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**The role of functional food in healthy ageing:  
a consumer research perspective**

PhD thesis

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## List of abbreviations

BMI – Body mass index

CI – Confidence interval

CVDs – Cardiovascular diseases

CNDs – Chronic non-communicable diseases

df – degrees of freedom

EC – European Commission

EFSA – European Food Safety Authority

EHLEIS – European Health & Life Expectancy Information System

EU – European Union

FÉLT – Funkcionális Élelmiszerlánc Terméktanács (Functional Food Chain Product Council)

FFC – Functional Food Center

FOSHU – Foods for Specified Health Use

FuFoSE – Concerted Action on Functional Food Science in Europe

GMO – Genetically modified organism

HLY – Healthy life years

ILSI – International Life Sciences Institute

JRC – Joint Research Centre of the European Commission

KMO test – Kaiser-Meyer-Olkin test

KSH – Központi Statisztikai Hivatal (Hungarian Central Statistical Office)

LE – Life expectancy

N – Number of respondents

Nébih – Nemzeti Élelmiszerlánc-biztonsági Hivatal (National Food Chain Safety Office)

NUTS-2 – Nomenclature of territorial units for statistics (basic regions for the application of regional policies)

OECD – Organisation for Economic Co-operation and Development

OGYÉI – Országos Gyógyszerészeti Intézet (National Institution of Pharmacy and Nutrition)

PCA – Principal component analysis

PUFAs – Polyunsaturated fatty acids

SD – Standard deviation

SCFAs – Short-chain fatty acids

UN – United Nations

USA – United States of America

WHO – World Health Organisation

## 1. Summary

The proportion of older adults in the population is significantly growing. Based on Eurostat data in the European Union, almost one-fifth of the population was over 65 years in 2018. Their relative proportion in the population is expected to reach 28.5% until 2050. According to WHO data, CNDs (primarily cardiovascular diseases, cancers, chronic respiratory diseases and diabetes) are the leading cause of death (71% in 2016) worldwide. Therefore, the relationship between healthy ageing and nutrition has become an emerging scientific and social issue. Functional food products with a nutritional composition that may reduce the risk of diet-related diseases or enhance physiological functions could play an important role in disease prevention and mitigation. Consumers often use the 'healthy food' terms in relation to functional food products, although this term is not correct from neither academic, nor a legal point of view. The functional food market is one of the fastest growing area of the food industry. However, new products had a high failure rate, because most of them were not preceded by a deeper exploration of consumer needs. Although, increasing the well-being of older consumers has been a key consideration since the emergence of the concept of functional food, only few consumer research studies are available which focus on senior consumers.

The present study is based on two quantitative consumer samples: a nationwide-representative sample (N = 1002; representative for the total adult Hungarian population in terms of sex, age and NUTS-2 geographical distribution according to the latest official census data) and a specific older adult large sample (N = 907; 60 years or over) were collected. The research followed an explorative approach focusing on the central areas of functional food development with supply chain approach. Hence, it covers nutrition claims, carrier types, health concerns, the acceptance of functional food for disease prevention and mitigation, other factors influencing the purchase decision, consumer knowledge, attitudes and socio-demographic factors. The research included a large number of variables from which factors were composed with PCA for better interpretation. Among older adults heterogeneity was identified in the preference of nutrition claims listed in the Regulation (EC) No. 1924/2006, therefore, cluster analysis was conducted to form consumer segments. The present study contributes to literature with practical findings to support product development and preventive public health programmes.

The findings of the representative survey highlight statistically significant differences in the preferences of older adults compared to other age segments. Based on the results, older adults tend to define the 'healthy food' term from a food safety point of view, while younger respondents described this category from nutritional aspects. Senior consumers generally accept functional foods. In case of most of the knowledge-related questions, younger respondents had a higher level of knowledge. Senior consumers preferred most of the listed

nutrition claims more, especially to the following ones: increased vitamin, mineral, protein and fibre content. Older adults also preferred products with lower salt and sugar content, which were less relevant for other age groups. Products of fruit and vegetable origin and fish were distinguished as carriers of functional traits. Compared to other age groups, older adults accept products of animal origin (especially dairy products and honey) on a higher level. Most of the listed product benefits (e.g. domestic origin, small-scale product) were preferred by the older adults to a higher extent. It indicates that the combination of these product parameters with health and nutrition claims on the product label could bear a recognised value for senior consumers. The results of the present study indicate that the Hungarian population is mainly concerned about the following health problems: vision deficiencies and disorders; dental problems; and heart and cardiovascular diseases. According to the responses, functional foods were the most suitable for disease prevention and mitigation in case of digestive problems, high cholesterol level, lactose sensitivity and gluten sensitivity. In the vast majority of the cases where significant differences were detected, older adults were more concerned about the certain health problem. After filtering the sample only for the concerned consumers, less significant differences between age groups were detected. Where significant differences were found, younger and middle-aged adults are more likely to accept food as a solution to disease prevention and mitigation. According to these findings, health concerns are more influential in the acceptance of functional foods for disease prevention and mitigation than the consumers' age. The results of the analysis of nationwide representative survey highlighted the importance of considering the well-being of older adults (especially consumers concerned about health problems) during product development. This investigation might be used for product differentiation between age groups, while explored differences between preferred shop types, communication channels and other factors influencing the purchase decision could also support the positioning of messages related to product promotion or intervention. The analysis contains a detailed data set about possible carrier types and nutritional claim combinations that might be used for subsequent academic studies and for field experts as well.

According to the results of the analysis of the specific older adult sample, senior consumers primarily preferred claims indicating added nutritional value, while reduced nutritional content was preferred less. Three segments were identified and characterised based on their preference of nutrition claims: 'nutrition-oriented' (33%), 'added nutritional value oriented' (46.5%) and 'nutrition sceptic' (20.5%). Previous studies identified scepticism among older adults about functional food products. However, the results of the present study suggested that scepticism was not general among older adults. Eighty percent of the senior consumers could be an appropriate target group for functional food market actors, since 33% was generally nutrition-oriented, while 46.5% rather searches added value. Only one-fifth of senior

consumers found to be resilient against functional food value offers. As an unexpected finding, age, income level, education and location of residence did not differentiate the groups significantly. However, the sex of the respondents was found to be significant factor: men were present in the highest proportion in the 'nutrition sceptic' segment. Older adults in the 'nutrition-oriented' segment were concerned about presented health problems at the highest rate in each case except in the case of digestive problems, where the 'added nutritional value oriented' segment demonstrated higher level of concerns. Consumers in the 'nutritional sceptic' group were the least concerned about the listed health problems. The proportion of overweight respondents was the highest in the 'nutrition-oriented' group, while the proportion of obese respondents was the highest in the 'added nutritional value oriented' segment. Significant differences in the acceptance of functional foods as a solution to disease prevention and mitigation were observed only in few cases. For heart and cardiovascular diseases, dental problems and digestive problems, the results suggested that the 'nutrition-oriented' segment had the highest rate of acceptance, followed by the 'added nutritional value oriented' segment, while the 'nutrition sceptic' consumer group was characterised by the lowest level of acceptance. The results suggest that older adults primarily pay attention to their nutrition due to existing health problems instead of prevention. To overcome this barrier, several practical findings were presented in terms of carrier types, attitudes, socio-demographic characteristics and other factors influencing purchase decisions. Considering that the prevention of CNDs and the well-being of older adults are serious social challenges, there are tasks for both the food business operators in development of accessible functional food products for older adults and policy makers in forming more effective preventive public health programmes to promote healthy ageing. Further studies focusing on older adults are needed to investigate possible product attribute combinations that meet the expectations of specified segments of senior consumers.



## 2. Introduction and aims of the study

The proportion of older adults in the population is significantly growing in the EU and on a global level too, therefore, well-being of the older population has become a social challenge (Eurostat, 2019a; UN, 2020). The relationship between health and nutrition has come to the forefront of scientific research due to global health trends and lifestyle changes (Kronl et al., 2008; Bauer et al., 2013; Jacobs & Tapsell, 2013; Irz et al., 2014; Collins & Bogue, 2015; Baugreet et al., 2017; Barabási et al., 2019; Willet et al., 2019). Functional foodstuffs are food products with a nutritional composition that may reduce the risk of diet-related diseases or enhance physiological functions (Diplock et al., 1999). They could play an important role in prevention and mitigation of health-related problems, and in promotion of healthy ageing (Marinangeli & Jones, 2013; Giacalone et al., 2016; Jędrusek-Golińska et al., 2020).

Nowadays, a rising number of consumers follow a special or consciously composed diet because of health issues or lifestyle decisions, which have opened new opportunities for food business operators. During the last decades, a focus was given to the health-related functionality of foodstuffs (Siró et al., 2008; Granato et al., 2017; Temesi et al., 2019; Baker et al., 2022). Functional foods with high added value have become the fastest growing area of the food industry (Vicentini et al., 2016; Bigliardi & Galati, 2013; Alongi & Anese, 2021). The increasing significance of the functionality of foodstuffs was recognised even before the turn of the millennium by the food industry, which has accelerated the development of new products. However, new products had a high failure rate on the market in the 1990s, because most of them were not preceded by a deeper exploration of consumer needs (Hilliam, 1998; Menrad, 2003).

Consumer studies emerged from 1990s to support evidence-based development and promotion of functional products (see in recent review articles: Mogendi et al., 2016; Bimbo et al., 2017; Santeramo et al., 2018; Topolska et al., 2021). These studies explored the most determinant factors to consumer acceptance of functional foods, and identified target-groups among the population according to different theoretical approaches. Previous Hungarian studies also contributed valuable results to the development of European functional food market (Siró et al., 2008; Szakály et al., 2012; Temesi et al., 2019; Papp-Bata & Szakály, 2020; Plasek et al., 2020). According to previous studies, age was an influential factor, however, such nationwide representative quantitative study has not yet been published in Hungary, which evaluates the perception of older adults about health-related functionality of foods compared with other age groups.

Functional foods originate from Japan, where the LE is the highest in the world, so the support of healthy ageing is of great importance (Ichikawa, 1994; WHO, 2021). Despite of that, only

few quantitative consumer studies are available in the international scientific literature that focus on the expectations of older adults (van der Zanden et al., 2015; Liu & Grunert, 2020; Febian et al., 2021). These studies revealed heterogeneity among older adults about the acceptance of functional food products, which justifies the need for segmentation of senior consumers. This can be identified as a research gap in Hungary.

The research followed an explorative quantitative approach focusing on the central areas of functional food development. Hence, it covers nutrition claims, health concerns, acceptance of functional food for disease prevention, carrier types, other factors influencing the purchase decision, attitudes and socio-demographic factors (Aschemann-Witzel & Hamm, 2010; Annunziata & Vecchio, 2011; Krutulyte et al., 2011; Mogendi et al., 2016; Bimbo et al., 2017; Topolska et al., 2021). The present study refers to consumers aged 60 years or above as 'older adults', and uses 'elder(ly)' or 'senior' terms as synonyms. Consumers aged below 60 years were referred as 'younger adults' or 'younger consumers'.

The aims of this study were:

- To evaluate the perception of older adults about health-related functionality of foods compared with other age groups;
- To define well-distinguished consumer segments among older adults based on preference of nutrition claims;
- To explore connection between health status and nutritional preferences of older adults.

### **3. Literature review**

#### **3.1. Functional food concept**

##### **3.1.1. History and definition**

The concept of functional food was introduced in Japan, in the 1980s, as a part of the reports on 'Systemic Analysis and Development of Food Functions' financed by the Ministry of Education, Science and Culture (Arai, 1996). Functions of food were divided into three components in these reports: nutrition, preference and disease prevention. According to the interim report of the 'Meeting for Functional Foods' held in Japan in 1988, it should be emphasised that the disease prevention role of functional food incorporates functions which had previously been allowed only in the case of drugs. In contrast to drugs, functional foods could provide additional health benefits as a part of a staple diet (Kwak & Jukes, 2001a). In 1991, the Japanese Ministry of Health officially introduced the FOSHU category, which included the establishment of specific health claims for this type of food.

The first international functional food conference was held by ILSI in 1995 (Kwak & Jukes, 2001a). The meeting defined functional foods as "foods that improve or affect body functions over and above their normal nutritional values", and laid down the following terms:

- "Functional foods should be distinguished from vitamins, minerals, and other dietary supplements;
- These foods should not be allowed to be included in medical claims;
- The altered functional effects of the foods must be substantiated and scientifically-proven through laboratory and human studies."

In the EU, the consensus document from the FuFoSE project defined functional food as follows: "a food product can only be considered functional if together with the basic nutritional impact it has beneficial effects on one or more functions of the human organism thus either improving the general and physical conditions or/and decreasing the risk of the evolution of diseases. The amount of intake and form of the functional food should be as it is normally expected for dietary purposes. Therefore, it could not be in the form of pill or capsule just as normal food form" (Diplock et al., 1999).

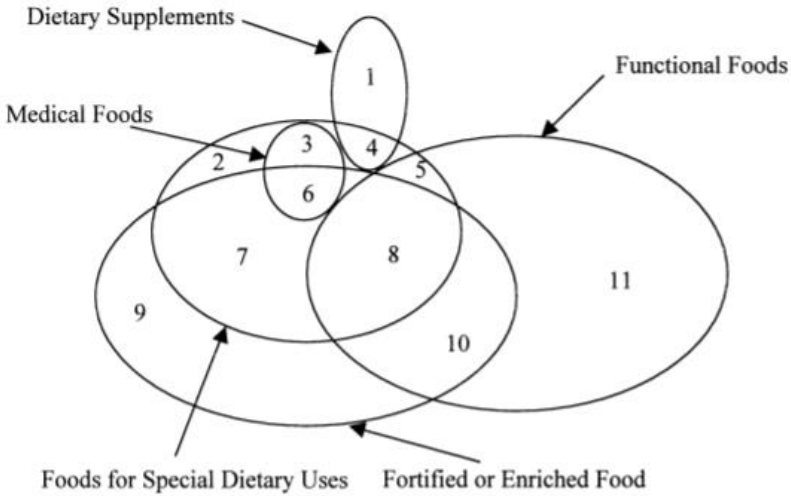
As shown, Eastern and Western cultures approached the concept of functional foods differently. In Japan, functional food tends to be regarded as a distinct class of products, while in Europe and USA, functional food means adding functionality to an existing traditional food product, and such food products do not create a separate group (Hilliam, 1998; Díaz et al., 2020).

The latest definition of the American FFC describes the category the following way: “natural or processed foods that contain biologically active compounds; which, in defined, effective, and non-toxic amounts, provide a clinically proven and documented health benefit utilizing specific biomarkers for the prevention, management, or treatment of a chronic disease or its symptoms” (Gur et al., 2018).

**3.1.2. Classification**

The definition and classification of functional foods have been the subject of scientific debate since the appearance of this product category. Potter (1996) suggested the use of ‘positive nutrition’ instead of functional food term, based on the concept that every type of food is functional. Positive nutrition was defined as “the consumption, as part of the normal diet, of everyday food and drink products that can provide positive health benefits”. Pascal (1996) found that the lack of an agreed terminology may not seem to be a direct obstacle to the development since consumers were more attracted by a health message rather than the use of a particular legal term. In contrast, several papers appointed the lack of an agreed terminology as a barrier for the development of the market (Alongi & Anese, 2021). Accordingly, the terms of nutraceutical and functional foods are often confused and interchanged by the stakeholders in the EU. Including conventional products which naturally contain bioactive components in functional food category is also a debate in the literature (Kaur & Das, 2011; Gur et al., 2018).

Several overlapping terms (e.g. medical foods, novel foods, nutraceuticals, ‘phood’) can be found in the literature, which refer to the health-related benefits of food products (Dixon et al., 2006). **Figure 1** shows the most important terms connected to the functional food category and the overlaps between them.

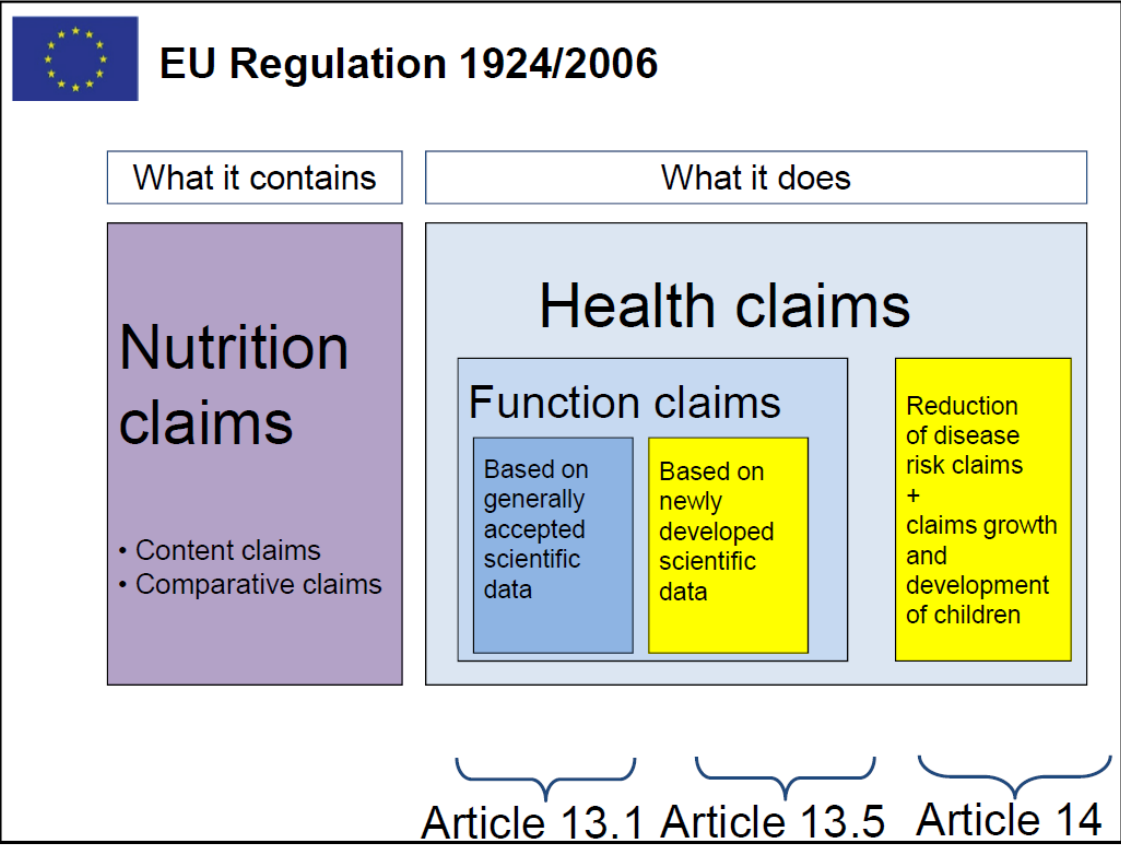


**Figure 1.** Terms connected to the functional food category and the overlaps between them (source: Kwak & Jukes, 2001b).

Several definitions and classification can be found in the literature to define the boundaries of functional food (Bigliardi & Galati, 2013). A commonly used classification from a product point of view is presented below (Spence, 2006):

- “Fortified products: increasing the content of existing nutrients;
- Enriched products: adding new nutrients or components normally not found in a particular food;
- Altered products: replace existing components with beneficial components;
- Enhanced commodities: changes in the raw commodities that have altered nutrient composition.”

Regarding labels, nutrition and health claims in the EU may appear on products by following the indications of Regulation (EC) No. 1924/2006 and Regulation (EU) 432/2012 based on the scientific advice of the EFSA (Verhagen et al., 2010; Verhagen & Loveren, 2016) (**Figure 2**).



**Figure 2.** Overview of nutrition and health claims in EU Regulation 1924/2006 (source: Verhagen & Loveren, 2016).

Nutrition claims refer to the nutritional composition of food. This claim category includes content claims and comparative claims. Health claims refer to what a food does through nutrition composition.

There are three types of health claims in the EU:

1. Function claims:
  - Relating to the growth, development and functions of the body;
  - Referring to psychological and behavioural functions;
  - On slimming or weight-control.
2. Risk reduction claims: on reducing a risk factor in the development of a disease.
3. Claims referring to children's development.

The use of lactose-free and gluten-free terms are controlled by the Regulation (EU) No 1169/2011 on the provision of food information to consumers. Food intended for infants and young children, food for special medical purposes and total diet replacement for weight control are regulated by Regulation (EU) No 609/2013. Authorisation of novel foods are controlled by Regulation (EU) 2015/2283.

In Hungary, FÉLT Council was established in 2014 to support domestic producers with professional advice and make a connection with universities for science-based product development (Store Insider, 2014).

### **3.1.3. Trends in the functional food market**

The functional food market is one of the fastest growing area of the food industry. Although, different market data are available due to different interpretations of the category. According to a recent market study, the size of the functional food market was estimated at 162 billion USD in 2018 and was projected to reach 280 billion USD by 2025 with an annual growth rate of around 8% (Grand View Research, 2019a; 2019b). Based on another report, the functional food market was projected to increase from about 300 billion USD in 2017 to over 440 billion USD in 2022 (Shahbandeh, 2018). The world's largest functional food market is the USA, followed by Japan and the EU. In Europe, Great Britain, France, the Netherlands, Germany and Spain are the leading countries in production of functional foods. The main categories of functional food in EU countries are dairy products (49%) and cereals (30%). In the USA and Japan, functional foods are dominated by drinks, cereal products and confectionery (Vicentini et al., 2016).

According to recent review studies, functional food products for older adults can be identified as one of the main directions of product development (Jędrusek-Golińska et al., 2020; Fernandes et al., 2021). The product development and promotion will continue to focus on the following specific health outcomes for older adults: gastrointestinal functions, CVDs, metabolic diseases such as diabetes type 2, bone health and cognitive support (Jędrusek-Golińska et

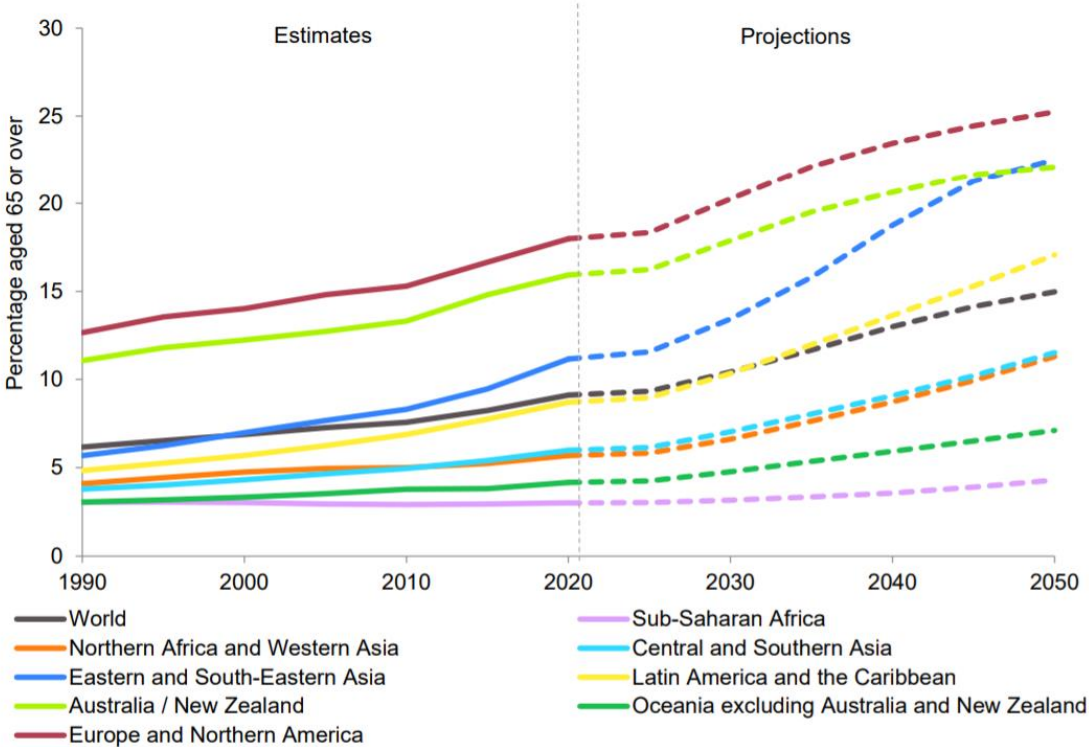
al., 2020). The growing trend of 'natural' products, plant-based protein sources, dairy analogues and meat substitutes is expected to continue (Izsó et al., 2019). Potential carrier categories are plant-based foods and beverages, whole-fat dairy, green juices, berries, tree nuts-based foods and seaweed snacks (Jędrusek-Golińska et al., 2020). Increasing demand is predicted for probiotic products (e.g. lactose-free dairy products), which support digestive health, certified by science-based and regulator-approved health claims in the EU (van Loveren et al., 2012). As described by Taylor (2011) and Fernandes et al. (2021), the most common functional foods are:

- Pre- and probiotics: yoghurts, dairy drinks and fruit juices;
- Products with lower cholesterol content: margarine, yoghurts, salad dressings, milk and fruit juices;
- Products enriched with omega-3 fatty acids: bread, margarine and plant-based 'milk' alternatives;
- Vitamin D and calcium-enriched products: milk, yoghurts, margarine, fruit juices and breakfast cereals.

Product development has begun focusing on new, more sustainable raw materials for functional food products, such as by-products (Helkar et al., 2016), and alternative protein sources (Gere et al., 2017). Hence, sustainable consumer orientation is more and more important (Vermeir & Verbeke, 2006; Reisch et al., 2013; Benedetti et al., 2018). In recent years, the development of '3D printed performance' foods was launched, which ensures the look, taste and consistency of traditional foods but the created food is also enriched in nutrients tailored to specific dietary needs of individuals or subgroups of consumers (Severini & Derossi, 2016; Kouzani et al., 2017). Personalised nutrition is an emerging direction of health-related nutrition research (Zeevi et al., 2015; Szakály et al., 2016). Encapsulation of nutraceuticals with micro- and nano-systems has also gained interest since this process allows the preservation of biological activity, while maximizing the efficiency of the delivery process (de Souza Simões et al., 2017; Gonçalves et al., 2018). Product development and scientific research should explore possible chemical interactions between functional food ingredients, medicines and nutraceuticals (Gupta & Prakash, 2015). Nowadays, functional food development for older adults lean on evidence of clinical research to a greater extent than before (Domingos-Lopes et al., 2017; Teradal et al., 2017; García et al., 2019; Keršienė et al., 2020; Marcello et al., 2020). During the product development, following the supply chain approach is a key to provide food safety and sustainable solutions (Kasza et al., 2019; Lakner et al., 2021).

### 3.2. Demographic trends

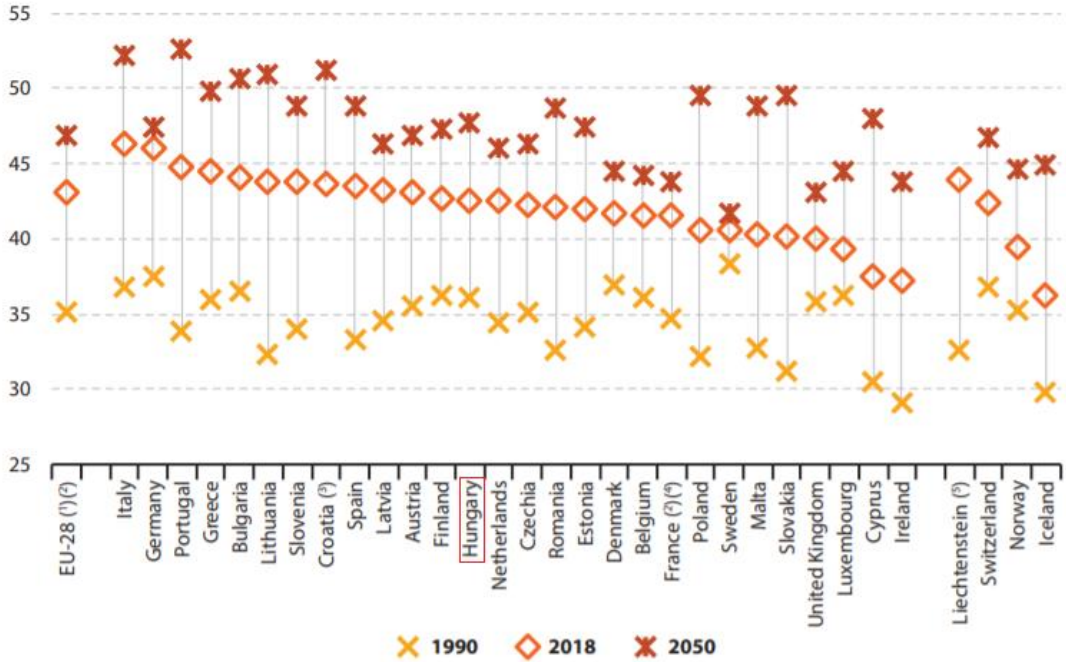
According to the UN estimations shown in **Figure 3**, the increase of the proportion of people over 65 years between 1990 and 2020 was a global trend, which is projected to accelerate (UN, 2020). Based on this study, countries with the most developed economy, Europe and North America have the highest rate of people over 65 years. This rate is presently over 15% and projected to reach 25% approximately by 2050 in Europe and North America. It was estimated that there were 703 million people aged 65 or over in 2019, and projections indicate that by 2050 the elderly population will be more than its double, reaching approximately 1.5 billion. According to Eurostat data, almost one-fifth of the population (19.7%) was over the age of 65 in 2018 in the EU, and the relative proportion in the population is projected to reach 28.5% until 2050 (Eurostat, 2019a). In parallel, the fertility rate has been declining in most European countries in the past decades, which resulted in a trend of the strong growth of the elderly population relative to younger populations in the countries with developed economy (Coale, 2017).



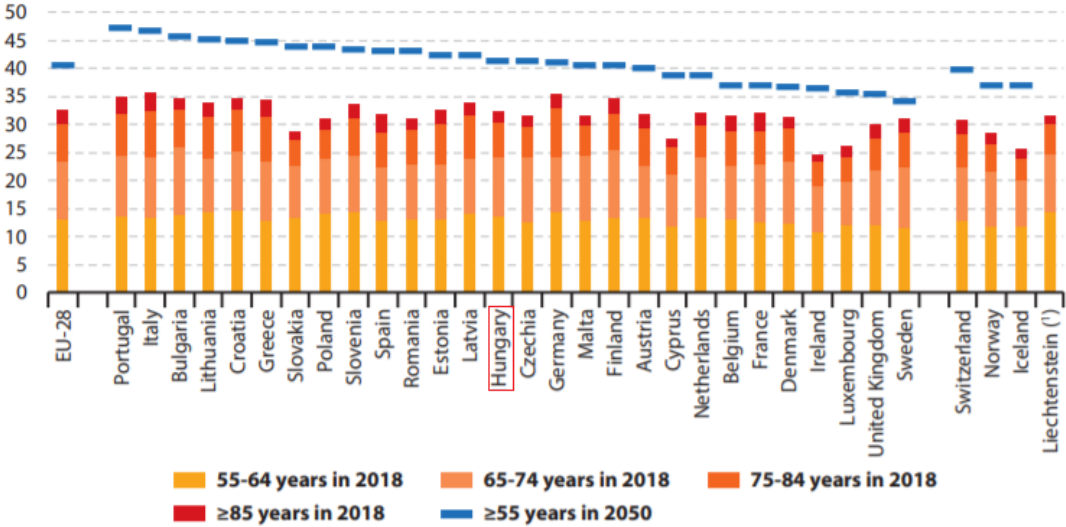
**Figure 3.** Share of total population aged 65 years or over, by region, 1990-2050 (source: UN, 2020).



**Figure 4** shows the median age data in the EU countries in 1990, 2018 and projection to 2050 (Eurostat, 2019a). In Hungary, the median age is slightly below the EU average at the present (43.1 years), but it will exceed it by 2050. In 2018, people aged 55 years or more accounted for almost one third (32.8%) of the total EU-28 population, and the distribution of age brackets among elderly population was similar in Hungary to the EU average (**Figure 5**). People aged 55-64 years comprised almost 15% of the total population in Hungary, while 65-74 shared 10%, and people over 75 represented approximately 7%.



**Figure 4.** The median age of the EU population by countries, in 1990, 2018 and 2050 (source: Eurostat, 2019a).



**Figure 5.** Age clusters of people aged ≥55 years in the EU by countries, in 2018 and 2050 (% share of total population) (source: Eurostat, 2019a).

Between 2000 and 2016, global LE at birth increased by 5.5 years, from 66.5 to 72.0 years (WHO, 2019). According to the latest country reports of the EHLEIS based on 2015 data, Hungarian LE was 21.2 years for women and 17.9 for men at the age 65 (Eurostat, 2020). This index, compared to LE at birth, provides a better estimation to older adults, but does not give information about the quality of those years. The same report presents HLY indicator (also called healthy life expectancy or disability-free life expectancy), which was 5.9 years in Hungary at the age 65, so 68% of elderly years (approximately 12 years) are usually spent with health disabilities. According to OECD data LE at birth in Hungary was 75.7 years in 2015, which was nearly 5 years below the EU average, mainly due to higher death rates from cardiovascular diseases and cancer (OECD, 2017).

### **3.3. Healthy ageing and nutrition**

#### **3.3.1. Health statistics**

According to WHO data, CNDs are the leading cause of death worldwide (WHO, 2016). In 2016, they were responsible for 71% (41 million) of the 57 million deaths which occurred globally, and 94% of the number of deaths in Hungary. Major CNDs are CVDs (e.g. coronary heart diseases, peripheral arterial disease, heart attacks; 44% of all CND deaths), cancers (malignant neoplasms e.g. colorectal cancer, breast cancer, lung cancer and prostate cancer; 22%), chronic respiratory diseases (9%), and diabetes (4%) (WHO, 2018; Eurostat, 2019b). Most of these health problems are strongly connected to diet, and significantly impair the quality of life and life expectancy of those affected. An OECD study highlights that only slightly more than half (56%) of Hungarians consider themselves to be in good health, which is one of the lowest rates in the EU (OECD, 2017). The need to improve nutrition status in the older population is suggested by Hungarian studies (Rurik et al., 2003; KSH, 2017).

Ageing population results in higher health care costs: older adults' malnutrition costs individually represent around 120 billion EUR each year to the EU health care system (Fried et al., 2001; Walker & Zaidi, 2019).

### **3.3.2. Age-related physiological changes and nutrition**

Ageing is a multidimensional complex process which can be classified in certain domains: normal ageing, somatic diseases and chronic conditions, psychological and cognitive changes, functional and socio-environmental changes (Jaul & Barron, 2017).

Normal ageing is associated with sensory impairment, like loss of hearing, decrease of visual acuity, reduced olfaction and gustation (Correia et al., 2016). Physical activity level typically decreases in older adults and significant changes occur in body composition. Bone mass, lean body mass and water content of body decrease, meanwhile fat mass usually increases. These physiological changes may lead to frailty (St-Onge & Gallagher, 2010). Sarcopenia is also a common condition among older adults with normal ageing, which means the loss of skeletal muscle mass and power, which is usually accompanied by the increase of fat mass, hence directly affecting the quality of life and influencing individuals' pharmacokinetics (Dionyssiotis, 2019). Immunosenescence is another consequence of normal ageing triggered by a range of dysregulated responses within the immune system (Pawelec, 2018). Ageing is associated with a decline in a number of physiological functions as well that can impact nutritional status (Jędrusek-Golińska et al., 2020). Among the older population, the risk of inadequate diet and malnutrition is outstandingly high (Brownie, 2006; Fernandes et al., 2021). Older adults may also experience dysphagia, meaning difficulty of swallowing foods, which affects 7-10% of people over 50 years of age (Sura et al., 2012). Other changes include degenerative changes of the mucous membrane, secretory glands and muscle tissue of the digestive tract (Rémond et al., 2015; Granic et al., 2018). Sensory impairments can negatively affect older people's intake of foods in terms of both quality and quantity in general (Doets & Kremer, 2016). Some studies analysed the impact of age on the recognition thresholds of basic flavours, especially sweet and salty (Heft & Robinson, 2010; Methven et al., 2012). Physiological changes connected to ageing are also related to changes in the gut microbiome and in the gut-brain axis as a consequence. It was found that older adult population typically displayed different gut microbiota profiles in contrast to younger adults. These results are likely to be in connection with ageing-associated inflammatory disorders and with lower SCFAs levels detected in older adults (Badal et al., 2020).

CVDs are the leading chronic diseases in the older adult population (Oliveros et al., 2020). Diabetes mellitus denotes a health condition with increasing prevalence in older adults that intensifies the risk of cardiovascular and microvascular events (Kirkman et al., 2012). Osteoporosis and osteoarthritis also affects primarily older adults (Glowacki & Vokes, 2016; Loeser & Lotz, 2016).

The psychological and cognitive changes that are the results of ageing can embody in difficulty in finding words, higher processing times and even mild short-term memory loss (Jaul &

Barron, 2017). Apart from these normal outcomes, more severe structural and functional changes are experienced with ageing, which results in cognitive impairments and degenerative disorders, such as dementia and related neurodegenerative diseases. As underlined by Kerchner & Wyss-Coray (2016), death rates have been increasing and quality of life has been decreasing worldwide due to Alzheimer's disease.

Changes described above provoke functional and socio-environmental changes. Reduced mobility, frailty, contingency and depression are the most perceivable changes when ageing and can be regarded as the physical responses to the underlying changes. Consequently, older adults often cannot easily interact with others and with its surrounding environment (Jaul & Barron, 2017).

### ***3.3.3. Dietary recommendations for older adults: role of functional foods***

Following a balanced diet is the suitable way for older adults to prevent nutrient deficiencies and maintain good health. Supplementing the diet with functional foods provides an opportunity that might prevent or mitigate chronic conditions in older adults (Jędrusek-Golińska et al., 2020).

Due to the decrease of the basal metabolism and physical activity in older adults, it is assumed that energy intake should be equal to 1.5 times the value of basal metabolism, and BMI should be in the range of 20 to 29 kg/m<sup>2</sup> (Tiit & Saks, 2015). Carbohydrates should provide 55-60% of the total energy intake, fats 25-30% (saturated acids up to 10%, 4-8% from indispensable PUFAs, and the ratio of n-6 to n-3 acids should be 4 to 6:1), and protein 12-15% (EFSA NDA Panel, 2010a; 2010b; Nowson & O'Connell, 2015). Meeting the decreased energy needs may pose some risk of unbalanced minerals or vitamins intake. In such cases, it is necessary to change the proportions of consumed products, for example, high-fat content and sugar products should be replaced by skimmed dairy products, lean meat, as well as vegetables and fruits (Ahmed & Haboubi, 2010).

The diet should contain components with the best bioavailability. Daily protein intake should be from 0.83 g to 1.0-1.3 g/kg of body mass, to optimise physical function (EFSA NDA Panel, 2012; Kourkouta et al., 2016; Nowson & O'Connell, 2015). Daily fibre intake should be approximately 25 g (Kourkouta et al., 2016). It is important to limit energy from simple sugars to 10% of total energy intake. Normal ageing is associated with a decreased perception of thirst that may lead to dehydration (Antal et al., 2014). In general, a recommended intake of water is 1 mL/kcal ingested or 30 mL/kg body mass per day.

Decreased needs for energy and several nutrients and appetite associated with ageing generate a necessity to produce fortified food and beverages for older adults. Older consumers

choose functional products with basic vitamin-mineral composition, and with low amounts of energy and certain components such as sugar, cholesterol and fat. Other products of interest to older adults are functional foods enriched with bioactive substances such as antioxidants, polyphenols, carotenoids and dietary fibre. These choices are primarily associated with the desire to prevent or lower the risk of diseases prevalent in older people (Gupta & Prakash, 2015). In contrast, younger consumers pay attention primarily to functional products enriched with substances that increase their physical and mental activity and improve mood, such as protein bars, energy drinks, specialty foods for athletes, bars with added fibre, xylitol sweets and chewing gum, probiotic yoghurt drinks and fruit and herbal teas (Jeżewska-Zychowicz, 2009; Zegan et al., 2016).

For older adults with dysphagia, the main recommendation is to modify texture (e.g. foams and soaking foods), temperature, volume or viscosity (Cichero, 2018; Payne & Morley, 2018). Sensory changes in taste and smell necessitate modifications of functional foods for older adults. Flavour enhancers such as spices and herbs, colorants – especially natural substances masking any off-notes of taste and smell – and ingredients enhancing texture may be incorporated in functional products to intensify their sensory properties (Gupta & Prakash, 2015).

#### **3.3.4. Disease prevention and nutrition**

Prevention of CNDs in earlier life stages is a significant aim for policy makers due to high health care costs (Fried et al., 2001; Walker & Zaidi, 2019). An important aim for health prevention policies is not only to increase LE worldwide, but to increase the well-being of older adults through ensuring a healthy ageing and the extension of healthy active years. Nutrition has a substantial impact on the longevity and life quality, for which adequate energy intake and maintenance of a healthy body weight are essential. Ageing is often linked to the decline of nutritional status in both hospitalised (Forster & Gariballa, 2005) and homebound older adults (Ahmed & Haboubi, 2010; Lee et al., 2015; Leslie & Hankey, 2015). Ageing is greatly associated with the risk of ‘nutritional frailty’, a state characterised as a significant loss of either weight, muscle mass and strength or essential physiologic reserves, hence compromising older adults’ ability to attain required nutritional needs (Shlisky et al., 2017). Furthermore, attaining such needs at an older age can be substantially more challenging, due to several factors, such as, dental and chewing problems; changes in smell and taste perception; reduction of mobility, which results in difficulties to access fresh foods; loss of appetite; alterations in the gastrointestinal tract; reduction of their metabolic rate; decrease of nutrient absorption, among others (Brownie, 2006). That said, nutritional requirements of older adults are yet to be thoroughly defined, since age-related changes are perceived differently in each

individual and may instigate higher needs for specific nutrients. Also, there are no clear standards to diagnose undernourishment and current screening methods do not have adequate specificity and sensitivity in spite of numerous attempts to define the risk of underlying factors such as illness, improper nourishment, financial difficulties, and polytherapy (Poggiano et al., 2017).

Deficiencies associated with unhealthy diet observed in older adults are a strong indication to emphasise the principles of proper nourishment and to provide adequate education, especially for those who are ill and their physicians (Sahyoun et al., 2004; Amarya et al., 2015). WHO formed a guideline for healthy diet to prevent chronic diseases worldwide, and national level health prevention programmes also emerged (WHO, 2003; Jankovic et al., 2014; Steptoe et al., 2015; Kiss et al., 2019). Recommendations suggested a more nutrient-dense although less energy-dense diet for a healthy ageing (i.e. foods high in nutrients, but low in calories) (WHO, 2015). This approach counters the actual trend: older adults excessively consume refined carbohydrates, processed baked products, saturated fats, processed meat, whole-fat dairy products, and other products that contribute to overnutrition and obesity. However, they fall below the recommended intake of proteins, dietary fibres, omega-3 fatty acids, vitamins (e.g. B6, B12, D, E, K, etc.) and some minerals (Millen et al., 2016). The last item can be attributed not only to the inadequate intake of fruits, vegetables and fish, but can be also linked to the experienced gastrointestinal changes, that can lead to malabsorption (Shlisky et al., 2017).

JRC report on nutrition and healthy ageing reviews the good practices in the EU (Mak & Louro Caldeira, 2014). In Belgium, a gastrological practice-based and evidence informed nursing approach affected positively the frequency and the burden of malnutrition on the older population. The approach constituted of a customised set of interventions focusing on the individuals, their needs and wishes of food and the institution in which they lived.

Also, an innovative homecare delivery programme to prevent undernutrition was established in Bruges for 600 elderly at home. The interventions consist of a learning programme, a systematic risk screening and monitoring, and suitable food delivered for the participating older adult.

In Italy, foods or diet supplements designed to reduce frailty in older people and to maintain sensory perception were launched in the market. Their main focus is the prevention of osteoporosis through vitamin D enriched diet including oils.

In Spain, there are also aspirations to improve the quality of life for the older population through functional foods targeting their specific needs that can be included in a normal diet. In order to do that, a technology was developed that allows the caramelisation of food carbohydrates under conditions that favour the formation of prebiotic oligosaccharides.

In Northern Ireland too, the improvement of the quality of nutritional care of adults is of high importance. The prevention, identification and management of malnutrition are at the forefront in all health and social care settings. Systematic, routine screening for pre-frailty stages in at risk patients and older people is also promoted. To support person-centred care, templates for malnutrition screening were published. Moreover, awareness raising materials for practitioners of the screening tools were also developed.

The Canadian Guelph University prepared a specific guideline for registered dietitians about functional foods for older adults which reviews the regulations and nutritional advantages of different functional foods (Duncan et al., 2012).

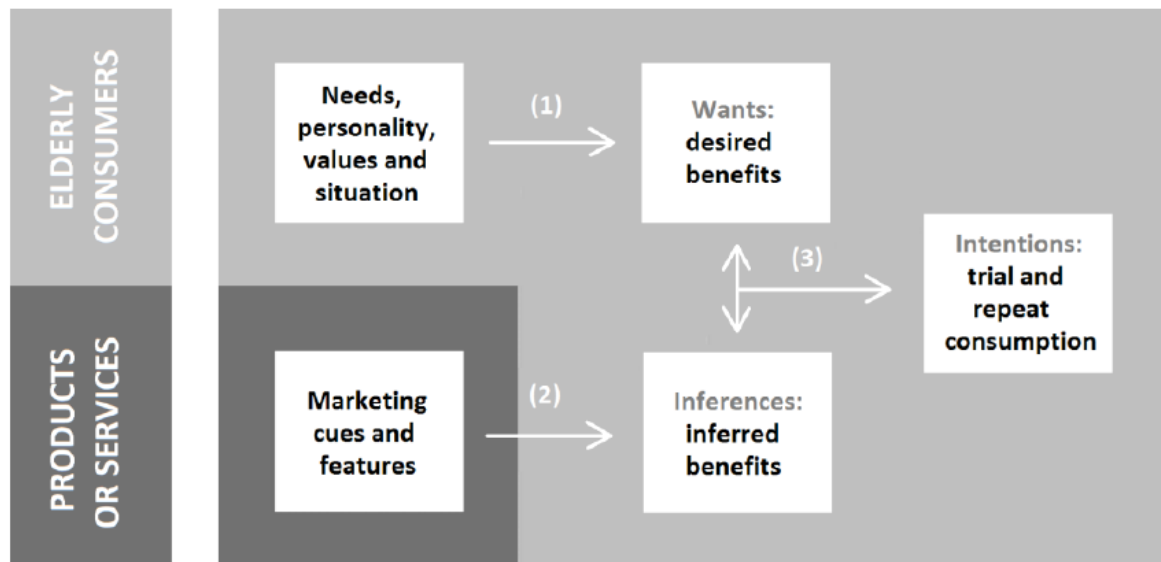
In Hungary OGYÉI launched a new national dietary recommendation for older adults and a thematic website called merokanal.hu (OGYÉI, 2020).

### **3.4. Consumer studies**

#### ***3.4.1. The importance of consumer studies in product development***

Functional foods can play a key role in healthy ageing, therefore well-grounded product development is one of the most important fields in the food sector (Siró et al., 2008; Bigliardi & Galati, 2013; Plasek et al., 2020; Alongi & Anese, 2021; Talens et al., 2021). The increasing importance of the functionality of foodstuffs was recognised even before the turn of the millennium by the food industry in the EU, which has accelerated the development of new products. However, new products had a high failure rate: it was estimated that at least 75 percent of newly launched functional food products were withdrawn from the market within the first two years, because most of them were not preceded by a deeper exploration of consumer needs (Hilliam, 1998; Biester, 2001; Menrad, 2003; Stein & Rodriguez Cerezo, 2008).

The idea behind consumer-oriented product development is that the success of a new product (or service) depends on the fit between its benefits and the needs and wants of the consumer (Grunert et al., 1996; Steenkamp & van Trijp, 1996; Grunert & van Trijp, 2014). **Figure 6** shows a theoretical framework of consumer decision-making, according to van der Zanden (2017), who adapted consumer-oriented product development theory from Grunert & van Trijp (2014), and tailored it to older consumers.



**Figure 6.** The framework of consumer decision-making, illustrating the process of forming wants (1), inferences (2) and intentions (3) (source: van der Zanden, 2017).

The framework of consumer decision-making distinguishes three key stages: want formation, inference formation and intention formation. Wants, or desires, represent the benefits that consumers (consciously or unconsciously) seek in a product or service, such as safety, convenience or healthiness. The development of these wants is guided by physical and psychological needs, personality, values as well as the situation a consumer is in (Grunert & van Trijp, 2014). What senior consumers want from food products, for example, includes the benefits that consumers want in general (e.g. great taste, high convenience and affordable price), but also includes age-specific benefits emerging from physical limitations (e.g. reduced taste sensitivity, specific nutritional needs) which may become relevant to different consumers at different ages. The success of the product development depends on the extent to which this total configuration of desired benefits is successfully identified and translated into perceived product benefits (Haley, 1968; Onwezen et al., 2012).

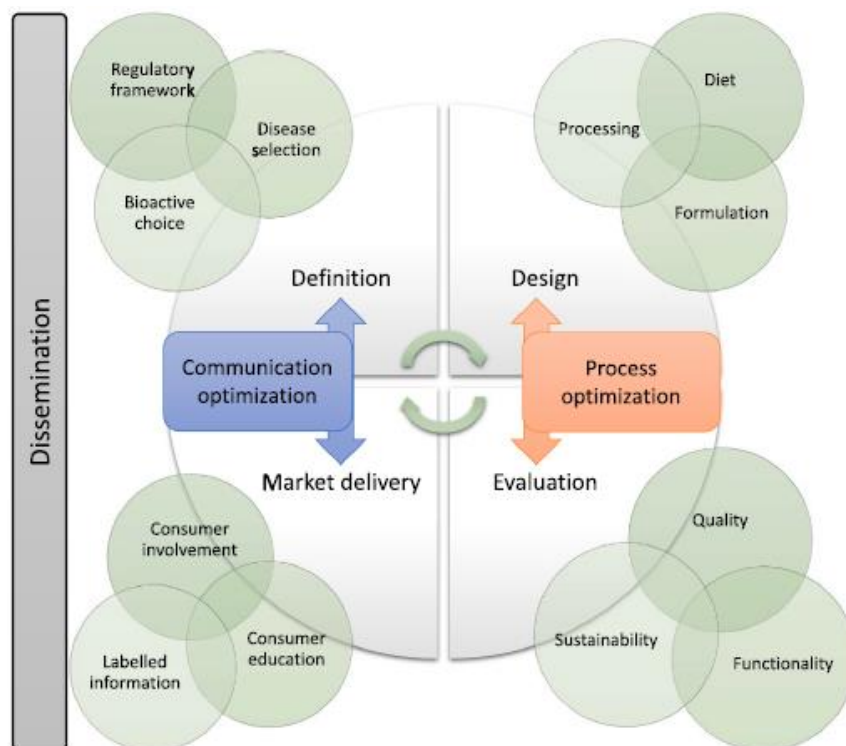
When confronted with products (e.g. through advertisements), consumers use a diversity of marketing-related cues to infer what they believe products and services have to offer in terms of (relevant) consumption benefits: the process of inference formation. Consumers make such inferences from a selection of cues observed in the offering (e.g. its features, packaging and communication); a process which involves a considerable amount of subjectivity. Truly ‘decoding’ what the product or service has to offer in terms of benefits is challenging, particularly in the case of a limited amount of available information or experience with comparable products or services, or limited motivation or cognitive capacity to deeply process available information. Consumers may thus not always infer benefits as they were intended by the manufacturer (Grunert & van Trijp, 2014). Inference formation is especially challenging for



innovative products, such as functional foods, as they often do not meet already existing consumer expectations and habits (Grunert & van Trijp, 2014). Such products require positioning and communication strategies that communicate the benefits that they deliver in a clear and convincing manner (Costa et al., 2004).

Consumption intentions, or goals, are formed when consumers perceive a match between what they want (i.e. their desired benefits) and what they believe the product or service has to offer (i.e. the inferred product benefits) (Kardes et al., 2004). Upon first-time (i.e. trial) consumption of the product or service, consumers may be able to verify some (e.g. taste, convenience) but not all (e.g. health and sustainability) inferred benefits, which may help them to decide whether the product or service is worthwhile to buy (Grunert & van Trijp, 2014). Trial consumptions are a necessary but insufficient condition for success (Tauber, 1973). In the end, it is the experience of relevant benefits (or the lack thereof) that will determine whether or not consumers will be convinced to repeat purchase and use the product and become loyal customers.

Employing such consumer orientation in both early (e.g. concept formulation) and later phases of development (e.g. prototype testing) positively contributes to the success of new products and services (Ernst, 2002). However, consumers are currently only involved in the prototyping and launching phases, but they could potentially play a crucial role in the previous ones, namely idea generation and concept design (Busse & Siebert, 2018). Accordingly, the latest conceptual approach for development of functional food products also involves results of consumer studies (**Figure 7**).



**Figure 7.** Functional food development cycle (source: Alongi & Anese, 2021).

From the 2000s, several consumer-related studies emerged in the EU about functional foods, the result of which could support product development. The first consumer studies related to functional foods attempted to explore the effect of socio-demographic factors (Childs, 1997; Gilbert, 2000; Verbeke, 2005), attitudinal profiles and motivations (Bech-Larsen & Grunert, 2003; Urala & Lähteenmäki, 2003; Landström et al., 2007; Niva, 2007; Urala & Lähteenmäki, 2007; Szakály et al., 2012) and reactions connected to health and nutrition claims (Urala et al., 2003; Van Kleef et al., 2005; Behrens et al., 2007; Van Trijp & Van der Lans, 2007). Based on the results of the studies that focused on the concept of functional foods in general, later studies targeted more specific product categories and novel concepts (Verbeke et al., 2009; Annunziata & Vecchio, 2013; Micale et al., 2017; Banovic et al., 2018; Wortmann et al., 2018; Sagan et al., 2019).

### ***3.4.2. Older adults as a consumer group and heterogeneity among them***

The older population is a large and growing consumer segment, however, these consumers were neglected up to the 1980s by this field of product development, which gradually changed in the past decades (Moschis, 2003; Giacalone et al., 2016). When positioning products for older adults, putting an emphasis on their age bracket is recommended against, as elderly tend to respond negatively to promotions associated with old age (e.g. senior discounts) (Tepper, 1994; Faranda & Schmidt, 1999).. Most Western cultures hold a stereotypical view of old age, associating it with both physical and psychological disability and this view is reinforced by the media, in which elderly are often displayed as fragile, impaired and needy (Sudbury & Simcock, 2009; Widrick & Raskin, 2010). In addition, older consumers tend to feel younger than their chronological age and not identifying themselves with old models and spokespersons in the media (Moschis & Mathur, 2006; Sudbury & Simcock, 2009). Thus, simply labelling such specific products as '50+' will likely not motivate consumers to start using them. In approaching this group with products, an emphasis should instead be placed on communicating the benefits that these products provide (Costa et al., 2004). Using such a positioning will help elderly to recognize that products offer benefits that match with their needs and wants, and will more likely lead to the formation of consumption intentions. Research findings claim that elderly consumers are not only more likely to repurchase but also actively resist switching brands once they have established a favourite brand (Karani & Fraccastoro, 2010).

Food related preference of older adults differs from other age groups in several aspects, which justifies targeted research approach (Wądołowska et al., 2009; Baugreet et al., 2017; Szakos et al., 2020a; 2020b; 2021; Oeser, 2021). **Table 1** shows identified opportunities and challenges in case of development of functional food products for older adults according to previous studies.

**Table 1.** Opportunities and challenges in the development of functional food products for older adults (source: own compilation).

<b>Opportunities</b>	<b>Challenges</b>
Large and growing consumer segment (UN, 2020)	Age-based stigmatisation (Tepper, 1994; Faranda & Schmidt, 1999)
Brand loyalty (Karani & Fraccastoro, 2010)	Resistance for brand switching (Karani & Fraccastoro, 2010)
General interest about healthy eating (Roininen et al., 1999; Vella et al., 2013)	Food neophobia (i.e. avoiding of trying new products) (Tuorila et al., 2001)
Willingness to pay for perceived product benefits (Leek et al., 2001; Siegrist et al., 2008; Yoon & Cole, 2008; Vassallo et al., 2009)	Difficulties in reading and interpreting information on food labels (Annunziata et al., 2015)
Evidence that medical advice and intervention programmes could be effective to increase acceptance of functional food products (van der Zanden et al., 2014a; Jeruszka-Bielak et al., 2018; Febian et al., 2021)	Scepticism about the reliability of the label information (Annunziata et al., 2015)
	Sensory impairments (Doets & Kremer, 2016)
	Lack of knowledge about nutrition (Jeruszka-Bielak et al., 2018)

Based on previous findings, the older population could not be considered as a homogenous consumer group (Moschis, 2003; van der Zanden et al., 2014b). Despite similar nutritional needs, food-related preferences of older adults differ to a great extent (Atchley, 1987; Rozin, 2006; Sobal et al., 2006; Locher & Sharkey, 2009). Studies described that senior consumers strongly differ from each other on a range of consumption behaviours. For instance, previous studies found differences between older consumers in restaurant selection (Moschis et al., 2003) and shopping orientation (Lumpkin, 1985). Identified differences in case of purchasing luxury products, can be explained by the different perception of cognitive age (i.e. the age they feel) (Amatulli et al., 2015). Possible reasons behind different travelling behaviour were differences in lifestyle and sought product benefits (Hildebrand, 2003; Sangpikul, 2008). Heterogeneity among older consumers can be explained partly by the fact that this consumer segment represents a variety of different cohorts, depending on the time and place they were born and raised (Schewe & Meredith, 2004). As a result of heterogeneity in needs and wants, elderly form different inferences and intentions, and will respond differently to marketing messages and interventions targeting them. Older adults have had a lifetime of experiences that have shaped their needs and wants (Moschis, 2000).

### **3.4.3. Age-related differences between consumers**

Consumer studies on a Finnish sample found that older respondents were more willing to use functional foods with claims to reduce the risk of a disease (such as blood pressure lowering milk drinks) than younger consumers (Urala & Lähteenmäki, 2004; 2007). Younger consumers instead show higher overall acceptance for products enhancing some physiological functions, such as those improving general well-being (Urala & Lähteenmäki, 2004; Hailu et al., 2009).

A study investigating a large across eight European country experienced that older consumers have more knowledge and familiarity with functional products and their effects on health, and are more likely to accept them, than the younger respondents (Messina et al., 2008). Further previous studies also found relationship between ageing and higher acceptance of functional food products (Peng et al., 2006; Ares & Gámbaro, 2007; Siegrist et al., 2008; Ares et al., 2009; Øvrum et al., 2012; Büyükkaragöz et al., 2014; Kraus et al., 2017; Verneau et al., 2019; Plasek et al., 2020). Studies about acceptance of functional dairy products also found higher consumption by older adults (de Jong et al., 2003; Chase et al., 2009; Bonanno, 2012; Mullie et al., 2012; Bimbo et al., 2017). However, a Polish study found that along with age, the level of interest in some functional foods, as a way to improve health, decreased (Wądołowska et al., 2009). A Spanish study also found that younger respondents consume more functional food than senior consumers, which can be explained with conservative cultural traditions (Carrillo et al., 2013).

Older individuals are more interested in nutrition, due to a generally increased health concern, though this baseline interest may be counteracted by more difficulties in processing information in the high age groups (Grunert & Wills, 2007). In Germany, there was a tendency for younger respondents to be better informed, while in the United Kingdom age had no impact, and in Spain the older grocery shoppers were somewhat better informed (Stein & Rodriguez Cerezo, 2008). A survey performed in Hungary, for example, revealed that elderly people were less familiar with the term 'unsaturated fatty acid' so the utilization of labelling is doubtful in the everyday practice (Bánáti et al., 2007).

#### **3.4.4. Segmentation of older adults**

Segmentation is a widely used process that aims the identification of homogenous consumer subgroups (Wedel & Kamakura, 2000), which was successfully adapted to the functional food market in several quantitative research studies (Ares & Gámbaro, 2007; Herath et al., 2008; Annunziata & Pascale, 2009; Sparke & Menrad, 2009; Szakály et al., 2012; Brečić et al., 2017; Karelakis et al., 2019; Roselli et al., 2020; Nystrand & Olsen, 2021). However, so far only few quantitative segmentation studies focused on older adults in functional food market. A Dutch study with 303 older adults measured the rate of the willingness to trial purchase of a set of carriers enriched with protein. It signlaed a low willingness to purchase level and identified significant heterogeneity in carrier acceptance (van der Zanden et al., 2015). Findings of this study underline the importance of taking heterogeneity into account when commercialising functional foods among elderly. Another study analysed the life satisfaction of Chinese elderly with food related life, and segmented the sample based on beliefs about healthiness, safety, freshness and taste (Liu & Grunert, 2020). This study distinguished three distinct consumer segments: 'health and safety concerned', 'hedonic and less health concerned' and 'less safety and somewhat health concerned', indicating that there are significant differences among the subgroups of elderly people.

## 4. Materials and methods

### 4.1. Survey method and questionnaire design

The present thesis contains the results of two quantitative consumer surveys. A nationwide-representative sample and a specific older adult sample were collected. The survey methods were identical in both cases, and the applied questionnaires were similar. For data collection, personal sampling method was used. Research was conducted at crowded public areas in different Hungarian cities. Although the questionnaire was designed to be self-administered, interviewers provided help to fill the questionnaire, which was important especially in the case of older respondents.

In the beginning of the interview, the respondents were informed about the aim of the research and the management of their anonymous data. If the respondents were willing to participate, before the research questions were asked, the quota parameters (age, sex, geographical distribution according to NUTS-2) had been recorded, which allowed the quota numbers to be tracked by the interviewers to ensure an appropriate level of representability according to the latest general Hungarian census data (KSH, 2016).

The questions were predominantly closed-form type, for which five-point Likert scales were attached, where grade 1 meant 'strongly disagree' and grade 5 meant 'strongly agree'. **Table 2** shows the content of the questionnaire in terms of all variables used in the study. The questionnaire is enclosed in the Appendix section.

Preliminary versions of the questionnaires were pretested with small samples for clarity of content and wording, in which overall understanding and the length of the surveys were also checked. Based on the feedback, the questions were refined and finalised.

**Table 2.** Summary of the questionnaire for all variables used in the study.

<b>Topic</b>	<b>Question</b>	<b>Set of values</b>
Attitude questions	To what extent do you agree with the following statements?	1-5 Likert scale
Consumer habits	To what extent do you agree with the following statements?	1-5 Likert scale
Associations with the 'healthy food' term	What do you think about the meaning of the 'healthy food' term?	Open-ended
Lifestyle patterns	Which of the following lifestyle statements is relevant for you?	Multiple choice
Nutrition claims	To which extent do you prefer the following nutrition claims while shopping?	1-5 Likert scale
Carrier types	How much do you think the consumption of the following foods contribute to your health?	1-5 Likert scale
Product parameters	How important is it for you that a 'healthy food' has the following properties?	1-5 Likert scale
Health concerns	Which health problems are you concerned about?	Not concerned/ Concerned
Acceptance of functional foods as a solution for disease prevention and mitigation	Would you choose 'healthier foods' to prevent or mitigate the following health problems?	Yes/no
Preferred shop types	Where does your household go shopping?	1-5 Likert scale
Preferred communication channels	Where do you get nutrition and food information?	1-5 Likert scale
Knowledge-test questions	Which statement is true and which is false?	Yes/no
Special dietary needs (cause)	Is there a reason why you need a special diet?	1-5 Likert scale
Socio-demographic factors	Different questions	Different question types

Because of the exploratory nature of the study, a wide range of variables were included in the questionnaire. The main health problems people are most concerned about and the acceptance of functional foods for disease prevention and mitigation were essential parts of the questionnaire. Nineteen health problems were listed, covering major CNDs, health problems that are usually connected with age (e.g. arthritis disorders, osteoporosis, memory disorders) and other health problems related to food consumption (e.g. lactose sensitivity, gluten sensitivity). Health-related lifestyle patterns and special dietary needs were also included in the survey.

Previous studies revealed that the type of carrier (combined with type of enrichment) is one of the most important factors in consumer acceptance of functional food products (Bech-Larsen & Grunert, 2003; Urala & Lähteenmäki, 2003; Ares & Gámbaro, 2007; Williams et al., 2008; Verbeke et al., 2009). For this reason, older adults could express their health-related preference about twenty-five types of foods in total, which covered all of the major processed and unprocessed food categories traditionally consumed in Hungary.

Variables influencing food purchasing were also included in the questionnaire (Moschis, 2003; Szegedyné Fricz et al., 2020). Product parameters used in the questions cover the origin of the products and different quality and sustainability attributes. Besides the nutrition claims listed in the Regulation (EC) No. 1924/2006 and used for segmentation, other nutrition claims were applied for the profiling of segments. These claims (e.g. prebiotic, contains antioxidant) were not connected directly to CNDs, however, they can be relevant for many consumers. Preference of common shop types were also included in the survey, as well as communication channels, through which senior consumers receive food related information, such as television, radio, online media platforms and also 'family, relatives, friends'.

Several attitude-related questions were included in the survey, such as questions about perceived connection between nutrition and health, dietary interests of consumers, eating habits, consumer opinions about price of functional foods, and other factors influencing the purchase decision.

During the research design, besides general socio-demographic characteristics, survey aimed to collect data on some further particular conditions that may affect food consumption directly according to literature (Verbeke, 2005). Age was measured by the year of birth, from which age categories were composed. Location of residence included three categories: capital city (Budapest), another city and village. Education level was recorded based on the highest accomplished qualification, and included three categories: primary and vocational school (merged category), high school (graduated) and higher education. Information about the responsible person for shopping in the household was also checked to define the relation of the respondent to purchasing decisions. Level of income was measured on a 5-level scale and merged into three categories for better interpretation: below average, average, above average. From body weight and height of the respondents, BMI was calculated: weight in kilogram divided by height in meter square. The sample was divided to three BMI categories according to WHO classification: normal (18.5-24.9 kg/m<sup>2</sup>), overweight (25.0-29.9 kg/m<sup>2</sup>), obese ( $\geq$ 30.0 kg/m<sup>2</sup>) (WHO, 1998).



## 4.2. Socio-demographic characteristics of the sample

### 4.2.1. Nationwide representative sample

The nationwide representative survey was conducted in the summer of 2018 with 1002 respondents. In terms of sex, age and geographical distribution (NUTS-2) of the respondents, the sample is representative of the total adult population of Hungary (**Table 3**). Further socio-demographic characteristics of the sample are shown in **Table 4**.

**Table 3.** Representative socio-demographic characteristics of the nationwide representative sample.

Socio-demographic categories	Sample	Population (KSH, 2016)
<i>Sex</i>		
Female	53.19	53.07
Male	46.81	46.93
<i>Age</i>		
18–29	17.96	17.59
30–39	16.97	17.04
40–59	34.53	33.83
> 60	30.54	31.54
<i>Geographical distribution (NUTS-2)</i>		
Central Hungary	31.04	30.75
Central Transdanubia	10.78	10.80
Western Transdanubia	10.18	10.03
Southern Transdanubia	8.68	9.13
Northern Hungary	11.48	11.62
Northern Great Plain	15.07	14.90
Southern Great Plain	12.77	12.78

(Percentages, N = 1002).

**Table 4.** Further socio-demographic characteristics of the nationwide representative sample.

<b>Socio-demographic categories</b>	<b>Sample</b>
<i>Location of residence</i>	
Village	15.49
Another city	61.54
Capital city	22.98
<i>Highest accomplished qualification</i>	
Primary and vocational school	11.46
High school (graduated)	33.37
Higher education	55.17
<i>Income level</i>	
Below average	13.11
Average	68.16
Above average	17.17
<i>Economic status</i>	
Active worker	54.64
Entrepreneur	6.25
Retiree	27.12
Job seeker	1.51
Homemaker	1.41
Student	9.07
<i>Responsible for shopping</i>	
Respondents themselves	39.50
Together with a family member	51.46
Other person	9.04
<i>Children under 15 years of age in the household</i>	
Yes	20.04
No	79.96
<i>Number of persons living in the household</i>	
1	16.48
2	40.88
3	17.83
4	14.18
5 or more	10.63

(Percentages, N = 1002).

#### 4.2.2. Older adult specific sample

A large (N = 907) sample of older adults aged 60 or above was collected in Hungary in the summer of 2021. The socio-demographic characteristics of this non-representative sample are shown in **Table 5**.

**Table 5.** Socio-demographic characteristics of the older adult specific sample.

<b>Socio-demographic categories</b>	<b>Sample</b>	<b>Population (KSH, 2016)</b>
<i>Sex</i>		
Female	69.90	60.18
Male	30.10	39.82
<i>Age</i>		
60-69 years	59.20	51.84
70-79 years	35.79	32.02
80 years and above	5.02	16.14
<i>Location of residence</i>		
Capital city	31.90	18.36
Another city	53.05	51.52
Village	15.05	30.12
<i>Highest accomplished qualification</i>		
Primary and vocational school	8.98	54.63
High school (graduated)	35.11	28.03
Higher education	55.91	17.35
<i>Responsible for shopping</i>		
Respondents themselves	59.57	n/a
Together with a family member	35.46	n/a
Other person	4.96	n/a
<i>Income level</i>		
Below average	21.38	n/a
Average	66.25	n/a
Above average	12.37	n/a
<i>BMI</i>		
Normal	32.09	n/a
Overweight	46.51	n/a
Obese	21.39	n/a

(Percentages, N = 907).

#### 4.3. Applied statistical methods

Statistical analysis of the data was carried out by IBM SPSS Statistics version 22.0 software package. In the case of the analysis of nationwide representative sample, beyond descriptive statistical tests, Chi-square tests (CI: 95%) of independence were conducted to investigate differences in case of the categorical variables. Kruskal-Wallis test was used to analyse Likert-type variables (Clason & Dormody, 1994).

Factor analysis (PCA) with Varimax rotation was performed to discover the underlying structure of items and to combine correlated variables (Grafen & Hails, 2002). The compliance of the PCA model was evaluated by KMO test and Bartlett test of sphericity (Hair et al., 2014).

For consumer segmentation, a two-step clustering procedure was applied (Wedel & Kamakura, 2000). As the first step, Ward's hierarchical clustering method was used to identify segments based on the six confirmed nutrition claims factors. Then, the clustering was completed with non-hierarchical K-means clustering method, following the identification of the optimal number of segments based on the assessment of the agglomeration schedule and the increase in agglomeration coefficient (Hair et al., 2014). One-Way ANOVA F-tests with Tukey post hoc tests and Chi-square tests were used to profile segments.

#### **4.4. Composed factors**

##### ***4.4.1. Nationwide representative sample***

The questionnaire contained thirty-nine nutrition claims in total, covering all options listed by the Regulation (EC) No. 1924/2006. In some cases, claims were presented through an example, such as 'source of calcium', while others used a generalized form, for instance, 'source of vitamins'. EU and national level food law allow the use of the terms salt and sodium as synonyms in labelling, so both terms were included in the questionnaire. Besides the claims listed in the regulation, some other elements were also included (e.g. prebiotic, contains antioxidants, etc.) (Szabó & Ózsvári, 2020; Sik et al., 2022). Respondents expressed their opinion on 1-5 Likert scale about their preference of the listed nutrition claims. For better interpretation, PCA was used with exploratory approach, to reduce thirty-nine items to eight well-distinguishable nutrition claim categories (**Table 6**). The eight principal components, explained 77% of the total variance and the Bartlett's test of sphericity was highly significant. 'Vitamins and minerals' forms a common group according to the PCA, similarly to 'protein and fibre'. Salt, sugar, fat and energy content related claims create distinct groups. PCA clearly indicated a group constituted by those claims that are not listed in the Regulation (EC) No. 1924/2006. 'Free from' category is composed by lactose-free and gluten-free claims.

From twenty-five listed carrier products five carrier categories were composed by PCA (**Table 7**). These five composed categories explained 54% of the total variance and the Bartlett's test of sphericity was also highly significant. Dairy products forms a distinct category according to the PCA. 'Fruits and vegetables' forms an independent group according to PCA, which contains processed products and mushrooms, too. The following categories were 'meat, fish and egg', 'natural products' and 'dairy products'. 'Natural products' is a heterogeneous group compared to the others. It contains juice; honey; tea; nuts and other oily seeds, muesli; and herbal products. 'Breakfast products' contains fruit jam, bakery products and margarine.

**Table 6.** Nutrition claims factor categories based on PCA.

<b>Factors and items</b>	<b>Cronbach's <math>\alpha</math></b>	<b>Variance explained (%)</b>
<i>Vitamins and minerals</i>	0.946	13.469
High in vitamins		
Source of vitamins		
Natural source of Calcium		
Naturally high in Calcium		
Source of Calcium		
High in Calcium		
<i>Salt</i>	0.946	13.353
Low in salt		
Low in sodium		
Very low in salt		
Very low in sodium		
Salt-free		
Sodium-free		
<i>Not listed claims</i>	0.895	11.714
Whole grain		
Contains antioxidant		
Contains herbs		
Live cultures		
Probiotic		
Prebiotic		
Contains pectin		
<i>Energy</i>	0.868	9.601
Low energy		
Light/lite		
Energy-reduced		
Energy-free		
<i>Sugar</i>	0.877	8.451
With no added sugar		
Low in sugar		
Sugar-free		
Low-carb		
<i>Fat</i>	0.905	8.108
Low-fat		
Low-saturated fat		
Saturated fat-free		
Reduced saturated fat		
Fat-free		
<i>Protein and fibre</i>	0.882	7.369
High in fibre		
High in protein		
Source of protein		
Source of fibre		
Increased protein		
<i>Free from</i>	0.846	4.693
Lactose-free		
Gluten-free		
Total variance explained		76.758

(Rotation method: Varimax with Kaiser Normalization; KMO measure: 0.944; Bartlett's test of sphericity: 30748.377, df = 741, p < 0.001).

**Table 7.** Carrier factor categories based on PCA.

<b>Factors and items</b>	<b>Cronbach's <math>\alpha</math></b>	<b>Variance explained (%)</b>
<i>Dairy products</i>	0.853	14.541
Yoghurt		
Kefir		
Cheese		
Cottage cheese		
Milk		
Butter		
Sour cream		
<i>Breakfast products</i>	0.696	10.256
Margarine		
Bakery products		
Fruit jam		
<i>Fruits and vegetables</i>	0.727	10.038
Fruits		
Vegetables		
Fruit-based products		
Vegetable-based products		
Mushroom-based products		
<i>Meat, fish and eggs</i>	0.704	9.783
Fish and fish-based products		
Poultry meals		
Egg and egg-based products		
Pork meals		
Meat products		
<i>Natural products</i>	0.676	9.349
Juice (fruit, vegetable)		
Honey		
Tea		
Nuts and other oily seeds, muesli		
Herbal products		
Total variance explained		53.967

(Rotation method: Varimax with Kaiser Normalization; KMO measure: 0.848; Bartlett's test of sphericity: 8043.992, df = 300,  $p < 0.001$ ).

#### **4.4.2. Older adult specific sample**

The segmentation is based on the consumer's acceptance of different nutrition claims. Nutritional composition is an exact, well-comprehensive concept for food business operators and policy makers, therefore the result of the segmentation could be easily interpreted to these stakeholders. Furthermore, based on previous research findings, health claims are often very difficult to be interpreted for consumers, therefore, nutrition composition related questions perform better in marketing studies (Lähteenmäki et al., 2010; Annunziata et al., 2015). Theoretical recommendations also suggest that elderly consumers' market might be best segmented using preference-based segmentation (van der Zanden et al., 2014b), which was also considered during the methodological design.

The questionnaire contained twenty-nine nutrition claims as variables for the factors of consumer segmentation. All of these claims are listed by the Regulation (EC) No. 1924/2006.

The following six segmentation factors were selected:

- Consumer preference of 'Salt' related claims was measured with a scale composed of six items: very low in sodium, very low in salt, sodium-free, salt-free, low in salt, low in sodium.
- 'Vitamins and minerals' belong to same factor according to the previous study. They were assessed with six items: high in vitamins, source of vitamins, high in calcium, natural source of calcium, source of calcium, naturally high in calcium.
- 'Protein and fibre' as a factor was measured with five items: source of protein, high in protein, increased protein, high in fibre, source of fibre. Increased protein claim is an example for 'increased' type of claims.
- The 'Energy' factor was measured with four items: energy-reduced, low energy, energy-free, light/lite.
- Claims related to 'Sugar' were assessed with three items: low in sugar, with no added sugar, sugar-free.
- 'Fat' related claims were measured with five items: low-fat, fat-free, low-saturated fat, saturated fat-free, reduced saturated fat.

The initial PCA resulted in six principal components. The inspection of the rotated component matrix suggested that the interpretation of some of the cross-loadings and components were not straightforward, therefore the following modifications were made. Two items (high in vitamins, source of vitamins) used to capture preference of vitamins were discarded due to cross-loading and low factor loading. So, 'Minerals' was used instead of the 'Vitamins and minerals' factor. One of the six items (increased protein) measuring the 'Protein and fibre' factor was omitted due to its low communality. 'Light/lite' claim was discarded from 'Low energy

content' factor due to cross-loading and low factor loading. 'Low-fat' and 'fat-free' claims were omitted due to cross-loadings and low factor loadings from the 'Low fat' factor, thus changing it to 'Low-saturated fat' factor. The final PCA revealed six principal components, explained 81% of the total variance and the Bartlett's test of sphericity was highly significant (**Table 8**). Factor loadings ranged from 0.71 to 0.89 and Cronbach's  $\alpha$  values were between 0.88 and 0.95 (Hair et al., 2014).

**Table 8.** Segmentation categories based on PCA.

<b>Construct and item</b>	<b>Factor loading</b>	<b>Cronbach's <math>\alpha</math></b>	<b>Variance explained (%)</b>
<i>Salt</i>		0.938	20.559
Very low in sodium	0.875		
Very low in salt	0.869		
Sodium-free	0.859		
Salt-free	0.807		
Low in salt	0.722		
Low in sodium	0.710		
<i>Minerals</i>		0.952	15.633
High in calcium	0.889		
Natural source of calcium	0.885		
Source of calcium	0.872		
Naturally high in calcium	0.710		
<i>Protein and fibre</i>		0.900	13.505
Source of protein	0.829		
High in protein	0.783		
High in fibre	0.774		
Source of fibre	0.739		
<i>Energy</i>		0.880	10.590
Energy-reduced	0.857		
Low energy	0.845		
Energy-free	0.740		
<i>Sugar</i>		0.882	10.521
Low in sugar	0.815		
With no added sugar	0.802		
Sugar-free	0.784		
<i>Saturated fat</i>		0.896	10.114
Low-saturated fat	0.837		
Saturated fat-free	0.786		
Reduced saturated fat	0.744		
Total variance explained			80.922

(Rotation method: Varimax with Kaiser Normalization; KMO measure: 0.902; Bartlett's test of sphericity: 15792.146, df = 253,  $p < 0.001$ ).



## 5. Results

### 5.1. Differences between older adults and other age groups

#### 5.1.1. Healthy food associations

Consumers often use the ‘healthy’ or ‘unhealthy’ terms in relation to food products. Although these terms are not correct from neither academic, nor a legal point of view, it is still important to examine what consumers mean by these. As a part of the survey, respondents were able to describe in their own words what makes a food ‘healthy’ to the following open-ended question: “What do you think about the meaning of the 'healthy food' term?” Out of the 787 responses, 1775 different answers were collected, because many respondents provided detailed, multi-element answers. Then, categories were formed based on the answers. The distribution of responses within the most significant categories is summarised in **Table 9** by ages below and above 60 years.

**Table 9.** Proportion of created categories, based on the consumer associations about ‘healthy food’ products by age (%).

<b>Formed categories</b>	<b>Below 60 years</b>	<b>Above 60 years</b>
Free from additives	33.92	30.28
High nutrient/vitamin content	26.19	16.97
With less sugar	16.52	13.30
Natural	14.76	8.26
Vegetables, fruits	14.41	14.22
Free from chemicals	14.24	25.23
Bio	9.84	9.63
Fresh	8.79	16.06
Low carbohydrate content	8.26	9.63
Low in fat	6.50	12.39
Less processed	5.45	3.21
Does not contain harmful ingredients	5.27	4.13
Easy to digest	5.10	2.75
Non-GMO	4.92	8.26
Domestic product	4.92	7.80
Does not make me fat	4.75	4.59

Both age groups mention the ‘free from additives’ in the first place, which category includes also the responses that mentioned ‘free from E-numbers’ and ‘free from preservatives’ too. In the second place, those below 60 years indicated high nutrient/vitamin content, while for those above 60 years, this was only the third most important factor. In their case, ‘free from chemicals’ was in second place. Furthermore, older adults mentioned the following terms in higher rate than the younger individuals: ‘low in fat’, ‘Non-GMO’, ‘domestic product’.

### 5.1.2. Attitudes and lifestyle patterns towards nutrition

At the beginning of the survey, 1-5 Likert questions were listed in order to characterise different age groups based on attitudes towards nutrition (**Table 10**).

**Table 10.** Attitudes towards nutrition in different age groups.

Variables	18-29	30-39	40-59	>60	Total sample	p-value
<i>Nutrition and health</i>						
Nutrition has a direct impact on health	4.51	4.60	4.61	4.64	4.60	0.362
Healthy diet has a strong impact on the prevention of diseases at older adults	4.57	4.43	4.50	4.49	4.50	0.534
For older adults, diet has more important role in health	4.34	4.16	4.28	4.42	4.42	*0.003
<i>Dietary interest</i>						
Healthy diet is important for me	4.05	4.16	4.31	4.45	4.28	*<0.001
I am interested in healthy diet	4.08	4.05	4.28	4.34	4.22	*0.001
I am interested in lifestyle-related scientific issues	3.55	3.69	3.94	3.92	3.82	*0.001
I consciously choose brand and manufacturer when it comes to food	3.60	3.85	3.86	3.73	3.77	*0.022
I constantly seek information and educate myself on food and nutrition	3.33	3.58	3.75	3.67	3.62	*<0.001
I thoroughly read the label of products	3.11	3.64	3.56	3.73	3.54	*<0.001
<i>Aspects in food purchase choices</i>						
Quality	4.16	4.34	4.38	4.42	4.35	*0.002
Nutritional composition	3.29	3.42	3.64	3.72	3.56	*0.001
Compliance with health-conscious diet	3.05	3.23	3.41	3.66	3.39	*<0.001
Domestic origin	2.64	3.27	3.50	3.79	3.39	*<0.001
Taste	3.44	3.20	3.19	3.41	3.30	*0.016
Price	3.13	2.87	2.93	3.02	2.98	0.067
Brand	2.54	2.67	2.71	2.74	2.68	0.315
Packaging	1.93	1.83	2.03	2.14	2.01	*0.042
<i>Eating habits</i>						
Mostly eat home-made dishes	3.79	3.69	4.05	4.30	4.02	*<0.001
Often consume low-carb or no-carb foods	2.38	2.55	2.90	2.94	2.76	*<0.001
Often consume sugar-free foods	2.55	2.63	2.84	2.79	2.74	0.089
Often consume lactose-free foods	2.07	1.98	2.11	2.03	2.05	0.860
Often consume gluten-free foods	1.73	1.92	1.98	1.89	1.90	0.161
Often eat in restaurant	2.46	2.51	2.25	1.94	2.24	*<0.001
<i>Consumer opinions about price and taste of functional foods</i>						
'Healthy foods' are more expensive	4.04	4.14	4.08	4.24	4.13	*0.027
I am willing to pay more for 'healthy foods'	3.71	3.95	4.02	4.02	3.95	*0.001
'Healthy foods' are less delicious	2.16	2.67	2.47	2.54	2.47	*0.002

(Mean values, 1-5 Likert scale, \*p < 0.05).

According to the results, each age group perceived strong connection between nutrition and health. While all age groups agreed that “healthy diet has a great impact on the prevention of diseases in older adults”, the oldest group attached significantly more importance to “for older adults, diet has a more important role in health” compared to other age groups. Higher general dietary interest was identified with ageing. Older adults show more interest in health-conscious diet and lifestyle-related scientific issues. Meanwhile, conscious brand and manufacturer preferences and self-education on food and nutrition were more characteristic of middle-aged consumer groups. Thorough reading of label information was the most common among older consumers. In general, considering the whole sample, quality was the most important aspect during food purchasing, followed by nutritional composition of food, and compliance with health-conscious diet. Taste and price were in the middle of the list, while brand and packaging were less relevant for consumers according to the results. Each statement’s importance increased with age, except for taste and price, as these were similarly important to the youngest and the oldest age groups of the sample. Older adults mostly eat home-made dishes, while they rarely eat in a restaurant. Low-carb or no-carb and sugar-free diets were more characteristic of ageing. Except for the consumption of lactose-free and gluten-free products, significant differences were not detected between age groups. Older consumers considered ‘healthier’ foods to be more expensive, but they were more willing to pay the extra price compared to the younger consumers. Respondents, especially the younger participants, disagreed with the statement “‘healthy foods’ are less delicious” in general.

The questionnaire also contained lifestyle-related multiple-choice questions, which allowed further differentiation of the age groups (**Table 11**).

**Table 11.** Health-related lifestyle patterns in different age groups.

Lifestyle patterns	18-29	30-39	40-59	>60	Total Sample	p-value
Feel healthy in general	67.05	57.23	57.85	59.72	59.96	0.184
Want to lose weight, and do something about this	38.07	39.76	44.77	41.13	41.63	0.461
Exercise regularly	48.30	43.03	35.17	30.85	37.64	*0.001
Have a stressful lifestyle	36.93	49.40	43.60	18.37	36.02	*<0.001
Inadequate sleep	31.82	40.96	39.53	23.67	33.75	*<0.001
Do not exercise enough	32.39	34.34	38.19	24.82	32.57	*0.005
Pay more attention to diet than average	22.73	34.34	28.78	33.57	30.03	*0.049
Use dietary supplements	22.16	28.92	27.33	24.03	25.70	0.400
Can spend only a short time on eating and cooking	33.52	25.90	19.19	6.01	19.09	*<0.001
Smoke every day	20.45	21.08	16.57	6.71	15.17	*<0.001

(Percentages, \*p < 0.05).

Significant differences between age groups were not observed in terms of self-estimation of health, the need for weight loss and the use of dietary supplements. Younger respondents exercise more often, although they still tend to think it is below the required level. Stressful lifestyle and inadequate sleep were the most common problems reported by the middle-aged groups. Older adults rarely smoke and this group spend more time on eating and cooking than the younger respondents. Consumers between 30 and 39 years and over 60 years state that they pay more attention to diet compared to the average.

Special dietary needs listed in **Table 12**.

**Table 12.** Special dietary needs in different age groups.

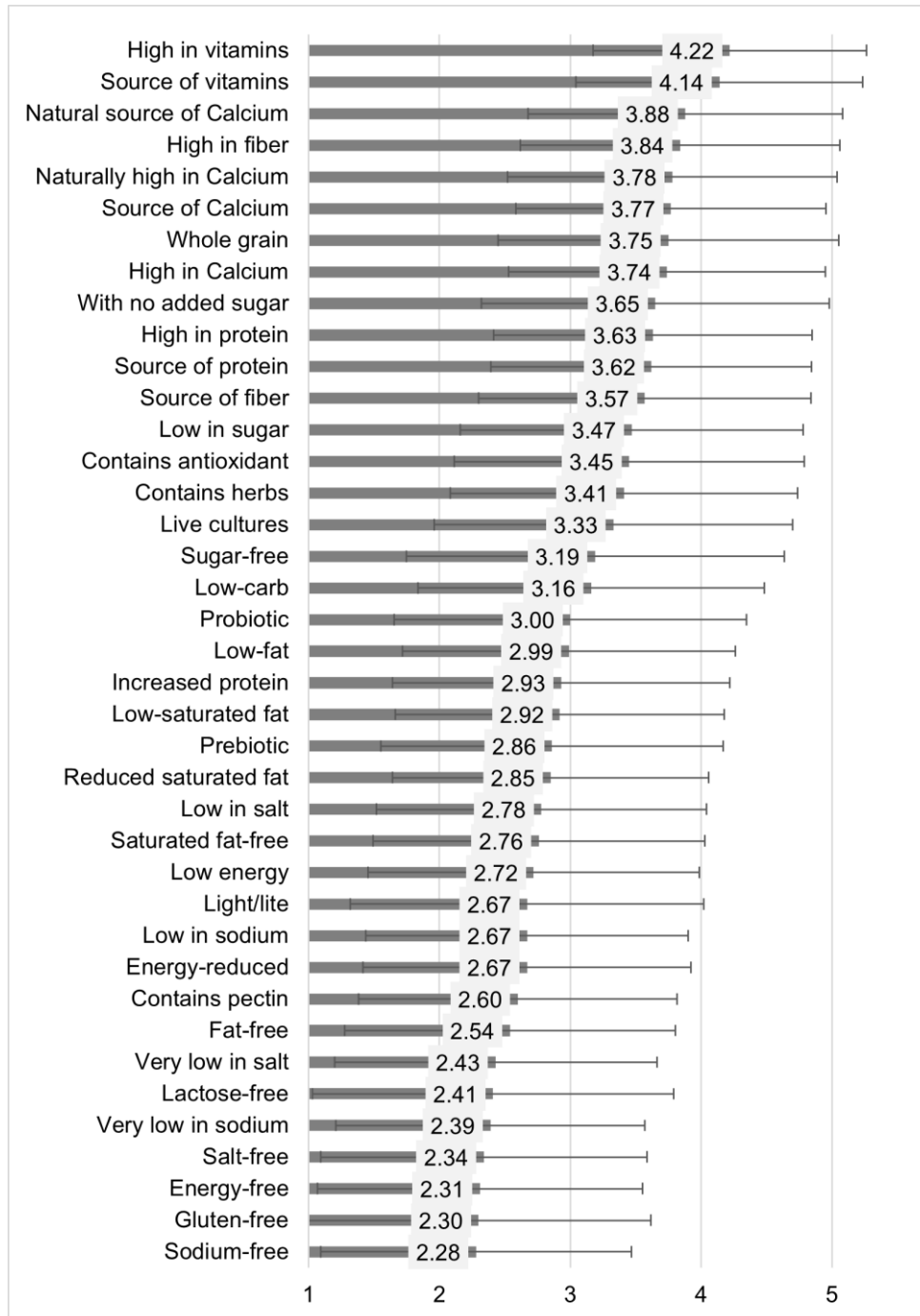
<b>Special dietary needs (cause)</b>	<b>18-29</b>	<b>30-39</b>	<b>40-59</b>	<b>&gt;60</b>	<b>Total sample</b>	<b>p-value</b>
No special dietary needs	34.71	37.80	37.61	35.56	36.46	0.875
Want to lose weight	18.82	20.12	27.76	25.00	24.03	0.086
High blood pressure	1.76	9.82	17.56	31.43	17.49	*<0.001
Want to be fit	30.00	26.83	14.29	5.00	16.53	*<0.001
Diabetes	3.33	2.44	11.31	16.07	9.47	*<0.001
Milk protein allergy	9.41	7.32	6.85	5.36	6.95	0.435
Follow a trending diet	2.35	3.05	2.98	2.14	2.63	0.901
Celiac disease	4.12	3.05	1.79	1.07	2.21	0.148
Vegan/vegetarian	2.94	0.61	2.08	1.07	1.68	0.293

(Percentages, \*p < 0.05).

High blood pressure and diabetes were identified as a cause of special dietary needs more often in case of older individuals, while 'want to be fit' was more frequent among younger consumers. Higher proportion of older adults marked 'want to lose weight' as a reason for following special diet, however, the difference was not significant. Significant differences between age groups were not found in terms of milk protein allergy, 'follow a trending diet', celiac disease and vegan/vegetarian diets.

### 5.1.3. Nutrition claims

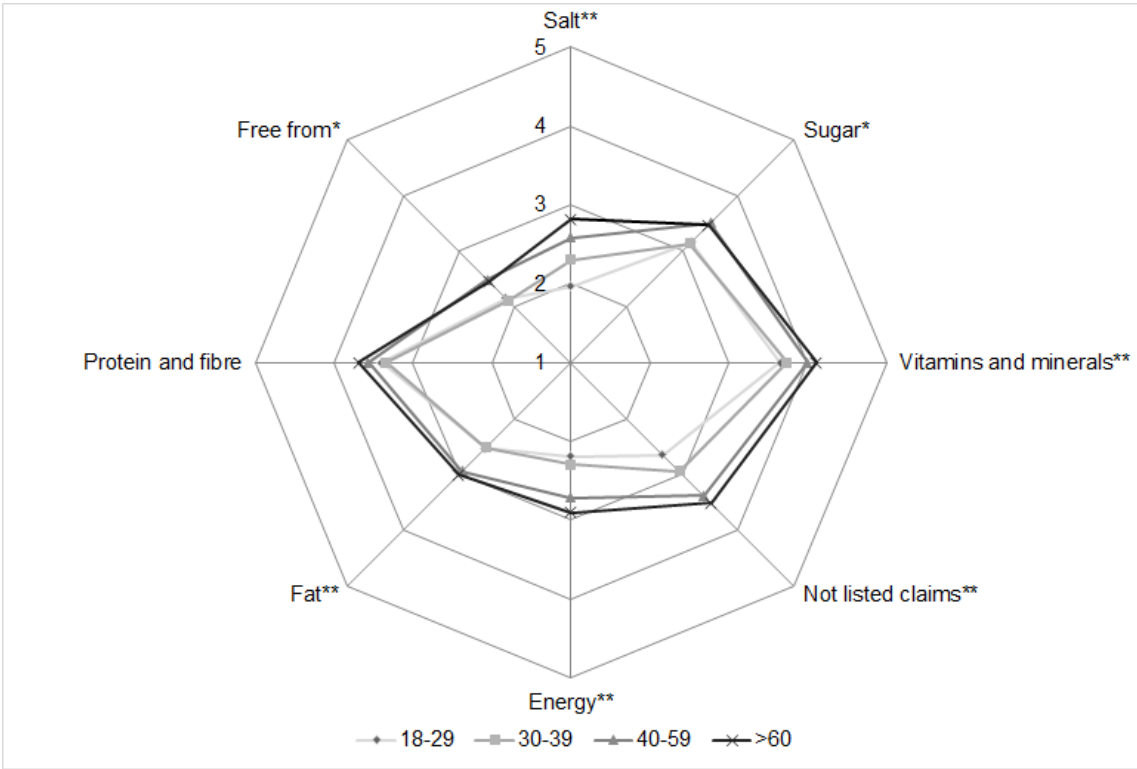
Respondents expressed their opinion on 1-5 Likert scale about their preference of the listed nutrition claims shown in **Figure 8**.



**Figure 8.** Preference of nutrition claims on food (mean values and SD, 1-5 Likert scale).

In general, nutrition claims related to vitamins and minerals received the highest preference scores. Protein, fibre and sugar content also seem to be important for the respondents. Claims related to fat content, energy and salt can typically be found in the middle section of the list. Lactose-free and gluten-free claims were at the bottom of the list. In terms of salt and sodium, the former one is more preferred by the consumers, although both terms indicate the same nutritional element.

**Figure 9** shows the differences between age groups in regard to the nutrition claims categories composed with PCA.

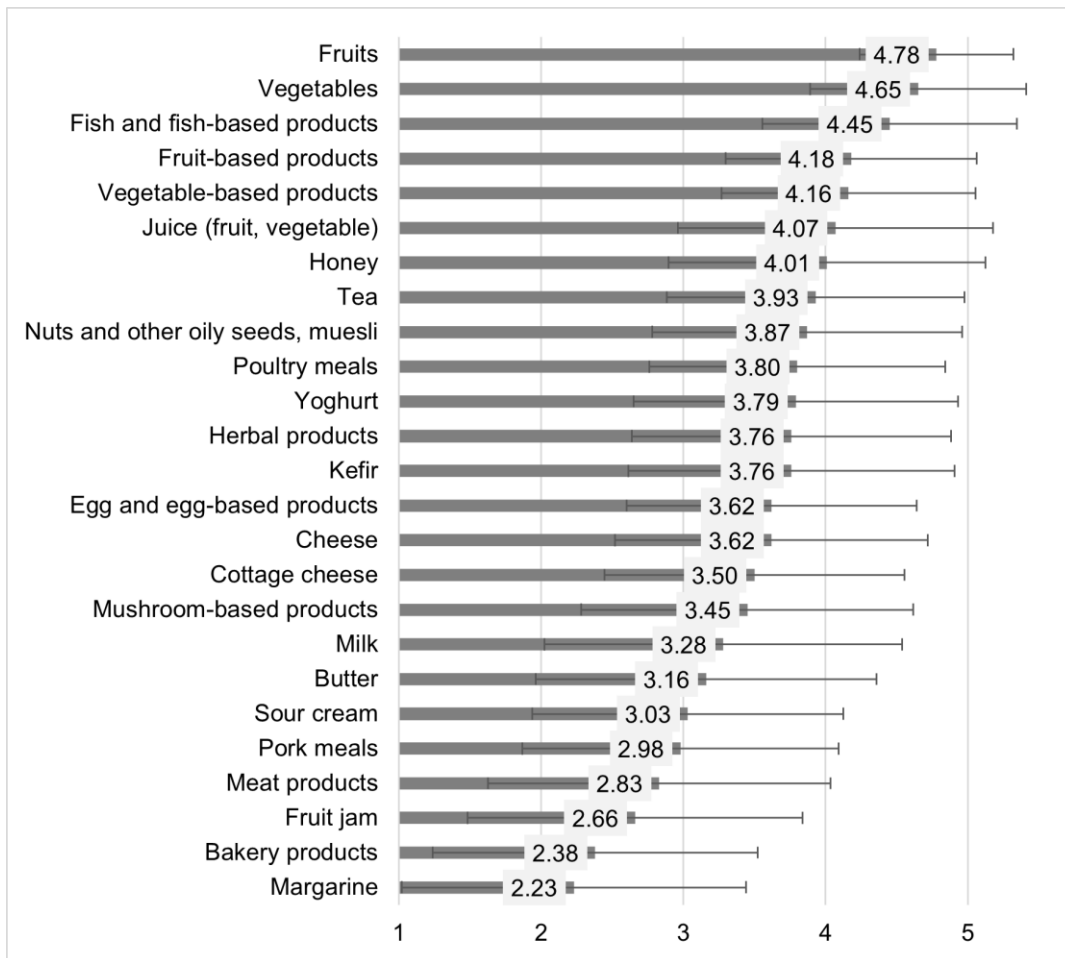


**Figure 9.** Preference of nutrition claims categories composed with PCA between different age groups (mean values, 1-5 Likert scale; \*p < 0.05; \*\*p < 0.01).

Differences between preferences of age groups were significant in all cases, except nutrition claims related to 'protein and fibre'. Respondents over 60 years typically have stronger preferences for the listed claims than the younger age groups.

#### 5.1.4. Carrier foods

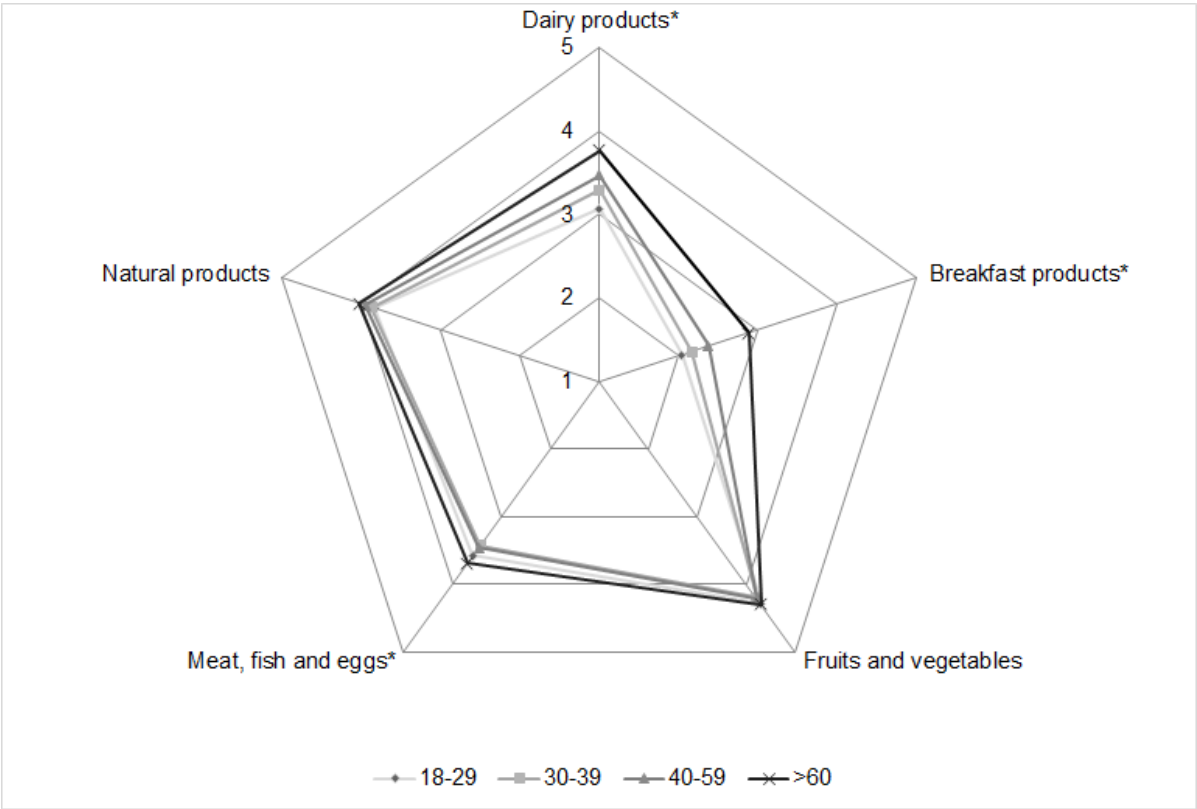
During data collection, respondents could express their health-related preference about twenty-five types of foods on 1-5 Likert scale (**Figure 10**).



**Figure 10.** Preferences of different food carriers (mean values and SD, 1-5 Likert scale).

Eating fruits and vegetables is the best way for keeping a healthy diet according to the respondents, followed by fish and fish-based products, fruit-based products, vegetable-based products, juices and honey. Tea; nuts and other oily seeds, muesli; poultry meals; yoghurt; herbal products; kefir; egg and egg-based products; cheese; cottage cheese; mushroom-based products; milk; butter and sour-cream were in the middle of the preference list. The least preferred carrier categories in terms of healthiness were pork meals, meat products, fruit jam, bakery products and margarine.

**Figure 11** shows the differences between age groups connected to carrier categories composed with PCA.



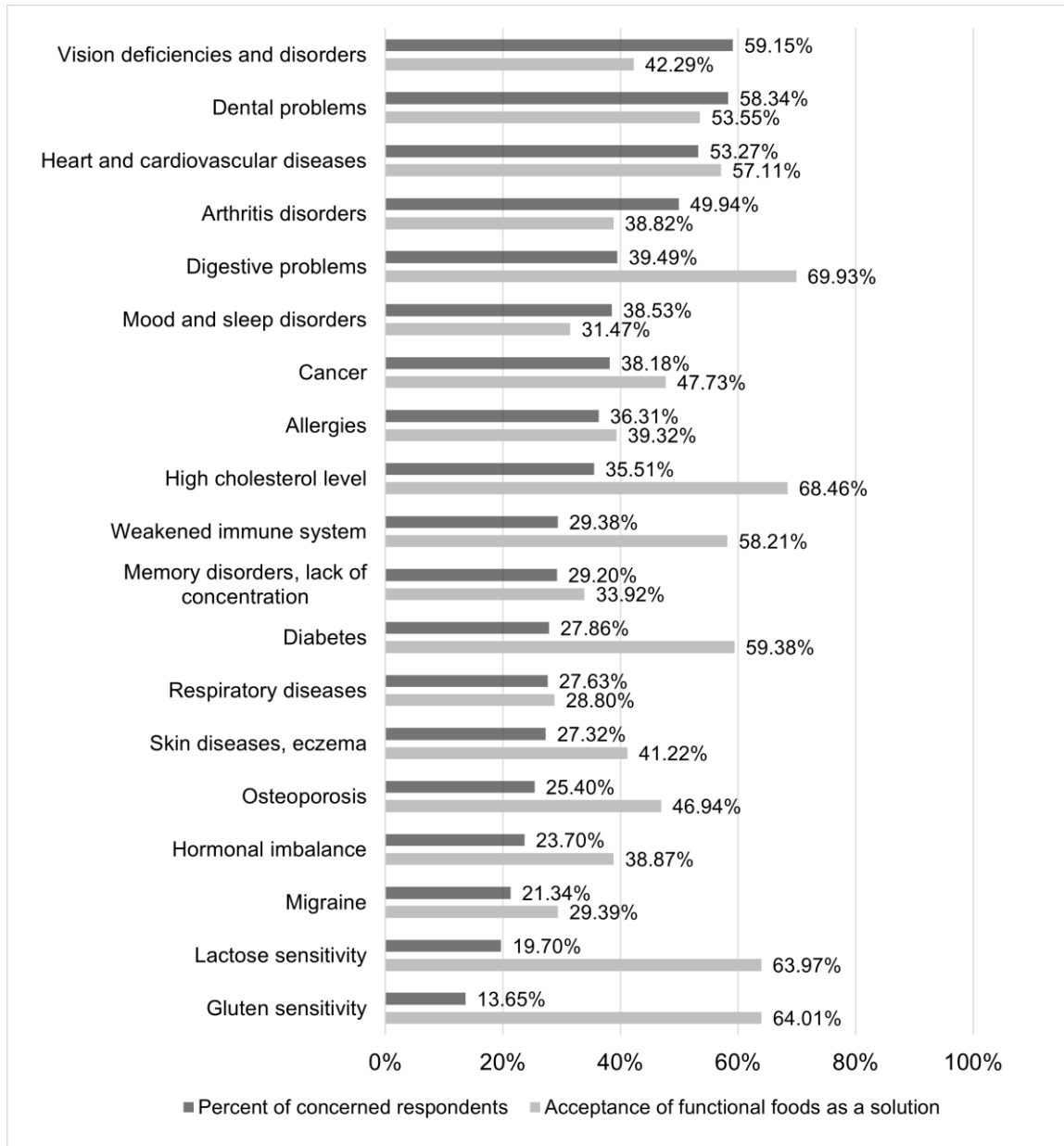
**Figure 11.** Preference of food carrier categories composed with PCA between different age groups (mean values, 1-5 Likert scale; \* p < 0.05).

Differences between preferences of age groups were significant in cases of dairy products; breakfast products; and meat, fish and eggs. Older adults preferred these products to a greater extent than other age groups. Fruits and vegetables and natural products were fairly important for all age groups.



### 5.1.5. Health concerns and acceptance of functional foods for disease prevention

The main health problems people were most concerned about compared to the acceptance of functional foods for disease prevention and mitigation are shown in **Figure 12**.



**Figure 12.** Consumer concerns in regard to certain health problems and the perceived suitability of functional foods to prevent or mitigate these problems (%).

According to the results, the Hungarian population is mainly concerned about the following health problems: vision deficiencies and disorders, dental problems, heart and cardiovascular diseases and arthritis disorders. Results also highlight that diets containing functional foods for the mitigation and prevention of health problems were mainly related to digestive problems, high cholesterol level, lactose sensitivity and gluten sensitivity.

Our study found that the age of the respondents was a significant factor in the concern in regard to several health problems, as shown in **Table 13**.

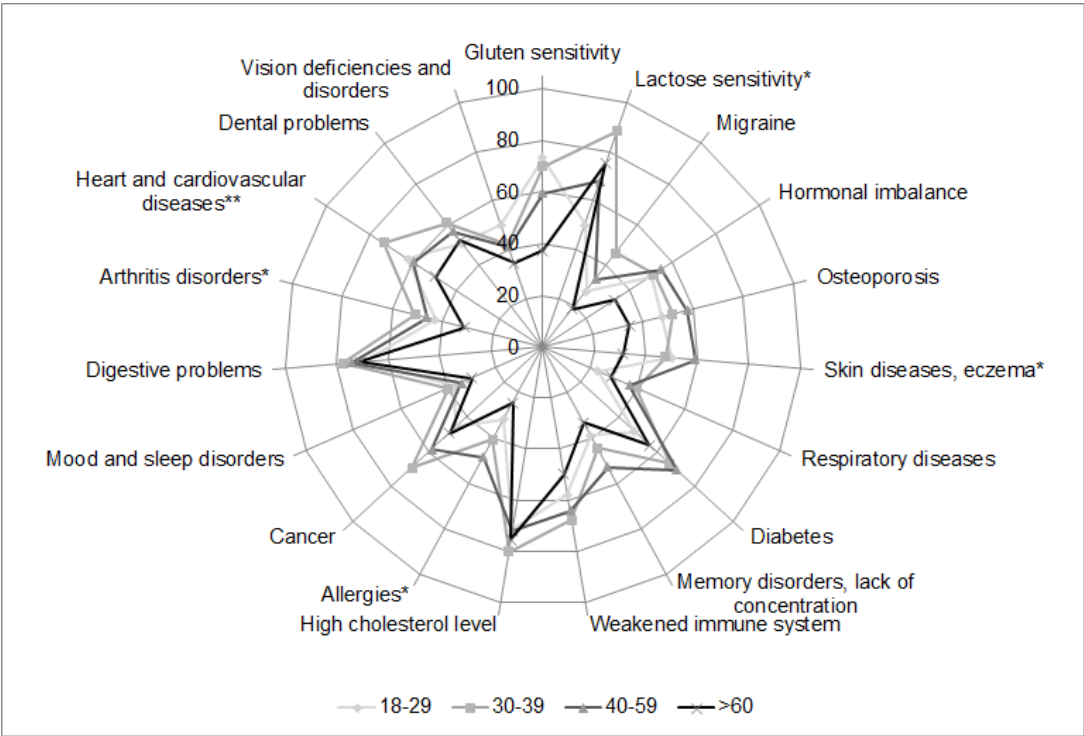
**Table 13.** Particular health concerns in different age groups.

Health problem	18-29	30-39	40-59	>60	p-value
Vision deficiencies and disorders	46.06	43.04	64.57	72.97	*<0.001
Dental problems	40.85	57.86	65.91	61.21	*<0.001
Heart and cardiovascular diseases	27.53	45.24	48.86	54.93	*<0.001
Arthritis disorders	27.11	37.34	53.97	69.70	*<0.001
Digestive problems	29.45	35.67	45.00	42.36	*0.006
High cholesterol level	19.88	31.45	34.56	51.60	*<0.001
Memory disorders, lack of concentration	23.49	26.42	28.19	38.02	*0.014
Diabetes	17.58	26.58	29.77	34.50	*0.003
Osteoporosis	13.25	20.13	27.65	36.79	*<0.001
Migraine	22.42	25.16	24.91	10.86	*0.002

(Percentages, \*p < 0.05).

In the vast majority of cases where significant differences were detected, older adults were more concerned about the certain health problems. The only exception is migraine, which seems that younger people are more concerned about.

**Figure 13** shows the proportion of concerned consumers in the age groups who would accept food as a solution to prevent and/or mitigate the particular health problem.



**Figure 13.** Proportion of concerned consumers in the age groups who accept food as a solution to prevent and/or mitigate a particular health problem (mean values, 1-5 Likert scale; \* p < 0.05; \*\* p < 0.01).

Significant differences were found between age groups about the level of concern in the case of heart and cardiovascular diseases, arthritis disorders, allergies, skin diseases and eczema and lactose sensitivity. In the majority of these cases, older adults were characterised by a lower level of acceptance than the younger ones. In general, concerned young adults and middle-aged adults show the highest level of acceptance of functional food products: younger adults particularly accept these in case of heart and cardiovascular diseases and lactose sensitivity, while middle-aged adults would prefer functional food to prevent/mitigate the effect of skin diseases and eczema and allergies.

### 5.1.6. Factors influencing purchase decision

In the context of functional food preferences, the possible value-added characteristics of functional food products were also analysed. It gives an opportunity to identify further consumer expectations about 'healthy food' products. Results about consumer perceptions are presented in **Table 14**.

**Table 14.** Preference of certain product parameters in regard to 'healthy foods' in different age groups.

'Healthy' product parameters	18-29	30-39	40-59	>60	Total Sample	p-value
Non-GMO	3.41	4.04	4.12	4.30	4.03	*<0.001
Safety according to the National Food Chain Safety Office	3.58	3.95	3.99	4.31	4.01	*<0.001
Domestic product	3.24	3.86	3.85	4.21	3.85	*<0.001
Small-scale production	3.06	3.71	3.92	4.05	3.77	*<0.001
Animal welfare considerations	3.51	3.77	3.73	3.83	3.73	0.143
Trademark	3.13	3.59	3.71	4.00	3.67	*<0.001
Produced by a well-known manufacturer	3.30	3.40	3.52	3.94	3.58	*<0.001
Traditional product	2.87	3.43	3.64	3.87	3.53	*<0.001
Organic product	3.08	3.29	3.61	3.65	3.47	*<0.001
Developed by domestic researchers	2.77	3.20	3.30	3.79	3.33	*<0.001
Produced with modern technology	2.52	2.69	2.95	3.29	2.93	*<0.001

(Mean values, 1-5 Likert scale, \*p < 0.05).

According to the preference of the consumers, non-GMO status, food safety, domestic origin and small-scale production were the most prominent product parameters. Animal welfare considerations, trademark, well-known manufacturer and being traditional were in the middle of the list, while organic status, developed by domestic researchers and production with modern technologies were at the end of the preference list. Except in the case of animal welfare, differences between age groups were proven to be significant.

The respondents also reported their preference for shop types, which is presented according to different age groups in **Table 15**.

**Table 15.** Preferred shop types in different age groups.

Shop types	18-29	30-39	40-59	>60	Total sample	p-value
Large stores (supermarket, hypermarket)	4.41	4.18	4.04	4.03	4.13	*0.004
Small grocery store	2.84	2.93	3.20	3.52	3.18	*<0.001
Directly from producer (e.g. market)	3.11	2.89	2.96	2.95	2.97	0.397
I produce it myself or I receive it as a gift	2.14	2.38	2.42	2.47	2.37	*0.180
Online shop	1.46	1.52	1.44	1.33	1.43	*0.003

(Mean values, 1-5 Likert scale, \*p < 0.05).

The most preferred shop types were large stores followed by small grocery stores. The former was significantly more preferred by the younger consumers, while the latter by older adults. Shopping directly from the producer and own production were less typical for all of the age groups. Online food purchasing was infrequent in the sample, however, younger consumers were significantly more open for this opportunity.

Respondents could express their preference for certain communication channels to get information about nutrition, the results of which are presented in **Table 16**.

**Table 16.** Preference of certain communication channels related to nutrition in different age groups.

Communication channels	18-29	30-39	40-59	>60	Total sample	p-value
News sites, websites, blogs	3.90	4.02	3.87	3.48	3.80	*0.001
Family, relatives, friends	3.42	3.30	3.32	3.62	3.42	*0.015
Social media	3.39	3.51	3.05	2.92	3.18	*<0.001
Television	2.32	2.60	3.09	3.51	2.97	*<0.001
Printed press, magazines	2.25	2.69	2.97	3.18	2.83	*<0.001
Radio	1.88	2.09	2.45	3.08	2.43	*<0.001
School, university, other education	2.73	2.37	2.37	2.22	2.41	*0.006

(Mean values, 1-5 Likert scale, \*p < 0.05).

Major communication channels were news sites, websites, blogs; family, relatives, friends; and social media, while television; printed press and magazines; radio; and school, university and other education were less prominent communication channels for Hungarian consumers in regard to nutrition. Significant differences were found between the segments for all of the listed communication channels. For older adults ‘family, relatives, friends’, television, ‘printed press, magazines’ and radio were more important. In contrast, younger respondents rather preferred ‘news sites, websites, blogs’, social media, ‘school, university, other education’.

Food-related questions were included in the survey to test consumer knowledge, presented in **Table 17**.

**Table 17.** Consumer knowledge based on several food-related questions in different age groups.

Knowledge questions	18-29	30-39	40-59	>60	Total sample	p-value
If a product contains bacteria, it is no longer safe	90.23	93.87	90.38	77.12	87.17	*<0.001
Natural/organic foods are risk-free	83.91	76.88	62.69	47.96	64.84	*<0.001
Traditional foods are ‘gene-free’	71.51	66.67	54.71	43.35	56.66	*<0.001
The characteristic taste of long-life milk is due to the preservative it contains	57.80	50.92	54.35	46.59	52.20	0.101
Canned foods contain preservatives	14.45	16.46	16.91	8.24	13.85	*0.012

(Percentage of correct answers, \*p < 0.05).

The vast majority of the respondents were aware that bacteria in food did not necessarily pose food safety risk. More than half of the respondents were informed about that natural/organic status of foods does not equal to a food safety guarantee. Slightly more than half of the respondents had appropriate knowledge about that traditional foods also contain genes and knew that long-life milk does not contain preservatives. Meanwhile, only 14% of the Hungarian consumers were aware that canned foods do not contain preservatives. In Hungarian the term used for canned food is ‘konzerv’, which might resemble conservation by chemical agents. Significant differences between knowledge of age groups were identified except in the case of preservative content of milk. In all cases, younger respondents had a higher level of knowledge.

## 5.2. Segmentation between older adults

### 5.2.1. Composed segments

To explore heterogeneity among older adults, hierarchical clustering was performed based on the mean values of the six constructs resulting from the PCA as segmentation variables. Based on the examination of the agglomeration schedule and the increase in agglomeration coefficient, a three-cluster solution was deemed to be optimal (Hair et al., 2014). **Table 18** shows mean ratings of segmentation variables and the sizes of the segments, as a result of K-means cluster analysis.

**Table 18.** Mean ratings of the segmentation variables.

Nutrition claims factors	Segment 1	Segment 2	Segment 3	Total sample	F-value	p-value
Size (N and %)	295 (32.89)	418 (46.60)	184 (20.51)			
Minerals	<sup>a</sup> 4.62	<sup>b</sup> 4.24	<sup>c</sup> 3.02	4.10	188.24	*<0.001
Protein and fibre	<sup>a</sup> 4.55	<sup>b</sup> 3.97	<sup>c</sup> 2.71	3.90	310.54	*<0.001
Sugar	<sup>a</sup> 4.61	<sup>b</sup> 3.56	<sup>c</sup> 2.12	3.61	506.63	*<0.001
Saturated fat	<sup>a</sup> 4.33	<sup>b</sup> 2.99	<sup>c</sup> 1.86	3.16	588.28	*<0.001
Energy	<sup>a</sup> 3.90	<sup>b</sup> 2.82	<sup>c</sup> 1.75	2.93	331.19	*<0.001
Salt	<sup>a</sup> 3.80	<sup>b</sup> 2.66	<sup>c</sup> 1.62	2.80	451.37	*<0.001
Segment name	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic			

(Mean values, 1-5 Likert scale, \*p < 0.05; different superscripts (a-c) indicate significant differences in means between segments found by the Tukey post hoc tests).

Segment 1 (32.89% of the sample) is constituted by participants who showed the highest level of preference about all of the composed nutrition claims factors. Therefore, this thesis refers to this segment as 'nutrition-oriented'.

Segment 2 (46.60% of the sample) is the largest consumer group, composed of respondents who preferred the nutrition claims on a moderate level. In case of claims connected to added nutritional value (minerals, protein and fibre), the mean scores were higher than the average of the total sample, while in case of claims about lower nutritional content (sugar, saturated fat, energy, salt), the mean scores were lower than the average. Based on these characteristics, this thesis refers to this segment as 'added nutritional value oriented'.

Segment 3 (20.51% of the sample) is the smallest consumer group, comprised of participants who preferred nutrition claims the least, thus this segment is called 'nutrition sceptic' in this thesis.

### 5.2.2. Profiling segments based on health-related questions

Differences between segments in health concerns presented in **Table 19**.

**Table 19.** Profiling segments based on health concerns.

	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
Heart and cardiovascular diseases	58.06	57.14	50.00	56.98	0.235
Vision deficiencies and disorders	52.79	57.23	51.00	54.52	0.357
Arthritis disorders	58.51	55.15	45.86	54.29	*0.042
Dental problems	41.85	47.94	49.35	46.32	0.253
High cholesterol level	48.03	41.76	33.33	41.97	*0.017
Digestive problems	37.93	42.02	30.20	38.19	*0.048
Osteoporosis	34.98	34.37	29.73	33.57	0.525
Mood and sleep disorders	33.18	25.40	34.01	29.73	0.069
Cancer	28.90	30.84	26.39	29.28	0.614
Memory disorders, lack of concentration	23.72	30.12	26.39	27.31	0.254
Diabetes	34.36	23.75	16.22	25.61	*<0.001
Allergies	20.48	22.15	19.44	21.03	0.783
Respiratory diseases	19.62	21.86	19.44	20.63	0.762
Weakened immune system	19.71	20.52	17.36	19.58	0.731
Skin diseases, eczema	13.53	19.56	16.67	17.07	0.198
Hormonal imbalance	12.87	18.24	11.89	15.18	0.118
Lactose sensitivity	18.14	14.33	9.59	14.52	0.077
Migraine	13.73	8.55	10.42	10.58	0.178
Gluten sensitivity	12.44	7.74	4.83	8.58	*0.033

(Percentages, \*p < 0.05).

Significant differences were detected among the segments in case of arthritis disorders, high cholesterol level, digestive problems, diabetes and gluten sensitivity based on their health concerns. Older adults in the 'nutrition-oriented' segment were concerned at the highest rate in each of the cases, except in the case of digestive problems, where the 'added nutritional value oriented' segment demonstrated higher level of concerns. Consumers in the 'nutritional sceptic' group were the least concerned by the listed health problems.

**Table 20** shows the differences between segments on acceptance of functional foods as a solution for disease prevention and mitigation.

**Table 20.** Profiling segments based on acceptance of functional foods as a solution for disease prevention and mitigation.

	<b>Nutrition-oriented</b>	<b>Added nutritional value oriented</b>	<b>Nutrition sceptic</b>	<b>Total sample</b>	<b>p-value</b>
Heart and cardiovascular diseases	63.79	61.90	49.30	60.00	*0.013
Vision deficiencies and disorders	36.72	32.72	28.21	33.04	0.311
Arthritis disorders	43.13	40.39	37.78	40.74	0.605
Dental problems	47.53	43.02	31.62	41.90	*0.026
High cholesterol level	68.78	74.91	64.80	70.80	0.086
Digestive problems	75.53	69.40	50.40	67.34	*<0.001
Osteoporosis	47.85	49.26	42.86	47.48	0.503
Mood and sleep disorders	29.31	32.05	26.02	29.86	0.476
Cancer	45.05	44.53	40.68	43.89	0.727
Memory disorders, lack of concentration	34.15	31.52	26.05	31.11	0.342
Diabetes	63.19	54.79	51.75	56.91	0.098
Allergies	35.44	36.65	27.27	34.30	0.210
Respiratory diseases	25.61	24.07	18.80	23.37	0.389
Weakened immune system	46.25	51.01	40.54	47.30	0.176
Skin diseases, eczema	32.72	34.29	27.59	32.31	0.442
Hormonal imbalance	33.11	29.71	25.69	29.86	0.434
Lactose sensitivity	58.39	55.10	44.55	53.88	0.070
Migraine	20.13	24.58	14.68	21.04	0.105
Gluten sensitivity	56.69	55.13	44.44	53.31	0.109

(Percentages, \*p < 0.05).

Significant differences about acceptance of functional foods as solution to risk prevention and mitigation were observed only in few cases. For heart and cardiovascular diseases, dental problems and digestive problems, the results followed the same trend. The ‘nutrition-oriented’ segment had the highest rate of acceptance, followed by the ‘added nutritional value oriented’ segment, while the ‘nutrition sceptic’ consumer group was characterised by the lowest level of acceptance.

Health-related lifestyle patterns were also analysed for the three segments, the results of which is detailed in **Table 21**.



**Table 21.** Profiling segments based on health-related lifestyle patterns.

Lifestyle patterns	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
Feel healthy in general	51.58	61.01	59.77	57.61	0.400
Want to lose weight, and do something about this	53.33	45.18	29.31	44.67	*<0.001
Pay more attention to diet than average	44.21	33.67	22.99	35.01	*<0.001
Exercise regularly	28.42	28.35	31.21	28.96	0.764
Do not exercise enough	28.77	29.95	27.01	28.96	0.774
Use dietary supplements	27.37	29.87	23.70	27.78	0.313
Do not sleep enough	29.12	22.53	28.16	25.88	0.114
Have a stressful lifestyle	20.70	18.48	19.65	19.46	0.769
Smoke every day	4.91	7.09	15.03	7.97	*<0.001
Can spend only a short time with eating and cooking	6.67	5.82	9.25	6.80	0.326

(Percentages, \*p < 0.05).

Only less than 60% percent of the respondents reported that they felt healthy in general. The differences were not significant, however, it can be said that the 'nutrition-oriented' segment feels the least healthy. Significant differences were found in terms of agreement with 'I want to lose weight, and I do something about this' and 'I pay more attention to my diet than average' options. In both cases, the statements were the most characteristic of the 'nutrition-oriented' segment, followed by the 'added nutrition value oriented', and 'nutrition sceptic' group. The 'added nutrition value oriented' segment use dietary supplements the most frequently, although the difference was not significant. The 'nutrition sceptic' group smoke significantly more than the other two groups.

Apart from lifestyle patterns, the survey also covered special dietary needs. **Table 22** presents segments profiling according to these.

**Table 22.** Profiling segments based on special dietary needs.

Special dietary needs (cause)	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
No special dietary needs	28.83	34.11	48.82	35.38	*<0.001
High blood pressure	34.67	35.14	15.88	31.05	*<0.001
Want to lose weight	34.67	25.84	18.24	27.20	*0.001
Follow a trending diet	5.47	1.55	0.00	19.46	*<0.001
Diabetes	22.63	12.14	5.88	14.32	*<0.001
Want to be fit	8.76	5.43	6.47	6.74	0.239
Milk protein allergy	6.93	4.90	4.12	5.42	0.370
Vegan/vegetarian	1.46	1.81	1.76	1.68	0.939
Celiac disease	2.19	0.78	1.76	1.44	0.300

(Percentages, \*p < 0.05).

The 'nutrition sceptic' segment reported in the highest rate that they did not have special dietary needs. In case of the following causes, significant differences were detected between the segments: high blood pressure, want to lose weight, follow a diet trend and diabetes. In all of these cases, the 'nutrition oriented' segment reported special dietary needs in the highest rate, except for high blood pressure, where the proportion of concerned consumers was the same as in the 'added nutritional value oriented' segment.

### 5.2.3. Carrier types and other factors influencing purchase decision

In the vast majority of the cases, significant differences were observed between the three consumer segments in terms of preference of carrier food categories (**Table 23**).

**Table 23.** Profiling segments based on preference of carrier food categories.

Carrier types	Nutrition -oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
Fruits	<sup>a</sup> 4.94	<sup>a</sup> 4.87	<sup>b</sup> 4.71	4.86	*<0.001
Vegetables	<sup>a</sup> 4.75	<sup>a</sup> 4.63	<sup>b</sup> 4.17	4.57	*<0.001
Fish and fish-based products	<sup>a</sup> 4.64	<sup>b</sup> 4.34	<sup>c</sup> 4.04	4.37	*<0.001
Vegetable-based products	<sup>a</sup> 4.64	<sup>b</sup> 4.28	<sup>c</sup> 3.85	4.30	*<0.001
Fruit-based products	<sup>a</sup> 4.53	<sup>b</sup> 4.32	<sup>c</sup> 3.79	4.27	*<0.001
Yoghurt	<sup>a</sup> 4.41	<sup>b</sup> 4.21	<sup>c</sup> 3.82	4.19	*<0.001
Honey	<sup>a</sup> 4.29	4.16	<sup>b</sup> 4.05	4.18	*<0.001
Juice (fruit, vegetable)	<sup>a</sup> 4.35	<sup>a</sup> 4.22	<sup>b</sup> 3.69	4.15	*<0.001
Tea	<sup>a</sup> 4.28	<sup>a</sup> 4.12	<sup>b</sup> 3.63	4.07	*<0.001
Cheese	<sup>a</sup> 4.19	<sup>b</sup> 3.95	<sup>b</sup> 3.92	4.03	*0.008
Kefir	<sup>a</sup> 4.33	<sup>b</sup> 4.00	<sup>c</sup> 3.61	4.03	*<0.001
Poultry meals	<sup>a</sup> 4.35	<sup>b</sup> 3.96	<sup>c</sup> 3.60	4.01	*<0.001
Nuts and other oily seeds, muesli	<sup>a</sup> 4.35	<sup>b</sup> 4.02	<sup>c</sup> 3.46	4.01	*<0.001
Cottage cheese	<sup>a</sup> 4.09	<sup>b</sup> 3.82	<sup>c</sup> 3.58	3.85	*<0.001
Egg and egg-based products	<sup>a</sup> 3.94	<sup>a</sup> 3.88	<sup>b</sup> 3.58	3.83	*<0.001
Herbal products	<sup>a</sup> 4.21	<sup>b</sup> 3.88	<sup>c</sup> 3.14	3.83	*<0.001
Mushroom-based products	<sup>a</sup> 3.97	<sup>b</sup> 3.67	<sup>c</sup> 3.28	3.68	*<0.001
Butter	3.73	3.56	3.51	3.61	0.109
Milk	<sup>a</sup> 3.66	3.50	<sup>b</sup> 3.24	3.50	0.088
Sour cream	<sup>a</sup> 3.61	<sup>b</sup> 3.38	<sup>b</sup> 3.18	3.41	*<0.001
Pork meals	3.06	3.20	3.25	3.17	0.150
Fruit jam	3.14	3.20	3.06	3.16	0.435
Bakery products	2.97	3.00	2.92	2.98	0.721
Meat products	2.86	3.01	3.02	2.97	0.220
Margarine	<sup>a</sup> 2.87	<sup>b</sup> 2.60	<sup>c</sup> 2.30	2.61	*<0.001

(Mean values, 1-5 Likert scale, \*p < 0.05; different superscripts (a-c) indicate significant differences in means between segments found by the Tukey post hoc tests).

According to the mean values of the total sample, fruits, vegetables, fish and fish-based products, vegetable-based products, fruit-based products and yogurt were at the top of the preference list. When there is a significant difference between the groups, the 'nutrition-oriented' segment has the highest preference in each case. The 'added nutritional value oriented' segment can be characterised by lower preference levels. However, mean values were not significantly differed from the 'nutrition-oriented' segment in case of fruits, vegetables, juice, tea, egg and egg-based products. For each food category where significant differences were observed, 'nutrition sceptic' segment had the lowest preferences. At the end of the list were pork meals, fruit jam, bakery products, meat products and margarine. No significant differences were observed in these carrier food categories, except in the case of margarine.

**Table 24** presents segments profiling based on further nutrition claims.

**Table 24.** Profiling segments based on further nutrition claims.

Further nutrition claims	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
High in vitamins	<sup>a</sup> 4.85	<sup>b</sup> 4.52	<sup>c</sup> 3.47	4.40	*<0.001
Source of vitamins	<sup>a</sup> 4.80	<sup>b</sup> 4.42	<sup>c</sup> 3.39	4.32	*<0.001
Whole grain	<sup>a</sup> 4.57	<sup>b</sup> 3.92	<sup>c</sup> 2.79	3.89	*<0.001
Contains antioxidant	<sup>a</sup> 4.41	<sup>b</sup> 3.89	<sup>c</sup> 2.57	3.75	*<0.001
Contains herbs	<sup>a</sup> 4.32	<sup>b</sup> 2.80	<sup>c</sup> 2.66	3.71	*<0.001
Live cultures	<sup>a</sup> 4.38	<sup>b</sup> 3.64	<sup>c</sup> 2.53	3.63	*<0.001
Low-carb	<sup>a</sup> 4.38	<sup>b</sup> 3.50	<sup>c</sup> 2.39	3.51	*<0.001
Low-fat	<sup>a</sup> 4.23	<sup>b</sup> 3.18	<sup>c</sup> 2.16	3.29	*<0.001
Probiotic	<sup>a</sup> 3.94	<sup>b</sup> 3.43	<sup>c</sup> 2.11	3.29	*<0.001
Prebiotic	<sup>a</sup> 3.87	<sup>b</sup> 3.27	<sup>c</sup> 2.02	3.17	*<0.001
Increased protein	<sup>a</sup> 3.63	<sup>b</sup> 3.03	<sup>c</sup> 2.05	2.99	*<0.001
Contains pectin	<sup>a</sup> 3.56	<sup>b</sup> 3.07	<sup>c</sup> 2.00	2.98	*<0.001
Light/lite	<sup>a</sup> 3.85	<sup>b</sup> 2.99	<sup>c</sup> 1.68	2.97	*<0.001
Fat-free	<sup>a</sup> 3.79	<sup>b</sup> 2.56	<sup>c</sup> 1.73	2.73	*<0.001
Lactose-free	<sup>a</sup> 3.24	<sup>b</sup> 2.54	<sup>c</sup> 1.69	2.57	*<0.001
Gluten-free	<sup>a</sup> 3.20	<sup>b</sup> 2.34	<sup>c</sup> 1.54	2.42	*<0.001

(Mean values, 1-5 Likert scale, \*p < 0.05; different superscripts (a-c) indicate significant differences in means between segments found by the Tukey post hoc tests).

Examination of preference of further nutrition claims (not listed by the Regulation (EC) No. 1924/2006 or omitted from the segmentation variables) validated the results described in the segmentation subsection. Differences were highly significant, and in all cases the 'nutrition-oriented' segment had the highest preference, followed by the 'added nutrition value oriented' group with the 'nutrition sceptic' segment at the end of the preference list.

The preference of the three segments was also inspected in the case of 'healthy' product parameters, as shown in **Table 25**.

**Table 25.** Profiling segments based on 'healthy' product parameters.

'Healthy' product parameters	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
Safety according to the National Food Chain Safety Office	<sup>a</sup> 4.68	<sup>b</sup> 4.41	<sup>c</sup> 3.86	4.38	*<0.001
Non-GMO	<sup>a</sup> 4.54	<sup>b</sup> 4.27	<sup>c</sup> 3.94	4.28	*<0.001
Domestic product	<sup>a</sup> 4.44	<sup>b</sup> 4.22	<sup>c</sup> 3.97	4.23	*<0.001
Small-scale production	<sup>a</sup> 4.35	<sup>b</sup> 4.03	<sup>c</sup> 3.64	4.04	*<0.001
Trademark	<sup>a</sup> 4.29	<sup>b</sup> 3.98	<sup>c</sup> 3.48	3.98	*<0.001
Produced by a well-known manufacturer	<sup>a</sup> 4.24	<sup>b</sup> 3.88	<sup>c</sup> 3.45	3.90	*<0.001
Traditional product	<sup>a</sup> 4.00	<sup>b</sup> 3.79	3.80	3.85	*0.023
Animal welfare considerations	<sup>a</sup> 4.25	<sup>b</sup> 3.88	<sup>c</sup> 3.21	3.85	*<0.001
Organic product	<sup>a</sup> 3.93	<sup>b</sup> 3.58	<sup>c</sup> 2.95	3.56	*<0.001
Produced with modern technology	<sup>a</sup> 3.48	<sup>a</sup> 3.29	<sup>b</sup> 2.61	3.19	*<0.001

(Mean values, 1-5 Likert scale, \*p < 0.05; different superscripts (a-c) indicate significant differences in means between segments found by the Tukey post hoc tests).

For the older adult consumers, food safety, non-GMO status, domestic origin and small-scale production were the most important product parameters, while production with modern technologies was at the end of the preference list. The same tendency was experienced in most of the cases: the 'nutrition-oriented' segment had a significantly higher preference for the 'healthy' product parameters, while the 'added nutritional value oriented' group also put these parameters in priority, compared to the 'nutritional sceptic' segment. Only two exceptions occurred. Traditional product attribute was equally preferred by the 'added nutritional value oriented' group and the 'nutrition sceptic' group. Besides, in case of the production with modern technology significantly different preference values were not observed between the 'nutrition-oriented' and the 'added nutritional value oriented' segments.

**Table 26** presents segments profiling based on the preference of different shop types.

**Table 26.** Profiling segments based on shop types.

Shop types	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
Large stores (supermarket, hypermarket)	4.11	3.97	3.89	4.00	0.109
Directly from the producer (e.g. farmers' market)	<sup>a</sup> 4.04	<sup>b</sup> 3.57	<sup>b</sup> 3.35	3.67	*<0.001
Small grocery stores	<sup>a</sup> 3.06	<sup>b</sup> 2.84	<sup>c</sup> 2.88	2.92	0.147
I produce it myself or receive it as a gift	<sup>a</sup> 2.85	<sup>b</sup> 2.41	<sup>b</sup> 2.27	2.50	*0.001
Online shop	1.47	1.31	1.35	1.36	0.168

(Mean values, 1-5 Likert scale, \*p < 0.05; different superscripts (a-c) indicate significant differences in means between segments found by the Tukey post hoc tests).

The most frequented shopping venues include the larger stores (supermarket, hypermarket), followed by purchasing directly from the producer (farmers' market). Significant difference between segments was identified only in the latter case: the 'nutrition-oriented' group shops the most frequently at farmers' markets.

Preference of communication channels, showcased in **Table 27**, were analysed as well for the three segments.

**Table 27.** Profiling segments based on communication channels.

Communication channels	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
Family, relatives, friends	<sup>a</sup> 3.90	<sup>b</sup> 3.49	<sup>b</sup> 3.39	3.59	*<0.001
News sites, websites, blogs	<sup>a</sup> 3.94	<sup>b</sup> 3.47	<sup>c</sup> 3.13	3.53	*<0.001
Television	<sup>a</sup> 3.77	<sup>b</sup> 3.40	<sup>b</sup> 3.19	3.47	*<0.001
Printed press, magazines	<sup>a</sup> 3.95	<sup>b</sup> 3.17	<sup>c</sup> 2.67	3.30	*<0.001
Social media	<sup>a</sup> 3.41	<sup>b</sup> 2.96	<sup>b</sup> 2.60	3.01	*0.001
Radio	<sup>a</sup> 3.31	<sup>b</sup> 2.92	<sup>b</sup> 2.69	2.97	*<0.001
School, university, other education	<sup>a</sup> 2.70	2.35	<sup>b</sup> 2.03	2.37	*0.003

(Mean values, 1-5 Likert scale, \*p < 0.05; different superscripts (a-c) indicate significant differences in means between segments found by the Tukey post hoc tests).

Major communication channels were 'family, relatives, friends', 'news sites, websites, blogs' and television. Significant differences were found between the segments in regard to all of the listed communication channels. The highest preference values were experienced among the 'nutrition-oriented' segment. The preference of the other two groups did not differ significantly in general, only in the case of 'news sites, websites, blogs' and 'printed press, magazines', where the 'added nutritional value oriented' group had higher preference values than the 'nutritional sceptic' segment.

**Table 28** shows the consumer knowledge based on several food-related questions.

**Table 28.** Profiling segments based on several food-related questions.

Knowledge questions	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
If a product contains bacteria, it is no longer safe	65.77	77.57	81.93	74.66	*<0.001
Natural/organic foods are risk-free	40.71	46.17	55.56	53.65	*0.013
Traditional foods are 'gene-free'	44.76	38.36	42.21	41.20	0.275
The characteristic taste of long-life milk is due to the preservative it contains	36.25	43.24	45.12	41.71	0.199
Canned foods contain preservatives	10.26	8.23	8.09	8.86	0.613

(Percentage of correct answers, \*p < 0.05).

Three-quarter of the respondents were aware that bacteria in food did not necessarily pose food safety risk. Slightly more than half of the respondents were informed that natural/organic status of foods did not equal to a food safety guarantee. Less than half of the respondents had appropriate knowledge about that traditional foods also contained genes and that long-life milk did not contain preservatives. Meanwhile, only 9% of the older consumers were aware that canned foods did not contain preservatives. Significant differences only occurred in case of 'If a product contains bacteria, it is no longer safe' statement, where the 'nutritional sceptic' group had the highest level of knowledge, followed by the 'added nutritional value oriented' segment, while 'nutritional-oriented' older consumers were at the end of the list.

#### **5.2.4. Attitudes and consumer habits towards nutrition**

Considering attitude related questions, the 'nutrition-oriented' segment can be characterised by the highest mean values about acceptance of the connection between nutrition and health (**Table 29**).

Significantly lower values were found in the 'nutrition sceptic' group. Findings were similar in case of questions related to dietary interest. During food purchasing, quality, domestic origin, nutritional composition of products and whether it is compliant with health-conscious diet were significantly more important for the 'nutrition-oriented' segment than for the other two consumer groups. No significant differences were indicated between the segments about the importance of the taste of food and the price of the products. Packaging and brand of the foodstuff were significantly more important aspects for the 'nutrition-oriented' and the 'added nutrition value oriented' groups than for the 'nutrition sceptic' segment. The 'nutrition-oriented' segment reported to consume no-carb, low-carb, sugar-free, lactose-free and gluten-free products more often than the other two consumer groups. Older adults responded that they mostly ate home-made dishes, while they rarely ate in a restaurant. The 'nutrition-oriented' and the 'added nutritional value oriented' segments considered 'healthier foods' to be more expensive, but they were more willing to pay the extra price than the 'nutrition sceptic' group. Senior consumers generally disagreed with the statement 'healthy foods are less delicious'.

**Table 29.** Profiling segments based on consumer attitudes.

<b>Variables</b>	<b>Nutrition-oriented</b>	<b>Added nutritional value oriented</b>	<b>Nutrition sceptic</b>	<b>Total sample</b>	<b>p-value</b>
<i>Nutrition and health</i>					
Nutrition has a direct impact on health	<sup>a</sup> 4.72	<sup>a</sup> 4.53	<sup>b</sup> 4.08	4.64	*<0.001
Healthy diet has a strong impact on the prevention of diseases at older adults	<sup>a</sup> 4.73	<sup>b</sup> 4.49	<sup>c</sup> 4.23	4.51	*<0.001
For older adults, diet has a more important role in health	<sup>a</sup> 4.66	<sup>b</sup> 4.47	<sup>c</sup> 4.23	4.49	*<0.001
<i>Dietary interest</i>					
Healthy diet is important for me	<sup>a</sup> 4.53	<sup>b</sup> 4.32	<sup>c</sup> 3.79	4.50	*<0.001
I am interested in healthy diet	<sup>a</sup> 4.72	<sup>b</sup> 4.44	<sup>c</sup> 3.87	4.41	*<0.001
I am interested in lifestyle-related scientific issues	<sup>a</sup> 4.26	<sup>b</sup> 4.00	<sup>c</sup> 3.28	3.93	*<0.001
I thoroughly read the label of products	<sup>a</sup> 4.11	<sup>b</sup> 3.81	<sup>c</sup> 3.24	3.80	*<0.001
I consciously choose brand and manufacturer when it comes to food	<sup>a</sup> 4.16	<sup>b</sup> 3.76	<sup>c</sup> 3.24	3.78	*<0.001
I constantly seek information and educate myself on food and nutrition	<sup>a</sup> 4.11	<sup>b</sup> 3.77	<sup>c</sup> 3.16	3.75	*<0.001
<i>Aspects in food purchase choices</i>					
Quality	<sup>a</sup> 4.62	<sup>b</sup> 4.45	<sup>c</sup> 4.19	4.45	*<0.001
Domestic origin	<sup>a</sup> 4.08	<sup>b</sup> 3.87	<sup>c</sup> 3.54	3.87	*<0.001
Nutritional composition	<sup>a</sup> 4.20	<sup>b</sup> 3.89	<sup>c</sup> 3.01	3.80	*<0.001
Compliance with health-conscious diet	<sup>a</sup> 4.19	<sup>b</sup> 3.79	<sup>c</sup> 3.09	3.77	*<0.001
Taste	3.46	3.43	3.54	3.46	0.534
Price	3.12	3.20	2.98	3.13	0.087
Packaging	<sup>a</sup> 2.35	<sup>a</sup> 2.22	<sup>b</sup> 1.84	2.18	*0.001
Brand	<sup>a</sup> 2.96	<sup>a</sup> 2.75	<sup>b</sup> 2.51	2.77	*<0.001
<i>Eating habits</i>					
Mostly eat home-made dishes	<sup>a</sup> 4.54	4.39	<sup>b</sup> 4.18	4.39	*0.008
Often consume low-carb or no-carb foods	<sup>a</sup> 3.59	<sup>b</sup> 2.90	<sup>c</sup> 2.08	2.95	*<0.001
Often consume sugar-free foods	<sup>a</sup> 3.41	<sup>b</sup> 2.80	<sup>c</sup> 1.93	2.82	*<0.001
Often consume lactose-free foods	<sup>a</sup> 2.38	<sup>b</sup> 2.07	<sup>c</sup> 1.56	2.06	*<0.001
Often consume gluten-free foods	<sup>a</sup> 2.31	<sup>b</sup> 1.89	<sup>c</sup> 1.47	1.93	*<0.001
Often eat in restaurant	1.88	1.83	1.89	1.85	0.777
<i>Consumer opinions about price and taste of functional foods</i>					
'Healthy foods' are more expensive	<sup>a</sup> 4.38	<sup>a</sup> 4.28	<sup>b</sup> 4.02	4.26	*0.001
I am willing to pay more for 'healthy foods'	<sup>a</sup> 4.28	<sup>b</sup> 4.05	<sup>c</sup> 3.63	4.04	*<0.001
'Healthy foods' are less delicious	2.60	2.66	2.43	2.60	0.170

(Mean values, 1-5 Likert scale, \*p < 0.05; different superscripts (a-c) indicate significant differences in means between segments found by the Tukey post hoc tests).

### 5.2.5. Profiling segments based on socio-demographic parameters

Based on the comparison of demographic parameters of the clusters, significant differences were found in the case of the sex and the BMI of the respondents (**Table 30**).

**Table 30.** Socio-demographic characteristics of the sample and profiling segments based on it.

Variable	Nutrition-oriented	Added nutritional value oriented	Nutrition sceptic	Total sample	p-value
Sex					*<0.001
Female	76.95	70.33	57.61	69.90	
Male	23.05	29.67	42.39	15.05	
Age groups					0.501
60-69	55.93	60.05	62.50	59.20	
70-79	38.64	34.45	34.24	35.79	
80 or above	5.42	5.50	3.26	5.02	
Location of residence					0.915
Capital city	34.03	31.08	30.39	31.90	
Another city	51.39	53.49	54.70	53.05	
Village	14.58	15.42	14.92	27.20	
Highest accomplished qualification					0.242
Primary and vocational school	9.97	8.11	9.44	8.98	
High school (graduated)	8.76	5.43	33.52	35.11	
Higher education	50.52	59.21	57.14	55.91	
Responsible for shopping					0.054
Respondents themselves	60.79	60.81	54.86	59.57	
Together with a family member	34.53	35.88	36.00	35.46	
Other person	4.68	3.31	9.14	4.96	
Income level (subjective estimation)					0.157
Below average	22.34	20.00	23.15	21.38	
Average	65.43	70.00	58.33	66.25	
Above average	12.23	10.00	18.51	12.37	
BMI					*0.044
Normal	28.10	31.73	39.63	32.09	
Overweight	51.82	44.16	43.29	46.51	
Obese	20.07	24.11	17.07	21.39	

(Percentages, \*p < 0.05).

The proportion of overweight respondents was the highest in the 'nutrition-oriented' group, while the proportion of obese respondents was the highest in the 'added nutritional value oriented' segment. Women could be found in the smallest proportion in the 'nutrition sceptic' segment. Although the difference was not significant, the highest proportion of respondents in the 'nutrition sceptic' group were those who were not responsible for shopping. As an unexpected finding, age, income level, education and location of residence did not differentiate the groups significantly.



## **6. Discussion**

### **6.1. Differences between older adults and other age groups**

This analysis aims to give an overall picture on the impact of age on consumer perceptions and expectations about the functionality of foods based on the nationwide representative consumer survey. Besides the description of significant differences between older adults and other age groups about health-related dietary attitudes and lifestyle patterns, the present study analyses the most important aspects of functionality of foods through quantification of consumer preferences. Thirty-eight nutrition claims and twenty-five carrier food types were categorised with PCA to identify the most prominent decision points of older adults compared to other age groups. Respondents expressed their concerns about nineteen health problems, and also gave their opinion about the suitability of food as a solution for disease prevention and mitigation. A special focus was placed on senior consumers in the analysis. The importance of the well-being of the older population is increasing, as their social representation grows. While there is a big variety of functional foodstuffs on the market already, their contribution to HLY also depends on consumer choice. The combination of functional foods with scientifically-proven health and nutrition claims and appropriate consumer perception would deliver significant social benefits.

Based on the results of an open-ended question, older adults tend to define the 'healthy food' term from a food safety point of view, while younger respondents described this category from nutritional aspects. These findings are similar to a previous Canadian study on adolescent women's sample (Chapman & Maclean, 1993), and to a Hungarian quantitative study (Szűcs, 2011).

Older adults show more interest in health-conscious diet and lifestyle-related scientific issues. Higher general dietary interest with ageing was also identified by previous studies (Roininen et al., 1999; Urala & Lähteenmäki, 2004; Urala & Lähteenmäki, 2007; Messina et al., 2008; Vella et al., 2013).

Based on the results of this analysis, older consumers were willing to pay a higher price for a functional food product with perceived health benefits, which was also suggested by previous studies (Leek et al., 2001; Siegrist et al., 2008; Yoon & Cole, 2008; Vassallo et al., 2009). According to former studies, the taste of the product was also a major factor in the case of preference of functional foods, which was also highlighted by the results of the present study, namely taste (and price) was similarly important to the youngest and the oldest age groups of the sample (Verbeke, 2005).

As expected on the basis of previous studies, the created nutrition claims categories highlighted that consumers did not perceive significant differences between multiple-level

claims (Hooker & Teratanavat, 2008; Verbeke et al., 2009). Accordingly, the created factor categories give a robust representation of multiple-level claims. For instance, with no added sugar, low in sugar, sugar-free are multiple-level claims considered to be within the factor named sugar. Vitamins and minerals, protein and fibre, and claims related to sugar content were found to be the most preferred nutrition claims. Differences between preferences of age groups were significant in all cases, except nutrition claims related to protein and fibre. Respondents aged over 60 years typically had a higher level of preference for the listed claims than those in the younger age groups. A recent Italian study with similar methodology also identified significant differences between age groups in regard to the preference of nutrition claims, and found similarly that claims related to vitamins are the most preferred ones by the consumers (Cavaliere et al., 2015).

Previous studies highlighted the importance of the type of carrier food products regarding acceptance of health benefits by consumers (Bech-Larsen & Grunert, 2003; Ares & Gámbaro, 2007; Williams et al., 2008; Verbeke et al., 2009). Based on the opinion of respondents, the following food categories were the most suitable for a healthy diet: fruits and vegetables; meat, fish, and egg; natural products (e.g. juices, tea, honey); and dairy products. Older adults had a significantly higher preference for the dairy products and breakfast products than the younger respondents. Related studies mostly analysed carrier food products combined with some particular claims that contributed for product development in a more direct manner (Bech-Larsen & Grunert, 2003; Ares & Gámbaro, 2007; Williams et al., 2008; Verbeke et al., 2009). These studies concluded that the type of the carrier had a greater effect on the acceptance of health benefits by consumers than the type of claim. Furthermore, consumers showed higher acceptance towards the functionality of foods in case the functional ingredient was inherently contained to some extent (Bech-Larsen & Grunert, 2003; Verbeke et al., 2009). Significant differences were found between older adults and other age groups in the preferences about the nutritional functionality of foods.

The results of the present study indicate that the Hungarian population is mainly concerned about the following health problems: vision deficiencies and disorders; dental problems; and heart and cardiovascular diseases. According to the responses, functional foods were most suitable for disease prevention and mitigation in case of digestive problems, high cholesterol level, lactose sensitivity and gluten sensitivity. In the vast majority of the cases where significant differences are detected, older adults were more concerned about health problems. A Dutch study which analysed health claims pointed out that health claims related to physiological health problems (e.g. heart and cardiovascular diseases, osteoporosis, cancer) are of greater importance among such claims stated on the labels of foodstuffs than those related to psychological problems (e.g. stress, fatigue), which are in line with our results (Van

Kleef et al., 2005). A recent Hungarian study which examined the effect of socio-demographic factors in the case of functional foods also highlighted the importance of age regarding health problems (Plasek et al., 2020). Moreover, previous studies indicated a connection between health status and the importance people attach to nutrition and health claims (Van Kleef et al., 2005; Urala & Lähteenmäki, 2007). After filtering the sample only for the concerned consumers, less significant differences were detected between the age groups. Where significant differences were found, younger and middle-aged adults accepted food more likely as a solution to prevent and/or mitigate the particular health problem. According to these findings, health concerns are more influential in the acceptance of functional foods for disease prevention and mitigation than the consumers' age.

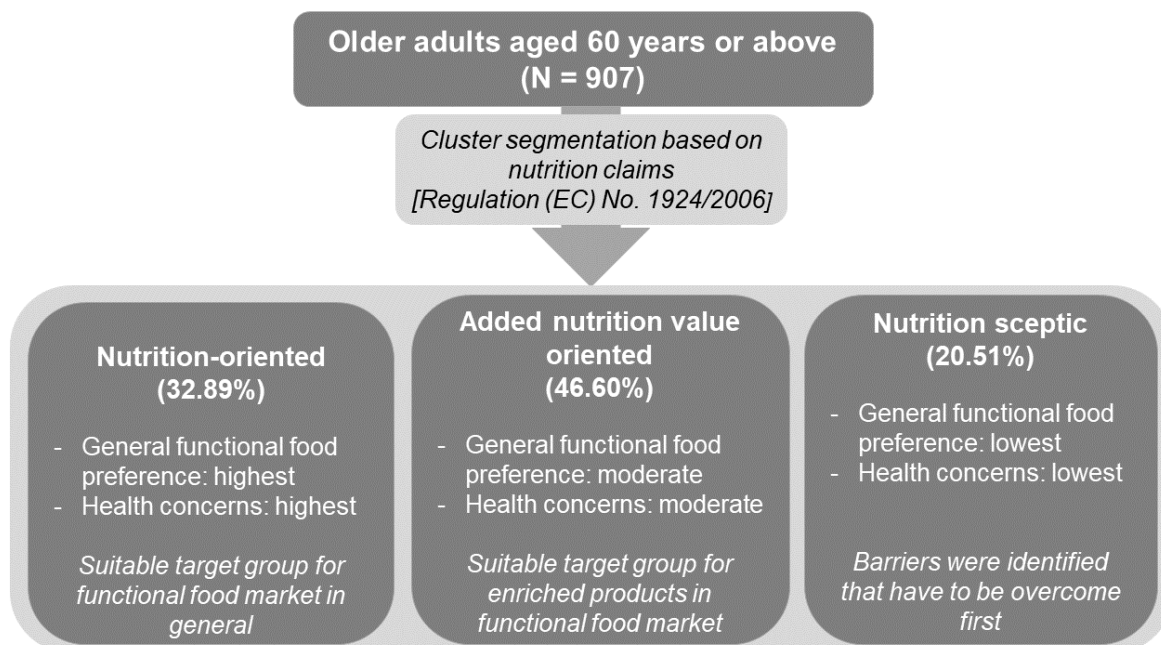
In the case of most of the knowledge-related questions, younger respondents had a higher level of knowledge. Former studies described lack of nutritional knowledge as a major barrier which could limit the acceptance of functional food products and also makes following health-conscious diet more difficult (Menrad, 2003; Ares et al., 2009; Jeruszka-Bielak et al., 2018). The results of the present study also highlight the importance of effective nutritional awareness-raising programmes.

In terms of 'healthy' product parameters, non-GMO status and food safety played the most important role, followed by domestic origin, small-scale production and animal welfare. Animal welfare was the only factor found to be universally appreciated, while other factors were preferred by the older adults to a higher extent. It indicates that the combination of these product parameters with health and nutrition claims on the product label could bear a recognised value for senior consumers (Grunert et al., 2014).

## 6.2. Older adult specific sample

From twenty-three nutrition claims, six factors were composed. Older adults primarily prefer claims indicating added nutritional value, while reduced nutritional content was preferred less, which was in line with results of previous research (Vella et al., 2013; van der Zanden et al., 2014a). Based on the preferences, three well-distinguished segments were identified: 'nutrition-oriented', 'added nutritional value oriented' and 'nutrition sceptic' groups.

Previous segmentation studies focused on functional food market applying more product-specific and theoretic approach (van der Zanden et al., 2015; Liu & Grunert, 2020). The present study aims to deliver claim-specific practical findings based on the exploration of preferences of older adults. Nutrition claims used for segmentation, carrier food products, health concerns and the acceptance of functional foods for disease prevention were analysed with respect to the segments (**Figure 14**).



**Figure 14.** Summary of the main findings of consumer segmentation among older adults.

Scepticism about functional foods were identified by several previous segmentation studies in general consumer samples (Sparke & Menrad, 2009; Szakály et al., 2012; Brečić et al., 2017; Nystrand & Olsen, 2021). Sceptic consumers were referred to as careless, uninterested, uninvolved, indifferent and unmotivated in these studies. Scepticism among older consumers was also identified by several previous studies that focused on senior consumers (Annunziata et al., 2015; van der Zanden et al., 2015; Febian et al., 2021). According to the findings of the present study, scepticism is not a general characteristic among older adults. While only 20.5% of the sample was identified as 'nutrition sceptic', the vast majority of senior consumers can

be described by a positive attitude toward nutrition claims ('nutrition-oriented' and 'added nutrition value oriented' segments), similarly to previous relevant studies (Vella et al., 2013; Karelakis et al., 2019).

The 'nutrition-oriented' and the 'added nutrition value oriented' segments were more concerned about health problems than the 'nutrition sceptic' group. The acceptance of functional foods as a means to disease prevention and mitigation showed similar picture. The results strongly suggest that older adults pay attention to their nutrition as a consequence of existing health problems, and not because of prevention. A Canadian consumer study also found that perceptions of disease threat was a key driver of receptivity towards functional foods, which tend to increase with age (Herath et al., 2008). According to the results, a significant part of the older adults are concerned about CNDs, which is in line with health statistics (WHO, 2018). These findings should be considered by product developers, but also policy makers could exploit this experience to form more effective health prevention programmes in earlier life stages. Consultation and collaboration with health associations are recommended to gain a deeper knowledge about the needs and habits of consumers affected by diseases. Based on findings of previous research, the consumer acceptance of the relationship between active component and health benefit is a key factor to increase acceptance of functional food products (Urala & Lähteenmäki, 2003; Vassallo et al., 2009; Verbeke et al., 2009). Lack of information can be a main barrier in regard to health improvement programmes among older adults as former studies revealed (Wądołowska et al., 2009; Jeruszka-Bielak et al., 2018). Qualitative stakeholder studies could foster the development of appealing and informative marketing strategies for reaching older adults (Collins & Bogue, 2015; Doma et al., 2019).

The results highlight promising opportunities for functional food market actors to develop and promote products for senior consumers. However, consumer acceptance depends on the suitable combination of product parameters, which requires comprehensive investigation of attributes of functional foods (Bech-Larsen & Grunert, 2003; Ares & Gámbaro, 2007; Verbeke et al., 2009). Fruits, vegetables, fish and fish-based products, vegetable-based products, fruit-based products and yogurt were found to be at the top of the carrier preference list. The 'nutrition-oriented' segment had significantly higher mean values compared to the 'nutrition sceptic' group in several carrier categories, however, the order of preferences was the same in case of all segments in essence. The results of present study are in line with previous research findings that suggest that functional properties are most prevalent in those categories that consumers consider to be healthier in general (Siegrist et al., 2008; Annunziata & Vecchio, 2011; Krutulyte et al., 2011; Plasek et al., 2021).

Elderly people significantly differ from other consumer groups in several aspects, yet older adults could not be considered to be a homogenous cluster (Moschis, 2003). The present study

also suggests the differentiation of promotion techniques in terms of different functional food parameters, shop types and communication channels. Food safety, non-GMO status, domestic origin and small-scale production are the most important product parameters for senior consumers, while production with modern technologies was at the end of the preference list. These findings are in line with previous studies which identified the importance of food safety for older adults and experienced distrust of unfamiliar foods (neophobia) among elderly consumers (Tuorila et al., 2001; Liu & Grunert, 2020). Preferred place for food purchase did not differ significantly between the segments, most of the older adults buy food in larger stores. According to the results of this study, the most trusted communication channel was 'family, relatives, friends' for elderly people. This reflected the findings of previous consumer studies in senior market, where the importance of word-of-mouth marketing was already identified (Kim et al., 2019).

Findings of attitude-related questions confirmed the differences between the three segments. The 'nutrition-oriented' segment highly accepted the connection between nutrition and health and showed a significant interest in healthy diet. This segment was quality-oriented, and the nutritional composition of products and compliance with health-conscious diet were important for them. The 'nutrition-oriented' segment more often ate 'free from...' foods. This group of senior consumers was the most willing to pay a higher price for functional food products. In contrast, the 'nutritional sceptic' segment was indifferent about the aspects presented above, while the 'added nutritional value oriented' group could be characterised with moderate interest.

According to the results of the present study, socio-demographic aspects (e.g. location of residence, level of education, income) did not influence health-related dietary preferences of older adults. However, the sex of the respondents was found to be significant: men were found in the highest proportion in the 'nutrition sceptic' segment. In previous related studies, sex was also identified as an influencing factor (Roininen et al., 1999; Irz et al., 2014; van der Zanden et al., 2015; Liu & Grunert, 2020; Oeser, 2021). The proportion of overweight respondents was highest in the 'nutrition-oriented' group, while the proportion of obese respondents was the highest in the 'added nutrition value oriented' segment, while respondents with normal BMI can be found in the 'nutrition sceptic' segment in the highest rate. These findings also highlight, that older adults pay more attention to nutrition due to existing health problems instead of prevention.

### **6.3. Limitations of the study**

The study did not cover several important groups of older adults, such as hospitalised consumers and older adults living in residential homes. The investigations were limited to respondents in relatively good health conditions, due to the methodology of data collection, which was performed at public areas. Another limitation of this segmentation study was the non-representative nature of the sample. Compared to the 2016 official census data, male respondents were under-represented in the sample (30% instead of 40%), as well as the '80 years or above' age group (5% instead of 16%) (KSH, 2016).

### **6.4. Conclusions**

The results of the analysis of the nationwide representative consumer survey on functional foods highlighted the importance of well-being of older adults, which should be considered during product development. The Hungarian older adult population's perception of the health-related functionality of foods was significantly more positive compared to other age groups. According to this finding, food business operators in this field should prioritize this consumer group. It is recommended for product developers to build on the experiences of a consumer research already in the conceptualisation phase. The investigation found significant differences between the attitudes and preferences of older adults and other age groups, which might facilitate product differentiation. The analysis contains a detailed data set about possible carrier food and functionality combinations that might be utilised by subsequent academic studies and by field experts as well. Vitamins and minerals; protein and fibre; and claims related to sugar content were found to be the most preferred nutrition claims. It is recommended for food business operators that they focus on the following carriers with the above mentioned added nutritional values: fruits and vegetables; meat, fish, and egg; natural products; and dairy products. Supply chain approach is essential for a successful exportable product development. Food business operators need to evaluate the availability of sustainable raw materials with required quality and quantity, professional expertise, infrastructure, and the current market situation. Health concerns were identified as an influential factor for the acceptance of functional foods for disease prevention and mitigation. Therefore, cooperation between food producers and patient advocacy organizations during the product development could be considered as a good practice. Differences between preferred shop types and communication channels of the elderly were also explored that could support the positioning of messages related to product promotion and intervention.

The segmentation study was able to define three significantly different groups of older adults based on their preference of nutrition claims. According to the findings, scepticism, which was an identified barrier by several previous international studies, was not a general characteristic

of Hungarian older adults. The vast majority of older adults can be described by a positive attitude towards nutrition claims. Based on the results, the senior consumer clusters referred to as 'nutrition-oriented' and 'added nutritional value oriented' could be appropriate target groups for functional food market actors. Only one-fifth of consumers (the 'nutrition sceptic' group) was found to be resilient against functional food value offers. Socio-demographic aspects (including location of residence, level of education, income) does not influence health-related dietary preferences of older adults in Hungary. The results strongly suggest that older adults primarily pay attention to their nutrition due to existing health problems instead of prevention. Considering that the prevention of CNDs and the well-being of older adults are serious social challenges, there are tasks for both the food business operators in development of accessible functional food products for older adults and policy makers in organising more effective preventive public health programmes.

Results of the present study could be a good starting point for an international comparative study focusing on the dietary needs and expectations of older consumers. A regional research collaboration in V4 countries with standardised questionnaire and data collection methodology would provide a strong base for product development, especially in case of time series research. Further studies focusing on older adults are needed to investigate possible product-attribute combinations, which meets expectations of specified segments of senior consumers. Targeted research approach is required to assess the opinion of certain patient groups (e.g. food allergies and intolerances, gastrointestinal problems). Evaluation of health insurance aspects and legislation of fortified food products (to reducing micronutrient deficiencies) could be identified as a potential additional research direction.



## **7. New and novel scientific results**

1. The perception of Hungarian older adults about health-related functionality of foods was significantly more positive compared to other age groups.
2. In case of Hungarian consumers, health concerns are more influential in the acceptance of functional foods for disease prevention and mitigation than the age of the consumers.
3. Preferences of Hungarian older adults for nutrition claims are heterogeneous according to the cluster analysis of large (N = 907) consumer sample: 33% is nutrition-oriented in general, 46.5% appreciates added value, and only 20.5% of the senior respondents is identified as nutrition sceptic.
4. Hungarian older adults pay special attention to nutrition due to existing health problems instead of prevention.
5. Most valued carrier foods for the Hungarian elder consumers found to be the following: fruits and vegetables, fish, yoghurt and honey. Most important nutrition claims are related to vitamin, mineral, protein and fibre content.
6. Most of the socio-demographic aspects (including location of residence, level of education, income) except the sex of the respondents does not influence health-related dietary preferences of older adults in Hungary.

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## 9. Appendix

### Applied questionnaire

Dear Respondent,

With the help of our questionnaire, we would like to get to know your opinion, knowledge, and habits about 'healthy foods' that support health-conscious diet. Our questionnaire is anonymous, and you cannot be identified in any way. Thank you for your help!

#### To what extent do you agree with the following statements?

Please rate from 1 to 5. 1: I do not agree at all; 5: I fully agree

I constantly seek information and educate myself on food and nutrition	①②③④⑤
I consciously choose brand and manufacturer when it comes to food	①②③④⑤
I thoroughly read the label of products	①②③④⑤
Nutrition has a direct impact on health	①②③④⑤
Healthy diet is important for me	①②③④⑤
'Healthy foods' are less delicious	①②③④⑤
For older adults, diet has more important role in health	①②③④⑤
Healthy diet has a strong impact on the prevention of diseases at older adults	①②③④⑤
I am willing to pay more for 'healthy foods'	①②③④⑤
'Healthy foods' are more expensive	①②③④⑤
I am interested in healthy diet	①②③④⑤
I am interested in lifestyle-related scientific issues	①②③④⑤
Taste of the food is the most important aspect when I purchase	①②③④⑤
Price of the food is the most important aspect when I purchase	①②③④⑤
Brand of the food is the most important aspect when I purchase	①②③④⑤
Domestic origin of the food is the most important aspect when I purchase	①②③④⑤
Quality of the food is the most important aspect when I purchase	①②③④⑤
Nutritional composition of the food is the most important aspect when I purchase	①②③④⑤
Compliance with health-conscious diet of the food is the most important aspect when I purchase	①②③④⑤

Which of the following lifestyle statements is relevant for you? You can mark multiple answers.

- Exercise regularly
- Want to lose weight, and do something about this
- Inadequate sleep
- Have a stressful lifestyle
- Feel healthy in general
- Can spend only a short time on eating and cooking
- Do not exercise enough
- Pay more attention to diet than average
- Smoke every day
- Use dietary supplements

**To which extent do you prefer the following nutrition claims while shopping?**

*Please rate from 1 to 5. 1: it is not important to me at all; 5: very important to me*

Low energy	①②③④⑤
Energy-reduced	①②③④⑤
Energy-free	①②③④⑤
Low-fat	①②③④⑤
Fat-free	①②③④⑤
Low-saturated fat	①②③④⑤
Saturated fat-free	①②③④⑤
Reduced saturated fat	①②③④⑤
With no added sugar	①②③④⑤
Low in sugar	①②③④⑤
Sugar-free	①②③④⑤
Low in sodium	①②③④⑤
Low in salt	①②③④⑤
Very low in sodium	①②③④⑤
Very low in salt	①②③④⑤
Sodium-free	①②③④⑤
Salt-free	①②③④⑤
Source of fibre	①②③④⑤
High in fibre	①②③④⑤
Source of protein	①②③④⑤
High in protein	①②③④⑤
Increased protein	①②③④⑤
Source of vitamins	①②③④⑤
High in vitamins	①②③④⑤
Source of Calcium	①②③④⑤
Natural source of Calcium	①②③④⑤
High in Calcium	①②③④⑤
Naturally high in Calcium	①②③④⑤
Contains pectin	①②③④⑤
Lactose-free	①②③④⑤
Gluten-free	①②③④⑤
Live flora	①②③④⑤
Whole grain	①②③④⑤
Contain herbs	①②③④⑤
Contain antioxidant	①②③④⑤
Prebiotic	①②③④⑤
Probiotic	①②③④⑤
Light/lite	①②③④⑤



**How much do you think the consumption of the following foods contribute to your health?**

*Please rate from 1 to 5. 1: no, not at all with this food; 5: yes, with this food especially*

Fruits	① ② ③ ④ ⑤
Yoghurt	① ② ③ ④ ⑤
Milk	① ② ③ ④ ⑤
Kefir	① ② ③ ④ ⑤
Cheese	① ② ③ ④ ⑤
Butter	① ② ③ ④ ⑤
Vegetables	① ② ③ ④ ⑤
Sour cream	① ② ③ ④ ⑤
Cottage cheese	① ② ③ ④ ⑤
Herbal products	① ② ③ ④ ⑤
Honey	① ② ③ ④ ⑤
Nuts and other oily seeds, muesli	① ② ③ ④ ⑤
Margarine	① ② ③ ④ ⑤
Vegetable-based products	① ② ③ ④ ⑤
Fruit-based products	① ② ③ ④ ⑤
Mushroom-based products	① ② ③ ④ ⑤
Fruit jam	① ② ③ ④ ⑤
Bakery products	① ② ③ ④ ⑤
Meat products	① ② ③ ④ ⑤
Poultry meals	① ② ③ ④ ⑤
Pork meals	① ② ③ ④ ⑤
Egg and egg-based products	① ② ③ ④ ⑤
Fish and fish-based products	① ② ③ ④ ⑤
Juice (fruit, vegetable)	① ② ③ ④ ⑤
Tea	① ② ③ ④ ⑤

**Where does your household go shopping?**

*Please rate from 1 to 5. 1: not typical at all; 5: very typical*

Large stores (supermarket, hypermarket)	① ② ③ ④ ⑤
Small grocery store	① ② ③ ④ ⑤
Directly from producer (e.g. market)	① ② ③ ④ ⑤
Online shop	① ② ③ ④ ⑤
I produce it myself or I receive it as a gift	① ② ③ ④ ⑤

**How important is it for you that a 'healthy food' has the following properties?**

*Please rate from 1 to 5. 1: this property is not important at all ; 5: very important property*

Small-scale production	① ② ③ ④ ⑤
Organic product	① ② ③ ④ ⑤
Traditional product	① ② ③ ④ ⑤
Domestic product	① ② ③ ④ ⑤
Trademark	① ② ③ ④ ⑤
Produced by a well-known manufacturer	① ② ③ ④ ⑤
Produced with modern technology	① ② ③ ④ ⑤
Non-GMO	① ② ③ ④ ⑤
Animal welfare considerations	① ② ③ ④ ⑤
Developed by domestic researchers	① ② ③ ④ ⑤
Safety according to the National Food Chain Safety Office	① ② ③ ④ ⑤

**Which health problems are you concerned about? Would you choose 'healthier foods' to prevent or mitigate the following health problems?**

Health problem	Concerned about	Could be prevented or mitigated with 'healthier foods'
Heart and cardiovascular diseases	<input type="checkbox"/>	<input type="checkbox"/>
High cholesterol level	<input type="checkbox"/>	<input type="checkbox"/>
Cancer	<input type="checkbox"/>	<input type="checkbox"/>
Mood and sleep disorders	<input type="checkbox"/>	<input type="checkbox"/>
Respiratory diseases	<input type="checkbox"/>	<input type="checkbox"/>
Skin diseases, eczema	<input type="checkbox"/>	<input type="checkbox"/>
Memory disorders, lack of concentration	<input type="checkbox"/>	<input type="checkbox"/>
Digestive problems	<input type="checkbox"/>	<input type="checkbox"/>
Migraine	<input type="checkbox"/>	<input type="checkbox"/>
Diabetes	<input type="checkbox"/>	<input type="checkbox"/>
Arthritis disorders	<input type="checkbox"/>	<input type="checkbox"/>
Osteoporosis	<input type="checkbox"/>	<input type="checkbox"/>
Weakened immune system	<input type="checkbox"/>	<input type="checkbox"/>
Allergies	<input type="checkbox"/>	<input type="checkbox"/>
Dental problems	<input type="checkbox"/>	<input type="checkbox"/>
Hormonal imbalance	<input type="checkbox"/>	<input type="checkbox"/>
Vision deficiencies and disorders	<input type="checkbox"/>	<input type="checkbox"/>
Lactose sensitivity	<input type="checkbox"/>	<input type="checkbox"/>
Gluten sensitivity	<input type="checkbox"/>	<input type="checkbox"/>

### Where do you get nutrition and food information?

Please rate from 1 to 5: 1: Not from here at all; 5: Especially from here

Television	① ② ③ ④ ⑤
News sites, websites, blogs	① ② ③ ④ ⑤
Social media	① ② ③ ④ ⑤
Radio	① ② ③ ④ ⑤
Family, relatives, friends	① ② ③ ④ ⑤
Printed press, magazines	① ② ③ ④ ⑤
School, university, other education	① ② ③ ④ ⑤

### Which statements is true and which is false?

Statement	True	False
The characteristic taste of long-life milk is due to the preservative it contains	<input type="checkbox"/>	<input type="checkbox"/>
Traditional foods are 'gene-free'	<input type="checkbox"/>	<input type="checkbox"/>
If a product contains bacteria, it is no longer safe	<input type="checkbox"/>	<input type="checkbox"/>
Natural/organic foods are risk-free	<input type="checkbox"/>	<input type="checkbox"/>
Canned foods contain preservatives	<input type="checkbox"/>	<input type="checkbox"/>

### DEMOGRAPHY

In order to process the research results, please answer the following questions about you – the research is anonymous and the way it is processed guarantees that you cannot be identified in the survey.

**Sex:**  Female  Male

**Year of birth:** \_\_\_ \_\_\_ \_\_\_ \_\_\_

**Location of residence (type):**  Village  Another city  Capital city

**Location of residence (county):** \_\_\_\_\_

#### Highest accomplished qualification

- Primary school (8 or less grade)
- Vocational school (profession qualification)
- High school (graduated)
- Higher education (college or university diploma)

#### Economic status (please, choose only one option)

- Active worker
- Entrepreneur
- Retiree
- Job seeker
- Homemaker
- Student

**Number of inhabitants in your household:**

Me
----

 + \_\_\_\_\_ persons

**Do you have a child under the age of 15 in your household?**  Yes  No

**Is there a reason why you need a special diet?** *You can mark multiple answers.*

- Yes, diabetes
- Yes, celiac disease
- Yes, milk protein allergy
- Yes, want to lose weight
- Yes, high blood pressure
- Yes, want to be fit
- Yes, vegetarian/vegan
- Yes, follow a trending diet
- No special dietary needs

**Who is responsible for food shopping in your household?**

- Me
- Together
- Other person

**Which statement is true about the income level of your household?**

- It is difficult to buy even the most essential things
- Below average
- Average
- Above average
- Our income level is outstanding

**Body weight:** ..... kg

**Body height:** ..... cm

## 10. Scientific publications

### 10.1. Publications related to the topic of the dissertation

#### 10.1.1. Full text papers in peer-reviewed journals with impact factor

Szakos, D., Ózsvári, L., & Kasza, G.: **Health-related nutritional preferences of older adults: a segmentation study for functional food development.** *Journal of Functional Foods*, 92. 105065, 2022.

Szakos, D., Ózsvári, L., & Kasza G.: **Perception of Older Adults about Health-Related Functionality of Foods Compared with Other Age Groups.** *Sustainability*, 12(7). 2748, 2020.

Szakos, D., Ózsvári, L., & Kasza, G.: **What makes a food "healthy"? - Functional food product path planning by evaluating the opinions of consumers from different age groups.** *Magyar Állatorvosok Lapja*, 143(7).439-447, 2021.

Szabó, E., Szakos, D., Kasza, G., & Ózsvári, L.: **The analysis of the target group of lactose-free functional foods for product development.** *Acta Alimentaria*, 50(2). 153-161, 2021.

Szabó, E., Szakos, D., Kasza, G., & Ózsvári, L.: **The legal background and institutional system of milk hygiene in Hungary.** *Magyar Állatorvosok Lapja*, 141(3). 181-191, 2019.

#### 10.1.2. Full text papers in peer-reviewed journals without impact factor

Szakos, D., Ózsvári, L., & Kasza, G.: **Consumer demand analysis in the Hungarian functional food market focused on the main health problems.** *Gradus*, 7(1) 62-66. 2020.

### **10.1.3. Presentations at international conferences**

Szakos, D., Ózsvári, L., & Kasza, G.: **Perception of older adults about health-related functionality of foods**. In: Kiss, O. (Ed.): *18<sup>th</sup> Wellmann International Scientific Conference, Book of Abstracts*, 69. Hódmezővásárhely, Hungary: University of Szeged, 3 May 2021.

Szabó, E., Szakos, D., Kasza, G., & Ózsvári, L.: **A tejhigiénia jogszabályi háttere és intézményrendszere Magyarországon**. In: Szenci, O., Brydl, E. (Eds.): *29<sup>th</sup> International Congress of the Hungarian Association for Buiatrics*, 70-74. Hévíz, Hungary, 13-16 November 2019.

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Szakos, D., Temesi, Á., Ózsvári, L., & Kasza, G.: **Consumer Acceptance of Functional Food Products – Risk Aspects**. In: Géczy, G., Korzenszky, P. (Eds.): *Researched Risk Factors of Food Chain, XIX. Risk Factors of Food Chain Conference*, 111-114. Mátrafüred, Hungary: Szent István University, 26-28 September 2018.

#### **10.1.4. Presentations at Hungarian conferences**

Szakos, D., Ózsvári, L., & Kasza, G.: **Az életkor hatása az élelmiszerek egészséggel összefüggő funkcionalitásának megítélésére.** MTA Akadémiai Beszámolók, Budapest, Hungary, 2021.

Szabó, E., Kasza, G., Szakos, D., & Ózsvári, L.: **Laktózérzékeny vásárlók élelmiszerfogyasztási szokásai.** MTA Akadémiai Beszámolók, Budapest, Hungary, 2020.

Szakos, D., Ózsvári, L., & Kasza G.: **Consumer demand analysis in the Hungarian functional food market focused on the main health problems.** In: Hoyk, E. (Ed.): *Környezettudományi és Analitikai Műhelykonferencia, Book of Abstracts*, 38-39. Kecskemét, Hungary: Neumann János Egyetem, 30 April 2019.

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## 10.2. Further publications

### 10.2.1. Full text papers in peer-reviewed journals with impact factor

Kasza, G., Csenki, E., Szakos, D., & Izsó, T.: **The evolution of food safety risk communication: Models and trends in the past and the future.** *Food Control*, 109025, 2022.

Madarász, T., Kontor, E., Antal, E., Kasza, G., Szakos, D., & Szakály Z.: **Food Purchase Behavior during The First Wave of COVID-19: The Case of Hungary.** *International Journal of Environmental Research and Public Health*, 19(2). 872, 2022.

Kuti, B., Fehér, O., Szakos, D., Kasza, G.: **Country of origin and place of provenance related food labelling regulation in the European Union.** *Magyar Állatorvosok Lapja*, 144(1). 45-48, 2022.

Visy, A., Jónás, G., Szakos, D., Horváth-Mezőfi, Zs., Hidas, K.I., Barkó, A., & Friedrich, L.: **Evaluation of ultrasound and microbubbles effect on pork meat during brining process.** *Ultrasonics Sonochemistry*, 75. 105589, 2021.

Szakos, D., Szabó-Bódi, B., & Kasza, G.: **Consumer awareness campaign to reduce household food waste based on structural equation behavior modelling in Hungary.** *Environmental Science and Pollution Research*, 28(19). 24580-24589, 2021

Vajda, Á., Ózsvári, L., Szakos, D., & Kasza, G.: **Estimation of the Impact of Foodborne Salmonellosis on Consumer Well-Being in Hungary.** *International Journal of Environmental Research and Public Health*, 18(19). 10131, 2021.

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### **10.2.2. Full text papers in peer-reviewed journals without impact factor**

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