University of Reading

Older adults' acceptability of and preferences for food-based protein fortification in the UK, France and Norway

Article

Published Version

Creative Commons: Attribution 4.0 (CC-BY)

Open Access

Smith, R. ORCID: https://orcid.org/0000-0002-1546-3847, Methven, L., Clegg, M. E., Geny, A., Ueland, Ø., Synnøve Grini, I., Helgesdotter Rognså, G., Maitre, I., Brasse, C., Van Wymelbeke-Delannoy, V. and Sulmont-Rossé, C. (2024) Older adults' acceptability of and preferences for food-based protein fortification in the UK, France and Norway. Appetite, 197. 107319. ISSN 1095-8304 doi: 10.1016/j.appet.2024.107319 Available at https://centaur.reading.ac.uk/117562/

It is advisable to refer to the publisher's version if you intend to cite from the work. See Guidance on citing.

To link to this article DOI: http://dx.doi.org/10.1016/j.appet.2024.107319

Publisher: Elsevier

All outputs in CentAUR are protected by Intellectual Property Rights law, including copyright law. Copyright and IPR is retained by the creators or other copyright holders. Terms and conditions for use of this material are defined in the End User Agreement.

University of Reading

www.reading.ac.uk/centaur

CentAUR

Central Archive at the University of Reading

Reading's research outputs online

Appetite 197 (2024) 107319

Contents lists available at ScienceDirect

Appetite

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

Older adults' acceptability of and preferences for food-based protein fortification in the UK, France and Norway.

Rachel Smith [a,*], Lisa Methven [a,**], Miriam E. Clegg [b], Alexia Geny [c], Øydis Ueland [d], Ida Synnøve Grini [d], Guro Helgesdotter Rognså [d], Isabelle Maitre [e], Céline Brasse [e], Virginie Van Wymelbeke-Delannoy [c,f], Claire Sulmont-Rossé [c]

[a] Department of Food and Nutritional Sciences, University of Reading, Whiteknights, Reading, RG6 6AP, UK
[b] School of Food and Nutritional Sciences, University College Cork, Ireland
[c] Centre des Sciences Du Goût et de L'Alimentation, CNRS, INRAE, Institut Agro, Université de Bourgogne, F-21000, Dijon, France
[d] Nofima AS, Osloveien 1, 1430, Ås, Norway
[e] GRAPPE, Ecole Supérieure des Agricultures, USC 1422, INRAE, 49007, Angers, France
[f] CHU Dijon Bourgogne, Unité de Recherche Pôle Personnes Âgées, Dijon, France

ARTICLE INFO

Keywords:
Co-creation
Protein fortification
Older adults
Personalised nutrition
Malnutrition

ABSTRACT

Research suggests that as we age, protein intake, recognised as vital for combating negative health outcomes, consistently falls below recommendations in older adults. Decreased food intake, combined with age-related eating complications is a major determinant of this protein undernutrition. If nutritional interventions are to be effective and sustainable, they must enable eating pleasure, cater for personal preferences and be adaptable to different eating patterns. As such, we aimed to identify successful strategies for at-home protein-fortification to empower older adults to take a personalised approach to their nutrition, without requiring a large behavioural change. To explore healthy older adults' (age 70+) acceptability and preferences for at-home protein fortification, European project Fortiphy led discussions with older adults (n = 37) and caregivers of older adults (n = 15) to develop high-protein recipes, which were then utilised in a home-use trial with healthy older adults (n = 158). Each fortified recipe was paired with a questionnaire to rate the ease of preparation and liking, and an end-of-study questionnaire was provided to capture overall opinions and preferences. The uniqueness of this study is that the protein fortified recipes were prepared and tested by older adults themselves, in their own homes. Findings showed that older adults were unaware of the importance of protein in ageing and did not have a desire to fortify their foods at present. Yet, they were positive regarding the concept and highlighted the importance of taste, familiar ingredients, and preferred preparation methods. Cultural preferences across countries were identified as having the most influence on the liking of fortified meals. This study also indicated a need for increased awareness of protein requirements to influence the motivation to use fortification.

1. Introduction

Societal and scientific breakthroughs in health, nutrition and technology have led to reduced mortality and increased population life expectancy (Mathers et al., 2015). As such, it is forecast that the number of people age eighty years or older is expected to triple between 2020 and 2050 (World Health Organization, 2022). With a growing percentage of the population comprising of older adults, it is important to ensure that populations not only live longer, but that those extended years of life are in good health (World Health Organization, 2020). This is referred to as 'adding life to years' and can be achieved by following healthy behaviours, such as maintaining healthy dietary patterns (World Health Organization, 2020).

One macronutrient recognised as key for combating negative health outcomes associated with malnutrition in older adults is protein. Adequate protein consumption minimises common physical complications with ageing, such as reduced fracture risk (Groenendijk et al., 2019), frailty (Mendonça et al., 2020) and sarcopenia, a progressive and

* Corresponding author.
** Corresponding author.
E-mail addresses: r.smith7@reading.ac.uk (R. Smith), l.methven@reading.ac.uk (L. Methven).

https://doi.org/10.1016/j.appet.2024.107319
Received 29 January 2024; Received in revised form 16 February 2024; Accepted 18 March 2024
Available online 19 March 2024
0195-6663/© 2024 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

generalised loss of muscle mass (Hunter et al., 2019). It is also responsible for reducing cognitive decline (Fernando et al., 2018) and improving immune function (Li et al., 2007). In protecting the individual from these ailments, protein aids in protecting a good quality of life (Hunter et al., 2019).

In Europe, the official recommendations for protein intake vary slightly. The current UK protein recommendation is 0.75 g/kg body weight per day (Scientific Advisory Committee on Nutrition, 2012). However, the European Society for Clinical Nutrition and Metabolism (ESPEN) and the PROT-AGE Study Group have advised that a health older adults daily protein intake should be increased to 1–1.2 g/kg body weight per day (Bauer et al., 2013; Deutz et al., 2014). The Norwegian government guidelines also advocate for increased protein intake with age with a recommended range of 1.2–1.5 g/kg body weight for older adults to prevent declined physical functioning (Blomhoff et al., 2023; Geirsdóttir & Pajari, 2023). The increase with age is proposed because older muscle is susceptible to anabolic resistance, so it requires greater amounts of amino acids to stimulate muscle anabolism (Coelho-Junior et al., 2020). Assessments of older adult's diets consistently reveal that protein intake falls short of these suggestions (Fleury et al., 2021; Lonnie et al., 2018; Mendonça et al., 2018; Morris et al., 2020; Roberts et al., 2018). For example, the mean protein intake of older adults in Norway is 1.1 g/kg body weight per day (Nygård et al., 2020), which is below the guidelines being advocated for by the Norwgian government (Blomhoff et al., 2023; Geirsdóttir & Pajari, 2023). Moreover, research shows that UK-based older adults have a median protein intake of 0.97 g/kg body weight per day (Mendonça et al., 2018) and indicates that they are potentially short of up to 26 g of protein per day (Smith et al., 2022). In addition, a study in France showed that older adults who received a "meals-on-wheels" service had an average protein deficit of 42 g a day (Fleury et al., 2020).

A key driver of protein-energy undernutrition is poor appetite, as older adults typically consume small portion sizes, which decreases the opportunities to consume the necessary nutrients (Sulmont-Rossé, 2020; van der Pols-Vijlbrief et al., 2014). As such, there is great value in finding alternative methods to supplement or fortify older adults' diets with protein without increasing portion size. Protein-fortification, that is incorporating high quality protein ingredients into a meal to increase the overall protein content, without substantially changing the portion size, is a particularly relevant solution (Douglas et al., 2017; Dunne, 2007; Geny et al., 2023; Morilla-Herrera et al., 2016). Products can be pre-fortified and purchased in the shops, or alternatively, older adults could fortify their own foods at home. Food has no nutritional value until it is chosen, accepted and consumed (Forde & Delahunty, 2004) and the at-home approach facilitates the most flexibility to fortify a limitless variety of foods that older adults enjoy eating.

Most protein-fortification studies have involved hospital or care home settings, and studies in participants homes have been either with pre-prepared meals or minimal adjustments in protein quantity (such as 5 g additional protein in one meal) with adults deemed nutritionally vulnerable (Douglas et al., 2017). In the current study, healthy older adults across three countries were asked to prepare protein-fortified meals in their own home. It is also a cross-cultural study to account for cultural differences and generate relevant insights that are appropriate for a range of populations. To make at-home protein fortification a successful and sustainable nutritional intervention, there are numerous caveats to consider. Older adults typically have a selection of meals on rotation in their diets (Whitelock & Ensaff, 2018) and can be reluctant to try new foods (van den Heuvel et al., 2019). Therefore, it is important to identify appropriate fortification ingredients and meal carriers. In addition, it would be important to incorporate good quality sources of protein, such as animal derived proteins like whey protein which have a complete balance of amino acids and lead to a greater muscle mass synthesis in older adults (Pennings et al., 2011; Wall et al., 2014). Secondly, the fortified foods must be easy to prepare from both dexterity and effort perspectives. Older adults may suffer with tremors, pain and weakness in the hands and fingers, which could lead to motor difficulties with the pre-oral stage of eating such as manipulating cutlery and cooking equipment, as well as transporting food into the mouth (Laguna et al., 2016; Westergren et al., 2002). Additionally, ageing can come with swallowing difficulties (Thiyagalingam et al., 2021) and some textures can lead to difficulties in oral manipulation (Hall & Wendin, 2008; Kremer et al., 2005; Rothenberg & Wendin, 2015), especially if the consumer has limited physical abilities or wears dentures (Appleton, 2016). There are also textural and appearance preferences, such as meat tenderness and vegetable preparation (whole versus sliced) which can be manipulated to increase meal enjoyment and food intake (Van Wymelbeke et al., 2020). Moreover, taste and aroma perception can decline with age (Doty & Kamath, 2014; Methven et al., 2012; Mojet et al., 2001; Sulmont-Rossé et al., 2015) and so the development of stronger tasting foods can be used to counter higher taste thresholds (Dermiki et al., 2014; Nieuwenhuizen et al., 2010). Thus, solutions must take these age-related complexities into consideration to ensure that the food is pleasurable to eat.

Incorporating solutions to account for the above can be undertaken through co-creation with the target consumers, where diverse actors share and combine knowledge (Raffaele, 2013; Slay & Stephens, 2013; Smith et al., 2022; Sulmont-Rossé et al., 2018). A recent systematic review revealed that the acceptability of fortified recipes is seldom done, and found no co-created approaches (Geny et al., 2023). As such, we recognised that older adults are experts of their diets and behaviours, and aimed to conduct culturally and contextually appropriate research, by engaging with older adults to inform each stage of the project. In the current study, which is part of Project Fortiphy (Preventing the risk of undernutrition by fostering meal FORTIfication and PHYsical activity in older adult), funded through the European Joint Programming Initiative, our aim was to identify the drivers and barriers for older adults fortifying their foods and potential strategies for success. We sought to investigate this through focus groups with older adults and caregivers, and a home-use trial in which older adults made and consumed fortified recipes. Our objectives were as follows.

1) To identify perception of protein fortification by European older adults.
2) To understand the likelihood of European older adults routinely fortifying their meals at home.
3) To identify what fortified meals and ingredients are most liked by European older adults.

As such, our paper establishes the key drivers and barriers of home-living older adults regarding at-home fortification.

2. Methods

This paper will report on data collected from two consecutive studies from participants across the UK, France and Norway. A two-pronged approach was used to explore potential options and preferences for protein fortification by obtaining both qualitative (Study 1 - focus groups) and quantitative insights (Study 2 - home-use trial).

2.1. Ethical considerations

All study procedures were approved by the University of Reading Research Ethics Committee (UREC 21/26), the Norwegian Agency for Shared Services in Education and Research (SIKT 452337), and the Research Ethical Committee (CER) of the University Bourgogne Franche-Comté (CERUBFC-2021-11-16-037). All participants provided written informed consent to take part.

2.2. Study 1: qualitative study (focus groups)

The purpose of these focus groups was to explore older adults' and

caregivers' attitudes and knowledge towards protein fortification, as well as potential protein rich ingredients and preferred food matrices for successful fortification. All focus groups were conducted according to a predetermined protocol to facilitate semi-structured data collection and had a duration of between one and a half to 2 h.

2.2.1. Participants

A total of six focus groups (two per country) were led with adults age 70+ years across the three countries (UK: n = 12, 70–86 years old, 75% female; France: n = 13, 70–90 years old, 69% female; Norway: n = 12, 73–84 years old; 83% female). All focus groups with older adults were separated into groups of participants who lived alone and groups who lived with a partner, to avoid emotional discomfort of those who may have been bereaved, and to ensure similarities in the barriers and opportunities within the group. In addition, a focus group was held in each country with professional and familial caregivers of adults aged 70+ (UK n = 3, 66% female; France n = 5, 80% female; Norway n = 6, 66% female). Norway only had familial caregiver participants. The UK focus group was smaller due to scheduling conflicts and the availability of carers, and an additional one to one interview (n = 1) was held with a female familial carer due to scheduling conflicts. All the older adults were living independently, and the caregivers did not have any connection to the older adult participants in the study. Participants were recruited via emails and posters and were reimbursed (£20 in the UK, €20 in France, and €30 in Norway).

2.2.2. Focus group procedure

The focus groups were run between November 2021 and March 2022. Focus groups were facilitated by 2–3 authors from each country who were trained in interviewing techniques. These focus groups with older adults were held in person in Norway and France, and online (Microsoft Teams) in the UK due to different Covid-19 guidelines regarding vulnerable persons at the time. The caregivers focus group in Norway was also held online. Due to the potentially unfamiliar technology and the older participant demographic, participants in the UK were offered practice calls in the lead up to the focus group so that they were comfortable with using the software and how to actively participate.

The protocol (Tables 1–in the supplementary material), began with an icebreaker task about preferred methods of cooking and then observed the following prompts and discussions. At points visual aids were used to tell a story about protein and fortification. For instance, photos of meals and snacks that might be consumed on a typical day in each country, informed by food diaries from an earlier Fortiphy study, were shown. The purpose was to illustrate how much food would need to be consumed to achieve the desired daily protein intake. That prompted a discussion about how difficult it can be to reach the recommended protein intake on a smaller appetite, and what barriers and opportunities there were for protein fortification in their lives. Participants were also shown images of various dry and non-dry fortification ingredients (i.e., ground almonds, protein powder, eggs and lentils) (Fig. 1 in supplementary material). In the UK, participants were sent images of these ingredients in advance in the post so that they could easily see them, as well as being shown them on the screen when taking part online. Participants in France and Norway, who took part in face-to-face focus groups, were not sent these in advance as they would be able to inspect them clearly in person. During the focus group, participants were asked to recall their meals (including snacks) from the previous (week – Norway) (day – France and UK) and consider how they could recreate them by including any high protein ingredients they thought would be enjoyable and typical of what they would usually eat. The same protocol was used for discussions with caregivers as it was for older adults, except that edits were made to elicit their opinions about older adults rather than themselves, for example a typical question in the discussion might have been "What do you think the older adult would think of such a change in the meal (e.g., smell and taste, appearance, consistency, quantity and price?".

2.2.3. Focus group analysis

Two to five groups per category of participant have been found to be adequate in reaching a point of data saturation, the point after which findings continue to be replicated across the groups and no new information is retrieved (Carlsen & Glenton, 2011). As such, six focus groups with older adults and three focus groups with caregivers was deemed an appropriate point to stop. In Norway and France, the focus groups were recorded and transcribed using a denaturalised approach which removed unnecessary stutters and pauses, as well as the correction of grammar (Oliver et al., 2005; Whitelock & Ensaff, 2018). Original quotations prior to translation to English are found in Table 2 in the supplementary material. In the UK, live transcripts were recorded by Microsoft Teams and were amended for auditory mistakes by replaying the original recorded discussions to corroborate them. The data were analysed by inductive thematic analysis (Kiger et al., 2020) to identify, analyse and report repeated patterns within the transcripts. Two researchers from each country led this analysis using Nvivo 12 (QSR International Pty Ltd, 2018) by analysing the transcripts separately, creating codes, and then discussing similarities and differences to decide on draft themes together. If an uncertainty arose, a third researcher was consulted. To synthesise the findings across all three countries, the multisite qualitative analysis approach was adopted (Jenkins et al., 2018). This involved an initial within country analysis, followed by a between country analysis to develop over-arching themes and finally a second within country analysis. Final themes were selected based on how often they occurred and how prominent they were in terms of how fellow focus group participants responded to them in discussions (either a topic brought up by a fellow participant or a researcher).

3. Results of focus groups

This paper elaborates on a total of five parent themes: 'typical approach to cooking' with two subthemes; 'priorities in food choice' with three subthemes; 'factors related to appetite' with five subthemes; 'fortification as a concept' with two subthemes; and 'fortification ingredients' with two subthemes. Themes are predominantly presented in the order that the protocol followed (refer to Table 1 in the supplementary). Direct quotes are used to support these themes, and the source can be identified by using the following code: Older Adult (OA), Professional Carer (PC) or Familial Carer (FC) and United Kingdom (UK), France (FR) and Norway (NO). For example, 'FC-UK' refers to a Familial Carer from the UK.

3.1. Theme 1: typical approach to cooking

3.1.1. Methods of food preparation

During the focus groups, the icebreaker provided an opportunity to discuss participants' preferred method of cooking. It was also frequently discussed throughout the focus group.

A preference for quick and convenient meals and cooking styles was the most popular. In more than one country there was a preference for making meals in larger amounts (batch cooking) and then having leftovers, as to not spend too much of the week preparing meals. The use of a microwave and minimal equipment was popular as to being easier to manage and avoid too much washing up.

> (FC – UK) "I think Granny finds things like doing veg a lot easier in the microwave."

> (OA – UK) "I do like using the slow cooker because then it makes meals for when you're in a hurry."

> (OA – UK) "I batch cook where possible, so I'm making spaghetti Bolognese or chilli con carne enough for 2–3 meals. Those get

portioned out, put in the freezer, brought out, defrosted at some stage in the future and then microwaved."

(OA – FR) I'm on the food processor because … for several years already, because I find that it frees up my time while having a good cuisine, a good stewed cuisine … well, we have all the possibilities of cooking with this machine."

(OA – FR) "The microwave helps me reheat because I don't make soup for a day. I make soup for three, four days."

(FC – FR) "I'm talking about microwaves at the moment because I've been with my mother for two years - before that I was with my father. And now we have … I'm bringing in meal trays/meal on wheels. So it's basically reheating in the microwave."

(OA – NO) "I really like cooked food, food with lots of sauce, fried food, yes … but I am very dependent on the microwave. There I cook, and there I heat food."

(OA – NO) "I probably like oven stuff the best. I found that it keeps the flavour very well and it is clean. It's cleaner than when you use the frying pan and stuff like that."

(OA – NO) "Yes, it is also easier in relation to washing up. You have serving dish and all in one. But it's mostly about the taste, and when you put it on, you don't have to stand by the pot all the time. You can do something else."

3.1.2. Who does the cooking

In the UK and Norway if a participant lived with someone else, cooking seemed to be a role in the household that one person took more responsibility for. This theme was not prominent in the France focus groups, although the researchers based in France noted that this is typically the case.

(OA – UK) "I am working in Marks and Spencer part time, so most of my cooking is done in the microwave. If I do any, and my wife does most of the cooking in the house. Guess we're old fashioned like that."

(OA – NO) "I seldom cook dinner now. I did it when I was working, then I started when the wife had arrived, I started with dinner. But now she is the one who controls everything, has taken over everything."

(FC – NO) "And often I make such a large portion that he then has for 2 days. And before he got home care, we had it like he got it for 3 days, so every time, so yes … and before that again, he cooked dinner himself."

(FC – NO) "She lives alone and fends for herself. Doesn't have home care or anything like that. She cooks herself dinner every day, mostly by herself, unless we who shop for her 1–2 days a week can also help cook and eat with her."

3.2. Theme 2: priorities in food choice

3.2.1. Taste and smell

Taste and eating pleasure were considered a highly important factor in food choice. This related to food they were currently choosing to consume, as well as when they were considering potential protein fortification.

(OA – UK) "You get to seventy years old. You're not gonna start eating stuff that you don't like so it's gotta taste good."

In France in particular, this related to the preferred method of cooking by caregivers that would retain the best flavour.

(FC – FR) "Steam cooking because it is very healthy. In my opinion, it really preserves the flavour and aromas of the food perfectly."

(FC – FR) "Cooking in a pan. For what? Because I find it easy and quick. I find that the smells that emerge during cooking are quite pleasant."

(FC – NO) "They [older adults] flavour the food more, use a lot of salt. Maybe less sense of taste."

(FC – NO) "[The older adult I care for] doesn't have as good a sense of taste as before. Uses the sense of smell."

(FC – NO) "But in recent years, perhaps during the pandemic, interest in food has waned. And she says that taste has changed and doesn't think things taste like they used to. There is little that tempts, so she eats less. She eats, but not a lot and doesn't bother to cook every day, or dinner every day. She has lost a lot of weight but is otherwise healthy."

3.2.2. Health

Older adults were concerned about the correct 'balance' of food groups and meal types when choosing what they were eating. They appeared to be mainly interested in reducing nutrients and food groups as a means of maintaining good health, and there was less discussion about adding important nutrients or food groups into their diets.

(OA – FR) "Eggs, I don't eat too many of them because of the cholesterol."

(OA – UK) "I don't eat pasta and I don't eat rice very much. Probably for two reasons. One to keep the carbohydrates down, but I find they make me feel very bloated".

(OA – UK) "I do try to have protein at lunchtime when we're having a vegetarian meal in the evening. Just to try and balance it."

(OA – FR) "Yes, I'm a little surprised. The proposals you present [the ideal meal picture] seem excessive to me. I generally tighten the bolts."

(OA – FR) "They say that coffee with milk is not digestible, so you should avoid milk in coffee."

(OA – NO) "We also eat very little potato, because my husband has gotten the idea that there is far too much starch."

It also related to timings of food and what they believed to be the healthiest.

(OA – FR) "I also think that we can eat more in the evening, but what you have to be careful about is that it is not too fatty. In fact, it may be more in the way we eat than in the quantity. Because if you eat fatty things, it's harder to digest."

(OA-FR). "With cholesterol, we say: you should not eat cheese in the evening, you should … with diabetes, you should limit the quantities of bread. So you always have to limit. So finally, I restricted myself and I barely eat anything anymore. And as a result, I lost 6 kg in a few weeks."

3.3. Theme 3: factors related to appetite

There were numerous social factors that appeared to influence self-reported appetite, particularly low or small appetites in older adults.

3.3.1. Social factors

Loneliness and bereavement were seen to have an impact on a loss of appetite or motivation to prepare meals in the same way that they once did.

(OA – UK) "My life has changed remarkably this last year because unfortunately I lost my husband so really cooking is the last thing I'm thinking of."

(OA – FR) *"I also think it's loneliness. Because the presence of someone stimulates … I'm not going to say laziness, but the desire to … more desire to cook. So, she just eats the soup and that's it, it's good."*

(OA – FR) *"I have my mother-in-law who hardly eats when she is alone, she has to be forced to make food for herself. But as soon as she is at our house, she eats, but like me. She eats normally. So, it's really loneliness that actually makes them become malnourished. And there you go. And in the evening, she eats her soup and then she goes to bed because she no longer has any interest in anything else."*

(PC – FR) *"Also, loneliness I noticed that people who are in a relationship, both, they still manage to eat better than a person alone. I recently had a lady with her husband when he was still there, they both ate really, really well. Her husband died two months ago. You have to see her now, I push her, but really so that she can eat just a little bit. For her, eating alone no longer really makes sense."*

(FC – NO) *"It is when we are together with my mother, for example on holiday and such, when she is with us for more than several days and eats all types of things with us, then she eats a lot more."*

(FC – NO) *"My mother says she forgets to eat. She can get preoccupied with something, or be busy with something, and suddenly almost the whole day has passed. Then she has forgotten to eat. So, she doesn't have a strong feeling of hunger anymore."*

3.3.2. Physiological considerations

Physiological considerations reflected a loss of appetite and taste/smell changes, as well as other complications such as mastication and dentition issues.

(OA – FR) "Loss of appetite linked to chewing problems. I see my mother who was 98 years old, she no longer had … her dentures, they were floating, she could no longer chew. And so afterward, she only ate the small biscuits bought in pharmacies".

(PC – FR) *"I am a professional carer and I have seen several of my patients. And the observation that has always come up over ten years in the profession is that people who have braces always eat less than people who have their teeth. It's really weird, despite trying to adapt the food according to their teeth, they still eat less than people who have their teeth"*

(FC – NO) "My mother feels that she has difficulty swallowing".

(OA – NO) "In periods of a lot of pain, I have had it. Bad appetite, yes. Poor appetite. When the pain subsides, it's back."

Some adults considered factors that made them choose to consume their largest meals at different times of day.

(OA-UK) "I suffer with indigestion sometimes, and it's far better for me to eat in the middle of the day."

(OA – FR) "I have a sister who is 80 years old and has a lot of health problems and she eats a lot less in the evening. In the evening, it's soup, yoghurt, and that's it. Because she no longer moves, she can no longer move."

This appeared to have an impact on overall intake as well.

(OA-UK) "So, for me one [problem] is indigestion, but I'm not eating too much in the evening that solves that problem, but it also it messes the deal if you have to spend a chunk of the middle of the day cooking and eating a large meal but inevitably feeling dozy in the afternoon."

3.3.3. Beliefs

This theme also ties into the above because there were many beliefs held about when and how much to eat. In particular, older adults in France held beliefs that they should have their smallest meal at the end of the day.

(OA – FR) *"I believe in many beliefs because many times I have heard: "you shouldn't eat too much in the evening because you don't sleep well and everything". So afterward, it's a vicious circle. The person eats less in the evening, then they will eat … In the morning, they will eat well because in general, they are … we are very hungry in the morning when we haven't eaten the day before. And then afterwards, we reduce the portions little by little, then we eat less and less, as you say. But it's a bit of a vicious circle."*

(OA – FR) *"When I listen to my grandmother, she said: "in the morning, you must eat like an emperor, at lunchtime like a king and in the evening like a pauper."*

(OA – FR) "I had memorized that dinner is a preparation for the night, that is better if it is rather light."

(OA – FR) *"It was also said that because we are older, we have less need to consume. There is also this idea that is made. And that if we also eat … there is also a person, if they eat too much in the evening, they have poor sleep."*

3.4. Theme 4: fortification as a concept

When we looked into fortification as a concept, there were mixed opinions and a number of barriers that were discussed that would need to be overcome.

3.4.1. Disassociation from age group

Many older adults in the UK and France spoke about the fortification process and increased protein requirements as though it was intended for someone older in years than themselves.

(OA – FR) "But at what age do you call "older person"? We have to set an age, but I find that here, 65–70 years old, we are much younger than 20 years ago, people aged 50″

(OA – FR)"Say "old" at 70, you're not old after all [Laughing.]"

(OA – FR) "Me, I have a dad who has just turned 101 and a mom who will be 100 tomorrow, indeed, I am young … that's it, absolutely."

(OA – UK) "I do think that the age group you're aiming at are quite set in their ways and they are not always happy to change."

(OA – UK) "I just don't think they see the need or that's not in their way of doing things."

3.4.2. Knowledge of protein

Participants were asked if they thought younger people (under 65 years) needed more or less protein per day than they did. Compared to professional caregivers who believed that protein requirements increase with age, most older adults and familial caregivers believed that they would need less.

(PC-UK) *"[Younger people need] less protein because you compare the immune system of older adults to the ones of young adults. I think the immune system of older adults is usually lower, so they should have more protein than young adults."*

(OA – NO) *"But I didn't know that. That we needed more protein when we got old."*

The reason they believed younger people need more protein was typically linked to activity levels, and associated intakes that were perceived necessary for such activity.

(OA-UK) "I would think [younger people would need] slightly more because below 65 are more likely to be more energetic, doing more and more energetic things."

(OA-UK) "I would say higher, possibly. Because they've got to maintain their body weight and their energy. For doing things like, because they are in the age group that work. And you know, [they] have more things to do in their life then what older people do so therefore they need the energy."

(OA – FR) "Perhaps people who have physical activity, good physical activity, can ultimately eat more, because they need more calories."

There were also comments regarding the use of protein within the body, which adults had mixed opinions on. As a whole, they appeared to be uncertain.

(OA-UK) "I mean young children are growing and then through teenage years they also growing at a different rate, probably from when they were young children. So, it's not simply age. It's also like a developmental stage and body requirements growth. I mean, when you're 65 plus, you're not going to grow very much, but you need protein for repair and all the other things you mentioned just now, whereas growth is more important perhaps than younger children."

(OA-UK) "It's a bit of a mixed 'cause those under 65 do need a lot of energy, but I think as you get older you perhaps don't process the absorption and the benefits of it as much as you do when you're younger. So that we might need more, I don't know."

In contrast to guidelines, some older adults also expressed that they thought it was possible to have too much protein or that a small amount was sufficient.

(OA-UK) *"For lunch, scrambled egg on a muffin so one egg, I could have two eggs for that, but I would have thought one egg was sufficient protein* per *meal."*

It was also mentioned that protein can be expensive and therefore frugal habits formed in childhood still influence food choices now.

(OA-UK) "I was obviously brought up poor because I've never put two proteins in a sandwich. I'd have ham or I have cheese. I wouldn't have it both. I always put lettuce or watercress. That's my sandwich and I wouldn't ever put two lots of protein in a sandwich, but my husband does, but I wouldn't. I'd always put just egg, or you know something on its own."

In terms of protein sources, there was generally a good understanding, with many participants citing meat, fish and eggs. However, no-one mentioned protein powders. There was a good understanding of what proteins were needed for with many older adults citing muscle mass and muscular function, although only the professional caregivers mentioned immune function, as indicated earlier.

(OA – FR) "*There are already animal proteins and there are vegetable proteins."*

(OA-FR) *"In meat, in eggs, fish" (OA – FR) … "Pulses" (OA – FR) … "Dairy"*

(FC – FR) *"Proteins, so they can be found in meat, fish, eggs. That's … and those for example who don't eat animal proteins or anything else, we can find that in plant proteins such as soy and others and even in legumes in particular. There you have it, legumes. So. So, proteins … yes, are particularly useful for muscle function."*

There were some occasions throughout the focus groups where foods typically low in protein were mentioned as an example of protein.

(OA – UK) "There was a little bit of protein [on the cake] because we had strawberries on top."

(OA – FR) "In all vegetables, there is a little [protein]."

All participants expressed gratitude for taking part in the focus groups and for learning more about protein and fortification. Most had not heard of the term fortification before and were keen to learn more about what they could be doing to benefit their health through further information.

(OA – UK) "If we'd been asked this before we started today it's not something any of us would have thought was something we'd want to do. But I think if you get the education, you realise the importance of it."

(OA – FR) "For us, we need to be aware of it [that we need to eat more proteins]."

(OA – FR) *"I realize that I have [nutritional] deficiencies."*

- (FC – NO) *"If I had known that my mother had been so malnourished, which I really don't think she is now, then I think that if she was going to take any protein powder, it would have to be her doctor who kind of, gave some kind of prescription on it and said that "this here is something you have to take."*

3.5. Theme 5: fortification ingredients

3.5.1. Everyday culinary ingredients

Participants were open to using everyday culinary ingredients to fortify their meals and had various preferences and strategies for how they would prefer to do it.

(OA – NO) *"If I had to add anything, it would be cheese. We love cheese. But I use most of this here almost every day. Both eggs and, ham I guess I don't use that much, but cheese. We use a lot of milk products. And grain."*

(OA – FR) *"Cheese in pasta, eggs in quiche, cream in soup."*

(OA – FR) *"On the ice cream, I didn't add anything, but I probably could have added a little ground almonds."*

(OA-UK) *"I suppose I could have done egg fried rice or something, maybe not, and then going back to a string of cutting out things and in the morning had a Kit Kat chocolate bar. And in the afternoon chocolate. Sorry, ginger cake. If I'd have cut those out completely that might be good. Or if I had had some like cheese on crackers in the afternoon, maybe that could also been better than what I had, chocolate."*

(OA – NO) *"No, I wouldn't use any protein, but eggs."*

3.5.2. Protein extracts

Participants and caregivers were initially suspicious of the protein powders and had many questions about how they would be found, used, and what affects they might have on a meal in terms of taste, texture and appearance.

(OA – NO) *"I thought this was pretty disgusting stuff. Milk proteins, that's … What am I going to use it for?"*

(FC – NO) *"Why should we have these powders, if we can use more eggs and more grated cheese or cheese in the menu? Are there any benefits to using these powders?"*

(FC-UK) *"Mum would probably be a bit nervous about it [protein powder] but if she couldn't taste the difference, I think she'd be fine."*

(OA – FR) *"When you want to enrich a meal with something like that, does it change the taste?"*

(OA – FR) *"And does it change the colour too, the visual?"*

(OA-UK) *"All these other kinds of powders I'd be really stuck to find out what to do with them."*

However, these thoughts were mediated by ideas about how to

substitute other dry ingredients with powders.

(RS) *"Does anyone else here use any kind of ingredient to thicken up a soup or casserole?"*, (OA – UK) *"Cornflower", (RS) "Ok so perhaps would you consider using a powder in place of that?"*, (Multiple OA's – UK) *"Yes"*, (OA-UK) *"Like if it's adding the protein, that's a double winner."*

(OA-FR) "And even if it modifies the taste, it depends a little on the taste because we put vanilla or vanilla sugar in certain cakes, why not that? It depends on the taste it gives." (OA-FR) "We add a little vanilla sugar to hide the taste."

Collagen was considered more acceptable by some participants, whereas in general the older adults did not view themselves as the target market for the powders.

(OA – NO) *"If I were to add something, it would have to be the collagen powder, because it is good for the skin, among other things. And it didn't taste bad."*

(FC – NO) *"I think my mother would have had a pretty high threshold for mixing this in her food. It is probably because she does not feel that she really needs it or, it doesn't mean to much."*

(OA – NO) *"Just heard that there is such a powder, but thought it doesn't concern me."*

(OA – NO) *"But those who build bodies, they're a bit confused, aren't they? They buy boxes of powder. That's not good, is it?"*

Some female older adults were also interested in the powders if they provided a lower fat option than other everyday culinary ingredients.

(OA-UK) *"Well, I personally would be more conscious. I love cheese and I would put grated cheese on a lot of things, but it's the calorie side of that. The fat side that I would be concerned about. I don't know what the makeup of the protein powders are, but I would assume they're lower in calories, and I think they would be a very good alternative."*

3.5.3. Natural ingredients

There was also some concern for the 'naturalness' of foods, primarily related to how processed they were, which impacted attitudes towards everyday culinary ingredients and protein extracts.

(OA-UK) "I'm a bit worried about ham at the moment because it's processed … you can think of things for protein and you can think of things against it. It's difficult because we're always told to eat one thing and then it's not good for something else and it gets very confusing. I am wary of ham I have to say."

(OA-UK) "It depends where the plant based or plant-based ones are produced … are they, are they you know are they covered in all sorts of chemicals sprayed with this, that and the other?"

(OA – FR) *"For me, it's artificial [protein powders]."*

(CS) "So under what conditions would you be ready to use them? What would it take for you to actually be ready to use them?"

(OA-FR) "Honestly, from the composition, knowing if it's really just the product or if there are additions, stuff."

4. Study 2: quantitative study (home-use trial)

After the focus groups, insights from these discussions as well as diet diaries from a previous Fortiphy study (data not shown), were used to develop eight recipes that provided an additional 6–10 g protein per portion compared to their unfortified counterparts. The recipes included fortified porridge, granola, Scotch pancakes, French toast, Bolognese sauce, carrot soup, mashed potatoes and vanilla cake (see Table 3 in supplementary material for recipe ingredients and protein increase). These recipes were initially developed in Norway (by author GHR) and were modified for subtle changes in relation to which ingredients were available in each country (e.g., a vanilla sugar available in Norway, was substituted for vanilla essence and sugar in France and the UK). These meals were purposely chosen to account for meals which were typically lower in protein, were commonly consumed by older adults in the three countries, except porridge in France, and were a suitable fit gastronomically for a range of everyday culinary and more functional protein sources to be added (such as whey protein isolate) (manuscript is in preparation). In particular, there was a strong emphasis on breakfast meals as meals this time of day are typically lower in protein than other meals in the day (Lonnie et al., 2018). The recipes were primarily fortified with two core high protein ingredients (extruded soya mince in granola and Bolognese, and milk protein powder in vanilla cake, Scotch pancakes, mashed potato, porridge and carrot soup). Other everyday culinary ingredients such as quark (a soft cheese) were also used (in French toast and Scotch pancakes), as well as ground almonds (in Bolognese and vanilla cake) and eggs (in French toast). To explore as to whether these recipes were easy to use and liked by older adults, a home-use trial was set up for older adults to recreate these meals in their home environment and provide receive feedback.

4.1. Participants

Adults aged 70+ years or older who lived independently in the community (i.e., not in a hospital or care home) were eligible to take part in this study. Participants were made aware of the study via emails, posters and word of mouth. Some participants who took part in previous Fortiphy studies, such as the focus groups and had indicated that they wanted to be invited to more studies in the future were also invited directly to take part again and be engaged in the whole co-creation process. The recruitment pool was wide because all interactions were completed over the phone or through the post, hence participants could participate from anywhere in the three countries. According to the powder calculation, 51 participants were required in each country ($\alpha = 0.05$, power = 80%, d = 0.8/7, ±SD = 1.6 (Sulmont-Rossé et al., 2018). In total 158 participants took part in the study (UK n = 51, 70–87 years old; 67% female, France n = 56, 70–96 years old; 89% female, Norway n = 51, 70–93 years old; 75% female). Table 1 details the demographics.

4.2. Home-use trial procedure

The home use trial ran from April 2022 through to September 2022.

Table 1
Participant characteristics in the home-use trial.

	France (n = 56)	Norway (n = 51)	UK (n = 51)	Total (n = 158)
Age				
Mean	76	75	75	75
Range	70–96	70–93	70–87	70–96
70–79	43 (77%)	41 (80%)	45 (88%)	129 (82%)
80–87	13 (23%)	10 (20%)	6 (12%)	29 (18%)
Gender				
Male	6 (11%)	13 (25%)	17 (33%)	36 (23%)
Female	50 (89%)	38 (75%)	34 (66%)	122 (77%)
Relationship and living status				
Living with a partner	23 (59%)	33 (65%)	33 (65%)	89 (56%)
Not living with a partner	33 (41%)	18 (35%)	18 (35%)	69 (44%)
Health status (self-reported)				
Better than others my age	21 (38%)	21 (42%)	23 (45%)	65 (41%)
Same as others my age	32 (57%)	28 (56%)	27 (53%)	87 (55%)
Worse than others my age	3 (5%)	1 (2%)	1 (2%)	4 (4%)

The recipes were posted out to participants in different ways for each country (Table 3 – see supplementary material) and porridge was not included in France due to it not being a commonly consumed food there. Participants were asked to make each recipe once, and complete a questionnaire designed by the Fortiphy team that assessed the preparation, usage and liking each time. Participants were allowed to choose when they wanted to make each recipe and had to make them all within a month of receiving the study materials. After this, participants were asked to complete a final questionnaire designed by the Fortiphy team about their experience with making the recipes, fortification in general, preferred recipes and comments about the study. Specifically, participants were asked to indicate their first, second and least favourite meals and provide their preferred fortification ingredients by selecting at least one option from 'Common high-protein ingredients (eggs, nuts, milk, cheese, almond flour … ', 'Protein extracts (milk protein powder and soya protein)' and 'None, I do not want to use fortification'. They were asked for their general opinions on how they felt about including the high protein ingredients using a 4-point scale ('I was happy with the outcome because they generally improved the meal', to 'I was disappointed with the outcome because they generally worsened the meal') and asked about the likelihood of them using fortification in the future using another 4-point scale ('Yes, most definitely' to 'No, most definitely not'). Ease of use was captured by a 5-point scale ('Very easy to use' to 'Very difficult to use') and an improvement 3-point scale from 'degraded', through 'did not change' to 'improved' were used for the impact of fortification on appearance, taste, texture and nutritional content. Understanding of fortification, awareness of protein requirement, protein knowledge, and understanding of nutrition for older adults were captured through quiz style questions developed by the authors. Food neophobia was measured using an adapted Food Neophobia Scale questionnaire adapted for older adults (it uses a 4-point scale instead of 7) (Mingioni et al., 2016). The final score varies from 10 (not neophobic) to 40 (very neophobic). As proposed by the original scale authors (Pliner & Hobden, 1992), negative statements were reversed and recoded for final score calculation. For the purposes of data analysis low food neophobia was regarded to be scores between 10 and

Table 2
Perception of protein ingredients from older European consumers.

	France (%) (n = 53)	Norway (%) (n = 49)	UK (%) (n = 51)	Male (%) (n = 36)	Female (%) (n = 117)	Total (%) (n = 154)
In general, what were your opinions on including the high protein ingredients?						
I was happy with the outcome because it improved the meal (1)	21.4	31.3	14.0	13.9	24.6	22.1
I was happy with the outcome because it did not seem to change the meal (2)	69.6	62.5	54.0	63.9	61.9	62.3
I was disappointed with the outcome because it did not seem to change the meal (3)	5.4	0	10.0	13.9	2.5	5.2
I was disappointed with the outcome because it worsened the meal (4)	3.6	6.3	22.0	8.3	11.0	10.4
Mean (±SD)	1.91[b] (±SD.640)	1.81[b] (±SD.734)	2.40[a] (±SD.990)	2.17 (±SD.775)	2.00 (±SD.847)	2.04 (±SD.831)
Median	2	2	2	2	2	2
How easy were the high protein ingredients to use?						
Very easy to use (1)	43.6	38.8	49.0	47.1	42.9	43.8
Easy to use (2)	43.6	55.1	34.7	32.4	47.9	44.4
Ok (Neither easy nor difficult) (3)	12.7	4.1	14.3	14.7	9.2	10.5
Difficult to use (4)	0	2.0	2.0	5.9	0	1.3
Mean (±SD)	1.69[a] (±SD.690)	1.69[a] (±SD.652)	1.69[a] (±SD.769)	1.79 (±SD.914)	1.66 (±SD.641)	1.71 (±SD.756)
Median	2	2	2	2	2	2
How did the high protein ingredients impact the food visually?						
Improved the visual impact of the food – making it more appetizing (1)	1.8	0	6.0	5.7	1.7	2.6
Did not change the visual impact of the food (2)	98.2	98.0	80.0	91.4	92.4	92.2
Degraded the visual aspect of the food – making it less appetizing (3)	0	2.0	14.0	2.9	5.9	5.2
Mean (±SD)	1.98 (±SD.135)	2.02 (±SD.143)	2.08 (±SD.444)	1.97 (±SD.296)	2.04 (±SD.273)	2.03 (±SD.279)
Median	2	2	2	2	2	2
How did the high protein ingredients impact the taste of the food?						
Improved the taste of the food (1)	14.5	26.5	16.0	25.7	16.8	18.8
Did not change the taste of the food (2)	83.6	69.4	58.0	60.0	73.9	70.8
Degraded the taste of the food (3)	1.8	4.1	26.0	14.3	9.2	10.4
Mean (±SD)	1.87 (±SD.388)	1.78 (±SD.511)	2.10 (±SD.647)	1.89 (±SD.631)	1.92 (±SD.507)	1.92 (±SD.536)
Median	2	2	2	2	2	2
How did the high protein ingredients impact the texture of the food?						
Improved the texture of the food (1)	32.7	20.4	20.4	20.0	26.3	24.8
Did not change the texture of the food (2)	63.6	69.4	55.1	68.6	61.0	62.7
Degraded the texture of the food (3)	3.6	10.2	24.5	11.4	12.7	12.4
Mean (±SD)	1.71 (±SD.533)	1.90 (±SD.549)	2.04 (±SD.675)	1.91 (±SD.562)	1.86 (±SD.612)	1.88 (±SD.600)
Median	2	2	2	2	2	2
How did the high protein ingredients impact the nutritional content of the food?						
Improved the nutritional content of the food (1)	89.1	97.9	89.8	90.9	92.4	92.1
Did not change the nutritional content of the food (2)	10.9	2.1	8.2	9.1	6.8	7.3
Degraded the nutritional content of the food (3)	0	0	2.0	0	0.8	0.7
Mean (±SD)	1.11 (±SD.315)	1.02 (±SD.146)	1.12 (±SD.389)	1.09 (±SD.292)	1.08 (±SD.309)	1.09 (±SD.304)
Median	1	1	1	1	1	1

[a,b] Mean values with different superscript letters were significantly different between Countries (Dunn's procedure, $p \leq 0.05$).

25, with high food neophobia regarded as scores above 26. Participants returned the questionnaires in the post. This paper considers the results of the final questionnaire, once the participants had tried all recipes; results from the individual recipes will be reported elsewhere in a separate manuscript which is in preparation.

4.3. Home-use trial data analysis

The data entry phase occurred as data was returned from participants from May–November 2022 and was statistically analysed in November–December 2023. Shapiro-Wilk tests on the variables showed that the data were not normally distributed, and so non-parametric statistical tests were used, although both mean and median values were both reported for clarity. Data were analysed using XLStat statistical software (version XLSTAT 2023.January 1, 1398, Paris, France). Older adults' overall perceptions of high protein fortificants and the likelihood of them continuing with fortification in the future were analysed with Mann-Whitney (for 2 group comparisons), Kruskal Wallis (for comparison of more than 2 groups) and Spearman's Rho Correlations. Further detail on the perceived impact of fortification on appearance, taste, texture and nutritional content was analysed with descriptive statistics. Preferred fortified meals and ingredients were analysed by Chi Square and demonstrating pairwise comparisons between countries using Fishers exact test.

4.3.1. What perceptions do older adults in Europe have of protein fortificants?

Table 2 shows the mean and percentage ratings of how older adults thought the high protein ingredients affected their meals. Most participants reported 'I was happy with the outcome because it did not seem to change the meal' (mean 2.04, ±SD0.831), however UK participants had a significantly lower opinion of the high protein ingredients ($p = 0.002$). There was no significant impact of age ($p = 0.375$), gender ($p = 0.129$), or food neophobia ($p = 0.490$) on this perception. Participants thought that the protein fortificants were easy to use (mean 1.71, ±SD0.756), however there was a weak positive correlation for increased age leading to a perceived increased difficulty of use (Rho = 0.220, $p = 0.048$). There were no statistically significant differences between country ($p = 0.992$), gender ($p = 0.556$) or food neophobia ($p = 0.185$) for ease of use. The 3-point scales for the impact of protein fortificants on appearance, taste, texture and nutritional content had very little distribution and so were not analysed for statistical differences by country, age, gender and food neophobia.

4.3.2. What is the likelihood of European older adults routinely fortifying their meals at home?

Older adults were asked 'are you likely to continue with fortifying your food with protein in the future?' and overall, their answers fell between 'yes, probably' and 'no, probably not' (mean 2.49, median 3). This was significantly different between countries, with the UK participants being less likely to continue with fortification. Increased age was associated with being less likely to continue with fortification, however this was not statistically significant (rho = 0.154, $p = 0.057$). Other factors such as gender ($p = 0.117$) and food neophobia (rho = 0.031, $p = 0.709$) did not influence the results. In addition, knowledge-based factors did not have an impact either, as there was no difference between people who had a correct understanding of what protein is used for versus those who did not (rho = 0.071, $p = 0.709$). There was no difference between those who understood what fortification was and those that did not (rho = 0.117, $p = 0.145$). Neither an understanding of nutrition in general nor an awareness of higher protein recommendations for older adults (rho = −0.125, $p = 0.124$; $p = 0.807$ respectively) impacted results either (Table 3).

4.3.3. What fortified meals and ingredients are most liked by European older adults?

Table 4 shows which fortification ingredients older adults preferred to use for fortification. The most popular choice was to only fortify foods with common high protein ingredients (such as eggs, nuts, cheese …) (55.8% of consumers). This was followed by a combination of common high protein ingredients and milk protein powders and soy proteins (23.4% of consumers) and a small number of older adults who preferred milk protein powders and soy proteins only (5.2%). Approximately 16% of consumers did not want to use fortification at all. There was not a statistically significant impact of country ($p = 0.195$), age ($p = 0.200$) or gender ($p = 0.272$) on preference. There was however a nearly significant impact of food neophobia ($p = 0.103$) which suggested that more food neophobic consumers would be more likely to prefer the use of milk

Table 4
Preferred fortification ingredients of older European consumers (as %).

	France (n = 54)	Norway (n = 49)	UK (n = 51)	Male (n = 36)	Female (n = 118)	Total (n = 154)
Common high-protein ingredients (eggs, nuts, milk, cheese, almond flour …) only	48.1%	59.2%	60.8%	55.6%	55.9%	55.8%
Common high-protein ingredients (eggs, nuts, milk, cheese, almond flour …) and Milk protein powder and soya proteins	27.8%	20.4%	21.6%	16.7%	25.4%	23.4%
Milk protein powder and soya proteins only	9.3%	4.1%	1.9%	8.3%	4.2%	5.2%
None, I do not want to use fortification	14.8%	16.3%	15.7%	19.4%	14.5%	15.6%

Table 3
Likelihood of older consumers in Europe to continue fortifying foods with protein after the interventions home-use study.

	France (%) (n = 53)	Norway (%) (n = 49)	UK (%) (n = 51)	Male (%) (n = 36)	Female (%) (n = 117)	Total (n = 153)
Yes, most definitely (1)	18.9	6.1	7.8	11.1	11.1	11.1
Yes, probably (2)	41.5	40.8	31.4	38.9	37.6	37.9
No, probably not (3)	30.2	44.9	51.0	38.9	42.7	41.8
No, most definitely not (4)	9.4	8.2	9.8	11.1	8.5	9.2
Mean (±SD)	2.30[b] (±SD.890)	2.55[b] (±SD.738)	2.63[a] (±SD.774)	2.50 (±SD.845)	2.49 (±SD.805)	2.49 (±SD.812)
Median	2.00	3.00	3.00	2.50	3.00	3.00

[a,b] Mean values with different superscript letters were significantly different between Countries (Dunn's procedure, $p \leq 0.05$).

protein powders and soy only, and those who were less food neophobic were open to using a wider variety of protein fortification ingredients ($p = 0.040$).

Tables 5–6 show the most preferred and least preferred meals (first and second choices were combined) tried in the home-use trial in each country. Four participants only stated one preference whereas 148 participants stated 2 preferences; however, all responses were combined for an overall percentage of preferences.

The most preferred meals overall were the Granola (21.5%) and Bolognese (22.1%), however it was more nuanced than this, as statistically significantly countrywide differences existed ($p = 0.015$). For example, Granola was preferred significantly less in France (14.4%) and Carrot soup was the most preferred meal in France (25.2%), whereas the soup was significantly less preferred in Norway and the UK. There was no statistically significant impact of gender ($p = 0.993$) or age ($p = 0.985$) on most preferred meals. There was a trend that food neophobia might influence the preferred meals; suggested that consumers with high food neophobia were less likely to prefer the Granola ($p = 0.070$), and consumers with low food neophobia were more likely to prefer it ($p = 0.011$). Moreover, consumers with high food neophobia were more likely to prefer the Mashed potato and those with low food neophobia ($p = 0.031$).

Overall, a fifth of total participants stated that they did not have a least favourite meal (20.9%). The least preferred meals had distinct and significant country-wide differences ($p < 0.001$). For example, the least preferred meal in France was Granola (35.7%), which was significantly more likely to be the least preferred than in the other countries, and Scotch pancakes were the least likely to be the least preferred meal in France (0.0%). However, the opposite was true of Norway. The UK consumers were significantly more likely to choose the Mashed potato as least liked. Neither gender ($p = 0.442$) nor age ($p = 0.110$) had a significant impact on least preferred meal, although the older consumers (over the median age of 75) preferred the Bolognese more than the younger consumers (those between 70 and 75 years old) ($p = 0.040$). There was neophobia trend that consumers with high food neophobia were less likely to have choose porridge as their least preferred meal ($p = 0.053$).

5. Discussion

The focus groups provided a deep dive into the matrix of factors that are important to consider when developing foods with older adults and provided excellent insight on how to work towards successful dietary changes. First, it was made clear that it is important to older adults that their food tastes and smells appealing, particularly as some mentioned a reduction in taste and smell which can be common with ageing (Whitelock & Ensaff, 2018). Increased protein may in fact improve taste for many older adults, as umami, the fifth basic taste found in protein-rich foods, has been shown to increase preference and consumption of meals by older hospital patients (Dermiki et al., 2014). In addition, umami can promote the secretion of saliva (Stańska & Krzeski, 2016), which promotes the ease of swallowing (Pedersen et al., 2002) and is important to gustatory function (Sasano et al., 2014) and can increase gut motility (Kendig et al., 2014), so this could potentially benefit the older adults who spoke of indigestion issues. However, if it is done with protein powders, such as whey protein, it can also increase 'off flavours' (Norton et al., 2020) and cause astringency or mouth drying attributes (Bull et al., 2017), so solutions must be developed carefully. Interestingly, most older adults were concerned that fortification could change the taste and preferred that the fortified meals would taste no different to their unfortified counterparts.

In addition to flavour, the focus groups revealed that fortification solutions should use cooking methods that allowed older adults and caregivers to prepare meals quickly. Recommendations for fortified meals should involve ingredients and meal carriers that can be made relatively quickly or in a way that can be prepared and left to cook without the need to supervise it (for example, in a slow cooker). It is perhaps a misconception that individuals of retirement age have spare time to or want to spend their time preparing meals, when in fact many participants cited often being in a rush and needing meals that came together very quickly. As such, the majority of recipes in the home-use trial were developed to be relatively quick to make (less than 20 min), with the shortest one (porridge) taking no more than 5 min, and the meals that took up to an hour were designed to be made in batch (Bolognese sauce and granola).

Overall, the focus group findings indicated that older adults and caregivers alike are interested in fortifying meals with protein and were open to learning more about their protein needs. Both the focus groups and home-use trial provided insights on what might encourage older adults to adopt fortification in terms of ingredients and meal carriers. When we discussed ingredients with older adults in the focus groups, they appeared to be more comfortable with using everyday ingredients that they were familiar with, and the caregivers agreed. As such this research indicates that promoting fortification with routinely used ingredients such as cheese, egg, and yoghurt is likely to be the most

Table 6
Least preferred fortified meals (as %).

	France (n = 56)	Norway (n = 49)	UK (n = 47)	Male (n = 32)	Female (n = 120)	Total (n = 152)
Porridge	n/a	14.6%	7.2%	5.9%	7.6%	7.2%
French toast	7.1%	8.3%	9.2%	5.9%	10.1%	9.2%
Scotch pancakes	0.0%[a]	8.3%[b]	4.6%[c]	2.9%	5.0%	4.6%
Cake	8.9%	4.2%	9.8%	8.8%	10.1%	9.8%
Granola	35.7%[a]	0.0%[b]	13.7%[c]	11.8%	14.3%	13.7%
Carrot soup	8.9%	14.6%	11.8%	17.6%	10.1%	11.8%
Mashed potato	7.1%[a]	4.2%[b]	14.4%[c]	11.8%	15.1%	14.4%
Bolognese	8.9%	10.4%	8.5%	5.9%	9.2%	8.5%
Did not have a least favourite	23.2%[b]	35.4%[a]	20.9%[b]	29.4%	18.5%	20.9%

[a,b] Values with different superscript letters were significantly different between Countries (Fishers exact, $p \leq 0.05$).

Table 5
Most preferred fortified meals (as %).

	France (n = 56)	Norway (n = 49)	UK (n = 47)	Male (n = 32)	Female (n = 120)	Total (n = 152)
Porridge	n/a	9.3%	7.6%	6.1%	5.1%	5.3%
French toast	8.1%	5.2%	5.4%	6.1%	6.3%	6.3%
Scotch pancakes	9.0%[b]	3.1%[a]	10.9%[b]	6.1%	8.4%	7.9%
Cake	14.4%	9.3%	9.8%	12.1%	11.0%	11.2%
Granola	14.4%[a]	27.8%[b]	21.7%[b]	22.7%	21.1%	21.5%
Carrot soup	25.2%[a]	12.4%[b]	14.1%[b]	15.2%	18.1%	17.5%
Mashed potato	10.8%	7.2%	6.5%	7.6%	8.4%	8.3%
Bolognese	18.0%	25.8%	23.9%	24.2%	21.5%	22.1%

[a,b] Values with different superscript letters were significantly different between Countries (Fishers exact, $p \leq 0.05$).

successful approach.

Our home-use trial aimed to achieve 6–10 g of additional protein per portion compared to the unfortified counterparts and so ingredients with a particularly high concentration of protein (milk protein powder, quark, ground almonds and extruded soya mince) were used. As the focus groups revealed that unfamiliarity of protein powders could be a barrier, where possible we tried to substitute them into meals which already typically included dry powders (such as replacing some flour in recipes with protein powder). This provided participants the opportunity to experiment using them and report back how they found it impacted the meals in relation to their main concerns. The results showed that the participants thought the fortification did not have a significant impact on ease of use, taste, texture and appearance, factors which they expressed concern over in the focus groups. They also thought that fortification increased the nutritional value of the meals overall, so this was promising.

Despite the attitudes towards the overall impact of fortification, the majority of older adults who took part in the home-use trial did not think they would continue with fortification in the future. Findings from the focus groups explained that older adults and familial caregivers of older adults may be more likely to support the addition of higher protein ingredients if their knowledge was developed on protein requirements in ageing. When fortification was discussed in the focus groups, protein did not appear to be in the forefront of their minds before the study compared to all the other dietary factors that they considered in living a healthy life. Therefore, increased awareness of the need for protein and protein sources might influence the openness and motivation to include these ingredients in their meals.

The most popular dishes in each country were Carrot soup (France), Granola (Norway) and Bolognese (UK). There were distinct differences for preferences across countries, when sometimes these preferences were opposites (such as Granola in Norway versus France). This highlighted the importance of trialling meals with older adults in three different countries to show that preferences can be very culturally dependent and that a 'one size fits all' approach would not work. As such, fortification solutions must be adapted to cultural preferences (Fatemi et al., 2023), which is why the at-home approach, using commonly eaten ingredients and meals most relevant to the individual, appears to be a preferable method for achieving enjoyment out of fortified meals.

In addition, there were some interesting findings for the influence of food neophobia. Firstly, there was an indication of a preference for softer foods (Porridge, Mashed potato; whereas the harder textured Granola was less likely to be liked) in those who were more neophobic, as is consistent with the literature (Cappellotto & Olsen, 2021). Somewhat surprisingly, the results indicated that consumers with high food neophobia might be more likely to prefer the use of milk protein powders and soy protein to fortify their foods, despite food neophobia being inversely related to willingness to try functional foods (Stratton et al., 2015). Perhaps this might be related to lower confidence in those with high food neophobia with their cooking skills and using everyday culinary ingredients, however we did not test for this.

With regards to study limitations, it is likely that we recruited older adults who were more interested in health than the rest of the population, were in a stable financial position and were likely to be educated. Moreover, as a volunteer seeking out participation in research studies, they may have been more independent and therefore more capable to utilise food-based fortification than others. As such, we need to be wary about generalising the results to the wider populations in the UK, France and Norway because psycho-social and social-economic factors are known to impact food choice and behaviours in older adults (Atkins et al., 2015; Walker-Clarke et al., 2022). We did ask about self-reported health status and the majority of people in each country felt that their health was the same as others their age, but we did not record education or financial status. Another limitation to consider, as is potential bias in the study; firstly, there is the possibility of a social desirability bias from the participants wishing to conform to the objectives of the tasks and please the researchers. However, there was little evidence of this from the discussions which were very open about what participants did not like, and likewise with the opinions in the home-use trial with the overall outcome that they did not want to fortify their foods at the current time. Secondly, within qualitative work there is the possibility of personal bias by the researchers (Morse et al., 2002). With this in mind, the multisite analysis (Jenkins et al., 2018) was a very collaborative process between the researchers and provided opportunities to sense check and challenge potential biases if they arose. Finally, our home-use trial did not compare the fortified recipes with its unfortified counterpart as this was deemed too big a burden on the participant to make that many meals, and it was more important to trial a variety of fortified meals. However, research that explores the liking of fortified versus unfortified meals designed for older adults would be recommended, as it is very likely that if it does not taste as good, despite being nutritionally improved, there may be lower uptake by older adults who do not want a compromise on taste.

Overall, we suggest that a focus on taste, cooking time, familiar ingredients and increased protein knowledge would facilitate a successful adoption of protein fortification for older adults.

Ethical statement

All study procedures were approved by the University of Reading Research Ethics Committee (UREC 21/26), the Norwegian Agency for Shared Services in Education and Research (SIKT 452337), and the Research Ethical Committee (CER) of the University Bourgogne Franche-Comté (CERUBFC-2021-11-16-037).

Funding

This work received funding from ANR (ANR-20-HDHL-0003 FORTIPHY), Research Council Norway (RCN 321819), BBSRC (BB/V018329/1) under the umbrella of the European Joint Programming Initiative "A Healthy Diet for a Healthy Life" (JPI HDHL) and of the ERA-NET Cofund ERA-HDHL (GA N696295 of the EU Horizon 2020 Research and Innovation Programme).

CRediT authorship contribution statement

Rachel Smith: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Lisa Methven:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Miriam E. Clegg:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Alexia Geny:** Writing – review & editing, Methodology, Formal analysis. **Øydis Ueland:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Ida Synnøve Grini:** Writing – review & editing, Methodology, Formal analysis, Conceptualization. **Guro Helgesdotter Rognså:** Writing – review & editing, Methodology. **Isabelle Maitre:** Writing – review & editing, Methodology, Conceptualization. **Céline Brasse:** Writing – review & editing, Methodology, Conceptualization. **Virginie Van Wymelbeke-Delannoy:** Writing – review & editing, Methodology, Conceptualization. **Claire Sulmont-Rossé:** Writing – review & editing, Methodology, Conceptualization.

Declaration of competing interest

The authors have no conflicting or competing interests to declare.

Data availability

Data will be made available on request.

Acknowledgements

In the UK, we would like to thank Edel Campbell for her assistance with preparing the home-use-trial and Sacha Guirgis for her assistance in data entry of the home-use trial questionnaires. In Norway, we would like to thank Solveig Nersten, Mads Erling Pedersen and Andrea Nyland Vinje for their assistance in preparing the home-use test. In France, we would like to thank Victorien Perrussel and Flore Lourtioux for their assistance with preparing the home-use-trial.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2024.107319.

References

Appleton, K. M. (2016). Barriers to and Facilitators of the consumption of animal-based protein-rich foods in older adults. *Nutrients, 8*(Issue 4). https://doi.org/10.3390/nu8040187

Atkins, J. L., Ramsay, S. E., Whincup, P. H., Morris, R. W., Lennon, L. T., & Wannamethee, S. G. (2015). Diet quality in older age: The influence of childhood and adult socio-economic circumstances. *British Journal of Nutrition, 113*(9), 1441–1452.

Bauer, J., Biolo, G., Cederholm, T., Cesari, M., Cruz-Jentoft, A. J., Morley, J. E., Phillips, S., Sieber, C., Stehle, P., Teta, D., Visvanathan, R., Volpi, E., & Boirie, Y. (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

Blomhoff, R., Andersen, R., Arnesen, E. K., Christensen, J. J., Eneroth, H., Erkkola, M., Gudanaviciene, I., Halldórsson, þ. I., Höyer-Lund, A., & Lemming, E. W. (2023). *Nordic nutrition recommendations 2023: Integrating environmental aspects*. Nordic Council of Ministers.

Bull, S. P., Hong, Y., Khutoryanskiy, V. V., Parker, J. K., Faka, M., & Methven, L. (2017). Whey protein mouth drying influenced by thermal denaturation. *Food Quality and Preference, 56*, 233–240. https://doi.org/10.1016/j.foodqual.2016.03.008

Cappellotto, M., & Olsen, A. (2021). Food texture acceptance, sensory sensitivity, and food neophobia in children and their parents. *Foods, 10*(10), 2327.

Carlsen, B., & Glenton, C. (2011). What about N? A methodological study of sample-size reporting in focus group studies. *BMC Medical Research Methodology, 11*(1), 26. https://doi.org/10.1186/1471-2288-11-26

Coelho-Junior, H. J., Marzetti, E., Picca, A., Cesari, M., Uchida, M. C., & Calvani, R. (2020). Protein intake and frailty: A Matter of quantity, quality, and timing. *Nutrients, 12*(10). https://doi.org/10.3390/nu12102915

Dermiki, M., Willway, J., Sargent, L., Kidman, J., Anderson, C., Kennedy, O. B., Gosney, M. A., & Methven, L. (2014). Preference and consumption of a taste enhanced meat meal by older hospital patients: A pilot study. *Nutrition and Aging, 2*(1), 69–75.

Deutz, N. E. P., Bauer, J. M., Barazzoni, R., Biolo, G., Boirie, Y., Bosy-Westphal, A., Cederholm, T., Cruz-Jentoft, A., Krznariç, Z., Nair, K. S., Singer, P., Teta, D., Tipton, K., & Calder, P. C. (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

Doty, R. L., & Kamath, V. (2014). The influences of age on olfaction: A review. *Frontiers in Psychology, 5*, 20.

Douglas, J. W., Lawrence, J. C., & Knowlden, A. P. (2017). The use of fortified foods to treat malnutrition among older adults: A systematic review. *Quality in Ageing and Older Adults, 18*(2), 104–119.

Dunne, A. (2007). Malnutrition: Supplements and food fortification in the older population. *British Journal of Community Nursing, 12*(11), 494–499.

Fatemi, S. F., Irankhah, K., Kruger, J., Bruins, M. J., & Sobhani, S. R. (2023). Implementing micronutrient fortification programs as a potential practical contribution to achieving sustainable diets. *Nutrition Bulletin, 48*(3), 411–424.

Fernando, W., Rainey-Smith, S. R., Gardener, S. L., Villemagne, V. L., Burnham, S. C., Macaulay, S. L., Brown, B. M., Gupta, V. B., Sohrabi, H. R., & Weinborn, M. (2018). Associations of dietary protein and fiber intake with brain and blood amyloid-β. *Journal of Alzheimer's Disease, 61*(4), 1589–1598.

Fleury, S., Sulmont-Rossé, C., Cabanes, H., Perruchaud, M., Roger, A., Lesourd, B., Tronchon, P., Van Wymelbeke-Delannoy, V., & Maitre, I. (2020). Relevance and Feasibility of a Personalized dietary intervention in older people with meals-on-wheels: A Randomized Controlled pilot trial. *JAR Life, 9*, 40.

Fleury, S., Van Wymelbeke-Delannoy, V., Lesourd, B., Tronchon, P., Maître, I., & Sulmont-Rossé, C. (2021). Home-delivered meals: Characterization of food intake in elderly beneficiaries. *Nutrients, 13*(6), 2064.

Forde, C. G., & Delahunty, C. M. (2004). Understanding the role cross-modal sensory interactions play in food acceptability in younger and older consumers. *Food Quality and Preference, 15*(7–8), 715–727.

Geirsdóttir & Pajari. (2023). In *Nordic nutrition recommendations 2023*. Nordic Council of Ministers. *Protein*.

Geny, A., Petitjean, M., Vanwymelbeke-Delannoy, V., & Sulmont-Rossé, C. (2023). Impact of food fortification on nutritional outcomes and acceptability in older people: Systematic literature review. *Frontiers in Nutrition, 10*, Article 1232502.

Groenendijk, I., den Boeft, L., van Loon, L. J. C., & de Groot, L. C. P. G. M. (2019). High versus low dietary protein intake and Bone health in older adults: A systematic review and meta-analysis. *Computational and Structural Biotechnology Journal, 17*, 1101–1112. https://doi.org/10.1016/j.csbj.2019.07.005

Hall, G., & Wendin, K. (2008). Sensory design of foods for the elderly. *Annals of Nutrition and Metabolism, 52*(Suppl. 1), 25–28.

Hunter, G. R., Singh, H., Carter, S. J., Bryan, D. R., & Fisher, G. (2019). Sarcopenia and its implications for metabolic health. *Journal of Obesity, 2019*.

Jenkins, E. K., Slemon, A., Haines-Saah, R. J., & Oliffe, J. (2018). A guide to multisite qualitative analysis. *Qualitative Health Research, 28*(12), 1969–1977.

Kendig, D. M., Hurst, N. R., Bradley, Z. L., Mahavadi, S., Kuemmerle, J. F., Lyall, V., DeSimone, J., Murthy, K. S., & Grider, J. R. (2014). Activation of the umami taste receptor (T1R1/T1R3) initiates the peristaltic reflex and pellet propulsion in the distal colon. *American Journal of Physiology - Gastrointestinal and Liver Physiology, 307*(11), G1100–G1107.

Kremer, S., Mojet, J. O. S., & Kroeze, J. H. A. (2005). Perception of texture and flavor in soups by elderly and young subjects. *Journal of Texture Studies, 36*(3), 255–272.

Laguna, L., Mingioni, M., Maitre, I., Vanwymelbeke, V., Pirttijärvi, T., Artigas, M. G., Kautola, H., Järvenpää, E., Mäenpää, T., & Tahvonen, R. (2016). Perception of difficulties encountered in eating process from European elderlies' perspective. *Journal of Texture Studies, 47*(4), 342–352.

Li, P., Yin, Y.-L., Li, D., Woo Kim, S., & Wu, G. (2007). Amino acids and immune function. *British Journal of Nutrition, 98*(2), 237–252. 10.1017/S000711450769936X.

Lonnie, M., Hooker, E., Brunstrom, J. M., Corfe, B. M., Green, M. A., Watson, A. W., Williams, E. A., Stevenson, E. J., Penson, S., & Johnstone, A. M. (2018). Protein for life: Review of optimal protein intake, sustainable dietary sources and the effect on appetite in ageing adults. *Nutrients, 10*(3), 360.

Mathers, C. D., Stevens, G. A., Boerma, T., White, R. A., & Tobias, M. I. (2015). Causes of international increases in older age life expectancy. *The Lancet, 385*(9967), 540–548. https://doi.org/10.1016/S0140-6736(14)60569-9

Mendonça, N., Granic, A., Mathers, J. C., Hill, T. R., Siervo, M., Adamson, A. J., & Jagger, C. (2018). Prevalence and determinants of low protein intake in very old adults: Insights from the Newcastle 85+ study. *European Journal of Nutrition, 57*(8), 2713–2722. https://doi.org/10.1007/s00394-017-1537-5

Mendonça, N., Kingston, A., Granic, A., & Jagger, C. (2020). Protein intake and transitions between frailty states and to death in very old adults: The Newcastle 85+ study. *Age and Ageing, 49*(1), 32–38.

Methven, L., Allen, V. J., Withers, C. A., & Gosney, M. A. (2012). Ageing and taste. *Proceedings of the Nutrition Society, 71*(4), 556–565. https://doi.org/10.1017/S0029665112000742

Mingioni, M., Mehinagic, E., Laguna, L., Sarkar, A., Pirttijärvi, T., Van Wymelbeke, V., Artigas, G., Chen, J., Kautola, H., Järvenpää, E., Mäenpää, T., Tahvonen, R., Grabska-Kobylecka, I., & Maitre, I. (2016). Fruit and vegetables liking among European elderly according to food preferences, attitudes towards food and dependency. *Food Quality and Preference, 50*, 27–37. https://doi.org/10.1016/j.foodqual.2016.01.003

Mojet, J., Christ-Hazelhof, E., & Heidema, J. (2001). Taste perception with age: Generic or specific losses in threshold sensitivity to the five basic tastes? *Chemical Senses, 26*(7), 845–860.

Morilla-Herrera, J. C., Martin-Santos, F. J., Caro-Bautista, J., Saucedo-Figueredo, C., Garcia-Mayor, S., & Morales-Asencio, J. M. (2016). Effectiveness of food-based fortification in older people a systematic review and meta-analysis. *The Journal of Nutrition, Health & Aging, 20*, 178–184.

Morris, S., Cater, J. D., Green, M. A., Johnstone, A. M., Brunstrom, J. M., Stevenson, E. J., Williams, E. A., & Corfe, B. M. (2020). Inadequacy of protein intake in older UK adults. *Geriatrics, 5*(1), 6.

Morse, J. M., Barrett, M., Mayan, M., Olson, K., & Spiers, J. (2002). Verification strategies for establishing reliability and validity in qualitative research. *International Journal of Qualitative Methods, 1*(2), 13–22.

Nieuwenhuizen, W. F., Weenen, H., Rigby, P., & Hetherington, M. M. (2010). Older adults and patients in need of nutritional support: Review of current treatment options and factors influencing nutritional intake. *Clinical Nutrition, 29*(2), 160–169. https://doi.org/10.1016/j.clnu.2009.09.003

Norton, V., Lignou, S., Bull, S. P., Gosney, M. A., & Methven, L. (2020). Consistent Effects of whey protein fortification on consumer perception and liking of Solid food matrices (cakes and biscuits) Regardless of age and saliva Flow. *Foods, 9*(9). https://doi.org/10.3390/foods9091328

Nygård, L. K., Dahl, L., Mundal, I., Šaltytė Benth, J., & Rokstad, A. M. (2020). Protein intake, protein Mealtime distribution and Seafood consumption in elderly Norwegians: Associations with physical function and Strength. *Geriatrics, 5*(4). https://doi.org/10.3390/geriatrics5040100

Oliver, D. G., Serovich, J. M., & Mason, T. L. (2005). Constraints and opportunities with interview transcription: Towards reflection in qualitative research. *Social Forces, 84*(2), 1273–1289.

Pedersen, A. M., Bardow, A., Jensen, S. B., & Nauntofte, B. (2002). Saliva and gastrointestinal functions of taste, mastication, swallowing and digestion. *Oral Diseases, 8*(3), 117–129.

Pennings, B., Boirie, Y., Senden, J. M. G., Gijsen, A. P., Kuipers, H., & van Loon, L. J. C. (2011). Whey protein stimulates postprandial muscle protein accretion more effectively than do casein and casein hydrolysate in older men. *The American Journal of Clinical Nutrition, 93*(5), 997–1005. https://doi.org/10.3945/ajcn.110.008102

Pliner, P., & Hobden, K. (1992). Development of a scale to measure the trait of food neophobia in humans. *Appetite, 19*(2), 105–120.

QSR International Pty Ltd. (2018). NVivo (Version 12) https://www.qsrinternational.com/nvivo-qualitative-data-analysis-software/home.

Raffaele, F. (2013). Consumer co-creation and new product development: A case study in the food industry. *Marketing Intelligence & Planning, 31*(1), 40–53. https://doi.org/10.1108/02634501311292911

Roberts, C., Steer, T., Maplethorpe, N., Cox, L., Meadows, S., Nicholson, S., Page, P., & Swan, G. (2018). *National diet and nutrition survey: Results from years 7 and 8 (combined) of the rolling Programme (2014/2015–2015/2016)*.

Rothenberg, E., & Wendin, K. (2015). Texture modification of food for elderly people. In *Modifying food texture* (pp. 163–185). Elsevier.

Sasano, T., Satoh-Kuriwada, S., Shoji, N., Iikubo, M., Kawai, M., Uneyama, H., & Sakamoto, M. (2014). Important role of umami taste sensitivity in oral and overall health. *Current Pharmaceutical Design, 20*(16), 2750–2754.

Scientific Advisory Committee on Nutrition. (2012). *Dietary reference values for energy*. The Stationery Office. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/339317/SACN_Dietary_Reference_Values_for_Energy.pdf.

Slay, J., & Stephens, L. (2013). *Co-Production in mental health: A literature review* (Vol. 4). London: New Economics Foundation.

Smith, R., Clegg, M., & Methven, L. (2022). Review of protein intake and suitability of foods for protein-fortification in older adults in the UK. *Critical Reviews in Food Science and Nutrition*, 1–18. https://doi.org/10.1080/10408398.2022.2137777

Stańska, K., & Krzeski, A. (2016). The umami taste: From discovery to clinical use. *Otolaryngologia Polska, 70*(4), 10–15.

Stratton, L. M., Vella, M. N., Sheeshka, J., & Duncan, A. M. (2015). Food neophobia is related to factors associated with functional food consumption in older adults. *Food Quality and Preference, 41*, 133–140. https://doi.org/10.1016/j.foodqual.2014.11.008

Sulmont-Rossé, C. (2020). Eating in the elderly. In *Handbook of eating and Drinking: Interdisciplinary Perspectives* (pp. 433–457).

Sulmont-Rossé, C., Maître, I., Amand, M., Symoneaux, R., Van Wymelbeke, V., Caumon, E., Tavarès, J., & Issanchou, S. (2015). Evidence for different patterns of chemosensory alterations in the elderly population: Impact of age versus dependency. *Chemical Senses, 40*(3), 153–164.

Sulmont-Rossé, C., Symoneaux, R., Feyen, V., & Maître, I. (2018). Improving food sensory quality with and for elderly consumers. *Methods in Consumer Research, 2*, 355–372. Elsevier.

Thiyagalingam, S., Kulinski, A. E., Thorsteinsdottir, B., Shindelar, K. L., & Takahashi, P. Y. (2021). Dysphagia in older adults. *Mayo Clinic Proceedings, 96*(2), 488–497.

van den Heuvel, E., Newbury, A., & Appleton, K. M. (2019). The psychology of nutrition with advancing age: Focus on food neophobia. *Nutrients, 11*(1), 151.

van der Pols-Vijlbrief, R., Wijnhoven, H. A. H., Schaap, L. A., Terwee, C. B., & Visser, M. (2014). Determinants of protein–energy malnutrition in community-dwelling older adults: A systematic review of observational studies. *Ageing Research Reviews, 18*, 112–131.

Van Wymelbeke, V., Sulmont-Rossé, C., Feyen, V., Issanchou, S., Manckoundia, P., & Maître, I. (2020). Optimizing sensory quality and variety: An effective strategy for increasing meal enjoyment and food intake in older nursing home residents. *Appetite, 153*, Article 104749.

Walker-Clarke, A., Walasek, L., & Meyer, C. (2022). Psychosocial factors influencing the eating behaviours of older adults: A systematic review. *Ageing Research Reviews, 77*, Article 101597.

Wall, B. T., Cermak, N. M., & van Loon, L. J. C. (2014). Dietary protein considerations to support active aging. *Sports Medicine, 44*(2), 185–194. https://doi.org/10.1007/s40279-014-0258-7

Westergren, A., Unosson, M., Ohlsson, O., Lorefält, B., & Hallberg, I. R. (2002). Eating difficulties, assisted eating and nutritional status in elderly (⩾65 years) patients in hospital rehabilitation. *International Journal of Nursing Studies, 39*(3), 341–351. https://doi.org/10.1016/S0020-7489(01)00025-6

Whitelock, E., & Ensaff, H. (2018). On your own: Older adults' food choice and dietary habits. *Nutrients, 10*(4), 413.

World Health Organization. (2020). Decade of healthy ageing 2020–2030. https://www.who.int/docs/default-source/decade-of-healthy-ageing/final-decade-proposal/decade-proposal-final-apr2020-en.pdf?sfvrsn=b4b75ebc_3.

World Health Organization. (2022). Ageing and health. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health#:~:text=By2030%2C1in6,willdouble(2.1billion.