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The role of ICT and animal welfare concerns in Estonian food purchasing channel preferences

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Abstract. The modern consumer is now more attentive to animal welfare practices, and this is an important factor when making food purchasing decisions. Different levels of concern for animal welfare as well as the use of information and communication technology (ICT) affect consumer food consumption and purchasing decisions and information access. This study explored both consumer preferences for food purchasing channels by using principal component analysis and regression analysis as well as the interaction between ICT use and animal welfare concerns. To analyse consumer preferences for food purchasing channels, we utilised data from a survey on the use of various retail outlets, such as buying online, retail stores, local markets, directly from producers, and organic or specialised shops. We used the varimax rotation method in principal component analysis to find the main factors in consumer choices related to animal health and welfare. Results from five generalised linear models indicated that Estonian consumers are more willing to purchase products of animal origin directly from producers or in organic or specialised shops when they pay attention to animal health and welfare. Animal health and general welfare practices aimed at ensuring the safety of food in large-scale production and distribution are significant for retail shop users. More frequent ICT use does not translate to a preference for online food shopping over more traditional retail purchasing. Compared with other age-gender groups, younger women prefer to buy food directly from producers. Older individuals in particular favour purchasing food from traditional retail stores rather than online. Consumers who prefer to buy food online are more concerned about animal health and welfare.

Key words: agri-food, animal welfare, consumer behaviour, ICT, online grocery shopping.

INTRODUCTION

Dietary habits and food purchasing behaviours are undergoing significant shifts, as consumers are increasingly voicing concerns related to the ethics and various consequences of their consumption choices (Roubík & Mazancová, 2017; Hölker et al., 2019; Hyland et al., 2022; Reeh et al., 2023). Animal welfare, environmental sustainability, and human health concerns are expected to drive consumer demand for

alternative foodstuffs and products that are perceived as higher value items as well as a reduction in meat consumption and shifts in dairy consumption, all of which will have a considerable impact on agricultural production practices (OECD, 2023). Digitalisation is another major driver of change, and it is anticipated that its technological opportunities, as well as its economic and social implications, will fundamentally transform agri-food value chains as well as consumer behaviours. Digitalisation is expected not only to boost productivity and efficiency in the agri-food sector and help tackle sustainability challenges (Kukk et al., 2022) but also to assist producers in adapting to changing customer needs (Atkočiūnienė & Papšienė, 2023). Digitalisation facilitates the collection and dissemination of copious amounts of information and rapid development of more – and more advanced – tools, and it also shapes the consumer's decision-making process itself (Linkiewicz & Bartosik-Purgat, 2022). The benefits of digitalisation, such as access to more information, multiple channels, and experience sharing (Linkiewicz & Bartosik-Purgat, 2022); convenience, time, and money savings; a wider variety of product offerings (Blitstein et al., 2020); and individually customised offers (Prause et al., 2021), allow consumers a more comprehensive analysis before making purchase decisions (Linkiewicz & Bartosik-Purgat, 2022).

The welfare of farm animals is under increasing public scrutiny due to public scandals, animal disease outbreaks, increased news and social media coverage, and expansion and visibility of animal protection organisations (Miele et al., 2011; Autio et al., 2017; Alonso et al., 2020). Consumer interest in sustainability and animal welfare issues is affected by a variety of factors, including sociodemographic factors such as age, gender, and place of residence (Verbeke, 2009; Alonso et al., 2020; Boaitey & Minegishi, 2020; European Commission: Directorate-General for Health and Food Safety et al., 2022; Hyland et al., 2022; Ammann et al., 2024). Studies have shown that consumers have considerable interest in animal welfare issues; however, their awareness of modern farming and animal welfare practices is very limited (Kupsala et al., 2010; Autio et al., 2017; European Commission: Directorate-General for Health and Food Safety et al., 2022; Fonseca & Sanchez-Sabate, 2022). Animal welfare labels on products are designed to convey information quickly to consumers, but these labels are often confusing for consumers (Di Pasquale et al., 2014; Autio et al., 2017; Thibault et al., 2022; Ingenbleek & Krampe, 2022). Digitalisation has the potential to facilitate both the sharing of this kind of information and interaction between the producers and consumers, thus improving the transparency of production practices and helping to address animal welfare issues (Fielke et al., 2020; Shepherd et al., 2020).

Consumer preferences for food shopping channels are influenced by convenience, with large discount stores, supermarkets, and online shopping channels growing rapidly as food retailing methods, while other channels such as traditional markets are in decline (Cho et al., 2020). The demand for online food purchasing options grew particularly during the COVID-19 pandemic (Alaimo et al., 2020; Benedek et al., 2021; Tyrväinen & Karjaluoto, 2022), which resulted in the rapid expansion of various online ordering and delivery options (Hobbs, 2020; Alaimo et al., 2022). Subsequent research has indicated that customers returned to traditional retail shopping channels after the pandemic (Brüggemann & Olbrich, 2023); however, some effects are expected to be more permanent with online retail continuing to grow (Verhoef et al., 2022). Sociodemographic characteristics, especially age, have also been key variables affecting

the adoption of and proficiency with ICT use as well as attitudes and expectations regarding digital tools (Linkiewicz & Bartosik-Purgat, 2022) and the uptake of online shopping channels (Zatz et al., 2021).

Shopping channels offer different types of interaction and information on animal welfare. Direct food distribution channels enable direct personal interaction with food producers and provide consumers with opportunities to learn about both the food and the producer; consequently, this will impact how much trust they build in vendors (Fehrenbach & Wharton, 2012). The information exchanged in such interaction is relatively limited and focused. However, online channels and new digital tools, including those integrated into traditional channels, offer opportunities to collect and exchange copious amounts of information (Linkiewicz & Bartosik-Purgat, 2022). The use of information to make informed purchasing decisions will depend on the consumer's ability to sift through a high volume of information and critically judge the sources, as well as on their ability to utilise digital tools for information gathering.

The aim of the present article is to analyse the interrelationship between Estonian consumer preferences regarding food shopping channels, ICT use, and animal welfare attitudes. Digitalisation has considerable potential to enhance consumer decision-making in the animal welfare context; however, the topic has received relatively limited research attention (Jose et al., 2025). To the authors' knowledge, no one has previously researched this topic in the Estonian context. The analysis utilised a dataset from a nationally representative study on Estonian consumers and explored what characterises their selection of food purchasing channels, how their attitudes on animal welfare interact with this selection, and their ICT use.

MATERIALS AND METHODS

Data collection

The data were collected in 2022 with a nationwide, cross-sectional, online questionnaire. The survey focused on Estonian consumers' attitudes toward animal welfare, dietary habits, and purchasing behaviours related to products of animal origin. Questions on food purchasing also addressed the kind of shopping channels consumers used for products of animal origin and the respondents' ICT use.

Execution of the survey was contracted to a professional public opinion polling company, which drew the sample from their virtual panel of 70,000 Estonian residents. The sample was designed to be representative of the Estonian population aged 18–74 years based on selected demographic and geographic variables, such as age, gender, language (Estonian, Russian), place of residence (capital, other urban area, or a rural area), and region of residence (northern, southern, central, western, and north-eastern Estonia). Data were collected from 1,000 respondents.

The questionnaire was divided into four parts. The first addressed sociodemographic characteristics including nationality (Estonian, other), level of education (basic, secondary school, vocational, undergraduate, graduate); average monthly household income (less than €1,000; €1,000–2,000; €2,001–3,000; €3,001–4,000; €4,001 or more). The second part of the questionnaire contained questions on attitudes towards animal welfare. These included the following questions (see Appendix 1, Tables A1–A3):

- A1. For which of the following animal health and welfare aspects are you willing to pay more? (yes, no)
- A2. Which aspects of animal health and welfare are important to you when buying food (1 = not important … 5 = very important)
- A3. How important to you are the following attributes in making purchasing decisions about food products? (1 = not important … 5 = very important)

The third part of questionnaire measured food purchasing behaviour, specifically what kind of shopping channels the respondents used to purchase food of animal origin and how often they used the channels. The response options were buying online, retail stores, local markets, buying directly from producers, and buying from organic or specialised shops. Respondents rated their preference for each retail type on a Likert scale ranging from 1 (never) to 5 (always). The fourth part inquired about ICT use. This included the question What device do you normally use to access the internet? in which respondents assessed their use of mobile phone, tablet, laptop, and desktop personal computer (PC) in the Likert type (1 = never … 5 = regularly).

Data analysis

Consumer behaviour analysis

To determine the main factors related to animal health and welfare influencing food purchasing behaviour, we conducted a principal component analysis (PCA) using the varimax rotation method. PCA is a technique used to analyse large datasets and helps to identify a new reference system that maximises the variance of the variables represented along the axes.

First, we applied Bartlett's test of sphericity to evaluate the suitability of the data for PCA (Costillas et al., 2016). Bartlett's test statistic follows an approximate chi-squared (χ^2) distribution. Bartlett's test assesses whether the correlation matrix significantly deviates from an identity matrix, indicating the presence of sufficient intercorrelations among variables for PCA. Second, we assessed sampling adequacy using the Kaiser-Meyer-Olkin (KMO) measure. A high KMO value suggests strong correlations between variables, which enhances the reliability of PCA or factor analysis (Blanc et al., 2020).

PCA simplifies data by transforming the original variables into new, uncorrelated components (or factors), thereby reducing the dimensionality while retaining as much of the variance as possible. The total variance of the variables is divided into components, which can be reduced based on the amount of variance each component explains. PCA was conducted for three sets of questions on animal welfare: willingness to pay for animal welfare attributes (A1), importance of animal welfare in purchase decisions (A2), and importance of general food purchase attributes (A3).

These questions had 14, 13, and 12 variants of responses, respectively (Appendix 1, Tables A1–A3). In the PCA, the goal was to reduce the dimensionality of the data and identify the principal components that would be included in subsequent regression analyses for the dependent variable.

In PCA, factors emerge that are described by a participation ratio. This ratio indicates how much a set of data influences the factor formed. If the participation ratio is less than 0.35, the factor is considered nonsignificant and is rejected. A ratio between 0.5 and 0.7 is considered satisfactory, while values above 0.7 indicate that the factor is well supported (Vlontzos et al., 2018).

Following PCA, we used the participation ratios (factor loadings) to identify the importance of each variable in each component. The analysis was conducted using R program, with the principal() function from the psych package, and factor rotations were done using the varimax method.

Econometric analysis

To examine the factors influencing the frequency of purchasing food of animal origin via different retail channels, we employed generalised linear models. Five separate regression models were constructed, each corresponding to a different retail channel based on the kind used to buy products of animal origin: online; retail stores; local markets; directly from the producer; and organic or specialised shops.

Each of the five models was specified as (Wooldridge, 2009)

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_n X_n + \varepsilon_i \quad (1)$$

where Y_i is the frequency of purchasing via a specific retail outlet; X_i (1,2,..n) denote the independent variables, including sociodemographic factors (e.g. age, gender, income, education); ICT usage (described below); and principal components received from PCA; β_i (1,2,..n) are the estimated coefficients; and ε_i is the error term.

For ordinal categorial outcomes (1 = never to 5 = often), ordinal logistic regression was employed using the proportional odds model.

To measure ICT use, the question on what devices (mobile phone, tablet, laptop, and desktop PC) and how often (ranging from 1 to 5) was used. For each respondent, the device with the highest score was identified. A binary variable was then created, indicating whether at least one device received a score of 4 or 5. If any device met this threshold, the variable was coded as 1 (high ICT usage); otherwise, it was coded as 0 (low ICT usage). To see how the effect of one variable (e.g. age) on the outcome (e.g. preference for buying directly from the producer) differed depending on response to another variable (e.g. gender), we added the interaction term in Eq. (1).

Regression analysis was conducted in R using the clm() function for multiple ordinal regression models from the ordinal package. Clm() function in R is related to cumulative link models, which is relevant if survey responses are on an ordinal scale.

RESULTS AND DISCUSSION

Sociodemographic characteristics and use of ICT and shopping channels

Of the 1,000 respondents, 547 were women (Table 1). The average age was 47.5 years, and 70.4% were Estonian. Just over half of the respondents had either a secondary school (26%) or a vocational education (27.6%), while 42.2% had completed an undergraduate degree. In all, 42.7% reported a monthly household income in the range of €1,001–2,000.

The main shopping channel for purchasing of food of animal origin was retail stores as 86.5% of respondents indicated that they always or mostly (5 and 4 in the Likert scale of 5, mean score 4.42) used this channel, followed by local markets (34.8%, mean score 2.93; Table 1). Overall, 75.5% of respondents indicated that they never used online shopping for food products of animal origin, while a third selected that they never bought directly from producers or from specialised shops. The main devices for internet use were mobile phones (mean score 4.23 in the Likert scale of 5) and laptops (mean score of 3.73).

Table 1. Descriptive statistics

Variable	Description	Result	
		%	Mean
Gender	Male	45.3%	
	Female	54.7%	
Age	Age in years		47.57
Nationality	Estonian	70.4%	
	Other	29.6%	
Level of education	Basic	4.2%	
	Secondary school	26.0%	
	Vocational	27.6%	
	Undergraduate	23.2%	
	Graduate	19.0%	
Average monthly household income	Less than €1000	30.1%	
	€1001–2000	42.7%	
	€2001–3000	16.7%	
	€3001–4000;	6.3%	
	€4001 or more	4.2%	
Shopping channels for purchasing food of animal origin	Online		1.46
	Retail stores		4.42
	Local markets		2.93
	Directly from producer		2.29
	Organic or specialised shop		2.20
Use of devices	Mobile		4.23
	Tablet		2.08
	Laptop		3.73
	Desktop PC		2.78

Results of PCA on animal welfare considerations

The results showed KMO > 0.9 (Table 2) for all subsamples (A1–A3), indicating excellent adequacy (Kaiser & Rice, 1974). Bartlett's test of sphericity was significant for all subsamples, which confirmed that the correlation matrix was not an identity matrix and thus appropriate for PCA.

Table 2. Suitability of data for PCA

Subset/question	Test	Result	Interpretation
A1. Willingness to pay for animal welfare attributes	KMO	0.94	Excellent (≥ 0.90 indicates sampling adequacy)
	KMO per item (range)	0.88–0.96	All items above acceptable threshold (≥ 0.50)
	Bartlett's test of sphericity	$\chi^2 = 398.19$, df = 13, p-value < 0.001	Significant correlations are adequate for PCA
A2. Importance of animal welfare in purchase decisions	KMO	0.97	Excellent sampling adequacy (≥ 0.90)
	KMO per item (range)	0.96–0.98	All items above the 0.50 threshold
	Bartlett's test of sphericity	$\chi^2 = 14\,700.51$, df = 78, p-value < 0.001	Significant correlations adequate for PCA
A3. Importance of general food purchase attributes	KMO KMO per item (range)	0.87 0.70–0.92	Very good (≥ 0.80) All above acceptable threshold
	Bartlett's test of sphericity	$\chi^2 = 4892.19$, df = 66, p-value < 0.001	Significant appropriate for PCA

Note: df mean degrees of freedom.

After confirming factorability with Bartlett's test and a high KMO measure, PCA with varimax rotation was performed (Appendix 1, Tables A4–A6).

Table 3. Summary of principal component analysis

Subset	Principal components	Variance explained	Rotated loadings summary
Subset A1 (Willingness to pay for animal welfare attributes)	three components (RC1.1, RC1.2, RC1.3)	61%	RC1.1 and RC1.2 explain most of the variance for most items.
Subset A2 Importance of animal welfare in purchase decisions	three components (RC2.1, RC2.2, RC2.3)	83%	RC2.3 and RC2.1 are highly related to most items, RC2.2 contributes less.
Subset A3 (Importance of general food purchase attributes)	three components (RC3.1, RC3.2, RC3.3)	62%	RC3.1 captures most variance, with RC3.2 and RC3.3 contributing less.

The PCA results (Table 3) revealed three principal components based on the correlation matrix of the data for each data subset (A1–A3) (Table 2). To ensure clarity and prevent confusion in the interpretation of regression equations and further analysis, the components were renamed (RC1.1, RC1.2, RC1.3 for Subset A1; RC2.1, RC2.2,

RC2.3 for Subset A2; and RC3.1, RC3.2, RC3.3 for A3). For Subset A1, A2, and A3, these three components together explained 61%, 83%, and 62% of the total variance, which was considered sufficient for further analysis.

Following the results presented in Table 3, we included in the regression equations the RC1.1 and RC1.2 components from Subset 1, the RC2.3 and RC2.1 components from Subset 2, and the RC3.1 component from Subset 3.

RC1.1 was strongly connected to consumer willingness to pay more for general good animal husbandry practices (transport times, lifespans, low mortality, normal behaviour). R1.2 captured overall willingness to pay more (including high negative loading of response that the consumer was not willing to pay) for an animal's lack of pain and suffering and species-appropriate husbandry, and thus, we interpreted it as willingness to pay for ethical concerns. Regarding which attributes of animal health and welfare were important to consumers, RC2.3 was strongly correlated with good housing conditions, short transportation times, normal feeding and rumination behaviour, and lack of pain, damage, and stress; these can be summarised as daily animal welfare practices. RC2.1 can be interpreted as animals' physical health as it has high loadings from response items related to low use of medication, lifespan, species-appropriate care and behaviour, and low calf mortality. RC3.1 from the question (A3) on what considerations were important when making food purchasing decisions reflects ethical and sustainability concerns (high loadings for recognisable animal welfare features: sold sustainably, organic, regionally produced, product traceability, fewer additives or preservatives).

Econometric results

As Table 4 shows, there were no significant effects of RC1.1 (willing to pay more for general good animal husbandry practices) on any food purchase channel preferences (Y_1 to Y_5), as all confidence intervals include zero. Principal component RC1.2 (willingness to pay for ethical considerations) had a significant effect on Y_1 (online) and Y_5 (organic and specialised shops). Principal component RC2.3 (daily animal welfare practices) positively influenced preferences for Y_2 (retail stores) and Y_5 (organic and specialised shops). The results indicate that higher RC2.1 (animals' physical health) was linked to a higher likelihood of choosing Y_2 (retail shops). Higher RC3.1 (general ethical and sustainability consideration in general food purchasing behaviour) was associated with greater Y_1 (online), Y_3 (local markets), Y_4 (directly from producer), and Y_5 (organic or specialised shops) preferences but lower Y_2 preference (retail stores). Consumers of Estonian nationality were more likely to prefer Y_4 (directly from producer) and Y_5 (organic and specialised shops) when purchasing animal-origin products, compared to consumers of other nationalities. This can be explained by better contact networks, particularly for buying directly from producers, who usually do not specifically advertise their produce in other languages and with whom contacts are often established through word of mouth in rural communities.

Table 4. Regression analysis results: influence of principal components on food purchase preferences for animal-origin products

Dependent variable	$\mathbf{Y_1}$ Online	$\mathbf{Y_2}$ Retail stores	$\mathbf{Y_3}$ Local markets	$\mathbf{Y_4}$ Directly from producer	$\mathbf{Y_5}$ Organic or specialised shops
RC1.1	-0.01	-0.003	-0.01	-0.05	-0.04
	(-0.16, 0.13)	(-0.13, 0.12)	(-0.13, 0.11)	(-0.17, 0.07)	(-0.16, 0.08)
RC1.2	0.21***	-0.03	0.01	-0.01	0.21***
	(0.05, 0.36)	(-0.17, 0.10)	(-0.10, 0.13)	(-0.13, 0.12)	(0.08, 0.33)
RC2.3	-0.07	0.17**	0.01	-0.05	0.16**
	(-0.25, 0.12)	(0.02, 0.32)	(-0.12, 0.14)	(-0.18, 0.09)	(0.02, 0.30)
RC2.1	-0.14	0.24***	-0.04	0.03	0.04
	(-0.31, 0.03)	(0.10, 0.39)	(-0.16, 0.09)	(-0.10, 0.16)	(-0.09, 0.18)
RC3.1	0.31***	-0.29***	0.20***	0.40***	0.70***
	(0.12, 0.51)	(-0.45, -0.13)	(0.06, 0.34)	(0.25, 0.54)	(0.54, 0.86)
Nationality	-0.13	-0.14	0.04	1.21***	0.94***
	(-0.45, 0.20)	(-0.42, 0.14)	(-0.21, 0.29)	(0.94, 1.48)	(0.67, 1.22)
Income	0.13*	-0.06	0.09	0.005	-0.002
	(-0.02, 0.28)	(-0.19, 0.07)	(-0.03, 0.20)	(-0.11, 0.12)	(-0.12, 0.12)
Age	-0.04***	0.02***	0.01	-0.002	0.004
	(-0.06, -0.03)	(0.005, 0.03)	(-0.004, 0.02)	(-0.01, 0.01)	(-0.01, 0.02)
Gender	-0.36	-0.01	0.01	-0.78*	0.07
	(-1.35, 0.63)	(-0.88, 0.85)	(-0.75, 0.78)	(-1.58, 0.03)	(-0.74, 0.89)
Education	-0.01	0.02	-0.04	-0.12**	0.003
	(-0.14, 0.13)	(-0.09, 0.13)	(-0.14, 0.06)	(-0.22, -0.02)	(-0.10, 0.11)
ICT usage	-1.09***	1.55***	0.25	-0.21	-0.55
	(-1.83, -0.35)	(0.81, 2.29)	(-0.42, 0.92)	(-0.90, 0.47)	(-1.22, 0.12)
I(age * gender)	0.01	-0.003	0.002	0.01*	-0.003
	(-0.02, 0.03)	(-0.02, 0.02)	(-0.01, 0.02)	(-0.002, 0.03)	(-0.02, 0.01)
Observations	1,000	1,000	1,000	1,000	1,000
Log likelihood	-808.51	-1,004.86	-1,544.55	-1,408.28	-1,309.49

Note: 95% confidence intervals are reported in parentheses; *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

There was a small positive association between higher income and Y_1 (online) preferences. This is consistent with the argument that higher income consumers are more capable of purchasing food with higher welfare standards, which may be more expensive or require greater access to specialised outlets. Older individuals were less likely to prefer Y_1 (online shopping) but more likely to prefer Y_2 (retail stores). Thus, younger people are more likely to prefer buying food online and less likely to prefer buying food from stores compared to older individuals. Gender was associated with significantly lower preference for Y_4: women are less likely to prefer buying food directly from producers compared to men, which may be linked to gendered preferences regarding convenience and time constraints. However, it is worth noting that younger women tended to show a higher likelihood of preferring to buy directly from producers, which potentially reflects a greater openness to sustainability-oriented and ethical purchasing habits in younger generations, as suggested by Hyland (2022). Higher education levels were linked to lower preferences for Y_4 (directly from producer).

The results suggest that individuals who are online more often using various ICT tools, particularly mobile phones, tended to show a lower preference for online food purchasing Y_1 but were more inclined to prefer alternative purchasing methods, such as buying from stores Y_2. This finding may reflect the fact that younger individuals, who are more adept at using digital technology, may prefer to engage in more hands-on, direct forms of food purchasing, especially if it aligns with their ethical preferences for animal welfare. Alternatively, the lower uptake of online food purchasing may be due to an underdeveloped online food retail infrastructure.

The interaction suggests that younger women might have a higher likelihood of preferring to buy directly from producers (Y_4), compared to other age-gender groups: while women generally prefer not to buy directly from producers, younger women might prefer this more than men or older women. This potentially indicates that the effect of age is context-dependent as suggested by Boaitey & Minegishi (2020). Similarly to studies by the European Commission (2022), Hyland (2022), and others, our results confirm that women generally express a stronger preference for animal welfare–friendly products than men. This finding agrees with the work of Amiot and Bastian (2017), who suggested that women typically show greater concern towards animal welfare issues.

CONCLUSIONS

This study examined consumer preferences in Estonia for food purchasing channels and their associations with attitudes towards animal health and welfare.

Results from multiple ordinal regression indicated that consumers who were more willing to pay for animal welfare based on their ethical beliefs were more likely seek out specific shopping channels such as online channels and organic or specialised shops. The expectation is that these channels are more likely to ensure higher transparency for their products and better traceability. Online channels offer opportunities to transmit a large amount of information directly to consumers easily and at low cost, and consumers filter and base their purchasing decisions on that information (Linkiewicz & Bartosik-Purgat, 2022). Consumers shopping in organic or specialised shops exchange less information and instead place trust in the belief that these shops uphold the values they advertise.

The main shopping channel for food purchases remains traditional retail shops. While traditional retailers are under increasing pressure (Brüggemann & Olbrich, 2023), it can be expected that they will continue to be the primary food purchasing channel for some time. Our analysis indicated that consumers had different expectations regarding animal welfare information. For users of retail shops, significant considerations were animal health and general welfare practices aimed at ensuring the safety of food in large-scale production and distribution.

Consumers for whom various ethical and sustainability considerations were important were more willing to seek out alternative, specialised shopping channels that could provide more direct interaction or specific information to assure them that production practices aligned with their values. As Estonia is expected to follow a trend similar to, for example, that of the Nordic countries - where consumers demand more information on animal welfare (European Commission: Directorate-General for Health and Food Safety et al., 2022) - retail shops are also coming under increasing pressure to provide this information, not only the specialised shopping channels.

Our findings highlight the significant role of sociodemographic factors, including gender, age, education, income, and nationality in the selection of food purchasing channels. As the demand for ethical and sustainable food choices is expected to grow, these sociodemographic factors will play a pivotal role in driving changes in the food supply chain and influencing market trends and consumer demand. Compared with other age-gender groups, younger women preferred buy food directly from producers. Older age groups preferred purchasing food from conventional retail stores and not from online outlets. However, consumers who used online food purchasing options more often indicated that they paid more attention to animal health and welfare issues.

More frequent ICT use did not translate into a preference for online food shopping over more traditional retail purchasing. Our interpretation is that unlike the case of non-food items, online channels for food items are less developed and include various considerations related to food perishability, logistics, convenience of use, and selection; and thus, active ICT use at this point in the Estonian context does not translate into active use of online shopping for food products of animal origin.

As with most cross-sectional and survey-based research, the reliance on self-reported data introduces the potential for social desirability bias, where participants may respond in a manner they perceive as favourable or acceptable while their actual purchasing behaviour and willingness to pay may differ from their answers. Despite this limitation, the survey captured responses from a large and demographically representative sample of the general population, lending robustness and credibility to the findings. In addition, future research could incorporate longitudinal or experimental designs and examine actual consumer behaviour through purchase tracking or behavioural experiments.

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APPENDIX 1

Table A1. Willingness to pay for animal welfare attributes: For which of the following animal health and welfare aspects are you willing to pay more?

Item	
A1_01	I am generally not prepared to pay more
A1_02	The animals have no disorders or diseases
A1_03	The animals do not have any pain, damage, suffering or stress
A1_04	The animals show normal rumination and feeding behaviour
A1_05	Good housing climate, ventilation, and hygiene and appropriate noise level
A1_06	Short transportation times (e.g. journey to slaughter)
A1_07	The animals have a good physical condition
A1_08	Species-appropriate husbandry system
A1_09	Low calf mortality
A1_10	The animal can perform species-specific behaviours
A1_11	Low use of medication
A1_12	Species-appropriate feeding, nutrition and pasture use
A1_13	The animal reaches its anticipated average lifespan (dairy cattle)
A1_14	The animal does not show any behavioural abnormality

Table A2. Importance of animal welfare in purchase decisions: Which aspects of animal health and welfare are important to you when buying food? (1 = not important … 5 = very important)

Item	
A2_01	The animals have no disorder or diseases
A2_02	The animals do not have any pain, damage or stress,
A2_03	The animals show normal rumination and feeding behaviour
A2_04	Good housing, climate, ventilation, hygiene and noise level
A2_05	Short transportation times (slaughter)
A2_06	The animals have good physical condition
A2_07	Species-appropriate husbandry system
A2_08	Low calf mortality
A2_09	The animals can perform species-specific behaviours
A2_10	Low use of medication
A2_11	Species-appropriate feeding, nutrition and pasture use
A2_12	The animal reaches their anticipated average lifespan (dairy)
A2_13	The animal does not show any behavioural abnormality

Table A3. Importance of general food purchase attributes: How important are the following attributes to you in making purchasing decisions about food products? (1 = not important … 5 = very important)

Item	
A3_01	Price
A3_02	Practicality
A3_03	Taste
A3_04	Appearance
A3_05	Texture
A3_06	Nutrition value
A3_07	Fewer food additives or preservatives
A3_08	Information on the source of products (Traceability)
A3_09	Organically produced
A3_10	Regionally produced
A3_11	Recognizable animal welfare features
A3_12	Sold sustainably

Table A4. PCA with varimax rotation. Subset 1: 'Willingness to pay for animal welfare attributes'

Item	RC1.1	RC1.2	RC1.3	h^2	u^2
A1_01	-0.03	-0.75	-0.40	0.72	0.28
A1_02	0.16	0.32	0.77	0.72	0.28
A1_03	0.24	0.70	0.21	0.59	0.41
A1_04	0.69	0.20	0.21	0.56	0.44
A1_05	0.59	0.45	0.12	0.56	0.44
A1_06	0.71	0.09	0.26	0.58	0.42
A1_07	0.52	0.27	0.43	0.53	0.47
A1_08	0.38	0.66	0.16	0.61	0.39
A1_09	0.75	0.25	0.16	0.65	0.35
A1_10	0.65	0.43	0.02	0.61	0.39
A1_11	0.27	0.22	0.71	0.63	0.37
A1_12	0.45	0.52	0.23	0.53	0.47
A1_13	0.75	0.33	0.04	0.67	0.33
A1_14	0.70	0.03	0.37	0.64	0.36

Note: communality (h^2) values were high across all items, indicating strong representation by the extracted components; uniqueness (u^2) values were generally low, suggesting little unexplained variance in most items.

Table A5. PCA with varimax rotation. Subset 2: 'Importance of animal welfare in purchase decisions'

Item	RC2.1	RC2.2	RC2.3	h^2	u^2
A2_01	0.32	0.87	0.32	0.95	0.05
A2_02	0.35	0.39	0.72	0.79	0.21
A2_03	0.34	0.32	0.79	0.84	0.16
A2_04	0.39	0.28	0.80	0.87	0.13
A2_05	0.43	0.12	0.76	0.78	0.22
A2_06	0.54	0.31	0.64	0.80	0.20
A2_07	0.65	0.26	0.59	0.85	0.15
A2_08	0.63	0.21	0.62	0.83	0.17
A2_09	0.71	0.22	0.55	0.85	0.15
A2_10	0.75	0.44	0.22	0.81	0.19
A2_11	0.76	0.30	0.44	0.87	0.13
A2_12	0.73	0.21	0.52	0.84	0.16
A2_13	0.63	0.20	0.56	0.75	0.25

Note: communality (h^2) values were high across all items, indicating strong representation by the extracted components; uniqueness (u^2) values were low, suggesting little unexplained variance in most items.

Table A6. PCA with varimax rotation. Subset 3: 'Importance of general food purchase attributes'

Item	RC3.1	RC3.2	RC3.3	h^2	u^2
A3_01	-0.02	0.09	0.93	0.87	0.13
A3_02	0.30	0.41	0.37	0.39	0.61
A3_03	0.06	0.67	0.23	0.50	0.50
A3_04	0.17	0.83	-0.08	0.72	0.28
A3_05	0.26	0.77	0.05	0.67	0.33
A3_06	0.59	0.32	0.24	0.51	0.49
A3_07	0.69	0.25	0.20	0.58	0.42
A3_08	0.76	0.22	0.10	0.63	0.37
A3_09	0.80	0.14	0.00	0.66	0.34
A3_10	0.76	0.10	-0.10	0.60	0.40
A3_11	0.82	0.11	-0.03	0.68	0.32
A3_12	0.81	0.12	0.05	0.67	0.33

Note: The communality values (h^2) ranged from 0.39 to 0.87, indicating that most items were well-explained by the three extracted components; uniqueness (u^2) values were generally low, suggesting little unexplained variance in most items.