Food Quality and Preference 93 (2021) 104242

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Understanding meat consumption in later life: A segmentation of older consumers in the EU

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ARTICLE INFO

Keywords:
Consumer preference
Elderly
Nutrition and health
Protein sources
Segmentation
Sustainability

ABSTRACT

Protein intake is important for the maintenance of health, independence, and quality of life especially for older adults, yet the expanding older population is at risk of not consuming adequate levels. Notwithstanding its importance in terms of health, dietary protein choice has major ramifications for the state of the environment and for climate change, with meat holding the most weight in the environmental impact of diets. To support older consumers in making environmentally sustainable dietary protein choices, this study aims to gain deeper understanding of older consumers' meat consumption behavior by profiling older consumer segments on the basis of their meat consumption and liking. Results were obtained through a 2019-survey among 2,500 community-dwelling older adults aged 65 years or above in Finland, Poland, Spain, the Netherlands, and the United Kingdom. Three segments of older consumers were identified by means of a two-step cluster analysis: heavy meat consumers, medium meat consumers, and light meat consumers. The segments differed significantly in several socio-demographics and background characteristics, appetite, protein intake, attitudes towards meat and plant-based 'meat' substitutes, and liking of protein sources other than meat. Health and sustainability food choice motives were important determinants for being classified as a medium or light meat consumer compared to a heavy meat consumer whereas food fussiness, sensory appeal, and familiarity were important determinants for being classified as a heavy meat consumer compared to a light meat consumer. Understanding older consumers' meat consumption behavior has important implications for designing dietary strategies to meet older consumers' protein needs in an environmentally sustainable way.

1. Introduction

It is estimated that between 2020 and 2050 the older adult population (aged 65 + y) will increase by 42.3% while the working-age population (aged 15–64 y) will decrease by 9.5% in the European Union (EU) (European Commission, 2017). While this demographic shift is expected to lead to new challenges with regard to health care, long-term care, and social expenditures, the challenges can be partly moderated by maintaining health and well-being in the growing older population (Cylus et al., 2019). Currently, protein intake of at least 0.8 g/kg body weight/day is recommended for adults, including adults aged 65 years and older (EFSA, 2012). Yet, short-term metabolic studies show that older adults require a higher protein intake compared to young adults to maximally stimulate muscle protein synthesis (Cuthbertson et al., 2005; Moore et al., 2015; Wall et al., 2015). Further, observational studies show that higher protein intake is associated with less decline in muscle or lean mass and in performance-based physical function in older adults (Houston et al., 2008; Isanejad et al., 2016; Scott et al., 2010), providing benefits for overall health, independence, and quality of life in old age (Mendonça et al., 2019; Paddon-Jones et al., 2015). Consequently, expert groups suggest increasing protein intake recommendations to 1.0 to 1.2 g/kg body weight/day for older adults aged 65 + years (Bauer et al., 2013; Deutz et al., 2014) and several nutrition societies have already revised their recommendations accordingly (Richter et al., 2019). However, a substantial number of older adults have a difficult time meeting the currently recommended daily protein intake

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https://doi.org/10.1016/j.foodqual.2021.104242
Received 12 October 2020; Received in revised form 30 January 2021; Accepted 7 March 2021
Available online 20 March 2021

Table 1
Segmentation variables and socio-demographic and background characteristics in total sample of adults aged 65 years and older from five EU countries, and differences between the older consumer segments.

	Total sample	Older consumer segments			
		Heavy meat consumer	Medium meat consumer	Light meat consumer	p-value (V or η_p^2)
n (%)	**2,478 (100)**	**663 (26.8)**	**1,290 (52.0)**	**525 (21.2)**	
Segmentation variables [1]					
Cooked meat consumption (g/d) [2]	33.1 ± 27.9	71.9 ± 28.1[a]	21.0 ± 12.5 [b]	13.6 ± 12.3 [c]	<0.001 (0.63)
Meat liking [3]	3.9 ± 0.8	4.1 ± 0.6 [b]	4.3 ± 0.4[a]	2.9 ± 0.7 [c]	<0.001 (0.52)
Socio-demographic & background characteristics [4]					
Gender (Male)	52.2	57.2[a]	54.8[a]	39.6 [b]	<0.001 (0.13)
Age (<75 y)	85.4	86.3	84.3	86.9	0.292 (0.03)
Country					
Finland	19.9	20.5	20.2	18.1	
Poland	20.1	13.7 [b]	24.4[a]	17.5 [b]	
Spain	20.2	20.4	20.8	18.5	<0.001 (0.14)
The Netherlands	20.1	26.1[a]	13.5 [b]	29.0[a]	
United Kingdom	19.7	19.3	21.1	17	
Education level					
Below Bachelor level	62.2	62.3	61.9	63	0.893 (0.01)
Bachelor level or higher	37.8	37.7	38.1	37	
Lives alone	28.5	24.7 [b]	27.2 [b]	36.4[a]	<0.001 (0.09)
HH financial situation (n=2,435)					
Manages well or very well	40.1	45.7[a]	38.3 [b]	40.8[a,b]	
Gets by alright	38	36.2	39	41	0.008 (0.05)
Has some or severe difficulties	20.1	18	22.7	18.2	
Main HH grocery shopper					
Yes	65.9	64.3 [b]	64.0 [b]	72.8[a]	
No	7.1	6.3	7.2	7.8	0.001 (0.06)
Shared responsibility	27	29.4[a]	28.8[a]	19.4 [b]	
Own food decision maker					
Yes, always	62.5	61.4 [b]	60.0 [b]	69.9[a]	
Yes, sometimes	31.6	32.9	33.7	25	0.003 (0.06)
No, someone else decides	5.9	5.7	6.3	5.1	
Ability to prepare own warm meals (n=2419)					
Yes without difficulties	88.3	88.3	89.2	86.1	0.201 (0.04)
Yes with difficulties or no unless with help	11.7	11.7	10.8	13.9	
BMI (kg/m^2; mean ± sd)	27.0 ± 4.3	27.1 ± 4.4	27.1 ± 4.2	26.6 ± 4.6	0.014 (<0.01)
Oral health problems (n=2,462)	26.2	27.1	25.8	26.8	0.822 (0.01)

[1] Cluster centroids for a three-cluster solution presented as mean ± standard deviation. [2] Cooked meat consumption frequency (d/wk) and average amount of meat consumed with warm meal (g/d) are provided in Appendix Fig. 1 for each consumer segment. [3] Meat liking is a mean liking score of four meat sources, namely beef or veal, lamb, pork and poultry, and is measured on a 5-point scale, ranging from 1 (dislike extremely) to 5 (like extremely). [4] Presented as percent (%) unless noted otherwise. [a-c] Different superscripts indicate significantly different standardized means in each row following ANOVA post hoc Tukey test or Chi-square test at $p < 0.01$. Cramer's V (V) and partial eta-squared (η_p^2) indicates the effect size. HH: household. BMI: body mass index.

(Hengeveld et al., 2020; Hung et al., 2019), warranting more research into effective strategies to increase protein intake in this growing older population.

Notwithstanding its importance in terms of health, dietary protein choice has major implications for environmental sustainability. Increasing protein intake is likely to result in net increases in the environmental impact of the diet, especially if consumption of meat is favored (Chen et al., 2019; Grasso et al., 2020). Animal protein accounts for approximately 60% of total protein consumed in the EU, with the largest contribution of protein being derived from meat (Halkjær et al., 2009). Meat production, and animal protein production in general, is resource intensive and on average produces more greenhouse gas emissions and has a larger impact on land use, water use, and biodiversity loss compared to plant protein production (Godfray et al., 2018; Poore and Nemecek, 2018). It has been previously shown that in addition to total energy intake, total meat and the proportion of ruminant meat (e.g. beef, veal, lamb) hold the most weight in the environmental impact of EU diets (Mertens et al., 2019). While meat and other animal protein sources such as dairy, fish, and eggs are important sources of high quality protein and essential nutrients (Phillips, 2012), the high levels of meat and animal protein consumed in the EU are considered not only unsustainable but also unhealthy (Willett et al., 2019). On average Europeans eat 36% more meat compared to the amount recommended in their respective food-based dietary guidelines, and 49% more than the amount recommended by the EAT-Lancet Commission's planetary health diet (Springmann et al., 2020). Therefore, to minimize the environmental costs of fulfilling the high protein requirement of the expanding older population, it is imperative to design dietary strategies that consider the environmental impacts of protein choices and promote pro-environmental protein consumption among older consumers.

According to de Boer and Aiking (2018) two interrelated types of pro-environmental behavior that are relevant for protein consumption are 1) "using fewer natural resources" and 2) "doing things in a different way and with a reduced environmental impact". Examples include reducing the portion size of meat (type 1) and replacing meat with a plant-based protein sources like legumes and nuts (type 2). Given the unique nutritional requirements of older adults, 'doing things differently' may be more appropriate than 'using less' to achieve adequate protein intake within environmental limits. There is a broad variety of alternative, more sustainable protein sources that can replace meat, including traditional plant-based sources (e.g. legumes, nuts, seeds, whole grains), processed plant-based 'meat' substitutes which are designed to imitate meat, and novel protein sources such as insects and cultured meat. Moreover, a large majority of the general population perceive a match between a healthy and a sustainable diet and associated this more with a plant-based rather than a meat-based diet (Van Loo et al., 2017). Yet, a study in the Netherlands found that older adults were more likely to prefer a smaller meat portion size rather than replacing meat by something else (de Boer et al., 2014). Another study in five EU countries found that there is low readiness among older consumers to eat novel protein sources such as insects, although their acceptance to eat plant-based sources (e.g. derived from soy or pea protein) was comparable to that of meat (Grasso et al., 2019). While past meat consumption behavior is a significant predictor of pro-environmental protein consumption (Çoker and van der Linden, 2020), unraveling the intricacies of older consumers' meat consumption behavior provides important information for the promotion of alternative, more sustainable protein sources.

Food consumption behavior is a complex issue influenced by many factors ranging from biological and psychological to environmental and lifestyle factors (Asp, 1999; Rozin, 2007). Multiple aspects may influence meat consumption behavior, including attitudes, values, subjective norms, culinary skills, habit, and tradition (Çoker & van der Linden, 2020; Macdiarmid et al., 2016; Stubbs et al., 2018). Consumers' positive perception of meat (e.g. taste, pleasure, nutritious, familiarity) and disbelief of meat's impact on the environment have been found to hinder attitudinal change (Macdiarmid et al., 2016). In addition, tradition, social norms, and lack of culinary skills have been found to impede willingness to change meat consumption behaviors (Sanchez-Sabate et al., 2019). However, important individual differences exist in terms of habitual meat consumption and willingness to reduce meat consumption. Dagevos and Voordouw (2013) reported that different modes of "flexitarianism", or meat reduction, exist, from "light flexitarians" who abstain from eating meat once or twice per week to "heavy flexitarians" who eat meat only once or twice per week. Ethical concerns, health motives, and personal norms were important drivers to being committed to change meat consumption behavior (Dagevos & Voordouw, 2013). Similarly, Vainio et al. (2016) found that food choice motives play an important role in explaining differences in meat consumption behavior, with health being a facilitating motive to replace meat with plant-based protein sources and convenience and price being inhibitory factors.

Considering the heterogeneity of older food consumers, a targeted approach to increase protein intake in an environmental-friendly manner would be more effective than a "one-size-fits-all" approach (den Uijl et al., 2014; van der Zanden et al., 2015). Identifying and comparing different groups or segments of consumers wherein individuals with a similar profile are clustered can help tailor dietary strategies to older consumer segments with specific needs and preferences (van der Zanden et al., 2014). This current study aims to analyze meat consumption decision-making and behavior in community-dwelling older adults in the EU by conducting a segmentation analysis. To gain an understanding of the consumers in each segment, the segments are profiled in terms of socio-demographics and background characteristics, appetite, protein intake, attitudes towards meat and plant-based 'meat' substitutes, and liking of protein sources other than meat. Further, this study explores whether psychographic characteristics including food choice motives, food fussiness, and food sustainability knowledge can explain the differences in segment membership.

2. Material and methods

2.1. Data collection

This study makes use of cross-sectional data from 2,500 community-dwelling adults aged 65 years and older from an online pan-EU survey conducted in October 2019. The survey was administered in Finland, Poland, Spain, the Netherlands, and the United Kingdom (UK) by a professional market research agency. It was developed in English and translated into the respective national languages. Respondents meeting the criteria of being 65 years or older and living independently were recruited by the agency using probabilistic sampling from an online access proprietary panel. Sampling quotas were applied on gender and regions proportional to the distribution within the national population. The target for gender (i.e. 50% women and 50% men) was not fully met but the distribution was close to evenly distributed (Table 1). All participants were asked to provide written informed consent before taking part in the study. Ethical approval for the study was granted by the Belgian Ethics Committee of Ghent University Hospital in August 2019 (Reference No. 2019/0933).

2.2. Questionnaire and scales

The survey was conducted within the PROMISS (PRevention Of Malnutrition In Senior Subjects in the EU) project, a five-year Horizon 2020 project funded by the European Commission focused on advancing healthy aging among seniors in the EU. It began with a brief overview of the PROMISS project and an informed consent, which was followed by a screening for gender, age, region, and current living situation. The questionnaire focused on dietary and physical activity habits, attitudes and preferences, and knowledge related to protein consumption. Individual items were rotated within questions to avoid order and response bias. Questions and scales used in this study are described below.

2.2.1. Dietary habits

Consumption frequency of ten protein-rich food groups, including cooked meat, was assessed with a short, modified version of a validated food frequency questionnaire (Beukers et al., 2015). The measurement included questions asking the number of days one consumed the ten different food groups with a reference period of four weeks. Examples of cooked meat were provided and adapted to the context of each country (e.g. beef steak, pork chop, hamburger meat, sausages, and chicken for the UK). In addition to consumption frequency, the average amount of meat consumed with a warm meal on a meat-eating day was assessed with five photos of a plate with different portion sizes of cooked meat. Cooked meat consumption was calculated by multiplying the frequency of consumption per day with the average portion size consumed.

The probability of low protein intake was assessed with the Protein Screener 55+ (Wijnhoven et al., 2018). Low protein intake was defined as having a 0.3 or higher probability of protein intake < 1.0 g protein per kilogram of adjusted body weight per day (g/kg adjusted BW/d) based on recalibrated models (Hung et al., 2019; Wijnhoven et al., 2018).

Further, respondents were asked to report whether or not they were following any dietary regime, with the following options and definitions provided: flexitarian diet (tries to limit meat intake), pesco-vegetarian diet (does not eat meat but eats fish and/or seafood), ovo- and/or lacto-vegetarian diet (does not eat meat but eats eggs and/or dairy products), vegan diet (does not eat meat, fish, and any other animal products, only eats plant-based foods), and other diet (not defined further). Respondents who chose 'other diet' were able to report the other diet they were following. Open responses were translated to English and then recoded, so that answers that are equivalent to a meat-limiting diet were recoded to one of the response options (e.g. flexitarian).

2.2.2. Appetite

Appetite was assessed using the validated simplified nutritional appetite questionnaire (SNAQ) consisting of four items (Hanisah et al., 2012; Wilson et al., 2005; Young et al., 2013). The total SNAQ score is the sum across the four items, ranging from 4 to 20, and was dichotomized such that a respondent with SNAQ ≤ 14 was classified as having a 'poor appetite' and SNAQ > 14 as having a 'good appetite' (Hanisah et al., 2012).

2.2.3. Liking of protein sources

Respondents were asked to what extent they like four different meat types (i.e. beef or veal, lamb, pork, poultry), other animal protein sources, and various plant protein sources. Respondents rated these items on a 5-point Likert scale ranging from 1 = Dislike extremely to 5 = Like extremely, with a sixth option 6 = I never tried this food. To gauge how much respondents like meat, liking scores for the four meat products were averaged to obtain a mean meat liking score, ranging from 1 = Extremely dislikes meat to 5 = Extremely likes meat. A meat liking score was calculated for respondents who answered on the Likert scale for at least one meat product, while no meat liking score was calculated for respondents who reported to have never tried any of the four meat products (n = 22).

Next, to get more insight into attitudes towards meat and plant-based 'meat' substitutes, reasons for liking or disliking meat and plant-based 'meat' substitutes were assessed. If respondents indicated that they like at least one of the meat products and/or plant-based 'meat' substitutes, or if they were neutral (neither like/dislike), respondents were then prompted to report their level of agreement towards statements about different reasons why one may like meat and/or plant-based 'meat' substitutes. Similarly, if respondents indicated that they dislike at least one of the meat products and/or plant-based 'meat' substitutes, respondents were then prompted to report their level of agreement towards statements about different reasons why one may dislike meat and/or plant-based 'meat' substitutes. Respondents answered on a five-point scale, ranging from 1 = Strongly disagree to 5 = Strongly agree.

2.2.4. Food choice motives

A single-item scale for six factors of the original food choice questionnaire developed by Steptoe et al. (1995) was used (Onwezen et al., 2019). The six food choice motives assessed include health, sustainability, price, sensory appeal, convenience, and familiarity. Respondents indicated the extent to which these motives are important when choosing a food eaten on a typical day on a five-point scale, ranging from 1 = Not at all important to 5 = Very important.

2.2.5. Food fussiness

A food fussiness scale was adapted from den Uijl et al. (2014) and Wardle et al. (2001) to assess the degree to which one is selective about consuming both known and unknown foods. The food fussiness scale consisted of seven items, e.g. "I decide that I don't like food, even without tasting it", for which respondents could indicate their level of agreement on a five-point scale ranging from 1 = Strongly disagree to 5 = Strongly agree. An exploratory factor analysis using principal components with varimax rotation confirmed that the items could be explained by a single factor with a reliability of $\alpha = 0.795$. The final food fussiness score is an average of the seven items, ranging from 1 = Not a fussy eater to 5 = A very fussy eater.

2.2.6. Food sustainability knowledge

Food sustainability knowledge was assessed by three true or false questions developed by the researchers: 1) A diet high in animal-based foods contributes more to global warming than a diet high in plant-based foods (true); 2) Eating foods with a high carbon footprint is bad for the environment (true); and 3) Eating beef is better for the environment than eating chicken (false). Respondents reported either 'true', 'false', or 'I don't know'. The correct answer was coded as 1, the incorrect answer and 'I don't know' were coded as 0, and a composite score was created, ranging from 0 = Not-informed, no answers correct to 3 = Well-informed, all answers correct.

2.2.7. Socio-demographic and background characteristics

Gender, age, education level, living situation, household (HH) financial situation, being the main HH grocery shopper, making own decisions of what to eat, ability to prepare own warm meal, and health status were assessed. Education level was defined by two categories based on respondents' highest level of education obtained: below Bachelor level (no education, primary education, lower secondary education or higher secondary education), and Bachelor level and above (bachelor level, master level or PhD). Living situation of older adults was defined by whether one lives alone or not, which was ascertained by the number of persons living in the HH. Respondents were asked to describe their HH financial situation by selecting one of the following: manages very well, manages quite well, gets by alright, has some financial difficulties, or has severe financial difficulties. Health status was assessed by asking respondents if they experienced some out of a list of 17 different possible health problems. Of the 17 health problems asked, four were used to assess oral health status, namely self-reported pain in the mouth, teeth, or gums, dry mouth, difficulty swallowing, and difficulty chewing. Oral health problems was dichotomized to 0 = no oral health problems, 1 = presence of one or more oral health problems.

2.3. Data analysis

All analyses were performed with SPSS version 26.0 (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0, Armonk, NY: IBM Corp.). Given the large sample size, statistical significance was considered at the α level of 0.01.

2.3.1. Segmentation

Cooked meat consumption and meat liking score were used to classify 2,478 older adults into consumer segments. The analytical sample excluded 22 respondents from the total sample of 2,500 respondents because "I never try this food" was indicated for each of the meat products. Segments of older adults based on cooked meat consumption and meat liking were identified using a Two-Step cluster analysis. This approach combines an agglomerative hierarchical clustering procedure and a non-hierarchal (k-means) approach. The hierarchical procedure is used as a basis for determining the appropriate number of clusters, and the non-hierarchical procedure "fine-tunes" the results and validates the final cluster solution (Hair et al., 2014). As the final solution may depend on the order of cases (i.e. respondents) (SPSS Inc., 2001), the cases were randomly ordered 10 times and a cluster analysis was run on each of the resulting datasets. The final solution was chosen based on a combination of the lowest Bayesian Information Criterion (BIC) in the 10 cluster analyses and interpretability. There was no issue of dependence between the variables in the cluster model (r = 0.249), but both variables deviated from a normal distribution (Shapiro-Wilk p-value < 0.001). Despite this violation, no transformation was applied to the variables as the Two-Step procedure has been shown to be fairly robust to violations of the major assumptions (SPSS Inc., 2009).

2.3.2. Profiling the segments

The segments were profiled based on socio-demographic and background characteristics, appetite, protein intake, liking of protein sources, and attitudes towards meat and plant-based 'meat' substitutes.

The role of the different variables in identifying the clusters was investigated with the use of Chi-square tests for categorical profiling variables and Kruskal-Wallis one-way analyses of variance for continuous profiling variables. To prevent making a Type I error in the null hypothesis testing due to the large sample size, the level of 0.01 is used as the threshold for statistical significance, and the effect size, i.e. Cramer's *V* (*V*) for Chi-square and partial eta-squared (η_p^2) for Kruskal-

Table 2
Appetite, protein intake, and liking of protein sources by older consumer segments.

	Older consumer segments			
	Heavy meat consumer (N = 663)	Medium meat consumer (N = 1,290)	Light meat consumer (N = 525)	*p*-value (V or η_p^2)
Poor appetite (SNAQ ≤ 14) [1]	27.5[b]	32.3[b]	39.0[a]	<0.001 (0.09)
High probability of low protein intake [2]	34.5[c]	53.5[b]	61.7[a]	<0.001 (0.20)
Dietary regime [3]				<0.001 (0.20)
Follows meat-limiting diet	8.1[c]	15.5[b]	29.3[a]	
Does not follow meat-limiting diet	91.9	84.5	70.7	
Consumption [4]				
Fish (d/wk)	1.5 ± 1.4	1.4 ± 1.4	1.3 ± 1.3	0.023 (<0.01)
Dairy products excl. cheese (d/wk)	3.5 ± 2.8[a]	2.8 ± 2.7[b]	3.3 ± 2.8[a]	<0.001 (0.01)
Eggs (d/wk)	2.2 ± 1.9 [a]	1.9 ± 1.7[b]	1.9 ± 1.9[b]	<0.001 (0.01)
Legumes (d/wk)	1.5 ± 1.8[a]	1.1 ± 1.4[b]	1.4 ± 1.7[a]	0.001 (0.01)
Nuts or peanuts (d/wk)	1.7 ± 2.1	1.5 ± 2.2	1.8 ± 2.3	0.116 (<0.01)
Pasta or noodles (d/wk)	1.4 ± 1.5	1.2 ± 1.2	1.2 ± 1.3	0.019 (0.01)
Processed meat (d/wk)	3.5 ± 2.3[a]	2.7 ± 2.1[b]	1.8 ± 2.0[c]	<0.001 (0.02)
Cheese (d/wk)	3.7 ± 2.5[a]	2.0 ± 2.5[b]	3.2 ± 2.6[b]	<0.001 (0.01)
Plant-based 'meat' (d/wk)	0.3 ± 1.0[c]	0.2 ± 0.6[b]	0.5 ± 1.1[a]	<0.001 (0.07)
Liking [5]				
Beef or veal (n = 2,444)	4.3 ± 0.8[a]	4.2 ± 0.7[a]	3.0 ± 1.0[b]	<0.001 (0.34)
Lamb (n = 2,403)	3.8 ± 1.1[b]	4.1 ± 0.9[a]	2.2 ± 1.0[c]	<0.001 (0.34)
Pork (n = 2,449)	4.1 ± 0.8[a]	4.2 ± 0.7[a]	2.8 ± 1.1[b]	<0.001 (0.31)
Poultry (n = 2,456)	4.3 ± 0.7[b]	4.4 ± 0.6[a]	3.4 ± 1.2[c]	<0.001 (0.20)
Fish or seafood (n = 2,449)	4.3 ± 0.9[b]	4.5 ± 0.8[a]	3.9 ± 1.2[c]	<0.001 (0.05)
Hybrid meat (n = 1,990)	2.4 ± 1.1[b]	2.6 ± 1.0[a]	2.5 ± 1.0[a,b]	0.008 (<0.01)
Dairy (n = 2,456)	4.4 ± 0.7[a]	4.4 ± 0.7[a]	4.1 ± 0.9[b]	<0.001 (0.03)
Egg (n = 2,458)	4.3 ± 0.7[a]	4.4 ± 0.6[a]	4.1 ± 0.9[b]	<0.001 (0.03)
Plant-based 'meat' (n = 2,101)	2.3 ± 1.1[c]	2.4 ± 1.1[b]	2.8 ± 1.2[a]	<0.001 (0.02)
Legumes (n = 2,429)	4.1 ± 0.9	4.2 ± 0.9	4.1 ± 1.0	0.025 (0.03)
Nuts or seeds (n = 2453)	4.1 ± 0.9[b]	4.2 ± 0.9[a]	4.1 ± 1.0[b]	0.009 (0.01)
Grain-based products excl. bread (n = 2,453)	3.8 ± 0.9[b]	4.0 ± 0.8[a]	3.8 ± 0.9[a,b]	<0.001 (0.02)
Bread (n = 2,464)	4.3 ± 0.8[a]	4.3 ± 0.7[a]	4.0 ± 0.9[b]	<0.001 (0.03)

[1] Presented as percent. [2] Presented as percent. High probability of low protein intake was defined as having a 0.3 or higher probability of protein intake lower than 1.0 g protein per kilogram of adjusted body weight per day. [3] Respondents who reported to follow either a flexitarian diet, a pesco-vegetarian diet, an ovo- and/or lacto-vegetarian diet or a vegan diet were grouped into one group 1 = Follows meat-limiting diet, while those who reported to not follow one of these diets were grouped into another group 0 = Does not follow meat-limiting diet. [4] Frequency of consumption in day per week (d/w) or consumption in grams per day (g/d) presented as mean ± sd. [5] Liking score is a continuous score from one to five, with a greater score indicating greater liking towards food item. Respondents were recoded as missing if they reported to have never tried the food. [a-c] Different superscripts indicate significantly different standardized means in each row following ANOVA post hoc Tukey test or Chi-square test at $p < 0.01$. Cramer's V (V) and partial eta-squared (η_p^2) indicates the effect size.

Wallis one-way test, is reported. Effect sizes measure the proportion of the variability in the older consumer segments that is accounted for by variation in the profiling variable, reflecting the strength of association between the variables (Levine and Hullett, 2002). Effect size was considered small when $0.1 \leq V < 0.3$ and $0.01 \leq \eta_p^2 < 0.06$, medium when $0.3 \leq V < 0.5$ and $0.06 \leq \eta_p^2 < 0.13$, and large when $V \geq 0.5$ and $\eta_p^2 \geq 0.14$ (Cohen, 1995; Lakens, 2013; Olivier et al., 2013).

2.3.3. Multivariate analysis

In a final step, we analyzed psychographic characteristics that can explain the differences between the segments. To substantiate differences between the segments we considered conducting discriminant analysis, however assumptions of multivariate normal distributions and homogeneity of covariance matrices were not satisfied. Multinomial logistic regression was therefore the chosen method. One of the resulting segments (the so-called "heavy meat consumer" segment, see results) was assigned as the reference group relative to which the other segments were compared. The explanatory variables included the following continuous variables: food choice motives (i.e. health, sustainability, price, sensory appeal, convenience, and familiarity), food fussiness, and food sustainability knowledge. Multicollinearity was checked and found not to be an issue (Appendix Table A.1).

3. Results

3.1. Identification of segments based on meat consumption and liking

Three segments based on meat consumption and liking were established as the optimal solution from the cluster analysis. The cluster centroids of the segmentation variables are shown in Table 1. The first segment represents 27% of the sample and is characterized by a relatively high consumption of cooked meat and a moderate to high meat liking score. Therefore this segment was labeled as "heavy meat consumers". The second segment is the largest, representing about half of the sample (52%). Respondents in this segment have the highest meat liking score. By contrast, they reported a lower cooked meat consumption relative to that of heavy meat consumers. Therefore this segment was labeled as "medium meat consumers". The third segment is the smallest, containing 21% of the sample. Respondents in this segment reported a significantly lower relative consumption of cooked meat and a lower meat liking score. Therefore this segment was labeled as "light meat consumers".

3.1.1. Socio-demographic and background characteristics

The light meat consumer segment is dominated by female gender and has a greater proportion of older adults living alone, who do most of the grocery shopping themselves, and decide what to eat for themselves compared to the other two segments (Table 1). Compared to the heavy

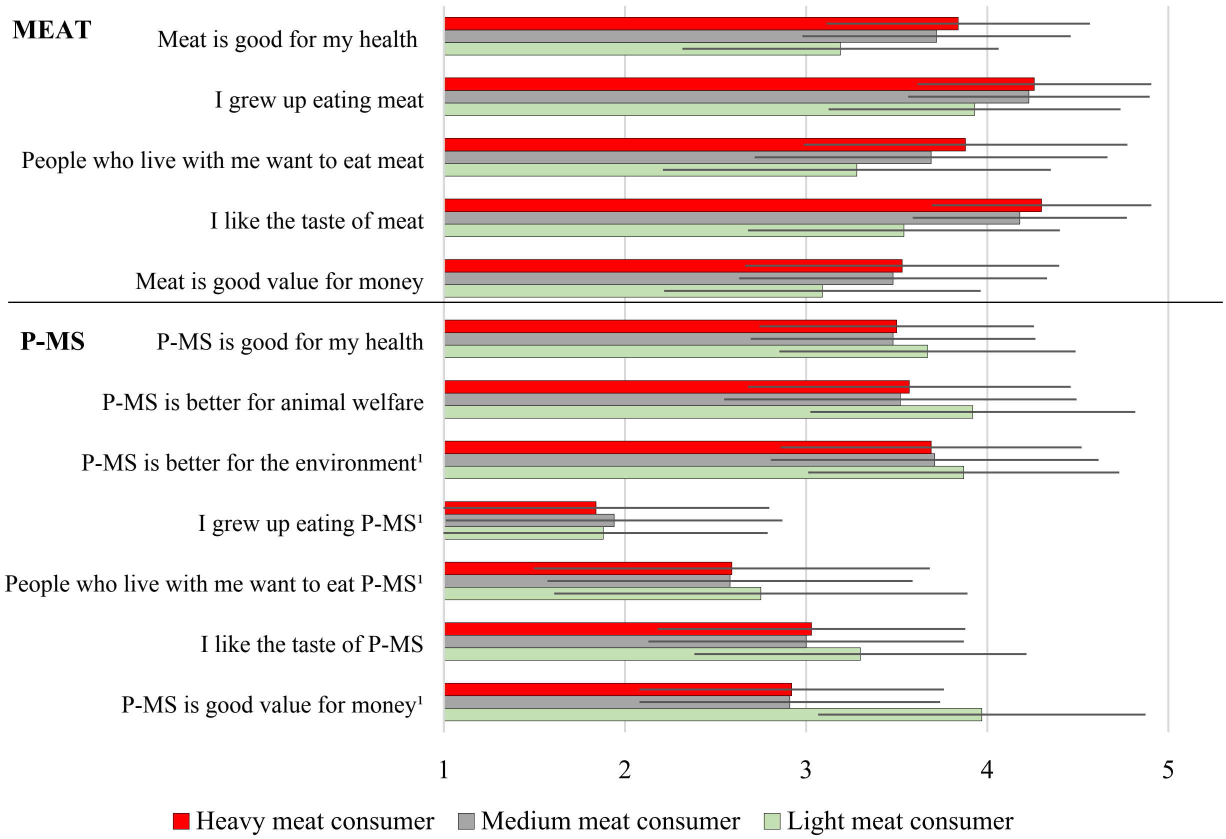

Fig. 1. Differences in agreement towards reasons of liking meat (n = 2,432) and plant-based 'meat' substitutes (P-MS) (n = 954) between the three older consumer segments. Bars represent means and lines represent standard deviations. Likert scale ranges from 1 = Strongly disagree to 5 = Strongly agree. [1] Differences between the segments not significant at p < 0.01 from Kruskal-Wallis one-way *t*-test. Otherwise, differences between segments significant at p < 0.01 from Kruskal-Wallis one-way *t*-test.

and light meat consumers, the medium meat consumer segment contains more older adults who live in Poland and fewer older adults who live in the Netherlands, and also fewer older adults who reported that their household financial situation is managed well or very well. The segments do not differ on body mass index and presence of oral health problems.

3.1.2. Appetite and protein intake, liking and attitudes

The light meat consumer segment is accounted by more older adults with a low appetite compared to the other two segments, although the effect size is considered small (Table 2). All three segments differ significantly in the proportion of older adults with a high probability of protein intake below 1.0 g/kg adjusted BW/d (Table 2). The light meat consumer segment has the largest proportion of older adults with a high probability of low protein intake (62%) while the heavy meat consumer segment has the smallest proportion of older adults with a high probability of low protein intake (35%). The segments also differ significantly in terms of proportion of older adults following a meat-limiting diet, with the light meat consumer segment having the largest share of older adults who reported to follow a meat-limiting diet on the one end and the heavy meat consumer segment having smallest share on the other end (Table 2). In total 14% of our respondents reported to follow a flexitarian diet while 17% reported to eat cooked meat five days or more per week and 5% to eat cooked meat every day of the week. Further

Table 3
Psychographic variables associated with being classified as a medium meat consumer or light meat consumer as compared to a heavy meat consumer– results from multinomial logistic regression analysis.

	Medium meat consumer (n = 1,290)			Light meat consumer (n = 525)		
	OR	95% CI		OR	95% CI	
		Lower	Upper		Lower	Upper
Food choice motive [1]						
Health	**1.14**	1.02	1.27	**1.20***	1.04	1.38
Sustainability	**1.12**	1.02	1.23	**1.35****	1.19	1.52
Price	1.04	0.94	1.14	0.92	0.81	1.03
Sensory appeal	0.92	0.82	1.03	**0.77****	0.67	0.88
Convenience	0.95	0.87	1.04	1.04	0.93	1.17
Familiarity	1.09	0.99	1.20	**0.87**	0.78	0.98
Food fussiness [2]	0.97	0.83	1.13	**1.42****	1.17	1.72
Food sustainability knowledge [3]	0.99	0.90	1.08	1.03	0.92	1.16

Note: R^2 = 0.045 (Nagelkerke). Reference category for the multinomial regression was the heavy meat consumer segment (n = 663). Significant odds ratio (OR) shown in bold based on p < 0.05. * p < 0.01. ** p < 0.001. [1] Food choice motives are a continuous score ranging from one to five, with a greater score indicating more importance is placed on the respective motive when making food choices. [2] Food fussiness is a continuous score from one to five, with a greater score indicating a greater tendency to be a fussy or picky eater. [3] Food sustainability knowledge is a continuous score from one to three with a greater score indicating greater knowledge related to the environmental impact of food.

examination of meat consumption tendencies reveal a negative correlation between meat consumption frequency and average portion size of meat consumed (Appendix Fig. A.1).

When it comes to consumption of protein-rich foods other than cooked meat, the heavy meat consumer segment reported greater consumption of eggs, processed meat, and cheese compared to the medium and light meat consumer segments. Medium meat consumers reported a lower consumption of dairy products and legumes compared to the heavy and light meat consumers and a higher consumption of processed meat compared to the light meat consumers. The light meat consumer segment reported a higher consumption of plant-based 'meat' substitutes compared to the heavy and medium meat consumers. These differences, however, resulted in small effects only.

The extent to which the older consumer segments like various protein sources differed across all protein sources except legumes (Table 2). The largest differences were found in the liking towards different types of meat, with light meat consumers having a lower liking across all meat types compared to heavy and medium meat consumers. Compared to heavy and medium meat consumers, light meat consumers had a higher liking score for plant-based 'meat' substitutes.

The level of agreement towards different reasons for liking and disliking meat and plant-based 'meat' substitutes differed between the segments (Fig. 1). Compared to light meat consumers, heavy and medium meat consumers agreed more strongly that meat is important for health, tastes good, is good value for money, that they grew up eating meat, and because the people they live with want to eat meat. Compared to heavy and medium meat consumers, light meat consumers agreed more strongly that plant-based 'meat' substitutes taste good and are good for health and better for animal welfare.

With regards to reasons for disliking meat, light meat consumers agreed more strongly that meat is not good for health nor the environment, that they do not like the taste of meat and did not grow up with it, and that they value animal welfare (Appendix Fig. A.2). Compared to light and medium meat consumers, heavy meat consumers agreed more strongly that they did not grow up with plant-based 'meat' substitutes and that they live with people who do not want to eat it as reasons for disliking plant-based 'meat' substitute.

3.2. Psychographic characteristics associated with segment classification

Table 3 shows the odds of being classified as a medium and light meat consumer as compared to being classified as a heavy meat consumer based on food choice motives, food fussiness, and food sustainability knowledge. A one-unit increase in the importance attached to health and sustainability when making food choices is associated with an average 12–14% increase in the odds of being classified as a medium meat consumer and 20–35% increase in the odds of being classified as a light meat consumer compared to a heavy meat consumer. A one-unit increase in the importance attached to sensory appeal and familiarity when making food choices is associated with a 13–23% decrease in the odds of being classified as a light meat consumer compared to a heavy meat consumer. Further, a one-unit increase in the food fussiness score (i.e. more likely to be a fussy eater) was associated with an average 42% higher likelihood of being classified as a light meat consumer than a heavy meat consumer. Food sustainability knowledge was not a significant determinant of the segment classification. Overall, these psychographic characteristics combined have low power to explain the variability in older consumer segments (Nagelkerke pseudo R-square = 4.5%).

4. Discussion

The present study identified three older consumer segments according to their cooked meat consumption and liking and explored differences in individual factors to better understand meat consumption behavior among community-dwelling older adults in the EU. Our findings confirm that the overwhelming majority of older adults is a meat-eater, with only 1.1% of the study sample being a self-declared pesco-vegetarian, 0.5% ovo- and/or lacto-vegetarian, and 0.1% vegan. Yet, the results show that there are diverse patterns of meat consumption analogous to the various levels of flexitarianism reported by Dagevos and Voordouw (2013). Opportunities and barriers to meeting the high protein needs in an environmentally sustainable way and implications for designing dietary strategies to address the unique health and sustainability challenges among older consumers in the EU are discussed below.

4.1. Socio-demographic and background characteristics

As observed in this study and supported by previous research (Dagevos & Voordouw, 2013; de Boer et al., 2014; Graça et al., 2015a, 2015b; Lacroix et al., 2019; Lacroix and Gifford, 2020; Schösler et al., 2015; Tobler et al., 2011), there were differences in gender between the different meat consumer segments, with females being more likely to be classified as a light meat consumer compared to males. Slightly more males than females were classified as heavy or medium meat consumers, which is consistent with studies observing the maleness of meat (De Backer et al., 2020; Rozin et al., 2012; Schösler et al., 2015). However, our results showed a rather small effect in gender, suggesting that cultural norms related to meat and masculinity may alter in later life, or that other factors may trump cultural norms in influencing meat consumption in older adults, such as changing appetite and reduced access to food due to mobility difficulties (Whitelock and Ensaff, 2018).

In line with previous studies, meat consumption and liking were also found to be closely linked to country of residence and household financial status (de Boer and Aiking, 2018; Milford et al., 2019). A study conducted across several EU countries found regional differences in terms of pro-environmental protein consumption and attitudes, which could be explained by cultural, culinary, and economic factors (de Boer and Aiking, 2018). For instance, a decrease in availability of animal protein and gross domestic product per capita going from west to east in the EU might explain why heavy meat consumers are largely made up of older adults living in the Netherlands and why medium meat consumers are largely made up of older adults living in Poland, and who have a less comfortable household financial situation compared to the other two segments (de Boer et al., 2018). Paradoxically, we found that the light meat consumer segment is also largely made up of older consumers living in the Netherlands. This might be due to heightened interest in the societal impacts of meat consumption and improvements in product development and marketing of commercial meat substitutes in the Netherlands (Dagevos et al., 2018). Further innovations and marketing in commercial meat substitutes may aid meat replacement in countries with similar food cultures where meal patterns and dishes are traditionally more centered on meat, such as the UK and Finland (Macdiarmid et al., 2016; Schösler et al., 2012; Vinnari et al., 2010).

In terms of involvement with food, it appears that light meat consumers were more likely to live alone and be the main household grocery shopper and food decision maker than the other two segments. In an earlier study in older adults in the UK, living alone was linked with a lack of motivation to cook and preparing simpler meals, which was further associated with a higher risk of low appetite and malnutrition (Whitelock & Ensaff, 2018). In the current study this connection between living alone and risk of low appetite and low protein intake was observed among light meat consumers. While Whitelock and Ensaff (2018) found that reduced meat consumption was also attributed to a deterioration in oral health, our study found no relationship between oral health and segment membership.

4.2. Appetite, protein intake and liking and attitudes towards protein sources

A positive relationship between meat consumption and protein intake status was observed in this study, which supports associations that have been previously reported in observational studies among community-dwelling older adults (Berner et al., 2013; Hengeveld et al., 2019). Light meat consumers are the most vulnerable segment according to their high probability of low protein intake and poor appetite. Although they reported a low consumption of meat, light meat consumers reported a higher frequency of consumption of plant-based 'meat' substitutes and a comparable frequency of consumption of non-meat protein-rich food groups compared to that of one or both segments. Further, light meat consumers tended to have a lower liking towards all meat types, fish or seafood, dairy, eggs, and bread, but reported to like and have more positive attitudes towards plant-based 'meat' substitutes compared to the other two segments. This presents an opportunity to focus on health, animal welfare, and taste of plant-based 'meat' substitutes to facilitate greater consumption of these protein sources among light meat consumers.

Contrastingly, heavy and medium meat consumers' positive attitudes towards meat with regards to health, taste, value for money, and their conditioning to eating meat, i.e. having grown up eating meat and being surrounded by others who like to eat meat, have been previously documented as key barriers to replacing meat with alternative, more sustainable plant-based protein sources (Macdiarmid et al., 2016; Stubbs et al., 2018). Notably, medium meat consumers had a slightly more positive attitude towards animal welfare compared to heavy meat consumers, suggesting that valuing animal welfare may caution medium meat consumers away from heavy meat consumption (de Boer et al., 2017; Hartmann and Siegrist, 2020).

4.3. Psychographic determinants of meat consumption behavior

Beyond investigating differences between the older consumer segments, we also identified potential determinants associated with the classification of older adults into one of the three consumer segments. The findings of this study reinforce the importance of health and sustainability food choice motives as facilitators and sensory appeal and familiarity as barriers for altering meat consumption behavior (Graça et al., 2019; Hoek et al., 2011). Convenience and price were not significant determinants in our study, although these motives have been found previously to be significant inhibitory motives for meat replacement and key motivations for food choice among older consumers (Kamphuis et al., 2015; Locher et al., 2009; Vainio et al., 2016). In this study, convenience was defined as the ease of food preparation (e.g. importance that the food can be cooked very simply, takes no time to prepare, is easy to prepare) whereas in other studies among older adults convenience also included the component of accessibility (e.g. importance that the food is easily available in shops or supermarkets) (Kamphuis et al., 2015; Locher et al., 2009). Kamphuis et al. (2015) found that the accessibility component of convenience (i.e. travel time) was a significant determinant for older adults' preferences in meal planning and food purchasing decisions while ease of food preparation (i.e. preparation time) was not. Further, we found that light meat consumers were more likely to be a fussy eater compared to heavy meat consumers, which contrasts expectations, as a previous study among adults found that food neophobia, an overlapping construct of food fussiness, was more common among those who eat meat more frequently (Lacroix & Gifford, 2019). However, as food fussiness has been previously linked to low appetite in older adults (Hung et al., 2019), it is likely that light meat consumers' poorer appetite partly explains this finding. Although several studies have found knowledge of the environmental impact of food to affect environmental sustainable food choices (Peschel et al., 2016; Wunderlich et al., 2018), our findings are in line with other studies that found knowledge not to influence environmental sustainable food choices (Asvatourian et al., 2018). This supports previous deductions that knowledge alone may be insufficient to directly change one's meat consumption towards more pro-environmental protein consumption (Asvatourian et al., 2018; Hoek et al., 2017).

4.4. Health and sustainability implications of meat consumption in older adults

Moderate consumption of meat is important for achieving high-quality protein and essential nutrients (Phillips, 2012; Phillips et al., 2015) and can be part of an environmentally sustainable diet (Vieux et al., 2020). However, cohort studies reporting the habitual meat intake of older adults indicate that their average meat consumption may be above the amount recommended for a healthy diet (Grasso et al., 2020; Struijk et al., 2018). The findings discussed above underscore the heterogeneity of meat consumption behavior in this sub-population and the importance of tailoring strategies for pro-environmental protein consumption among older consumers. Further, they support the hypothesis that older adults need to 'do things differently', e.g. choose alternative protein sources instead of meat, rather than only 'use less', e.g. meat reduction only, to achieve adequate protein intake within environmental limits. The actual pro-environmental protein consumption strategy, however, will vary depending on alternative proteins being readily available in the market (Schösler et al., 2012) and the country in which the strategy is implemented given the different food cultures, preferences, and habits across the EU countries (see Appendix Table A.2).

A diet optimization study in older adults shows that meat reduction paired with increases in diverse plant-based protein sources is a potential strategy to increase protein intake in older adults that can have dual benefits in terms of human and planet health (Grasso et al., 2020). The current study shows that older adults on average like legumes, nuts or seeds, and bread and grain products, all of which could be options for sustainable protein sources. Emphasizing the healthiness and sustainability of these alternatives and other plant-based protein sources could be used as a focus in targeted strategies relating to meat replacement among medium meat consumers (Graça et al., 2019). By contrast, addressing sensory appeal and familiarity of alternative protein sources in communication strategies and product development is needed for meat replacement particularly among heavy meat consumers. Consumer-oriented product development and improvements in the resemblance and sensory attributes of commercial meat substitutes may be important incentives for heavy meat consumers in the transition towards pro-environmental protein consumption (Stubbs et al., 2018).

While a reduction in meat consumption and increase in plant-based protein sources would provide the greatest health and environmental benefits (Springmann et al., 2018), it may not be suitable for vulnerable older adults with a high risk of low protein intake. A strategy to lower the diet's impact on the environment without changing the amount of meat consumed is substituting environmentally-intensive meat (e.g. beef) with less environmentally-intensive meat (e.g. chicken, pork) (Berners-Lee et al., 2012; Grasso et al., 2020; Willett et al., 2019). Further, encouraging increased consumption of other animal-based protein sources such as dairy, fish, and eggs may be beneficial for increasing the intake of high-quality protein and essential nutrients (Vieux et al., 2020), yet would elicit more adverse effects for the environment compared to promoting intake of plant-based protein sources like legumes, nuts, and whole grains (de Gavelle et al., 2020). This is a trade-off that needs to be made especially for vulnerable older adults with poor appetite. As plant-based protein sources contain fewer and lower amounts of essential amino acids and are less well digested than animal-based protein sources, higher intakes of plant-based proteins per meal may be needed to achieve similar anabolic responses as compared to animal-based protein foods (Berrazaga et al., 2019). Further, older adults with poor appetite have a slightly higher risk of malnutrition than those with a good appetite (Hung et al., 2019) and hence promotion of animal-based protein sources may be a more efficient source of protein and other nutrients like vitamin B12, iron, and zinc (Lonnie et al., 2018; Tijhuis et al., 2011).

5. Future prospects

More research is needed to understand the factors that influence meat consumption in later life. Food choice motives, food fussiness, and food sustainability knowledge were found to explain little of the variance in older consumer segment membership, making it clear that there are other important factors that influence meat consumption behavior. Food sustainability knowledge was assessed using an ad hoc scale and should be tested for validity and reliability and refined in future studies. Investigating other factors such as values, subjective norms, self-efficacy, and motivations may help further the understanding of pro-environmental protein consumption in community-dwelling older adults (Çoker & van der Linden, 2020; Hunter and Röös, 2016; Lacroix & Gifford, 2019).

In addition, more exploratory research is needed to identify culturally acceptable sustainable protein sources that older adults are willing to either replace meat with or to consume in greater quantity to increase their protein intake. Increasing awareness and acceptance of hybrid meat, for instance, may be a viable solution especially for heavy meat consumers as it is most similar to conventional meat in terms of texture and taste (Lang, 2020). It was previously found that older adults are not accepting of alternative protein sources like insects and cultured meat, but that they were relatively accepting of plant-based protein sources (Grasso et al., 2019). Further innovations in plant-based 'meat' substitutes could better appeal to those who enjoy eating meat. Protein enrichment in foods by the food industry or by adding protein powder to meals are other alternative approaches to increasing protein intake, yet the environmental impact of these approaches are under-researched.

Meat consumption in this study was measured by two questions on frequency of cooked meat consumption and average portion size of meat consumed with a warm meal. No distinction was made on the types of meat consumed. It is likely that intake of cooked meat was underestimated due to the measurements' reliance on memory and the global-way meat consumption was probed (Haftenberger et al., 2010). As different meat types are associated with different environmental impacts (Poore & Nemecek, 2018), future segmentation research among older adults should evaluate habitual consumption of various types of meat to get a more nuanced picture of meat consumption in this older population. For instance, heavy meat consumers may be fragmented into smaller groups depending on the type of meat eaten (e.g. heavy meat consumers primarily eating beef may have a different profile than heavy meat consumers primarily eating poultry). Furthermore, different meat types are associated with additional concerns outside the scope of this paper, e.g. antibiotic use in poultry production and animal welfare (Mottet and Tempio, 2017), warranting more differentiated (e.g. food safety-related) considerations in future research searching for more sustainable meat consumption strategies. Assessing attitudes towards other factors influencing the sustainability of meat, such as its production method (e.g. conventional versus organic meat) (Garnett et al., 2017), could provide further insights into meat consumption behavior.

The use of the Protein Screener 55 + allowed us to gauge the risk of low protein intake using a short food frequency questionnaire with relatively low burden on the participant. Consequently, this study did not conduct a full assessment of protein intake. A limitation of the Protein Screener 55 + is that it focuses on the most important protein sources for Dutch community-dwelling older adults, which may overestimate low risk of protein intake in countries that have different important sources of protein. Future studies should determine the habitual protein intake of the older consumer segments to determine whether intake is indeed above or below their protein requirement. Further, as the division of protein over meals may be relevant to maintain lean body mass and strength (Farsijani et al., 2016; Loenneke et al., 2016), more research into the timing of protein-rich food groups consumption would give more insights into a redistribution strategy.

The results of the current study apply primarily to community-dwelling older adults with access to and basic competencies for using a computer, and the implications should therefore focus on this target group. While the relevance of the implications drawn in this study may extend to other older populations, more research is needed to identify, quantify, and profile consumer segments within such populations.

6. Conclusions

In conclusion, community-dwelling older adults in the EU can be grouped into three segments based on meat consumption and liking. Relevant differences between the older consumer segments were found in socio-demographic and background characteristics, appetite, protein intake status, and liking and attitudes towards meat and plant-based 'meat' substitutes. Health, sustainability, sensory appeal, and familiarity food choice motives and food fussiness were the main drivers of the segmentation. These findings reinforce the importance and need for developing dietary strategies that consider the context of meat consumption, the environmental impact of protein sources, and the unique nutrition and health needs and preferences of different older consumer groups.

Funding

This work was supported by the EU-funded project PROMISS ('PRevention Of Malnutrition In Senior Subjects in the EU') within the framework of Horizon 2020 research and innovation program [grant number 678732].

CRediT authorship contribution statement

Alessandra C. Grasso: Conceptualization, Writing - original draft, Writing - review & editing. **Yung Hung:** Conceptualization, Writing - review & editing. **Margreet R. Olthof:** Supervision, Funding acquisition, Writing - review & editing. **Ingeborg A. Brouwer:** Supervision, Funding acquisition, Writing - review & editing. **Wim Verbeke:** Conceptualization, Funding acquisition, Writing - review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

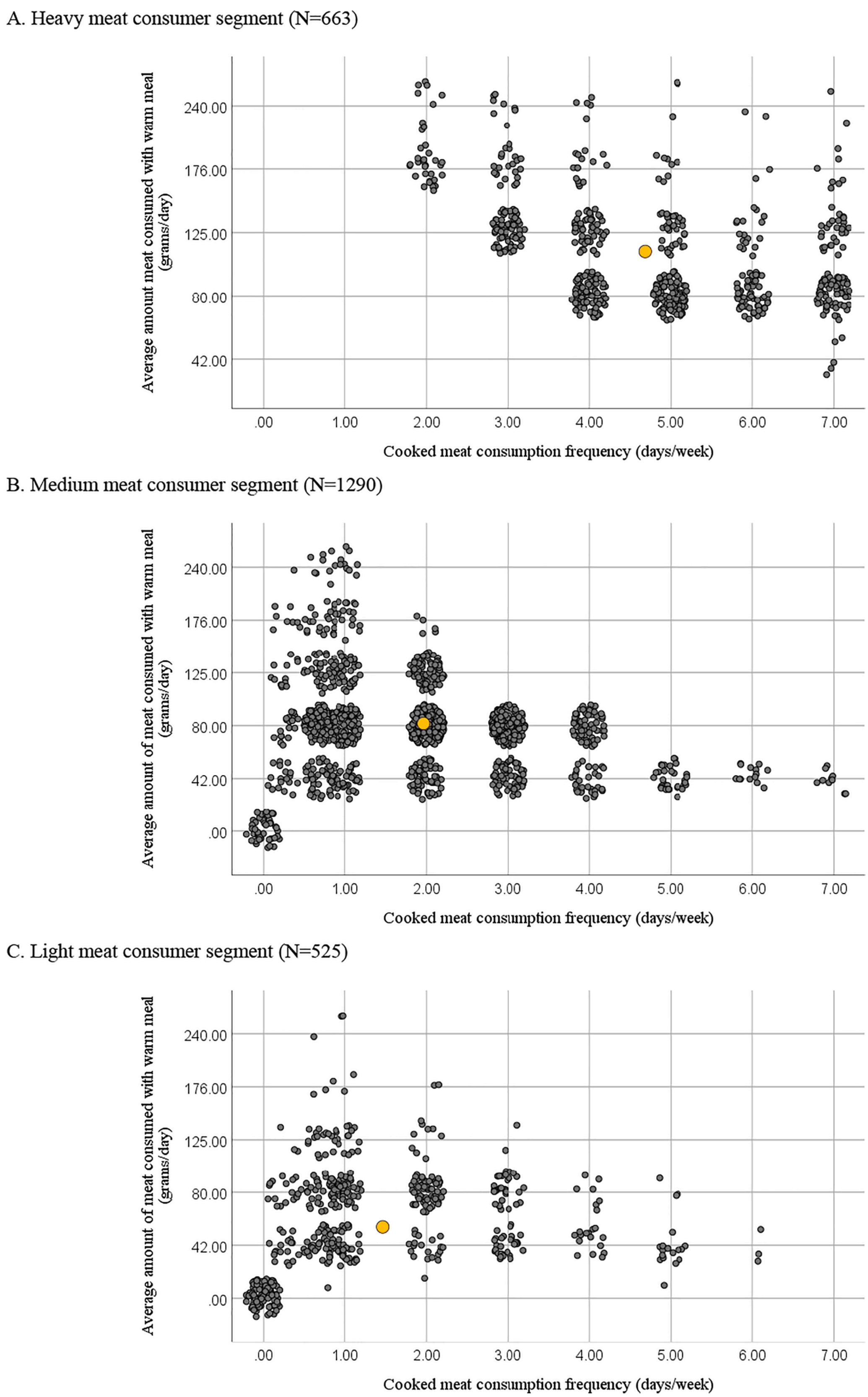

Fig. A1. Jittered scatterplots of cooked meat consumption frequency and average amount of meat consumed with warm meal by older consumer segments. Pearson correlations between cooked meat consumption frequency and average amount of meat consumed with warm meal are r = -0.458, p < 0.001 for heavy meat consumers, r = -0.216, p < 0.001 for medium meat consumers, and r = 0.177, p < 0.001 for light meat consumers. Orange dot represents average value. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.) (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

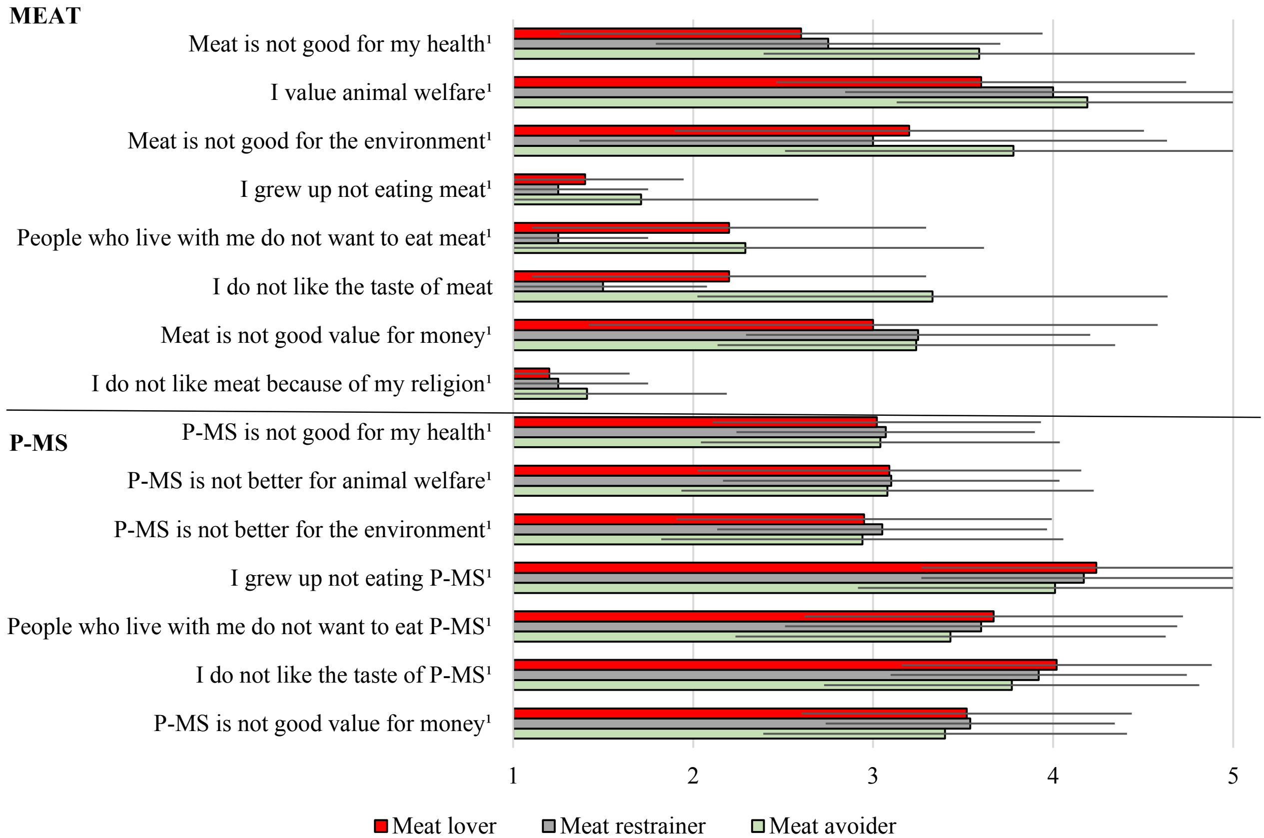

Fig. A2. Differences in agreement towards reasons of disliking meat (n = 99) and plant-based 'meat' substitutes (P-MS) (n = 1147) between the older consumer segments. Bars represent means and lines represent standard deviations. Likert scale ranges from 1 = Strongly disagree to 5 = Strongly agree. [1] Differences between the segments not significant at p < 0.01 from Kruskal-Wallis one-way *t*-test. Otherwise, differences between segments significant at p < 0.01 from Kruskal-Wallis one-way *t*-test.

Table A1
Correlation matrix of determinants in multinomial logistic regression.[1]

	X1	X2	X3	X4	X5	X6	X7	X8
X1: Health [2]	–							
X2: Sustainability [2]	0.500*	–						
X3: Price [2]	0.214*	0.154*	–					
X4: Sensory appeal [2]	0.356*	0.233*	0.250*	–				
X5: Convenience [2]	0.153*	0.101*	0.311*	0.189*	–			
X6: Familiarity [2]	0.146*	0.105*	0.220*	0.171*	0.328*	–		
X7: Food fussiness [3]	−0.207*	−0.125*	−0.027	−0.199*	0.119*	0.254*	–	
X8: Food-related sustainability knowledge [4]	0.144*	0.119*	0.044	0.134*	−0.013	−0.92*	−0.232*	–

[1] Items with asterisk have a statistically significant Pearson correlation, *p < 0.01. [2] Food choice motives are a continuous score ranging from one to five, with a greater score indicating more importance is placed on the respective motive when making food choices. [3] Food fussiness is a continuous score from one to five, with a greater score indicating a greater tendency to be a fussy or picky eater. [4] Food sustainability knowledge is a continuous score from one to three with a greater score indicating greater knowledge related to the environmental impact of food.

Table A2
Consumption and liking of meat and other protein-rich food groups in older adults by country.

	Finland (n = 500)	Poland (n = 500)	Spain (n = 500)	Netherlands (n = 500)	UK (n = 500)	*p*-value (η_p^2)
Consumption						
Cooked meat (g/d)	35.0 ± 33.4 [a]	25.6 ± 27.8[b]	33.7 ± 29.6 [a]	37.6 ± 28.1 [a]	32.1 ± 28.2 [a]	<0.001 (0.09)
Frequency (d/wk)	2.7 ± 2.0[b]	2.1 ± 1.6[c, d]	2.1 ± 1.5 [d]	3.6 ± 2.0 [a]	2.5 ± 1.9[b, c]	<0.001 (0.09)
Fish (d/wk)	1.8 ± 1.7 [a]	1.0 ± 1.1[b]	2.0 ± 1.6 [a]	1.1 ± 1.1[b]	1.1 ± 1.0[b]	<0.001 (0.09)
Dairy products excl. cheese (d/wk)	3.7 ± 2.9 [a, b]	2.1 ± 2.2[c]	3.4 ± 2.7[b]	4.1 ± 2.7 [a]	2.2 ± 2.6[c]	<0.001 (0.09)
Eggs (d/wk)	2.3 ± 2.3 [a]	1.8 ± 1.6[b]	2.3 ± 1.7 [a]	2.0 ± 1.8 [a, b]	1.6 ± 1.5[b]	<0.001 (0.02)
Legumes (d/wk)	0.6 ± 1.2[c]	1.3 ± 1.4[b]	1.9 ± 1.4 [a]	1.6 ± 2.0 [a]	1.0 ± 1.4[b]	<0.001 (0.07)
Nuts or peanuts (d/wk)	1.4 ± 2.2[c]	1.4 ± 2.0[c]	2.4 ± 2.4 [a]	1.9 ± 2.1 [a]	1.1 ± 1.9[c]	<0.001 (0.05)
Pasta or noodles (d/wk)	1.1 ± 1.6[b]	1.4 ± 1.3 [a]	1.4 ± 1.3 [a]	1.2 ± 1.2 [a, b]	1.0 ± 1.0[b]	<0.001 (0.02)
Processed meat (d/wk)	3.5 ± 2.6 [a]	3.3 ± 2.0 [a]	2.1 ± 1.8[c]	2.8 ± 2.3[b]	1.6 ± 1.5 [d]	<0.001 (0.11)
Cheese (d/wk)	4.9 ± 2.4 [a]	2.8 ± 2.4[c]	2.0 ± 2.1 [d]	4.1 ± 2.4[b]	2.4 ± 2.0[c, d]	<0.001 (0.19)
Plant-based 'meat' (d/wk)	0.2 ± 0.7[c]	0.3 ± 0.9[b, c]	0.2 ± 0.8[c]	0.4 ± 1.0 [a]	0.3 ± 0.9 [a, b]	<0.001 (0.01)
Liking						
Beef or veal (n = 2444)	4.0 ± 0.9	4.0 ± 0.9	4.0 ± 0.9	4.0 ± 1.0	4.0 ± 1.0	0.394 (<0.01)
Lamb (n = 2403)	3.4 ± 1.1[b]	3.6 ± 1.2[b]	3.9 ± 1.0 [a]	3.1 ± 4.1[c]	3.9 ± 1.3 [a]	<0.001 (0.06)
Pork (n = 2449)	3.9 ± 0.9 [a]	4.0 ± 0.9 [a]	3.9 ± 0.9 [a]	3.6 ± 1.2[b]	3.9 ± 1.1 [a]	<0.001 (0.03)
Poultry (n = 2456)	4.4 ± 0.7 [a]	4.2 ± 0.8[b, c]	4.1 ± 0.8[c]	4.0 ± 1.1[c]	4.3 ± 0.9 [a, b]	<0.001 (0.03)
Fish or seafood (n = 2449)	4.4 ± 0.8 [a]	4.3 ± 1.0 [a, b]	4.4 ± 0.7 [a]	4.1 ± 2.1[b]	4.3 ± 1.0 [a, b]	<0.001 (0.02)
Hybrid meat (n = 1990)	2.6 ± 0.9 [a, b]	2.5 ± 0.9[b, c]	2.8 ± 1.1 [a]	2.3 ± 1.1[c]	2.4 ± 1.0[c]	<0.001 (0.04)
Dairy (n = 2456)	4.3 ± 0.8	4.3 ± 0.8	4.3 ± 0.7	4.4 ± 0.7	4.4 ± 0.7	0.441 (<0.01)
Egg (n = 2458)	4.4 ± 0.6	4.4 ± 0.8	4.3 ± 0.7	4.3 ± 0.7	4.3 ± 0.8	0.059 (<0.01)
Plant-based 'meat' (n = 2101)	2.7 ± 1.0 [a]	2.5 ± 1.0 [a, b]	2.3 ± 1.1[b]	2.5 ± 1.3 [a, b]	2.4 ± 1.2 [a, b]	<0.001 (0.01)
Legumes (n = 2429)	3.8 ± 0.9[b]	4.4 ± 0.8 [a]	4.4 ± 0.7 [a]	4.5 ± 0.6 [a]	3.6 ± 1.1[c]	<0.001 (0.16)
Nuts or seeds (n = 2453)	4.1 ± 1.0 [a, b]	4.3 ± 0.9 [a]	4.3 ± 0.8 [a]	4.2 ± 0.9 [a]	3.9 ± 1.0[b]	<0.001 (0.02)
Grain-based products excl. bread (n = 2453)	3.8 ± 0.8[c]	4.1 ± 0.8 [a]	3.9 ± 0.9[b, c]	3.9 ± 1.0[b, c]	4.0 ± 0.8 [a, b]	<0.001 (0.02)
Bread (n = 2464)	4.5 ± 0.7 [a]	4.2 ± 0.8[b]	4.2 ± 0.7[b]	4.2 ± 0.8[b]	4.1 ± 0.7[b]	<0.001 (0.03)

[a-d]Different superscripts indicate significantly different standardized means in each row following ANOVA post hoc Tukey test at $p < 0.01$. Partial eta-squared (η_p^2) indicates the effect size.

References

Asp, E. H. (1999). Factors affecting food decisions made by individual consumers. *Food Policy, 24*(2), 287–294. https://doi.org/10.1016/S0306-9192(99)00024-X

Asvatourian, V., Craig, T., Horgan, G. W., Kyle, J., & Macdiarmid, J. I. (2018). Relationship between pro-environmental attitudes and behaviour and dietary intake patterns. *Sustainable Production and Consumption, 16*, 216–226. https://doi.org/10.1016/j.spc.2018.08.009

Bauer, J., Biolo, G., Cederholm, T., Cesari, M., Cruz-Jentoft, A. J., Morley, J. E., et al. (2013). Evidence-based recommendations for optimal dietary protein intake in older people: A position paper from the PROT-AGE study group. *Journal of the American Medical Directors Association, 14*(8), 542–559. https://doi.org/10.1016/j.jamda.2013.05.021

Berner, L. A., Becker, G., Wise, M., & Doi, J. (2013). Characterization of dietary protein among older adults in the United States: Amount, animal sources, and meal patterns. *Journal of the Academy of Nutrition and Dietetics, 113*(6), 809–815. https://doi.org/10.1016/j.jand.2013.01.014

Berners-Lee, M., Hoolohan, C., Cammack, H., & Hewitt, C. N. (2012). The relative greenhouse gas impacts of realistic dietary choices. *Energy Policy, 43*, 184–190. https://doi.org/10.1016/j.enpol.2011.12.054

Berrazaga, I., Micard, V., Gueugneau, M., & Walrand, S. (2019). The role of the anabolic properties of plant- versus animal-based protein sources in supporting muscle mass maintenance: A critical review. *Nutrients, 11*(8), 1825. https://doi.org/10.3390/nu11081825

Beukers, M. H., Dekker, L. H., de Boer, E. J., Perenboom, C. W. M., Meijboom, S., Nicolaou, M., et al. (2015). Development of the HELIUS food frequency questionnaires: Ethnic-specific questionnaires to assess the diet of a multiethnic population in The Netherlands. *European Journal of Clinical Nutrition, 69*(5), 579–584. https://doi.org/10.1038/ejcn.2014.180

Chen, C., Chaudhary, A., & Mathys, A. (2019). Dietary change scenarios and implications for environmental, nutrition, human health and economic dimensions of food sustainability. *Nutrients, 11*(4), 856. https://doi.org/10.3390/nu11040856

Cohen, J. (1995). Statistical power analysis for the behavioral sciences (2nd ed., 5th print. ed.). Hillsdale, N.J.: Erlbaum, (Chapter 7).

Çoker, E. N., & van der Linden, S. (2020). Fleshing out the theory of planned of behavior: Meat consumption as an environmentally significant behavior. *Current Psychology*. https://doi.org/10.1007/s12144-019-00593-3

Cuthbertson, D., Smith, K., Babraj, J., Leese, G., Waddell, T., Atherton, P., et al. (2005). Anabolic signaling deficits underlie amino acid resistance of wasting, aging muscle. *The FASEB Journal, 19*(3), 1–22. https://doi.org/10.1096/fsb2.v19.310.1096/fj.04-2640fje

Cylus, J., Figueras, J., & Normand, C. (2019). *Will population ageing spell the end of the welfare state: A review of evidence and policy options*. Copenhagen, Denmark: World Health Organization.

Dagevos, H., Verhoog, D., Van Horne, P., & Hoste, R. (2018). *Vleesconsumptie per hoofd van de bevolking in Nederland, 2005–2017*. Wageningen Economic Research: Wageningen.

Dagevos, H., & Voordouw, J. (2013). Sustainability and meat consumption: Is reduction realistic? *Sustainability: Science Practice and Policy, 9*(2), 60–69. https://doi.org/10.1080/15487733.2013.11908115

De Backer, C., Erreygers, S., De Cort, C., Vandermoere, F., Dhoest, A., Vrinten, J., et al. (2020). Meat and masculinities. Can differences in masculinity predict meat consumption, intentions to reduce meat and attitudes towards vegetarians? *Appetite, 147*, 104559. https://doi.org/10.1016/j.appet.2019.104559

de Boer, J., & Aiking, H. (2018). Prospects for pro-environmental protein consumption in Europe: Cultural, culinary, economic and psychological factors. *Appetite, 121*, 29–40. https://doi.org/10.1016/j.appet.2017.10.042

de Boer, J., Schösler, H., & Aiking, H. (2014). "Meatless days" or "less but better"? Exploring strategies to adapt Western meat consumption to health and sustainability challenges. *Appetite, 76*, 120–128. https://doi.org/10.1016/j.appet.2014.02.002

de Boer, J., Schösler, H., & Aiking, H. (2017). Towards a reduced meat diet: Mindset and motivation of young vegetarians, low, medium and high meat-eaters. *Appetite, 113*, 387–397. https://doi.org/10.1016/j.appet.2017.03.007

de Boer, J., Schösler, H., & Aiking, H. (2018). Exploring the relative importance of "Reward" and "Reflection" in food orientations: Relevance for healthier and more sustainable diets. *Food Quality and Preference, 64*, 126–130. https://doi.org/10.1016/j.foodqual.2017.10.001

de Gavelle, E., Leroy, P., Perrimon, M., Huneau, J.-F., Sirot, V., Orset, C., et al. (2020). Modeled gradual changes in protein intake to increase nutrient adequacy lead to greater sustainability when systematically targeting an increase in the share of plant protein. *Climatic Change, 161*(1), 129–149. https://doi.org/10.1007/s10584-019-02592-6

den Uijl, L. C., Jager, G., de Graaf, C., Waddell, J., & Kremer, S. (2014). It is not just a meal, it is an emotional experience - a segmentation of older persons based on the emotions that they associate with mealtimes. *Appetite, 83*, 287–296. https://doi.org/10.1016/j.appet.2014.09.002

Deutz, N. E. P., Bauer, J. M., Barazzoni, R., Biolo, G., Boirie, Y., Bosy-Westphal, A., et al. (2014). Protein intake and exercise for optimal muscle function with aging: Recommendations from the ESPEN Expert Group. *Clinical Nutrition, 33*(6), 929–936. https://doi.org/10.1016/j.clnu.2014.04.007

EFSA. (2012). *Scientific opinion on dietary reference values of protein European Food Safety Authority Panel on Dietetic Products*. Nutrition and Allergies (NDA): Parma.

Commission, E. (2017). *The 2018 Ageing Report: Underlying assumptions & projection methodologies*. European Union: Luxembourg.

Farsijani, S., Morais, J. A., Payette, H., Gaudreau, P., Shatenstein, B., Gray-Donald, K., et al. (2016). Relation between mealtime distribution of protein intake and lean mass loss in free-living older adults of the NuAge study. The American Journal of Clinical Nutrition, 104(3), 694-703. https://doi.org/10.3945/ajcn.116.130716.

Garnett, T., Godde, C., Muller, A., Röös, E., Smith, P., de Boer, I., et al. (2017). Grazed and confused? Ruminanting on cattle, grazing systems, methane, nitrous oxide, the soil carbon sequestration question - and what it all means for greenhouse gas emissions. Food Climate Research Network, Oxford Martin Programme on the Future of Food, Environmental Change Institute, University of Oxford: Oxford.

Godfray, H. C. J., Aveyard, P., Garnett, T., Hall, J. W., Key, T. J., Lorimer, J., et al. (2018). Meat consumption, health, and the environment. *Science, 361*(6399), eaam5324. https://doi.org/10.1126/science:aam5324

Graça, J., Calheiros, M. M., & Oliveira, A. (2015a). Attached to meat? (Un)Willingness and intentions to adopt a more plant-based diet. *Appetite, 95*, 113–125. https://doi.org/10.1016/j.appet.2015.06.024

Graça, J., Godinho, C. A., & Truninger, M. (2019). Reducing meat consumption and following plant-based diets: Current evidence and future directions to inform integrated transitions. *Trends in Food Science & Technology, 91*, 380–390. https://doi.org/10.1016/j.tifs.2019.07.046

Graça, J., Oliveira, A., & Calheiros, M. M. (2015b). Meat, beyond the plate. Data-driven hypotheses for understanding consumer willingness to adopt a more plant-based diet. *Appetite, 90*, 80–90. https://doi.org/10.1016/j.appet.2015.02.037

Grasso, A. C., Hung, Y., Olthof, M. R., Verbeke, W., & Brouwer, I. A. (2019). Older consumers' readiness to accept alternative, more sustainable protein sources in the European Union. *Nutrients, 11*(8), 1904. https://doi.org/10.3390/nu11081904

Grasso, A. C., Olthof, M. R., van Dooren, C., Broekema, R., Visser, M., & Brouwer, I. A. (2020). Protein for a healthy future: How to increase protein intake in an environmentally sustainable way in older adults in the Netherlands. *The Journal of Nutrition, 151*(1), 109–119. https://doi.org/10.1093/jn/nxaa322

Haftenberger, M., Heuer, T., Heidemann, C., Kube, F., Krems, C., & Mensink, G. B. M. (2010). Relative validation of a food frequency questionnaire for national health and nutrition monitoring. *Nutrition Journal, 9*(1), 36. https://doi.org/10.1186/1475-2891-9-36

Hair, J. F., Black, B., Babin, B., & Anderson, R. E. (2014). *Multivariate data analysis: Pearson new international edition* (7th ed.). Essex: Pearson Education Limited (Chapter 8).

Halkjær, J., Olsen, A., Bjerregaard, L. J., Deharveng, G., Tjønneland, A., Welch, A. A., et al. (2009). Intake of total, animal and plant proteins, and their food sources in 10 countries in the European Prospective Investigation into Cancer and Nutrition. *European Journal of Clinical Nutrition, 63*(S4), S16–S36. https://doi.org/10.1038/ejcn.2009.73

Hanisah, R., Shahar, S., & Lee, F. S. (2012). Validation of screening tools to assess appetite among geriatric patients. *The Journal of Nutrition, Health & Aging, 16*(7), 660–665. https://doi.org/10.1007/s12603-012-0056-6

Hartmann, C., & Siegrist, M. (2020). Our daily meat: Justification, moral evaluation and willingness to substitute. *Food Quality and Preference, 80*, 103799. https://doi.org/10.1016/j.foodqual.2019.103799

Hengeveld, L. M., Boer, J. M. A., Gaudreau, P., Heymans, M. W., Jagger, C., Mendonça, N., et al. (2020). Prevalence of protein intake below recommended in community-dwelling older adults: A meta-analysis across cohorts from the PROMISS consortium. *Journal of Cachexia, Sarcopenia and Muscle., 11*(5), 1212–1222. https://doi.org/10.1002/jcsm.v11.510.1002/jcsm.12580

Hengeveld, L. M., Pelgröm, A. D. A., Visser, M., Boer, J. M. A., Haveman-Nies, A., & Wijnhoven, H. A. H. (2019). Comparison of protein intake per eating occasion, food sources of protein and general characteristics between community-dwelling older adults with a low and high protein intake. *Clinical Nutrition ESPEN, 29*, 165–174. https://doi.org/10.1016/j.clnesp.2018.10.013

Hoek, A. C., Luning, P. A., Weijzen, P., Engels, W., Kok, F. J., & de Graaf, C. (2011). Replacement of meat by meat substitutes. A survey on person- and product-related factors in consumer acceptance. *Appetite, 56*(3), 662–673. https://doi.org/10.1016/j.appet.2011.02.001

Hoek, A. C., Pearson, D., James, S. W., Lawrence, M. A., & Friel, S. (2017). Healthy and environmentally sustainable food choices: Consumer responses to point-of-purchase actions. *Food Quality and Preference, 58*, 94–106. https://doi.org/10.1016/j.foodqual.2016.12.008

Houston, D. K., Nicklas, B. J., Ding, J., Harris, T. B., Tylavsky, F. A., Newman, A. B., et al. (2008). Dietary protein intake is associated with lean mass change in older, community-dwelling adults: the Health, Aging, and Body Composition (Health ABC) Study. The American Journal of Clinical Nutrition, 87(1), 150-155. https://doi.org/10.1093/ajcn/87.1.150.

Hung, Y., Wijnhoven, H., Visser, M., & Verbeke, W. (2019). Appetite and protein intake strata of older adults in the European Union: Socio-demographic and health characteristics, diet-related and physical activity behaviours. *Nutrients, 11*(4), 777. https://doi.org/10.3390/nu11040777

Hunter, E., & Röös, E. (2016). Fear of climate change consequences and predictors of intentions to alter meat consumption. *Food Policy, 62*, 151–160. https://doi.org/10.1016/j.foodpol.2016.06.004

Isanejad, M., Mursu, J., Sirola, J., Kröger, H., Rikkonen, T., Tuppurainen, M., et al. (2016). Dietary protein intake is associated with better physical function and muscle strength among elderly women. *British Journal of Nutrition, 115*(7), 1281–1291. https://doi.org/10.1017/S000711451600012X

Kamphuis, C. B., de Bekker-Grob, E. W., & van Lenthe, F. J. (2015). Factors affecting food choices of older adults from high and low socioeconomic groups: A discrete choice experiment. *The American Journal of Clinical Nutrition, 101*(4), 768–774. https://doi.org/10.3945/ajcn.114.096776

Lacroix, K., & Gifford, R. (2019). Reducing meat consumption: Identifying group-specific inhibitors using latent profile analysis. *Appetite, 138*, 233–241. https://doi.org/10.1016/j.appet.2019.04.002

Lacroix, K., & Gifford, R. (2020). Targeting interventions to distinct meat-eating groups reduces meat consumption. *Food Quality and Preference, 86*, 103997. https://doi.org/10.1016/j.foodqual.2020.103997

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology, 4*(863). https://doi.org/10.3389/fpsyg.2013.00863

Lang, M. (2020). Consumer acceptance of blending plant-based ingredients into traditional meat-based foods: Evidence from the meat-mushroom blend. *Food Quality and Preference, 79*, 103758. https://doi.org/10.1016/j.foodqual.2019.103758

Levine, T. R., & Hullett, C. R. (2002). Eta Squared, partial eta squared, and misreporting of effect size in communication research. *Human Communication Research, 28*(4), 612–625. https://doi.org/10.1111/j.1468-2958.2002.tb00828.x

Locher, J. L., Ritchie, C. S., Roth, D. L., Sen, B., Vickers, K. S., & Vailas, L. I. (2009). Food choice among homebound older adults: Motivations and perceived barriers. *The Journal of Nutrition, Health and Aging, 13*(8), 659–664. https://doi.org/10.1007/s12603-009-0194-7

Loenneke, J. P., Loprinzi, P. D., Murphy, C. H., & Phillips, S. M. (2016). Per meal dose and frequency of protein consumption is associated with lean mass and muscle performance. *Clinical Nutrition, 35*(6), 1506–1511. https://doi.org/10.1016/j.clnu.2016.04.002

Lonnie, M., Hooker, E., Brunstrom, J., Corfe, B., Green, M., Watson, A., et al. (2018). Protein for life: Review of optimal protein intake, sustainable dietary sources and the effect on appetite in ageing adults. *Nutrients, 10*(3), 360. https://doi.org/10.3390/nu10030360

Macdiarmid, J. I., Douglas, F., & Campbell, J. (2016). Eating like there's no tomorrow: Public awareness of the environmental impact of food and reluctance to eat less meat as part of a sustainable diet. *Appetite, 96*, 487–493. https://doi.org/10.1016/j.appet.2015.10.011

Mendonça, N., Granic, A., Hill, T. R., Siervo, M., Mathers, J. C., Kingston, A., et al. (2019). Protein intake and disability trajectories in very old adults: The Newcastle 85+ study. *Journal of the American Geriatrics Society, 67*(1), 50–56. https://doi.org/10.1111/jgs.2019.67.issue-110.1111/jgs.15592

Mertens, E., Kuijsten, A., van Zanten, H. HE., Kaptijn, G., Dofková, M., Mistura, L., et al. (2019). Dietary choices and environmental impact in four European countries. *Journal of Cleaner Production, 237*, 117827. https://doi.org/10.1016/j.jclepro.2019.117827

Milford, A. B., Le Mouël, C., Bodirsky, B. L., & Rolinski, S. (2019). Drivers of meat consumption. *Appetite, 141*, 104313. https://doi.org/10.1016/j.appet.2019.06.005

Moore, D. R., Churchward-Venne, T. A., Witard, O., Breen, L., Burd, N. A., Tipton, K. D., et al. (2015). Protein ingestion to stimulate myofibrillar protein synthesis requires greater relative protein intakes in healthy older versus younger men. *The Journals of Gerontology: Series A, 70*(1), 57–62. https://doi.org/10.1093/gerona/glu103

Mottet, A., & Tempio, G. (2017). Global poultry production: Current state and future outlook and challenges. *World's Poultry Science Journal, 73*(2), 245–256. https://doi.org/10.1017/S0043933917000071

Olivier, J., Bell, M. L., & Rapallo, F. (2013). Effect sizes for 2×2 contingency tables. *PLOS ONE, 8*(3), e58777. https://doi.org/10.1371/journal.pone.0058777

Onwezen, M. C., Reinders, M. J., Verain, M. C. D., & Snoek, H. M. (2019). The development of a single-item food choice questionnaire. *Food Quality and Preference, 71*, 34–45. https://doi.org/10.1016/j.foodqual.2018.05.005

Paddon-Jones, D., Campbell, W. W., Jacques, P. F., Kritchevsky, S. B., Moore, L. L., Rodriguez, N. R., et al. (2015). Protein and healthy aging. The American Journal of Clinical Nutrition, 101(6), 1339S-1345S. https://doi.org/10.3945/ajcn.114.084061.

Peschel, A. O., Grebitus, C., Steiner, B., & Veeman, M. (2016). How does consumer knowledge affect environmentally sustainable choices? Evidence from a cross-country latent class analysis of food labels. *Appetite, 106*, 78–91. https://doi.org/10.1016/j.appet.2016.02.162

Phillips, S. M. (2012). Nutrient-rich meat proteins in offsetting age-related muscle loss. *Meat Science, 92*(3), 174–178. https://doi.org/10.1016/j.meatsci.2012.04.027

Phillips, S. M., Fulgoni, V. L., III, Heaney, R. P., Nicklas, T. A., Slavin, J. L., & Weaver, C. M. (2015). Commonly consumed protein foods contribute to nutrient intake, diet quality, and nutrient adequacy. *The American Journal of Clinical Nutrition, 101*(6), 1346S–1352S. https://doi.org/10.3945/ajcn.114.084079

Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science, 360*(6392), 987–992. https://doi.org/10.1126/science.aaq0216

Richter, M., Baerlocher, K., Bauer, Jürgen M., Elmadfa, I., Heseker, H., Leschik-Bonnet, E., et al. (2019). Revised reference values for the intake of protein. *Annals of Nutrition and Metabolism, 74*(3), 242–250. https://doi.org/10.1159/000499374

Rozin, P. (2007). *Understanding Consumers of Food Products*. Cambridge: Woodhead Publishing Limited (Chapter 1).

Rozin, P., Hormes, J. M., Faith, M. S., & Wansink, B. (2012). Is meat male? A quantitative multimethod framework to establish metaphoric relationships. *Journal of Consumer Research, 39*(3), 629–643. https://doi.org/10.1086/664970

Sanchez-Sabate, R., Badilla-Briones, Y., & Sabaté, J. (2019). Understanding attitudes towards reducing meat consumption for environmental reasons. A qualitative synthesis review. *Sustainability, 11*(22). https://doi.org/10.3390/su11226295

Schösler, H., de Boer, J., & Boersema, J. J. (2012). Can we cut out the meat of the dish? Constructing consumer-oriented pathways towards meat substitution. *Appetite, 58*(1), 39–47. https://doi.org/10.1016/j.appet.2011.09.009

Schösler, H., de Boer, J., Boersema, J. J., & Aiking, H. (2015). Meat and masculinity among young Chinese, Turkish and Dutch adults in the Netherlands. *Appetite, 89*, 152–159. https://doi.org/10.1016/j.appet.2015.02.013

Scott, D., Blizzard, L., Fell, J., Giles, G., & Jones, G. (2010). Associations between dietary nutrient intake and muscle mass and strength in community-dwelling older adults: The Tasmanian Older Adult Cohort Study. *Journal of the American Geriatrics Society, 58*(11), 2129–2134. https://doi.org/10.1111/j.1532-5415.2010.03147.x

Springmann, M., Spajic, L., Clark, M. A., Poore, J., Herforth, A., Webb, P., et al. (2020). The healthiness and sustainability of national and global food based dietary guidelines: Modelling study. *BMJ, 370*, Article m2322. https://doi.org/10.1136/bmj.m2322

Springmann, M., Wiebe, K., Mason-D'Croz, D., Sulser, T. B., Rayner, M., & Scarborough, P. (2018). Health and nutritional aspects of sustainable diet strategies and their association with environmental impacts: A global modelling analysis with country-level detail. *The Lancet Planetary Health, 2*(10), e451–e461. https://doi.org/10.1016/S2542-5196(18)30206-7

SPSS Inc. (2001). The SPSS TwoStep cluster component: A scalable component enabling more efficient customer segmentation. White paper - technical report. IBM: Armonk.

SPSS Inc. (2009). *SPSS Statistics base 17.0 user's guide*. IBM: Chicago.

Steptoe, A., Pollard, T. M., & Wardle, J. (1995). Development of a measure of the motives underlying the selection of food: The food choice questionnaire. *Appetite, 25*(3), 267–284. https://doi.org/10.1006/appe.1995.0061

Struijk, E. A., Banegas, J. R., Rodríguez-Artalejo, F., & Lopez-Garcia, E. (2018). Consumption of meat in relation to physical functioning in the Seniors-ENRICA cohort. *BMC Medicine, 16*(1), 50. https://doi.org/10.1186/s12916-018-1036-4

Stubbs, R. J., Scott, S. E., & Duarte, C. (2018). Responding to food, environment and health challenges by changing meat consumption behaviours in consumers. *Nutrition Bulletin, 43*(2), 125–134. https://doi.org/10.1111/nbu.2018.43.issue-210.1111/nbu.12318

Tijhuis, M. J., Ezendam, J., Westenbrink, S., van Rossum, C., & Temme, L. (2011). Replacement of meat and dairy by more sustainable protein sources in the Netherlands, Quality of the diet. Dutch National Institute for Public Health and the Environment (RIVM): Bilthoven.

Tobler, C., Visschers, V. H. M., & Siegrist, M. (2011). Eating green. Consumers' willingness to adopt ecological food consumption behaviors. *Appetite, 57*(3), 674–682. https://doi.org/10.1016/j.appet.2011.08.010

Vainio, A., Niva, M., Jallinoja, P., & Latvala, T. (2016). From beef to beans: Eating motives and the replacement of animal proteins with plant proteins among Finnish consumers. *Appetite, 106*, 92–100. https://doi.org/10.1016/j.appet.2016.03.002

van der Zanden, L. D. T., van Kleef, E., de Wijk, R. A., & van Trijp, H. C. M. (2014). Understanding heterogeneity among elderly consumers: An evaluation of segmentation approaches in the functional food market. *Nutrition Research Reviews, 27*(1), 159–171. https://doi.org/10.1017/S0954422414000092

van der Zanden, L. D. T., van Kleef, E., de Wijk, R. A., & van Trijp, H. C. M. (2015). Examining heterogeneity in elderly consumers' acceptance of carriers for protein-enriched food: A segmentation study. *Food Quality and Preference, 42*, 130–138. https://doi.org/10.1016/j.foodqual.2015.01.016

Van Loo, E. J., Hoefkens, C., & Verbeke, W. (2017). Healthy, sustainable and plant-based eating: Perceived (mis)match and involvement-based consumer segments as targets for future policy. *Food Policy, 69*, 46–57. https://doi.org/10.1016/j.foodpol.2017.03.001

Vieux, F., Privet, L., Soler, L. G., Irz, X., Ferrari, M., Sette, S., et al. (2020). More sustainable European diets based on self-selection do not require exclusion of entire categories of food. *Journal of Cleaner Production, 248*, 119298. https://doi.org/10.1016/j.jclepro.2019.119298

Vinnari, M., Mustonen, P., & Räsänen, P. (2010). Tracking down trends in non-meat consumption in Finnish households, 1966–2006. *British Food Journal, 112*(8), 836–852. https://doi.org/10.1108/00070701011067451

Wall, B. T., Gorissen, S. H., Pennings, B., Koopman, R., Groen, B. B. L., Verdijk, L. B., et al. (2015). Aging is accompanied by a blunted muscle protein synthetic response to protein ingestion. *PLOS ONE, 10*(11), e0140903. https://doi.org/10.1371/journal.pone.0140903

Wardle, J., Guthrie, C. A., Sanderson, S., & Rapoport, L. (2001). Development of the children's eating behaviour questionnaire. *Journal of Child Psychology and Psychiatry, and Allied Disciplines, 42*(7), 963–970. https://doi.org/10.1111/1469-7610.00792

Whitelock, E., & Ensaff, H. (2018). On your own: Older adults' food choice and dietary habits. *Nutrients, 10*(4). https://doi.org/10.3390/nu10040413

Wijnhoven, H. A. H., Elstgeest, L. E. M., de Vet, H. C. W., Nicolaou, M., Snijder, M. B., Visser, M., et al. (2018). Development and validation of a short food questionnaire to screen for low protein intake in community-dwelling older adults: The Protein Screener 55+ (Pro55+). *PLOS ONE, 13*(5), e0196406. https://doi.org/10.1371/journal.pone.0196406

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., et al. (2019). Food in the Anthropocene: The EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet, 393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Wilson, M.-M. G., Thomas, D. R., Rubenstein, L. Z., Chibnall, J. T., Anderson, S., Baxi, A., et al. (2005). Appetite assessment: Simple appetite questionnaire predicts weight loss in community-dwelling adults and nursing home residents. The American Journal of Clinical Nutrition, 82(5), 1074-1081. https://doi.org/10.1093/ajcn/82.5.1074.

Wunderlich, S., Gatto, K., & Smoller, M. (2018). Consumer knowledge about food production systems and their purchasing behavior. *Environment, Development and Sustainability, 20*(6), 2871–2881. https://doi.org/10.1007/s10668-017-0021-y

Young, A. M., Kidston, S., Banks, M. D., Mudge, A. M., & Isenring, E. A. (2013). Malnutrition screening tools: Comparison against two validated nutrition assessment methods in older medical inpatients. *Nutrition, 29*(1), 101–106. https://doi.org/10.1016/j.nut.2012.04.007