Undernutrition management and the role of protein-enriched meals for older adults

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This research was conducted under the auspices of the Graduate School VLAG (Advanced studies in Food Technology, Agro-biotechnology, Nutrition and Health Sciences).

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Thesis

submitted in fulfilment of the requirements for the degree of doctor
at Wageningen University
by the authority of the Rector Magnificus
Prof. Dr A.P.J. Mol,
in the presence of the
Thesis Committee appointed by the Academic Board
to be defended in public
on Friday 9 December 2016
at 4 p.m. in the Aula.

Canan Ziylan
Undernutrition management and the role of protein-enriched meals for older adults
150 pages.

PhD thesis, Wageningen University, Wageningen, NL (2016)
With references, with summaries in English and Dutch

ISBN 978-94-6257-932-3
DOI 10.18174/390155

A candle loses none of its light by lighting another candle

Mevlânâ Celâleddîn-i Rûmî

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CHAPTER 1

General introduction

I cannot see, I cannot pee
I cannot chew, I cannot screw
Oh my God, what can I do?
My memory shrinks, my hearing stinks
No sense of smell, I look like hell
My mood is bad – can you tell?
My body's drooping, have trouble pooping
The Golden Years have come at last
The Golden Years can kiss my ___!

As Dr. Seuss' Cat in the Hat illustrated with his poem, ageing comes with its drawbacks. Although since this poem from 1957 medicinal developments have greatly improved the ageing process, some aspects will always remain part of it. The crux is to assess which aspects are inevitable and – perhaps more importantly – which are not. In a world where the ageing population keeps growing, this assessment is crucial.

Worldwide, the group of older adults is growing faster than any other age group, and the number of people aged over 80y is growing the fastest [1]. This increase is due to both improved longevity and the ageing of larger cohorts of people. The United Nations has projected that by 2030, 1.4 billion people will be aged over 60y, translatable to one in six people [1]. This proportion is expected to be even larger in the Netherlands, as one in four inhabitants will be aged over 65y by 2040 [2]. Despite these obvious benefits of our globally improving living conditions and health care, not all is rosy. Sadly, as already mentioned, increasing age often comes with physical and psychological frailty [3]. Although 95% of the Dutch elderly still manage to live at home, one in four Dutch community-dwelling older adults is frail [4,5]. Frail older adults may suffer from symptoms like fatigue, weakness, impaired mobility, unintended weight loss, and undernutrition [6]. Besides the obvious negative effects of this frailty on older adults' quality of life, it increasingly burdens the health care system. This notion prompted the Dutch government to underline the importance of frailty prevention among its elderly citizens, stimulating a variety of preventive measures addressing elements of frailty [7].

Undernutrition conceptualisation

One of the symptoms of frailty is undernutrition, which in turn negatively affects the other symptoms. Moreover, undernutrition is a major health problem in the elderly population, with a high prevalence in many Western countries. It is estimated that, worldwide, one in twenty community-dwelling older adults is suffering from undernutrition [8], and one in ten Dutch community-dwelling older adults [9]. Actual prevalence may be higher, as in

older adults many diseases typically develop for some time before they are recognised, mainly because they are misdiagnosed or attributed to normal ageing [10]. Undernutrition is probably not an exception to this rule. Undernutrition may lead to many negative consequences, ranging from fatigue and falls to impaired immune function and death [11]. This makes undernutrition an obvious target for preventive measures.

Undernutrition can be defined as deficient energy or protein intake or absorption, often described as protein energy malnutrition [12]. Here, undernutrition falls within the broader concept of malnutrition, which in turn is defined as 'a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size and composition) and function, and clinical outcome' [13].

Malnutrition is actually an umbrella term for three different syndromes: cachexia, sarcopenia, and wasting. The definition of these syndromes is provided in **Table 1.1**. Each of these syndromes may have a different etiology and therefore requires a different treatment, even within one syndrome. Nonetheless, counteracting possible protein energy malnutrition will virtually always play a minor or major role in the overall treatment. For this reason, in this thesis, we focused on the problem of protein energy undernutrition and on its possible countermeasures.

Table 1.1 Definition and general etiology of three malnutrition syndromes.

Syndrome	Definition
Cachexia [14]	An ongoing loss of skeletal muscle mass, with or without loss of fat mass. The cause is a negative protein and energy balance driven by a variable combination of reduced food intake and abnormal metabolism.
Sarcopenia [15]	The age-associated loss of skeletal muscle mass and function. The causes can include disuse, altered endocrine function, chronic diseases, inflammation, insulin resistance, and nutritional deficiencies.
Wasting [16]	The loss of both muscle and fat mass. The cause is a severe deficiency in food intake, for example due to anorexia nervosa, neglect, or loneliness.

Protein intake needs

Adequate protein intake may to some extent prevent and reverse protein energy undernutrition. Before we elaborate on when protein intake is considered adequate, we need to look into the ageing process and its associations with protein needs and intakes. These associations are illustrated by the ESPEN Expert group in **Figure 1.1**. As summarised in part A of this figure, older adults develop higher protein needs because of several negative factors [17]. Firstly, older adults may experience difficulties in protein synthesis

as they develop resistance to the positive effects of dietary protein consumption. This so-called anabolic resistance limits muscle maintenance and growth [18,19]. Moreover, the availability of amino acids after protein consumption may be decreased too, as well as muscle perfusion of these amino acids [19,20]. The combination of both a prolonged disuse of muscles and diseases that trigger protein catabolism often increases the protein needs of older adults during ageing.

These higher protein needs call for higher protein intakes. Unfortunately, older adults actually tend to demonstrate lower protein intakes (**Figure 1.1B**) [17]. This lower intake can be caused by a variety of risk factors related to genetic predisposition, physiological changes, and medical conditions. These factors may decrease older adults' appetite and food enjoyment. In addition, physical and mental disorders can negatively affect appetite and food consumption, while simultaneously limiting older adults' ability to buy, prepare, and consume food. Moreover, these problems with food provision could worsen when accompanied by financial and social limitations. This combination of factors leading to lower protein intake hampers the attainment of the higher protein needs. To prevent protein energy undernutrition, finding solutions for these bottlenecks that prevent adequate protein intake seems necessary.

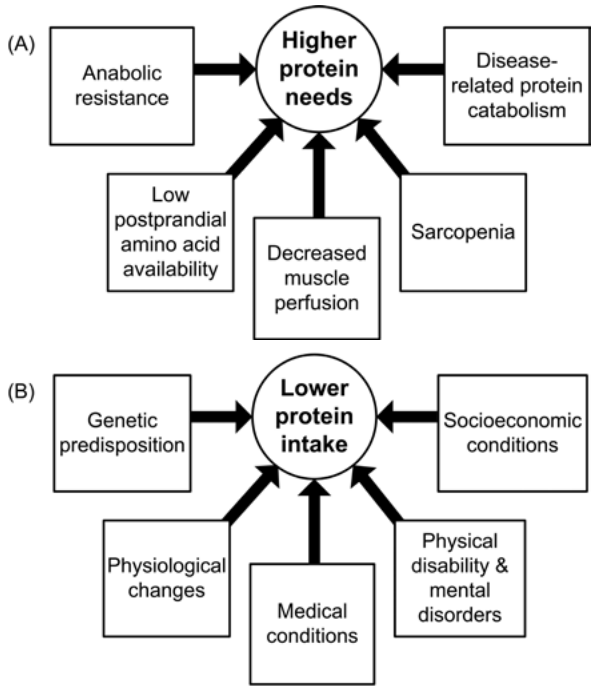

Figure 1.1 Factors leading to (A) higher protein needs and (B) lower protein intake in older adults as illustrated by Deutz et al. [17].

According to the current recommended dietary allowance (RDA), a protein intake of 0.8g protein/kg body weight/day (g/kg/d) is required across all adults aged over 18y. Not surprisingly however, there is a call for higher protein intakes for older adults that align with their higher protein needs [21]. A group of experts formed the PROT-AGE Study Group to review available evidence on optimal rather than minimal dietary protein intake in older adults [22]. This resulted in a position paper with newly proposed protein intake recommendations. Although they state that more research is needed regarding some of their recommendations, three intake recommendations were sufficiently supported by evidence:

1. Older adults in general should consume an average daily protein intake at least in the range of 1.0 to 1.2g/kg/d.
2. Most older adults with an acute or chronic disease should consume 1.2 to 1.5g/kg/d. Those with severe illness/injury or marked malnutrition may need 2.0g/kg/d.
3. Older adults with severe kidney disease who are not on dialysis (GFR < 30 mL/min/1.73m^2) are an exception and need to limit protein intake.

In addition, some evidence indicated that consuming 25–30g protein per meal occasion might be beneficial for muscle protein synthesis, with an even distribution over the day [23]. In contrast, other evidence suggested that pulse-feeding of protein – consuming the majority of total protein intake at one meal occasion, leading to an uneven distribution – might be beneficial, at midday [24,25] or overnight [26]. As more evidence is needed on these matters, we opted to focus on the general protein intake recommendation. For this reason, we considered 1.2g/kg/d as adequate protein intake for our research project concerning community-dwelling older adults.

Protein enrichment instruments

In Dutch community-dwelling older adults, protein intake is around 1.0 g/kg/d [27], implying room for improvement. However, it is possible that many of these older adults deal with physiological changes, medical conditions, and physical and mental limitations that impair their appetite and food provision, as shown in **Figure 1.1**. For these older adults with higher protein needs, merely recommending that they eat more would not be realistic [28,29]. It would be more realistic to explore strategies that increase protein intake without having to increase the volume of food intake [30]. A commonly applied strategy to achieve this in the clinical setting is the use of oral nutritional supplements. When consistently applied, oral nutritional supplements are highly effective instruments to increase protein intake [31]. However, these supplements are also prone to be accompanied by taste challenges and elicit low enthusiasm among older adults, reducing their use in non-controlled settings such as homes [31,32]. This leads to the conclusion

that the health benefits of oral nutritional supplements do not outweigh their limitations for many community-dwelling older adults [33,34]. This obvious mismatch calls for the exploration of other instruments that match not only the needs of older adults, but also their preferences: protein-enriched regular products.

Two systematic reviews have already shown that, in general, enriched products lead to increased energy and protein intakes in older adults [30,35]. Both reviews concluded that enriching regular food products is a simple strategy to increase calorie and protein intake. At the same time, the reviews note that it cannot be concluded that this increased intake leads to improvement in health outcomes. The main explanation provided by the authors for this is the poor quality of the conducted studies. This exact same message was also conveyed by the Health Council of the Netherlands [36]. The Council furthermore stated that it is difficult to disentangle the illnesses of older adults in clinical settings from their nutritional status and other health outcomes. For now, we could argue – until qualitatively better studies are conducted – that enriched foods are more suitable as supportive measures in at-risk groups, rather than as the sole solution to reach adequate protein intake.

One particular group that can be identified as an at-risk group are older adults who receive home care. As already mentioned, one in ten Dutch community-dwelling older adults is undernourished, but that proportion reaches one in three among older adults who depend on home care [9]. This may be explained by their health problems that led to this dependence on home care [11]. Likewise, many of these older adults also depend on meals-on-wheels. Earlier studies have shown that meals-on-wheels recipients, regardless of whether they receive home care or not, often risk undernutrition too [37–40]. In both these (overlapping) care-dependent groups, difficulties in adhering to energy and protein recommendations can be discerned. For this reason, enriching the readymade meals that these older adults receive may contribute to the prevention of protein undernutrition by increasing protein intake while maintaining the same food intake.

Still, another challenge comes into play here, as protein-enriched readymade meals are not yet offered by meal services. To develop readymade meals that are effective in increasing protein intake, the first condition is to make sure that they are acceptable, especially in light of the bottlenecks formed by a reduced food enjoyment due to, for example, physiological and physical limitations. Therefore, one important issue to consider in the development of protein-enriched readymade meals is the current dietary behaviour of older adults and the modifiable factors within this behaviour [41–43]. The reason for this is that the current dietary behaviour leads to difficulties in meeting nutritional recommendations and needs to be modified [44]. These habits can be modified to a certain extent with the support of appropriate motivations [45,46]. Therefore, the enriched meals should be in line with current dietary behaviour, involving necessary dietary modifications that remain small

and realistic, thereby achieving a match between older adults' needs and preferences. For this reason, elucidating potential consumers' current dietary behaviour forms a necessary first step for developing protein-enriched readymade meals to be used as acceptable and effective protein enrichment instruments.

Undernutrition management

Protein enrichment instruments can be used to partly counteract undernutrition, but only when implemented in a timely manner. In protein energy undernutrition, prevention is especially better than cure, as the related muscle loss is hard to reverse. Adequate undernutrition management systems are therefore necessary to facilitate timely intervention, ensuring that the developed protein-enriched meals are actually offered and effective.

In the Netherlands, since 2005 the Dutch Malnutrition Steering Group has taken it upon itself to take the leading role in setting up a malnutrition management system. This multidisciplinary group includes national key persons, ranging from medical doctors and researchers to health practitioners and policy advisors. Since its formation, the Dutch Malnutrition Steering Group has developed tools and guidelines that facilitate adequate screening and treatment of malnutrition in older adults at home, in hospitals, and in long-term care facilities. Its most prominent screening tool is the Short Nutritional Assessment Questionnaire [47] (SNAQ) for hospitals, which in addition has a version for the general older adult population [48] ($SNAQ^{65+}$) and for older adults in a residential care setting [49] ($SNAQ^{RC}$). These effective, quick tools require no training, equipment, or calculations, making them suitable for practice.

The developed tools are part of the overall Guideline Screening and Treatment of Malnutrition [50] that includes recommendations regarding early recognition and treatment of malnutrition in different Dutch healthcare settings. Part of this guideline is the National Primary Care Collaboration Agreement on Malnutrition [51], which specifically acknowledges the important role of primary care in malnutrition. In secondary care, undernutrition screening is furthermore included in the Guideline Comprehensive Geriatric Assessment [52] and the Guideline Malnutrition in the Geriatric Patient [53]. Training sessions and workshops are provided to raise awareness of, and familiarity with, undernutrition management. These combined efforts have resulted in tangible positive developments, such as decreasing malnutrition prevalence rates in all heath care settings in the Netherlands [54]. Not surprisingly, this so-called Dutch Approach was awarded the accolade of being the best national initiative to fight malnutrition in 2010 [54]. The largest improvement in the application of the screening and treatment guidelines has been achieved in secondary care settings, with their application lagging behind in the primary

and home care setting [55]. Community-dwelling older adults who risk undernutrition are often identified too late, or not at all when their deteriorating health state is attributed to normal ageing [10]. This tardiness leads to difficulties in the subsequent treatment of undernutrition, decreasing its effectiveness. The Steering Group calls for a better alignment across all health care settings: primary care, home care, hospitals, and residential care homes. To improve this alignment and facilitate timely treatment implementation, we therefore firstly needed to understand the current bottlenecks that hamper adequate application of the guidelines in primary care.

The PRIMA Meal study

In our overall research project, we focused on current bottlenecks in both undernutrition management and protein enrichment in the expectation that exploring these bottlenecks might facilitate the subsequent development and improvement of effective countermeasures for undernutrition in primary care and home care. For this reason, we launched the PRIMA Meal study in 2012 (*PRIMA Maaltijd* in Dutch). This acronym stands for PRotein-enriched InstruMental and Acceptable Meal.

The overall aim of this research project was to gain insight into the current state of undernutrition management in community-dwelling older adults in the Netherlands and explore the role of protein-enriched regular products as a supportive instrument in protein undernutrition management. To be able to reach our overall aim, four studies were conducted, with each having its own objective, design, and methodology (**Figure 1.2**).

Study 1 (chapter 2) explored the experiences of 22 Dutch nutrition and care professionals and researchers with undernutrition awareness, monitoring, and treatment among community-dwelling older adults. This qualitative study among, for example, dietitians, general practitioners, nurse practitioners, and home care nurses provided insight into the current bottlenecks within the existing undernutrition management guidelines. In these interviews, these experts also discussed the current dietary behaviour problems of older adults and their impact on undernutrition risk, which we then further investigated in Study 2 (chapter 3). In this mixed-methods study, with interviews, we qualitatively explored the dietary behaviour and undernutrition risk of 12 Dutch elderly meals-on-wheels clients, one of the largest at-risk groups. We followed up on this information by quantifying the topics that emerged from the qualitative exploration of experienced bottlenecks in performing adequate dietary behaviour. For this, we used a survey among 333 meals-on-wheels clients. After learning about the general dietary behaviour of these older adults, we used this information to develop two kinds of protein-enriched readymade meals that are in line with the needs and preferences of older adults: one of regular size (450g) and

one of reduced size (400g). In Study 3 (chapter 4), we tested these meals in a lab setting in 120 community-dwelling older adults in a single-blind randomised crossover trial. One day a week at lunchtime, for four weeks, participants had to consume and evaluate a readymade meal. After establishing that the protein-enriched meals were effective and acceptable in the lab setting, we moved to the homes of older adults to test the meals in a longer-term study in Study 4 (chapter 5). In this double-blind randomised controlled trial, we also included protein-enriched bread to assess whether both this bread and the meals could increase daily protein intake to 1.2g/kg/d in 42 community-dwelling older adults to reach optimal protein intake. We assessed their daily food intake four times over two weeks. In the general discussion of this thesis (chapter 6), we combined our experiences from the four studies to reflect on protein undernutrition management in community-dwelling older adults and the possible role of protein-enriched regular products.

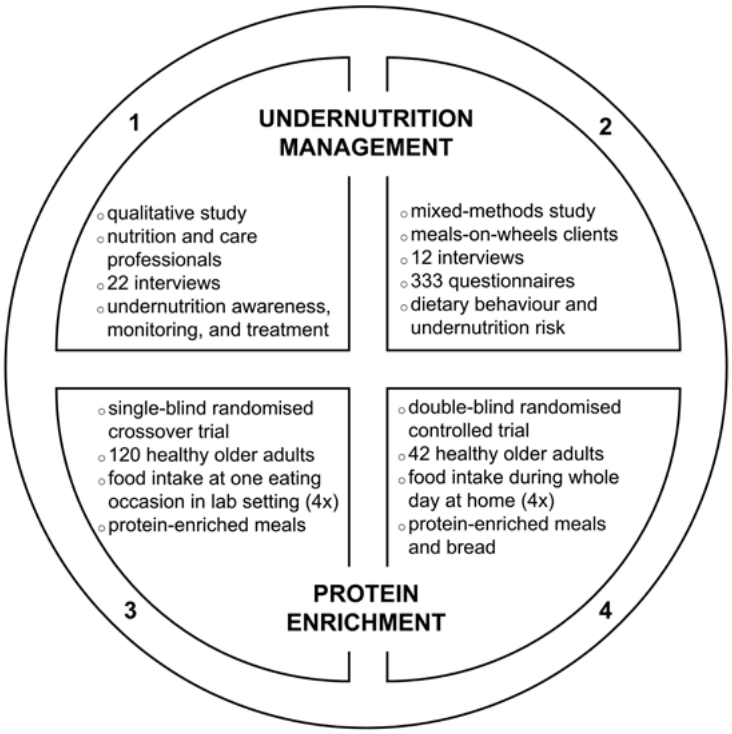

Figure 1.2 Overview of the four studies within the overall PRIMA Meal study, with a focus on undernutrition management and protein enrichment, showing the general design, target group, method, and topic of interest.

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CHAPTER 2

Dutch nutrition and care professionals' experiences with undernutrition awareness, monitoring, and treatment among community-dwelling older adults: a qualitative study

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BMC Nutrition, 2015, 1(1):38
DOI 10.1186/s40795-015-0034-6

Abstract

Background: Undernutrition can negatively affect community-dwelling older adults' health and quality of life. Undernutrition management guidelines have been developed in the Netherlands for the primary care setting, however, the application of these guidelines remain unsatisfactory. The current study therefore aims to explore qualitatively the experiences of Dutch nutrition and care professionals and researchers with undernutrition awareness, monitoring, and treatment among community-dwelling older adults.

Methods: We telephonically interviewed 22 Dutch nutrition and care professionals and researchers. Our semi-structured interview guide elicited answers that we audiotaped and transcribed verbatim. The interviews were coded using grounded theory and content analysis with the qualitative analysis software MAXQDA, after which the codes were categorized into themes.

Results: The interviews resulted in six themes relevant to the topics of interest: undernutrition awareness, monitoring, and treatment. These were: (1) adverse changes in nutrition behaviour; (2) limited undernutrition awareness; (3) unclear monitoring responsibilities and procedures; (4) lack of awareness, time, and priority as monitoring barriers; (5) lack of treatment personalization and justification; (6) lack of timely treatment implementation and evaluation.

Conclusions: The experts' experiences imply that undernutrition awareness is limited, among both older adults and care professionals. In addition, the interviewees are unclear about which professionals are responsible for monitoring and which monitoring procedures are preferred. The dietitians feel that they become involved too late, leading to decreased treatment effectiveness. In general, the interviewees desire a coherent and feasible allocation of responsibilities regarding undernutrition monitoring and treatment. This implies that the available guidelines on undernutrition management require more attention and facilitation.

Background

Undernutrition can negatively affect community-dwelling older adults' health and quality of life [1] and can be caused by a variety of risk factors such as burden of diseases [2], chewing and swallowing problems [3], alterations in taste sensibility and appetite [4], loneliness [5], and difficulties with meal preparation and food shopping [6]. For many older adults, these risk factors are out their control and enter their lives gradually, often without their noticing and counteracting them. In the Netherlands, the steadily increasing undernutrition in older adults resulted in a prevalence of between 11% and 35% among Dutch community-dwelling older adults in 2012 [7]. To manage undernutrition successfully, adequate undernutrition monitoring and treatment are imperative. Therefore, in 2011, undernutrition management guidelines have been developed in the Netherlands for the primary and secondary care setting [8].

In the undernutrition management guidelines, the Dutch Malnutrition Steering Group addresses the essential steps regarding undernutrition monitoring and treatment for different care settings. By widely disseminating these guidelines throughout public health organizations, they aimed to achieve the necessary levels of awareness regarding undernutrition management. However, although progress is seen since 2011, both the application of the monitoring guidelines and the results of the provided treatments remain unsatisfactory [9]. According to this article, this dissatisfaction is probably caused by impeding factors such as a lack of priority among general practitioners and limited undernutrition knowledge among dietitians. However, to date, no study has qualitatively explored the reasons for the inadequate undernutrition management in the Dutch primary care setting yet. Conversely, an Australian study that addressed this topic found an explanation in reasons like limited time, priority, and patient willingness [10]. In addition, although more focused on nutrition in general, a Canadian study found similar barriers in primary care, with family physicians reporting 'their formal nutrition training in medical school to be inadequate' [11]. Nonetheless, these reasons seem to explain only part of the problem and can vary with each country and its healthcare system.

In view of the aforementioned difficulties in the Netherlands, we need more insight into the current application of the undernutrition management guidelines. These guidelines describe that to *treat* undernourished older adults successfully, it is necessary that these older adults are *monitored* regularly, which is not possible without firstly being *aware* of undernutrition among older adults. Using these three pillars of undernutrition management as a starting point, we hypothesised that the difficulties in following the guidelines start at undernutrition awareness, with a continuing negative effect on monitoring and treatment. The current study therefore aims to explore qualitatively the experiences of Dutch nutrition and care professionals and researchers with undernutrition awareness, monitoring, and treatment among community-dwelling older adults.

Methods

Methodological approach

The applied methodological approach of this study was a combination of both grounded theory and content analysis. The former manifested itself in the choice to use constant comparative analysis, which meant that data collection and data analysis occurred simultaneously [12]. Regarding the latter, inductive content analysis was applied by using the data directly to define codes and themes [13], which is further explained in the associated analysis section.

Study population

To reflect the multidisciplinary nature of a successful approach to counteract undernutrition, we applied purposive expert sampling to select a variety of professionals. We explicitly selected groups of professionals with either a direct involvement in the nutrition of older adults or an intensive involvement in their home setting. Consequently, the older adults whom the participants refer to in the interviews were mainly community-dwelling older adults, who nonetheless often suffer from diverse and multiple health concerns. Moreover, we chose participants based on their known involvement with undernutrition management initiatives, such as members of the Dutch Malnutrition Steering Group and researchers. In turn, these experts referred us to other professionals who showed an interest in these experts' activities. All potential participants were contacted by email or telephone and provided with the study's background information. In total, 31 Dutch professionals were contacted, of whom 22 agreed to participate in a telephone interview. The participants included one dietitians' coordinator (DC), five dietitians (Ds), three meal service employees (MSEs), one elder-issues consultant (EC), one informal care consultant (ICC), one geriatric specialist (GS), two general practitioners (GPs), one nurse practitioner (NP), three home care nurses (HCNs), and four researchers involved in nutrition and care research (Rs) (**Table 2.1**). Four GPs, three nurse practitioners, and two dietitians declined the interview request because of their self-declared lack of knowledge on undernutrition in older adults.

Data collection

The telephone interview method was chosen because of its convenience and its ability to be concise yet sufficiently open to assess experiences [14]. The telephone interviews made it possible for the interviewees to talk to the researchers when it suited the interviewees best. For some of them this meant that they called the researcher back on a later occasion because of a client emergency; for others it meant they were available after

they got home from work. Although in qualitative research face-to-face interviews are often preferred, evidence is limited regarding the notion that telephone interviews elicit lower quality data [15]. However, because of the known issues regarding building rapport and responsiveness [16], additional care was given to starting with friendly rapport and providing continuous verbal acknowledgment tokens throughout the interview. The researcher who led the interview has extensive experience with qualitative interviews; however, because this was the first time that telephone interviews were used, these two issues were pretested to become accustomed.

Table 2.1 Characteristics of the interviewed professionals, grouped by expertise area.

Code	Profession	Interview duration (minutes)
Nutrition		
DC	Dietitians' Coordinator	37
D1	Dietitian	27
D2	Dietitian	31
D3	Dietitian	43
D4	Dietitian	40
D5	Dietitian	29
MSE1	Meal Service Employee	38
MSE2	Meal Service Employee	30
MSE3	Meal Service Employee	34
Care		
EC	Elder-issues Consultant	22
ICC	Informal Care Consultant	40
GS	Geriatric Specialist	16
GP1	General Practitioner	26
GP2	General Practitioner	28
NP	Nurse Practitioner	33
HCN1	Home Care Nurse	26
HCN2	Home Care Nurse	28
HCN3	Home Care Nurse	32
Research		
R1	Researcher	35
R2	Researcher	25
R3	Researcher	49
R4	Researcher	36

After verbal consent, the interviews were digitally recorded and transcribed verbatim. All participants verbally approved the anonymous use of these transcripts for publications. After the interviews, the interviewees were rewarded with a gift certificate of 25 euros. The interviews were reviewed until no new themes emerged from the interviews. After 20 interviews, we added the geriatric specialist and nurse practitioner, as suggested by a

researcher. Their addition eventually led to sufficient insight into the topics of interest from 10 professionally different viewpoints. Hereafter, no new participants were added. Ethical approval was obtained from the Social Sciences Ethics Committee of Wageningen UR.

For this study, an extended form of the Food Choice Process Model (FCPM) [17] was used as a tool to develop a semi-structured interview guide, as food behaviours heavily influence the problem of undernutrition. The FCPM broadly considers the range of factors involved in food behaviours. To achieve comprehensiveness in the current study, on the level of *influences* in the FCPM, we added two nutritional aspects that were lacking: intrinsic product properties and physiological signals, as described by Shepherd [18]. Hereafter, we developed questions that were broad enough to elicit general answers for each main topic, followed by relevant prompts based on the provided answer to elicit in-depth answers within that topic. For example, we asked about the role of nutrition and undernutrition in the daily lives of older adults, and in the professional life of the interviewees (awareness). Following our hypothesis, we inquired how older adults are monitored regarding undernutrition and whether awareness issues affect monitoring effectiveness (monitoring). Finally, we asked the professionals how undernutrition among older adults is currently being treated and whether the treatment is affected by awareness and monitoring (treatment). A simplified form of the complete interview guide is given in **Table 2.2**.

Table 2.2 Global overview of main interview questions (follow-up questions not shown).

Topics and questions
Undernutrition awareness
What role does nutrition play in the daily lives of older adults?
What is the influence of previous eating habits and traditions on the current eating habits of older adults?
How would you define adequate nutrition and undernutrition?
To what extent are you and [people of the same profession] engaged in nutrition among older adults?
What role does undernutrition play in the daily lives of older adults?
To what extent are you and [people of the same profession] engaged in undernutrition among older adults?
Undernutrition monitoring
How is the nutritional status of older adults currently being monitored?
To what extent is the monitoring of undernutrition effective?
What are risk groups for undernutrition among older adults?
Undernutrition treatment
How is undernutrition among older adults currently being treated?
To what extent is the current treatment of undernutrition effective?
What are your experiences with medical nutrition for older adults?
What are your experiences with home-delivered meals for older adults?
How should we communicate with older adults about undernutrition?

Data analysis

The interview transcripts were coded using constant comparison and content analysis, facilitated by the qualitative analysis software MAXQDA, version 10 (VERBI Software, Berlin, 2010). Two researchers in-vivo coded the first three interviews together to reach clarity about how to code the interviews consistently. The two researchers then coded the remaining interviews separately. Hereafter, the researchers discussed any conflicting codes and ambiguous statements to come to an agreement about the final coding scheme. Then, the identified experiences were categorized into main themes. Finally, the possible relationships between these emerged main themes were depicted within an overarching conceptual model.

Results

The interviews resulted in six major themes relevant to the three topics of interest: undernutrition awareness, monitoring, and treatment (**Table 2.3**).

Table 2.3 Themes that emerged from the interviews, shown by corresponding topic of interest.

Topics and themes
Undernutrition awareness
Theme 1 Adverse changes in nutrition behaviour
Theme 2 Limited undernutrition awareness
Undernutrition monitoring
Theme 3 Unclear monitoring responsibilities and procedures
Theme 4 Lack of awareness, time, and priority as monitoring barriers
Undernutrition treatment
Theme 5 Lack of treatment personalization and justification
Theme 6 Lack of timely treatment implementation and evaluation

Undernutrition awareness

Theme 1 Adverse changes in nutrition behaviour

Interviewees stated that the nutrition behaviour of many older adults changes negatively with ageing. A first example of a change as provided by the interviewed professionals is the reduced appetite of older adults:

> *Many don't feel any appetite or thirst anymore, but they are often not aware of that. Only when I ask them about it, they say: 'Oh, yes, that's true actually'. [D2]*

A second adverse change in nutrition behaviour is that some older adults suffer from reduced food enjoyment. According to the dietitians and researchers, this is caused by a diminished sense of taste, due to either ageing or medication use. One meal service employee related the diminished sense of taste to complaints they received from clients:

> *When they get older, they taste less or differently. For example, sometimes we receive complaints from clients about specific meals that they have consumed for a long time without any problems. They ask why we changed the meal, although there hasn't been a single change in the recipe. [MSE3]*

Even when the third adverse change, reduced food intake, has resulted in a tangible indication such as weight loss, older adults do not recognize this:

> *When I tell them they have lost weight, they respond: 'Well that's strange because I still eat normally, like I always did'. Their idea of eating normally has changed because obviously they ate more when they were younger, but they really fail to see that. [HCN3]*

However, as mentioned by the interviewees, when older adults do recognize the consequences of their reduced food intake, they do not counteract this reduction because they believe that losing weight is typical for ageing:

> *They don't see that* [weight loss] *as a problem and simply accept it as part of getting older. Old age comes with its infirmities, as they say. [R3]*

The reduced food intake is often attributed to the types of meals that older adults consume. The hot meal, which traditionally consists of a meat, vegetable, and starch component, is commonly the first meal that slowly deteriorates. Interviewees provided two reasons for reduced hot meal intake: lack of a dinner companion and their own physical limitations regarding walking and standing:

> *What we often hear is that people say: 'I'm alone, so then I have to cook for only myself, and I just don't feel like it'. And there's also a large group of people who just aren't able to cook anymore. Because let's be honest: it's not just cooking the meal, but you have to do the shopping, and planning, and so on. It's a lot more than merely cooking. [MSE1]*

Theme 2 Limited undernutrition awareness

The term undernutrition is often not known to many older adults, nor its characteristics and consequences. Older adults have difficulty recognizing the characteristics of undernutrition:

> *When you look at older adults who live at home, if they suffer from undernutrition, it's often from sarcopenia. Then, there isn't much different on the outside, but rather with the body composition. The muscle mass decreases and fat mass increases, which makes them less functional, which is also a form of undernutrition. I think it's exactly this form of undernutrition that they don't recognize or that they aren't familiar with. [DC]*

According to the interviewees, even when older adults do notice their decreased appetite, food intake, or weight, they do not think about undernutrition. Some older adults even perceive weight loss as positive rather than alarming:

> *Many people were like, 'Me, malnourished? No, I'm not malnourished. Yes, I lost some weight, but that's not so bad'. Or 'Yes, I'm a bit lighter than I was before, but is that such a problem?' [R2]*

Because of this attitude towards weight loss, in most cases older adults take no action to counter their state of malnourishment:

> *Nobody comes into my office to complain about losing weight, telling me how malnourished they are, so that's obviously a problem. And when heavy people are losing weight, they are actually happy because, to be honest, that's beneficial for many physical ailments. And you have to realize that we work with a 'squeak system'*

> [complaint system]. *If people have a complaint and squeak about it, we try to fix it. […] So that 'squeak system' predominates, and because there is almost no screening, there is a problem with tackling malnourishment. [GP2]*

Lastly, as the characteristics of undernutrition are difficult for older adults to recognize, so are its consequences:

> *They don't see the direct consequences of it* [undernutrition]. *While they are probably a little more tired, and have a reduced appetite. It's difficult to convince them that the reason for this is because they eat too little or inadequately. [R2]*

It is clear, therefore, that according to the interviewees older adults are either not aware of the adverse changes in nutrition behaviour or perceive the noticed changes more positively than negatively, and that both situations cause older adults to refrain from counteracting the adverse changes. This can lead to a state of undernutrition, about which little is known and which is neither recognized nor acted upon by older adults.

Undernutrition monitoring

Theme 3 Unclear monitoring responsibilities and procedures

The interviewees' experiences and views regarding monitoring responsibilities and procedures varied both between and within the different types of professionals. Table 4 depicts these diverse views, grouped into undernutrition monitoring responsibilities, procedures, and barriers. The barriers are described in Theme 4.

As can be seen in Table 4, the interviewees pointed to three groups of professionals as being responsible for undernutrition monitoring: home care nurses, GPs, and nurse practitioners. The nurses themselves also stated that they have a responsibility in undernutrition monitoring. However, they prefer observational procedures rather than procedures that involve systematic screening:

> *Do you use a questionnaire in which you ask about older adults' appetite, whether they experience difficulties walking up and down a staircase... [Interviewer]*
>
> *No. No, and I think that that would be going too far. [HCN2]*
>
> *For the home care nurses? [Interviewer]*
>
> *Yes. I mean, if you ask someone if they can still go up and down a staircase, that could be related to their knees, or their lungs, and their diet. There are so many things going on there, that a questionnaire like that does not tell me more. [HCN2]*
>
> *Are home care nurses the designated professionals to monitor undernutrition then? [Interviewer]*

> *Well yes, and we certainly keep an eye on nutritional status, but never with a checklist. If we ask them questions, then those questions are tailored to that person, what you see at that time. [HCN2]*

This is in contrast to the views of dietitians and researchers, who would like to see monitoring by nurses using general screening questionnaires, like the SNAQ^{65+} (Short Nutritional Assessment Questionnaire for 65+). The interviewed geriatric specialist mentioned being aware of some negative experiences of nurses with general questionnaires. For this reason, at the time of the interview, the geriatric specialist was developing a questionnaire that matches the nurses' way of working, asking more specifically about nutrition behaviours:

> *When GPs want to ask home care nurses to keep an eye on patients, the GPs really have to provide the most literal questions you can think of. So currently, we're developing checklists [...]: has the patient eaten today, did you find food in the garbage, did you find empty bottles, do you think the patient drinks enough water? That kind of questions. You have to approach these people* [nurses] *on their own level. [GS]*

In addition, the interviewed nurse practitioner mentioned a combination of methods: observation and the use of a general screening questionnaire:

> *Nutrition is always discussed, but that can vary from asking whether someone had breakfast in the morning, and discussing the whole day like that. […] I also use the SNAQ*[$^{65+}$]*, so measuring the arm circumference, and how much weight someone has lost. […] I look at what strikes me, for example, that people use very few dairy products, which is always a very big gap. They often eat too little, and many unhealthy things in between. [NP]*

General practitioners were also mentioned as having an undernutrition monitoring responsibility. The interviewed GPs, however, consider neither themselves nor their own professional group as the designated monitoring professionals. Reasons for this are provided in the barriers in Theme 4.

Lastly, some interviewees underlined that older adults themselves and their informal caregivers also form an important link in undernutrition monitoring. However, as mentioned in Theme 2, limited undernutrition awareness among older adults impedes their role in undernutrition monitoring.

Theme 4 Lack of awareness, time, and priority as monitoring barriers

The interviewees provided seven barriers to undernutrition monitoring, shown in **Table 2.4**. These monitoring barriers are lack of undernutrition awareness among older adults, GPs, and home care nurses; lack of time among GPs and home care nurses; and low priority of nutrition among GPs and home care nurses.

Table 2.4 Experiences and views on undernutrition monitoring responsibilities, procedures, and barriers that emerged from the interviews.

	Nutrition						Care									Research		
Monitoring responsibilities	DC	D1	D2	D3	D5	MSE1	EC	ICC	GS	GP1	GP2	NP	HCN1	HCN2	HCN3	R1	R2	R3
Older adults themselves											x						x	x
Informal caregiver				x		x		x										
General practitioner (GP)	x	x	x	x					x							x	x	x
Home care nurse (HCN)	x			x	x		x	x	x	x	x	x	x	x	x	x	x	x
Nurse practitioner	x		x				x		x			x				x	x	
Monitoring procedures	DC	D1	D2	D3	D5	MSE1	EC	ICC	GS	GP1	GP2	NP	HCN1	HCN2	HCN3	R1	R2	R3
Screening with questionnaire at general practice		x	x	x												x		x
Screening with questionnaire by HCN	x			x	x		x		x	x		x				x	x	x
Observation by the HCN													x	x	x			
Screening with questionnaire by nurse practitioner									x			x						
Monitoring barriers	DC	D1	D2	D3	D5	MSE1	EC	ICC	GS	GP1	GP2	NP	HCN1	HCN2	HCN3	R1	R2	R3
Lack of awareness older adults	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	
Lack of awareness GP	x	x	x	x					x	x	x		x			x	x	x
Lack of awareness HCN			x										x					
Lack of time GP				x					x	x	x					x	x	
Lack of time HCN				x	x		x		x			x	x	x	x			x
Low priority of nutrition GP	x	x								x	x					x		
Low priority of nutrition HCN				x					x			x						x

DC, dietitians' coordinator; D, dietitian; MSE, meal service employee; EC, elder-issues consultant; ICC, informal care consultant; GS, geriatric specialist; GP, general practitioner; NP, nurse practitioner; R, researcher. Note: The interviews with D4, MSE2, MSE3, and R4 did not result in answers relevant to undernutrition monitoring responsibilities, procedures, and barriers.

The lack of undernutrition awareness among older adults, the first monitoring barrier, has already been described extensively in Themes 1 and 2. According to the interviewees, the lack of undernutrition awareness among GPs is another factor that directly hampers undernutrition monitoring:

> *GPs are not concerned with undernutrition. That's a big problem. […] They don't know anything about nutrition. They only recognize undernutrition in the emaciated patients, who anyone from a distance can see are malnourished. [R1]*

Although the problem starts with limited undernutrition awareness among GPs, it is worsened by their limited time and the low priority they give to nutritional topics:

> *Older people often experience multiple problems. They have swollen feet, they have blood in their stool, and they are short of breath. So these are actually common medical complaints that take so much time that the aspect of nutrition becomes underexposed. [GP1]*

Regarding the nurses, similar to the GPs, awareness, time, and priority constraints apply. As stated by the interviewees, although undernutrition is currently better known among home care nurses than it was some years ago, progress is still necessary. In addition, as home care nurses' main tasks are care-related, undernutrition still tends to be a side issue with low priority. This low priority is partly caused by the time limitations the nurses already experience regarding their core (care) tasks:

> *One client, who has now moved, ate better if you stayed with her, because then there was some socializing. In the meantime, she ate only a little, and then you could stimulate her to eat more. We paid attention to that. [HCN3]*
>
> *Did you have time for that? [Interviewer]*
>
> *Well, that was difficult of course, because less and less is covered by the CIZ* [Dutch care provision authority] *anyway, so we have to be very creative with our time. That's because it's not seen as very important. [HCN3]*
>
> *Undernutrition? [Interviewer]*
>
> *Well, perhaps undernutrition is, because you cannot avoid finding that important, but they don't translate that to 15 or 30 minutes of mealtime tasks, as that's a whole different order. [HCN3]*

Lastly, several interviewees stated that nurse practitioners are likely to have time for undernutrition monitoring. Nurse practitioners make house calls too, but contrary to home care nurses, they do not have specific care tasks that need to be completed within a certain time. This relates back to Theme 3, where the practice nurse was indicated as one of the designated professionals for undernutrition monitoring.

In summary, the statements on undernutrition monitoring responsibilities, procedures, and barriers reflect diverse views regarding both the responsible monitoring professionals

and the preferred monitoring procedures. Although mainly the GPs and home care nurses are pointed to as playing a monitoring role, the stated awareness, time, and priority barriers indicated a discrepant view on undernutrition management.

Undernutrition treatment

Theme 5 Lack of treatment personalization and justification

The patient's treatment compliance affects the effectiveness of any undernutrition treatment. As stated by the interviewees, treatment compliance in turn is affected by two issues: personalization and justification.

The interviewees mentioned that GPs tend to be quick to prescribe ONS, whereas other types of treatment that are closer and personalized to the daily nutrition behaviour of older adults are possibly more appropriate. This tendency to prescribe ONS by default sometimes applies to dietitians too, depending on their knowledge and experience:

> *There are just a lot of dietitians who have a certain routine for themselves and think that they know what's good. And just continue prescribing those oral nutritional supplements. [R2]*

According to the researchers and dietitians, the correct manner would be to assess the underlying causes of the undernutrition and look into the elderly client's options. This process of personalization is seen as being necessary regarding the appropriate type of treatment, such as tube feeding, ONS, dietary advice, and home-delivered meals:

> *In our approach, we very much try to focus on screening first, followed by diagnostics. So screening is very general, looking at unintentional weight loss, low BMI, and arm circumference. Then we really want to look further at the actual cause of undernutrition. And the cause of undernutrition then predicts the treatment options. [R1]*

In addition, to meet a patient's needs and preferences, the prescriber should optimally offer variety and choice within this type of treatment:

> *Something you often see is that there are many flavours that they don't like, but, if you look further, there will always be two or three flavours that are reasonable. That's my experience. You have to explain to people* [patients] *that it's a search, and motivate them to keep trying until they find the taste they do like. That they should not give up at the first taste. [D4]*

The second important factor in treatment compliance is the extent of justification of that treatment. The chance of compliance is stated to be lower when professionals provide no or limited explanation to the patient regarding the need of the treatment. Adequate justification, on the other hand, can improve compliance:

> *Really, the role of the dietitian is very important in this topic* [treatment compliance]. *Recently, a study was performed regarding compliance with ONS. Also about who uses them, and for how long. When the GP prescribes ONS and lets the pharmacy deliver four boxes of them to the house, it doesn't work. Then they drink one of them and then they say 'Oh, I don't want this, I'll just have yogurt'. But when a dietitian is involved and adequately explains how it works, and why ONS* [in this case] *are better than full-fat yoghurt, well, then it works better. [R1]*

Theme 6 Lack of timely treatment implementation and evaluation

The effectiveness of undernutrition treatment is affected by the timely implementation and evaluation of the treatment. The interviewees stated that both are currently inadequately performed, mainly because of their underlying causes: inadequate monitoring and low compliance:

> *I would like to see it done differently, but I'm afraid we're quite often forced to use ONS to prevent clients from worsening. The moment that undernutrition is assessed is often too late, so people are already weakened and their food intake has become quite low, making it more difficult to get them back on their feet again, and, in those cases, a tool* [ONS] *is quite desirable. [D5]*

In other cases, even after a malnourishment diagnosis, a considerable amount of time passes before older adults receive the correct treatment. In addition, the progress of the treatment is often evaluated inadequately:

> *Oral nutritional supplements are given pretty quickly* [after diagnosis]. *That's not the case with tube feeding. I think that sometimes professionals wait too long with it, muddle along too. [...] We looked at the use of ONS in a study a year ago: what happens at home and how is the dietary guidance there? There we saw that ONS compliance was very low and that the main reason was that the people using them are not being guided. [...] Then you often see that the drinks are not used the way they should be used, and not in the correct amount and for correct the period of time. So you're actually missing out, because then your goal is not achieved. But that goal in turn is not evaluated either, because the people are no longer being guided by a dietitian. […] Simply prescribing without guiding is much less effective. [DC]*

In summary, the interviewees mentioned that adequate undernutrition treatment requires two factors for the desired treatment compliance: treatment personalization and justification. In addition, to be able to assess both this compliance and the general success of treatment, continuous treatment evaluation is said to be imperative. Lastly, a thorough undernutrition diagnosis and cause assessment is mentioned as being crucial for the timely implementation of the correct treatment.

The combined experiences of the participants within the described six themes can be illustrated with a conceptual model regarding undernutrition awareness, monitoring, and treatment, shown in **Figure 2.1**. This model shows the overarching association of limited undernutrition awareness with monitoring and treatment. Moreover, it depicts the impeding factors of the latter two matters. These nine impeding factors are described extensively within the last four themes that emerged from the interviews.

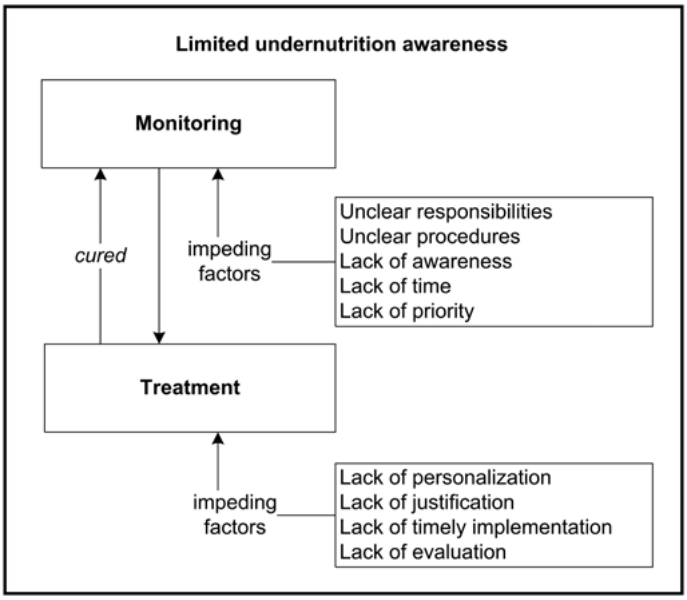

Figure 2.1 Conceptual model of nutrition and care professionals' experiences regarding undernutrition management.

Discussion

This is the first study to assess qualitatively the experiences of Dutch nutrition and care professionals and researchers with undernutrition awareness, monitoring, and treatment among older adults. We considered such a study to be necessary because of current undernutrition management difficulties [9]. Moreover, because such difficulties are not confined to the Netherlands, studies that resembled ours were conducted in Australia [10, 19, 20], Canada [11], and the UK [21], with in general similar results.

As hypothesised, the relationships between the different topics and themes as shown in **Figure 2.1** indicate that limited undernutrition awareness negatively affects the aspects of monitoring and treatment. Despite recent efforts in practice, more awareness is still necessary to achieve adequate undernutrition management. According to the interviewees, limited awareness causes older adults to refrain from counteracting the adverse nutrition changes that are often associated with ageing. Furthermore, there seems to be ambiguity about which professionals are responsible for monitoring and which monitoring procedures are preferred. In addition, the experiences indicate that lack of awareness, time, and priority are monitoring barriers. Lastly, they indicate that the currently inadequate treatment personalization, justification, implementation, and evaluation negatively influence undernutrition management.

Limited awareness among older adults appears to be an important impeding factor for undernutrition management. According to the professionals, if the older adults themselves take no action, it becomes less likely that potentially needed interventions will be applied in the first place, let alone in a timely manner. This puts the burden of undernutrition monitoring in almost its entirety on the primary care professionals and informal caregivers around the older adults. However, as pointed out by many interviewees, undernutrition awareness among primary care professionals also leaves much to be desired. Although not specifically focused on undernutrition, other nutrition-related studies reveal similar findings among primary care professionals [11,19,20]. Fortunately, these awareness issues are gradually being acknowledged, as efforts are being put into facilitating adequate undernutrition management in the home care setting [9,22]. Still, it would be helpful to make an early start with increasing awareness about adequate nutrition among older adults, preferably even before already suffering from many risk factors. This need for more nutrition education among older adults is also recommended in a review, in which it is proposed that older adults can change their eating habits when sufficiently supported [23].

Our results indicate that GPs, nurse practitioners, and home care nurses need to pay more attention to undernutrition monitoring, as they are the first and most accessible health professionals for older adults. However, the GPs in our study stressed that they lack both

the time and the expertise to monitor undernutrition among their patients, deeming themselves incapable of doing so. These experiences are similar to those of GPs and nurse practitioners in a recent Australian study [10], and of community nurses in a study in the UK [21]. On the other hand, the home care nurses stated that they should monitor for undernutrition, but they too lack the time as the more severe and acute problems take priority. Finally, nurse practitioners are suggested as being the most suitable professionals to take on undernutrition monitoring, as they are able to make more time available for undernutrition monitoring than either GPs or home care nurses. Previous Dutch research, although more in relation to obesity, indicates the involvement of practice nurses in nutrition [24]. However, since nurse practitioners have many responsibilities too, there is still no consensus among the interviewees about the most suitable group of professionals for undernutrition monitoring. Nonetheless, the current Dutch guidelines for undernutrition management advocate that primary care professionals should monitor older adults and refer at-risk older adults to a dietitian for further treatment. Moreover, as self-management gains popularity in our society, other solutions that require more involvement of older adults and their informal caregivers can be found in the current trend of using telehealth and e-health approaches to improve health [25].

According to the Dutch undernutrition guidelines and as stated by the interviewees, adequate undernutrition treatment is only likely when preceded by a full undernutrition diagnosis and cause assessment. This facilitates personalization and justification of the treatment towards the older adults. In severe cases, this treatment cannot be limited to the mere promotion of food consumption, and other approaches are necessary. As compliance with ONS, which in practice are often the first choice, can be low in community-dwelling older adults, dietitians should try to find the most suitable treatment or type of supplement and above all, explain its necessity [26]. Innovative nutritional concepts that are closer to common nutritional habits of older adults could provide an appropriate treatment. Nonetheless, regardless of the type of treatment, successful undernutrition treatment requires the setting of personalized targets for older adults regarding their treatment and the continuous evaluation of their progress.

This study purposively selected a variety of professionals and researchers and succeeded in recruiting 22 participants. It should be noted that the purposively selected experts represent only a selection of all possible nutrition and care professionals who are involved in undernutrition management. For instance, treatment of undernutrition can also connote the involvement of dentists, psychologists, and physical therapists. However, our study intended to provide an explorative impression of the experiences of a varied, but not complete, collection of professionals and researchers. Still, it should be also noted that the interviewees presumably assign more importance to undernutrition management than random professionals from the same profession.

Conclusions and implications

The experts' experiences imply that undernutrition awareness is limited, both among older adults and among care professionals. As supported by other studies, more nutrition education can counteract this limited awareness. In addition, it seems unclear to the interviewees who exactly are responsible for undernutrition monitoring and how this monitoring should be carried out. Whereas the care-oriented interviewees feel that they have few nutritional responsibilities, the Dutch guidelines propose that home care nurses play a large role in the monitoring. Although it is already valuable that, contrary to many other countries, the Netherlands have undernutrition management guidelines, attracting more attention to these guidelines can counteract this ambiguity. Improved monitoring can support the dietitians, who currently feel that they become involved too late, leading to decreased treatment effectiveness. In turn, treatment effectiveness would benefit greatly from dietitians who train in following the guidelines on undernutrition treatment, with specific attention to personalization, justification, implementation, and evaluation. In general, the interviewees desire a coherent and feasible allocation of responsibilities regarding undernutrition monitoring and treatment. This implies that the available guidelines on undernutrition management require more attention and facilitation.

Acknowledgements

The authors gratefully acknowledge the financial support from the Wageningen UR IPOP Customized Nutrition programme financed by Wageningen UR, the Dutch Ministry of Economic Affairs, Agriculture & Innovation, and the graduate school VLAG. The authors would like to thank all interviewees for their time and involvement, and Catherine O'Dea for her professional work as language editor.

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CHAPTER 3

Dietary behaviour and undernutrition risk of Dutch elderly meals-on-wheels clients: a mixed-methods study

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Submitted

Abstract

Objectives: For many dependent older adults, difficulties in adhering to protein recommendations lead to an increased risk of undernutrition. To formulate strategies to increase their protein intake, this study aimed to investigate the current dietary behaviour and undernutrition risk of elderly meals-on-wheels clients.

Design: Exploratory sequential mixed-methods design with face-to-face interviews and a cross-sectional survey.

Participants: Twelve Dutch elderly meals-on-wheels clients (≥ 65y) in the interviews and 333 clients (≥ 55y) of the same meals-on-wheels service in the survey.

Measurements: A semi-structured interview guide was used for the interviews, containing questions on dietary behaviour and undernutrition risk. The survey contained questions on general eating behaviour, readymade meal behaviour, and undernutrition risk.

Results: Elderly meals-on-wheels clients (mean age 80.3 ± 9.9 years; mean BMI: 25.5 ± 4.7kg/m^2) eat according to fixed habitual patterns and their main motivation is the physiological need to maintain their health. Moreover, the older clients (≥ 75y) more often indicated their portion sizes to be too large and having difficulties with finishing regular size meals. In addition, limited awareness of undernutrition risk was indicated by the interviewees and by the finding that one in three respondents was not aware of any weight change in the previous six months. Nonetheless, no differences over age were seen in undernutrition risk, with 22.4% of the survey respondents being undernourished and 7.0% at risk.

Conclusions: Staying close to the identified dietary habits may facilitate small yet effective modifications within these habits to prevent inadequate nutritional intake. Still, the limited awareness of undernutrition risk is expected to play a limiting role in whether clients believe they need dietary modifications. Consequently, informing them about this need can facilitate their motivation to implement modifications.

Introduction

For many dependent older adults, difficulties in adhering to energy and protein recommendations lead to an increased risk of undernutrition [1–3]. In the Netherlands, one in ten community-dwelling and one in three dependent older adults who receive home care is undernourished [4]. The higher prevalence in the latter group can be explained by their health problems, which led to this dependence on home care [5]. Difficulties in adhering to nutritional recommendations can be partly solved by providing readymade meals to dependent older adults, of whom many are at risk of undernutrition [6–9]. With the current trend of older adults staying home longer, accompanied by an increasing burden of physical limitations, readymade meals can contribute to the prevention of an undesirable increase in undernutrition prevalence in this group.

A possible effective strategy to increase protein intake in older adults is to offer them functional foods in the form of nutrient-dense meals [10]. Such meals lead to higher nutrient intakes with the same absolute intake [11,12]. This approach could counteract the consequences of the notion that appetite decreases with increasing age [13]. However, a necessary step before offering nutrient-dense meals is to explore the current dietary behaviour of these older adults, as these behaviours are among the most common barriers that prevent older adults from meeting nutritional recommendations [14]. As these habits can be modified to a certain extent when the right motivations are offered, it is thought to be important to align with the current dietary behaviour of frail older adults by keeping the necessary dietary modifications small [15,16]. Moreover, since differences in dietary behaviour can be expected in different age groups, an exploration of this behaviour per age group could be useful [17]. Likewise, elucidating the reasons behind the behaviour is necessary to achieve feasible and effective modifications.

As older adults' current dietary behaviour can affect their future undernutrition risk, it is important to explore behaviours that might contribute to this risk. Our earlier qualitative study on Dutch nutrition and care professionals indicated that older adults encounter adverse changes (e.g. reduced appetite, food enjoyment, and food intake) in their nutrition behaviour, often without being aware of these changes [18]. This lack of awareness is one of the reasons why the necessary actions are not taken. To support the required actions, we aimed to explore the dietary behaviour and undernutrition risk of Dutch elderly meals-on-wheels clients using a mixed-methods study.

Methods

Design

An exploratory sequential mixed-methods design was used to enable the construction of an appropriate questionnaire and quantify the initial qualitative findings, as in this design the quantitative study follows the qualitative one [19]. The qualitative part consisted of face-to-face interviews, where inductive content analysis was applied, as codes were defined directly by the data [20]. The quantitative part consisted of a cross-sectional, self-administered survey. Ethical approval for both studies was obtained from the Social Sciences Ethics Committee of Wageningen UR.

Participants

The participants for the qualitative study were recruited among the clients of the meals-on-wheels caterer, Food Connect (Almelo, the Netherlands). A convenience sample was used to include urban and rural clients in the east of the Netherlands. Participants were eligible if they were aged 65 years or older, had been a client for longer than six months, and were mentally capable of participating in an interview. These inclusion criteria were checked prior to recruitment with the available information at Food Connect. In total, 113 elderly clients were invited and 15 of them signed up to participate. Three participants dropped out because of acute health problems, leading to 12 final participants (10.6%). The characteristics of these participants are shown in **Table 3.1**.

Table 3.1 Interviewees' characteristics.

Code	Sex	Age	Living situation	Area of residence	Home care or domestic help	Undernourished[a]	Client for	Number of meals
M66	Male	66	Alone	Rural	None	No	< 1 year	5
F68	Female	68	Alone	Urban	Both	No	3 years	7
M72	Male	72	Alone	Rural	Domestic	No	< 1 year	6
M80	Male	80	Alone	Urban	Domestic	No	< 1 year	7
M81	Male	81	Alone	Urban	Domestic	No	15 years	7
F83	Female	83	With partner[b]	Urban	Both	No	3 years	6
F85	Female	85	Alone	Rural	Domestic	Yes	10 years	4
F86a	Female	86	Alone	Rural	Both	No	1 year	4
F86b	Female	86	Alone	Urban	Both	Yes	< 1 year	4
M89	Male	89	Alone	Urban	Home care	No	8 years	7
M92	Male	92	Alone	Urban	Both	At risk	2 years	5
F92	Female	92	Alone	Rural	Domestic	Yes	6 years	5

[a]As measured by the Short Nutritional Assessment Questionnaire 65+. [b]Partner did not participate.

The participants for the quantitative study were recruited among the clients of the same caterer, after the data collection and analysis of the qualitative study. Participants were eligible if they were aged 55 years or older and had been a client for longer than six months. This lower age limit was chosen to be able quantify differences between a wider range of age groups. In total, 696 clients living in the centre, north, and south of the Netherlands were randomly invited to participate in a survey about their eating habits and undernutrition risk. In total, 333 clients returned the questionnaire (47.8%).

Data collection

Face-to-face semi-structured interviews at the participants' home were chosen to flexibly elicit in-depth answers while facilitating participation among frail older adults [21]. The selected clients received an invitation letter for the interview together with their meals, after which they could return a participation form via postal mail or via the meal deliverer to facilitate application. The semi-structured interview guide was developed based on knowledge from the prior study among nutrition and care professionals [18] and the Food Choice Process Model [22]. The interview guide contained general questions and appropriate prompts to elicit in-depth answers on the two topics of interest: dietary behaviour and undernutrition risk. The interview guide with the main questions is given in **Table 3.2**. After written consent was obtained, the interviews were digitally recorded and transcribed verbatim. At the end of each interview, the Short Nutritional Assessment Questionnaire for 65^{+} ($SNAQ^{65+}$) [23] was used to assess the participants' undernutrition risk.

Table 3.2 Global overview of main interview questions (follow-up questions not shown).

Dietary behaviour
In general, could you describe your eating occasions over the day?
To what extent have your eating habits changed over the course of your life?
What is the role of eating in your life?
What are the largest problems you encounter regarding your own eating habits?
Undernutrition risk
To what extent are you able to finish your meals?
What are your associations with undernutrition among older adults?
In your opinion, to what extent are you at risk of becoming undernourished yourself?
In your opinion, do you eat well enough to prevent undernutrition, and how?
To what extent do you consume protein-rich products?

For the survey, an invitation letter, a hardcopy questionnaire, and a return envelope were sent to the selected clients. Participants were invited to complete the questionnaire voluntarily and anonymously. They could do this on paper, online, or via telephone. The paper questionnaires were returned via postal mail or via the meal deliverer, whereas the

online questionnaire could be found on a website provided on the invitation letter. To accommodate the frailest older adults, the respondents had the option of filling out the questionnaire by telephone with a researcher. The questionnaire was developed according to the findings of the interviews in the qualitative first part of the study. It consisted of 28 questions on the following areas of interest: sociodemographic background (i.e. sex, age, living situation, city of residence, body weight, body height, use of domestic help and home care), general eating behaviour (i.e. frequency of eating over the day, main reason to eat), readymade meal behaviour (i.e. number of meals per week, time of meal consumption, rating of meal liking, rating of portion size, meal leftover habits), and undernutrition risk (i.e. SNAQ^{65+}, self-perceived health). Three main reasons to eat were provided based on a previous, as yet unpublished, segmentation study among older adults by Den Uijl and colleagues, who found that most relatively healthy older adults were functionally oriented eaters (i.e. physiological need), followed by equal groups of socially oriented eaters (i.e. enjoyment) and habit eaters. Because the questionnaire did not contain a measure of mid-upper arm circumference (MUAC) as proposed by the SNAQ^{65+}, a cut-off value of < 21kg/m^2 for BMI was used as equivalent to a MUAC < 25 cm [24]. When respondents reported not knowing whether they had involuntarily lost more than 4kg of their body weight in the previous six months, they were assigned to 'less than 4kg loss of body weight' to determine undernutrition risk according to the SNAQ^{65+}, in order to prevent overestimation.

Data analysis

The transcribed interviews were coded using qualitative analysis software MAXQDA version 10. Two researchers together coded the first three interviews to reach consensus about the manner of coding. The other nine interviews were coded separately by the same two researchers. Deliberation on conflicting codes and uncertainties led to a final coding scheme. Finally, the findings on dietary behaviour and undernutrition risk were grouped into main themes.

IBM SPSS Statistics 23 was used to analyse the survey data. Simple descriptive statistics were used to describe the respondent characteristics and dietary habits of the sample per age category (i.e. 55–64y, 65–74y, 75–84y, 85y and older). To test for associations across respondents' age, linear regression and univariate binary logistic regression models were used for continuous variables and categorical variables, respectively. Significance was set at $p < 0.05$.

Results

Interviews

The interviews led to six themes within the two main topics: three themes regarding dietary behaviour and three themes regarding undernutrition risk (**Table 3.3**).

Table 3.3 Main themes derived from the interviews.

Dietary behaviour
Theme 1 Different attitudes towards the role of eating in life
Theme 2 Consistent eating habits
Theme 3 Preference for familiar meals from the past
Undernutrition risk
Theme 4 Lower appetite than in the past
Theme 5 Regular size meals too large
Theme 6 Limited awareness of undernutrition

Dietary behaviour

Theme 1 Different attitudes towards the role of eating in life

When asked about the role of eating in their life, some interviewees mentioned it being merely an obligatory part of life.

> *You eat because you have to. If you ask me 'Do you enjoy eating?', and you hear this from everybody: No. [F92]*

Others also stated that they saw eating as a necessity, but linked this necessity to their health.

> *Eating is necessary… I don't want to say a necessary evil, but… necessary good. […] I have a schedule. I often eat by the clock. […] Is it because I'm hungry? No, no, no. But I notice that it makes me feel good, that I remain standing and healthy, well, then you still eat. [M80]*

On the other hand, other interviewees stated that eating was something joyful.

> *I think eating is a party. Not a necessary evil, it's a party. [M89]*

Theme 2 Consistent eating habits

When asked about their general dietary behaviour, interviewees gave a specific enumeration rather than talking in generalities.

> *At breakfast, I eat one slice of bread with jam and one slice of gingerbread and drink buttermilk. [F86a]*

In addition, specific times within such enumerations were mentioned.

> *At half past ten, we drink a cup of coffee, and a Dutch rusk with cheese. […] Half past two we eat an orange or an apple. And in the evening a couple of mandarins, oranges, or a banana. [F83]*

Theme 3 Preference for familiar meals from the past

Interviewees indicated a preference for ingredients with which they were familiar from the past.

> *I'm a fan of gravy and vegetables I used to cook myself. Once in a while, I order something special, but mainly a meatball, beef steak, stuffed beef roll. […] And potatoes… boiled, but more often mashed potatoes. […] You can hear it, they're all very Dutch, or familiar things. [M80]*

Not being familiar with ingredients prevented some interviewees from ordering certain meals.

> *It's all good, but those sauces…. I have no idea what it all is. Sauce 'remoulade' for example. And sauce 'provincial', what might that be? Or sauce 'hollandaise'? We just pick gravy, we know that one and like it a lot. [F83]*

Others appreciated the notion that vegetables with which they grew up but are now hard to find in grocery stores were still available via the meal service.

> *With those special vegetables you get, those you almost can't buy anywhere. […] Purslane, where do you still see purslane in the store, not much anymore… But here you get it regularly and well prepared. [M89]*

Undernutrition risk

Theme 4 Lower appetite than in the past

Interviewees stated that they had a lower appetite compared to when they were younger, linking it to their diminished activities.

> *When my husband cooked, I ate a lot, it was very tasty. We travelled a lot and there I ate everything. But here, because I have no movement.... Yes, that's it. Because you do not move enough, you also have no appetite and you think, well, do I have to eat? If you move, walk, cycle, and you go there, and you take the stairs… but I have this now* [pointing to walker]. *[F85]*

Others added the notion that real hunger does not exist anymore.

> *I eat less than in the past, but then I had to work hard. At that time, I was busy on the farm, and with three children. Now, you're never really hungry. Here, we don't know real hunger. Especially nowadays. [F83]*

Theme 5 Regular size meals too large

Some interviewees mentioned the meal portion size as appropriate, whereas others stated that they experienced difficulties with finishing a regular size meal on each day, so consistently divided their meals over two days.

> *I receive four meals per week, sometimes even fewer. […] I almost never have to throw food away. […] I divide them* [each meal] *over two days. [F85]*

Others who experienced this problem divided their meals throughout one day.

> *In the morning, I eat two slices of bread and one currant bun. At noon, I eat the readymade meal. In the evening, I eat the leftovers of the afternoon meal and a dessert. [M92]*

Theme 6 Limited awareness of undernutrition risk

Some of the interviews had not heard about undernutrition, whereas others had heard or read about it. One undernourished interviewee was aware of undernutrition in general and thought that she was not at risk of becoming undernourished herself.

> *Oh the magazines are full with that, and the television. 'Older adults can become undernourished' they say. Well not me, absolutely not! Because I know how to eat well, they don't. […] Well, I do lose weight, but I absolutely do not eat less than usual. It's just a symptom of ageing, losing weight as you get older. I think that it* [losing weight] *has nothing to do with whether you eat responsibly, because I do, but I still lose weight, much to my horror, because I have to take in all my clothes. [F85]*

One interviewee was told that she was undernourished and was surprised to hear this from her general practitioner, although she was aware of the symptoms.

> *Of course you know that you have to eat a little, a little healthily, but if no one tells you that and you don't have any appetite and you're tired, then you're going to neglect yourself, you're not aware of it. Well, I guess I was aware but thought it was a normal part of ageing. [F86b]*

When asked about their views on protein-rich products that might prevent undernutrition, some interviewees said that they consumed these products regularly. Others were sceptical about them.

> *I'm under the impression that too much meat isn't good either. At least that's what you read all the time. [M72]*
> *We eat an egg every evening, that's protein. That's not good, I know but… That's what I thought, sometimes I hear people say that that isn't good. Yes, I sometimes think we eat too many eggs. [F83]*

To summarize the six themes, the interviewees revealed different attitudes towards the role of eating in life: out of habit, for health purposes, and for pleasure. The interviewees described their current eating patterns as rather fixed and habitual, with a preference for familiar meals and ingredients. Regarding undernutrition risk, the interviewees stated that their appetite had decreased throughout the years and that regular portion size meals could be perceived as too large. Lastly, the interviewees showed limited awareness of undernutrition risk, as some of them had never heard about it, whereas others who did could not recall or recognize the signs of being undernourished.

Survey

Respondent characteristics

Mean age of the respondents was 80.3 ± 9.9 years and most respondents were 75y or older (74.2%) (**Table 3.4**). More women (57.6%) than men were present in the overall sample and especially in the older age categories. Most participants were living alone (87.0%) and in an urban area (56.3%). Body weight and height were significantly lower in older age regardless of sex, whereas BMI was significantly lower in women only (mean BMI: 25.5 ± 4.7kg/m^2). Difference in body weight between the youngest and the oldest elderly was 20.9kg in women and 6.7kg in men. The older elderly lived together more often and were more likely to receive domestic help and/or home care.

Dietary behaviour

The majority of the respondents consumed all three main meals frequently (83.3%); respondents of older age more often reported having breakfast and a dessert frequently (**Table 3.5**). Most respondents reported physiological needs as their main reason to eat (65.7%). An almost equal percentage reported that enjoyment (16.7%) and habit (17.6%) are the main reason to eat; the oldest elderly more often reported eating out of habit. Around half of the respondents received five or more meals per week. Although in general most readymade meals were consumed in the evening (69.6%), the older elderly reported more often consuming these meals in the afternoon. Overall, typical Dutch meals were regularly consumed by more clients (97.6%) in comparison to non-Dutch meals (55.1%), with a significantly lower consumption of the latter by those aged over 75y. The majority were satisfied with the taste (73.1%).

Table 3.4 Survey respondents' background characteristics.

	Total (% (*n*) or mean ± SD)	**Per age category (% (*n*) or mean ± SD)**				***P*-value[a]**
		55–64	65–74	75–84	85+	
	n = 333	*n* = 35	*n* = 51	*n* = 117	*n* = 130	
Sex						0.363
Men	42.4 (*140*)	55.9 (*19*)	48.0 (*24*)	34.5 (*40*)	43.8 (*57*)	
Women	57.6 (*190*)	44.1 (*15*)	52.0 (*26*)	65.5 (*76*)	56.2 (*73*)	
Age (y)	80.3 ± 9.9					
% Per category		10.5	15.3	35.1	39.0	
Living situation						0.019
With partner	13.0 (*43*)	5.7 (*2*)	9.8 (*5*)	8.6 (*10*)	20.0 (*26*)	
Alone	87.0 (*289*)	94.3 (*33*)	90.2 (*46*)	91.4 (*106*)	80.0 (*104*)	
Area of residence						0.489
Urban	56.3 (*179*)	54.3 (*19*)	61.7 (*29*)	48.2 (*53*)	61.9 (*78*)	
Rural	43.7 (*139*)	45.7 (*16*)	38.3 (*18*)	51.8 (*57*)	38.1 (*48*)	
Body weight (kg)						
Men	76.2 ± 11.5	80.3 ± 10.9	80.4 ± 13.0	75.6 ± 11.7	73.6 ± 10.2	0.042
Women	69.1 ± 15.6	83.9 ± 21.8	76.4 ± 18.8	69.8 ± 13.1	63.0 ± 12.2	<0.001
Body height (m)						
Men	1.74 ± 0.09	1.79 ± 0.08	1.75 ± 0.12	1.74 ± 0.07	1.73 ± 0.09	0.025
Women	1.63 ± 0.08	1.67 ± 0.08	1.64 ± 0.07	1.63 ± 0.07	1.62 ± 0.09	0.018
BMI (kg/m^2)						
Men	25.1 ± 3.6	25.1 ± 3.6	26.3 ± 4.0	24.9 ± 3.5	24.7 ± 3.4	0.525
Women	25.9 ± 5.4	29.9 ± 7.8	28.1 ± 6.6	26.1 ± 4.8	24.1 ± 4.3	<0.001
Care needs						
No domestic help and home care	11.7 (*39*)	28.6 (*10*)	25.5 (*13*)	8.6 (*10*)	4.6 (*6*)	<0.001
Only domestic help	41.0 (*136*)	42.9 (*15*)	35.3 (*18*)	37.9 (*44*)	45.4 (*59*)	0.352
Only home care	8.1 (*27*)	5.7 (*2*)	7.8 (*4*)	7.8 (*9*)	9.2 (*12*)	0.530
Both domestic help and home care	39.2 (*130*)	22.9 (*8*)	31.4 (*16*)	45.7 (*53*)	40.8 (*53*)	0.066

n = number of respondents; SD = standard deviation; BMI = body mass index. [a]*P*-value calculated using linear regression and binary logistic regression for continuous and categorical variables, respectively.

Table 3.5 Respondents' dietary behaviour and undernutrition risk.

	Total (% (*n*))	**Per age category (% (*n*))**				***P*-value[a]**
	n = 333	55–64 *n* = 35	65–74 *n* = 51	75–84 *n* = 117	85+ *n* = 130	
Dietary behaviour						
Main reason for eating						
I enjoy eating	16.7 (*54*)	21.2 (*7*)	14.0 (*7*)	23.3 (*27*)	10.4 (*13*)	0.144
Out of habit, no real reason	17.6 (*57*)	9.1 (*3*)	14.0 (*7*)	13.8 (*16*)	24.8 (*31*)	0.029
My body needs food, for my health	65.7 (*213*)	69.7 (*23*)	72.0 (*36*)	62.9 (*73*)	64.8 (*81*)	0.536
Having breakfast						0.003
Always/usually	93.7 (*312*)	82.9 (*29*)	90.2 (*46*)	94.9 (*111*)	96.9 (*126*)	
Sometimes/rarely/never	6.3 (*21*)	17.1 (*6*)	9.8 (*5*)	5.1 (*6*)	3.1 (*4*)	
Having lunch						0.451
Always/usually	90.4 (*301*)	91.4 (*32*)	84.3 (*43*)	90.6 (*106*)	92.3 (*120*)	
Sometimes/rarely/never	9.6 (*32*)	8.6 (*3*)	15.7 (*8*)	9.4 (*11*)	7.7 (*10*)	
Having dinner						0.487
Always/usually	97.0 (*322*)	91.4 (*32*)	100.0 (*51*)	96.6 (*112*)	97.7 (*127*)	
Sometimes/rarely/never	3.0 (*10*)	8.6 (*3*)	0.0 (*0*)	3.4 (*4*)	2.3 (*3*)	
Having dessert						0.001
Always/usually	64.9 (*216*)	57.1 (*20*)	49.0 (*25*)	60.7 (*71*)	76.9 (*100*)	
Sometimes/rarely/never	35.1 (*117*)	42.9 (*15*)	51.0 (*26*)	39.3 (*46*)	23.1 (*30*)	
Average number of meals per week						0.556
≤ 4 meals	43.6 (*143*)	45.7 (*16*)	52.0 (*26*)	42.6 (*49*)	40.6 (*52*)	
> 4 meals	56.4 (*185*)	54.3 (*19*)	48.0 (*24*)	57.4 (*66*)	59.4 (*76*)	
Time of hot meal consumption						<0.001
Afternoon	30.4 (*100*)	17.6 (*6*)	14.0 (*7*)	28.4 (*33*)	41.9 (*54*)	
Evening	69.6 (*229*)	82.4 (*28*)	86.0 (*43*)	71.6 (*83*)	58.1 (*75*)	
Type of meal regularly consumed[b]						
Typical Dutch meals	97.6 (*324*)	88.6 (*31*)	96.1 (*49*)	99.1 (*116*)	99.2 (*128*)	0.005
Non-Dutch meals	55.1 (*183*)	74.3 (*26*)	80.4 (*41*)	47.9 (*56*)	46.5 (*60*)	<0.001
Taste of meals						
Excellent/good	73.1 (*239*)	85.7 (*30*)	68.0 (*34*)	69.3 (*79*)	75.0 (*96*)	0.530
Average	20.5 (*67*)	8.6 (*3*)	26.0 (*13*)	24.6 (*28*)	18.0 (*23*)	0.624
Fair/poor	6.4 (*21*)	5.7 (*2*)	6.0 (*3*)	6.1 (*7*)	7.0 (*9*)	0.741

n = number of respondents; SD = standard deviation; BMI = body mass index; [a]*P*-value calculated using binary logistic regression. [b]Check-all-that-apply question.

Table 3.5 Respondents' dietary behaviour and undernutrition risk. (Continued)

	Total (% (*n*))	**Per age category (% (*n*))**				***P*-value[a]**
		55–64	65–74	75–84	85+	
	n = 333	*n* = 35	*n* = 51	*n* = 117	*n* = 130	
Undernutrition risk						
Portion size of meals						
Way too small/too small	6.3 (*21*)	23.5 (*8*)	3.9 (*2*)	6.8 (*8*)	2.3 (*3*)	0.001
Just right	81.6 (*271*)	76.5 (*26*)	88.2 (*45*)	80.3 (*94*)	81.5 (*106*)	0.259
Too large/way too large	12.0 (*40*)	0.0 (*0*)	7.8 (*4*)	12.8 (*15*)	16.2 (*21*)	<0.001
Meal leftovers[b]						
No meal leftovers	57.3 (*188*)	73.5 (*25*)	65.3 (*32*)	60.3 (*70*)	47.3 (*61*)	0.001
Throwing away leftovers	26.8 (*89*)	20.0 (*7*)	23.5 (*12*)	31.6 (*37*)	25.6 (*33*)	0.317
Saving meal leftovers for same day	4.2 (*14*)	0.0 (*0*)	3.9 (*2*)	3.4 (*4*)	6.2 (*8*)	0.120
Saving meal leftovers for next day	13.9 (*46*)	5.7 (*2*)	13.7 (*7*)	10.3 (*12*)	19.4 (*25*)	0.057
Involuntary weight loss previous 6 months						
No, or less than 4kg	55.3 (*177*)	55.9 (*19*)	51.0 (*25*)	57.7 (*64*)	54.8 (*69*)	0.953
More than 4kg	13.8 (*44*)	14.7 (*5*)	16.3 (*8*)	10.8 (*12*)	15.1 (*19*)	0.890
Don't know how much	30.9 (*99*)	29.4 (*10*)	32.7 (*16*)	31.5 (*35*)	30.2 (*38*)	0.867
Poor appetite in previous week						0.992
No	85.3 (*278*)	88.2 (*30*)	77.1 (*37*)	87.9 (*102*)	85.2 (*109*)	
Yes	14.7 (*48*)	11.8 (*4*)	22.9 (*11*)	12.1 (*14*)	14.8 (*19*)	
SNAQ^{65+} qualification						
Not undernourished	70.6 (*233*)	65.7 (*23*)	70.6 (*36*)	75.9 (*88*)	67.2 (*86*)	0.670
Risk of undernutrition	7.0 (*23*)	8.6 (*3*)	9.8 (*5*)	6.0 (*7*)	6.3 (*8*)	0.219
Undernourished	22.4 (*74*)	25.7 (*9*)	19.6 (*10*)	18.1 (*21*)	26.6 (*34*)	0.772
Self-perceived health						0.889
Excellent/good/average	76.9 (*256*)	80.0 (*28*)	80.4 (*41*)	74.4 (*87*)	76.9 (*100*)	
Fair/poor	23.1 (*77*)	20.0 (*7*)	19.6 (*10*)	25.6 (*30*)	23.1 (*30*)	

n = number of respondents; SD = standard deviation; SNAQ^{65+} = Short Nutritional Assessment Questionnaire^{65+}.
[a]*P*-value calculated using binary logistic regression. [b]Check-all-that-apply question.

Undernutrition risk

The majority of the respondents were satisfied with the portion size of the meals (81.6%) (**Table 3.5**). On the other hand, the older eldest reported that the portion size of the meals was too large (16.2%) more often than the youngest elderly, who in turn reported more often that the portion size was too small (23.5%). Consistent with this, significantly more of the older respondents reported having meal leftovers, and a trend was seen in their being inclined to save their meal leftovers for the next day. Overall, 13.8% of the respondents reported an involuntary weight loss of more than 4kg in the previous six months, and 30.9% did not know the extent of their weight loss. Moreover, 14.7% reported having a poor appetite in the previous week. In general, 22.4% of all respondents were undernourished, 7.0% were at risk, and 76.9% were satisfied with their health.

Discussion

This mixed-methods study provides an insight into the dietary behaviours and undernutrition risk of Dutch elderly meals-on-wheels clients. The combined findings of both studies were highly confirmative of each other and indicated that elderly clients eat according to fixed habitual patterns and their main motivation is their body's physiological need to maintain health. In addition, the older clients more often perceived their portion sizes as too large and more often had meal leftovers. Limited awareness of undernutrition risk was indicated by the interviewees and by the finding that one in three respondents was not aware of any weight change in the previous six months. Moreover, almost one in four clients was undernourished. Nonetheless, no differences over age were seen in undernutrition risk.

The physiological need to eat has been shown to be the main reason to eat, regardless of age. More remarkable was our finding that the older elderly more often reported eating out of habit, and fewer indicated that they enjoyed eating. These results suggest either that, over time, fixed eating habits take over or that members of the older generation are less inclined to be socially oriented eaters and more inclined to be habit eaters. On the other hand, we know that the main reason to eat can differ per situation (e.g. hospitalization) and circumstance (e.g. having the flu) [25]. Nonetheless, the results indicate the existence of fixed eating patterns, with most respondents reporting that they eat three main meals throughout the day and interviewees listing their food intake rather specifically. The oldest elderly showed a clear preference for meals they know (i.e. typical Dutch meals) and were more inclined than the younger elderly to have breakfast and consume a dessert. Although our findings are of a general nature, they do show large similarities with the findings in the Dutch National Food Consumption Survey Older Adults 2010–2012 [26]. The higher percentage of dessert consumers probably contributes to that survey's finding that community-dwelling older adults consumed dairy products on 90% or more of consumption days, as cream desserts and puddings are typical Dutch desserts among the elderly. This indicates once again that we can strategically use existing dietary habits to implement desired small modifications, as long as we adequately motivate older adults to apply these modifications [16,17]. However, as these habits change quickly over time, their recurrent assessment in future generations will be necessary within the same target group. Likewise, this calls for a separate exploration of dietary habits for each country or culture, as these can differ even more substantially [27].

Although the current dietary habits seem to be fixed, one point that is indicated to be different compared to the past is older adults' appetite. This was already established in a systematic review on determinants of undernutrition [28], but our respondents illustrated the consequences of this poor appetite for their dietary behaviours. The older elderly, in particular, more often perceived the readymade meals as too large. A possible explanation

for this is also provided by our interviewees, who noticed becoming less active with age, leading to a diminished need for food. Although this gut feeling is actually supported by research showing that older adults have lower energy requirements [29], many older adults subsequently fail to draw the right conclusions. In fact, their lower energy needs call for a different distribution of energy sources rather than just eating less of everything. More specifically, it requires the consumption of more nutrient-dense foods, preferably with a relatively high protein content [30]. When we keep this in mind and then look at how respondents deal with meal leftovers, it becomes apparent that, with older age, more meal leftovers are reported. One in five of the oldest group of respondents consistently divides one meal over two days. In the long term, this poor-appetite-induced behaviour is likely to cause inadequate protein-energy intake, leading to an increased undernutrition risk [28].

In our study, almost one in three elderly meals-on-wheels clients is undernourished or runs the risk of becoming undernourished. This high percentage supports Schilp and colleagues' finding [4] that 35% of dependent older adults who received home care were undernourished, the target group that is most comparable to ours. The suggestion in our results that undernutrition is not related to age in meals-on-wheels clients is in line with the aforementioned systematic review [28]. Specific to our target group, another explanation for this probably lies in the fact that the youngest group (55–64y) is relatively more vulnerable and dependent compared with their age peers in the general population. This finding underlines the importance of increasing older adults' awareness of adverse dietary behaviours and undernutrition risk at a younger age than the typical age of 65y. This increase in awareness could lead to more older adults being aware of their own undernutrition risk by the age of 65y and older. Now, for example, one in three survey respondents had no notion of their weight loss; and one undernourished interviewee was convinced that she was not at risk of undernutrition, despite having lost so much weight that she had to take in all her clothes. Moreover, regarding nutritional knowledge, interviewees were not aware of the current nutritional recommendations. Moreover, they were not familiar with the fact that older adults have different recommendations than the general adult population. Hence, besides staying close to dietary behaviours and recommend modifications within them, we propose that increasing older adults' awareness of undernutrition risk and adequate food intake might play an important role in achieving dietary modifications to prevent undernutrition. However, merely increasing awareness among older adults would not suffice, as they still need facilitation from the environment to take the right actions [18]. Older adults would benefit from clear and consistent messages regarding adequate dietary behaviour and possible undernutrition risk factors. Well-informed family members and meals-on-wheels caterers could also actively offer adequate food options, reinforcing older adults' positive, informed choices regarding their own dietary behaviour [31].

This study has the usual limitations inherent in cross-sectional studies and self-reported data, requiring cautious generalization of the findings. However, the findings of the two different studies did reinforce and confirm each other largely, indicating reliable data on general dietary behaviour and undernutrition risk. Still, the choice of a survey forced the use of BMI as a proxy for MUAC, and this is expected to be less accurate in detecting actual undernutrition risk. Secondly, given the high number of respondents who did not know the extent of their weight loss, it should be questioned whether their self-reported weight is their actual weight. Thirdly, to prevent overestimation, we chose to assign respondents who did not know the amount of their weight loss to the 'less than 4kg loss of body weight' group. It is possible that this in fact led to an underestimation of undernutrition risk, making the actual number higher. For these reasons, to be able to assess the actual magnitude of dietary problems among care-dependent older adults, future studies should aim to measure actual food intake and undernutrition risk of elderly meals-on-wheels clients in the Netherlands.

Taken together, these insights into the dietary behaviour and undernutrition risk of Dutch elderly meals-on-wheels clients suggest that the oldest elderly are more inclined to display fixed eating habits with familiar foods and more often report difficulties in finishing regular size meals. Staying close to these dietary habits may facilitate small yet effective modifications within these habits to prevent inadequate nutritional intake. Still, the limited awareness of undernutrition risk among meals-on-wheels clients is expected to influence whether or not they believe they need dietary modifications in the first place. Consequently, informing them about this need can facilitate their motivation to implement modifications.

Acknowledgements

The authors would like to thank all interviewees and respondents for their time, the research assistants Lutine Schoemaker and Laura Rietberg for all their input, Food Connect and Elles Steggink for their involvement in the participant recruitment, and Catherine O'Dea for her professional work as language editor.

Funding source

The authors gratefully acknowledge the financial support of the Wageningen UR IPOP Customized Nutrition programme financed by Wageningen UR, the Dutch Ministry of Economic Affairs, and the graduate school VLAG. The funding sources had no further role in the study design, data collection, analysis and interpretation of the data, writing the article, or in the decision to submit the article for publication.

Ethical declaration

The authors declare that this study complies with the current laws of the Netherlands.

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CHAPTER 4

Effect of meal size reduction and protein enrichment on intake and satiety in vital community-dwelling older adults

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Appetite, 2016, 105: 242-248
DOI 10.1016/j.appet.2016.05.032

Abstract

Undernutrition risk among community-dwelling older adults is partly caused by inadequate protein intake. Enriching readymade meals with protein could be beneficial in increasing protein intake. Moreover, reduced-size meals could suit older adults with diminished appetite. In this single-blind randomized crossover study with 120 participants (age: 70.5 ± 4.5 y, BMI: 27.2 ± 4.4 kg/m^2), 60 participants consumed four beef meals and another 60 consumed four chicken meals on four different days, once per week. These meals were produced according to a 2x2 factorial design: the protein content was either ~25 g (lower) or ~30 g (enriched), and the portion size was either 450 g (normal) or of 400 g (reduced). Palatability evaluation, meal intake, and subsequent satiety ratings after 120 minutes were measured. No significant differences in palatability among meals were found. While absolute intake (g) of the normal-size meals was significantly higher than that of the reduced-size meals, the relative intake (%) of the served meals did not differ between the four meals. Both protein and energy intakes were significantly higher for the enriched meals, regardless of portion size. Protein intakes were 5.4 g and 5.1 g higher in the normal-size and reduced-size enriched beef meals, respectively, and 6.1 g and 7.1 g higher in the enriched chicken meals, respectively. The normal-size enriched beef meal and reduced-size enriched chicken meal led to slightly but significantly higher ratings of satiety than the non-enriched meals. Due to these mixed satiety findings, separate effects of meal-size reduction and protein enrichment could not be distinguished in this study. The intake findings show that palatable protein-enriched meals support higher protein and energy intakes in vital community-dwelling older adults during a single meal.

Introduction

Undernutrition risk among community-dwelling older adults in developed countries is shown to be as high as 24%, with a higher risk and prevalence among frail and hospitalized older adults [1]. One of the main causes of undernutrition among older adults is reduced food intake and consequently lower energy and protein intake [2,3]. Among Dutch community-dwelling older adults, average protein intake is around 1.0 g protein/kg/day, and about 10% of such adults have a protein intake below the current estimated average requirement (EAR) of 0.66 g protein/kg/day [4]. Moreover, it has been argued that this current EAR may not be adequate to fulfil the higher needs of older adults and that a higher intake is more beneficial [5–7]. It is also suggested that, to stimulate protein turnover sufficiently, older adults should consume a high dose of protein between 25 and 30 g per meal occasion [5,8].

One suitable strategy to improve energy and protein intake in older adults is the dietary enrichment of regular meals, because of their easy use and fit in daily eating patterns [9]. Such enriched meals have resulted in high protein and energy intakes in nursing homes [10,11], hospitals [12,13], and at home [14]. The latter study compared regular readymade meals with readymade meals of the same portion size but higher energy density. This study showed that energy intake increased with the energy-enriched meals without affecting fullness and subsequent food intake in older adults. Similarly, in the general adult population, energy intake was highest for foods with both higher energy density and larger portion sizes [15,16]. In an older population with a reduced appetite, however, a larger portion size might not result in a higher energy intake. Other factors that need to be taken into account are the higher satiating properties of protein [17] and older adults' difficulties with finishing regular size, regular meals that are provided by meals-on-wheels caterers [18–20]. Hence, a perceptibly smaller portion size might be more enticing for older adults to eat as it conveys the idea that there is less food on the plate for them to eat. For this reason, reducing rather than increasing the portion size of protein-enriched meals may be a better way to increase protein intake in older adults.

To our knowledge, this reasoning has not been tested for protein- and energy-enriched meals and in community-dwelling older adults. Therefore, the objective of the current study was to assess the effect of size reduction or protein enrichment of readymade meals on protein and energy intakes at lunchtime and on subsequent ratings of satiety in vital older adults. We hypothesized that enriched meals would lead to increased protein and energy intakes among vital community-dwelling older adults, and that lower satiety ratings would emerge for the reduced-size meals.

Methods

Experimental design

The study was performed as a randomized single-blind crossover study in the sensory lab of Wageningen UR in November and December 2014. Over four consecutive weeks, 120 participants consumed a meal once per week (beef meals n=60; chicken meals n=60) (**Additional Figure 4A**). On each of the four testing days, we assessed meal evaluation, direct meal intake, and satiety. This study was approved by the Social Sciences Ethics Committee of Wageningen UR.

Participants

A total of 120 participants were recruited by email among members of the SenTo older consumer panel of Wageningen UR Food & Biobased Research (~800 community-dwelling adults aged 55 years or older). As all these panel members are relatively healthy and independent, none of them is a regular consumer of home-delivered readymade meals. Earlier studies have found very little difference in liking between healthy and frail older adults [22,23] and suggested that initial hedonic testing can be completed within healthy older adults [24]. Panel members were eligible if they were aged 65 years or older, were proficient in using the computer, were not participating in any other related research, followed a normal diet without dietary restrictions (including voluntary weight management restrictions), and indicated that they generally liked the meal components used in this study (by scoring at least ≥6 on a scale of 1 to 10 prior to the study). The participants were allocated to one of the meal types, taking their liking of the food components into account, leading to 60 participants in the beef group and 60 participants in the chicken group. Although protein intake was our main outcome of interest, we used liking for the power analysis, as liking requires a higher number of participants to be able to detect differences than differences in protein intake do. As a difference in liking of 10 on a 100 mm visual analogue scale (VAS) is considered relevant and a standard deviation of 19 in meal liking is expected [25], this leads to the calculation that around 57 participants would be required (with 80% statistical power and *p*-value of 0.05). All participants were asked to complete an informed consent form prior to the start of the study. After completion of all the measurements, participants received a financial compensation of 100 euros.

Test meals

In consultation with a commercial meal delivery service provider, prior to the development of the meals, we selected some of the most popular and frequently ordered meal components from their ordering service (Food Connect, Almelo, the Netherlands). Subsequently, the following two meal types were composed by professional chefs: beefsteak with gravy (150 g), a mix of peas and carrots (150 g), and mashed potatoes (150 or 100 g) (hereafter referred to as beef meal) and chicken fillet with mushroom sauce (150 g), creamed spinach (150 g), and mashed potatoes (150 or 100 g) (hereafter referred to as chicken meal). Per meal type, the recipe for the meal was modified to contain either ~25 g protein (lower) or ~30 g protein (enriched) (**Table 4.1**). The second modification included a difference in portion size: the meals weighed either 450 g (normal) or 400 g (reduced). Both the normal-size and the reduced-size meals contained similar amounts of protein and energy. The modifications were realized by replacing ingredients with low protein and energy densities (e.g. water, potatoes, sauce) with ingredients with higher protein and energy densities (e.g. cooking cream, milk powder, meat), while simultaneously aiming to comply with other Dutch dietary guidelines (e.g. vegetable content, salt level) (**Additional Table 4A**).

Professional chefs from Food Connect cooked the various components of the microwaveable meals according the adjusted recipes. In order to ensure the correct weights at an accuracy of 1 gram, each component was weighed separately into the ready-meal container by Wageningen UR research assistants at the production location on the day of production. The different meals were then encoded and labelled with random 3-digit numbers to achieve blinding for the participants.

Table 4.1 Test meal characteristics for the beef and chicken group. The meals were modified in portion size and protein and energy content.

Meal	Portion (g)	Protein (g)[a]		Energy (kJ)[a]	
		Beef	Chicken	Beef	Chicken
Normal size, Lower protein	450	24.5	27.8	1784	1827
Normal size, Enriched	450	30.7	32.8	2155	2009
Reduced size, Lower protein	400	25.1	27.6	1776	1816
Reduced size, Enriched	400	30.5	32.7	2076	2028

[a]Nutritional content based on the Dutch Food Composition Database and manufacturers' information.

Procedures

Participants consumed one of the four different variants of one meal type once a week at lunchtime, on the same day of the week, at the Wageningen UR sensory lab. To prevent order effects, the order of the meals was randomized. To facilitate similar within-person pre-testing satiety levels, the participants were instructed to eat the same breakfast on each day of testing and to refrain from eating in the two hours before the test. In order to provide a relevant meal context, the participants were informed about the true origin of the meals (meal delivery service) and that they were cooked for older adults who receive meals at their home and reheat them in their oven or microwave. Participants were told that the recipes for the meals were different, without revealing that the protein and energy contents were changed, blinding them regarding the treatment. The meals were heated in the oven for 30 min at 120°C as per instructed procedure and kept warm in a holding cabinet at 85°C for ~ 15 min to ensure equal meal temperatures. The meals were then served in the associated three-compartment containers. During meal consumption, participants were situated in a sensory booth to minimize social influences and were instructed to eat from their meal until a pleasant fullness was experienced. After finishing their meal, participants were situated in another room together with other participants, where they were allowed some leisure time, but they were instructed to refrain from communicating about the research and the meals with other participants. They filled out the postprandial satiety questionnaires in this room.

Participants' background characteristics

To describe the participants, weight (kg), height (cm), self-reported physical activity level (a 100mm VAS asking 'How physically active are you?'), nutritional status (Mini Nutritional Assessment Short-Form (MNA-SF)) [26]), quality of life (Short Form (36) Health Survey (SF-36) [27]), and physical functioning (Lawton's Instrumental Activities of Daily Living (IADL) [28]) were assessed once, at the beginning of the first visit. Furthermore, questions were asked about characteristics that can affect appetite and intake, such as 'How is your appetite normally around noon?', 'Do you currently wear dentures?', 'Have you been ill (and what type of illness) in the past week?', and 'To what extent do you feel bored with the meal?' The last two questions were asked each week.

Nutritional intake

Meal intake was measured by subtracting the weight of the meal residues (assessed out of sight of the participants) from the predetermined weight of the meals. Each component of the meals was weighed separately. Total protein and energy intakes were calculated by applying standard protein and energy values from the Dutch Food Composition Database (NEVO database 2013/4.0) and manufacturers' information. For each meal, the relative intake (%) of the served meal was also calculated.

Satiety

Satiety levels were assessed by combining ratings from four 100 mm VASs (satiety = fullness – hunger – desire to eat – prospective food consumption) [29]. High ratings of satiety correspond with low feelings of hunger, high feelings of fullness, and low appetite. The VASs were anchored from lowest intensity ratings (i.e. not much at all) to highest intensity ratings (i.e. a lot). The participants indicated their preprandial level of satiety (T0) prior to eating. They indicated their postprandial level of satiety 45 minutes later after finishing their meal (T45), and repeated this at 60 minutes (T60), 75 minutes (T75), 90 minutes (T90), 105 minutes (T105), and 120 minutes (T120).

Meal evaluation

To check whether the modification of the meals was successful in terms of palatability, for each component within a meal, overall liking, liking of smell, liking of appearance, liking of mouthfeel, portion size, flavour intensity, fattiness, bitterness, and saltiness were rated on a 100 mm VAS. Overall liking of the whole meal was also rated on this scale. Almost none of the measurements differed significantly between the meals. For this reason, this paper includes only data on component liking and whole meal liking.

Analyses

Descriptive data are presented as means ± SD. Data were analysed with IBM SPSS Statistics 22; significance was set at $p < 0.05$. Statistical analysis was done by meal type. Regarding the outcome measures, the between-meal, within-person differences were of main interest. To detect between-meal differences for all four meals, a mixed linear model approach was used. The outcomes in these analyses were absolute intake, relative intake, protein intake, energy intake, satiety levels, and hedonic and sensory attribute scores per component. The fixed factors were set to be meal, day, and meal*day interaction. Participants were included as a random factor. These data are presented as means ± SEM. For the post-hoc comparisons, Bonferroni's correction for multiple testing was used with an alpha value of 0.05. The assumption of normal distribution in multiple regression was met for all variables. The influence of the participant characteristics age, sex, weight, and BMI were examined by adding these factors into the mixed models, but as they did not influence the outcomes, these are not presented.

Results

Participants

The mean age of the 120 participants was 70.5 years, with a mean BMI of 27.2 kg/m^2 ± 4.4 (**Table 4.2**). Two people were at risk of undernutrition as indicated by an MNA-SF score of 8-11 (total range: 0-14), mean self-reported PAL was 68.4 ± 15.4 (total range: 0-100), and one participant had mild immobility as indicated by an IADL score < 6 (total range: 0-8). Furthermore, mean physical functioning (77.7 ± 19.5) and mental functioning (83.4 ± 15.2) as measured by the SF-36 were relatively high (total range: 0-100). One in four participants indicated having a lower appetite at lunchtime compared to the evening, and preprandial satiety was 3.7 ± 1.5. No statistical differences were found in the reported illnesses during the test weeks or in boredom ratings between the different meals.

Table 4.2 Participants' background characteristics. SD, standard deviation; n, number of participants; MNA-SF, Mini Nutritional Assessment Short-Form; IADL, Instrumental Activities of Daily Living; SF-36, Short Form (36) Health Survey.

		Mean ± SD or Percent (*n*)
Sex	Male %	45.7 (*53*)
Age (years)		70.5 ± 4.5
BMI (kg/m^2)		27.2 ± 4.4
Weight (kg)		79.3 ± 15.0
Height (m)		1.71 ± 0.1
Risk of undernutrition (MNA-SF 8-11)	Yes %	1.7 (*2*)
Lawton's IADL (0-8)		7.9 ± 0.46
Physical activity level (PAL) (0-100)[a]		68.4 ± 15.4
Physical functioning by SF-36 (0-100)		77.7 ± 19.5
Mental functioning by SF-36 (0-100)		83.4 ± 15.2
Dentures	Yes %	32.5 (*39*)
Appetite at noon compared to evening	Lower %	28.4 (*34*)
Preprandial satiety (0-10)		3.7 ± 1.5

[a]Self-reported PAL was measured by a 100 mm visual analogue scale with the question "How physically active are you?"

Nutritional intake

Figure 4.1 presents the absolute intake data. Similar results were found for both the beef meals and the chicken meals. Firstly, the absolute intake (g) of the reduced-size meals was significantly lower than that of the normal-size meals: approximately 37 g lower in the beef meals and 42 g lower in the chicken meals (**Table 4.3**). On the other hand, relative intake (%) of the served meal did not differ significantly between the meals: approximately 81% of the beef meals and 89% of the chicken meals was consumed, regardless of meal size and protein content.

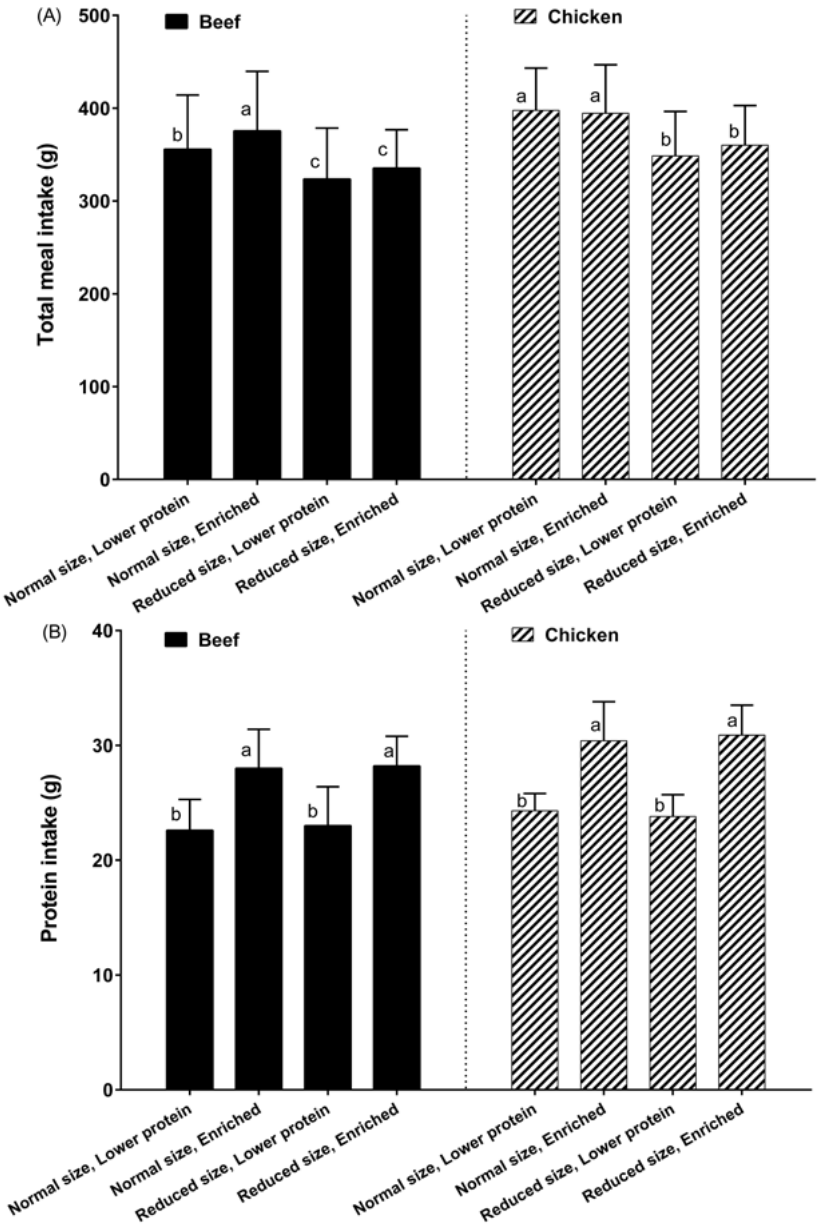
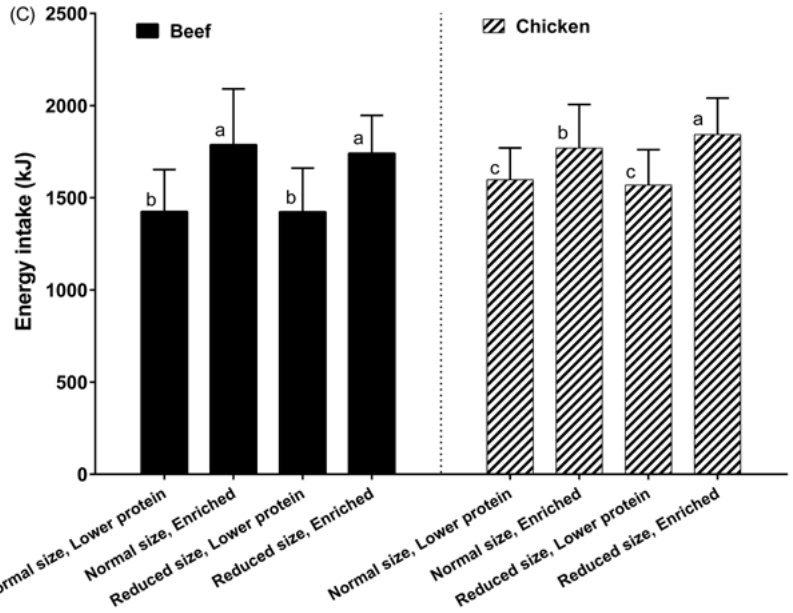


Figure 4.1 Mean ± SD (A) total meal, (B) protein, and (C) energy intake per meal, for both the beef and the chicken meals. Statistical analysis using mixed models approach with fixed factors set to be meal, day, and meal*day interaction; participants included as random factor. Significance was set at $p < 0.05$. Meals with different superscripts are significantly different with Bonferroni's correction for multiple testing, within the beef or chicken meals. Common superscript letters denote that means were not different ($p \geq 0.05$).



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The enriched meals resulted in significantly higher protein and energy intakes than the lower-protein meals. In the enriched beef meals, protein intake was 5.4 g and 5.1 g ($p < 0.001$) higher in the normal-size and the reduced-size meals, respectively. In the enriched chicken meals, protein intake was 6.1 g and 7.1 g ($p < 0.001$) higher in the normal-size and the reduced-size meals, respectively. Similar significant findings were found in the beef meals regarding energy intake in the enriched meals compared to the lower-protein meals. However, in the chicken meals, the reduced-size enriched meal led to a significantly higher energy intake compared to the three other meals.

Satiety

Satiety ratings are presented in **Figure 4.2** (A, beef meal; B, chicken meal). In the beef meals at T45, the satiety level of the normal-size enriched meal was significantly lower than that of both lower-protein meals, and similar to the reduced-size enriched meal. At T75, the VAS score following the normal-size enriched meal was significantly higher compared to the three other meals. Significantly higher ratings for this meal were found at T120 too, with a satiety level of 7.3, whereas it was 6.8, 6.6, and 6.9 for the normal-size lower-protein, the reduced-size lower-protein, and the reduced-size enriched meals, respectively.

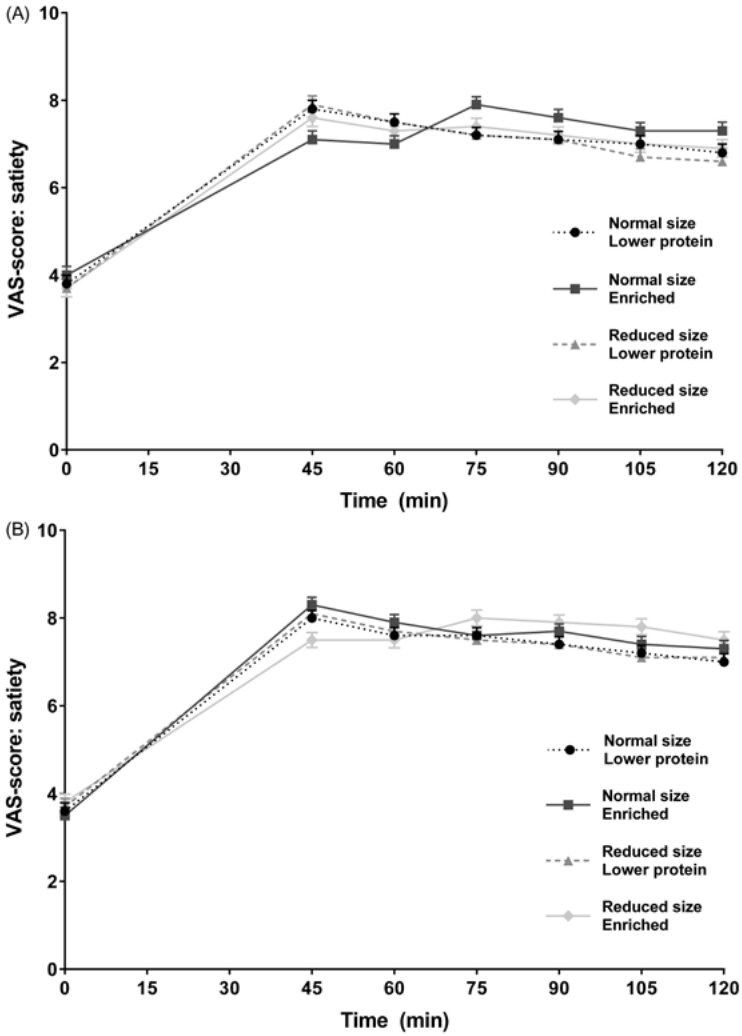

Figure 4.2 Mean ± SEM satiety ratings of (A) beef meal and (B) chicken meal, measured on 100 mm visual analogue scales at set time points up to 120 min.

For the chicken meals at T45, the satiety level of the reduced-size enriched meal was significantly lower than the normal-size lower-protein, the normal-size enriched, and the reduced-size lower-protein meal. At T75, the satiety level of the reduced-size enriched meal was significantly higher than the normal-size lower-protein meal and the reduced-size lower-protein meal. At T120, the reduced-size enriched meal showed significantly higher satiety levels compared to all three other meals, with a satiety level of 7.5, whereas it was 7.0, 7.3, and 7.1 for the normal-size lower-protein, the normal-size enriched, and the reduced-size lower-protein meals, respectively.

Table 4.3 Mean ± SEM nutritional intake per meal. Numbers shown are means. Statistical analysis using mixed models approach with fixed factors set to be meal, day, and meal*day interaction, participants included as random factor. Significance was set at $p < 0.05$. Common superscript letters within a row denote that means were not different ($p \geq 0.05$). Columns without letters denote that there were no significant differences between the meals.

	Normal size Lower protein	Normal size Enriched	Reduced size Lower protein	Reduced size Enriched
Beef meal				
Intake (g)	355.8 ± 7.4^{b}	375.6 ± 7.4^{a}	323.7 ± 7.4^{c}	334.4 ± 7.6^{c}
Intake (%)	79.9 ± 1.7	82.6 ± 1.7	79.9 ± 1.7	82.9 ± 1.7
Protein intake (g)	22.6 ± 0.4^{b}	28.0 ± 0.4^{a}	23.0 ± 0.4^{b}	28.1 ± 0.4^{a}
Energy intake (kJ)	1427 ± 33^{b}	1787 ± 33^{a}	1424 ± 33^{b}	1742 ± 33^{a}
Chicken meal				
Intake (g)	397.6 ± 6.2^{a}	394.5 ± 6.2^{a}	348.6 ± 6.2^{b}	360.1 ± 6.3^{b}
Intake (%)	89.3 ± 1.4	87.9 ± 1.4	88.2 ± 1.4	90.7 ± 1.4
Protein intake (g)	24.3 ± 0.3^{b}	30.4 ± 0.3^{a}	23.8 ± 0.3^{b}	30.9 ± 0.3^{a}
Energy intake (kJ)	1598 ± 26^{c}	1770 ± 26^{b}	1568 ± 26^{c}	1843 ± 27^{a}

Meal evaluation

None of the components differed significantly in their liking across the four meal variants in either the beef or the chicken meal, and overall liking of the whole meal varied between 5.4 and 6.0 (**Additional Table 4B**). Taken together, this indicates that the enriched meals were similar in their palatability.

Discussion

This single-blind randomized crossover study among 120 community-dwelling older adults demonstrates that the palatable protein-enriched meals led to increased protein and energy intakes in both normal-size and reduced-size meals, and that the two enriched meals led to higher satiety ratings.

Absolute total intake was higher for the normal-size meals than for the reduced-size meals. As meal evaluation did not differ significantly between the meals, this higher intake is most likely caused by the larger portion size. This notion that a larger portion size leads to a higher intake is in line with earlier findings in the general adult population [15] and in older adults [30], as the relative intake of the meals did not differ significantly between all the meals. As Olin and colleagues [13] found for different energy densities, we found that, regardless of energy and protein content, relative intake was similar for all meals at an overall mean around 85%. Consequently, because of these similar relative intakes, significantly higher protein and energy intakes were found for the enriched meals compared to the lower-protein meals. Thus, it seems that the participants stopped eating when a certain amount of food was left in their container rather than when they had consumed a certain amount of energy. This too is in line with the finding that portion size rather than energy density was the main determinant of intake in the general population [15] and in older adults [13]. Finally, the reduced-size enriched meals led to higher protein and energy intakes compared to the normal-size, lower-protein meals; this supports the findings of Barton and colleagues [30], who also found higher energy intakes with their reduced-size enriched meals. This finding seems relevant for older adults, in particular for meal service clients who are discouraged if a meal is large in volume. This approach could have the potential to reduce both food waste and inadequate food behaviour [30,31]. Nonetheless, it should be said that a 50 g reduction in a meal of 450 g might not be substantial enough to prevent older adults from dividing their meals over two days, as is done by 18% of meal service clients aged over 65 y and 25% of those aged over 85 y (Ziylan, Haveman-Nies, Kremer, & de Groot, *in preparation*). Future research could therefore aim to reduce the portion size even more to have a more substantial effect. However, it is important to note that this approach is self-limiting, as reducing portion sizes is accompanied by increasing technological and taste challenges. For this reason, the aim should always be to find the right balance between a substantial portion size reduction and a protein intake increase.

Satiety ratings in the lower-protein meals slowly decreased over time for both portion sizes. This indicates that there was no effect of energy density on the satiety ratings and also that, as found by Leidy, Apolzan, Mattes, and Campbell [33], there was no effect of portion size on satiety ratings. On the contrary, the protein-enriched meals showed more fluctuations. On the one hand, satiety ratings ended by being higher for the normal-size

enriched beef meal and for the reduced-size enriched chicken meal compared to their lower-protein counterparts. On the other hand, the reduced-size enriched beef meal and the normal-size enriched chicken meal led to similar satiety levels as their normal counterparts. This suggests mixed findings on the satiating effect of enrichment in this study. The absolute differences in satiety, however, were so small that it is unlikely they affected intake during the remainder of the day [29]. Still, the reduced-size meals might not have been perceptibly smaller as far as the participants were concerned; this implies the need for a larger reduction in future research. Again, the self-limiting factor of this approach on the palatability of meals should be taken into account.

The current study assessed meal intake in a relatively large sample size, in a controlled manner, blinding the participants to the modifications. Despite these study strengths, limitations lie in the possibility that the current research setting may have evoked behaviour that would not have occurred at home [34]. In addition, readymade home-delivered meals are often intended for relatively dependent older adults who are not able to prepare their own meals. They are at higher risk of undernutrition and tend to be more frail and dependent than our study participants, in addition to possibly having an even smaller appetite [18]. Most importantly, data in vital older adults may differ from those in at-risk older adults, so the effects reported here require extension to that group.

In conclusion, palatable protein-enriched meals, regardless of portion size, led to increased protein and energy intakes during a single meal in vital community-dwelling older adults. The chronic effects of such protein enrichment, especially in at-risk populations, remain to be investigated.

Acknowledgements

The authors gratefully acknowledge the financial support from the Wageningen UR IPOP Customized Nutrition programme financed by Wageningen UR, the Dutch Ministry of Economic Affairs, Agriculture and Innovation, and the graduate school VLAG. The authors would like to thank Food Connect and Elles Steggink for the meals and their development, all participants and research assistants for their time and involvement, Eric Boer for his statistical guidance, and Catherine O'Dea for her professional work as language editor.

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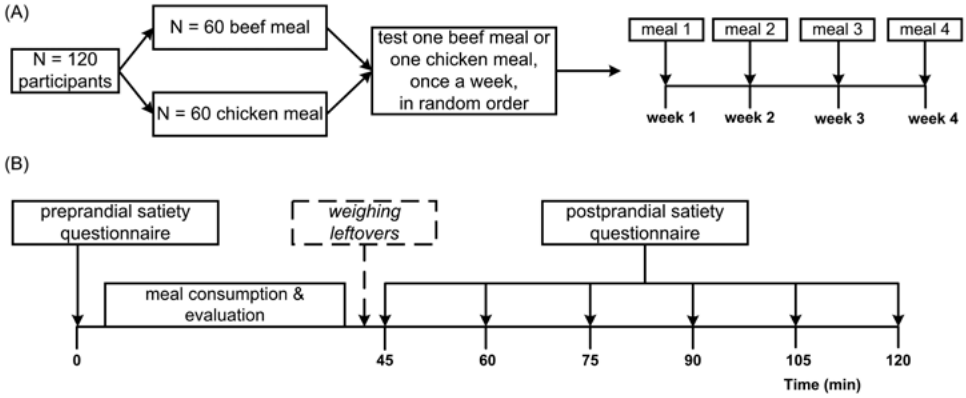

Additional Figure 4A The (A) overall experimental design and (B) study measurements at each of the four test days of this randomized crossover study. Of the 120 participants, once a week, 60 participants tested one of the four different beef meals randomly, and 60 different participants tested one of the four different chicken meals randomly. On each of the four testing days, participants consumed and evaluated their meal, after which research assistants discreetly weighed the leftovers. Preprandial satiety was assessed once before meal consumption; postprandial satiety was assessed six times after meal consumption.

Additional Table 4A Specification of the different meals.

Food component	Meal	Weight (g)	Enrichment method
Beef meal			
Beefsteak	Normal size, Lower protein	70	Varying proportion of beefsteak and gravy
	Normal size, Enriched	80	
	Reduced size, Lower protein	80	
	Reduced size, Enriched	80	
Gravy	Normal size, Lower protein	80	Replacing water and gravy with milk powder and cooking cream
	Normal size, Enriched	70	
	Reduced size, Lower protein	70	
	Reduced size, Enriched	70	
Mashed potatoes	Normal size, Lower protein	150	Replacing potatoes and water with milk powder and cooking cream
	Normal size, Enriched	150	
	Reduced size, Lower protein	100	
	Reduced size, Enriched	100	
Peas and carrots	Normal size, Lower protein	150	Varying proportion of peas and carrots
	Normal size, Enriched	150	
	Reduced size, Lower protein	150	
	Reduced size, Enriched	150	

Additional Table 4A Specification of the different meals. (Continued)

Food component	Meal	Weight (g)	Enrichment method
Chicken meal			
Chicken fillet	Normal size, Lower protein	70	Varying proportion of chicken fillet and mushroom sauce
	Normal size, Enriched	80	
	Reduced size, Lower protein	70	
	Reduced size, Enriched	80	
Mushroom sauce	Normal size, Lower protein	80	Replacing water and sauce with milk powder and cooking cream
	Normal size, Enriched	70	
	Reduced size, Lower protein	80	
	Reduced size, Enriched	70	
Mashed potatoes	Normal size, Lower protein	150	Replacing potatoes and water with milk powder and cooking cream
	Normal size, Enriched	150	
	Reduced size, Lower protein	100	
	Reduced size, Enriched	100	
Creamed spinach	Normal size, Lower protein	150	Replacing spinach with milk powder and cooking cream
	Normal size, Enriched	150	
	Reduced size, Lower protein	150	
	Reduced size, Enriched	150	

Additional Table 4B Mean ± SEM ratings of liking per meal and per meal component measured on 100 mm visual analogue scale. Statistical analysis using mixed models approach with fixed factors set to be meal, day, and meal*day interaction, participants included as random factor. Significance was set at $p < 0.05$.

Food component	Meal	Mean ± SEM
Beef meal in its entirety	Normal size, Lower protein	5.5 ± 0.29
	Normal size, Enriched	5.5 ± 0.29
	Reduced size, Lower protein	5.5 ± 0.29
	Reduced size, Enriched	5.6 ± 0.29
Beefsteak and gravy	Normal size, Lower protein	5.4 ± 0.30
	Normal size, Enriched	6.1 ± 0.30
	Reduced size, Lower protein	5.9 ± 0.30
	Reduced size, Enriched	6.0 ± 0.30
Mashed potatoes	Normal size, Lower protein	4.5 ± 0.30
	Normal size, Enriched	4.4 ± 0.30
	Reduced size, Lower protein	4.9 ± 0.30
	Reduced size, Enriched	5.3 ± 0.30
Peas and carrots	Normal size, Lower protein	5.0 ± 0.30
	Normal size, Enriched	4.7 ± 0.30
	Reduced size, Lower protein	5.0 ± 0.30
	Reduced size, Enriched	5.7 ± 0.30
Chicken meal in its entirety	Normal size, Lower protein	5.6 ± 0.28
	Normal size, Enriched	5.8 ± 0.28
	Reduced size, Lower protein	6.0 ± 0.28
	Reduced size, Enriched	5.9 ± 0.28
Chicken fillet and mushroom sauce	Normal size, Lower protein	5.6 ± 0.30
	Normal size, Enriched	5.6 ± 0.30
	Reduced size, Lower protein	5.3 ± 0.30
	Reduced size, Enriched	6.0 ± 0.30
Mashed potatoes	Normal size, Lower protein	5.5 ± 0.29
	Normal size, Enriched	5.0 ± 0.29
	Reduced size, Lower protein	5.6 ± 0.29
	Reduced size, Enriched	5.5 ± 0.29
Creamed spinach	Normal size, Lower protein	5.1 ± 0.33
	Normal size, Enriched	5.2 ± 0.33
	Reduced size, Lower protein	5.2 ± 0.33
	Reduced size, Enriched	5.4 ± 0.33

CHAPTER 5

Protein-enriched bread and readymade meals increase community-dwelling older adults' protein intake in a double-blind randomised controlled trial

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JAMDA, in press
DOI 10.1016/j.jamda.2016.08.018

Abstract

Objectives: Sufficient protein intake can decrease undernutrition risk among community-dwelling older adults. This study aimed to increase community-dwelling older adults' daily protein intake with acceptable and applicable protein-enriched bread and readymade meals at home.

Design: Double-blind randomised controlled trial of two weeks.

Setting: Senior residential centre in the Netherlands.

Participants*:* Forty-two community-dwelling elderly residents (≥65y) participated, with a mean age: 74.0 ±6.9y and mean BMI of 28.5 ±3.45kg/m^2.

Intervention: The intervention group (n=22) received five protein-enriched readymade meals and plentiful protein-enriched bread during two weeks, whereas the control group (n=20) received the regular equivalents during these two weeks.

Measurements: Food intake was assessed by using dietary food record-assisted 24-hour recalls and by weighing meal leftovers. Acceptability of the enriched products was assessed with product evaluation questionnaires and in-depth interviews.

Results: Mean intake of food products (g) and energy (kJ) did not differ significantly between the control and the intervention group. Total daily protein intake in the intervention group was 14.6g higher than in the control group (87.7 vs 73.1g/day, p=0.004). Expressed in g per kg body weight per day, protein intake was significantly higher in the intervention group than in the control group (1.25 vs 0.99g/kg/day, p=0.003). The enriched products were equally liked, scoring 7.7 out of 10. The in-depth interviews with participants indicated high acceptability of the enriched products.

Conclusion: This study showed that community-dwelling older adults' protein intake can be increased to recommended levels with highly acceptable and applicable protein-enriched products that fit into the normal eating pattern. Future studies should investigate whether this effect is maintained in the long term among a frailer population.

Introduction

Worldwide, one in 20 community-dwelling older adults suffers from undernutrition [1], and one in 10 Dutch community-dwelling older adults [2]. Given that almost one in five Dutch inhabitants is aged 65 years or older and that this proportion is expected to become one in four by 2040, undernutrition will affect a growing share of the population [3]. The negative consequences of undernutrition call for action on its numerous causes [4]. In developed countries, undernutrition in many older adults is caused by protein-energy wasting [5,6]. As the PROT-AGE group has described extensively, this wasting is caused mainly by inadequate food intake, reduced capacity to use available proteins, and a higher need for protein due to a lifelong cumulative physical decline [7]. This higher need for protein is at odds with the lower food intake demonstrated by many older adults. Although the general recommendation for all adults is set at 0.8g protein per kilogram body weight per day (g/kg/day), experts recommend a daily protein intake of 1.2g/kg/day for community-dwelling older adults [7].

In Dutch community-dwelling older adults, protein intake is around 1.0g/kg/day [8], implying room for improvement. In this context, researchers have been investigating strategies to increase older adults' protein intake without having to increase their food intake [9]. For community-dwelling older adults, common strategies include dietary advice, high-protein foods, small meals, between-meal snacks, regular product enrichment, and oral nutritional supplements (ONS) [9,10]. Despite the obvious positive effects of ONS on protein intake in individuals in clinical settings [11,12], in less supervised contexts such as at home, ONS have limitations due to their taste challenges and older adults' low willingness to consume them repeatedly [13,14]. In addition, older adults are in general poorly aware of their often deteriorating health status, despite their high risk of undernutrition [15]. This discrepancy between actual and perceived health status leads to a low likelihood to largely deviate from existing dietary patterns. This notion calls for an investigation of the strategy to increase protein intake with regular products that fit into older adults' dietary behaviour and thereby do not require such large deviations.

A systematic review showed potential for protein-enriched products among older adults [9], but most of the studies had been conducted within a clinical setting rather than at home. For example, protein-enriched bread was shown to be effective in increasing protein intake in the Dutch clinical setting [16,17]. Likewise, we investigated protein-enriched readymade meals within a lab setting and found that these meals resulted in significantly higher protein intakes in 120 vital community-dwelling older adults [18]. However, some of these meals resulted in higher ratings of satiety two hours after consumption, and this could negatively affect food intake for the rest of the day. Moreover, the lab setting might have elicited different behaviour than the home setting would [19]. In addition, the question remained whether such meals are still acceptable when continuously consumed

instead of only once per week. For these reasons, we currently aim to investigate the effectiveness of protein-enriched readymade meals and bread in increasing daily protein intake over two weeks. Here, we aim to investigate whether such products fit in existing dietary behaviour in a regular daily life setting. In a double-blind randomised controlled trial, we tested whether older adults reach the 1.2g/kg/day daily protein recommendation in their regular eating environment at home. It was hypothesised that the participants in the control and the intervention group would consume equal amounts of the meals and bread, leading to a significantly higher daily protein intake in the intervention group than in the control group. Moreover, we hypothesised that this higher intake would be attributable to the large acceptability and applicability of the protein-enriched products in existing dietary behaviour.

Methods

Design

This study was conducted as a two-week double-blind randomised controlled trial (RCT) in a senior residential centre in November 2015, with the week prior to the RCT serving as a baseline week (**Figure 5.1**). The randomised participants received either protein-enriched bread and meals (intervention group) or regular bread and meals (control group) for two consecutive weeks. The study was approved by the Medical Research Ethics Committee and the Social Sciences Ethics Committee of Wageningen UR, and written consent was obtained from all participants.

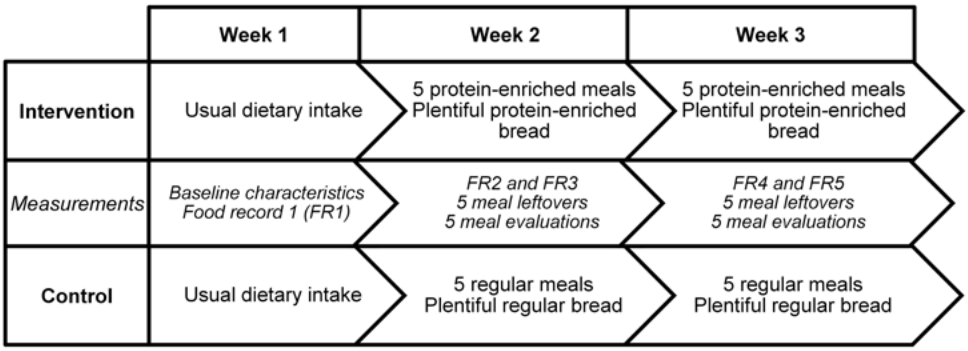

Figure 5.1 Schematic overview of the study design and measurements.

Participants

The participants were recruited among elderly residents at a senior residential centre in eastern Netherlands. This centre is inhabited by community-dwelling older adults only and provides the residents with specific activities and facilities for older adults. These self-sufficient residents do not require continuous care and monitoring like residents of long-term care facilities and vary in their level of self-arranged use of domestic help, home care, and meal services. Residents were eligible when we established after screening that they 1) were aged 65 years or over, 2) were able to choose and eat their food by themselves, 3) liked whole-wheat bread and at least five of the eight offered meals, 4) did not have an allergy/intolerance for milk, lactose, soy, or gluten, 5) were not following a diet that disallowed the use of normal bread or meals, 6) were not suffering from renal insufficiency (eGFR < 60 ml/min) or other medical conditions that limit intake of protein-enriched foods, 7) were not suffering from a terminal illness, 8) had a Mini Mental State Examination score ≥24, and 9) gave permission to contact their general practitioner (GP) to confirm eligibility regarding allergies/intolerances and renal insufficiency/ medical conditions.

All 308 elderly residents were invited to participate in the study with a leaflet briefly informing them about the study background to prevent any influence of new nutritional knowledge on future measurements. In total, 42 participants were enrolled and randomly allocated to the two treatment groups by a researcher who was not involved in the overall study (**Figure 5.2**). Couples were assigned to the same treatment group to prevent them mixing up the received products or noticing any differences between the products of the control and the intervention group.

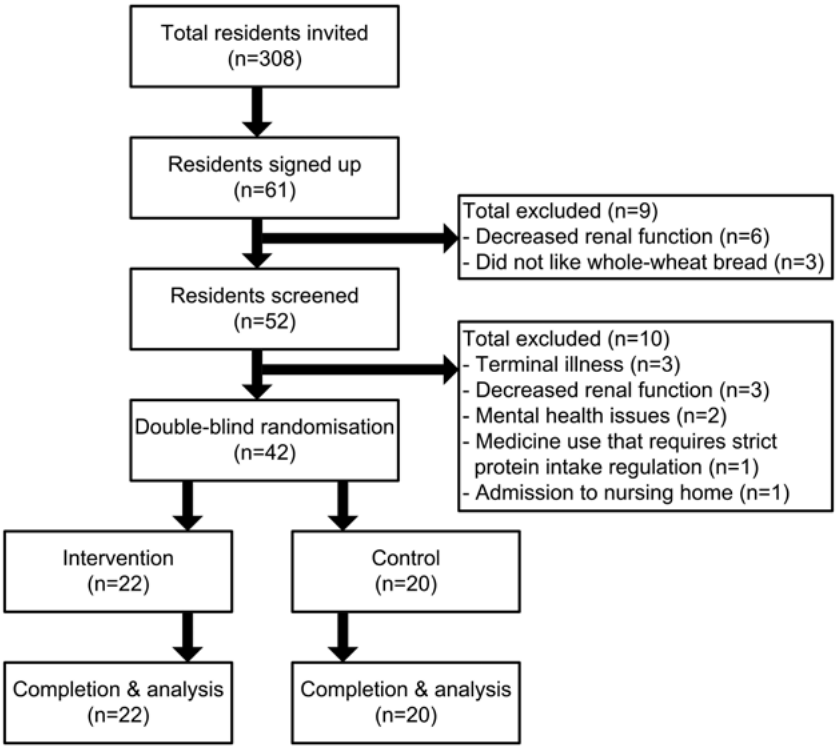

Figure 5.2 Flowchart of recruitment, inclusion, and exclusion of participants.

Products

Carezzo Nutrition BV's commercially available whole-wheat protein-enriched bread was used in this study. Earlier clinical studies had shown this bread to be palatable and effective in increasing protein intake [16,17]. The protein-enriched readymade meals were eight meals specifically developed for the current study in collaboration with the professional chefs of the meal service Food Connect (Almelo, the Netherlands). The modifications in these meals were based on the modification principles previously tested in our study [18]. The modifications were realised by replacing ingredients with a low protein density (e.g. water, potatoes, carrots, sauce) with ingredients with a higher protein density (e.g. milk

powder, peas, meat). Mean difference in protein content was 2.2g per slice of bread and 7.9g per meal; for energy content, this was 29kJ per slice of bread and 372kJ per meal (see **Additional Table 5A**). The weight (450g) of the total meals was the same for both the control and the intervention meals.

All bread was repacked in neutral, non-transparent plastic bags by a researcher who was not involved in the study. Participants received five half loafs of frozen bread per week, as it is customary in the Netherlands to buy sufficient bread for a week and freeze it. Throughout the week, participants could request more bread if necessary to make sure plentiful bread was offered. To mimic real life, participants were allowed to consume other kinds of bread if wanted, for example white bread, a bread roll, or a baguette. All meals were cooked at Food Connect, after which the researchers weighed the meals into readymade-meal containers to an accuracy of 1g. Thereafter, another researcher who was not involved in the study labelled and repacked the meals in non-transparent plastic bags to achieve double blinding. Again, to align with the meal service custom, three weeks before the start of the study, participants could choose only five different meals per week from the in total eight different meal options, so ten meals for the whole intervention. The participants could choose themselves when they reheated and consumed which readymade meals during the intervention weeks. To summarise, each participant received five readymade meals and plentiful bread per trial week. The readymade meals were consumed during their daily hot meal occasion (once per day), while the bread was consumed during their daily bread meal occasions (twice per day).

Measurements

In the first (baseline) week, body weight (kg) was measured with a calibrated weighing scale, and height (m) was assessed using a measuring tape. Protein recommendations were calculated as 1.2g per g/kg/day. For participants with a BMI>27.5kg/m^2, their body weight was adjusted based on a BMI of 27.5kg/m^2, leading to adjusted protein recommendations [20]. In addition, nutritional status (Mini Nutritional Assessment, MNA) and functional status (Katz-6 Activities of Daily Living, ADL, Lawton's Instrumental ADL, IADL) were assessed.

A food record (FR) was used to determine the usual nutritional intake on a typical day (FR1). This means that participants filled out a dietary food record on a randomly pre-arranged day, and, the next day, a dietitian visited the participant to go through the food record and clarify any ambiguities and confirm the filled-out food records. In the second and the third week, participants received and consumed the bread and meals. Each participant was visited twice weekly on a randomised day during the second week (measurements FR2 and FR3) and the third week (measurements FR4 and FR5). During these visits, again the FR was used to determine nutritional intake. Participants had to consume a readymade

meal on the day prior to these visits, in order to ensure that our meal was included in the FR. In total, five FRs were collected. Daily nutritional intake was calculated based on these FRs, using the Dutch Food Composition Database (NEVO database 2013/4.0).

To check for any possible issues with the meals, each time participants consumed a readymade meal, they had to evaluate the meal on several sensory attributes using a 100mm visual analogue scale (VAS). Thereafter, they had to place both the evaluation questionnaire and their meal leftovers in the original container in a box in front of their door. These containers were picked up daily in the afternoon and evening by the researchers. The leftovers were weighed on a scale per participant and per meal component: starch, vegetables, meat, and sauce. These data were used to complete the FRs, so the participants did not have to note their meal consumption themselves. In total, 10 meal leftovers and evaluations were collected per participant.

To check for acceptability, directly after the final visit in the last study week, all participants were asked once to evaluate the bread and the meals in general with an overall mark between 1 (lowest) and 10 (highest). Nine weeks after this final visit and after analysis and thereafter de-blinding of the data, 14 intervention group participants were interviewed more in-depth about the acceptability of only the protein-enriched products. The other eight intervention group participants could not participate because they were not available at the time of the interviews (n=3), or due to an acute illness (n=4) or death (n=1). No significant differences were found in the characteristics of the 14 interviewees compared with those of the total intervention group. During the interviews, questions were asked regarding their experiences with the consumed protein-enriched products and their attitude towards their use in undernutrition prevention.

Data analysis

A sample size calculation was done based on data from an earlier study of community-dwelling frail older adults, who had a mean daily protein intake of 69g ±18g protein per day, which with a mean weight of 69kg translated to 1.0g/kg/day [8]. As the aim was to reach the recommended mean protein intake of 1.2g/kg/day, an increase in protein intake of around 13g was expected to be necessary. Reaching this effect was calculated to be achievable with 30 participants per group, with a statistical power of 80% and a *p*-value of 0.05.

Descriptive data are presented as mean ±SD. Statistical analysis was according to the intention-to-treat principle. A result was considered statistically significant when $p<0.05$. All data were normally distributed and analysed using IBM SPSS Statistics 23. Baseline characteristics were analysed by independent samples T-test for continuous variables and Chi square/Fisher's exact test for categorical variables. Statistical differences in overall

evaluation of the meals and overall protein and energy intakes between the control and the intervention group were analysed by independent samples T-test and Linear Mixed Models, respectively. In the latter, control/intervention group was indicated as fixed factor and participant and repeated measures of each participant as random factors. The participant characteristics age, sex, weight, and BMI did not influence the results, so they were excluded from the Linear Mixed Models. The data from the Linear Mixed Models are presented as mean ±SEM.

After transcription of the in-depth interviews verbatim, MAXQDA version 12 was used to analyse and code the transcripts using constant comparison and content analysis [21]. The first three interviews were coded together by two researchers to reach clarity about how to code the interviews consistently. Thereafter, the remaining interviews were coded separately. When this coding was finished, the researchers discussed any conflicting codes and ambiguous statements to come to an agreement about the final coding scheme.

Results

Participant characteristics

The total study population was aged 74.0 ±6.9y, with a mean BMI of 28.5 ±3.45kg/m^2 and a majority of women (**Table 5.1**). Most participants had a normal nutritional status and appeared to be independent in daily activities. Two in three participants typically consumed the hot meal in the evening. No statistically significant differences in baseline participant characteristics were observed between the intervention and the control group.

Table 5.1 Baseline characteristics of the participants, depicted as *n* or mean ± SD.

	Control (*n*=20)	**Intervention (*n*=22)**
Women/Men	13/7	15/7
Age (y)	74.0 ± 6.6	73.9 ± 7.3
Height (m)	1.66 ± 0.09	1.67 ± 0.08
Weight (kg)	78.6 ± 13.4	79.2 ± 12.5
BMI (kg/m^2)	28.6 ± 3.7	28.4 ± 3.3
Estimated protein requirement (g/day)*	86.8 ± 9.0	88.3 ± 11.1
Living situation		
Living together	9	11
Living alone	11	11
Mini Nutritional Assessment		
Normal nutritional status (24–30)	19	21
Risk for undernutrition (17–23.5)	1	1
Undernutrition (<17)	0	0
Katz-6 Activities of Daily Living		
Independent	17	20
Dependent for one item	3	2
Dependent for two or more items	0	0
Lawton's Instrumental Activities of Daily Living		
Independent	18	19
Dependent for one item	1	3
Dependent for two or more items	1	0
Time of hot meal consumption		
Afternoon	6	7
Evening	14	15

*Calculated as 1.2g per g/kg/day. For participants with a BMI>27.5kg/m^2, their body weight was adjusted based on a BMI of 27.5kg/m^2 [20].

Nutritional intake

Mean intake of food products (g) and energy (kJ) did not differ significantly between the control and the intervention group, for all five days of the study period. At baseline (FR1), mean food intake ±SEM was 2828 ±136g and 2686 ±166g in the control and intervention group, respectively (p=0.516); mean energy intake was 7593 ±486kJ and 7306 ±397kJ, respectively (p=0.648). Mean intake as measured by FR2–FR5 was also similar between the two groups: 2731 ±157g and 2800 ±149g in control versus intervention for food products (p=0.750), and 7250 ±366kJ versus 7369 ±349kJ for energy (p=0.816).

The provided bread and readymade meals were consumed in comparable amounts by the control and the intervention group. Mean intake of bread was 3.18 ±0.14 slices per day for the control group and 3.34 ±0.15 for the intervention group (p=0.433). The same similarity was found in the mean intake of all consumed meals based on the measured leftovers: control group 416.9 ±6.4g and intervention group 418.2 ±6.1g (p=0.878); this comprises around 93% of total meal size.

Protein intake at baseline (FR1) did not differ significantly between the control and the intervention group (77.2 ±4.4g vs. 73.5 ±4.5g, p=0.562) (**Table 5.2**). During the trial weeks, average daily protein intake (g/day) in the intervention group was 14.6g higher than in the control group (p=0.004). This is consistent with the protein intake expressed in g/kg/day, which was significantly lower in the control group than in the intervention group (0.99 vs 1.25g/kg/day, p=0.003). The recommended protein intake of 1.2g/kg/day was reached by four participants in the control group and 12 participants in the intervention group (20% vs 55%) (**Figure 5.3**).

Table 5.2 Mean ± SEM protein intake of the participants.

	Control (n=20)	Intervention (n=22)	*P*-value
Usual daily protein intake (FR1, g/day)	77.2 ± 4.4	73.5 ± 4.5	0.562†
Average protein intake during the trial (FR2–FR5, g/day)	73.1 ± 3.6	87.7 ± 3.4	0.004*
FR2	74.0 ± 3.1	85.4 ± 3.1	0.013†
FR3	75.6 ± 6.0	91.4 ± 4.2	0.034†
FR4	71.5 ± 3.8	86.3 ± 3.6	0.007†
FR5	71.3 ± 3.8	87.6 ± 3.9	0.005†
Mean protein intake during the trial expressed as g protein per kg body weight (FR2–FR5, g/kg/day)	0.99 ± 0.06	1.25 ± 0.06	0.003*

*Linear Mixed Models, †Independent samples T-test

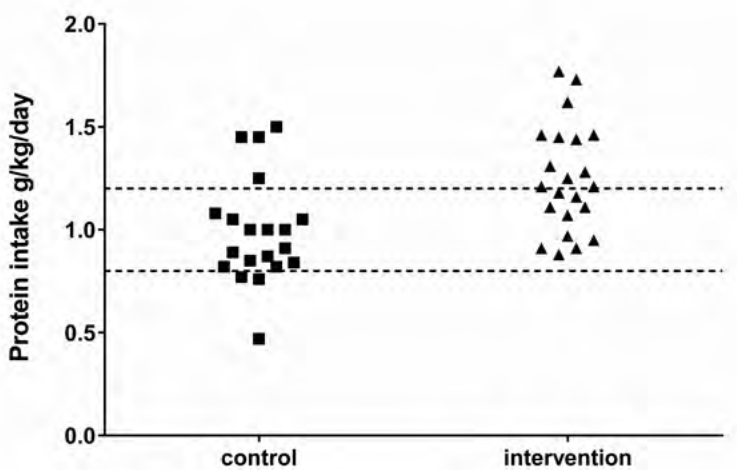

Figure 5.3 Protein intake per participant in g/kg/day, calculated from FR2–FR5 as average protein intake in grams during the whole trial divided by participant's weight in kg. The horizontal dotted lines represent the current (0.8g/kg/day) and the new (1.2g/kg/day) recommendation for older adults' protein intake.

Table 5.3 shows total protein intake per meal occasion and protein intake from bread and readymade meals. Protein intake from bread and meals was significantly higher in the intervention group than in the control group, for each meal occasion (breakfast p=0.048; second bread meal p=0.004; hot meal p<0.001). During the three snack occasions, non-significant but slightly lower protein intakes were noticeable in the intervention group compared with the control group. Overall, protein-enriched bread and meals accounted for 54.3g of the mean daily protein intake in the intervention group; this translates to 61.9% of total daily protein intake. In the control group, 39.2g protein was consumed from the non-enriched products we provided; this is 53.6% of total daily protein intake.

Table 5.3 Total mean ± SEM protein intake and protein intake from bread and meals per meal occasion, calculated from average daily protein intake during the trial (FR2–FR5). A dash (-) means not applicable.

	Control (n=20)			Intervention (n=22)		
Meal occasion	Total	Bread	Meals	Total	Bread	Meals
Breakfast 7:00-10:00	11.3 ± 0.1	5.1 ± 0.3	-	14.8 ± 0.2	7.9 ± 0.4	-
Morning snack 10:00-12:00	2.5 ± 0.1	-	-	2.0 ± 0.1	-	-
Second bread meal 12:00-14:00 or 17:00-19:00	17.5 ± 0.2	7.3 ± 0.3	-	21.2 ± 0.3	11.6 ± 0.6	-
Afternoon snack 14:00-17:00	3.0 ± 0.1	-	-	2.0 ± 0.1	-	-
Hot meal 12:00-14:00 or 17:00-19:00	33.8 ± 0.3	-	26.8 ± 0.4	43.6 ± 0.4	-	34.8 ± 0.5
Late-night snack 19:00-00:00	5.1 ± 0.1	-	-	4.1 ± 0.2	-	-

Acceptability of protein-enriched products

No significant differences were found in the overall evaluation for bread and readymade meals. The regular bread was rated with an 8.0 and SD of ±1.0 out of 10 and the protein-enriched bread with a 7.8 ±0.9 (p=0.408). Both the regular and the protein-enriched meals scored 7.7 (±0.6 for control and ±0.8 for intervention meals, p=0.986). No issues emerged from the meal evaluations, and the liking scores were in line with the overall evaluation ratings. In addition, no significant differences were found in liking of the meals over time (p=0.491).

These high ratings were supported by the findings in the in-depth interviews. Twelve of the 14 interviewees had no idea of which group they were allocated to, as they did not notice anything that would indicate that they received protein-enriched products. They stated that the products were similar to what they would normally eat. One interviewee thought that she was in the intervention group because the meal tasted a bit different than she would expect, and another thought so because she felt a bit bloated.

Interviewees indicated a positive attitude towards incorporating protein-enriched products into their eating behaviour for prevention reasons, especially if they tasted good, as was the case with the enriched products. However, the products' convenience was mentioned as being crucial.

> *It shouldn't take too much of an effort. I'm not going to search for it specifically. When I'm in the store, it's just grabbing everything I need without too much thinking and done as quickly as possible. [85y male]*

In line with this convenience, all interviewees were highly positive about using the protein-enriched bread to increase their protein intake, as it would be easy and effortless. In addition, the only interviewee who already consumed readymade meals from supermarkets regularly was very positive about the protein-enriched meals and had no doubts about incorporating those meals in his eating pattern whenever possible.

> *If it was easily available, then I definitely would buy it. Oh yes, because the meals were good to eat. The meals were tasty. (...) If I could buy it at the supermarket or, well I do not know, a butcher or something, then I would buy it. [68y male]*

All other interviewees, however, indicated that protein-enriched readymade meals would not be a regular option for them in their current circumstances, their main reason being that they would like to keep cooking themselves.

> *When I'm* really *old, yes… I am not the youngest anymore either of course, but as long as I can cook for myself, I prefer to cook for myself. [69y female]*

Still, this hesitation was targeted at the readymade character of the meals rather than at protein-enriched meals in general, as interviewees had an open attitude towards paying

attention to cooking protein rich for themselves. This focus was triggered mainly by the research and the background information they received prior to participating in the study.

> *Well, I'm already doing that actually* [cooking protein rich]. *It happens more often, since because of this research I know that proteins are healthy. So I already pay attention to whether or not there are proteins in products. [87y female]*

When asked what they would do when they become frailer and at risk of undernutrition, the interviewees stated that they would try to improve their health status. They indicated that, in that case, they would be more likely to incorporate protein-enriched readymade meals into their eating pattern, especially if their GP advised them to do so. Most interviewees mentioned that the value of health would then outweigh the value of cooking for themselves.

> *If you have common sense, then you're just going to do that. If I have a deficiency, then you're going to supplement that. [75y male]*

Discussion

This double-blind randomised controlled trial showed that community-dwelling older adults' daily protein intake can be significantly increased over two weeks with the use of protein-enriched bread and readymade meals. No significant differences were found for mean intake of food products (g) and energy (kJ) between the control and the intervention group. The mean protein intake per day was 14.6g higher in the intervention group; this translated to a protein intake of 1.25g/kg/day. In addition, the positive evaluations of the protein-enriched products in both the overall evaluation questionnaire and the in-depth interviews indicated a high long-term acceptability and applicability.

Overall, the protein-enriched bread and readymade meals resulted in a protein intake increase of 38.5% for the three main meals. The overall increase of 14.6g protein in the intervention group was in line with expectations, as the readymade meals contained 7.9g extra protein, and we knew from previous research that Dutch older adults typically consume around three slices of bread per day [17], leading to around 6.6g extra protein intake from bread. This increase is comparable to that found in Silver and colleagues' intervention involving protein-enriched hot meals at home, where the protein intake increase was 7.3g [22]. In studies looking at protein-enriched bread, an increase of 8.9g and 6.1g in protein intake was seen in older adults in a rehabilitation centre [17] and hospital [16], respectively; this is comparable to our protein intake increase attributable to bread. A clear difference between these clinical studies and ours lies in the level of freedom of choice. Although our participants had to consume the meals we provided, they were free to consume whatever kind of bread they wanted during the whole intervention. This freedom of choice facilitated a better alignment with their dietary habits, providing a protein intake increase that is probably more representative and sustainable.

The similar high ratings of protein-enriched meals and bread with their regular equivalents indicated a high acceptability. Moreover, on average, the participants finished virtually their whole meals throughout the intervention. These positive findings are in line with previous studies on bread [16,17] and are further confirmed by our interviews. However, in our previous lab study on 120 older adults, the ratings for the protein-enriched meals were lower: between 55 and 60 on a 100mm VAS [18]. The consumption of the meals was also lower, with a percentage between 80 and 90%. This could indicate that, in a lab setting, the participants experienced the meals differently than the participants at home, because the lab setting evoked other expectations [19]. Moreover, earlier research indicated that older adults tend to become more cautious when using unfamiliar foods [23], but that enrichment of healthy, traditional meal components was evaluated most positively [24]. Therefore, the high acceptability found within our study can be explained by the similarity of the provided bread and meals to what the participants normally eat, but also by the fact that the participants ate in a setting where they usually eat. Finally,

interviewees mentioned that their eating pattern did not really change during the intervention period compared to their normal eating pattern. This is an overt advantage of protein-enriched regular products over ONS

The positive attitude towards protein-enrichment was confirmed by the finding that interviewees were willing to pay more attention to protein intake in their own diet. Some already do so when buying and cooking food, as this research made them aware of the possible health benefits of a higher protein intake. The bread was especially popular because of its ease of use, leaving participants slightly disappointed when they heard that it is not yet available in supermarkets. Conversely, the protein-enriched readymade meals were not that popular, as the interviewees indicated that, under current circumstances, it was not likely that they would incorporate readymade meals in their own eating pattern. The main reason was that they valued their current independence and freedom of choice. Moreover, they did not see the need for such meals as they were convinced that they already ate well and therefore were not at risk of undernutrition. This attitude is in line with findings that people who are feeling healthy are more reluctant to use functional foods in a preventive way [25]. On the other hand, older adults are more willing to incorporate functional foods than younger adults, as the role of apparent health-benefit belief becomes more important [26]. Particularly if their GP advised them to consume protein-enriched products for their health, they stated that they would listen to that advice. This importance of medical advice was found in an earlier study among Dutch older adults too [27].

The strong design of this double-blind randomised controlled trial is an apparent strength of this study. Another strength is the older adults' normal eating environment in which the research was performed and the relatively high freedom of food choice. In addition, the meals were weighed before packaging, as were meal leftovers after consumption, leading to a precise estimation of participants' meal intake. Moreover, dietitians could measure the sizes of cups and bowls while going through the dietary food records at the participants' home, increasing the precision of the food intake estimation. Therefore, the fact that both our final effect size was larger and the standard deviation was smaller than the values estimated on initial calculation of the sample size probably explains how significant effects in protein intake were found despite the lower sample size.

The study's limitations relate to the study population and duration. Firstly, the participants were rather healthy, independent older adults, whereas the protein-enriched products are more intended for frail, dependent older adults. The latter group might have a smaller appetite and therefore show larger compensational behaviour throughout the day. Still, the participants were residents of a senior residential centre – indicating a more care-dependent population than the vital participants in our lab study – who are in addition more likely to become users of readymade meals in the nearer future. Nevertheless, it is

possible that the more nutritionally interested residents agreed to participate, decreasing comparability to the more general older adult population regarding protein enrichment applicability. Secondly, the two study weeks led to positive effects on liking and intake, but a longer-term use of the enriched bread and meals could elicit different effects. Although the interviews indicated sustainable positive effects of the products even if the participants became frail, other studies should aim to include actual frail older adults for a longer period.

In conclusion, this double-blind randomised controlled trial showed that the highly acceptable and applicable protein-enriched foods, as replacements for regular products, provide an opportunity for community-dwelling older adults to reach their recommended daily protein intake. Future studies should investigate whether this effect is maintained in the long term among a frailer population and how this affects health outcomes.

Funding

This work was supported by the Wageningen UR IPOP Customized Nutrition programme (grant number KB-15-007-001) financed by Wageningen UR, the Dutch Ministry of Economic Affairs, and the graduate school VLAG. All authors declare no conflicts of interest as the funding sources had no further role in the study design, data collection, analysis and interpretation of the data, writing the article, or in the decision to submit the article for publication.

Acknowledgements

The authors would like to thank all participants for their time, research assistants Berber Dorhout, Melissa Kolhorn, and Moniek van Waaijenburg for all their input, Elles Steggink and Food Connect for their involvement in the meal development, Eric Boer for his statistical guidance, and Catherine O'Dea for her professional work as language editor.

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Additional Table 5A Weight, protein content, and energy content of regular and protein-enriched bread and meals.

	Regular			Protein-enriched		
	Weight (g)	Protein (g)	Energy (kJ)	Weight (g)	Protein (g)	Energy (kJ)
Whole-wheat bread (per slice)	35	3.9	343	35	6.1	372
Meal 1						
Endive mashpot	300	8.6	1046	300	13.8	1393
Butler steak	70	20.9	552	80	23.9	632
Gravy	80	1.0	280	70	0.8	247
Total	*450*	*30.5*	*1879*	*450*	*38.5*	*2272*
Meal 2						
Curly kale mashpot	275	7.6	812	250	11.4	1071
Beef stew	175	17.1	686	200	22.2	1046
Total	*450*	*24.7*	*1498*	*450*	*33.6*	*2117*
Meal 3						
Nasi	300	13.5	1577	290	19.2	1833
Chicken strips in sweet-sour sauce	150	15.7	602	160	18.9	753
Total	*450*	*29.2*	*2180*	*450*	*38.1*	*2586*
Meal 4						
Boiled potatoes	150	2.9	523	150	2.9	523
Spinach with scrambled eggs	150	4.6	264	160	8.5	427
Chicken	70	21.6	464	80	24.7	515
Mushroom sauce	80	1.1	151	60	2.1	209
Total	*450*	*30.2*	*1402*	*450*	*38.2*	*1674*
Meal 5						
Mashed potatoes	150	4.1	615	150	5.8	757
Carrots and peas	150	3.2	490	150	5.5	464
Beef steak	70	20.2	602	80	23.1	690
Gravy	80	1.0	280	70	0.8	247
Total	*450*	*28.5*	*1987*	*450*	*35.2*	*2159*
Meal 6						
Mashed potatoes	150	4.1	615	150	5.8	757
Cauliflower with cheese sauce	150	5.1	393	150	7.5	598
Beef roulade	70	13.2	335	90	16.9	469
Gravy	80	1.0	280	60	0.7	209
Total	*450*	*23.4*	*1623*	*450*	*30.9*	*2033*
Meal 7						
Cooked rice	110	3.4	791	90	2.8	644
String beans	180	3.0	377	140	2.3	293
Pork schnitzel	70	18.1	469	90	23.2	602
Peanut sauce	90	7.8	1142	130	12.9	1724
Total	*450*	*32.3*	*2778*	*450*	*41.2*	*3264*
Meal 8						
Mashed potatoes with chive	150	4.1	611	150	6.3	799
Carrots and peas	150	3.2	490	150	5.5	464
Stuffed beef roll	70	15.7	653	80	17.9	745
Gravy	80	1.0	280	70	0.8	247
Total	*450*	*24.0*	*2033*	*450*	*30.5*	*2255*

CHAPTER 6

General discussion

Main findings

The explorative studies of the PRIMA Meal study as described in chapter 2 (Study 1) and chapter 3 (Study 2) provided us with in-depth knowledge on bottlenecks in undernutrition management. In general, the interviews with professionals uncovered that undernutrition awareness is limited among both older adults and care professionals, and that this lack of awareness leads to difficulties and delays in setting subsequent monitoring and treatment in motion. The interviews with elderly meals-on-wheels clients made clear that they have fixed and habitual eating patterns, while at the same time their appetite has decreased throughout the years. This was confirmed by the survey finding that regular portion-size meals were perceived as too large by the oldest group aged over 75y. In addition, as the professionals had suggested earlier, the interviewed elderly clients indeed showed limited awareness of undernutrition risk. Simultaneously, the survey showed that almost one in four elderly meals-on-wheels clients was undernourished.

The experimental studies described in chapter 4 (Study 3) and chapter 5 (Study 4) provided us with knowledge on the effectiveness and acceptability of protein enrichment. In Study 3, we developed a regular-size meal and a reduced-size meal to address the bottleneck of the reduced appetite of older adults as expressed in Study 2. Overall, regardless of portion size, the protein-enriched meals led to higher protein intakes in vital older adults in a lab setting at lunchtime. In this crossover study, the participants liked the protein-enriched meals and the regular meals equally. However, we did not find the expected lower ratings of satiety after the reduced-size meals, with one reduced-size enriched meal and another regular-size enriched meal leading to higher ratings of subsequent satiety. This higher satiety from the enriched meals could lead to compensational behaviour throughout the rest of the day. In Study 4, we assessed the effectiveness and acceptability of protein-enriched meals and bread among community-dwelling older adults living in a senior residential centre over the whole day to test for any compensational behaviour. Here, we found that these enriched products again led to higher protein intakes and a high liking. The mean protein intake per day was 14.6g higher in the intervention group; this amounted to a protein intake of 1.25g/kg/d compared with 0.99g/kg/d in the control group. In addition, the meals scored 7.7 out of 10, and the bread scored 7.8 out of 10, both of which were comparable with their regular counterparts. Lastly, we found no negative effect of compensational behaviour throughout the day. These promising findings indicated that we had achieved a good match between older adults' needs and preferences regarding protein intake.

The abovementioned general findings of the four studies led to the development of the conceptual framework for adequate protein undernutrition management depicted in **Figure 6.1**. This framework consists of three wheels of protein undernutrition management: awareness, monitoring, and treatment. With this framework, we propose

six main conditions that can facilitate adequate undernutrition management and argue how this management can benefit from protein enrichment. Using this framework, we go deeper into our study findings and compare them with other studies' findings.

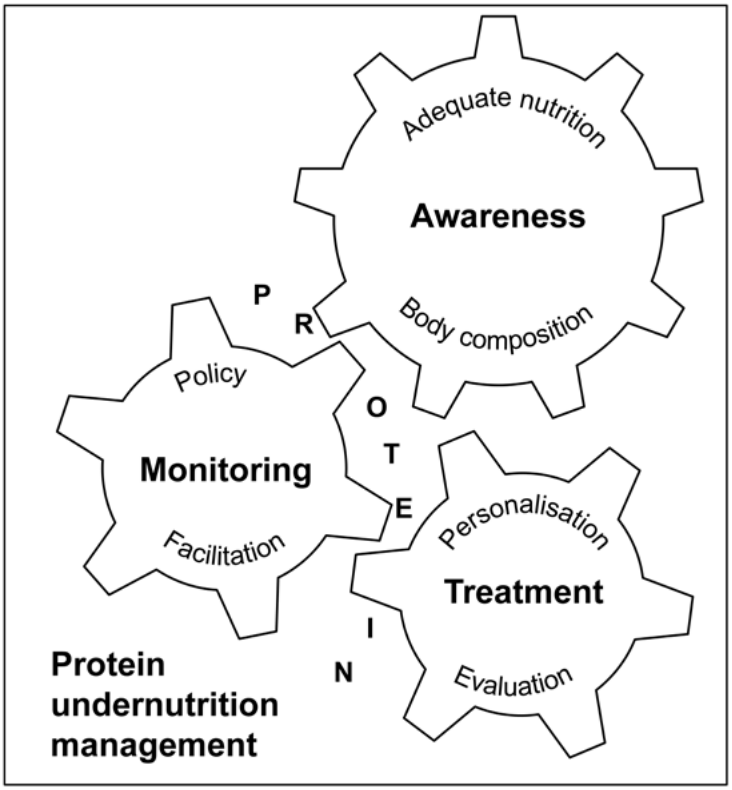

Figure 6.1 Conceptual framework for adequate protein undernutrition management, with the main conditions per undernutrition management phase. Awareness: adequate nutrition and body composition. Monitoring: policy and facilitation. Treatment: personalisation and evaluation.

Awareness

The awareness wheel is the largest in the conceptual framework, as Study 1 suggested that limited awareness of adequate nutrition and body composition forms the largest bottleneck in undernutrition management.

Adequate nutrition

The first condition in undernutrition management is achieving higher awareness about adequate nutrition. Our interviews with older adults suggested the existence of cumulative confusion about nutrition. The main reason for this is that knowledge about the effect of nutrition on health and illness has been subject to changes throughout the

years. These sometimes contradictory findings cause older adults to refrain from trying to keep track of them [1]. This could explain why most of our participants in Study 2 and Study 4 were not aware of the specific nutritional guidelines for older adults. Admittedly, these guidelines are formulated and communicated regarding only a few nutritional components like calcium, vitamin D, vitamin B12, and fibre. Moreover, strictly speaking, there are no specific guidelines for older adults on protein intake, as the official guidelines apply equally to the total adult population. Given this evident barrier, it is not surprising that the interviewed older adults were not aware of their higher protein needs and lower protein intakes, let alone their higher undernutrition risk. This was the case for the less dependent seniors in the senior residential centre in Study 4, but also for the frailer group of older adults: the meals-on-wheels clients in Study 2. This lack of awareness hampers the actual display of adequate nutritional behaviour regarding protein intake [2].

The advice based on this finding is to generate awareness among older adults about how to eat adequately at their stage of life, thereby meeting energy and protein requirements. However, while doing this, we should tailor this nutritional knowledge to their needs in their current stage of life. Hence, it would be necessary to highlight the health benefits of age-appropriate adequate nutrition and explain that many prior recommendations and BMI ranges are no longer relevant to them. Older adults should be provided with specific and practical advice that they can apply in their dietary behaviour. However, scientific agreement on specific protein recommendations is needed before the message about higher protein needs can be conveyed officially. Nonetheless, the actual challenge lies in how to convey this advice. It could be done by proactively offering this information to all older adults, using a reliable, non-confusing source of information [1]. This advice could also be conveyed by the general practitioners, home care nurses, and dietitians with whom all older adults in some way come in contact. However, according to the professionals in Study 1, here another challenge awaits, as these health professionals show limited awareness too; this lack has also been described in Australia [3–5], Canada [6], and the UK [7]. It is illustrated by our finding that care professionals rely on their clinical judgement, as was the case in other studies [8–10], but this is often inadequate compared to a proper screening tool. Increasing awareness in this context would therefore benefit not only early intervention but also familiarity with the existing general guidelines [11,12]. Currently, within the field of primary care, due to this limited awareness, there are many wasted opportunities to take adequate action. Nonetheless, the responsibility for increasing awareness on adequate nutrition among older adults cannot be limited to care professionals. Given the influence of nutrition in many fields, we propose that community workers such as social workers and informal care consultants could also play a role in this matter. However, although the benefits of disseminating nutritional knowledge through multiple professionals are obvious, it is even more important to ensure that all these professionals convey the same message.

Body composition

Older adults need to be more aware about how their health is linked to their body composition. If this is made clear, the physical disadvantages of inadequate nutrition will become easier to discern. However, the largest caveat in this matter is that older adults often suffer from a variety of illnesses, making it difficult to disentangle symptoms of undernutrition risk from other diseases [13]. Even worse, some of our interviewed older adults in Study 2 and Study 4 stated that they were happy about involuntary weight loss, and others expressed the desire to lose weight. This desire often originates from the lifelong negative messages about being overweight. Of course, weight loss in overweight and obese older adults does have health benefits [14], but a drawback is the potential loss of skeletal muscle mass because of this weight loss [15]. Older adults need to be more aware that losing weight increases undernutrition risk, while on the other hand being overweight or even obese does not mean that they do not risk undernutrition. In addition, explaining that symptoms like fatigue and involuntary weight loss should not be taken for granted as part of normal ageing, or be welcomed even, may trigger early action among older adults. It should be made clear that becoming thinner is not an inevitable part of ageing.

When older adults are made aware of changes in their body composition, the second step is to make the link with physical activity. From our interviews with older adults in Study 2 and Study 4, we recurrently heard the idea that older adults have lower nutritional needs because they are not as active as they once were. This idea was also articulated by the professionals in Study 1. However, older adults should be encouraged to be active or to exercise in order to maintain their muscle mass. Moreover, we know that prevention of muscle mass loss is more effective when adequate nutritional intake is supported by regular exercise, and regular exercise in turn requires higher food intake [16]. Making this link more apparent to older adults can motivate them to become more active. In addition, although older adults do have lower energy requirements [17], our participants were not aware that these lower energy requirements call for a different distribution of energy sources rather than just eating less [16]. In other words, in addition to being more physically active, older adults need to consume foods with a higher nutrient density to facilitate muscle maintenance. To achieve this, older adults may be supported by professionals where required, especially when it is necessary to determine what kind of physical activity at what intensity best suits older adults' health and capacity. For example, when the benefits were well-explained, older adults expressed a positive attitude towards physical exercise during hospitalisation [18] and rehabilitation [19]. We expect similar attitudes among community-dwelling older adults, especially when the advice on physical activity is matched with their own preferences and competences. When this is combined with an increased knowledge on adequate nutrition, the awareness wheel can be set in motion within the undernutrition management framework, facilitating the other wheels.

Monitoring

When older adults have sufficient awareness of undernutrition risk, the next step would be to monitor this risk continuously. On the basis of Study 1, we argue that a policy and the actual facilitation of that policy are required for this monitoring to succeed.

Policy

For adequate undernutrition monitoring, general guidelines that transcend all health and care disciplines are a must. The mere existence of the Dutch Guideline Screening and Treatment of Malnutrition [11] is a plus. That said, for these general guidelines to have a real effect, it is necessary to develop a subsequent specific undernutrition policy per health care organisation. This is especially true for those organisations whose core business is not nutrition and this topic risks falling through the cracks.

A policy analysis might aid in developing the most appropriate policy per health care organisation. This analysis focuses on the problem, the policy actors and stakeholders, the resources and instruments, and the policy context [20]. Although general policies can be developed with these core elements of policymaking, these guidelines need to be tailored to the specific circumstances of a specific organisation within branch organisations. This can be done with the frequently used 50 determinants of innovations within health care organisations formulated by Fleuren and colleagues [21]. So, for example, the National Primary Care Collaboration Agreement on Malnutrition [22] can serve as a starting point for a specific policy with integrated care agreements per region in the Netherlands, taking into account the many determinants that affect its success. Likewise, a general policy for hospitals needs to be tailored to the stakeholders and resources in each specific hospital. Then, embedding this tailored policy in the prevailing social and administrative structures can increase the actual implementation of this policy [20].

Facilitation

From Study 1, it became apparent that, even when there is a policy, implementation is skewed per organisational branch. Although long-term care facilities and hospitals have gradually implemented quality indicators that are assessed by care inspections, implementation is hampered in home care, but also in transmural care that transcends these branches [23]. From Study 1, we discerned that the monitoring of undernutrition depends mostly on interested individuals in organisations. Moreover, implementation varies both in extent and in the way of working, driven by the lack of specific policies and, more importantly, the lack of training. From the outside, awareness campaigns can increase the attention paid to the guideline, but its facilitation in organisations needs action from the inside.

A policy serves as a starting point for further implementation of monitoring but needs to be supplemented with necessary training and resources [12,24]. Within primary care, especially home care organisations and general practitioners tend to pay less attention to undernutrition monitoring, as they perceive that nutrition does not fall within their responsibilities [23]. This rather short-sighted approach cannot be reconciled with the well-established knowledge that nutritional status affects many illnesses that require their care [25]. This calls for the provision of education and training regarding nutrition to new but also to existing professionals within these branches. This would facilitate adequate monitoring by general practitioners, nurse practitioners, and nurses. However, as already indicated, other professionals within the community can play a role in monitoring too. The effectiveness of monitoring would benefit from these social workers also keeping an eye on the adequate nutrition and body composition especially of those older adults who do not use care services. Nonetheless, actual systematic undernutrition monitoring should be done by general practitioners, nurse practitioners, and home care nurses. Weighing their patients regularly and screening them at the yearly flu vaccination could be easy approaches within this monitoring. However, one requirement for this lies in the health care system as shaped by governmental regulations [26]. These regulations should facilitate improvements in the monitoring system, which in turn can be facilitated when health insurers also acknowledge the importance of undernutrition and provide more funding for its prevention.

Treatment

When monitoring is performed adequately, the appropriate treatment can be carried out. In Study 1, personalisation and evaluation of the treatment were shown to be important conditions. In addition, in Study 4, we were able to establish that protein-enriched readymade meals and bread increased protein intake significantly in a trial. But what about their applicability in real life? How can protein enrichment play a role in treatment?

Personalisation

Treatment personalisation, that is, tailoring the treatment to the needs and preferences of older adults, is necessary to achieve effective treatment, as indicated by all interviewed researchers and some dietitians in Study 1. This personalisation starts from an assessment of the underlying factors for the diagnosed state of undernutrition, as these can be very diverse [27,28]. For this, collaboration between similarly diverse health professionals is key, initiated by the professional who first diagnoses the undesirable nutritional status. This recommendation is also mentioned by the Dutch Malnutrition Steering Group [11], but many professionals in Study 1 were not aware of it.

Driven by the diagnosis, the proper treatment options must be offered by the most relevant professionals. This may vary from psychological guidance and fixing dentures to offering meals-on-wheels and prescribing oral nutritional supplements, and often a combination of these. Admittedly, this multidisciplinary approach is becoming more difficult to achieve as older adults are becoming less institutionalised and are encouraged to stay longer at home [29]. This leads to vastly scattered older adults and thereby lower availability and proximity of the necessary professionals. This requires continuous reciprocal feedback among these professionals. This feedback also extends to the older adults themselves, as the treatment has to be explained thoroughly to them, too. When properly informed and motivated, older adults are more likely to follow these recommendations [30–32]. An increased feeling of involvement leads to patients actively thinking about their preferences and expressing these, facilitating personalisation of the treatment. This higher feeling of freedom of choice increases the effectiveness of the treatment [33], as also indicated by our interviewed professionals in Study 1. In addition, in relation to nutritional interventions, professionals should keep in mind that food has many functions and that a merely clinical approach could therefore fall short. We found this in Study 4 too, where the protein-enriched meals and bread showed large potential mainly because of their high likability. Moreover, on average, participants finished practically their whole meals throughout the intervention in Study 4. This indicates that the products matched their dietary behaviour and preferences, which can be very diverse given older adults' heterogeneity [34,35]. The finding that liking was high is especially important, as sensory appeal is one of the most important motivators in food choice [31]. This underlines again that, although the health implications are the main reason for offering protein-enriched products, we should acknowledge nutrition's many other non-health-related roles in older adults' life, such as enjoyment and social aspects, and personalise our message accordingly [36]. When healthy becomes tasty, it becomes easier to achieve necessary modifications.

This is also what we learned from our in-depth interviews in Study 4, as they indicated a high acceptability based on the products' high palatability. In addition, these interviewees mentioned that their eating pattern during the intervention period did not differ from their regular eating pattern. This is an overt advantage of protein-enriched regular products over oral nutritional supplements, making protein enrichment a highly applicable tool in undernutrition treatment [37]. This good match with participants' personal preferences was in line with the achieved optimal protein intake of around 1.2g/kg/d in Study 4. We achieved this increase despite – or perhaps thanks to – the high level of freedom of choice given to our participants during the intervention, as they were free to consume whatever kind of bread they wanted during the whole intervention. This reinforces our argument that the achieved higher protein intake is sustainable, making protein-enriched regular products promising strategies for achieving optimal protein intake in real life.

Evaluation

Evaluation relates to treatment implementation, which should be evaluated regularly according to our interviews in Study 1. Here, adequate evaluation is mentioned as still lacking within the management system. This applies to the evaluation of whether the treatment as prescribed by dietitians positively affects the nutritional state, but also to the joint evaluation and reciprocal feedback when several professionals are involved [7]. Currently, one of the greatest problems arises when older adults are discharged from hospital and the transmural assignment is inadequate [23]. Within the hospital setting, informing older adults themselves about their adverse nutritional status is often insufficient. As our interviewees in Study 1 stated, this lack of awareness makes it unlikely that older adults will take action to counteract their increased undernutrition risk, which requires ongoing evaluation by a multidisciplinary team in this crucial phase [23]. Regular feedback among the team is considered important, as it facilitates early adjustments when necessary. When a treatment does not improve the nutritional state, the main question is whether this is because the treatment has failed, or because the implementation of the treatment is substandard. Assessing this difference is crucial, as this knowledge on treatment fidelity determines whether the treatment in itself needs to be changed or the extent of this treatment's implementation needs to be increased. Drawing the wrong conclusion based on an inadequate evaluation is likely to inhibit treatment effectiveness throughout all care settings.

Methodological considerations

Different methodological approaches were used to explore the variety of topics of interest in the four studies within PRIMA Meal, eventually leading to the discussed conceptual framework. Throughout the studies, we aimed to remedy each successive study's limitations in a subsequent study with different designs and participants. Still, we need to discuss some important considerations regarding these two topics.

Study design

In the PRIMA Meal study, we started exploring our topics of interest with a qualitative study of professionals, followed by a mixed-methods study of older adults. The findings from the latter reflected those from the former well, indicating that the interviewed professionals are familiar with their target group. In addition, the interviews with older adults helped us to ask the right questions and offer the most appropriate answer options in the survey, after which we saw the findings from the interviews confirmed by the survey. Later on, we used the knowledge from these studies in a single-blind crossover trial and a double-blind controlled trial, as we assessed the acceptability and effectiveness of protein-enriched regular products. This use of different methodological approaches that increased the strength of the study is an obvious asset of the PRIMA Meal study.

Nonetheless, we also encountered some limitations. Throughout all our studies, we relied on self-reported data. It is possible that information bias occurred in both the professionals and the older adults, either intentionally (social desirability bias) or unintentionally (recall bias), which would negatively affect internal validity [38]. We cannot be certain that participants did not provide socially desirable answers; however, we tried to overcome this with the guarantee of anonymity in the interviews and the survey throughout all studies. We tried to overcome recall bias by encouraging participants to fill in their food record immediately after eating in Study 4. In addition, choosing to conduct a double-blind trial in Study 4 decreased the chance of this kind of information bias affecting the ultimate outcomes in protein intake [39].

Another challenge related to the level of control in particularly Study 3 and Study 4. In Study 3, we could exactly weigh everything that was consumed, thereby increasing control and precision, whereas the lab setting in which we did so might have evoked behaviour that would not have occurred at home, thereby decreasing sustainability and applicability [40]. The exact opposite was the case in Study 4, where choosing to stay close to the regular life of our participants increased our knowledge on sustainability and applicability of the protein-enriched products, while it simultaneously decreased our level of control and precision. Although we have no reason to assume that any information bias differed between the control and the intervention group, this trade-off leads to

the notion that we cannot be sure whether the reported consumptions were the actual consumptions in these groups. For this reason, the accuracy of the protein intake data in Study 4 would have benefited from the verification of the self-reported data with proxy sources like direct observation (e.g. via cameras) and biological markers (e.g. via urine collection). Nonetheless, these proxy measurements would in turn have created issues relating to the generalisability of the results, as we could expect that these measurements would result in the participation of fewer and healthier participants, as explained in the next section. Lastly, the generalisability of our two-week randomised controlled trial to months or even years is limited. Still, the positive product evaluations in the in-depth interviews indicate that the findings might be sustainable over a longer period than the current two weeks.

Study participants

Undeniably, the participants in our trials were more independent and healthier than the final target group, the meals-on-wheels clients. In Study 2, we did manage to involve dependent older adults by means of elderly meals-on-wheels clients. Although we reached only 10% of the invited interviewees, we reached 50% of them for the survey. The latter reach was higher as this was a non-invasive measurement. As we expected a much lower response among these older adults for the more invasive trials in Study 3 and Study 4, we opted to invite relatively more independent older adults. Here, we reached a response rate of 50% and 20%, respectively; these are expectable numbers given the intensity levels of these studies. Still, the latter percentage for Study 4 is low enough to warrant the choice for older adults who are healthier than the ultimate target group, the meals-on-wheels clients.

To illustrate this claim with Study 4: some of the residents had, for example, medical or mental issues that prevented them from participating. We expect cases like that to be even more prevalent in meals-on-wheels clients, decreasing the chance of attracting enough participants. In addition, many residents stated that they did not feel like participating in a study, as it would cost them too much effort without really knowing what they would get back in return. This was already the case without the aforementioned suggested observations and biological markers that would increase accuracy and the inclusion of such measurements could further lower the response rate. Here, the barrier of being part of a scientific study for the first time may be large enough to prevent dependent older adults from participating. For this reason, it would be more apposite to recommend setting up consumer panels like the SenTo panel that we used in Study 3, in which senior consumers are included starting at 55y [41]. Although some of them will suffer from the same medical and mental issues by the time they reach 70y or even 80y, at least they will have become used to participating in a study. Setting up longitudinal studies and

consumer panels like these, with the early inclusion of future older adults, can therefore overcome the reluctance to be part of a scientific study. Until that time, it is more likely that we will mainly attract the relatively healthy community-dwelling older adults for trials like ours, even those that target frail populations like senior centre residents.

Despite the inclusion of relatively healthier older adults in Study 4, we actually do not expect any problems with generalisability regarding the acceptability of the protein-enriched products. The reason for this is that earlier studies have found very little difference in liking between healthy and frail older adults [42,43], and it was suggested that liking could be tested in healthy older adults [44]. Moreover, the in-depth interviews after Study 4 indicated that the protein-enriched products were so much liked that the participants expressed that they would use them as they became older and frailer. Nevertheless, this positive notion does not extend to the generalisability of the level of consumption of the enriched products, hence requiring its assessment in the ultimate target group with their possibly lower appetite. Although the residents in Study 4 were more dependent than the consumer panel members of Study 3, food intake still has to be measured in the ultimate target group. For this reason, we would recommend conducting nutritional studies in different phases, starting with the global exploration of many necessary outcomes in healthier older adults, and becoming denser in measurements as the study gets closer to the ultimate, frail target group. In the latter, studies should measure only what could not be extrapolated fully from measurements in the healthier target group, such as food intake and subsequent satiety in our particular case.

Future research

The overall aim of the PRIMA Meal study was to gain insight into the current state of undernutrition management in community-dwelling older adults in the Netherlands and to explore the role of protein-enriched readymade meals and bread as a supportive instrument in protein undernutrition management. Here, our focus was on protein intake only and not on the long-term outcomes of this intake and future implications. Given this focus and our findings, some questions remain unanswered. These questions relate to three main topics: application in the target group, application in the food industry, and long-term costs and effectiveness.

Application in the target group

The effective use of protein-enriched products has one yet-to-be-solved prerequisite: clarity. Future studies should investigate how the use of protein-enriched regular products needs to be communicated and promoted among both older adults and professionals. We already know that older adults are willing to use functional foods [45], especially when it is advised by medical specialists [32]. What society now needs is more clarity on who should consume how much of which protein when. For example, we chose to adhere to the recommendation of 1.2g/kg/d for community-dwelling older adults and conveyed this message to our participants. Unfortunately, this number had absolutely no meaning for them, even when this was translated to a protein intake of 96g based on a body weight of 80kg. It was very hard for them to visualise how much they had to eat of which products to achieve this amount. Imagine the confusion that such messages convey when older people are hospitalised and only then hear about adequate protein intake for the first time. This would make the then acutely necessary increase in protein intake even more unlikely. Given the ambiguity surrounding protein, which was also found in earlier studies [32], perhaps it would be better to give older adults early recommendations, and only about the kind of products they need to eat during the day to achieve a general increase in protein intake, without them having to calculate the actual amounts. Future studies should look into the best approach to achieve this goal.

Furthermore, the PROT-AGE study group has provided an overview of all that we know regarding optimal dietary protein intake [16]. They have listed different sources of protein, with different recommendations in optimal protein intakes per disease and injury. This brings about new difficulties, given that many older adults suffer from a variety of diseases, and this again makes it hard to give clear-cut recommendations to older adults. In our study, we were able to exclude participants with decreased renal function for example, but how would that work in real life, when meals-on-wheels clients are given the option to choose protein-enriched meals? All our excluded participants were convinced that they had no renal problems, whereas consultation with their general

practitioner showed that they did to some extent. If we want to make the application of protein-enriched products possible, we should convey clearly that people with severe kidney disease should not consume extra protein and stimulate older adults to check this with their general practitioner [16]. Simultaneously, it would be important to ensure that the target group understands that high protein intake does not *lead* to renal problems – a common but incorrect belief among a variety of professionals [46]. On the contrary, adequate protein intake up to 1.2g/kg/d is assumed to maintain nitrogen balance without affecting renal function [47]. Future studies should therefore look into the most effective ways to make older adults and professionals aware of the benefits of adequate protein intake, accompanied by the caveat about the situation when someone is already suffering from kidney disease, without making the target group unnecessarily concerned about health risks. These studies could build on existing literature on older adults' motivators regarding the use of protein-enriched products [32,34,48,49].

Application in the food industry

Studies like ours will probably lead to the food industry paying increased attention to the commercial opportunities in contributing to protein intake increase with protein-enriched regular products. Because the principle of protein enrichment applied in our meals can be easily used by anyone in any meal, so the knowledge does not have to stay within merely one organisation or even within one industry. The principles do not even have to be limited to meals-on-wheels, as they can also be applied to readymade meals in supermarkets, for example to accommodate the more independent older adults. Nonetheless, before the food industry can commit itself to the development of protein-enriched products, more research is needed on two related issues: marketability and safety.

At the time of writing, the meals are not yet produced commercially, and the bread is only available for use in clinical settings. There are, however, several other protein-enriched products available in supermarkets, such as desserts and dairy drinks. Nonetheless, these products are not overtly advertised towards older adults. One reason for this lies in the difficulty of knowing how to market such products to the target group, as explained in the previous section. Further studies should investigate the composition of the intended target group and how this group should be approached. What kind of products should be enriched? Should they be marketed as food for older adults? Starting from what age? Should only the food industry take on this responsibility or should nutritionists play a role too? Moreover, should these products be actively promoted to the general elderly population or is it too soon for that? Some of these questions were explored by Van der Zanden and colleagues [34,35], who recommended strategies like increasing willingness to try protein-enriched products with in-store sampling and cash-back promotions and taking

into account the different segments of older adults. However, these recommendations were based on self-reported measures rather than actual purchasing behaviour, given the lack of sufficient protein-enriched products. Moreover, another question remains: to what extent is it safe to promote such products for older adults? Besides the older adults with kidney problems, what would happen if healthy older adults overconsumed protein-enriched products? We know that overconsumption in healthy adults is associated with health risks [50], but how likely is it that older adults will reach similar extreme protein intakes like athletes and bodybuilders when there is no supervision? Future studies should therefore analyse the risks and benefits associated with different forms of advertising of protein-enriched products to prevent us becoming either too cautious (i.e. only offering protein-enriched products under professional supervision) or too liberal (i.e. actively advertising protein-enriched products to everyone without proper information).

Long-term costs and effectiveness

The PRIMA Meal study focused on the short-term effect of protein enrichment on protein intake. Clearly, this is only half the story when we want to achieve protein undernutrition management, since we know that protein enrichment elicits the largest effects on body composition when it is combined with physical activity, especially in the long term [16]. Future research should therefore investigate the long-term health effects of the combination of protein enrichment and physical activity, preferably in the homes of older adults. We need high-quality studies with these characteristics, as we still do not know whether such interventions actually translate into better health outcomes [51–53]. We currently accept that protein enrichment indeed helps to prevent undernutrition and/or muscle loss, especially when combined with physical activity, but in the end, what do such products yield in terms of health and quality of life gains and cost savings? As this is still unknown, it is necessary to conduct a proper cost-effectiveness analysis of offering protein-enriched products to older adults. Admittedly, intensive studies like these entail difficulties in recruitment and implementation, as it is difficult to obtain valid measures of food intake in frail older adults at home and motivate them to become physically active. However, physical activity can always be matched to participants' health and capacity, as has been demonstrated with resistance training in frail older adults [18,19,54,55]. In addition, valid measures can be obtained by taking pictures with, and using e-health applications on, mobile phones [56–59]. Moreover, the trend of using special weighing scales that are directly linked to apps can be used for food weight as well as body weight. Such tools have the potential to facilitate easy, valid measures of food intake – including in the increasingly mobile-savvy older adults – which we expect to benefit future studies in community-dwelling older adults.

General conclusion

In this thesis, we have shown that undernutrition awareness is limited among both older adults and care professionals, leading to difficulties and delays in subsequent undernutrition monitoring and treatment. This finding may pose a problem for vulnerable groups such as meals-on-wheels clients, as our findings suggest that nearly one in four of these clients was actually undernourished. Here, it is crucial to convey the message that undernutrition is not an inevitable part of ageing and ensure that this message is heard by both older adults and professionals. In addition, collaboration among the many relevant professionals around community-dwelling older adults is necessary to adequately monitor and treat these older adults. Protein-enriched meals and bread could be supportive in this process, as we were able to show that they were effective in supporting community-dwelling older adults in reaching an optimal protein intake. Moreover, the positive evaluation of protein-enriched products indicates a good match between the needs and preferences of older adults as well as a positive long-term acceptability in real life. Still, future studies should investigate the application of more protein-enriched products and assess whether such products indeed lead to better undernutrition management in the long term, especially when combined with physical activity. All in all, the public health implications that we have discussed on the basis of our findings can be summarised by the three key messages that could help us *ace* in adequate protein undernutrition management: address awareness, collaborate continuously, and enrich expediently.

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Summary

Undernutrition is a major health problem in the growing elderly population. It is estimated that one in ten Dutch community-dwelling older adults is suffering from undernutrition, and one in three Dutch older adults who receive home care. Undernutrition may lead to many negative consequences, ranging from fatigue and falls to impaired immune function and death. This makes undernutrition an obvious target for preventive measures.

Undernutrition can be defined as "a state of nutrition in which a deficiency or excess (or imbalance) of energy, protein, and other nutrients causes measurable adverse effects on tissue/body form (body shape, size and composition) and function, and clinical outcome". In addition, it is often described as protein energy malnutrition. Adequate protein intake may to some extent prevent and reverse this process. However, throughout ageing, it becomes increasingly difficult to reach adequate protein intake due to higher protein needs and lower protein intakes. Finding solutions to assist older adults in reaching their optimal protein intake is necessary.

In our overall research project, we considered 1.2g protein per kg weight per day (g/kg/d) as adequate protein intake. In Dutch community-dwelling older adults, protein intake is around 1.0 g/kg/d, implying room for improvement. However, it is possible that many of these older adults deal with physiological changes, medical conditions, and physical and mental limitations that impair their appetite and food provision. For these older adults with higher protein needs, merely recommending that they eat more would not be realistic. It would be more realistic to explore strategies that increase protein intake without having to increase food intake. This calls for the exploration of instruments that match the needs and preferences of older adults: protein-enriched regular products.

One particular group that can be identified as a target group for such products, are older adults who receive home care. Undernutrition prevalence is high in this group, which may be explained by their health problems that led to this dependence on home care. Likewise, many of these older adults also depend on meals-on-wheels. These meals-on-wheels recipients, regardless of whether they receive home care or not, often risk undernutrition too. In both these (overlapping) care-dependent groups, difficulties in adhering to energy and protein recommendations can be discerned. For this reason, enriching the readymade meals that these older adults receive may contribute to the prevention of protein undernutrition by increasing protein intake while keeping food intake the same. Here, protein enrichment instruments can be used to prevent undernutrition, but only when implemented in a timely manner. Adequate undernutrition management systems are therefore necessary to facilitate timely intervention, ensuring that the developed protein-enriched meals are actually offered and effective. For this reason, the overall aim of our research project was to gain insight into the current state of undernutrition management in community-dwelling older adults in the Netherlands and explore the role of protein-enriched regular products as a supportive instrument in protein undernutrition management.

In Study 1 (chapter 2) we explored the experiences of 22 Dutch nutrition and care professionals and researchers with undernutrition awareness, monitoring, and treatment among community-dwelling older adults. This qualitative study among, for example, dietitians, general practitioners, nurse practitioners, and home care nurses provided insight into the current bottlenecks within the existing undernutrition management guidelines. In these telephone interviews, these experts also discussed the current dietary behaviour problems of older adults and their impact on undernutrition risk. The experts' experiences implied that undernutrition awareness is limited, among both older adults and care professionals. In addition, the interviewees were unclear about which professionals are responsible for monitoring and which monitoring procedures are preferred. The dietitians feel that they become involved too late, leading to decreased treatment effectiveness. In general, the interviewees desired more collaboration and a coherent and feasible allocation of responsibilities regarding undernutrition monitoring and treatment. This implied that the available guidelines on undernutrition management require more attention and facilitation.

In the following mixed-methods study (chapter 3), with interviews, we qualitatively explored the dietary behaviour and undernutrition risk of 12 Dutch elderly meals-on-wheels clients, one of the largest at-risk groups. We followed up on this information by quantifying the topics that emerged from the qualitative exploration of experienced bottlenecks in performing adequate dietary behaviour. For this, we used a survey among 333 meals-on-wheels clients. The interviews with elderly meals-on-wheels clients made clear that they have fixed and habitual eating patterns, while at the same time their appetite had decreased throughout the years. This was confirmed by the survey finding that regular portion size meals were perceived as too large by the oldest group aged over 75y. In addition, as the professionals suggested earlier, the interviewed elderly clients indeed showed limited awareness of undernutrition risk. Simultaneously, the survey showed that almost one in four elderly meals-on-wheels clients was undernourished. These findings led to the conclusion that staying close to the identified dietary habits may facilitate small yet effective modifications within these habits to prevent inadequate nutritional intake. Still, the limited awareness of undernutrition risk was expected to play a limiting role in whether clients believe they need dietary modifications. Consequently, informing them about this need could facilitate their motivation to implement modifications.

After learning about the general dietary behaviour of these older adults, we used this information for Study 3 (chapter 4). We developed two kinds of protein-enriched readymade meals that are in line with the needs and preferences of older adults: one of regular size (450g) and one of reduced size (400g). We tested these meals in a lab setting in 120 community-dwelling older adults in a single-blind randomised crossover trial. One day a week at lunchtime, for four weeks, participants had to consume and evaluate a readymade meal. Overall, regardless of portion size, the protein-enriched meals led to

higher protein intakes in vital older adults in a lab setting during lunch. In this crossover study, the participants liked the protein-enriched meals and the regular meals equally. However, we did not find the expected lower ratings of satiety after the reduced-size meals, while one reduced-size enriched meal and another regular-size enriched meal led to higher ratings of subsequent satiety. This higher satiety in the enriched meals could lead to compensational behaviour on the remainder of the day.

After establishing that the protein-enriched meals were effective and acceptable in the lab setting, we moved to the homes of older adults to test the meals in a longer-term study in Study 4 (chapter 5). In this double-blind randomised controlled trial of two weeks, we also included protein-enriched bread to assess whether both this bread and the meals could increase daily protein intake to 1.2g/kg/d in 42 community-dwelling older adults to reach optimal protein intake. We found that the enriched products again led to higher protein intakes and a high liking. The mean protein intake per day was 14.6g higher in the intervention group, which amounted to a protein intake of 1.25g/kg/d, compared with 0.99g/kg/d in the control group. In addition, the meals scored 7.7 out of 10, while the bread scored 7.8 out of 10, which both were comparable with their regular counterparts. Lastly, we found no negative effect of compensational behaviour throughout the day. These promising findings indicated that we achieved a good match between older adults' needs and preferences regarding protein intake.

In the general discussion of this thesis (chapter 6), we combined our learnings from the four studies to reflect on protein undernutrition management in community-dwelling older adults and the possible role of protein-enriched regular products. We have discussed a conceptual framework consisting of three wheels of protein undernutrition management. In the first wheel regarding awareness, we proposed that limited awareness of adequate nutrition and body composition forms the largest bottleneck in undernutrition management. When this awareness is generated among both older adults and professionals, it will benefit the second wheel of monitoring. Here, we argued that a policy and the actual facilitation of that policy are required for this monitoring to succeed. When the monitoring is performed adequately, in the third wheel, the appropriate treatment can be carried out. We discussed that personalisation and evaluation of this treatment are important conditions. All in all, the public health implications that we have discussed on the basis of our findings can be summarised by the three key messages that could help us ace in adequate protein undernutrition management: address awareness in both older adults and professionals, facilitate continuous collaboration between professionals, and offer protein-enriched products expediently.

Samenvatting

Ondervoeding vormt een van de belangrijkste gezondheidsproblemen onder de groeiende groep ouderen. De gevolgen variëren van vermoeidheid en valincidenten tot een verslechterd immuunsysteem en in het uiterste geval overlijden. Het voorkomen van ondervoeding verdient dan ook bijzondere aandacht.

Geschat wordt dat in Nederland een op de tien thuiswonende ouderen heeft ondervoeding, en van de groep ouderen die thuiszorg ontvangen een op de drie. De laatste groep is ook vaak afhankelijk van een maaltijdservice aan huis. De maaltijdontvangers, ongeacht of ze nu wel of geen thuiszorg ontvangen, lopen een hoger risico op ondervoeding.

In de praktijk gaat het bij ondervoeding van ouderen vaak mede om een tekort aan eiwit. Aan de ene kant stijgt hun eiwitbehoefte doordat ouderen eiwit minder gemakkelijk opnemen, aan de andere kant daalt de eiwitconsumptie door minder eetlust en problemen bij het kopen, koken en eten.

Om het ontstaan van ondervoeding te voorkomen, of om dit proces om te keren, moeten we manieren vinden die ouderen helpen hun optimale eiwitinname te realiseren. Het doel van ons onderzoek was daarom tweeledig:

- inzicht verkrijgen in de huidige ondervoedingsaanpak bij thuiswonende ouderen in Nederland en aanknopingspunten vinden voor verbeteringen;
- nagaan of eiwitverrijkte voedingsmiddelen kunnen bijdragen aan deze aanpak.

In ons onderzoek is ondervoeding gedefinieerd als 'een acute of chronische toestand waarbij een tekort of disbalans van energie, eiwit en andere voedingsstoffen leidt tot meetbare, nadelige effecten op lichaamssamenstelling, functioneren en klinische resultaten'. Daarbij zijn we uitgegaan van 1,2g eiwit per kg lichaamsgewicht per dag (g/kg/d) als streefniveau voor de eiwitinname. In de praktijk hebben thuiswonende ouderen in Nederland een eiwitinname van ongeveer 1,0g/kg/d.

In studie 1 (hoofdstuk 2) hebben we 22 voedings- en zorgprofessionals gevraagd naar hun ervaringen met de bekendheid, monitoring en behandeling van ondervoeding bij thuiswonende ouderen. We hebben onder anderen diëtisten, huisartsen, praktijkondersteuners, thuiszorgverpleegkundigen en onderzoekers telefonisch geïnterviewd. Ze vertelden dat ouderen minder eetlust hebben en minder eten, terwijl ouderen dat zelf niet in de gaten hebben. Bovendien was het voor de geïnterviewden onduidelijk welke professionals verantwoordelijk zijn voor het monitoren van ondervoeding, en welke procedures hiervoor gelden. De diëtisten gaven aan dat zij te laat werden ingeschakeld, waardoor ze ondervoeding bij oudere cliënten minder effectief konden behandelen. Over het algemeen hadden de geïnterviewden behoefte aan meer samenwerking en een duidelijke verdeling van verantwoordelijkheden rondom de monitoring en behandeling van ondervoeding.

Deze kwalitatieve studie laat zien waar de knelpunten zitten in de bestaande richtlijnen van ondervoedingsmanagement en dat zowel ouderen als zorgprofessionals zich vaak niet bewust zijn van het risico op ondervoeding.

In de navolgende mixed-methods-studie (hoofdstuk 3) hebben we eerst met interviews het voedingsgedrag en het ondervoedingsrisico van 12 oudere klanten van een maaltijdservice verkend. De inzichten uit dit onderzoek zijn vervolgens gebruikt voor een enquête onder 333 mensen uit deze doelgroep.

De interviews maakten duidelijk dat klanten van een maaltijdservice een vast eetpatroon hebben, terwijl hun eetlust door de jaren heen is verminderd. Vooral mensen van 75 jaar en ouder ervaren de maaltijden als te groot. Verder bleek dat de ouderen zich niet bewust waren van hun risico op ondervoeding, zoals de professionals al eerder signaleerden. Dit zagen we terug in de resultaten van de enquête: bijna een op de vier oudere maaltijdserviceklanten heeft verschijnselen die kunnen duiden op ondervoeding.

Uit deze studie hebben we geconcludeerd dat we bij de ontwikkeling van eiwitverrijkte voedingsmiddelen moeten aansluiten bij bestaande voedingsgewoonten van ouderen. We vermoeden dat kleine aanpassingen gemakkelijk een inadequate eiwitinname kunnen voorkomen. Een voorwaarde daarbij is dat de oudere klant van de maaltijdservice eerst wordt geïnformeerd over het risico op ondervoeding, en dat hij wordt gemotiveerd om zijn eetgedrag aan te passen.

De opgedane kennis over het voedingsgedrag van ouderen hebben we gebruikt voor studie 3 (hoofdstuk 4). Hierin ontwikkelden we twee soorten eiwitverrijkte kant-en-klaar maaltijden die passen bij de behoeften en voorkeuren van ouderen; een van normale portiegrootte (450g) en een van een kleinere portiegrootte (400g). Deze maaltijden zijn in een laboratoriumstudie getest bij 120 thuiswonende ouderen in een gerandomiseerde cross-overstudie. Gedurende vier weken hebben de deelnemers één dag in de week tijdens de lunch een kant-en-klaar maaltijd geconsumeerd en beoordeeld. De eiwitverrijkte maaltijden leidden gemiddeld tot een hogere eiwitinname bij vitale ouderen, ongeacht de portiegrootte. De deelnemers beoordeelden de eiwitverrijkte maaltijden net zo goed als de normale maaltijden. Tegen de verwachting in zagen we geen lagere gevoelens van verzadiging bij de kleinere maaltijden. De eiwitverrijkte maaltijden van normale en kleinere portiegrootte leidden tot hogere gevoelens van verzadiging. Dit kan mogelijk tot compensatiegedrag leiden gedurende de rest van de dag, dat is in deze studie niet onderzocht.

Nu duidelijk was dat eiwitverrijkte maaltijden gewaardeerd worden en ze inderdaad de eiwitinname verhogen, hebben we in studie 4 (hoofdstuk 5) de maaltijden getest bij ouderen thuis. Aan deze dubbelblinde gerandomiseerde gecontroleerde studie van twee weken was ook eiwitverrijkt brood toegevoegd. We hebben hiermee bij 42 thuiswonende ouderen onderzocht of we de gestreefde dagelijkse eiwitinname van 1,2g/kg/d konden bereiken.

We vonden opnieuw dat de eiwitverrijkte producten goed gewaardeerd werden en tot een hogere eiwitinname leidden. De gemiddelde eiwitinname per dag was 14,6g hoger in de interventiegroep (die de eiwitverrijkte producten kreeg) dan in de controlegroep (die de reguliere producten kreeg). De interventiegroep bereikte hiermee een eiwitinname van 1,25g/kg/d, tegenover 0,99g/kg/d in de controlegroep. De eiwitverrijkte maaltijden werden beoordeeld met een 7,7 en het eiwitverrijkte brood met een 7,8, beide vergelijkbaar met de scores van de normale producten. In deze studie bleek dat de hogere eiwitinname niet leidde tot compensatiegedrag (minder eten) gedurende de rest van de dag.

De bevindingen uit deze studie zijn veelbelovend. We hebben aangetoond dat de gebruikte eiwitverrijkte voedingsmiddelen goed aansluiten bij de voorkeuren van ouderen en dat ze de eiwitinname daadwerkelijk verhogen.

In de algemene discussie van dit proefschrift (hoofdstuk 6) reflecteren we op de aanpak van eiwitondervoeding bij thuiswonende ouderen en de mogelijke rol hierin van eiwitverrijkte voedingsmiddelen aan de hand van de bevindingen uit de vier studies. Daarbij hebben we een conceptueel kader voor ondervoedingsmanagement ontwikkeld, bestaande uit drie wielen.

In het eerste wiel, rondom bewustwording, laten we zien dat de beperkte bekendheid over adequate voeding en veranderende lichaamssamenstelling het grootste knelpunt vormt. Verbeteren van het ondervoedingsmanagement begint dan ook met een groter bewustzijn bij ouderen en professionals.

In het tweede wiel, rondom monitoring, stellen we dat goed beleid rondom ondervoeding bij ouderen nodig is, in combinatie met een goede uitvoering. Daarvoor is het belangrijk dat de verschillende betrokken professionals intensief samenwerken.

In het derde wiel, rondom doelmatige eiwitverrijking, constateren we dat eiwitverrijkte voedingsmiddelen die aansluiten bij de eetgewoonten van ouderen daadwerkelijk zorgen voor een verhoogde eiwitinname. Het evalueren van deze interventies zien we als een belangrijke voorwaarde voor een blijvend succesvolle aanpak van eiwitondervoeding.

Onze bevindingen over adequaat management van eiwitondervoeding bij ouderen kunnen we samenvatten in drie kernboodschappen:

1. Zorg voor bewustwording bij ouderen en professionals;
2. Maak verantwoordelijkheden en taken rondom monitoring duidelijk voor een betere samenwerking tussen professionals;
3. Geef doelmatig eiwitverrijkte producten aan de risicogroep.

Dankwoord

A candle loses none of its light by lighting another candle

Het motto van dit proefschrift is tevens mijn levensmotto, dus hoe toepasselijk is het dan om mijn levenswerk ermee te beginnen! Door de jaren heen hebben heel wat mensen mij onbaatzuchtig opgeleid, ondersteund en opgevoed, en nu kan ik dan eindelijk al die mensen bedanken. Helaas resulteerde dat na mijn eerste poging in een dankwoord van 5000 woorden en dat is echt te veel. Vandaar dat ik het nu, geheel in Twitter-stijl, in maximaal 140 leestekens per persoon heb gedaan.

De Opleiders

Allereerst de vele opleiders in mijn leven, waarvan ik er maar zeven ga uitlichten. Om in omgekeerde chronologische volgorde te beginnen met mijn promotoren. **Lisette:** Mocht ik ooit nog professor worden, dan ben jij mijn grootste voorbeeld! Je was er altijd, zélfs als je er (eigenlijk) niet was. **Annemien:** Je bent een super begeleider: ik ken niemand die zo snel, uitgebreid en nauwkeurig feedback geeft... Maar bovenal ben je een goed méns! **Stefanie:** Als het niet kan zoals het moet, dan moet het maar zoals het kan: die instelling onthoud ik voor altijd, scheelt heel wat stress!

Ook nog even aandacht voor mijn voormalige copromotor natuurlijk. **Gertrude:** *Genieten aan tafel* was ingewikkeld, maar ik heb veel geleerd van je nauwkeurigheid. En natuurlijk van hoe attent je altijd bent!

Iets meer terug in de tijd, zijn mijn scriptie- en stagebegeleiders. **Reint Jan:** Ooit noemde je mij een ideale student voor iedere begeleider, maar geloof me, jij bent ook de ideale begeleider voor iedere student. **Anne Margriet:** Bedankt dat je mij als voedingswetenschapper in je afdeling rondom ouderenpsychologie opnam en mij motiveerde om te promoveren. **Beppie:** Je bent zo creatief dat veel van je projecten te vooruitstrevend waren voor hun tijd, maar daarna succesvol bleken te zijn. Lesson learned!

Ik wil hierbij ook de leden van de thesiscommissie bedanken. **Hans van Trijp**, **Jaap van Binsbergen**, **Wender Bredie** en **Liesbeth Zandstra**. Strikt genomen zijn jullie meer mijn ondervragers dan opleiders, maar dat klinkt ook weer zo onaardig, dus ik schaar jullie gewoon onder mijn opleiders. Bedankt voor de tijd en moeite die jullie nemen om mijn proefschrift door te nemen en te bediscussiëren. Waarschijnlijk zijn jullie na mijn promotoren de enigen die dit hele boek een keer doornemen, dus ik hoop dat het een beetje boeiend is: we hebben ons best gedaan!

De Ondersteuners

Heel wat mensen hebben mij ondersteund in de afgelopen 4 jaar en ook hen wil ik graag bedanken. **Marchel:** Je was een ondersteunende manager die goed luisterde naar wat ik wilde toen ik eerst als onderzoeker begon bij FBR (namelijk: promoveren). **Herman:** Bedankt voor je enthousiasme, creativiteit, overal kansen in zien, en meedenken bij het bepalen van de richting van het onderzoek! **Manon**, **Mariska**, **Milou** en **Nancy:** Wat waren jullie onmisbaar tijdens de interventies! Elk paniekmomentje over de praktische invulling van iets dat mij onmogelijk leek werd gewoon weggelachen door jullie, aangezien jullie daar allang een oplossing voor hadden bedacht. Elk nieuw probleem waar ik tegenaan liep, hadden jullie al zes keer eerder gehad en elke keer weer opgelost. Bedankt dat jullie deur altijd open stond (behalve als het koud was, maar dan hing er een keurig bordje dat we gewoon welkom waren), zodat ik me ook niet bezwaard voelde om even om advies te vragen. **Anke**, **Daniella**, **Esmée**, **Esther**, **Judith**, **Marjon** en **Rene:** Ook jullie bedankt voor alle betrokkenheid en regelmatig vragen hoe het gaat! Het was fijn om jullie er vanaf het begin tot het einde erbij te hebben. **Eric:** Dankzij jou wist ik welke statistische tests ik moest doen en vooral waaróm ik die moest doen. Je was onmisbaar binnen alle onderzoeken. **Hajo:** Dank voor het meedenken over mijn omslag (aangezien je oog voor detail hebt) en toekomst (aangezien je gewoon heel aardig bent)! **Guido:** Sinds jij als sportieveling opperde dat traplopen slecht is voor je knieën, heb ik extra genoten van onze liftgesprekken! **Julia** en **Marion:** Bedankt voor jullie ondersteuning in de afgelopen jaren: ik heb jullie hulp bij alle praktische zaken enorm gewaardeerd! **Bonno**, **Erik** en **Rob:** Ik heb niet bijgehouden hoe vaak jullie auto's, papier, enveloppen, mappen, batterijen en kilo's pakketpost voor me hebben geregeld, maar ik hoop dat jullie weten dat het allemaal een doel diende en mij heel gelukkig maakte. Jullie zijn de ruggengraat van FBR, ik hoop dat jullie dat beseffen!

Dankzij mijn dubbele affiliatie was ik gezegend met nóg meer collega's op de universiteit. **Agnes**, **Anouk**, **Elske**, **Evelien**, **Lonneke**, **Lotte, Margot**, **Marije**, **Marit**, **Mike**, **Nikita**, **Nikkie**, **Roland**, en **Ondine:** Ik vond het heerlijk om ervaringen uit te wisselen over onze onderzoeken en heb heel wat van jullie opgestoken. Jullie waren ideaal om even van mijn eilandje af te komen en, eerlijk is eerlijk, opgelucht te voelen dat ik niet de enige ben die tegen problemen aanliep. Gelukkig waren er altijd wel oplossingen en konden we elkaar daarin steunen! **Carla:** Bedankt voor je hulp met ingewikkelde METC zaken. Ik snap wel dat het je baan is, maar de boodschapper zijn is vast niet altijd makkelijk. **Jeanne** en **Corine:** Dank voor jullie wijsheid met voedingsdagboekjes en Compl-Eat. En ik maar denken dat ik er als niet-diëtist ook wel uit zou komen! Gelukkig werd ik op jullie advies bijgestaan door het volgende viertal diëtisten. **Anna**, **Renske**, **Vera** en **Yvonne:** Ook jullie bedankt voor de inzet en praktische instelling: jullie waren echt onmisbaar in de interventie! **Joanne:** Heerlijk die kennis van je over kwalitatief onderzoek en je constante vraag naar meer diepgang. Ook genoten van de colleges voor je vak! **Karen** en **Jacqueline:** Bedankt voor alle snelle, nauwkeurige, zorgzame ondersteuning door de jaren heen!

Er waren ook niet-collega's die een rol speelden bij verschillende onderzoeken. Allereerst mijn studenten, die allemaal iets van zichzelf hebben toegevoegd aan dit proefschrift. **Berber**, **Francy**, **Jessie**, **Laura**, **Lutine**, **Melissa** en **Moniek:** Het was een éér om jullie te mogen begeleiden bij jullie stages en theses! Geloof me, ik heb net zoveel van jullie geleerd als jullie (hopelijk) van mij. Elke keer was ik weer trots op jullie eindproducten en presentaties. Omdat jullie zulke geweldige studenten waren, ben ik gemotiveerd geraakt om verder te willen in onderwijs. De lat ligt dus hoog voor alle studenten na jullie, maar al komen er misschien weer nieuwe *Canan's Angels*, iedereen weet dat jullie *the originals* zijn! **Emmelyne**, **Nancy** en **Nicole:** Dank voor de leuke samenwerking rondom Cater with Care, en voor het meedenken voor mijn onderzoek. Met zulke enthousiaste mensen als jullie komt het wel goed met voeding in de zorg. **Jeanette**, **Judith** en **Petra:** Bedankt voor de ondersteuning vanuit GGD Noord- en Oost-Gelderland, vooral rondom de data van de ouderenmonitoren. Natuurlijk ook bedankt voor de leuke tijd daarvoor, tijdens mijn scriptie bij de GGD (toen het nog GGD Gelre-IJssel heette). **Nathalie:** Jouw enthousiasme en betrokkenheid met mensen is inspirerend en effectief: hopelijk kom je nog heel lang voor al onze (zorg)belangen op! **Catherine:** I don't know how you manage to be so quick and meticulous at the same time, but I know that I appreciated your textual improvements a lot! **Aliëtte** en **Rhijja:** Door jullie talentvolle wetenschapsjournalisten kreeg mijn wetenschappelijke werk aandacht van de uiteindelijke doelgroep. Jullie zijn daarmee echt een onmisbare schakel in het systeem! **Volkan:** Ontzettend fijn dat je mijn onderzoek boeiend vond en ondervoeding bij ouderen ook onder de aandacht bracht van Turkse Nederlanders.

Dan naar de ondersteuning vanuit Food Connect. **Astrid:** Bedankt voor je enthousiasme en visie, waardoor je heil zag in eiwitverrijking van maaltijden en dit alles mogelijk werd. **Elles**: Dank voor je begrip voor mijn wetenschappelijke eisen en voor je goeddoordachte alternatieve voorstellen vanwege de praktische realiteit. **Wim:** Met realisme kom je uiteindelijk verder dan het onmogelijke beloven, en volgens mij zijn we daarom nu zo ver gekomen, dank daarvoor! Daarnaast gaat mijn dank natuurlijk ook uit naar alle medewerkers van Food Connect: van de klantenservicemedewerkers en bezorgers naar de portioneerders en koks: jullie hebben allemaal een steentje bijgedragen aan de nieuwe kennis in dit proefschrift, dank!

Natuurlijk ook aandacht voor **alle deelnemers** aan mijn onderzoeken: professionals, klanten van Food Connect, SenTo-leden en deelnemende bewoners in Velp. Bedankt voor jullie bijdrage aan de wetenschap en aan mijn promotie! Iedereen in dit dankwoord was in een bepaalde mate onmisbaar, maar zonder jullie betrokkenheid was er werkelijk geen één artikel mogelijk geweest. **Bert** en **Ria**: Bedankt dat jullie ons bij het laatste onderzoek zo hartelijk verwelkomden en ons alle benodigde ruimte gaven, en nog zoveel meer!

Door met al mijn (ex-)kamergenoten door de gebouwen en jaren heen. **Ilse** en **Monique:** Ik heb echt genoten van jullie gezelligheid en het uitwisselen van levenswijsheden over werk en privé! Ik zit al een tijdje niet meer bij jullie, maar gelukkig verhelpen we dat probleem prima met gezellige etentjes. **Vivian:** You once told me that you're funnier in Mandarin, but trust me, I laughed a lot in English too. Still honoured to have been your paranymph! **Geerke** en **Marieke:** Wat ik het meest aan jullie heb overgehouden is toch wel jullie heerlijke nuchterheid. Helaas geldt dat niet voor jullie plezier en bekwaamheid met statistiek en SPSS, maar je kunt niet alles hebben he? **Rianne:** Ooit kwam ik voorzichtig jouw kamer binnen als student, later zat ik daar als aio. Dank voor de inspiratie om te promoveren! **Sandra:** Uiteindelijk zijn we vooral vriendinnen geworden, en ik jouw paranimf. Weet dat ik je ook hierna altijd bij zal staan! **Ellen:** Dank voor alle steun, realisme, en praktische kijk op alles. Er is geen uitdaging die jij niet aan kan, dat is echt inspirerend om te zien! **Louise:** Met jouw nauwkeurigheid en discipline is het geen wonder dat je láter bent begonnen en éérder promoveert. Je verdient elk stukje goeds!

Op naar de vrienden en vriendinnen. **KaYin**, **Natalie**, **Nicole** en **Trudy:** Jullie waren er vanaf het begin van mijn school-/studietijd bij en hebben mij er ook echt doorheen geholpen met de nodige steun en uitleg. *If you're the smartest person in the room, you're in the wrong room*, zeggen ze altijd. Met jullie zat ik dus altijd in de juiste kamer! **Jens** en **Marco**: Jullie betrokkenheid bij mijn promotie was meer mentaal dan inhoudelijk, maar dat hielp me wel altijd om met beide benen op de grond te staan. En nogmaals excuses dat ik mijn verdediging tegelijk heb gepland met het optreden van Rico, Sticks & Ty… **Mehmet:** Fijn dat je nog wilde meedenken over mijn stelling, terwijl je me alleen via Twitter kent. De kracht van sociale media is weer eens bewezen! **Jan:** Jij hebt je gewoon ontpopt als mijn *motivational speaker* rondom mijn toekomst. Je steun gaf me echt het zelfvertrouwen dat ik nodig had!

Nu dan mijn paranimfen, officieel mijn ondersteuners tijdens het laatste moment, maar eigenlijk al vanaf het eerste moment. **Janne**: Je onderzoeksvaardigheden zijn net zo goed ontwikkeld als je sociale. Ik ben blij dat we tegelijk vertrekken: het wordt te stil zonder jou! **Renske:** Er is geen verleden, heden en toekomst in mijn leven zonder jouw vriendschap.

De laatste ondersteuner van het rijtje: **Ferid**. Het is onmogelijk om uit te leggen wat jij voor mij betekent: niet in 140 karakters, noch in 1400. Kleine poging: *You save me from myself* ♫

De Opvoeders

Voor ik opleiders en ondersteuners kreeg, had ik natuurlijk te maken met opvoeders. Allereerst al mijn ooms en tantes, nichtjes en neefjes. Bedankt voor jullie vertrouwen in mij. Ik heb veel van jullie geleerd, zelfs van de kinderen, als het gaat om beseffen wat belangrijk is in het leven. Jullie waren er bij elk succesje bij, of het nou een diploma was of een krantenartikel, en altijd zo trots! Julie steun is hartverwarmend en motiverend. **Hala:** Jij was mijn grootste voorbeeld door als eerste van de familie naar de uni te gaan. Je beseft wel dat ik je nu officieel overstijg he? **Teyze:** Bedankt dat je voor elke 10 die ik op school haalde, mij 10 gulden gaf. En natuurlijk voor je onmisbare levenswijsheid en *street knowledge*.

Nu dan de belangrijkste opvoeders in mijn leven, waarvoor ik de 140-leestekens-regel laat varen.

Bekir Can en **Osman Celil**: Hoe groot jullie ook worden, hoe trots jullie me ook maken, voor mij blijven jullie altijd mijn kleine broertjes. Door jullie is mijn liefde voor onderwijs begonnen en heb ik geleerd hoe ik anderen het beste kan motiveren. Verder heb ik geleerd dat studenten beter luisteren naar een docent als die docent niet hun zus is... Hoe groot jullie ook worden, weet dat jullie altijd bij me terecht kunnen!

Mama en **papa:** Jullie zijn de grootste reden dat ik zo ver ben gekomen in mijn carrière. Jullie hebben ons echt verwend, maar tegelijkertijd ook gestimuleerd om het goed te doen op school. Ik beloof dat dit mijn laatste "school" was, maar ook dat ik niet stop met mezelf ontwikkelen. Mama, jouw zorgzaamheid is uniek, en met al het lekkere eten dat jij voor ons maakt, zullen wij nooit ondervoed raken. Dank voor alles, maar vooral voor je onvoorwaardelijke liefde. Senin gibisi yok ♥

Ik sluit mijn dankwoord af met de meest toepasselijke opvoeders, mijn **oma's** en **opa's**. Het maakt me gelukkig dat jullie mijn promotie mogen meemaken. Ik weet als geen ander wat voor moeilijkheden jullie hebben moeten doorstaan om uiteindelijk jullie kinderen en kleinkinderen een goed leven te kunnen laten leiden. Ik hoop dat ieder van ons een steentje bijdraagt aan jullie geluk, zodat het allemaal de moeite waard was. Dit proefschrift is mijn steentje voor jullie.

About the author

Curriculum vitae

Canan Ziylan was born on January 2nd, 1988 in Amersfoort, the Netherlands. In 2006, she received her secondary school diploma from 't Atrium in Amersfoort.

Thereafter, she started her post-secondary education in Nutrition and Health at Wageningen University. Within her BSc, she completed a minor and thesis in communication.

During her MSc, she specialised in Public Health Nutrition. She conducted her thesis at the Community Health Service in Apeldoorn (GGD Noorden Oost-Gelderland), where she interviewed older adults to evaluate a real-life intervention that aimed to prevent loneliness among older adults. Hereafter, she completed two internships.

During her first internship at the National Institute for Health Promotion and Disease Prevention (NIGZ), she used online questionnaires to evaluate whether the internet community 50plusnet.nl prevents loneliness among older adults. During her second internship at the Netherlands Institute of Mental Health and Addiction (Trimbos-instituut), she studied the effects of case management regarding dementia among older adults, by means of focus groups with caregivers and professionals.

After finishing her MSc in 2011, she started working as a junior researcher at Wageningen Food & Biobased Research, at the department of Consumer Science & Health. Here, she studied the effects of a real-life intervention on optimizing meal enjoyment of older adults in Dutch nursing homes to prevent undernutrition.

In 2012, she started her PhD project within the overall IPOP Customized Nutrition programme of Wageningen UR, working both within the division of Human Nutrition at Wageningen University and within the department of Consumer Science & Health at Wageningen Food & Biobased Research. Here, the aim was to develop protein-enriched meal concepts that are tailored to the needs and preferences of older adults to prevent undernutrition. During her PhD project, she joined the educational programme of the Graduate School VLAG and was a member of the VLAG PhD Council. Moreover, she has co-taught MSc courses in the Nutrition and Health programme, and supervised thesis and internships students from various study programmes.

Currently, Canan works as a teacher within the department of Nursing and as a researcher within the Care Innovation Knowledge Centre, both at Rotterdam University of Applied Sciences.

List of publications

Publications

Ziylan C, Haveman-Nies A, Kremer S, de Groot CPGM (2016) Protein-enriched bread and readymade meals increase community-dwelling older adults' protein intake in a double-blind randomised controlled trial, *JAMDA*, in press. DOI: 10.1016/j.jamda.2016.08.018.

Ziylan C, Kremer S, Eerens, J, Haveman-Nies A, de Groot CPGM (2016) Effect of meal size reduction and protein enrichment on intake and satiety in vital community-dwelling older adults, *Appetite* 105, 242-248. DOI:10.1016/j.appet.2016.05.032.

Ziylan C, Haveman-Nies A, van Dongen EJI, Kremer S, de Groot CPGM (2015) Dutch nutrition and care professionals' experiences with undernutrition awareness, monitoring, and treatment among community-dwelling older adults: a qualitative study, *BMC Nutrition* 1:38. DOI: 10.1186/s40795-015-0034-6.

Zeinstra GG, van Atten MN, **Ziylan C**, Boelsma E, Peppelenbos HW, den Brok P (2014) Rapportage onderzoeksproject Genieten aan tafel: een toegepast onderzoek naar maaltijdbeleving in verpleeghuizen, Wageningen UR Food & Biobased Research, Wageningen. ISBN: 978-94-6257-053-5.

Honigh-de Vlaming R, Haveman-Nies A, **Ziylan C**, Renes RJ (2013) Acceptability of the components of a loneliness intervention among elderly Dutch people: a qualitative study, *American Journal of Health Education* 44(3), 136-145. DOI: 10.1080/19325037.2013.767734.

Submitted manuscripts for publication

Ziylan C, Haveman-Nies A, Kremer S, de Groot CPGM. Dietary behaviour and undernutrition risk of Dutch elderly meals-on-wheels clients: A mixed-methods study.

Beelen J, Vasse E, **Ziylan C**, Janssen N, de Roos NM, de Groot CPGM. Undernutrition: Who cares? Perspectives of dietitians and elderly patients on undernutrition treatment.

Overview of completed training activities

Discipline specific activities	Organiser and location	Year
Nationale dag diëtisten in zorgcentra	NVD, Heerenveen	2011
11e Nationaal Gerontologiecongres, *oral presentation*	NVG-KNOWS, Ede	2012
Master class: How to develop effective interventions in public health practice	VLAG, AGORA, Wageningen	2012
Adding Healthy Years to the Human Lifespan	Netherlands Consortium for Healthy Aging, Den Haag	2013
Nationaal Voedingscongres	Alliantie Voeding Gelderse Vallei, Ede	2013
Master class: Valuable interaction between policy, practice and research in public health: expectations and desired outcomes	VLAG, Maastricht University, Maastricht	2013
Folia Orthica Symposium, *poster presentation*	Folia Orthica, Amersfoort	2013
Master class: How to evaluate interventions in public health practice	VLAG, AGORA, Wageningen	2013
Nutritional Science Days	NWO, Deurne	2013
Congres Online Hulp	Bohn Stafleu van Loghum, Utrecht	2013
Symposium 25 years of aging and nutrition research in Wageningen University	WUR HNE, Wageningen	2013
Symposium Wetenschap en beleid rondom een gezond voedingspatroon	Zuivel en Gezondheid, Utrecht	2013
Sensory Perception and Food Preference	VLAG, Wageningen	2013
Final NCHA congress	Netherlands Consortium for Healthy Aging, Den Haag	2013
Master class: Costs and benefits of public health interventions	VLAG, Maastricht University, Maastricht	2014
Symposium Pt-Global ondervoeding	Hanzehogeschool Groningen, Groningen	2014
10th Congress of the EUGMS – 12e Nationaal Gerontologiecongres, *oral presentation*	EUGMS, NVG-KNOWS, Rotterdam	2014
39th Annual Meeting of the British Feeding & Drinking Group, *oral presentation*	BFDG, Wageningen	2015
WPC PhD Symposium, *oral presentation*	Wageningen PhD Council, Wageningen	2015
13e Nationaal Gerontologiecongres, *oral presentation*	NVG-KNOWS, Ede	2015
Symposium Nutritional Sciences, The Future is Ours	WUR HNE, Wageningen	2015
Voedingswetenschap over grenzen heen; nieuwe wegen verkennen	NAV, Maastricht	2016
Nationale Masterclass: Multidisciplinaire zorg rondom de fysiek kwetsbare oudere patiënt, *oral presentation*	Nutricia, Utrecht	2016

General courses	Organiser and location	Year
VLAG PhD week	VLAG, Baarlo	2012
Reviewing a Scientific Paper	WGS, Wageningen	2013
Scientific Writing	WGS, Wageningen	2014
Mobilising your -scientific- network	WGS, Wageningen	2015
Survival Guide to Peer Review	WIAS, Wageningen	2015
Career Orientation	WGS, Wageningen	2016
Optional courses and meetings	**Organiser and location**	**Year**
Preparing PhD research proposal	WUR HNE, Wageningen	2012
Analytical Epidemiology	WUR HNE, Wageningen	2013
PhD Study Tour	WUR HNE/VLAG, Sydney & Melbourne	2013
Lunch meetings elderly research	WUR HNE, Wageningen	2012-2016
Expertise meetings Consumer Science FBR	WUR FBR, Wageningen	2012-2016
Concepts and Methods in Epidemiology	WUR HNE, Wageningen	2014-2015
VLAG PhD Council	VLAG, Wageningen	2014-2016

The research described in this thesis was financially supported by the Wageningen UR IPOP Customized Nutrition programme (grant number KB-15-007-001), financed by Wageningen UR, the Dutch Ministry of Economic Affairs, and the graduate school VLAG. In-kind support was received from meal service Food Connect, Almelo.

Financial support from Wageningen University for printing this thesis is gratefully acknowledged.

Photo cover	Olena Danileiko
Photo CV	Şeyma Altınkaya
Cover design & lay-out	Iliana Boshoven-Gkini | www.AgileColor.com
Printing	GVO drukkers & vormgevers B.V. | Ede