

# Cross-sectional determinants of lactose-free food awareness and purchase among adult consumers

## Research Article

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### Abstract

This research was conducted to evaluate the knowledge and purchasing behaviour of consumers regarding lactose-free foods. Study data were collected from 1882 individuals with the help of a questionnaire form. Attitudes towards animal welfare, healthy nutrition and gastrointestinal symptoms were also evaluated. The majority (86.6%) of the participants reported that they had heard of the concept of lactose-free foods before, but more than half (67.0%) did not report buying them because of their higher costs compared to regular products and lack of sufficient information. Not causing gas/bloating (32.5%) and being healthier (28.3%) were shown to be the most significant motivational factors in purchasing lactose-free foods ( $P < 0.05$ ). The factors affecting purchase of lactose-free products were education, employment status, history of having a food intolerance test and animal welfare perception together with higher scores from the gastrointestinal symptom rating scale, and attitude scale for healthy nutrition ( $P < 0.05$ ). Body mass index was not found to be an effective factor determining purchase intention. The results provide a general overview of consumers, however, further studies on other demographic groups are needed.

Lactose [4-O-(b-galactopyranosyl)-D-glucopyranose] is the main carbohydrate found in the milk of most mammals and can constitute as much as 98.0% of the carbohydrate in milk. The single source of lactose in nature is mammalian milk and its derivatives (Gambelli, 2017; Hartmann *et al.*, 2018; Ibrahim *et al.*, 2021). The lactose concentration in the milk of mammals varies between 0.1 and 8.0% (humans 7.0% and cows 4.6%). Lactose is essential for mammalian infants in the first few months. Lactose is not only the main source of carbohydrates for infants but also provides galactose for the synthesis of nerve structures (Gambelli, 2017; Gänzle, 2022).

Although milk is an important component of the human diet with its high nutritional value, lactose can cause tolerance problems in some individuals (especially in adults). The inability to digest lactose at varying rates leads to lactose digestion disorder in the form of intolerance (Paige, 2013). Lactose intolerance (LI), which is often mistaken for cow's milk allergy by patients, is the result of a deficiency of the enzyme commonly called 'lactase' or 'β-galactosidase', which is more precisely defined as a lactase-phlorizin hydrolase (Paige, 2013; Di Costanzo and Berni Canani, 2018). There are three types of lactose intolerance: (i) congenital lactase deficiency, (ii) primary lactose intolerance or adult-type lactase deficiency, and (iii) secondary lactase deficiency (Di Costanzo and Berni Canani, 2018).

The prevalence of LI varies greatly by countries. While LI prevalence is only 1% for the Dutch, it is 85.0% for adult Australian Aborigines and 100% for adult Native Americans (Silanikove *et al.*, 2015). Consuming a 'lactose-free diet' is the most effective treatment for individuals with LI. However, in lieu of complete elimination, limiting lactose intake has been shown to be effective as well. Current data show that individuals with LI can tolerate up to 12–15 g (~1 cup of milk) of lactose daily (Szilagyi and Ishayek, 2018). Foods to be avoided in a lactose-free diet are mainly milk and dairy products, although many processed foods also contain dairy ingredients (Berni Canani *et al.*, 2016).

The increase in the health and nutrition awareness of consumers has led the food industry to develop innovative diet products. Today, the dairy industry develops new products using exogenous lactase enzymes to meet dietary calcium and protein requirements whilst removing lactose so as to increase the quality of life of individuals with LI. Lactose-free and lactose-reduced milk and dairy products are available in most supermarkets in Western countries and are similar in nutrient profiles to regular milk and dairy products

(Silanikove *et al.*, 2015). In addition, since the hydrolysis of lactose in milk increases the sweetness of the product to a similar degree as adding 2% extra sugar, lactose hydrolysis in dairy products attracts attention as an alternative option for reducing sugar without compromising the sweet taste (McCain *et al.*, 2018). However, it is important to examine the sensory properties and consumer knowledge and awareness regarding lactose-free milk. The consumer acceptance of dairy products is mainly sensory-oriented. For this reason, consumers pay attention to the fact that lactose-free milk and dairy products are similar to regular dairy products in terms of sensory properties, and they make preferences in this direction (Claassen and Lawless, 2006; Adhikari *et al.*, 2010). Adhikari *et al.* (2010) reported that the increased sweetness of lactose-free milk compared to regular milk could be perceived as a negative factor in purchasing, however, another study (Rizzo *et al.*, 2020) reported it as a motivational factor for consumers. The consumers who preferred plant-based milk as non-dairy alternatives stated that they would choose dairy lactose-free products if they could find products with the same flavour (McCarthy *et al.*, 2017). In addition to the flavour of the lactose-free milk, it has been shown that intrinsic characteristics (such as nutritional composition), psychological factors (such as knowledge of nutrition), socio-cultural factors (such as income), situational factors (habits, for example) and biological and physiological factors (such as body mass index: BMI) can be determinants of consuming lactose-free milk (Castellini and Graffigna, 2022).

A more diverse range of lactose-free products have been offered to consumers in recent years with a significant increase in quality and variety (Dekker *et al.*, 2019). Accordingly, lactose-free dairy products are currently reported to be among the fastest-growing markets in the dairy industry (Dekker *et al.*, 2019). However, consumer research evaluating awareness and purchase of lactose-free products is very limited. Therefore, this research paper was conducted to evaluate the knowledge, behaviour, and attitudes of adult consumers regarding lactose-free foods.

## Materials and methods

### Participants and setting

The study was conducted with 1882 participants, 1046 women and 836 men, aged between 19 and 65 years living in Turkey. The data were collected with an online questionnaire prepared by the researchers between December 2020 and March 2021. Before filling out the questionnaire, the participants were informed about the study to get their written consent. The following ethical considerations when recruiting: to respect the privacy of participants, not put pressure on participants to complete the questionnaire, to give an accurate and clear description of the study and to present the study impartially whilst avoiding words that invite specific answers (eg attractive sounding words). The inclusion criteria of participants were defined as not being under 19 and not over 65 years of age, not having a cognitive problem or other advanced diseases that affect decision-making skills, for women, not being pregnant or lactating, and also not being qualified as a dietitian, nutritionist or other food expert. Participants also had the following characteristics: being voluntary, having a food shopping experience, having internet access, not having a communication problem, and being literate. The study was approved by the Atilim University Human Research Ethics (approval number: E-59394181-604.01.02-3038).

### Assessment of sociodemographic and nutrition-related variables

The questionnaire is shown in full (in Turkish) in the online Supplementary File. It included sociodemographic variables, knowledge of the concept of lactose-free food, attitudes and behaviours about lactose-free products, self-reported height (cm), and body weight (kg), presence of chronic disease(s), and history of having had a prior food intolerance testing. To assess the perceptions regarding animal welfare sensitivity, participants were asked if the consumption of lactose-free products increased animal welfare or not. The body weight and height information reported by the individuals were used to calculate BMI with the equation of  $\text{body weight/height}^2$  ( $\text{kg/m}^2$ ). The classification of the World Health Organization (WHO) was used to categorize BMI. Accordingly, BMI categories were considered as <18.5 for underweight, 18.5–24.9 for normal weight, 25.0–29.9 for overweight, and  $\geq 30.0 \text{ kg/m}^2$  for obesity (WHO, 2004).

### Scales

Gastrointestinal symptom rating scale or GSRS was used to evaluate the gastrointestinal system (GIS) symptoms of individuals, and attitude scale for healthy nutrition or ASHN was used to evaluate the attitudes toward healthy eating (Turan *et al.*, 2017; Tekkurşun Demir and Cicioğlu, 2019). GSRS is a 7-point Likert-type scale with 15 items, with options starting from 'no problem' to 'severe discomfort'. Based on factor analysis, GSRS has five sub-dimensions: abdominal pain, reflux, diarrhoea, indigestion and constipation. Turkish validity and reliability of the scale were made by Turan *et al.*, in 2017. GSRS evaluates how the individual feels regarding GIS problems in the last week. High scores indicate severe symptoms (Turan *et al.*, 2017). ASHN as adapted to Turkish society (Tekkurşun-Demir and Cicioğlu, 2019) consists of 21 items and 4 factors (information on nutrition, emotion for nutrition, positive nutrition, and malnutrition). The lowest and the highest scores to be taken from the ASHN are 21 and 105, respectively and score categories are as follows; 21 is very low, 23–42 is low, 43–63 is moderate, 64–84 is high and 85–110 is ideal.

Regarding lactose-free products, the following questions were asked to the participants:

- Have you ever heard of the concept of lactose-free food? Yes/No
- Do you buy lactose-free food? Yes/No
- Have you seen the label lactose-free on food packaging before? Yes/No
- If yes; where did you see it in the package?" Response options of front, back, ingredients, allergen information and others
- Why do you buy lactose-free food? Reasons for purchasing of losing weight, having allergies/intolerance, being healthy, feeling good, being delicious, having a good image in the media, not causing gas/bloating and others
- Why do you not buy lactose-free food? Reasons for not purchasing of being expensive, not doing food shopping, being unavailable, inability to distinguish lactose-free foods, not having enough information and others

### Outcomes of the study

The primary outcome was to evaluate the determinants affecting the purchase of lactose-free products. The secondary outcome was

to identify relationships between purchase intention, BMI and ASHN.

### Statistical analysis

For the primary outcome, the impact of ASHN, GSRs, and BMI on the odds of purchasing lactose-free food were determined with binary logistic regression models. Estimates were adjusted for age, sex, education, employment status, presence of chronic disease, history of food intolerance test and animal welfare perception.

For the secondary outcome, multilinear regression was used to explain the relationship between BMI with ASHN and GSRs scores after adjusting for age, sex, education, employment status, presence of chronic disease, and history of food intolerance test. All the analyses were performed using IBM Statistical Package for the Social Sciences (IBM SPSS) V.23. Categorical data are presented as numbers (n) and percentages (%), and arithmetic mean and standard deviation values of continuous data are presented. The normality of continuous variables was analysed by Kolmogorov–Smirnov test. A chi-square test of independence was performed to examine the differences between the motivating factors for lactose-free product purchases. Logistic regression models were used to examine the factors affecting the purchase of lactose-free milk. The level of significance was accepted as  $P < 0.05$  in all statistical analyses.

### Results

The mean age of the individuals in the study was  $27.7 \pm 9.15$  years, and 55.6% of them were women. More than half were single (68.9%), 78.5% had, as a minimum, a university degree, and more than half (53.6%) were employed. 13.5% had chronic diseases, and the majority (96.1%) did not report having a history of food intolerance tests. Further details regarding demographic characteristics of individuals are given in online Supplementary Table S1.

We observed that 7.7% of those purchasing lactose-free foods had a history of food intolerance test (n:48) and, among them, 60.4% (n:29) were diagnosed with lactose intolerance. The status of purchasing lactose-free foods with lactose intolerance was not found statistically significant according to sex ( $P = 0.832$ ). As for the BMI classification, it was determined that the individuals who preferred lactose-free foods the most were individuals with normal BMI values, but there was no significant difference between the groups ( $P > 0.05$ , data not shown).

The analysis of individual knowledge, attitudes and behaviours about lactose-free foods is reported in Fig. 1. Most (86.6%) of the respondents (79.1% of men and 92.5% of women) were familiar with the concept of lactose-free food and 78.6% of them reported seeing the label 'lactose-free' on the food (of which 82.7% on the front of the package). However, more than half (67.0%) reported not buying these products and the most important reasons for this were their high prices compared to regular dairy products and the lack of sufficient information about lactose-free products. The most significant motivation factors for individuals who did buy lactose-free foods (33.0%) were found to be not causing gas/bloating (32.5%), being healthy (28.3%) and feeling better after consumption (12.4%). Moreover, there were significant ( $P < 0.05$ ) gender differences in the knowledge, attitudes, and reported behaviours of individuals towards lactose-free foods: while the primary reason to buy lactose-free products was found to be healthy for men (32.1%), for women it was not

causing gas/bloating (36.9%). In addition, women were found to buy lactose-free products more frequently than men (data not shown).

The factors affecting the purchase of lactose-free products were evaluated with logistic regression models and are shown in Table 1. The effect of age on purchasing lactose-free food was not statistically significant in either the univariate analysis ( $P = 0.81$ ) or the multivariate analysis ( $P = 0.08$ ). While the mean age was 27.63 for those who did not buy, it was 27.74 for those who did. One third of all participants (33.3% of males and 32.8% of females) were reported to purchase lactose-free products. When women were taken as reference, the effect of gender was not found to be significant in the purchasing process according to both univariate and multivariate analysis results. Purchasing status according to education level was determined as 23.4% for those with less than high school education, 40.0% for those with high school education and 32.2% for those with a university or above education level. When those with university or higher education are taken as reference, the purchase probability of high school graduates was 1.404 times higher in the univariate analysis, and 1.39 in the multivariate analysis ( $P < 0.01$ ). While the rate of purchasing was 36.7% for working participants, it was 30.0% for those who did not work. In the univariate analysis, the probability of purchasing was 1.357 times higher in working participants than in non-workers, while this value is 1.471 in multivariate analysis ( $P < 0.01$ ). While the rate of purchase was 39.3% in those with chronic diseases, it was 32.0% in those without chronic diseases, a significant difference by univariate analysis (1.376 times higher,  $P < 0.05$ ) but not in the multivariate analysis. While purchasing frequency was reported to be 64.9% in those who had a history of food intolerance test, it was 31.7% in those who did not (significant in both analyses,  $P < 0.001$ ). The purchasing rate was 53.8% for those who thought lactose-free food consumption would increase animal welfare, a significant ( $P < 0.001$ ) difference compared either with 28.5% for those who thought it would not (28.5%) and those who had no idea (29.2%). The BMI value was found to be 24.12 in the purchasers and 24.27 in the non-purchasers, and it was not found statistically significant in either univariate or multivariate analyses.

Data for ASHN and GSRs measures are given in Table 1. While the average value of ASHN was 67.08 for those who did not buy, it was 64.43 for those who did. Both univariate and multivariate analyses showed that the increase in the ASHN value has an effect in favour of not purchasing ( $P < 0.01$ ). While the GSRs value was 27.83 for those who did not buy, it was 29 for those who purchase lactose-free products, a significant difference ( $P < 0.05$ ) in both analyses.

Analysis was performed to examine relationships between BMI and other outcomes (online Supplementary Table S2). When considering BMI as the dependent variable, the multiple linear regression model developed to explain its relationship with ASHN and GSRs scores after adjusting for age, sex, education, employment status, presence of chronic disease and history of food intolerance test was found to be statistically significant ( $P < 0.001$ ). In the model, 8.42% of the BMI value is explained with the independent variables. Analysis of the BMI determinants showed age as a statistically significant determinant ( $P < 0.001$ ), BMI increasing with age. When gender was added to the model as a dummy variable, the BMI value was found to be 2.364 units higher in men ( $P < 0.001$ ). In terms of education level, the BMI value was 3.977 units lower in high school graduates and 4.103 units lower in university graduates ( $P < 0.001$ ). Employment status, presence of chronic diseases, having an intolerance test, ASHN,

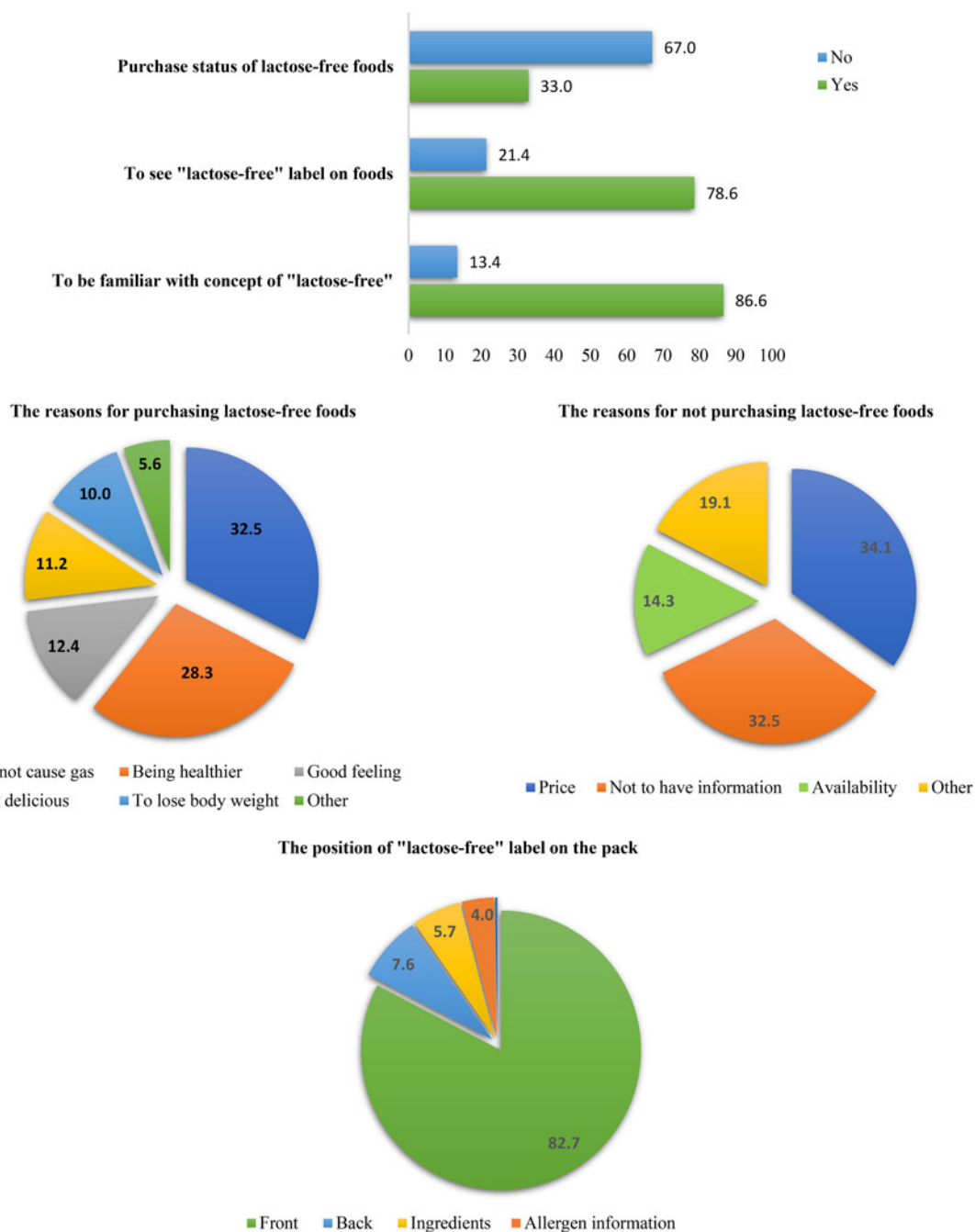


Fig. 1. The knowledge, attitudes, and behaviours of individuals regarding lactose-free foods.

and GRS total values were not found to be significant determinants for BMI as a continuous variable ( $P > 0.05$ ).

Table 2 shows the analysis with ASHN considered as the dependent variable. The regression model developed with variables of age, sex, education, employment status, presence of chronic diseases, food intolerance test, BMI and GRS was found to be statistically significant ( $P < 0.001$ ). In the model, 3% of the ASHN value is explained with the independent variables. When the ASHN determinants were examined, age was found to be a statistically significant determinant ( $P < 0.01$ ), decreasing with age. When gender was added to the model, the ASHN value was found to be 1.916 units lower in men ( $P = 0.01$ ). The ASHN value was found to be 6.33 lower in those who had a

food intolerance test ( $P < 0.001$ ). A one-unit increase in the GRS total value caused an increase of 0.099 units in the ASHN value ( $P = 0.001$ ). Other independent variables, including BMI, were not found to be significant for ASHN ( $P > 0.05$ ).

### Discussion

Although the prevalence of lactose intolerance varies between countries, significant increases have been observed in the number of individuals with food intolerance over the last few years (Turnbull *et al.*, 2015). Accordingly, there have been significant developments in the lactose-free product market in recent years, yet only limited numbers of studies have been conducted



**Table 1.** Logistic regression analysis results determining the factors affecting purchasing lactose-free products

	Purchasing status of lactose-free products		Univariate		Multivariate	
	No	Yes	OR (%95 CI)	P	OR (%95 CI)	P
Age (year)	27.63 ± 9.34	27.74 ± 8.73	1.001 (0.991–1.012)	0.806	0.987 (0.973–1.001)	0.079
Sex						
Male	558 (66.7)	278 (33.3)	1.021 (0.842–1.239)	0.832	0.878 (0.705–1.095)	0.249
Female	703 (67.2)	343 (32.8)	Reference		Reference	
Education						
Below high school	72 (76.6)	22 (23.4)	0.644 (0.394–1.050)	0.078	0.701 (0.41–1.198)	0.193
High school	180 (60)	120 (40)	1.404 (1.088–1.813)	<b>0.009</b>	1.39 (1.059–1.825)	<b>0.018</b>
University and above	1009 (67.8)	479 (32.2)	Reference		Reference	
Employment status						
Yes	532 (63.3)	309 (36.7)	1.357 (1.119–1.646)	<b>0.002</b>	1.471 (1.16–1.866)	<b>0.001</b>
No	729 (70)	312 (30)	Reference		Reference	
Presence of chronic diseases						
Yes	156 (60.7)	101 (39.3)	1.376 (1.049–1.804)	<b>0.021</b>	1.347 (0.993–1.828)	0.055
No	1105 (68)	520 (32)	Reference		Reference	
History of food intolerance test						
Yes	26 (35.1)	48 (64.9)	3.979 (2.444–6.478)	<b>&lt;0.001</b>	3.498 (2.109–5.802)	<b>&lt;0.001</b>
No	1235 (68.3)	573 (31.7)	Reference		Reference	
Animal welfare perception						
Yes	139 (46.2)	162 (53.8)	2.824 (2.181–3.657)	<b>&lt;0.001</b>	2.747 (2.108–3.579)	<b>&lt;0.001</b>
No	269 (71.5)	107 (28.5)	0.964 (0.746–0.245)	0.779	0.916 (0.703–1.193)	0.513
No idea	853 (70.8)	352 (29.2)	Reference			
BMI (kg/m <sup>2</sup> )	24.27 ± 10.31	24.12 ± 4.19	0.998 (0.985–1.010)	0.724	0.997 (0.98–1.015)	0.748
ASHN	67.08 ± 13.77	64.43 ± 17.46	0.989 (0.983–0.995)	<b>&lt;0.001</b>	0.99 (0.984–0.997)	<b>0.004</b>
GSRS_total	27.83 ± 11.15	29 ± 11.7	1.009 (1.001–1.017)	<b>0.036</b>	1.011 (1.002–1.02)	<b>0.015</b>

OR, Odds ratio; CI, Confidence interval; BMI, Body mass index; ASHN, Attitude Scale for Healthy Nutrition; GSRS, Gastrointestinal Symptom Rating Scale.

exploring the purchasing intentions and perceptions of consumers regarding dairy products and lactose-free products in different societies (Rizzo *et al.*, 2020; Merlino *et al.*, 2022). In this study, the knowledge levels of adult individuals regarding the consumption of lactose-free products and the motivating factors affecting their purchase of lactose-free products were evaluated.

Factors affecting the purchase of lactose-free products were determined as education level, employment status, food intolerance testing status, animal welfare perception, ASHN score, and GSRS score. However, interestingly, we found that BMI was not an effective determinant in the decision to purchase lactose-free products. On the other hand, age (BMI increases with increasing age), gender (BMI is higher in males), and educational status (BMI decreases as the level of education increases) were found to be significant determinants associated with BMI.

Barriers against purchasing lactose-free products were found to be higher prices and a lack of consumer awareness. The results of this study suggest that not only the health (ASHN and GSRS) but also socio-cultural characteristics of individuals have a significant role in motivating consumers for purchasing lactose-free products. Similar results were obtained in a recent systematic review that

included studies from the United States, Spain, and Brazil (Savarese *et al.*, 2021). These authors discussed the determinants of consumption of foods that contain 'free-from' claims and determined that nutritional facts and labels were found to be facilitating factors for individuals with food intolerance. The same study reported that high prices and lack of access to lactose-free products were the main problems mitigating against purchasing. Authors also emphasized that only a limited number of studies assessed the link between purchasing behaviour and individual preferences of consumers, socio-cultural, and psychological factors (Savarese *et al.*, 2021). Moreover, animal welfare and environmental awareness may affect the purchasing behaviour of some consumers (de Jonge *et al.*, 2015; Jiang *et al.*, 2021). Consumers who prefer non-dairy plant-based products vs. those who prefer dairy lactose-free products were compared in the literature. It was determined that plant-based products that contributed to the goal of consuming less animal products, beliefs about animal abuse and perceived lower negative impact on the environment were the main determinants (McCarthy *et al.*, 2017). We also determined that one of the factors affecting purchasing lactose-free products was animal welfare perception, and more than half of the participants (53.8%)

**Table 2.** Multiple linear regression analysis results in determining the factors affecting the Attitude Scale for Healthy Nutrition

	$\beta^1$ (%95 CI)	SE	$\beta^2$	t	P	Zero	Partial	Part	VIF
(Constant)	66.501 (61.433–71.57)	2.584		25.733	<b>&lt;0.001</b>				
Age (year)	–0.15 (–0.244– –0.055)	0.048	–0.091	–3.114	<b>0.002</b>	–0.126	–0.072	–0.071	1.637
Sex									
Female (code:0)	Reference								
Male (code:1)	–1.916 (–3.377 – –0.456)	0.745	–0.063	–2.573	<b>0.010</b>	–0.094	–0.059	–0.058	1.158
Education									
Below high school	Reference								
High school	1.465 (–2.107–5.037)	1.821	0.035	0.804	0.421	–0.030	0.019	0.018	3.764
University	1.782 (–1.546–5.11)	1.697	0.048	1.050	0.294	0.052	0.024	0.024	4.027
Employment status									
Unemployed (code:0)	Reference								
Employed (code:1)	–0.86 (–2.465–0.744)	0.818	–0.028	–1.052	0.293	–0.091	–0.024	–0.024	1.398
Presence of chronic diseases									
No (code:0)	Reference								
Yes (code:1)	–0.562 (–2.673–1.55)	1.077	–0.013	–0.522	0.602	–0.048	–0.012	–0.012	1.153
History of food intolerance test									
No (code:0)	Reference								
Yes (code:1)	–6.33 (–9.817 – –2.842)	1.778	–0.081	–3.560	<b>&lt;0.001</b>	–0.083	–0.082	–0.081	1.012
BMI (kg/m <sup>2</sup> )	0.041 (–0.039–0.122)	0.041	0.024	1.002	0.316	–0.021	0.023	0.023	1.096
GSRS total	0.099 (0.039–0.159)	0.031	0.074	3.248	<b>0.001</b>	0.083	0.075	0.074	1.014

SE, Standard error; CI, Confidence interval; VIF, Variance inflation factor; BMI, Body mass index; ASHN, Attitude Scale for Healthy Nutrition; GSRS, Gastrointestinal Symptom Rating Scale. Dependent variable: ASHN;  $\beta^1$  Non-standard coefficient;  $\beta^2$ : Standard coefficient; F (9;1868) = 7392; P < 0001; Adj. R<sup>2</sup> = 003.

believed that buying lactose-free products would increase animal welfare.

Since there are many factors such as cultural, economic, social, and personal that affect the purchasing behaviour of consumers, consumer behaviour has been the subject of market research, especially since the beginning of the 21st century (Ramya and Ali, 2016; Qazzafi, 2020). The third industrial revolution at the end of the 20<sup>th</sup> century and the rapid developments in information and communication technology led to significant changes in the purchasing behaviour of individuals (Victor *et al.*, 2018). Moreover, in recent years, the process called 'industry 4.0', which aims to meet personalized customer needs, has brought a completely different perspective on consumer behaviour (Vaidya *et al.*, 2018; Victor *et al.*, 2018). It has been emphasized that consumption of free-from food (lactose and gluten-free) during the Coronavirus Disease 2019 (COVID-19) pandemic may be related to the psychological distress experienced by individuals. Consumers who were reported to prefer the food that have 'free-from' claims tend to be younger and more concerned about their health (Savarese *et al.*, 2022).

In the present study, individual factors that affect purchasing were discussed as much as possible. In this context, examining the relationship between individual healthy eating attitudes and GIS symptoms and purchasing lactose-free products has revealed significant results. It is not surprising that as GIS symptoms increased, the likelihood of purchasing lactose-free products increased. On the other hand, the increase in the ASHN score was effective in favour of not purchasing lactose-free products.

Age, sex, history of food intolerance test status and GSRS total score were found to be significant variables as factors affecting ASHN. These results suggest that individual factors can influence purchasing behaviour through different mechanisms. Rizzo *et al.* (2020) reported that despite the notable nutritional and label claims like 'high protein, high calcium, and organic' in the packages of lactose-free products, they are not effective in the purchasing behaviour of consumers. In line with that, 21% of lactose-free products do not have additional labelling claims, other than the 'lactose-free' claim (Martínez Rodríguez *et al.*, 2021). In another study, while the primary determinant in purchasing lactose-free products was the price, 'sweeter taste' has been a significant driver for most lactose-free consumers in the United States (Rizzo *et al.*, 2020).

Different from the American consumers, in the present study adults from Turkey opted for lactose-free products mainly for health reasons and lactose-free products were not found to be preferred unless there was a health problem. Accordingly, the participants had an increased likelihood of purchasing lactose-free products as their reported GIS symptoms increased. In this context, it is thought that awareness about lactose-free milk and products should be raised, especially among individuals with gastrointestinal symptoms as well as among health care practitioners. Additionally, since the need for calcium increases especially in the elderly population, a group with intense GIS problems, purchasing awareness in this group could also be addressed in further studies. Dairy products have high nutritional value but have in the past been linked to adverse health outcomes

due to the high amount of saturated fat they contain and the known risks posed by such fats (Te Morenga and Montez, 2017; Sindhav et al., 2023). Therefore, beverage innovations in the food industry should include skimmed lactose-free products.

It is reported that individuals prefer animal-based milk to plant-based milk due to their habits and being accustomed to the flavour (Palacios et al., 2010). However, a number of studies emphasize the environmental sustainability of plant-based diets (Lacour et al., 2018; Poore and Nemecek, 2018). Plant-based diets were shown to be negatively associated with diet-related greenhouse gas emissions, cumulative energy demand, and land occupation indicators (Lacour et al., 2018). Thus, compared to dairy milk, plant-based milk may be more advantageous in terms of environmental effects, yet comprehensive studies should be done and other dairy products should be examined as importing plant-based ones could be far less sustainable as well (Carlsson Kanyama et al., 2021). Consequently, as the lactose-free market is growing rapidly, the assessment of the environmental impact of dairy lactose-free milk, regular milk, and plant-based derivatives should be considered to ensure sustainability.

The present study is novel research on a relatively large sample size, but does have some limitations. Firstly, data were collected via online methods, which might introduce inconsistencies. Secondly, the participants were overly educated when compared to the population at large (the average education period in Turkey is around 8.4 years). Finally, the sample mostly consisted of young consumers, hence the generalizability of the results for other demographic groups could be limited.

In conclusion, the knowledge, behaviour, and attitudes of adults regarding lactose-free products were examined. The most important motivational factors in purchasing lactose-free products were determined as not causing gas/bloating, being healthy and feeling better after consumption. BMI did not significantly influence purchasing intention, but education, employment status, history of food intolerance testing status, animal welfare perception, ASHN and GSRS scores were significant factors. As GIS symptoms increased, the likelihood of purchasing lactose-free products increased. High cost and lack of sufficient information were the major reasons for avoiding purchase. Since motivational factors were mostly related to health, awareness of lactose-free products should be increased among less healthy consumers and healthcare practitioners and it is recommended to plan studies focused on specific groups with GIS-related symptoms and diagnosed with lactose intolerance.

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