Both products were perceived to be healthier if there was a "no added sugar" label on the package. For the remaining nine products, no statistically significant group differences were found ($ds \leq |0.14|$). The results of all eleven comparisons are listed in Table 5.

3.4.1 Influence of nutritional knowledge and the label on healthiness perceptions

There were no statistically significant main effects of interactions in addition to the already established main effect of condition for the healthiness perception of chocolate ($F(1,409) = 6.56$, $p = .011$, $\eta_{p2} = 0.02$; see Table 6 for a summary).

3.4.2 Influence of the responsibility for grocery shopping and the label on healthiness perceptions

The ANOVAs show main effects of shopping responsibility for blackberries ($F(1, 468) = 6.03$, $p = .014$, $\eta^2_p = 0.01$) and for canned corn ($F(1, 466) = 9.35$, $p = .002$, $\eta^2_p = 0.02$). In case of blackberries, a higher mean health estimate was given by the group that frequently bought food for others ($M = 4.85$,

SD = 0.86) than by the group that was more responsible for themselves (*M* = 4.62, *SD* = 1.01). An opposite result is shown for the health ratings regarding sweet corn. Here, the group with high purchasing responsibility gave a lower estimation of the health value (*M* = 4.01, *SD* = 0.87) than the group that rarely shops for others (*M* = 4.27, *SD* = 0.80). Results regarding a main effect of the experimental condition were consistent with the result of the *t*-tests presented above. Interaction effects were not statistically significant (see Table 7).

3.5 Perception of and knowledge about the label

Participants' responses regarding label perception are summarized in Figure 1. Products with the label are seen by most respondents when grocery shopping (81.0%). However, 51.6% of the participants stated that they do not pay attention to such labels when shopping. Regarding the sugar content, 95.7% agreed that products with the label "no added sugar" still contain sugar, while 39.2% assumed that these products are lower in sugar compared to products without the label (see Figure 1). Most participants (90.8%) correctly identified household sugar as a prohibited ingredient; another 60.8% correctly identified glucose-fructose-syrup as a prohibited ingredient. Participants struggled to correctly indicate whether products carrying the "no added sugar" label could contain these ingredients (see Figure 2 for a summary).

4. DISCUSSION

This study systematically investigated the impact of the "no added sugar" label on consumers' sugar intake and health assessment using products with original labels. The results of the present study show negligible impact of the label on consumers' sugar content estimation and healthiness perception. Nutritional knowledge or being responsible for grocery shopping for others do not seem to have additional influence. The impact of the "no added sugar" label on product perceptions may be limited because consumers do not generally assess products with the label as sugar-free, have little knowledge about sugar alternatives, and often do not pay attention to the label when grocery shopping.

4.1 Impact of the label on sugar content estimation and healthiness perception

Previous research suggested that sugar labels influence consumers' product perceptions. For example, Prada et al. (2021) showed that products with sugar-related labels (e.g., sugar-free, no added sugar, and low sugar) are rated as healthier and lower in calories than their regular alternatives. Also, Zühlsdorf et al. (2021) suggested that sugar-related claims on products may cause health-halo effects. Similarly, a study by Chien et al. (2018) shows that 50-70% of mothers surveyed assumed that products labeled "no added sugar" contained less sugar (see also Patterson et al., 2012, for similar results in UK citizens). A similar impact of the sugar label was found in here, over half of the study participants expected that products marketed with sugar-reducing labels (such as "reduced sugar," "no added sugar") would also have reduced calorie content. Although sugar content estimation and healthiness perceptions did generally not differ between products with and without a "no added sugar" label, a small significant effect in the expected direction was found for ketchup and chocolate. These products are generally known to contain large amounts of sugar and are considered unhealthy. Therefore, it could be assumed that labels are more influential for stereotypically unhealthy foods and serve as a cue for healthier alternatives in the same product category, as indented by the regulations. This would be consistent with previous research showing that the effect of health and nutrition claims depends on the product category (Steinhauser and Hamm, 2018).

In addition, the methodology used in the present study differs from previous work, which may explain the differences in findings. For instance, Prada et al. (2021) did not present participants with pictures but instead asked them to rate the healthiness of listed foods, each combined with and without a sugar claim. As the present study used photos of original products with original labels, smaller effects may be due to the more realistic presentation of the label; indeed, previous research suggests that effects are generally smaller under more realistic conditions because of more distractions (Kaur et al., 2017).

4.2 Influence of nutritional knowledge and responsibility for grocery shopping

Based on previous research showing that nutritionists were more accurate in estimating the calories of a fast-food meal compared to normal consumers (Chandon and Wansink, 2007), it was assumed that nutrition knowledge may buffer against wrong interpretations of the label. However, no consistent impact of nutrition knowledge on sugar content estimation or healthiness perceptions were found in this study. These findings contrast with previous research indicating that nutrition knowledge strongly influences food label use and understanding of nutrition information (Grunert et al., 2010; Miller and Cassady, 2015). It is important to note, however, that nutrition knowledge was inferred from participants' academic majors or occupations in the interest of keeping the survey concise, which is only an indirect and superficial measure of nutrition knowledge. On the one hand, the classification might have underestimated the nutrition knowledge in some participants since curricula were not inspected; on the other hand, also participants who did not complete a degree in nutrition might have acquired high nutrition knowledge through other means. Future studies should thus replicate these findings using established nutrition knowledge measures.

Similarly, the no "no added sugar" labels' influence on product perceptions did not differ depending on the grocery shopping responsibility. One reason could be the lack of manipulation in the present study. Sah et al. (2021) found a stronger effect of a sugar teaspoon label on parents than other participants. However, they explicitly primed all participants for either responsible behavior or joy, which may have been more influential in parents. Indeed, studies showed that manipulations can influence choice toward both hedonic (Raghunathan et al., 2006; Sah et al., 2021) and utilitarian foods (Sah et al., 2021). Without this manipulation, the present study might not have succeeded in inducing a shopping mindset in the participants, so their judgements might have diverged from a real shopping situation (Orquin and Scholderer, 2015).

4.3 Perception of and knowledge about the label

Consumers correctly indicated that products with a "no added sugar" label are not allowed to contain household sugar; however, they were not able to identify other sugars that the products must not contain, which is in line with previous surveys (Prada et al., 2020, p. 202; Tierney et al., 2017; Zühlsdorf et al., 2021). Still, participants did not assume that products with a "no added sugar" label are sugar free (see also Patterson et al. (2012)). However, a substantial amount of participants of the present study as well as previous studies (Annunziata and Mariani, 2019; Chien et al., 2018) assumed that products carrying the label contained less sugar, which might not always be the case (Chien et al., 2018; Kaur et al., 2016). These results indicate that consumers might benefit from educational interventions on sugars and the intended meaning of sugar-related claims on food products to be able to make informed purchasing and consumption decisions (for reviews see Chiang et al. (2022) and Evenson et al. (2017)).

4.4 Strengths and limitations

The present study adheres to principles of open and reproducible science: it tested preregistered hypotheses derived from the literature, and data and materials are available online to allow for replication. Furthermore, the study was powered to be able to reliably detect small to medium effects. Nonetheless, some important limitations of the study need to be acknowledged. First, the study sample is not representative of the German population because of a higher level of education and higher proportion of women. A higher level of education is positively associated with nutrition knowledge (Parmenter et al., 2000; Wardle et al., 2000), and women tend to be more interested in foods with nutrition and health claims (Nocella and Kennedy, 2012). However, it is important to note that sugar content estimation, one of two primary outcomes of this study, was previously shown not to be influenced by gender (König et al., 2019). Still, generalization of the study findings may be limited.

Second, the study was conducted online and not in a real shopping situation, which may distort product perceptions. Participants could look at the photos for as long as they liked, which may contrast with time pressure when grocery shopping (Fenko et al., 2018). Also, participants were unable to assess the ingredient list and nutrition fact table usually presented at the back of the packaging. Accordingly, the external validity of the study might be reduced. On the other hand, the online format may simulate the expanding market of online grocery shopping (Statista, 2021). Assessing the groceries as a photo on the screen is thus becoming increasingly realistic.

Third, the present study focused on product perceptions and did not take actual choice into account. Since there is a wide range of food choice motives which may differ in importance depending on the situation (Wahl et al., 2020), the possibility of the label influencing choice via other motives cannot be ruled out. Furthermore, studies suggest that it does make a difference whether individuals make decisions for themselves or for others (Aaker and Lee, 2001; Polman, 2010). Accordingly, it can be assumed that the strength of a goal or motivation is also influenced by the social context of the decision, which was not manipulated in the present study.

4.5 Policy implications

In terms of the NHCR, the understanding of an average consumer is assumed, which is generally understood to be a “reasonably well-informed and reasonably observant and circumspect” (see recital 15 of Regulation (EC) No 1924/2006 L 404/11) consumer. While in EU food law, the consumer image was meanwhile adjusted to represent a more real-life consumer (Purnhagen et al, 2016), the sample of the present study corresponds to the traditional image of the average consumer due to the high level of education. The results show that the claim "no added sugar" is correctly understood by the majority of the study sample. However, due to the high level of education (Statistisches Bundesamt, 2020), the study sample does not represent the more real-life consumer which needs to be protected according to EU food law. It is therefore questionable whether it can be assumed that such an average consumer as required by EU food law can also interpret the label correctly. Future studies should

therefore investigate how a representative sample interprets the claim "no added sugar". If subsequent studies show that the label leads to an erroneous assessment of sugar content, the level of understanding of the average consumer may need to be adapted in future procedures.

In general, health claims such as "no added sugar" can only help consumers to make a nutritionally more favorable food choice to a limited extent in the current legal situation. Generally, it cannot be concluded from products with a nutritional label that they have a health-promoting composition (Kaur et al., 2016). An introduction of the nutrient profiles, setting upper limits for nutritional values to market a product with a health claim, as originally foreseen in Art. 4 NHCR could set guidelines for the use of health claim statements. As a result, products with a high sugar content, such as fruit juices, would no longer be allowed to carry claims such as "no added sugar" and so consumers could indeed be supported in making healthier food choices by health and nutrition claims. However, despite its legal mandate to provide for such nutrition profiles by 19. January 2009 (*NHCR*, 2006, art. 4 (1)), the EU Commission has neither proposed a concept for the creation of nutrient profiles nor nutrient profiles themselves. Given the benefits of nutrient profiles, the implementation of this legal obligation is warranted. The consumer study by Zühlsdorf et al. (2021) recommends to either ban claims on products with a poor nutritional profile, or make the Nutri-Score mandatory on all foods to increase transparency. Indeed, the Nutri-Score has repeatedly been shown to be effective in guiding consumers towards making healthier choices (Pettigrew et al., 2022). A preventive effect of the Nutri-Score regarding the health halo effect caused by sugar claims was shown (Jürkenbeck et al., 2022). However, the Nutri-Score presents a summary evaluation, which is more useful for identifying foods with an overall favorable nutritional profile but may not be helpful to consumers that want to base their decision on specific nutrients, such as sugar. It is for this reason and others such as the methodology of the underlying algorithm that in the legal realm the Nutri-Score labelling has been identified as misleading itself (see e.g. *Decision of the Hamburg Lower Court of April 16, 2019* (2019)). Future studies need to examine the extent to which the potential introduction of nutrient profiles would

affect consumer attitudes toward the "no added sugar" label, knowledge about its implications, and impact on product evaluation and choice.

Tables and Figures

Table 1. Impact of the label on sugar content estimation. Results of the independent samples t-test.

Product	Real sugar content [g/100g]	with label		no label		*t*	*df*	*p*	Cohen´s d
		M	*SD*	*M*	*SD*				
Blackberries	6.9	20.45	16.79	18.10	14.80	1.58	458.00	0.114	0.15
Dates	65	40.86	24.80	39.01	23.26	0.82	460.00	0.412	0.08
Fruit yoghurt[a]	4.9	20.00	16.06	19.71	13.92	0.21	461.92	0.837	0.02
Fruit muesli	22	25.28	15.78	26.26	15.38	-0.67	457.00	0.504	-0.06
Fruit gum	72	36.40	23.30	37.07	21.65	-0.32	458.00	0.752	-0.03
Oat milk	4	12.61	12.77	11.82	10.83	0.71	461.00	0.480	0.07
Ketchup	6.9	34.82	20.84	38.65	20.00	-2.00	457.00	0.046*	-0.19
Sweet corn	7.4	18.71	16.38	17.59	15.19	0.76	460.00	0.449	0.07
Granola bar	1.7	33.00	20.28	34.94	18.53	-1.07	457.00	0.287	-0.10
Orange juice[a]	8.8	27.68	19.69	26.42	16.57	0.75	456.64	0.456	0.07
Chocolate	6.9	34.24	22.09	42.61	21.48	-4.12	461.00	< .001***	-0.38

[a] Welch t-Test. The remaining products were tested by a Student t-test.

*p < .05; ***p < .001

Table 2. Overestimation of the estimated sugar consent. Results of the one sample t-test.

	Actual Sugar Content	Estimated Sugar content	*t*	*df*	*p*
Blackberrys	6.0	19.3	16.8	459	< .001
Dates	65.0	40.0	-22.3	461	1
Fruit yoghurt	4.9	19.9	21.4	463	< .001
Fruit muesli	22.0	25.7	5.1	458	< .001
Fruit gum	72.0	36.7	-33.6	459	1
Oat milk	4.0	12.2	14.9	462	< .001

Ketchup	6.0	36.6	31.0	458	< .001
Sweet corn	7.4	18.2	30.5	458	< .001
Granola bars	1.7	33.9	35.4	458	< .001
Orange juice	8.8	27.1	21.4	458	< .001
Chocolate	6.9	38.1	30.3	462	< .001

Note. Tested with a one-sided *t*-test. Alternative hypothesis: Mean is greater than actual sugar content.

Table 3. Influence of nutrition knowledge and the label on sugar content perceptions. Results of the ANOVA.

Product	Typ III Sum of Squares	*df*	Mean square	$F(1, n^o)$	*p*	η^2_p
Blackberries						
Nutrition knowledge	102.67	2	51.33	0.20	0.819	0.00
Label	5.62	1	5.62	0.02	0.883	0.00
Nutrition knowledge ✻ Label	247.26	2	123.63	0.48	0.619	0.00
Residuals	104088.53	404	257.65			
Dates						
Nutrition knowledge	1624.45	2	812.23	1.52	0.221	0.01
Label	150.70	1	150.70	0.28	0.596	0.00
Nutrition knowledge ✻ Label	271.13	2	135.56	0.25	0.777	0.00
Residuals	218177.94	407	536.06			
Fruit yoghurt						
Nutrition knowledge	566.09	2	283.05	1.30	0.273	0.01
Label	0.52	1	0.52	0.00	0.961	0.00
Nutrition knowledge ✻ Label	7.95	2	3.97	0.02	0.982	0.00
Residuals	88372.58	407	217.13			
Fruit muesli						
Nutrition knowledge	359.84	2	179.92	0.77	0.463	0.00
Label	297.21	1	297.21	1.27	0.26	0.00

Product	Typ III Sum of Squares	*df*	Mean square	*F(1, n°)*	*p*	η^2_p
Nutrition knowledge ✻ Label	274.47	2	137.24	0.59	0.556	0.00
Residuals	94275.47	404	233.36			
Fruit gum						
Nutrition knowledge	1177.15	2	588.57	1.20	0.302	0.01
Label	364.84	1	364.84	0.75	0.389	0.00
Nutrition knowledge ✻ Label	907.03	2	453.51	0.93	0.397	0.01
Residuals	198299.08	405	489.63			
Oat milk						
Nutrition knowledge	298.79	2	149.40	1.18	0.308	0.01
Label	0.06	1	0.06	0.00	0.983	0.00
Nutrition knowledge ✻ Label	25.18	2	12.59	0.10	0.905	0.00
Residuals	51531.09	407	126.61			
Ketchup						
Nutrition knowledge	88.34	2	44.17	0.11	0.895	0.00
Label	1073.26	1	1073.26	2.69	0.102	0.01
Nutrition knowledge ✻ Label	100.56	2	50.28	0.13	0.882	0.00
Residuals	161449.28	405	398.64			
Sweet corn						
Nutrition knowledge	195.33	2	97.67	0.40	0.669	0.00
Label	0.21	1	0.21	0.00	0.977	0.00
Nutrition knowledge ✻ Label	52.00	2	26.00	0.11	0.898	0.00
Residuals	98658.02	407	242.40			
Granola bars						
Nutrition knowledge	1813.82	2	906.91	2.61	0.075	0.01
Label	568.53	1	568.53	1.64	0.202	0.00

Product	Typ III Sum of Squares	*df*	Mean square	*F(1, n[a])*	*p*	η^2_p
Nutrition knowledge ✻ Label	181.35	2	90.68	0.26	0.77	0.00
Residuals	140681.70	405	347.36			
Orange juice						
Nutrition knowledge	584.62	2	292.31	0.92	0.401	0.01
Label	282.10	1	282.10	0.88	0.348	0.00
Nutrition knowledge ✻ Label	862.29	2	431.15	1.35	0.26	0.01
Residuals	128604.18	403	319.12			
Chocolate						
Nutrition knowledge	1173.95	2	586.98	1.31	0.271	0.01
Label	6764.15	1	6764.15	15.11	< .001***	0.04
Nutrition knowledge ✻ Label	947.02	2	473.51	1.06	0.348	0.01
Residuals	181791.88	406	447.76			

[a] n = 462 (blackberries, ketchup, orange juice); n = 463 (fruit muesli, fruit gum, granola bars, oat milk sweet corn); n = 464 (dates, fruit yoghurt); n = 464 (chocolate). Nutrition knowledge: high n = 24, moderate n = 63; low n = 329.

****p* < .001

Table 4. Impact of the responsibility for grocery shopping and the label on the sugar content estimation. Results of the ANOVA.

Product	Typ III Sum of Squares	*df*	Mean square	*F(1. n[a])*	*p*	η^2_p
Blackbarries						
Condition	612.02	1	612.02	2.44	0.12	0.01
ShopOthersGroup	1277.82	1	1277.82	5.09	0.03*	0.01
Condition ✻ ShopOthersGroup	13.83	1	13.83	0.06	0.82	0.00
Residuals	114250.14	455	251.10			

Product	Typ III Sum of Squares	*df*	Mean square	*F(1. n^a)*	*p*	η^2_p
Dates						
Condition	373.00	1	373.00	0.64	0.42	0.00
ShopOthersGroup	0.65	1	0.65	0.00	0.97	0.00
Condition ✻ ShopOthersGroup	28.76	1	28.76	0.05	0.82	0.00
Residuals	265340.29	457	580.61			
Fruit gum						
Condition	6.59	1	6.59	0.01	0.91	0.00
ShopOthersGroup	17.66	1	17.66	0.04	0.85	0.00
Condition ✻ ShopOthersGroup	116.50	1	116.50	0.23	0.63	0.00
Residuals	232102.64	455	510.12			
Oat milk						
Condition	67.97	1	67.97	0.48	0.49	0.00
ShopOthersGroup	111.03	1	111.03	0.79	0.38	0.00
Condition ✻ ShopOthersGroup	23.62	1	23.62	0.17	0.68	0.00
Residuals	64410.04	458	140.63			
Fruit yogurt						
Condition	22.26	1	22.26	0.10	0.76	0.00
ShopOthersGroup	42.35	1	42.35	0.19	0.67	0.00
Condition ✻ ShopOthersGroup	15.96	1	15.96	0.07	0.79	0.00
Residuals	105156.84	459	229.10			
Ketchup						
Condition	1041.50	1	1041.50	2.49	0.12	0.01
ShopOthersGroup	137.96	1	137.96	0.33	0.57	0.00
Condition ✻ ShopOthersGroup	358.24	1	358.24	0.86	0.36	0.00
Residuals	189897.91	454	418.28			
Sweetcorn						
Condition	83.42	1	83.42	0.34	0.56	0.00

Product	Typ III Sum of Squares	*df*	Mean square	*F(1. n[a])*	*p*	η^2_p
ShopOthersGroup	1722.76	1	1722.76	6.96	0.01*	0.02
Condition ⁎ ShopOthersGroup	195.70	1	195.70	0.79	0.37	0.00
Residuals	113172.06	457	247.64			
Fruit muesli						
Condition	53.93	1	53.93	0.22	0.64	0.00
ShopOthersGroup	55.39	1	55.39	0.23	0.63	0.00
Condition ⁎ ShopOthersGroup	2.44	1	2.44	0.01	0.92	0.00
Residuals	109147.35	454	240.41			
Granola bar						
Condition	317.58	1	317.58	0.84	0.36	0.00
ShopOthersGroup	81.96	1	81.96	0.22	0.64	0.00
Condition ⁎ ShopOthersGroup	1.96	1	1.96	0.01	0.94	0.00
Residuals	171281.47	454	377.27			
Orange juice						
Condition	190.43	1	190.43	0.57	0.45	0.00
ShopOthersGroup	220.93	1	220.93	0.66	0.42	0.00
Condition ⁎ ShopOthersGroup	0.17	1	0.17	0.00	0.98	0.00
Residuals	152846.71	454	336.67			
Chocolate						
Condition	6877.35	1	6877.35	14.40	< .001***	0.03
ShopOthersGroup	160.25	1	160.25	0.34	0.56	0.00
Condition ⁎ ShopOthersGroup	30.24	1	30.24	0.06	0.80	0.00
Residuals	218800.99	458	477.73			

[a] n = 454 (ketchup, fruit cereal, granola bars, orange juice), n = 455 (blackberries, fruit gum), n = 457 (dates, sweet corn), n = 458 (oat milk, chocolate), n = 459 (fruit yoghurt)

*p < .05; ***p < .001

Table 5. Impact of the label on the healthiness perception. Results of the independent samples t-test.

Product	with label		no label		*t*	*df*	*p*	Cohen's *d*
	M	*SD*	*M*	*SD*				
Blackberries[a]	4.73	1.00	4.83	0.81	-1.14	463.47	0.254	-0.11
Dates	3.90	0.90	3.87	0.93	0.32	467	0.751	0.03
Fruit gum	3.03	1.11	2.97	1.02	0.56	465	0.576	0.05
Oat milk	4.46	0.87	4.46	0.79	-0.05	466	0.964	-0.004
Fruit yoghurt	3.54	0.88	3.41	0.95	1.52	467	0.128	0.14
Ketchup	2.16	0.85	2.08	0.80	1.03	467	0.303	0.10
Sweetcorn	4.10	0.84	4.06	0.87	0.07	465	0.942	0.01
Fruit muesli	3.79	0.92	3.67	0.91	1.44	466	0.151	0.13
Granola bar	2.64	0.87	2.47	0.87	2.02	467	0.044*	0.19
Orange juice	3.60	0.96	3.57	0.96	0.29	467	0.773	0.03
Chocolate	2.17	0.85	1.85	0.84	4.14	466	< .001***	0.38

[a] Welch t-Test. Regarding all other products a Student t-test was conducted.

*p < .05; ***p < .001

Table 6. Influence of nutrition knowledge and the label on health perceptions. Results of the ANOVA.

Product	Typ III Sum of Squares	*df*	Mean square	*F(1. n[a])*	*p*	η^2_p
Blackberries						
Condition	0.15	1	0.15	0.18	0.67	0.00
Nutri. Knowledge	2.74	2	1.37	1.67	0.19	0.01
Condition ⁎ Nutri. Knowledge	0.27	2	0.14	0.16	0.85	0.00
Residuals	337.30	410	0.82			
Dates						
Condition	0.01	1	0.01	0.01	0.91	0.00
Nutri. Knowledge	3.01	2	1.51	1.79	0.17	0.01
Condition ⁎ Nutri. Knowledge	1.29	2	0.65	0.77	0.46	0.00
Residuals	344.65	410	0.84			
Fruit gum						
Condition	4.16	1	4.16	3.68	0.06	0.01
Nutri. Knowledge	3.15	2	1.58	1.40	0.25	0.01

Product	Typ III Sum of Squares	*df*	Mean square	*F(1. n^a)*	*p*	η^2_p
Condition ✻ Nutri. Knowledge	6.44	2	3.22	2.85	0.06	0.01
Residuals	462.41	409	1.13			
Oat milk						
Condition	2.51	1	2.51	3.93	0.05	0.01
Nutri. Knowledge	0.13	2	0.07	0.11	0.90	0.00
Condition ✻ Nutri. Knowledge	5.21	2	2.60	4.07	0.02	0.02
Residuals	261.78	409	0.64			
Fruit yogurt						
Condition	0.59	1	0.59	0.68	0.41	0.00
Nutri. Knowledge	0.69	2	0.35	0.40	0.67	0.00
Condition ✻ Nutri. Knowledge	0.16	2	0.08	0.09	0.91	0.00
Residuals	354.87	410	0.87			
Ketchup						
Condition	0.47	1	0.47	0.74	0.39	0.00
Nutri. Knowledge	0.24	2	0.12	0.19	0.83	0.00
Condition ✻ Nutri. Knowledge	0.37	2	0.19	0.29	0.75	0.00
Residuals	261.76	410	0.64			
Sweet corn						
Condition	0.33	1	0.33	0.44	0.51	0.00
Nutri. Knowledge	1.74	2	0.87	1.18	0.31	0.01
Condition ✻ Nutri. Knowledge	0.34	2	0.17	0.23	0.80	0.00
Residuals	303.11	409	0.74			
Fruit muesli						
Condition	0.84	1	0.84	1.02	0.31	0.00
Nutri. Knowledge	1.77	2	0.88	1.08	0.34	0.01
Residuals	335.36	409	0.82			
Granola bar						
Condition	0.70	1	0.70	0.35	0.56	0.00
Nutri. Knowledge	1.58	2	0.79	0.39	0.68	0.00
Condition ✻ Nutri. Knowledge	2.52	2	1.26	0.62	0.54	0.00
Residuals	827.82	410	2.02			
Orange juice						

Product	Typ III Sum of Squares	*df*	Mean square	*F(1. n[a])*	*p*	η^2_p
Condition	0.48	1	0.48	0.51	0.48	0.00
Nutri. Knowledge	2.98	2	1.49	1.59	0.21	0.01
Condition ✻ Nutri. Knowledge	3.48	2	1.74	1.86	0.16	0.01
Residuals	385.06	410	0.94			
Chocolate						
Condition	4.34	1	4.34	6.56	0.01*	0.02
Nutri. Knowledge	1.77	2	0.89	1.34	0.26	0.01
Condition ✻ Nutri. Knowledge	0.04	2	0.02	0.03	0.97	0.00
Residuals	270.341	409	0.661			

[a] n = 409 (fruit gums, oat milk, sweet corn, fruit cereal, chocolate); n = 410 (blackberries, dates, fruit yoghurt, ketchup, granola bar, orange juice)

*$p < .05$

Table 7. Influence of the grocery shopping responsibility and the label on health perception. Results of the ANOVA.

Products	Typ III Sum of Squares	df	Mean Squares	*F*(1, n[a])	*p*	η^2_p
Blackberries						
Label	1.81	1	1.81	2.18	0.141	0.01
Responsibility	5.02	1	5.02	6.03	0.014**	0.01
Label ✻ Responsibility	2.18	1	2.18	2.62	0.106	0.01
Residuals	385.70	464	0.83			
Dates						
Label	0.30	1	0.30	0.36	0.550	0.00
Responsibility	3.09	1	3.09	3.72	0.055	0.01
Label ✻ Responsibility	0.83	1	0.83	0.98	0.319	0.00
Residuals	386.47	464	0.83			
Fruit gum						
Label	0.21	1	0.21	0.18	0.674	0.00
Responsibility	0.64	1	0.64	0.55	0.457	0.00
Label ✻ Responsibility	0.03	1	0.03	0.03	0.863	0.00
Residuals	533.03	462	1.15			
Oat milk						

Products	Typ III Sum of Squares	df	Mean Squares	$F(1, n^a)$	p	η^2_p
Label	0.03	1	0.03	0.04	0.846	0.00
Responsibility	0.01	1	0.01	0.01	0.931	0.00
Label ✻ Responsibility	0.14	1	0.14	0.19	0.660	0.00
Residuals	323.79	463	0.70			
Fruit yoghurt						
Label	1.97	1	1.97	2.34	0.127	0.01
Responsibility	0.37	1	0.37	0.45	0.505	0.00
Label ✻ Responsibility	0.13	1	0.13	0.16	0.691	0.00
Residuals	390.35	464	0.84			
Ketchup						
Label	0.83	1	0.83	1.20	0.275	0.00
Responsibility	0.04	1	0.04	0.05	0.820	0.00
Label ✻ Responsibility	0.22	1	0.22	0.32	0.570	0.00
Residuals	321.17	464	0.69			
Sweet corn						
Label	0.00	1	0.00	0.00	0.969	0.00
Responsibility	6.64	1	6.64	9.35	0.002**	0.02
Label ✻ Responsibility	0.064	1	0.06	0.09	0.764	0.00
Residuals	328.21	462	0.71			
Fruit muesli						
Label	1.44	1	1.44	1.71	0.192	0.00
Responsibility	0.17	1	0.17	0.20	0.656	0.00
Label ✻ Responsibility	0.03	1	0.05	0.06	0.814	0.00
Residuals	391.56	463	0.85			
Granola bar						
Label	7.58	1	7.58	3.94	0.048*	0.01
Responsibility	0.77	1	0.77	0.40	0.528	0.00
Label ✻ Responsibility	0.09	1	0.09	0.05	0.829	0.00
Residuals	892.76	464	1.92			
Orange juice						
Label	0.21	1	0.21	0.23	0.634	0.00
Responsibility	0.06	1	0.06	0.07	0.795	0.00
Label ✻ Responsibility	0.40	1	0.40	0.43	0.514	0.00
Residuals	431.00	464	0.93			

Products	Typ III Sum of Squares	df	Mean Squares	$F(1, n^a)$	p	η^2_p
Chocolate						
Label	12.80	1	12.80	17.92	< .001***	0.04
Responsibility	0.08	1	0.08	0.11	0.745	0.00
Label ✻ Responsibility	0.70	1	0.70	0.99	0.322	0.00
Residuals	330.75	463	0.71			

[a] n = 468 (blackberries, dates, fruit yoghurt, ketchup, granola bars, orange juice); n = 467 (oat milk, fruit muesli, chocolate); n = 466 (fruit gum, sweet corn); responsible for others: n = 300; not responsible: n =166

*p < .05; **p < .01; ***p < .001

Figure 1. Consumers perception of the “no added sugar“ label: Distribution of responses to the presented statements.

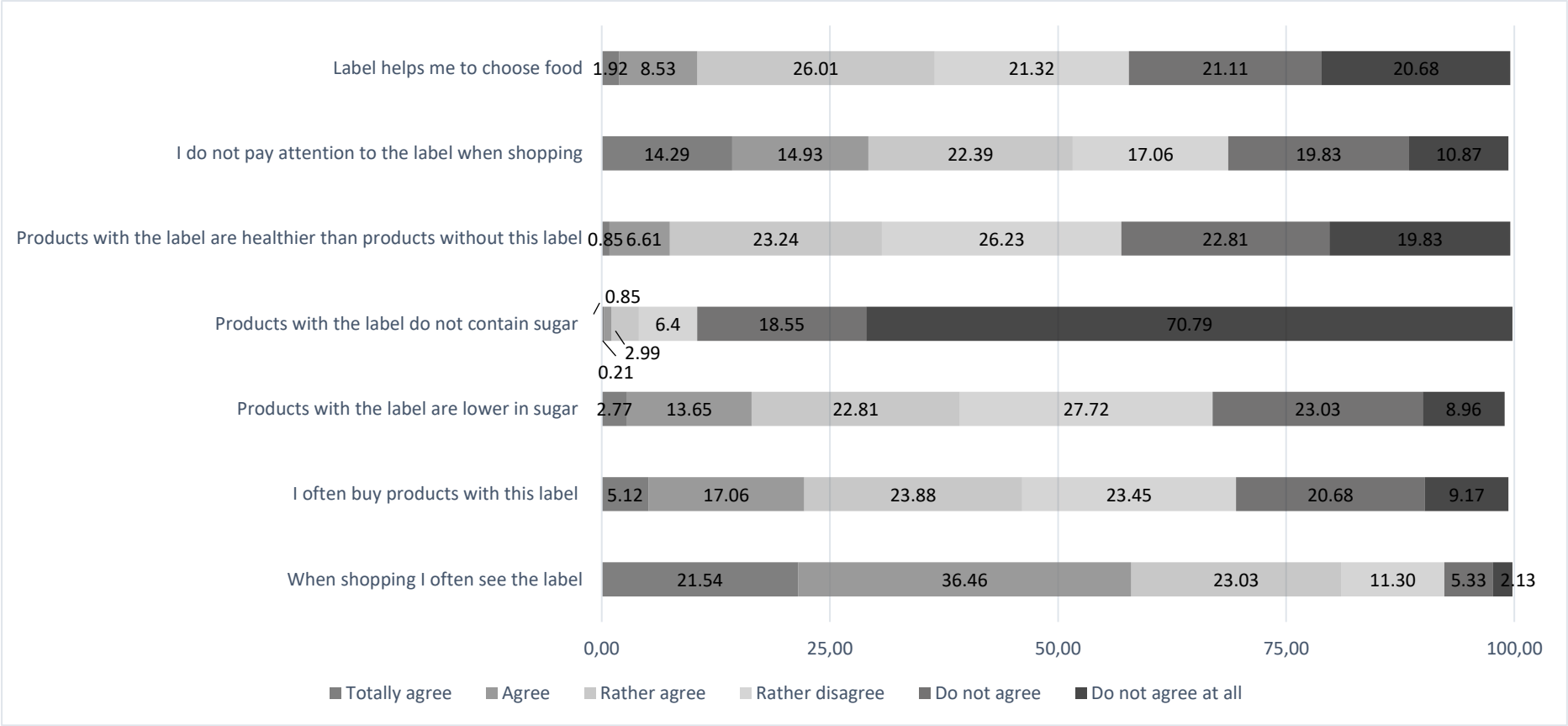
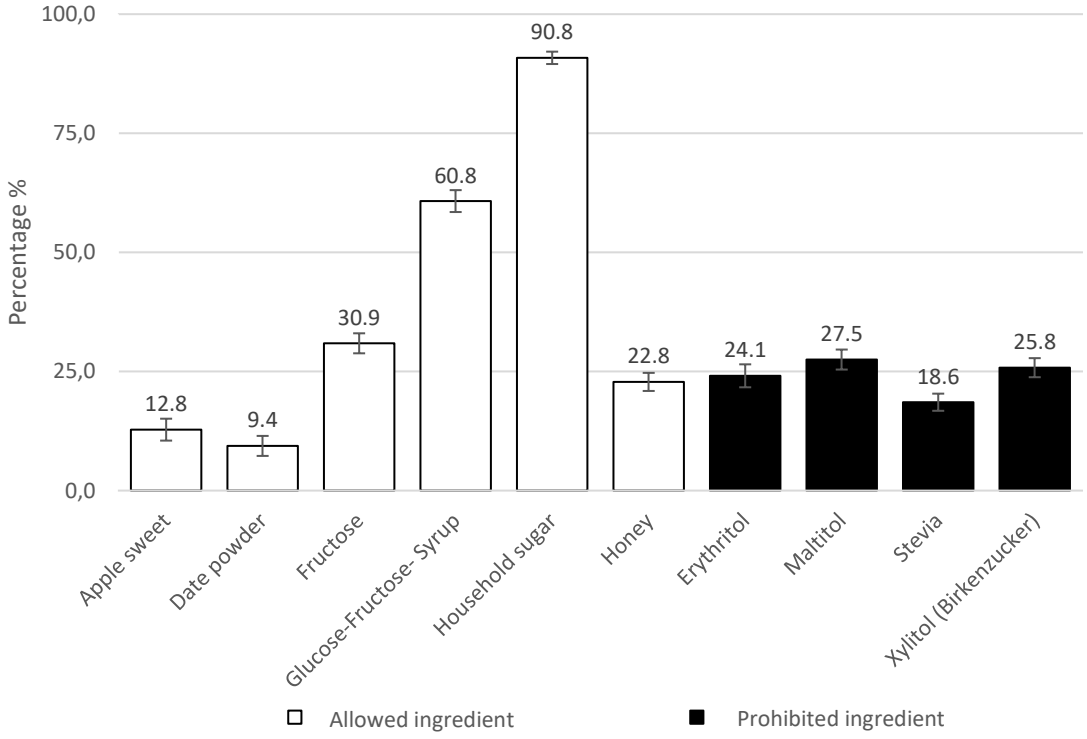


Figure 2. Consumers' ability to identify added sugars. The percentage of correct answers are shown for identifying allowed and prohibited ingredients regarding the "no added sugar" label. The error bars indicated the standard error of the mean.



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Supplementary Material

Table S1. Examples for the classification of the nutrition knowledge of the consumers based on their occupation, education, or field of study.

Nutrition knowledge	Occupation / Education / Field of Study
Low	Geoecology, business psychology, business administration, biology, retail saleswoman, mechanical engineering, business informatics, educator
Medium	Human Medicine, dentistry, medical assistant, geriatric nurse, physician assistant, nutrition management, health economics
High	Biology and Pharmacy, Pharmacy, Nutritional Sciences, Certified Nutrition and Supply Assistant, Midwifery or Applied Midwifery Science, Food and Health Sciences.