

Technology-mediated patient engagement in nutrition care

Opportunities for early intervention to support health and independence in old age

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Abstract

Background: Norwegian health policies promote increased focus on health promotion in home care services to support older adult's opportunity to maintain health experiences and independence. Good nutrition status is a core enabler of health and active participation in old age and ageing in place. However, with advanced age, the risk of undernutrition increases. Undernutrition can negatively affect the health of older people, and is seen in connection with increased dependence. A large proportion of older adults who receive home care services are at high risk of developing undernutrition, and many are undernourished. It is often the small and unconscious changes in dietary habits that increase vulnerability for weight loss and risk of undernutrition in old age. Technology provides opportunities to increase awareness among older adults and health professionals about dietary challenges in old age. Nutrition applications can facilitate self-management of diet by providing people with data and feedback about their dietary behavior and information about nutrition. Such apps can increase the individual's awareness of their own diet and support good food choices. Nutrition apps have proven beneficial as part of nutrition interventions for obesity treatment and management of chronic diseases, e.g. diabetes. However, the potential of nutrition apps to support diet self-management to prevent undernutrition among older adults is scarcely explored. There is a need for knowledge about feasibility, user experiences, and the opportunities in using nutrition apps as part of nutrition care in home care contexts. We developed a nutrition app called Appetitus to support older adults' diet self-management and specifically address the challenge of undernutrition among older adults. This thesis explores the feasibility of introducing Appetitus for nutrition care in home care and opportunities in supporting early interventions to prevent undernutrition and manage nutritional challenges among home-dwelling older adults.

Methods: This feasibility study had an explorative design, with emphasis on using qualitative methods to explore the experiences of older adults and health care professionals who used the Appetitus app (Papers I, II, and III). In Paper III, we supplemented this with quantitative method to explore older adults' user patterns in the Appetitus app. We interviewed 25 older adults who used Appetitus in an 8-week trial, and we collected log data on use of the app directly from the Appetitus app. We interviewed 24 health care professionals who either provided support to the older adults who used Appetitus or who facilitated the trial as managers in the study sites.

Results: The majority of older adults recorded their food and beverage consumptions in the Appetitus app daily or several days a week during the trial period. They reported a personal interest in nutrition and being highly committed to participating in a research project. Those

who did not use Appetitus regularly in the trial period explained that poor health experiences influenced negatively their use pattern, and they perceived less personal relevance of using a nutrition app.

Several older adults were inspired to have a more varied diet when they used Appetitus, and they chose food alternatives that helped them to consume sufficient protein or energy. The familiar meal suggestions and visualization of goal achievement in the app further stimulated dietary change. However, some participants experienced rarely getting close to pre-calculated goal achievements for energy, protein, and fluids in Appetitus. For them, the visualization had a demotivating effect since they did not reach the recommended values. They had not actively tried to change by eating more, fortifying their dishes, or choosing other foods.

When older adults showed more interest in their diet, they initiated dialogs about nutrition with health care professionals. Most health care professionals experienced that their nutrition care was strengthened by the support of the apps' visualization of the patient's dietary patterns. It was also easier to suggest changes to energy, protein, and fluid consumption in relation to the personalized, estimated need for nutrients. Health care professionals focused on encouraging and giving advice based on the older adults existing dietary habits. However, lack of confidence in their own nutrition knowledge was seen as a barrier to nutrition follow-up for some health care professionals and resulted in them focusing on the technical follow-up rather than nutrition-specific follow-up.

Conclusion: This study supports the feasibility of implementing patient-facing nutrition apps in nutrition care in home care settings. Creating or adopting solutions that are inspiring and easy to use can positively influence user acceptance and sustain engagement. Regular follow-up from health care professionals can influence older adults' motivation to adopt nutrition apps and to continue diet self-monitoring over time. However, this study also indicated that older people with high disease burden may not manage or prioritize using such self-management tools on a regular basis.

The Appetitus app inspired variation and more conscious food choices in the users' diet. Concrete support tools that increase dietary awareness among older adults themselves carries great potential as an early intervention to prevent development of undernutrition. Self-management tools, such as Appetitus, can drive interactions between health care professionals and older adults to develop patient-centered care and increased attention to health promotion. Such changes are in line with political objectives to increase focus on health-promoting activities, and is central to strengthening the older adult's self-care, independence and opportunities to age in place.

Abstract in Norwegian

Bakgrunn: Norske helsemyndigheter oppfordrer til økt fokus på helsefremmende arbeid i hjemmebaserte tjenester for å støtte Eldres mulighet for å bevare god helse og uavhengighet i alderdommen. God ernæringsstatus spiller en viktig rolle for Eldres helse, aktivitet og mulighet for å bo hjemme. Imidlertid øker risikoen for underernæring med høy alder. Underernæring kan prege helsen til eldre personer negativt, og sees ofte i sammenheng med tiltakende avhengighet av hjelp. En stor andel eldre som mottar hjemmetjenester er i høy risiko for å utvikle underernæring, og mange er underernærte. Det er gjerne de små og ubevisste endringene i kostholdet som øker sårbarheten for vekttap og bidrar til risiko for underernæring blant eldre. Teknologiske løsninger, som kostholds applikasjoner (apper), kan øke eldre og helsepersonells bevissthet om vanlige ernæringsutfordringer hos eldre. Kostholdsapper kan gi persontilpassede tilbakemeldinger på kostholdet og være en informasjonskilde om ernæring. Innholdet i slike apper kan øke den enkeltes bevissthet om eget kosthold og styrke gode matvalg. Kostholdapper har vist seg å være gunstige som en del av ernæringsintervensjoner i behandling av overvekt og fedme, og i behandling og oppfølging av kroniske sykdommer som diabetes. Mulighetene med å bruke kostholdsapper for å styrke gode matvalg og måltidsvaner for å forhindre underernæring blant eldre er imidlertid lite utforsket. Det er derfor behov for kunnskap om gjennomførbarhet, brukeropplevelser og implikasjoner bruk av slike kostholdsapper i ernæringsarbeid i kommunehelsetjenesten. Vi utviklet en kostholdsapp, kalt Appetitus, for å støtte Eldres egenomsorg i forhold til kosthold og ernæring. Appetitus-appen søker å stimulere til matvalg som kan forebygge vekttap og underernæring. Denne avhandlingen utforsker gjennomførbarhet av å ta i bruk Appetitus i hjemmetjenesten for å støtte ernæringsarbeidet, og muligheter appen har for å støtte tidlige intervensjoner for å forebygge underernæring og håndtere ernæringsutfordringer blant hjemmeboende eldre.

Metode: Denne studien har et utforskende design, og vektlegger bruk av kvalitativ metode for å utforske erfaringene til eldre og helsepersonell som brukte Appetitus-appen (Artikkel I, II og III). I artikkel III kombinerte vi dette med kvantitativ metode for å utforske de Eldres brukermønstre i Appetitus-appen. Vi intervjuet 25 eldre som brukte Appetitus i en 8-ukers utprøving, og samlet loggdata om bruk direkte fra Appetitus-appen. Vi intervjuet 24 helsepersonell som ga opplæring og oppfølging til de eldre som brukte Appetitus i utprøvsperioden. Vi inkluderte også ledere som deltok i rekruttering og tilrettelagt for studien på de ulike utprøvsstedene i fokusgruppene.

Resultater: Flertallet av de eldre registrerte det de spiste og drakk i Appetitus-appen daglig eller flere dager i uken i utprøvsperioden. De eldre fortalte at personlig interesse for

ernæring og interesse for å delta i et forskningsprosjekt var faktorer som motiverte dem til dette. De som ikke brukte Appetitus regelmessig i utprøvningsperioden forklarte at de opplevde å ha dårlig helse, som påvirket deres bruksmønster i appen negativt. De opplevde også mindre personlig relevans av å bruke en kostholdsapp.

Mange av de eldre som deltok i studien ble inspirert til et mer variert kosthold da de brukte Appetitus. Gjenkjennelige og relevante måltidsforslag i kombinasjon med visualiseringen av måloppnåelse for energi, protein og væske i Appetitus stimulerte mange deltakere til å gjøre noen endringer i kostholdet. Flere eldre fortalte at de gjorde aktive matvalg for å sikre at de fikk tilstrekkelig protein eller energi i tråd med målsettingen som ble presentert i appen. Noen opplevde sjelden å komme nær måloppnåelser for energi, protein og væske i Appetitus. Da hadde visualiseringen en demotiverende effekt. De hadde ikke aktivt prøvd å gjøre noen endringer i kostholdet, som for eksempel å berike måltider, spise mer eller velge annen mat.

Helsepersonell opplevde at de eldre tok initiativ til samtaler om ernæring og viste mer interesse for kostholdet sitt. De fleste helsepersonell opplevde at deres oppfølging av ernæring ble styrket av Appetitus-appen fordi den gav dem en detaljert presentasjon av mat og måltidsvalgene til den enkelte pasient. Det gjorde det også lettere å foreslå endringer for å øke av inntak av energi, protein og væske. Helsepersonell fokuserte på å oppmuntre og gi kostholdsråd basert på de Eldres eksisterende kostholdsvaner. Noen helsepersonell hadde lav tiltro til egne ernæringskunnskaper, og dette ble en barriere for å gi ernæringsoppfølging slik at de fokuserte mer på teknisk oppfølging i stedet for ernæringsspesifikk oppfølging.

Konklusjon: Denne studien peker på muligheter for å implementere kostholdsapper i ernæringsarbeidet i hjemmetjenesten. Å skape eller ta i bruk løsninger som er inspirerende og enkle å bruke er viktig for at eldre skal være villige til å bruke kostholdsapper. Regelmessig oppfølging fra helsepersonell kan påvirke Eldres motivasjon for å bruke kostholdsapper, og registrere mat- og drikkeinntak over tid. Denne studien viste også at eldre som opplever å ha dårlig helse opplever det som mindre aktuelt å bruke slike verktøy regelmessig.

Appetitus-appen inspirerte de eldre til økt variasjon i kostholdet og mange tok mer bevisste matvalg. Appetitus er et eksempel på en velferdsteknologisk løsning de eldre selv kan bruke og som skaper økt fokus på kosthold og ernæring. Velferdsteknologi som støtter egenomsorg og mestring, og bevissthet hos den enkelte om gode matvalg i eldre år har stort potensial som tidlig intervensjon for å forhindre utvikling av underernæring. Studien peker på at slik teknologi også kan påvirke samspillet mellom helsepersonell og eldre, og påvirke til pasientsentrert omsorg og økt oppmerksomhet om helsefremming. Slike endringer er i tråd med politiske målsettinger om et økt fokus på helsefremmende aktiviteter fordi det er sentralt for å styrke Eldres egenomsorg og mulighet for å klare seg selv og bo hjemme.

List of publications

Paper I

Farsjø, C., Kluge, A. & Moen, A. (2019) Using a tablet application about nutrition in home care—Experiences and perspectives of healthcare professionals. *Health & Social Care in the Community*, 27, (3), 683–692. <https://doi.org/10.1111/hsc.12685>

Paper II

Aure, C.F., Kluge, A. & Moen, A. (2020) Promoting dietary awareness: Home-dwelling older adults' perspectives on using a nutrition application. *International Journal of Older People Nursing*, 15, (4), e12332. <https://doi.org/10.1111/opn.12332>

Paper III

Aure, C.F., Kluge, A. & Moen, A. (2020) Older Adults' Engagement in Technology-Mediated Self-Monitoring of Diet: A Mixed-Methods Study. *Journal of Nursing Scholarship*. Advance online publication. <https://doi.org/10.1111/jnu.12619>

The publications will be referred to in the text by their Roman numerals (I–III).

Abbreviations

APPETITT	APPLikasjon om Ernæring – TilTak for helse og Trivsel
App	Application, a program running on tablet computer or smartphone
Appetitus	The nutrition application developed in the APPETITT project
BMI	Body mass index
COPD	Chronic obstructive pulmonary disease
MNA	Mini Nutrition Assessment.
MNA-sf	Mini Nutrition Assessment, short form.
WHO	World Health Organization

1 Introduction

Currently, the western world is experiencing an ongoing demographic change defined by the combination of a growing population of older adults and decreasing birth rates (World Health Organization WHO, 2015). In Norway, it is expected that every fifth person will be over 70 years old by 2060, compared to the current one in eight. The expected growth is especially high in the oldest age groups: those over 80 (Thomas & Syse, 2020). The aging population is a story of success in terms of how western societies have systematically improved their citizens' living conditions through laws and regulations, safeguarding hygiene, knowledge building, and public education. In addition, high quality health services and medical advances play a major role in improving life expectancy, and more people live longer with chronic disease (Tønnessen, 2015). However, the shift in population composition is also a concern, as it is expected to become a socioeconomic burden for society (NOU 2011:11; WHO, 2015). In old age, the prevalence of chronic disease, functional decline, and poorer health experiences increase. Cardiovascular disease, cancer, diabetes, chronic obstructive pulmonary disease, dementia, and muscle and skeletal diseases are prevalent chronic diseases among older adults, and extensive comorbidity is associated with high cost for the individuals, their families, and society (Prince et al., 2015; Storeng et al., 2020).

Norwegian health policies promote reorganizing health care services from providing passive care towards providing care that supports the recipients in becoming more active participants and focusing more on health promotion and early interventions to manage health problems at the earliest possible time (Jacobsen, 2017; Norwegian Ministry of Health and Care Services, 2015; NOU 2011:11). This policy is strongly influenced by policy frameworks from the World Health Organization (WHO) developed to promote discussions and action plans to support active and healthy aging (Jacobsen, 2017; WHO, 2002, 2015). Healthy aging policy emphasizes the need for action in society to enable older adults to live active lives and remain a resource for their families, communities, and economies (WHO, 2015). Healthy aging is the focus in WHO's public health strategy on aging 2015-2030. WHO defines healthy aging as "the process of developing and maintaining the functional ability that enables well-being in older age" (WHO, 2015, p. 28). In this definition, healthy does not refer to a disease free state but rather to a more holistic health based on a life-course and functional perspective that focuses on the more subjective "well-being." Functional ability comprises the health-related

attributes that enable older adults to do what they value and what matters to them (WHO, 2015).

Aging in place is one of the most powerful policy strategies to support older adults to have active lifestyles that preserve social connections and that maintain independence and autonomy despite care needs (Meld.St. 15 (2017-2018); Vanleerberghe et al., 2017). Aging in place refers to individuals growing old in their current home (or appropriate housing), despite chronic illness and health decline. Health care services developed to support ageing in place aim to prevent or delay moves to a dependent facility, such as a nursing home (WHO, 2004).

Aging in place is desired by most older people (Vanleerberghe et al., 2017). Klugar et al. (2016) reviewed qualitative evidence of European older adults' perspectives on personal strategies to experience active and healthy aging. According to their results, older adults take an active approach to adapt to and cope with the daily struggles involved in their life in efforts to remain in their homes and be as independent as possible. They found that older adults remained mentally, socially, and physically active, as well as financially responsible as strategies to age in place (Klugar et al., 2016). However, aging in place may not be the goal or an opportunity for all older adults. Some may experience feelings of unsafety or worry when living at home with advanced chronic illness (Munkejord et al., 2018). Several chronic conditions are also associated with functional limitations and poorer general health experiences. These factors have been associated with moving older adults to institutions, such as nursing homes (van der Pers et al., 2018). Loneliness and social isolation is another factor that can affect older adult's perspective on aging in place (Munkejord et al., 2018). It is therefore acknowledged that older adults need support structures like family or friends and appropriate health care for "successfully" aging in place (Munkejord et al., 2018; WHO, 2015).

The authorities facilitate aging in place by delivering services like home health care and day care services to older adults. Services to support older adults' opportunities to live at home is also considered a cost-effective solution (NOU 2011:11; Vanleerberghe et al., 2017). Home health care services, day care for older adults with cognitive decline, and senior centers are well-established service offers in Norway and are available to all citizens independent of wealth or individual insurance (Lunde & Otterlei, 2020; Saunes et al., 2020). However, equity in access to these types of primary care services may be an issue in rural areas with long travel distances both for the older adults and health personnel (Moholt et al., 2020; Saunes et

al., 2020). Home care services provide help with medical related tasks, such as medicine administration and wound treatment. Providing help with daily personal care is also an essential part of the service offer; for example, help with meal preparation, getting out of bed and getting dressed, and toilet visits (Lunde & Otterlei, 2020). Home health care in Norway is not clearly defined, but services are assigned based on individual need assessments in relation to function and illness (Lunde & Otterlei, 2020).

To get ahead of the projected pressure on health care services that is expected to follow from demographic changes, Norwegian health policies encourage increased focus on health promotion in home care services to support older adult's opportunity to maintain health experiences and independence (Meld.St. 15 (2017-2018)). The core focus in health promotion strategies targeting older adults is the same as for the rest of the population: keeping a healthy diet and exercising regularly to maintain a healthy weight and prevent lifestyle diseases; vaccination; and screening to detect and manage disease early (Agarwal et al., 2013; Heflin, 2020; Hernandez & Johnston, 2017). Health promotion can also include strategies to manage health problems at the earliest possible time as many older adults have chronic conditions (Friedman et al., 2019).

Functional decline, disability, and dependence on others, which are commonly seen in old age and in relation to chronic conditions, can in many cases be prevented or postponed (Prince et al., 2015; Tak et al., 2013).

Physical activity can be both a measure to improve physical functioning and maintaining health experiences and independence in old age (Franzke et al., 2018; Macera et al., 2017; Tak et al., 2013). Studies show that replacing sedentary time with light activity may significantly reduce the risk of functional limitation among older adults (Tak et al., 2013; White et al., 2017). Likewise, dietary habits have been associated with health-related outcomes. A Finnish study from 2019 found that older adults who had a healthy Nordic diet, with high intake of fruits and vegetables, whole grain products and fish, and a moderate intake of sugar, full fat dairy produces, and red meat had lower likelihood of developing difficulties with self-care activities. They also experienced less mobility difficulties in a 10-year period compared to those who had lower adherence to a healthy Nordic diet at baseline (Perälä et al., 2019).

Changes in the body that are associated with normal aging, such as reduction in muscle mass and impaired sense of smell and taste, increase the risk of nutritional challenges among older adults (Ritchie, 2019). Obesity is widely acknowledged as a growing health threat in western society and as a major risk factor for chronic diseases and dependence in old age (Perreault, 2019). However, a growing body of evidence point to undernutrition as one of the most severe health challenges among older adults, especially among those connected to health care services, such as home care services (Cereda et al., 2016; Crichton et al., 2019). A recent meta-analysis reported an undernutrition prevalence rate of 14.6% (95% CI: 9.9–20.0%) among older adults receiving home care services (Crichton et al., 2019).

Undernutrition often starts subtly with appetite loss and small changes in diet (Fávaro-Moreira et al., 2016; van der Pols-Vijlbrief et al., 2017). In this way, it can slowly develop without being noticed before severe effects on physical and mental health. Studies have documented clear relationships between undernutrition, physical frailty, and increased mortality (Söderström et al., 2017; Verlaan et al., 2017). Although some studies have demonstrated that frail older adults who adjust their diet to include more energy and protein can prevent progression of functional decline, situations of manifest undernutrition can be hard to turn around and are severe threats to health experiences, well-being, and independence in old age and aging in place (Agarwal, 2019; Kim et al., 2013).

Factors such as social isolation and functional decline serve as risk factors for undernutrition but can also develop as a consequences of appetite loss and low food consumption, leading older adults into a downward spiral with declining health experiences and increased dependency (de Boer et al., 2013; Egbert, 1996; Fávaro-Moreira et al., 2016). It is therefore paramount to look for opportunities for early interventions to prevent older adults from entering a spiral of health decline and undernutrition (Agarwal, 2019; Egbert, 1996).

Home-dwelling older adults are largely autonomous in relation to their diet. Although many older adults receive some help with things such as grocery shopping or home-delivered meals, it is personal habits and preferences that largely control what people eat (Brug, 2008; van der Pols-Vijlbrief et al., 2017). Therefore, nutrition can be regarded as a very personal area and it can be a sensitive area for the health care professionals to step into (Hestevik et al., 2020).

Older adults who maintain an active lifestyle and who have a healthy diet can in many cases be motivated by knowledge about health benefits and opportunities to minimize risk for care

dependence (Bloom et al., 2017; Vesnaver et al., 2012). Social support structures and environmental factors are also recognized as having a significant influence on older adults' health behaviors (Klugar et al., 2016; Sallis & Neville, 2015; Zubala et al., 2017).

Increased use of technology can be a strategy to support innovation in care and enhance aging in place (Kim et al., 2017; NOU 2011:11). Older adults have indicated that technologies could serve as important tools to adopt to new life circumstances and limiting boundaries that often occur in old age, such as functional decline or chronic illness (Klugar et al., 2016). For example, the Internet can make information more available to older adults, and online shopping opportunities can reduce dependence on family (Chiu et al., 2019; Klugar et al., 2016). Technologies like stove guards and safety alarms are examples of welfare technologies that are widely implemented in Norway and which enable people to remain safe in their own home for longer, and they increase the experience of safety for older adults and their families (Berge, 2017).

Introduction of technologies in health care services can also challenge and enable older adults to take a more active role in their care. Health care professionals can in turn be challenged to be more proactive and focus on health promotion and prevention in meeting with older adults (Creber et al., 2016). One example of this is management of heart failure at home with support from welfare technology. Studies indicate that technological tools that support self-assessment of symptoms of the disease and self-care activities in combination with regular contact with health care professionals can lead to improved self-care abilities among patients with heart failure, such as higher adherence to taking medications as prescribed (Aamodt et al., 2020; Guo & Albright, 2018). In addition, health care professionals can become more attentive to decline in health states and intervene at an early stage. These are both important factors to prevent hospital readmissions among older adults with heart failure (Aamodt et al., 2020; Lind et al., 2016).

Despite the large potential, technology implementation in the health care sector can also be a source of concern among older adults, caregivers, and health care providers. Potential reduction in face-to-face communication, usability concerns, and data security are significant barriers for technology acceptance in this context (Kim et al., 2017; Lee & Coughlin, 2015).

In the same way that technology-based solutions can help in the self-management of chronic diseases, such as heart failure, there exists potential in using technology to increase awareness

among older adults and health professionals regarding dietary challenges in old age. For example, nutrition applications can increase people's awareness of dietary behaviors by offering immediate personalized feedback on food and beverage consumption (El Khoury et al., 2019; McCarroll et al., 2017). It can also be a powerful tool for health care professionals who provide care and professional advice to patients with nutrition challenges (Chen, Gemming, Hanning, & Allman-Farinelli, 2018). However, there is a scarcity of studies on the user acceptance and use value of technological self-management interventions intended for older adults covering undernutrition (Marx et al., 2018).

My PhD and the present study was part of a larger research project: APPETITT (*APplikasjon om Ernæring – TilTak for helse og Trivsel*). APPETITT was a regional funded innovation project (2015-2017) aiming to explore opportunities in technological solutions to create awareness of and prevent nutritional challenges among older adults. In the APPETITT project, a tablet application called Appetitus was developed and tested with older adults and health care professionals in home care services and in a senior center. The Appetitus app was developed for older adults to use, and content-wise, it encourages and provides advice on weight maintenance or weight gain.

1.1 Aim of the study

This thesis explores the feasibility of introducing Appetitus for nutrition care in home care and opportunities in supporting early interventions to prevent undernutrition and manage nutritional challenges among home-dwelling older adults.

1.2 Outline of the thesis

The APPETITT project and this thesis are influenced by healthy aging policy. Healthy aging policy focuses on promoting strategies that can enable older people to live active lives and be a resource for their family and their society. Good nutrition status is a core enabler for older adults' opportunities to age in place and maintain their independence. This is also the topic in this thesis.

In the background chapter (Chapter 2), I elaborate on strategies in the health care system considered central to support aging in place; health promotion, patient-centered care, and the introduction of welfare technology (Sections 2.1 and 2.2). In Section 2.3, I provide an

overview of nutritional challenges among older adults who live at home, with emphasis on protein-energy undernutrition. Section 2.4 describes the role of health care professionals in nutrition care and early interventions to prevent and manage undernutrition, and Section 2.5 addresses the use of technology in nutrition care.

In Chapter 3, I present the socio-ecological model. This model is the theoretical perspective used in this study.

The present study is comprised of three sub-studies, which are presented in original papers (Papers I–III). In Chapter 4, the overall aim of the study and specific aims for the three sub-studies are presented.

Chapter 5 is a presentation of the method and aims to provide the reader with an overview of the study. More detailed presentations of methods used in the three sub-studies are presented in the papers (Paper I–III).

In Chapter 6, I present the main results from the three sub-studies.

The discussion chapter (Chapter 7) includes three sections. In Section 7.1, I discuss the feasibility of the Appetitus app in home care settings. In Section 7.2, I discuss opportunities with the Appetitus app to support dietary behavioral change among home-dwelling older adults from a socio-ecological perspective. Section 7.3 is a discussion regarding the methodological approach in this study.

Finally, the conclusion and implications for practice and future research are presented in Chapter 8.

2 Background

Deployment of technology in home care is a political strategy to support older adults' opportunities to age in place (NOU 2011:11). Health care professionals can also support older adults' opportunities to remain active and participate in their full potential by emphasizing health promotion and early interventions to manage health problems at the earliest possible time (Meld.St. 15 (2017-2018)). Good nutrition status is a core enabler for preserving function and good health experiences in old age (Engdahl et al., 2019). Nutrition is therefore an important focus area in strategies that aim at supporting healthy aging and aging in place (Meld.St. 15 (2017-2018)).

In this chapter, I present the concepts of health promotion, patient-centered care, welfare technology, and nutrition to provide a background for understanding the APPETITT intervention and my analysis and discussion of the current study results. These concepts form the basis of this research.

2.1 Approaches to support aging in place

Norwegian policy documents indicate that to support older adults in remaining active and participating to their full potential, changes need to occur in the health care system (Meld.St. 15 (2017-2018); NOU 2011:11). Increased focus on patient-centered care and health promotion are among the core strategies suggested to reorient the health care systems in line with healthy aging policy (Meld.St. 15 (2017-2018); WHO, 2015).

2.1.1 Health promotion

Health promotion aims at supporting health experiences, well-being, and quality of life (Aglen et al., 2018). The WHO defines health promotion as “the process of enabling people to increase control over, and to improve their health” (WHO, 1987, p. 17). Health is in this context viewed as a resource to master and adapt to the challenges life presents (Aglen et al., 2018). Maintaining good nutrition status and being physically and socially active are considered important strategies older adults can engage in to maintain health experiences and age in place (Engdahl et al., 2019).

In health promotion strategies, the individuals' active participation in the decision-making processes is emphasized, as well as their own responsibility for their health (Aglen et al.,

2018; Nutbeam, 1998). It has been suggested that information enables people to take greater responsibility for their health (Mead & Bower, 2000; Mittelmark et al., 2017). Health care professionals can support older adults' uptake of information with efficient communication strategies and by collaborating with relatives and other health care professionals to create supportive environments (Constand et al., 2014; Mead & Bower, 2000; Mittelmark et al., 2017).

Older adults also believe that knowledge is a key factor that can help them better manage chronic conditions and gain greater control over their lives and health (McGilton et al., 2018). Older adults and their relatives call for increased focus on health promotion in the health care system (McGilton et al., 2018). They request more information in plain language so they can understand health-related information better. However, older adults also emphasize the role of relatives and health care professionals in facilitating and stimulating them to adopt health-promoting activities, such as increasing their physical activity or implementing dietary alterations (McGilton et al., 2018).

Senior center services in municipalities are an example of a health-promoting initiative with intention to support healthy and active aging (Håvelsrud et al., 2011). Senior center services aim to serve as social meeting places for older adults. Social isolation and loneliness are associated with increased morbidity and reduced health experiences in old age (Coyle & Dugan, 2012), as well as increased risk of undernutrition (Boulos et al., 2017). Several senior centers have food service and exercise groups, and some offer courses with a specific health-promoting focus. Although senior centers can promote social interaction and a more active lifestyle, scientific knowledge about the health effects of senior centers are scarce (Håvelsrud et al., 2011).

In this thesis, I refer to health promotion and prevention as intertwined concepts. However, it can be argued that health promotion and prevention needs to be considered as two fundamentally different strategies to support health experiences in old age. Health promotion focuses on supporting older adults to empower themselves and control their life and health, as well as adopting to changing circumstances of life (e.g. in relation to chronic disease) so they can experience coherence (Aglen et al., 2018). Health is in this perspective not viewed as absence of disease. Prevention is more directly connected to disease prevention and efforts to postpone or reduce the consequences of disease. The power to identify and recognize early signs of disease traditionally lie with the health care professionals and their expertise (Aglen

et al., 2018). Thus, a distinct difference exists between health promotion and prevention regarding the expert perspective, and the role of the older adults in their own health promotion. However, in the context of supporting healthy aging, a complementary approach where health-promoting work includes prevention strategies is timely (Friedman et al., 2019). It has been argued that it is especially relevant to have such a broad understanding of health promotion in the context of home care because many older adults who health care professionals meet in this context live with chronic conditions, such as heart failure, diabetes, and chronic obstructive lung disease (COPD) (Engdahl et al., 2019; Friedman et al., 2019). Preventing further worsening of these conditionings can be a measure to strengthen older adults' opportunities to age in place because far developed conditions are seen in relation to higher dependency levels (Prince et al., 2015; Storeng et al., 2020).

Building on older adults' resources and strengthening their abilities for self-care is considered a vital element in reorienting home care services to meet the increasing number of older adults who live with chronic conditions for many years (Tønnessen, 2015). The distinct focus in health promotion is on supporting peoples' own capacities and building on their resources so they can master their own life and health and maintain their quality of life. Examples of how health care professionals can apply a health-promoting focus to strengthen older adults' self-care abilities in relation to chronic conditions such as heart failure, diabetes, and COPD, is shown in telehealth interventions. Such interventions have proven to be opportunities to improve older adults with chronic conditions self-care abilities and quality of life as well as prevent worsening of conditions and hospital admissions (Creber et al., 2016; Guo & Albright, 2018). In this thesis, I explore opportunities with the Appetitus app to support early interventions to prevent undernutrition and manage nutritional challenges. Good nutrition status is a core enabler for health experiences, quality of life, and active participation in old age (Engdahl et al., 2019; Heflin, 2020). The APPETITT intervention, which consisted of the Appetitus app and support from health care professionals, had a health-promoting focus as it aimed to support older adults' health experiences by mobilizing their awareness, knowledge, and motivation for good food choices and healthy dietary self-care.

Nurses and other health care professionals have been criticized for traditionally focusing largely on disease management and management of complications following acute and chronic illness, which overshadow their abilities to center health promotion and early interventions to prevent health decline (Aglen et al., 2018; Gammersvik & Alvsvåg, 2009).

Health care professionals are criticized for primarily acting as experts and presenting solutions for older adults rather than working in collaboration with them to find good strategies to manage their health challenges as independently as possible. With this approach it is a challenge that older adults become passive recipients of care rather than being engaged in self-care and health promotion activities (Aglen et al., 2018).

In this research, strategies to support older adults' self-care in relation to nutrition and opportunities for them to be actors in their own care were emphasized. Patient-centered care is a practice model that opens opportunities for health care professionals to work according to health-promoting standards and that strengthens older adults' opportunities for active involvement and engagement in care.

2.1.2 Patient-centered care

Patient-centered care is a practice model that can enhance nurses and other health care professionals' health promotion strategies in clinical practice (Constand et al., 2014; Meld.St. 15 (2017-2018)).

There is lack of a universally agreed definition leading to numerous patient-centered care frameworks and models being described in the literature (Wilberforce et al., 2016). Several researchers have reviewed the literature to identify conceptual dimensions across the field (Constand et al., 2014; Lusk & Fater, 2013; Mead & Bower, 2000).

Understanding the person as a whole and exploring patients' experience of disease and illness and how it has affected their life is fundamental to patient-centered care (Constand et al., 2014; Lusk & Fater, 2013; Mead & Bower, 2000). Another important dimension is sharing power and strengthening patients' autonomy by involving patients in care decisions (Lusk & Fater, 2013; Mead & Bower, 2000). Patient-centered care models also emphasize the professional–patient relationship (Constand et al., 2014; Lusk & Fater, 2013; Mead & Bower, 2000). Developing partnership can be considered a goal in patient-centered care. Partnership can be developed through finding common ground, priorities, and goals of treatment (Mead & Bower, 2000). Furthermore, building good relationship with patients and their families is an important part of patient-centered care because this contributes to understanding what problems the patient is most concerned with and how their health decline has affected their life in total (Constand et al., 2014).

Efficient and good communication is a core value in patient-centered care (Constand et al., 2014; Lusk & Fater, 2013). Strategies such as active listening and goal developments have been identified as strengthening communication and supporting partnership (Constand et al., 2014; Mead & Bower, 2000). Good communication can also facilitate patients' uptake of health-related information, which is important to empower patients in decision making and to support good self-care and healthy life choices (Constand et al., 2014; Mead & Bower, 2000; Mittelmark et al., 2017). Health care professionals who provide compassionate and empowering care can contribute to the development of patients' autonomy and trust, and this has been identified as being crucial for effective communication (Constand et al., 2014; Lusk & Fater, 2013; Mead & Bower, 2000).

According to patient-centered care models, effective health promotion can be achieved if health care plans are tailored to the individual and reflect the individual patient health history and current concerns (Constand et al., 2014; Lusk & Fater, 2013).

Home-based reablement services can be viewed as an example of a patient-centered intervention focusing on health promotion (Cochrane et al., 2016). The primary goal of home-based reablement is that the older adults restore skills they perceive as important in their own everyday life. This can increase their independence in daily activities and enable individuals to age in place, be active, and participate socially (Førland & Skumsnes, 2016; Tuntland et al., 2015).

Home-based reablement has become central part of Norwegian home care services in the last decade (Førland & Skumsnes, 2016). These services are primarily offered to older adults who have experienced a functional loss, such as in relation to hospitalization (Førland & Skumsnes, 2016).

A Norwegian study investigating the effect of home-based reablement demonstrated that home-dwelling older adults with functional decline could improve their functioning in daily life and restore their independence (Tuntland et al., 2015). In their study, preparing food independently was one of the goals older adults prioritized highly, which indicates the significant value of self-reliance in relation to food for older adults. Home-based reablement is an example of how patient-centered care interventions aiming to support older adults' self-capacities and building on their resources can be a vital element in their self-care abilities and opportunities to age in place.

Health care professionals can support older adults' opportunities to age in place by emphasizing health promotion. Patient-centered care is a practice model that can strengthen the focus on promotion of patients' resources for self-care and healthy lifestyle choices.

2.2 Technology supporting aging in place

Deployment of technology in home care is part of a comprehensive strategy to support aging in place and innovate services to improve resource utilization and the quality of service provision (Frennert & Östlund, 2018; NOU 2011:11). Technology holds opportunities to implement solutions that enable people with disabilities and chronic illnesses to live safely at home and master their lives and health in the best possible way (Haukelien, 2020). It has been suggested that technology use in health care could improve people's access to care, ensure that they receive better information and support, and enable them to be more active participants in care (Frennert & Östlund, 2018; Solli et al., 2012).

In the Scandinavian context, the term welfare technology is used to describe the use of technology in the health care sector to support aging in place (Frennert & Baudin, 2019).

2.2.1 Welfare technology

Welfare technology is a broad term that encompasses use of technology in health care that can contribute to increase people's activity, participation, and feeling of safety, as well as promoting self-care and independence for people who have or who are at increased risk of developing a disability (Frennert & Östlund, 2018; NOU 2011:11).

Both in Norway and internationally, several other terms are used to describe technology use in the context of home health care. Assistive technology cover technologies that aim to improve individuals' functioning and independence, thereby promoting their well-being (Khasnabis et al., 2015). Assistive technology is a term that largely overlaps with welfare technology and, as with welfare technology, is frequently used in the contexts of home health care services for older adults with the aim of supporting aging in place (Frennert & Östlund, 2018).

Telehealth or telemedicine services covers use of electronic communication tools to offer consultations with health care professionals remotely or for remote rehabilitation, treatment, and management of chronic diseases (Knutshaug & Nakrem, 2017). Smart devices, m-health,

and mobile technology are examples of terms that refer to mobile solutions, such as sensors, to measure blood sugar or heart rate or exercise or nutrition apps for smartphones or tablet computers. Such technological solutions support collection and storage of health data, with opportunities for sharing with health care professionals. Such mobile solutions are similar to telehealth solutions, regarded as powerful tools to support self-management of chronic disease like diabetes (Knutshaug & Nakrem, 2017).

Based on the breadth of the term welfare technology, the Norwegian Directorate of Health have suggested a categorization of welfare technology based on the purpose of the technological devices being used. This categorization consist of four areas: 1) technology to support security and safety, 2) technology for coping with chronic disease and mobility limitations, 3) technology to support advanced health examination and remote treatment, and 4) technologies for wellness (Melting & Frantzen, 2016).

Technology to support security and safety and technology for coping with chronic disease are the two areas that have been focused mostly on in the development of welfare technological services in Norway (Haukelien, 2020; Melting, 2017). I present some examples of welfare technologies that are implemented in Norwegian municipalities from these two categories in the next two sections. Lastly, I present Appetitus in this welfare technological landscape.

Technology to support security and safety

Sensors that register movement, temperature and light, digital supervision at night, and stove guards are examples of technology to support security and safety. Such solutions can, for example, increase safety for older adults with cognitive decline who live at home and provide a sense of security for relatives and health care professionals responsible for care to the individual with cognitive decline (Melting, 2017). Such welfare technologies can also support resource-efficient home care services by reducing the frequency of human interactions (D'Onofrio et al., 2017). GPS tracking of people with dementia and safety alarms are technological solutions to increase security and safety for older adults who are well-established in home care services in Norway (Berge, 2017). Such welfare technologies can support aging in place and help those with less opportunities to make well-considered choices and decisions related to their own health due to cognitive impairment (Berge, 2017). However, embedding these technologies in home care services also gives rise to ethical

concerns regarding aspects, such as privacy and autonomy, and safety related to technical vulnerability (Sánchez et al., 2017).

Technology for coping with chronic disease

Electronic medicine dispensers are an example of welfare technology that can support coping with chronic diseases. Electronic medicine dispensers can replace the need for home care visits; for example, by giving older adults with memory problems daily reminders to take their medicines. If the reminder is not complied with, indicating that the medicine is not taken as planned, a notification can be sent to health personnel or relatives. For example, for persons with Parkinson disease who need to take medications multiple times a day and within a strict and set schedule to have optimal effect, a change from home nursing supervision to electronic medicine dispenser use can increase both the compliance with medication regimes and also have a significant influence on independence and opportunities for social and activity participation (Melting, 2017).

COPD and heart failure are other examples of chronic diseases where welfare technology has innovated the way health care services are provided in primary care settings. People with these chronic conditions have in some municipalities been offered access to welfare technological solutions for regular health monitoring in combination with solutions that support communication with health care professionals regularly and remotely (Intro International, 2018).

Studies have indicated that older adults can increase their self-care abilities and become more active participates in decision-making processes about their care when welfare technology is used as part of the service offer to manage chronic conditions, such as COPD and heart failure (Aamodt et al., 2020; Barken et al., 2017). This is also a central element in health care interventions focusing on health promotion.

Technology for wellness

Technologies for wellness is the fourth categorization of welfare technology from the Norwegian Directorate of Health. Technologies for wellness are described as solutions that help people become more aware of their own health and alleviate everyday chores without impaired health being the reason for the use of technology (Melting & Frantzen, 2016). The Appetitus app can be considered a relevant welfare technological solution within this area, as

it seeks to inform older adults about dietary choices in old age that can support health experiences, independence, and aging in place. This fourth category of welfare technology is thus also considered as having a health-promoting focus.

Technologies like nutrition apps are increasingly being used in health promotion interventions (Kampmeijer et al., 2016). The Appetitus app is intended for older adults who have cognitive and general health capacities to actively engage in self-care activities and who will most probably benefit from health promotion interventions.

2.2.2 Technology for health promotion interventions

There is a growing body of literature that points to the potential in using technology to support health promotion in older adults (Kampmeijer et al., 2016). As mentioned before, physical activity and proper diet are cornerstones in health promotion strategies across the life span (Agarwal et al., 2013; Hernandez & Johnston, 2017; Macera et al., 2017).

Several studies have targeted activity and diet challenges by introducing older adults to the Internet. Websites providing health information, such as in relation to healthy dietary habits in old age, online courses, and webinars with a health-promoting focus, are examples of interventions provided through the Internet (Olson, 2016). However, a review by Kampmeijer et al. (2016) indicated that publications increasingly report on the use of mobile apps as a technological intervention in health promotion programs (Kampmeijer et al., 2016). Mobile apps have considerable potential in health promotion interventions as they can support healthy lifestyle choices by providing personalized information and feedback on health related behavior (Hingle & Patrick, 2016; Olson, 2016).

Interventions targeting dietary behavior and physical activity often uses some form of self-monitoring in combination with goal setting, feedback, and knowledge provision (Bartels et al., 2019; Jonkman et al., 2018; Olson, 2016; Scott et al., 2018). For example, interventions that focus on increasing older adults' physical activity often use automatic activity measurement through a wearable device in combination with feedback on how the individual's activity level is compared to his/her individual goal or recommended activity levels. Many interventions also provide general health information, for example tips to implement more active minutes during a day. These interventions appear to be acceptable for older adults and result in increased physical activity, at least in the short term (Jonkman et al.,

2018). Technology-based health promotion interventions that focus on nutrition primarily target older adults in need of weight reduction (Kampmeijer et al., 2016). This is not surprising as many chronic diseases and functional limitations can be prevented through physical activity or maintenance of a healthy weight (Macera et al., 2017; Perreault, 2019). However, this also indicates that the challenge of undernutrition among older adults is rarely considered in health promotion interventions targeting them.

2.2.3 Factors affecting older adults' adoption of technology

Older adults' adoption of welfare technology does not solely depend on the design of the technology but involves multiple aspects, including the individual motivation to use technology and support structures when the technology is introduced to care services (Lee & Coughlin, 2015).

Individual factors and considerations that affect older adults' adoption of technology

Older adults often make a thorough consideration before they adopt welfare technology (Larsen et al., 2019). Studies have indicated that older adults' willingness to use technology in general and health technologies in particular often depends on their interest, perceived personal need for the technology, and expected benefits (Lee & Coughlin, 2015; Liu et al., 2016; Matthew-Maich et al., 2016). For example, a recent survey of Norwegian older adults' technology use revealed that the main reasons for not using the Internet included lack of interest and also no need for Internet because they managed well without it (Sletteameås et al., 2018). However, older adults also display positive attitudes towards adopting technology that can support them in becoming more informed on and managing their own health optimally (Howard et al., 2020). In many cases, welfare technology provides opportunities to strengthen older adults' independence. For example, in relation to medicine handling, and thus a perceived personal need for and value of the welfare technology can enable its adoption and use (Larsen et al., 2019).

Furthermore, if the welfare technology is perceived as a beneficial solution to the specific challenges older adults experience in their daily life, it is likely to be accepted by the user (Howard et al., 2020). For example, older adults display high acceptance to fall detection sensors and other smart home technologies as they experience increased safety, independence, and confidence through the technology and thus consider it as enabling aging in place (Berge,

2017; Liu et al., 2016). However, maintaining the use of welfare technology over time can be threatened by low usability, the stigma of using welfare technology, or the technology simply failing to provide the intended support they need (Howard et al., 2020; Larsen et al., 2019). This is especially the case with technologies that require active engagement from older adults, such as nutrition apps or telehealth solutions (McCarroll et al., 2017).

High cost and privacy concerns are other major hindrances to a positive attitude towards health technology adoption among older adults (Howard et al., 2020; Lee & Coughlin, 2015; Liu et al., 2016; Sánchez et al., 2019). In addition, older adults express concerns about whether or not they will be able to use the technology properly and if it will interfere in their daily life in a negative way (Howard et al., 2020; Peek et al., 2014; Wildenbos et al., 2018). The digital divide between older and younger generations is decreasing, especially in those aged under 75 (Sletteameås et al., 2018). However, among the oldest adults and those with disabilities, the use of new technology and the Internet remains low (Anderson & Perrin, 2017; Keränen et al., 2017).

Cognitive decline is a barrier to adopting new skills in general and can negatively impact many older adults' opportunities to become active Internet and technology users (Wildenbos et al., 2018). However, cognitive decline and dementia are prevalent among older adults (Prince et al., 2015). Consequently, there is a large group of older adults that are less likely to be included and benefit from several of the technological advancements in the health care sector, which demands active use of welfare technologies from them as end-users. However, another pervasive perspective related to the use of welfare technology is that the technology can support more continuous monitoring of older adults and thus help to secure them while aging in place. Fall detection sensors or sensors on exit doors that can alert in case of an event are examples of such technologies (Knutshaug & Nakrem, 2017). Such technologies are relevant for older adults with cognitive decline and dementia as they do not require active engagement in the technology on their part.

Since older adults are more likely to adopt welfare technology when they perceive its usefulness and potential benefit, developing technologies that target relevant issues for them and communicating how the technology can support their independence and aging in place are crucial (Lee & Coughlin, 2015).

Design aspect of the technology that affects adoption

Technology interface can affect uptake by limiting or strengthening the users' confidence when interacting with technology (Takemoto et al., 2018). Touch screen devices, such as tablet computers, have less complex interface compared to regular computers and are considered more intuitive and easy to use (Ramprasad et al., 2019; Vaportzis et al., 2018). However, research has demonstrated that the design of the apps running on touch screen devices are also crucial to older adults' perception of user friendliness (Hingle & Patrick, 2016). Positive user experiences can be supported by apps with larger icons that are supported by text, good contrast, appropriate text size, simpler device menus, and app navigation that relies less on memory (Al-Razgan et al., 2012; Takemoto et al., 2018). In particular, among older adults who lack experience with technology, these features can be highly influential for technology acceptance (Howard et al., 2020; Wildenbos et al., 2018).

Support structures

For older adults, receiving technical assistance is essential when learning to use a new technology, as well as having someone to ask for help in later stages of use (Kampmeijer et al., 2016; Lee & Coughlin, 2015; Wildenbos et al., 2018).

Family or other social networks often have a positive influence on older adults' adoption of modern technology, such as smartphones and tablet computers (Slette-meås et al., 2018). They make older adults aware of the relevance of such technologies, and they also provide guidance in use and assists with installations and software updates (Slette-meås et al., 2018). However, many older adults express concern about being a burden to their family in terms of requiring support when adopting technologies, including welfare technologies (Lee & Coughlin, 2015; Peek et al., 2014).

When welfare technology is implemented and used in the home care settings, health care professionals play a vital role in providing support to end users (Haukelien, 2020). This takes the form of technical support, as well as professional support (Konttila et al., 2019). Welfare technological services are not stand-alone technical devices that support independence, self-care, and safety, but rather technological solutions integrated with health care professionals' support and competence (Kleiven, 2017).

Introduction of welfare technology in the health care sector is often met with a combination of positive attitudes and resistance from health care professionals and managers (Frennert &

Baudin, 2019; Gagnon et al., 2012; Nilsen et al., 2016). Perceived usefulness is an important facilitator for implementation of welfare technology in health care, both from the perspective of health care professionals and older adults (Gagnon et al., 2012; Howard et al., 2020; Konttila et al., 2019). Some health care professional gain motivation in their work when welfare technologies become part of their work day, as it opens opportunities for professional development (Konttila et al., 2019). However, fear of more work on top of an already heavy workload can lead to resistance among health care professionals (Gagnon et al., 2012; Haukelien, 2020).

Health professionals' resistance may also be influenced by fear that the technology becomes a threat to existing practice and fear of degraded quality in the services they provide (Kleiven, 2017; Konttila et al., 2019). Research has indicated that when technology is implemented in health care, new practice forms occur and interaction patterns among health care professionals and between health care professionals and patients may change (Frennert & Baudin, 2019; Gagnon et al., 2012; Lyngstad et al., 2014; Nilsen et al., 2016).

Although implementation of technology holds promise to reorganize services so they become more resource efficient, evaluations and research suggest that at least the implementation phase is resource demanding and often underestimated (Haukelien, 2020). Getting support in the form of practical training and organizational support with resources, such as sufficient time and collegial support, are factors identified as facilitating the adoption of welfare technologies (Gagnon et al., 2012; Konttila et al., 2019).

Lack of technological experience in staff groups can be a barrier for implementation of welfare technology (Konttila et al., 2019). In addition, the support system around health care professionals are often weak, as technological infrastructure in municipalities and primary health care services are not adopted to rapid technology development (Frennert & Baudin, 2019; Gagnon et al., 2012; Haukelien, 2020).

Since older adults often are in need of technical and professionals support when introducing welfare technology, it is vital to ensure that health care professionals possess the right competence and motivation to support them and that they are allocated resources to provide older adults with the support and follow-up they need to become comfortable with using the technology.

2.3 Nutrition in older adults

Research indicates a connection between the food we eat and independence and disease development in older years (Perälä et al., 2019). Good nutrition status is considered fundamental for opportunities to experience healthy, active aging (Verlaan et al., 2017). To maintain a good nutrition status, having a varied diet to ensure sufficient intake of all essential nutrients and a good energy balance in the diet are crucial (Sortland et al., 2011).

Unfortunately, with old age, the risk of imbalance in food intake increases (Jadczak & Visvanathan, 2019). Studies have repeatedly uncovered the extensive prevalence of malnutrition or its risk among older adults (Cereda et al., 2016; Kaiser et al., 2010). Malnutrition as a term embraces a wide variety of nutrition challenges, including obesity, undernutrition, and vitamin deficiency (Cederholm et al., 2017). Both obesity and undernutrition are prevalent nutrition problems among older adults and are linked to increased morbidity and mortality (Perreault, 2019; Ritchie, 2019).

The focus in this thesis is on undernutrition. Undernutrition can be defined as follows:

a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease. (Cederholm et al., 2017, p 51)

The term undernutrition further refers to the specific challenge often seen in older adults with unintended weight loss and protein and energy undernutrition as a consequence of insufficient food consumption (Agarwal et al., 2013). Undernutrition can also be caused by disease-associated factors, such as acute or chronic inflammation. Undernutrition associated with disease or injury develops as a consequence of the combination of reduced food intake and inflammatory mechanisms (Cederholm et al., 2019).

Undernutrition is a multifactorial problem where several different factors play a role (de Boer et al., 2013). Poor appetite is often an early sign of undernutrition and a significant influencer of low food consumption, leading to insufficient energy and protein consumption (Ritchie, 2019; van der Pols-Vijlbrief et al., 2017).

With advancing age, there are several factors that make older adults vulnerable to loss of appetite and low food consumption. Reduced taste and smell, changes to the indigestive

process, and reduced activity are among the most common factors (de Boer et al., 2013). Acute and chronic illness also contribute to making older adults vulnerable for unintended weight loss and undernutrition (Jacobsen et al., 2016). Many older adults take medications, and common side effects of medications are mouth dryness, nausea and obstipation which can create additional problems related to food intake (Host et al., 2016; Ritchie, 2019).

Experiences of loneliness can be associated with reduced food enjoyment and consumption (de Boer et al., 2013; Jadcak & Visvanathan, 2019). Impaired mental health and cognitive impairment are likewise associated with increased risk of undernutrition in older adults (Fávaro-Moreira et al., 2016; Kvamme et al., 2011).

For older adult, the consequences of undernutrition can be very intrusive and can lead to poorer quality of life (Rasheed & Woods, 2013). However, the early symptoms of undernutrition and consequences on health are tend to be gradually developing, and are often unspecific. Undernutrition are therefore not always perceived as affecting daily life to any relevant extent and consequently, many older adults do not consider this a relevant area for them to focus on (Piantadosi et al., 2015; van Doorn-van Atten, Haveman-Nies, et al., 2019).

However, reduced physical abilities are often associated with undernutrition in old age, and the two are interrelated (Fávaro-Moreira et al., 2016). Too little supply of energy and protein in the diet manifests in loss of muscle mass and fat and reduced muscle strength (Jadcak & Visvanathan, 2019; Sortland et al., 2011). Chronic conditions that are common in old age, such as heart and lung disease and musculoskeletal disorders, can lead to reduced physical abilities and energy loss. This may hinder grocery shopping or food preparation (van der Pols-Vijlbrief et al., 2017). A person with a chronic illness might have to portion out their energy throughout the day. In practice, this can mean that after the morning care, they have to rest before acquiring the energy for preparing and eating breakfast.

Acute illness might lead to reduced food consumption for some days, for example in connection with hospital stays (Patel & Martin, 2008; Sortland et al., 2011). As opposed to younger people who have their appetite regulated and regain weight after a period of acute illness, older adults are likely to continue to eat less after a period of decreased consumption, and the weight loss can be permanent (Ritchie, 2019). A period of acute illness can therefore lead older adults into a downward spiral of weight and function loss (Agarwal, 2019; Egbert, 1996).

Cereda and colleagues (2016) performed a meta-analysis of prevalence data using the Mini Nutrition Assessment (MNA). This review of undernutrition and undernutrition risk found that undernutrition prevalence was directly correlated with the level of dependence associated with care settings (Cereda et al., 2016). The prevalence was highest among patients in long-term care and rehabilitation care institutions, with an average prevalence of undernutrition of nearly 30%. Among community living older adults, the prevalence of undernutrition was much lower at an average of 3.1% (Cereda et al., 2016). Undernutrition prevalence in older adults who receive home care services is higher compared to those who live at home and do not receive any help (Cereda et al., 2016; Crichton et al., 2019). Cereda and colleagues found that 8.7% (95% CI: 5.8–11.7) of older adults who received home care services were malnourished according to the MNA, and 46.6 % (95% CI: 39.2–54.1) had risk of undernutrition. Studies from Norway show the same trend: namely, that the occurrence of malnutrition and the risk of malnutrition are intertwined with dependency and care level (Jacobsen et al., 2016; Kvamme et al., 2015; Söderhamn et al., 2011).

The majority of older adults want to live at home (Berge, 2017; Klugar et al., 2016; Vanleerberghe et al., 2017). Having a balanced, healthy diet and being physically and socially active are important self-care strategies for older adults who can counteract dependence in old age (Engdahl et al., 2019; Heflin, 2020). Changes in dietary and physical activity habits can contribute to better health experiences, also when changes are implemented in old age (Agarwal et al., 2013; Kim et al., 2013; Macera et al., 2017).

Older adults view diet as an important aspect of keeping their independence and staying healthy, and this can have a protective effect because it can motivate maintaining healthy habits, such as preparing and eating hot meals (Bloom et al., 2017; Vesnaver et al., 2012; Winter et al., 2016). However, widowhood, illness, and functional decline make many older adults vulnerable to abandoning good dietary routines and habits (van der Pols-Vijlbrief et al., 2017). Widowhood or other losses in the social network often have severe consequences on food enjoyment and cooking patterns, and adjusting habits to meet the new life form of more solitary meals can be a challenge for many (Bloom et al., 2017).

Dietary patterns are often established in young age, and many older adults refer to learning in their childhood homes what to eat and how to prepare meals (Bloom et al., 2017; Locher et al., 2009; Winter et al., 2016). However, media coverage and social networks are important influencers for dietary habits over the lifespan (Bloom et al., 2017; Winter et al., 2016). The

media often convey contradictory health and nutrition messages, and this can lead to nutrition confusion (Nagler, 2014).

It is a concern that older adults frequently lack awareness of the importance of maintaining their weight as a self-care activity in old age (Winter et al., 2016). Body mass index (BMI) is a common way to measure body composition. Healthy body weight in relation to height are commonly defined as BMI between 18.5 and 24.9 for adults, as this is associated with reduced mortality risks (Meyer & Vollrath, 2017; WHO, n.d.). However, there is a growing consensus that higher BMI levels are more protective for older adults (Cederholm et al., 2015). Research has shown that older adults have a lower mortality risk when they have BMI levels between 23 and 29 (Winter et al., 2017). However, studies suggest that older adults do not have sufficient or balanced knowledge of what is considered a healthy body mass index in old age and how unintended weight loss can start to impact their health negatively (Beelen et al., 2017; Craven et al., 2018; Winter et al., 2016).

For older adults who receive home care services, inadequate intake of food and beverages are considered a primary mechanism for unintended weight loss and development of undernutrition (Shlisky et al., 2017). Older adults who are undernourished can enter a negative, downward spiral of undernutrition, which leads to reduced energy levels and even lower food intake, thereby aggravating the situation (Agarwal, 2019; Fávoro-Moreira et al., 2016). It is therefore paramount to focus on health promotion strategies and look for opportunities for early interventions, which can prevent undernutrition from developing.

Screening for undernutrition risk is important to identify those at risk and are fundamental in early nutrition intervention strategies (Volkert, et al., 2019). In the context of home care, many older adults also receive practical help with food delivery and meal preparation. Nurses and other health care professionals can play crucial roles in early treatment of undernutrition if they learn how to implement diet modifications so the diet becomes more nutrient dense (Findalen et al., 2012; Rea et al., 2019). Nursing interventions in the area of nutrition care can also include education and nutritional counseling strategies (Rea et al., 2019; Vasiloglou et al., 2019).

2.4 Early interventions to prevent and manage undernutrition

Providing nutrition care can be considered as one of the primary responsibilities of nurses and other health care professionals in the health care sector (Guttormsen et al., 2009). Several guidelines have been published in the last decade to support the nutrition care process in hospitals and primary care, including home care. These guidelines are meant to support nutrition practice that are in line with up-to-date research and clinical expertise in the field (Guttormsen et al., 2009; NICE Guideline, 2006; Volkert, et al., 2019).

Early identification of risk for undernutrition is a key factor to stop and reverse an initial nutritional challenge (Guttormsen et al., 2009; Hickson, 2006). Initial symptoms of undernutrition are often subtle, nonspecific, and difficult to recognize (Agarwal et al., 2013). Diagnostic criteria for undernutrition are based on unintended weight loss as a long term indicator and insufficient intake of nutrients as a short term indicator (Guttormsen et al., 2009). Low BMI can also be a criteria for undernutrition diagnosis (Cederholm et al., 2015; Guttormsen et al., 2009). A person who has lost 5% of their weight in the last 2 months is considered undernourished, but he or she can still have a BMI within “normal” range or even within the obesity range (Agarwal et al., 2013; Guttormsen et al., 2009). Undernutrition is therefore not always visible to the naked eye. Structured assessment of undernutrition with screening tools and regular weighing are therefore recommended strategies to identify undernutrition risks early (Guttormsen et al., 2009; Volkert, et al., 2019).

The most commonly used screening tool that has been developed and validated for older persons is the Mini Nutritional Assessment-short form (MNA-sf) (Vellas et al., 1999; Volkert, et al., 2019). However, there are several other screening tools that are validated and used to screen for undernutrition risk in older adults, many are adopted for a specific setting, such as hospital setting (Gjerlaug et al., 2016; Guttormsen et al., 2009).

Performing a systematic assessment and implementing individualized intervention if the screening results suggest that the person is at risk of or undernutrition or undernourished is recommended (Volkert, et al., 2019). A systematic assessment includes considering underlying causes of undernutrition and identifying preferences and resources of the individual, as well as dietary intake monitoring. Such a systematic assessment will lay the foundation for the planning of individualized interventions (Volkert, et al., 2019).

Treatment of underlying causes, such as medical illness or mouth and teeth problems, is recommended as the first step in a treatment plan (Volkert, et al., 2019). Furthermore, focus must be placed on nutrient intake (Volkert, et al., 2019). Nutrition interventions can focus on improving or increasing individuals' intake and variety of food and nutrients. Early alteration in the diet can turn a situation of nutritional deficiencies. Simply enriching diet with protein and fat and increasing meal frequency is a good start (Guttormsen et al., 2009; Morilla-Herrera et al., 2016). Two common strategies to achieve this goal include nutrition education and increasing food access and availability (Zhou et al., 2018).

Nutrition interventions emphasizing diet advice can provide increased knowledge about adequate nutrition and can improve nutrition status among older adults (Astrup & O'Connor, 2018; Rea et al., 2019). A patient-centered approach has been identified as the best method of providing nutritional counselling (Vasiloglou et al., 2019). The literature indicates that nutritional counseling from registered dietitians is more effective compared to follow-up from other health care professionals, such as nurses or general practitioners. However, nurses and other health care professionals are also vital and have the benefit of regular interactions with patients in primary care as well as a comprehensive understanding of their life situation, which can facilitate a patient-centered approach (Chen et al., 2018; Vasiloglou et al., 2019).

A recent review suggested that providing nutrition support in the form of fortifying meals and oral nutritional supplements (e.g. sip-feeds) to patients who were undernourished or at risk of undernutrition was associated with improved nutritional and clinical outcomes (Gomes et al., 2019). Home-delivered meal programs are another intervention strategy that can improve diet quality and increase nutrient intake among home-dwelling older adults (Zhu & An, 2013).

Although nutrition care is a core responsibility of nurses and other health care professionals and although there has been more systematic focus on this topic with the introduction of guidelines, the research still suggests that nutrition care practice has potential to improve (Fjeldstad et al., 2018; Fleurke et al., 2020; The Norwegian Directorate of Health, 2020). Studies reveal that nurses and other health care professionals lack awareness of the magnitude of undernutrition as a challenge and all the severe consequences it can have on patients' health experience and daily functioning (Beelen et al., 2017). Health professionals' nutrition knowledge are scarce, and they often provide less focus and priority to nutrition-related care activities compared to other medical-related care activities (Bauer et al., 2015; Hestevik et al., 2020; Mowe et al., 2008; O'Connell et al., 2018). In addition, a lack of routines and support

systems at an organizational level to support good nutrition practice in Norway has been reported (Aagaard & Grøndahl, 2017; Eide et al., 2015; Paulsen et al., 2019).

Since good nutrition status can be vital for older adults' health experiences and opportunities to age in place, it is critical to emphasize more early interventions in the health care sector and to support health care professionals with tools and organizational resources that can facilitate such practices.

2.5 Nutrition apps: Tools to support dietary behavioral change

Nutrition apps can be important tools in nutrition care practice because they open up opportunities for people to learn, as well as monitor food and beverage intake. Such self-monitoring can increase awareness of behaviors and can strengthen individuals' opportunity for diet self-management (Chen et al., 2018; Hingle & Patrick, 2016).

There are a number of commercially developed nutrition apps on the market (Chen et al., 2015; Hingle & Patrick, 2016). However, commercially developed nutrition apps usually support weight control and dieting and are therefore considered less relevant for older adults with undernutrition challenges or health care professionals who work with this patient group (Hingle & Patrick, 2016). Researchers have indicated an absence of scientific and health professionals guiding the design and development of commercially available nutrition apps. This is considered disconcerting, as it results in apps that do not embed evidence-based knowledge and strategies to support behavioral change (Chen et al., 2015; Olson, 2016). For example, health advice and information about unhealthy eating and more healthful alternatives to increase user focus on self-care management and integration of behavioral change techniques are less common features in commercially developed nutrition apps (Chen et al., 2015). This can be considered a limitation in commercially developed apps, since it is recognized as important elements in successful dietary behavioral change interventions.

Nutrition apps have become a common delivery mode in health care supported nutrition interventions (El Khoury et al., 2019; McCarroll et al., 2017; Olson, 2016). Dietary interventions aiming to prevent or manage obesity and chronic diseases, such as diabetes and heart and kidney disease, are areas in which most research has been undertaken and for which most nutrition apps have been developed within the scientific community. Several

interventions have a combined focus on nutrition and physical activity or nutrition and disease-specific monitoring (El Khoury et al., 2019; Kiss et al., 2019; McCarroll et al., 2017). However, there is a scarcity of studies that have studied nutrition apps to target undernutrition (Marx et al., 2018).

Nutrition apps often support individual goal setting for energy consumption and nutrients in combination with opportunities for the user to monitor their diet and receive instant feedback related to goals (Hingle & Patrick, 2016; Olson, 2016). Goal setting is a core element in behavioral change interventions (Bodenheimer & Handley, 2009). An important role of dietitians and other health care professionals that work with nutrition interventions is helping individuals identify realistic goals for dietary change in light of their current dietary pattern and life situation (Chen et al., 2018). Such personalization of goals is critical for sustained engagement in behavior change. However, opportunities for personalization of goal setting in nutrition apps vary (Chen et al., 2018).

Recording of food and beverage consumption in apps, as well as more traditional paper-based methods, can be considered burdensome, and dietary self-monitoring adherence declines over time (Bonilla et al., 2015; Chen et al., 2018; McCarroll et al., 2017). Combining diet self-monitoring with follow-up from health care professionals is therefore recommended because it can strengthen motivation and commitment over time (Bonilla et al., 2015; El Khoury et al., 2019). Another well-known challenge with dietary self-monitoring is related to inaccuracy. It is connected to difficulties in estimating portion size and remembering to record everything eaten or drunk (Subar et al., 2015). This is the case in both technology-supported and paper-based dietary self-monitoring. Many apps have imbedded bar code scanning and other semi-automatic features to ease the process of food and beverage recording (Chen et al., 2015; Chen et al., 2018).

Dietary goals and advice for prevention of undernutrition differ greatly from those for weight loss. As a result, the literature has indicated that nutrition apps with a specific focus on achieving adequate intake of protein and energy to maintain or increase weight are needed for older adults (Hingle & Patrick, 2016; Scott et al., 2018).

2.5.1 Technology-supported interventions to target undernutrition

Marx and colleagues (2018) reviewed the literature on the efficacy of telehealth intervention to manage malnutrition in community dwelling older adults. In this review, telehealth was classified as the delivery of health care services from a distance using telecommunication techniques. The authors conclude that telehealth intervention was likely to result in clinical improvements in older adults with malnutrition. The meta-analysis revealed that telehealth interventions were effective in improving protein intake and quality of life among participants. The authors also report a positive trend towards improved energy intake, nutrition status and physical function with telehealth interventions. Readmission rates and mortality also decreased in the intervention groups (Marx et al., 2018). Many of the interventions focused on providing individualized advice on how the older adults could improve their diet, and particular their energy and protein consumption. The older adults included in the studies received closer follow-up support compared to the control groups and compared to regular nutrition practice in primary care settings.

In this review telephone consultations with dietitians was the most common way of delivering telehealth interventions to older adults, and only a few have studied feasibility of using technology supported diet self-monitoring, e.g. nutrition apps, in interventions targeting undernutrition among community dwelling older (Marx et al., 2018).

We have found three feasibility and pilot studies that focused on undernutrition and older adults and that required older adults to actively use technology for diet self-monitoring as part of a nutrition intervention (Kraft et al., 2012; Lindhardt & Nielsen, 2017; van Doorn-van Atten, Haveman-Nies, et al., 2019). In these studies, older adults were asked to record their weight, appetite, or selected items in their diet with technology as part of a nutrition intervention (Kraft et al., 2012; Lindhardt & Nielsen, 2017; van Doorn-van Atten, Haveman-Nies, et al., 2019).

These three studies indicated that recruitment to these types of studies was challenging and that dropout was high. This is mainly explained by poor health experiences and by the fact that the interventions were considered burdensome, but dropout was also seen in relation to poor usability experience of the technical device (Kraft et al., 2012; Lindhardt & Nielsen, 2017; van Doorn-van Atten, Haveman-Nies, et al., 2019). It was reported in all three studies that the older adults needed close follow-up with use of the technological device to overcome technological barriers. In addition to low technological experience among older adults, this

can also be seen in relation to the technology being unstable and immature (Kraft et al., 2012; Lindhardt & Nielsen, 2017; van Doorn-van Atten, Haveman-Nies, et al., 2019).

However, a study of Astell et al. (2014) indicated the feasibility of engaging older adults in comprehensive diet self-monitoring if the technology is stable and user friendly. In their study, home-dwelling older adults recorded food and beverage consumption in an app developed by the research team for a total of 3 weeks in a 12-week intervention period. The authors indicated that older adults were comfortable using technology to record what they ate and drank (Astell et al., 2014). The older adults did not receive feedback on diet directly from the app in this study, which suggested their high commitment to the project.

These studies show that although recruitment can be a challenge, motivating older adults in nutrition-related self-care activities through technology is feasible. This conclusion is in line with a growing body of literature that demonstrate potential in using technology to support health promotion in older adults, as they are able and willing to use technological innovations in health, and mobile apps in particular (Matthew-Maich et al., 2016; Wildenbos et al., 2018).

However, older adults' dietary behavior and engagement in technology-mediated interventions are likely to be influenced by multiple factors, such as their health condition, support structures, and the individual's attitudes toward change (Chen et al., 2018; Host et al., 2016; Lindhardt & Nielsen, 2017; van Doorn-van Atten, Haveman-Nies, et al., 2019).

Applying a multilevel approach in research is recommended to capture the complexity in interventions targeting behavioral change (Sallis & Neville, 2015).

The socio-ecological model can be a tool to explore influences on behavior from the individual perspective, as well as from a broader environmental context (Sallis & Neville, 2015). A socio-ecological approach is considered suitable to guide nutrition intervention research because eating is influenced by factors on several levels (Sheats et al., 2015). I will discuss the socio-ecological model further in the next chapter.

3 The socio-ecological model

The socio-ecological model can be a tool to help broaden the perspective on factors that influence people's health-related behavior in general and food choices in old age (Locher & Sharkey, 2009; Sallis & Neville, 2015). Key features of the socio-ecological model include the multiple levels of influence on health behavior and their interdependence (Sallis & Neville, 2015). The model suggests the need to broaden perspective beyond the individual or microlevel factors such as knowledge, motivations, and beliefs, and include the environmental context when trying to understand what influences health behavior (Sallis & Neville, 2015). The environmental context includes both mesolevel influences, such as family and local community, and macrolevel influences, such as policy, laws, and regulations (Sallis & Neville, 2015).

The socio-ecological model is considered suitable for guiding nutrition intervention research, because food choices and dietary habits are based on complex interactions between social and environmental contexts, the individual, and the food (Brug, 2008; Host et al., 2016; Locher et al., 2009; Sheats et al., 2015). The socio-ecological perspective has been central to health promotion practice for several decades (Sallis & Neville, 2015) and can also bring merit to early interventions that can prevent undernutrition and that support opportunities for aging in place (Locher & Sharkey, 2009; Sheats et al., 2015). The socio-ecological approach is appropriate and helpful in this thesis because it contributes to a multilayered perspective in exploring the feasibility of introducing *Appetitus* for nutrition care in home care as well as opportunities in supporting early interventions to prevent undernutrition and manage nutritional challenges among home-dwelling older adults.

In the process of developing an intervention and planning for evaluation, it is important to specify factors within the micro-, meso-, and macrolevels that can influence the specific health behavior the intervention targets (Sallis & Neville, 2015). In this thesis, I have taken inspiration from Booth and colleagues' (2001) socio-ecological model of influences of diet and physical activity. Interventions to promote healthy diet have traditionally targeted microlevel factors such as personal knowledge and motivation (Sahyoun et al., 2004). Although such interventions can be feasible to implement and can lead to improved nutrition-related knowledge among older adults, the long-term effects in regards to behavioral change are questionable (Booth et al., 2001; Locher & Sharkey, 2009; Sahyoun et al., 2004). Therefore, the next step towards developing successful interventions to support more

longstanding healthful food intake includes considering environmental factors that are likely to influence people’s behavior (Brug, 2008; Locher & Sharkey, 2009; Sahyoun et al., 2004). Booth and colleagues addressed this by developing a comprehensive ecological model that identified individual, social, environmental, and policy variables that are hypothesized to affect physical activity and eating behaviors (Booth et al., 2001).

The socio-ecological model for dietary choices (Figure 1 below) illustrates factors at micro-, meso-, and macrolevels, which are considered specifically relevant as influencers of older adults’ dietary choices in the context of this study.

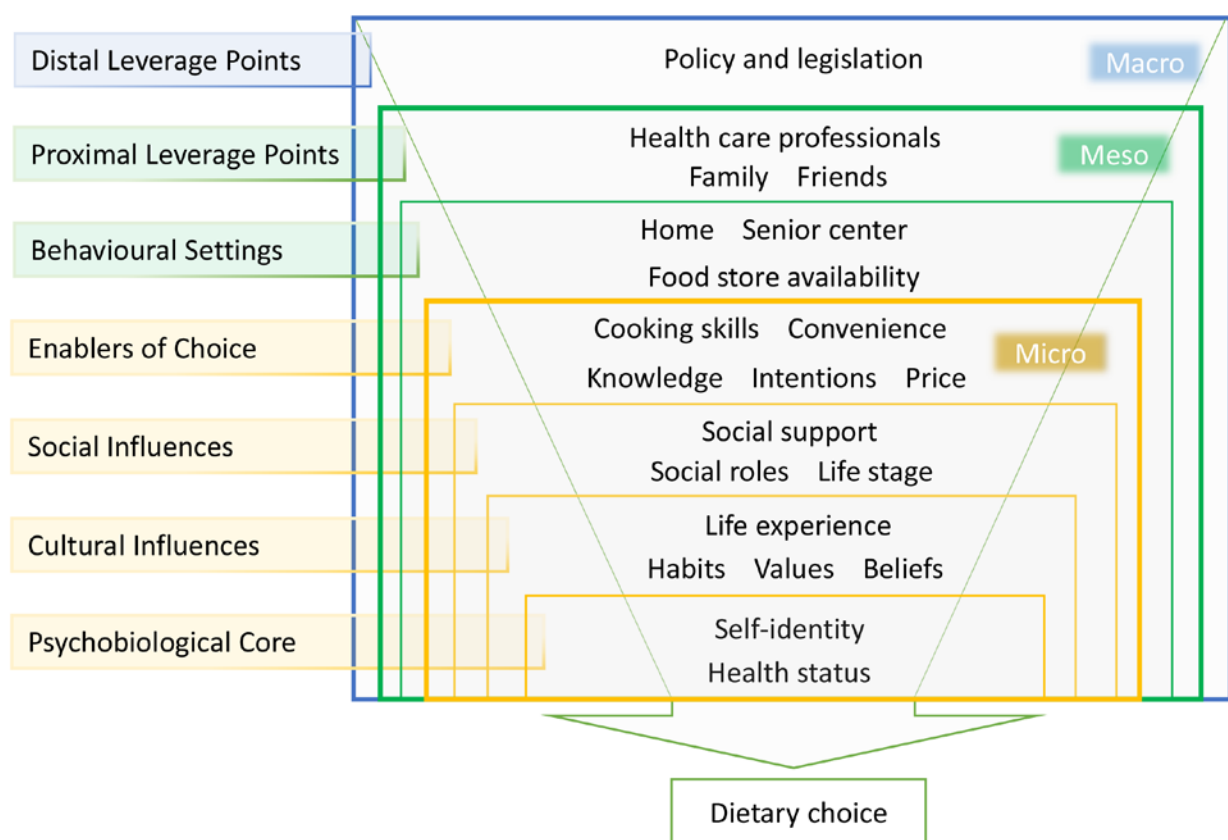


Figure 1. Socio-ecological model for dietary choices.

The Socio-ecological model for dietary choices (Figure 1) presents microlevel factors that are likely to influence older adults nutritional behavior in four layers: *Psychobiologic core*, *Cultural influences*, *Social influences*, and *Enablers of choice* (Booth et al., 2001).

Psychobiologic core represents health status and self-identity. Reduced health experiences conditioned by functional or cognitive declines can pose a significant barrier for good

nutritional choices among older adults; for example, by limiting opportunities to go to the grocery store or making cooking a difficult activity to maintain (Host et al., 2016; Locher et al., 2009). For some older adults, health problems, such as poor oral status or indigestive problems, are also likely to influence their food choices (Host et al., 2016). Self-identity refers to stable and prominent aspects of one's self-perception, such as viewing oneself as a person conscious of health. Health maintenance can thus be a significant motivating factor for food choices among older adults. Several older adults are conscious of making healthy choices, either by the motivation of maintaining independence and aging in place or as an effort to control chronic disease, such as diabetes or heart failure (Vesnaver et al., 2012; Winter et al., 2016).

However, as shown in the second layer in Figure 1 (*cultural influences*), eating behavior is to a large degree based on habits, and choices tend to be automatic and based on prior experiences and taste preferences (Brug, 2008). Food and taste preferences are culturally sensitive; ideals and habits regarding food are formed during childhood and may persist throughout the life course (Bloom et al., 2017; Winter et al., 2016). Taste preferences is identified as a key consideration governing food choice in old age (Host et al., 2016; Locher et al., 2009).

The *societal layer* represents social influences, such as life stage (e.g. working life vs retirement) and individuals' social roles. Everyday dietary decisions are often influenced by environmental cues, social expectations, distractions, and the people one is with (Brug, 2008). Studies show that sharing meals is associated with improved intake among older adults (Vesnaver & Keller, 2011). In old age, changing life circumstances, such as widowhood or moving to senior housing, can be factors that largely impact dietary habits (Bloom et al., 2017; van der Pols-Vijlbrief et al., 2017). Social isolation and perceptions of low levels of social support are associated with increased nutrition risk (Boulos et al., 2017; Locher et al., 2005).

Factors identified in the layer *enablers of choice* can either facilitate or impede healthy eating (Booth et al., 2001). Cooking skills and poor personal economy are examples of factors that can affect everyday decisions concerning diet. For example, a study of 185 homebound older adults identified sensory appeal, convenience, and price as key motivations for food choice (Locher et al., 2009). Intentions can also strongly influence everyday dietary descriptions (Sheats et al., 2015). If a person has a clearly defined intention, such as intending to increase

vegetable intake, this can influence dietary decisions (Bodenheimer & Handley, 2009). Nutrition-related knowledge and adequate cooking skills are considered essential for ensuring sound nutritional intake in old age (Host et al., 2016). However, individuals' capacity to make rational decisions about food are often constrained by lack of information related to personal dietary needs (Sheats et al., 2015).

Environmental influences are conceptualized in three layers in the socio-ecological model for dietary choices (Figure 1): *Behavior settings*, *Proximal leverage points*, and *Distal leverage points*.

Environmental factors, such as neighborhoods with available senior centers where meals can be eaten in social contexts and access to nearby grocery stores, are factors that can affect older adults' meal choices and dietary habits, as well as serve as protective factors against undernutrition (Host et al., 2016; Sylvie et al., 2013). Such mesolevel influences are categorized as specific *behavior settings* in this model (Figure 1).

Proximal leverage points refer to influence from people that surround the older adults (e.g., family, friends, and health care professionals). Many older adults receive help from family members or friends to shop for groceries, and family and friends can potentially be a vital part of older adult's abilities to maintain dietary habits and continue with culturally sensitive dietary traditions, such as Sunday family meals or special food for holidays (Brug, 2008; Sahyoun et al., 2004).

In the context of home care in Norway, there are several older adults who receive some form of nutrition support, either with grocery shopping, home delivery of meals through municipality care sector, practical support with food preparations, or dietary advice from health care professionals. Health care professionals will therefore have the opportunity to influence their patients' meal choices and diet, and they can have a crucial role in their opportunity for dietary change (if warranted). Evidence of possible effectiveness of mesolevel interventions to prevent undernutrition among older adults has been demonstrated in research on "meals on wheels" services, which suggest that such home-delivered meal programs improve diet quality and increase nutrient intakes among participants (Zhu & An, 2013).

Distal leverage points refer to legislation and policy. Legislation and policy are macrolevel factors that have indirect, but still important influences on health behavior (Booth et al., 2001). Macrolevel factor influence activities at meso- and microlevels.

Legislation and policies regulate health care services and influence attention and time allocated to nutrition in home care services. The national patient safety program “In safe hands 24/7” (*I trygge hender 24/7*) is an example of how national policies have influenced attention to undernutrition in Norwegian home care services. In this national patient safety program initiated by the Norwegian Directorate of Health (2014-2018), the municipalities received access to systematic procedures to enhance quality of care and patient safety. Prevention and treatment of undernutrition was one of the focus areas (Deloitte, 2019). As indicated in the quality indicators for nutrition-related work in the municipalities, more attention has probably been paid to undernutrition with the implementation of this patient safety program (The Norwegian Directorate of Health, 2020).

A Norwegian whitepaper from 2018 entitled “A full life all your life – A quality reform for older persons” (*Leve hele livet – En kvalitetsreform for eldre*) is another example of policy that emphasized the importance of facilitating healthy diet and maintaining good nutrition status in old age. This reform has received substantial media coverage (Kleven, 2020; Omland, 2017; Solheim & Odland, 2019), and this may have increased attention to undernutrition as a challenge among at-risk older adults and their relatives.

3.1 Applying the socio-ecological perspective

The socio-ecological perspective, as presented in Figure 1 has influenced this study from design of the APPETITT intervention, through data collection, analysis and discussion of the results. Figure 2 visualizes how I have embedded the socio-ecological perspective in this thesis. In the current study, the Appetitus app is explored as a mediator for dietary change. Using the socio-ecological model helps indicate that this mediator works in interplay with multiple influences on micro-, meso-, and macrolevels as indicated by the green arrow.

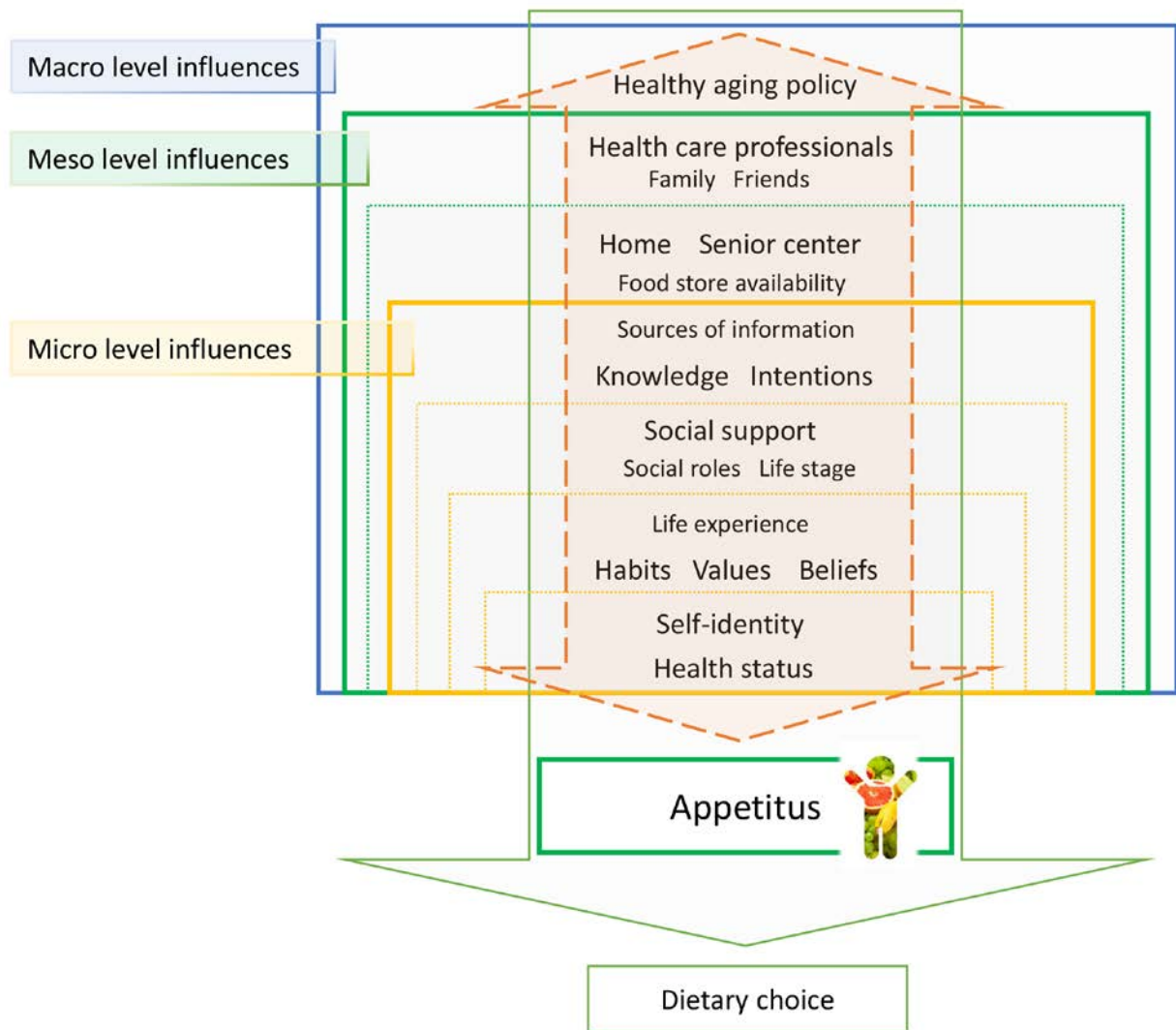


Figure 2. A socio-ecological perspective on the APPETITT intervention.

The dotted two-way arrow (orange) in Figure 2 points to how the Appetitus app was assumed to influence factors at micro- and mesolevels. For example, the Appetitus app presented a various selection of meal suggestions with pictures. In this way, the app aimed to inspire and influence older adults' dietary habits towards increased variance. Information and practical tips for protein and energy fortification of meals are also presented in the app. The health care professionals acquired access to the app, and this information in the app aimed to increase both the older adults and health care professionals' attention to and knowledge of food fortification.

The two-way arrow also indicates that factors at micro-, meso-, and macrolevels would be likely to affect older adults' adoption of the Appetitus app. For example, is self-efficacy towards technology use a factor that could influence whether or not older adults are willing to

engage in digital health (Howard et al., 2020; Wildenbos et al., 2018). However, health care professional and family support can make up for low technological confidence by offering regular support and encouraging feedback (Haukelien, 2020; Slette-meås et al., 2018). The digitalization of society, with more public services mainly available online, availability of news and information and communication with friends and relatives happening on the Internet, are also likely to affect older adults' attitudes towards adopting technology (Slette-meås et al., 2018).

The main component in the APPETITT intervention is the Appetitus app, as presented in more detail in Chapter 5.2.1. The Appetitus app is primarily developed as a microlevel intervention focusing on informing about age-friendly diets, and inspires older adults at risk of undernutrition to implement dietary changes. In line with research on perceived motivations and barriers for food choice among older adults, we incorporated food suggestions that were culturally and seasonally sensitive and provided inspiration for hot meals that were available as ready-to-heat meals or easy to prepare with support from recipe texts. The Appetitus app was also developed to be a source of information. We included advice for food fortification and suggested a meal structure throughout the day that encouraged night fasting for less than 12 hours. When older adults used Appetitus to record their food and beverage consumption, they received individualized feedback on energy, protein, and fluid consumption.

It has been recommended that caregivers should be involved in nutrition interventions because they can play a critical role in information dissemination and support and consequently impact the success of interventions (Bonilla et al., 2015; Locher et al., 2009). The APPETITT intervention was set up in the context of primary care services, and the intervention included follow-up support from health care professionals (described in more detail in Section 5.2.2.). This can be regarded as the mesolevel component of the intervention.

At the macrolevel, the APPETITT intervention is influenced by healthy aging policy. Appetitus was developed to support older adults' active participation in nutrition care by providing them the app to use on a daily basis and placing them at the center of the intervention. The intervention has a health promotion perspective by enabling older adults to increase control over and to improve their diet and consequently supporting older adults' independence and health experiences in old age.

4 Aims and research questions

The overall aim of this study was to explore the feasibility of introducing Appetitus for nutrition care in home care and opportunities in supporting early interventions to prevent undernutrition and manage nutritional challenges among home-dwelling older adults. Three specific aims were investigated in three research papers:

- 1) To explore the experiences and perspectives of health care professionals who used the Appetitus app for home care services.
 - Paper I entitled “Using a tablet application about nutrition in home care— Experiences and perspectives of healthcare professionals” explores how health care professionals embedded and considered the relevance of Appetitus in nutrition care practice. Furthermore, health care professionals’ perspective on barriers and facilitators for use of Appetitus in nutrition care were explored.
- 2) To explore the experience of home-dwelling older adults who used the Appetitus app in home care settings.
 - Paper II entitled “Promoting dietary awareness: Home dwelling older adults’ perspectives on using a nutrition application” explored older adults’ experience of using the Appetitus app with support from health care professionals in the home care context, and their perspective on the influence on their diet when using Appetitus.
- 3) To explore older adults’ use of Appetitus and discuss factors that affected their engagement in technology-mediated diet self-monitoring.
 - Paper III entitled “Older Adults’ Engagement in Technology-Mediated Self-Monitoring of Diet: A Mixed-Methods Study” explored older adults’ engagement in dietary self-monitoring through the trial period, and aspects which could affect differences in use patterns.

5 Research design and methods

5.1 Design

Implementation of Appetitus as part of nutrition care practices in home care can be regarded as a complex intervention. Complex interventions contain several interacting components, target different groups, and/or affect behavior in various ways (Craig et al., 2008). In this study, I regarded both the Appetitus app and the follow-up support from health care professionals as components that were likely to influence older adults' dietary behavior. Furthermore, I considered health care professionals' nutrition care practice as being influenced by access to the Appetitus app, as well as the role they were assigned in the project.

The Medical Research Council in the United Kingdom has developed an influential guidance on development and evaluation of complex interventions. They present a cycle of four phases: development of the intervention, feasibility and piloting, evaluation, and implementation (Craig et al., 2008). This thesis reports from the feasibility study of the APPETITT intervention.

Feasibility studies are recommended to gain knowledge about aspects, such as the acceptability, compliance with, and use value of interventions from the perspective of various stakeholders. Feasibility studies can thus build a knowledge base for future studies that focus on the clinical effects on the intervention. Insights from feasibility studies can be a critical element to ensure that such effect studies are not undermined by factors that could have been accounted for and addressed (Giangregorio & Thabane, 2015).

This study employed an explorative design, which is considered the most appropriate design when there is limited knowledge available about the topic being studied (Laake & Benestad, 2015; Polit & Beck, 2012). The APPETITT intervention was innovative in terms of developing and exploring opportunities with a nutrition app in supporting early interventions to prevent undernutrition and manage nutritional challenges among home-dwelling older adults. This research builds on studies that explore the feasibility of introducing tailored and simple technological aids to older adults without technology experience, as well as research examining the opportunities in using apps to support dietary behavioral change (DiFilippo et al., 2015; Watkins & Xie, 2015; Werner et al., 2012). However, the scarcity of studies about

the use of patient-facing technology focusing on the challenge of undernutrition among older adults supports the need for explorative studies.

This thesis emphasizes using qualitative method to explore the experiences of older adults and health care professionals who use the Appetitus app (Papers I, II, and III). Interviews are beneficial in gathering qualitative data as it allows for insights into other peoples' perspectives (Patton, 2002). We interviewed older adults and health care professionals to capture their perspectives of user acceptance and experiences of use value of the APPETITT intervention (Papers I and II). The qualitative method is considered an appropriate approach to provide insights and understanding of people's perspectives and experiences and was thus considered relevant in this study (Malterud, 2001).

In Paper III, a mixed-method approach was used that combined qualitative analysis of interviews with older adults and quantitative analysis of log-data from the Appetitus app. A mixed-method approach was considered useful as it allowed for a comprehensive investigation of older adults' use pattern in Appetites (Creswell & Plano Clark, 2011). This provided opportunities for a strong exploration of the usability aspects of the Appetitus app for this user group.

The explorative approach with different data material and methods was crucial in this research as acceptance of and use value of welfare technologies, such as Appetitus, involves several factors and stakeholders.

5.2 Intervention

This study reports from two 8-week trial periods. The first trial was conducted in autumn 2015, and the second in the autumn and winter of 2016/2017. The APPETITT intervention, as it was presented to the older adults, consisted of the Appetitus app and follow-up support from health care professionals. In this Chapter, I presents the APPETITT intervention as it was designed and organized in the second trial period. This is because the three papers primarily report from this trial. See Section 5.3 for more details.

I present the Appetitus app and the underlying theoretical foundation and design considerations for it in Section 5.2.1, followed by a brief description of the development process of the app throughout the APPETITT project. A description of the organization of the second trial period is presented in Section 5.2.2.

5.2.1 The Appetitus app

The Appetitus app was developed to encourage and provide advice on weight maintenance or weight gain among older adults. It emphasizes eating sufficiently, variedly, and regularly. Advice for diet alterations are based on Norwegian nutritional guidelines for the treatment and prevention of undernutrition, professional advice, and research (Findalen et al., 2012; Guttormsen et al., 2009). Initial measures to alter the diet in cases of poor appetite and low food consumption could serve to facilitate snack meals or adding more energy and/or protein to existing meals (Guttormsen et al., 2009).

Appetitus contains two panels: the main surface and the back panel. The main surface includes a meal plan, an inspiration area where meal suggestions are presented with pictures, and a gradually filling figure visualizing energy and fluids in recorded consumption. Furthermore, the back panel holds a list of recorded meals and daily and weekly graphs presenting registered calories, proteins, and fluids. Personalized settings are also activated in the back panel.

The Appetitus app presents a meal plan consisting of four main meals and two snack meals (Figure 3). By covering the full day, the meal plan implies that night fasting should be less than 12 hours (Jadczyk & Visvanathan, 2019). For those who struggle with early satiety, spreading meals across the whole day can serve as a measure to ensure adequate food consumption to meet energy needs (Nieuwenhuizen et al., 2010).

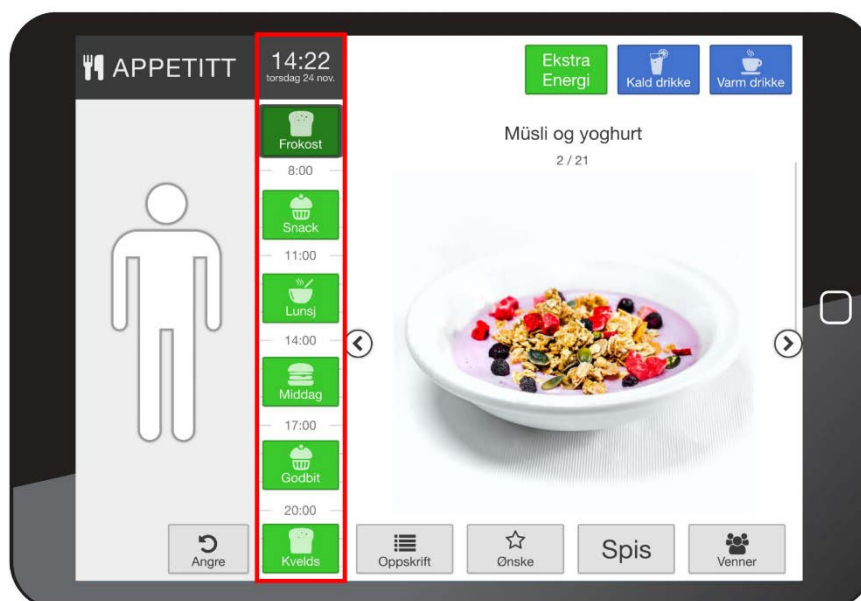


Figure 3. The meal plan in the Appetitus app.

Variation in diet can be crucial in maintaining appetite and can also have a positive impact on energy intake among older adults at risk of under consumption (Pilgrim et al., 2015; Wijnhoven et al., 2015). Suggestions for meals and snacks in Appetitus are presented with a picture. A food stylist worked on the presentation of the meals to create appetite-friendly presentations. Appetitus included pictures of 147 dishes. Suggestions for meals and snacks in Appetitus sought to present common and easily available food appropriate for the season.

There are recipe texts with customized suggestions for protein and/or energy fortification to most of the meal and snack suggestions in Appetitus. Using full fat dairy products and fortifying meals with neutral oil are examples of how a meal can be fortified with more energy, which are presented in the app. Such alterations are recommended because they are easy and cheap, and high fat diets are least satiating (Findalen et al., 2012; Nieuwenhuizen et al., 2010). Unlike medical-related interventions, such as sip-feeds, these measures are not associated with side effects such as nausea (Guttormsen et al., 2009; Milne, 2009).

The user could record in the app if they fortified their meals with products such as oil or crème. Figure 4 depicts how the Appetitus app presented suggestions for food fortification and supported recording of fortification of meals under the button Extra Energy (*Ekstra Energi*).

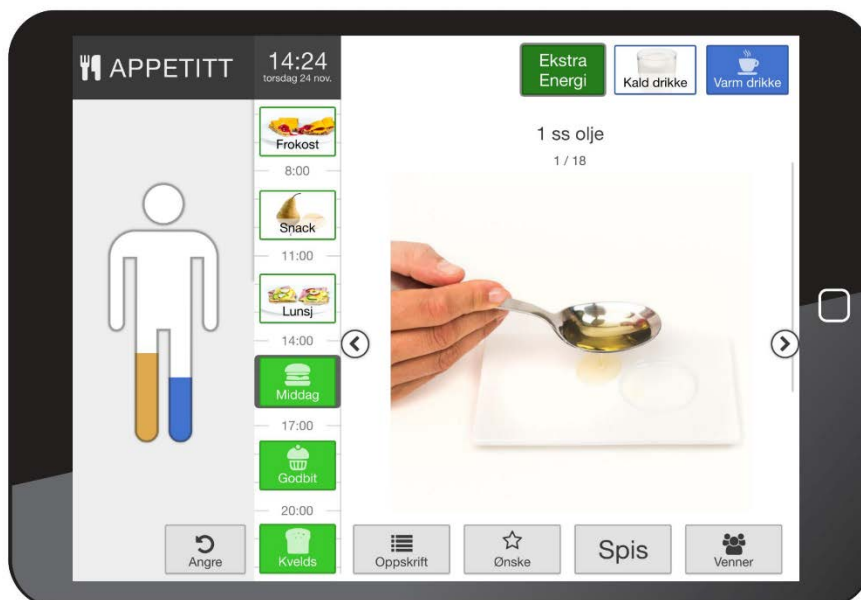


Figure 4. Visualization of tips for food fortification.

The user of Appetitus could record their food and beverage consumption and get personalized feedback on how their consumption reflected their need for energy, protein, and fluids.

Special consideration was made to minimize the work of detailed recording of food and beverage consumption in Appetitus. The user was able to record consumption by choosing from the available meals and beverages in the app. They had the ability to adjust the portion size of their meals (by percentage) to better reflect their consumption, but the content of the meals was not adjustable. Feedback on food and beverage consumption was presented as the filling of the figure and visualization of energy, protein, and fluid consumption in graphs. Figure 5 visualizes daily (left) and weekly (right) consumption of energy, protein, and fluids in graphs as presented in the back panel.



Figure 5. Visualization of consumption of energy, protein, and fluids in graphs.

Calculation of recommended daily nutrient need is based on the algorithm of 30 kcal of energy, 1.2 g protein, and 30 ml fluid per kg of body weight. Users who meet their energy and fluid goals by recording taken meals and drinks for the day receive feedback in the form of a full figure smiling and making a cheering sound.

Getting estimates of energy, protein, and fluid consumption is a crucial part of a diet evaluation. Another important aspect is gaining an overview of variance in the diet and the number and type of meals eaten (Beelen et al., 2017; Chen et al., 2018). To support the latter, the back panel in the Appetitus app has a list that presents what the user recorded as having eaten/drunk each day they used the app and the time of day they recorded this (Figure 6).

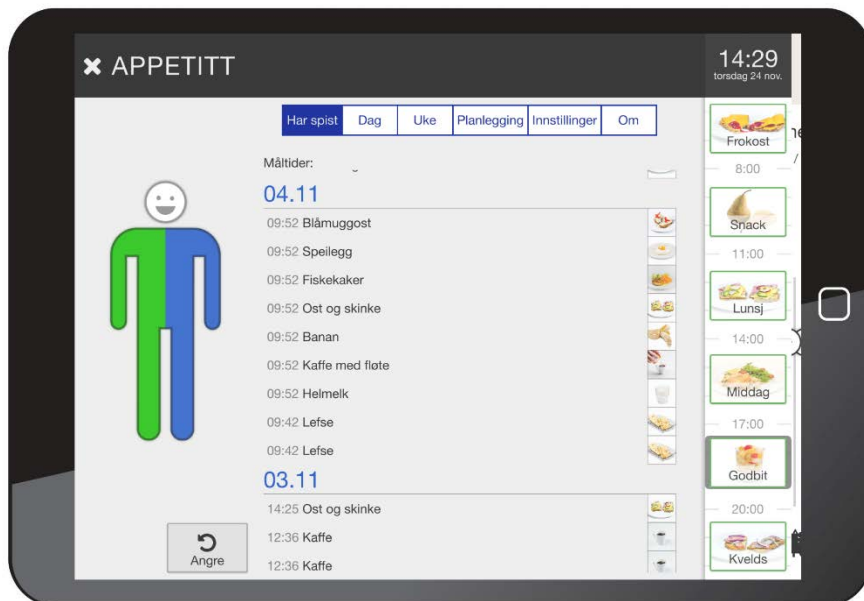


Figure 6. List of recorded food and beverages with time stamp.

Development of the Appetitus app

The Appetitus app was developed and refined in several iterations during the APPETITT project. Core functionalities were comparable in both trial periods. Core functionalities included the meal plan, meal suggestions presented in pictures, self-recording of diets with visualization of consumption in figures and graphs. Figure 7 depicts how the interface of the app's main surface developed from the first prototype to the versions used in the two trial periods.

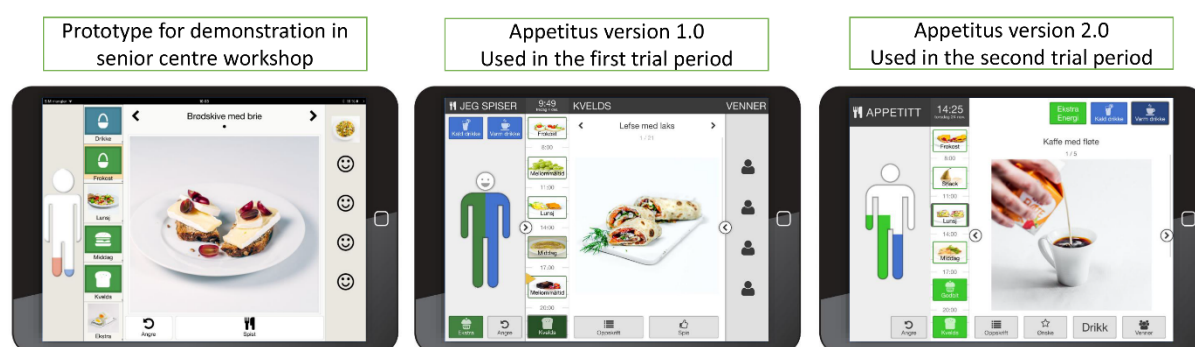


Figure 7. Development of the main panel in Appetitus.

We held workshops with older adults in a senior center twice in the development phase of Appetitus, where we did structured observations of the older adults' interactions in the app and received feedback on content and user experience. In the autumn of 2015, we held a trial in which older adults used Appetitus for 8 weeks. This group of older adults provided

feedback on the representativeness of the app content. Based on their feedback in terms of the representativeness of the content, we extended the repertoire of dishes. We also observed older adults' user interactions in the app after they had used Appetitus for 8 weeks, and we also recorded detailed field notes on this. These observations led to more extensive alterations in the design of the app interface (Fuglerud et al., 2018). In the first two versions, we had three sliding panels instead of a main surface and a back panel. However, the older adults accidentally accessed the side panel, and this created confusion among many of the naïve technology users. In version 2.0, we therefore made efforts to ensure that the user did not accidentally access the back panel. In this version, the user had to press the cutlery symbol for 2 s to access the back panel. We also changed the data basis for feedback presented to the user in the figure. In version 1.0, the figure was filled up according to servings of meals and beverages, as an effort to encourage more frequent meals throughout the day. However, this was easily misunderstood as energy and fluid consumption. We changed the filling of the figure to visualize energy and fluid consumption to this related goal setting in version 2.0.

5.2.2 Organization of the second trial period

The trial was held in the four municipalities that were formal partners in the APPETITT project. In three of these municipalities, the trial was set up in home care contexts. In the fourth municipality, it was set up as an 8-week course with regular meetings in a senior center.

All the older adults who participated in the trial received access to an iPad with the Appetitus app installed, and they were encouraged to use it regularly for 8 weeks. We also provided them with a user guideline on basic functionalities on the iPad (Appendix 1). The health care professionals received access to iPads with the Appetitus app installed in their workplace prior to the trial so they could familiarize themselves with the app and iPad.

Health care professionals from home care services introduced the older adults to the iPad and the Appetitus app and provided all follow-up support in the 8-week trial periods. We made a protocol for the follow-up in cooperation with the study sites. We planned for the health care professionals to meet the participating older adults in the participants' homes at least three times. In the first two meetings, which were conducted at a maximum of 2-week intervals, they had to focus on introducing the Appetitus app and the iPad. In the third meeting, the focus was primarily on nutrition. We let the health care professionals consider if the older

adults needed more follow-up. However, we encouraged health personnel to make contact with older adults weekly or every fortnight during the project period by means such as telephone to ensure continuity in follow-up. The health care professionals were responsible for helping the older adults customize the set up in the app by entering the older adult's weight, age and portion size of meals. In the first trial, a paper-based version of a user guideline (Appendix 2) explaining how to set up the individual settings were available in the homes of all the older adults. In the second trial, this guideline was available in the back panel of Appetitus.

The health care professionals reported that they had allocated 1.5 h to the first meeting with the older user, and this allowed for a thorough introduction to the app and its basic functionalities. It was sufficient time for the older adults to try the app independently and become comfortable in navigating it. By the next meeting, most of the users had used the app regularly. Questions about how to record consumption if a meal did not fit exactly what they had eaten was typically a thing they discussed with health care professionals in this session (Paper II). Health care professionals reported that they needed less time in the follow-up sessions compared to the introduction meeting. Figure 8 summarizes the organization of the trial in home care services.

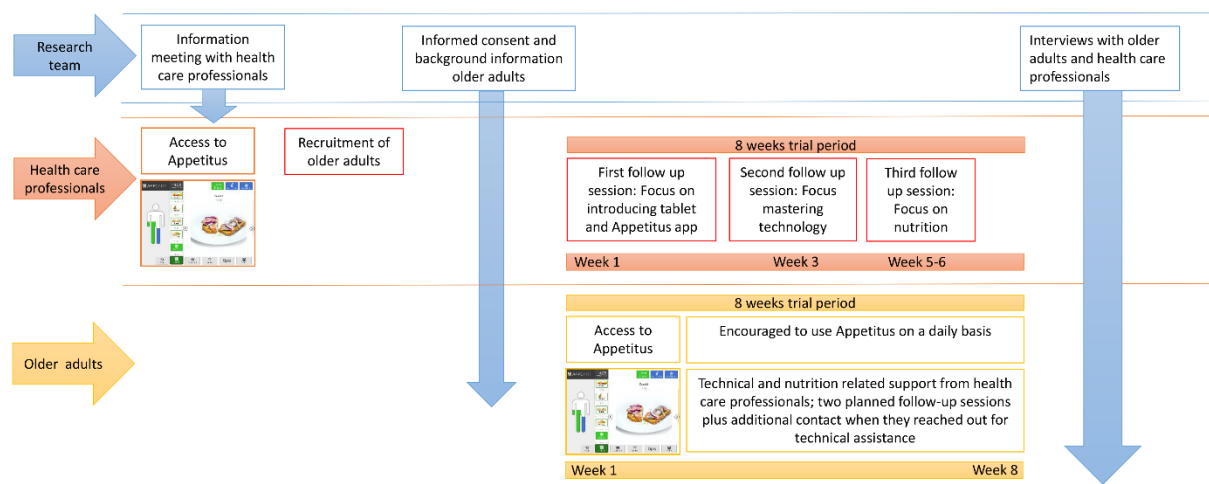


Figure 8. Organization of the trials in the home care services.

The older adults obtained contact information (telephone number) from the health care professionals who were responsible for follow-up and were asked to reach out if they needed help with the Appetitus app or the iPad between the follow-up sessions.

In the senior center, the trial was set up as a course over 8 weeks, with five group meetings held in the senior center buildings. The leader of the center was responsible for recruitment. The follow-up support provided to the participating older adults in the course was two-fold: The nutrition follow-up was provided in two sessions by a nurse with continuing education in nutrition, and three senior volunteers assisted with technical introduction and follow-up to tablet use (in all sessions). The nurse and the senior volunteers acquired access to iPads with Appetitus so they could familiarize themselves with the app prior to the trial. The older adults obtained the contact information of the leader of the center so they could reach out in case of technical difficulties or if they had questions between the group meetings.

5.3 Material

Our material included focus group interviews with health care professionals, individual interviews with older adults, and log data from the Appetitus app on older adults' use of the app. Figure 9 provides an overview of the material and the data we used for the three papers included in this thesis.

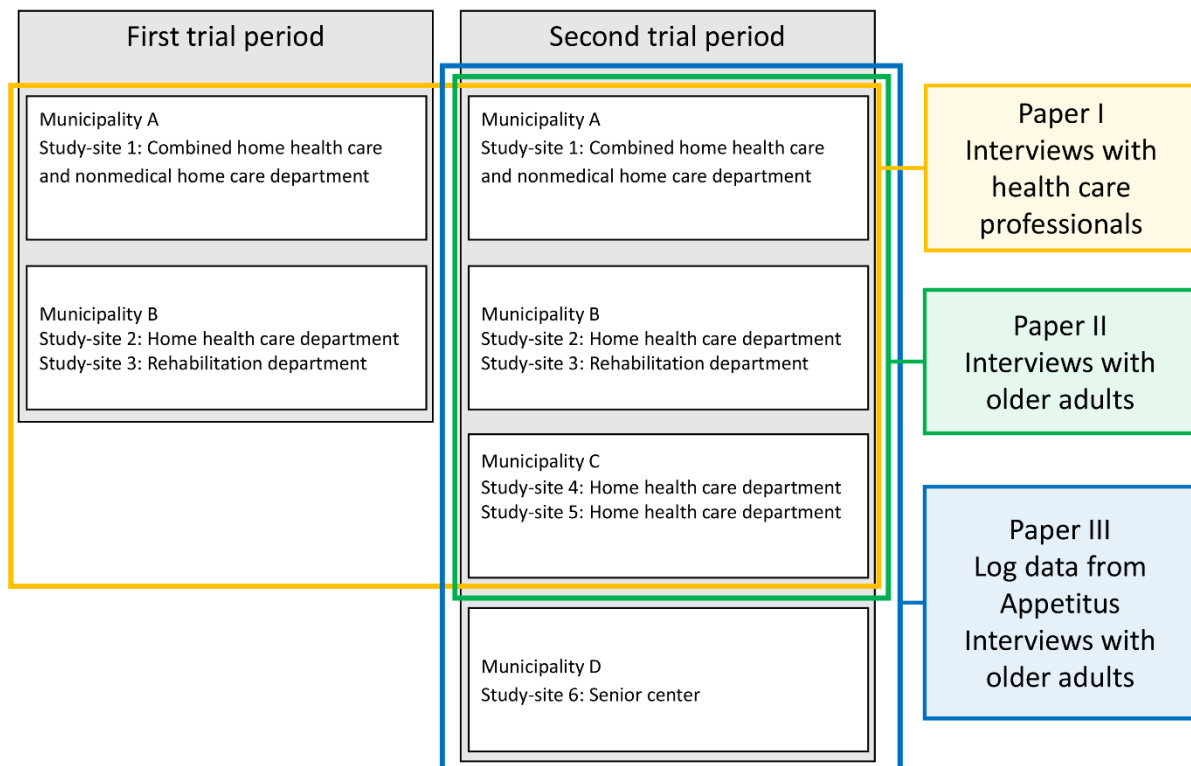


Figure 9. Overview of material and data in the three papers.

In the first trial period, we focused on receiving initial feedback on the app, recruitment and follow-up procedure, and health care professional's perspective of opportunities with

technology supported nutrition care. We included three home care departments as study sites in this trial. The second trial period extended the focus and included older adults' experience of using Appetitus and their user patterns in terms data collection. In this trial period, we expanded to include two more home care departments and one senior center, which made up a total of six study sites.

5.3.1 Study site selection

The four municipalities that were partners in the APPETITT project were represented by a project contact in the project group. The project contacts from three of the municipalities reached out to the managers of the home care services in their respective municipalities to recruit home care departments as study sites.

We recruited one home care department that combined home health care and nonmedical home care (practical help), three home health care departments, and one home rehabilitation department as study sites. The sixth study site was a senior center and was recruited in the fourth municipality. This was considered a relevant study site because this senior center offers group-based courses to facilitate self-reliance for people who have long-term health challenges and courses to promote healthy lifestyles for older adults. Several of the older adults that attended the group based course also received home care services. The leader of the senior center was one of the project contacts.

5.3.2 Recruitment procedure

We recruited health care professionals and older adults. I described recruitment of health care professionals in home care settings as this reflects the dataset included in Paper I and recruitment of older adults for the second trial as this reflects the dataset included in Papers II and III (see Figure 9).

Health care professionals

Twenty-four health care professionals were recruited to this study. The managers of the departments who decided to participate as study sites in the trial recruited health care professionals to provide follow-up support to older adults using Appetitus. Health care professionals included both managers who facilitated the trial and participated in the recruitment process and staff who were directly involved with the follow-up of the patients in

the trials. This latter group included clinical leaders, nurses, home health aides, and nursing students. See Paper I for more details.

Older adults

A total of 25 older adults participated in the second trial period. The majority of the older adults were recruited through home care services. Health care professionals were asked to recruit individuals over 65 years of age and without pronounced cognitive decline. They were asked to recruit individuals who they considered were likely to benefit from participation in a nutrition intervention and who could learn to use the application and the tablet computer independently. The sample of older adults represented older adults with varying technological experience and skills and different profiles with regards to nutrition status. For more details, see Table 1 in Paper II and Table 1 in Paper III.

Health care professionals brought the iPad with Appetitus installed with them when recruiting older adults to participate. In the focus groups after the first trial period, health care professionals explained that it could be challenging to explain what the project entailed to those older adults who lacked smartphone or tablet experience, because the concept of apps and technology was hard for them to grasp. Some health care professionals had therefore started to bring the iPad with them when they had a candidate they wanted to recruit. Therefore, in the second trial, health professionals brought the iPad with Appetitus as it was easier to explain to the older adult what the Appetitus app and trial was about when they could be shown the app simultaneously. If participants were willing to participate, they were given written information about the study and a consent form before the first contact with researchers was established. In the senior center, recruitment for the 8-week course was done through existing group activities, user organizations (diabetes and stroke associations), and Facebook. The leader of the center was responsible for recruitment.

Health care professionals initially recruited a total of 39 older adults to the second trial. Nine withdrew consent prior to the start of the study, and one died. Four terminated participation shortly after trial start up. Six of the 14 who withdrew from the study explained this with high illness burden. One participant explained that it was difficult and tiring to self-record diet, and the rest did not give a reason.

5.3.3 Data collection

Health care professionals and older adults were interviewed to explore their experience of using the Appetitus app and participating in the project. In addition, log data were collected directly from the Appetitus app.

Focus group interviews with health care professional

In both trials, the health care professionals participated in focus groups at the end of the 8-week trial periods. In the first trial, health care professionals were also interviewed 4 weeks into the trial period. The purpose of these midway interviews was two-fold: 1) to elicit experiences of the participants and 2) expose their understanding of the functionalities, correct possible misunderstanding, and provide additional training if needed.

The focus group interviews were held in each study site with a combination of managers and other staff. I held individual interviews in one of the study sites because the focus group interview we had planned in the middle of the first trial was canceled due to sick leave. Because of part-time work schedules and other practical challenges to gather the group on short notice, I decided to interview the health care professionals individually at this data point. The focus group did not become complete on two other occasions: Both instances were related to sick leave and managers prioritizing colliding tasks.

A thematic, semi-structured interview guide was used in the interviews (Appendixes 3, 4, and 5). Primary focus in the interviews were as follows: a) the recruitment process, b) introducing older adults to iPad and Appetitus, c) nutrition follow-up of older adults, d) general experience of participation, e) design and usability reflections, and f) reflection of Appetitus in nutrition work in the home care setting.

Two researchers were present in the focus groups. One researcher acted as the moderator and one as secretary. To avoid skewed balance in the individual interviews, I performed these interviews alone.

Semi-structured interviews with older adults

Older adults were interviewed in their home or at the senior center at the end of the 8-week trial period. These interviews were guided by a thematic interview guide (Appendix 6). Themes addressed in the interviews included the following: a) general experience with participation, b) user experience in Appetitus and iPad, c) user patterns, d) follow-up from

health care professionals, e) implication on dietary habits, and f) reflections on content in the app.

I conducted most of the interviews, with some assistance from a research assistant (ALJ). We used the Appetitus app actively in the interview and asked the participants to demonstrate how she/he had used it. This provided insight into how older adults had used the app and whether or not they managed to use it independently. It also contributed to a data material where the older adults' reflections concerning use and how it affected their diet were closely linked to specific use and specific descriptions of changes in their diet or eating habits. Average duration of the interviews was 34 min, and the range was 19–54 min.

Log data from the Appetitus app

When the participants used Appetitus to log food or beverage consumption, usage data was automatically transferred to University of Oslo's IT platform TSD (Service for Sensitive Data). This IT platform was developed for research purposes in compliance with Norwegian privacy regulation. The usage data we collected from the Appetitus app included a time-stamp specified as date and time, what item the user recorded (ID of meal or beverage suggestion in app), and action, specified as add or undo. The log data from Appetitus also included an automatically generated user ID. The user ID could not be linked to an individual participant due to privacy concerns.

5.4 Analysis

The main source of data in this study was interview data, supplemented with log data from the Appetitus app as a complimentary source. I performed the analysis in collaboration with my supervisors, who are co-authors in all three papers included in this thesis. We had regular analysis seminars during the analytic processes.

5.4.1 Analysis of interview data

All interviews were recorded. The interviews were transcribed verbatim, and emotional aspects such as laughter and silences were noted. We used content analysis inspired by the description of Graneheim and Lundman in all three studies (Graneheim & Lundman, 2004).

The analysis started when I read interviews and field notes to get an overview of the data material. Next, I used HyperResearch (3.7.1) to extract meaning units from interview

transcripts and coded and sorted them into categories. In the substudies presented in Paper II and Paper III, we used much of the same interview material from the older adults for our analysis. The analysis of these two substudies was performed separately, with analysis of substudy two being completed before we analyzed data for substudy three. However, the aims for the two substudies were outlined at the same time, and this helped me to be clear on how to set up a selection of meaning units to focus on different areas in the two articles.

Table 1. Illustration of the process of data analysis

	Paper1	Paper 2	Paper 3
Meaning unit	I must honestly admit that at the beginning we were much more engaged. I felt that. And then there was also allocated time for it. But eventually ... I felt there was not allocated time for this. And other tasks have displaced the whole project.	Yes, there was one thing I wanted to eat. And it was like that... What's the name now, again? The plate of different sausages, and... Cured meats! I forget the word, you know. Cured meats, it looked so good here. I don't usually eat that. So I had to buy that...	So, all in all, I really don't feel like I have ... Having enough strength to take this ... To be very careful.. I must confess that I have done this once a day. Yes, it has been in the evening. And it's been a weakness for ... Because I happen to be so tired that I fall asleep ... Sleeping away from it.
Condensed meaning unit	Experienced a decreasing engagement in project in the workplace. Other tasks displaced the project, less time allocated to the project.	Craving for food they know of, but rarely eat, after seeing pictures of it in the app.	Did not have the strength to be very careful about the recordings. Recording often incomplete because of evening recording pattern.
Coding	Decreasing engagement in project. Lack of allocated time. Prioritized other tasks.	Inspiration Familiar suggestions. App influence on diet.	Lack of strength. Irregular recording. Recorded once a day. Recorded in evening.
Subcategory	Many other focuses.	Dishes are familiar.	Influencing factors on low use.
Category	Personal and work environment barriers and facilitators.	Inspiring variety.	Considerations influencing self-monitoring.
Theme	Organizational barriers.	Mobilization of self-reflection on dietary habits.	Engagement in self-monitoring.

I condensed each meaning unit. As illustrate in Table 1, I kept expressions and words from the informants' original statements in this shortening of the text.

The final part of the analysis was a parallel and back and forth process of writing the analytical text and organization of categories and subcategories. The subcategories were helpful in realizing an overview of the variety of understandings and experiences within a category. I went back to the original manuscripts in this part of the analysis to see if the results were recognizable in the original text.

The prominent themes represent analytic abstractions of findings across the cases in all three articles. However, we did explore whether different perspectives in the themes were related to background variables, such as older adults technical experience or characteristics like educational background or work experience among health care professionals. In Article III, we took this a step further and used the three use patterns we identified in the analysis of log data as an approach to illuminate conditions for older adults' different levels of engagement in technology-mediated self-monitoring.

5.4.2 Analysis of log data

The processing and analysis of log data was performed in three steps. In the first step, I cleaned the data file to only include log data from the older adults who participated in the trial. The log data were connected to a user ID that was automatically generated in the app when it was downloaded on an iPad. However, during the trial period, some participants updated their app and the user ID was changed. In the preparation for data analysis, I therefore combined datasets based on time stamps and user patterns. Five of the datasets used in the final analysis consisted of combined data sets. In the second step I used descriptive statistics to create variables at individual participant level. Examples of individual variables created was "number of user days, Week 1" and "mean number of recording periods per day". In the final step, I developed a flowchart of cut points for three user pattern categories; daily use, weekly use and occasional use (see description in article III). I used descriptive statistics with frequency distribution and central tendency analysis to describe usage patterns across cases and to describe differences in usage pattern in the Appetitus app on group level (daily users, weekly users and occasional users).

I used SPSS version 26 and Excel 2016 in processing and analyzing the usage data.

5.5 Ethical considerations

The Norwegian Center for Research Data approved the study (project number 44004).

All older adults and health care professionals who participated in the study provided their written consent after receiving both written and oral information about the project. The older adults received a written consent form some days before the first interview took place. To ensure that the older adults had received information before they signed the consent form, the interviewer read it aloud and explained in more detail in the first meeting with the older adults. As an example, we explained how we kept the interview recordings and other data securely stored in more detail. We emphasized for all the older adults that they could withdraw from the study at any time, and that this would not affect the help they received from the home care services. We considered all older adults to be competent to provide their informed consent, as we did not include older adults with severe cognitive impairment.

All the collected data were stored in University of Oslo's IT platform called Service for Sensitive Data (Tjenester for Sensitive Data - TSD). This IT platform was developed for research purposes in compliance with Norwegian privacy regulation. I performed all statistical analysis in this platform. The initial steps of the qualitative analysis were also performed here.

6 Results

In this chapter, main results from the three papers included in this thesis are presented. Paper I reports from the health care professionals' perspective on using Appetitus as part of nutrition care in home care services, whereas Paper II presents the older adults' perspective and Paper III elaborates their use pattern in Appetitus.

6.1 Paper I

The aim of this paper was to explore the experiences and perspectives of health care professionals who used our nutrition app, Appetitus, for home care services.

Health care professionals used Appetitus as a mediator in dialogs about nutrition with the older adults. The older adults' recorded their food and beverage consumption in Appetitus, and the app visualized how their consumption was related to their energy, protein, and fluid requirement. This could reveal or highlight problematic situations related to nutrition for both the older adults and the health care professionals. Giving the older adults an active role in nutrition assessment afforded opportunities to strengthen their involvement in care. Health professionals found that participants became more interested and engaged in nutrition, and they started to ask questions and seek advice. Health professionals sought to increase patients' awareness about diet and health and strived to provide personalized advice for dietary change based on the patients' existing dietary habits. They experienced that their advice was strengthened by the visualization function in the Appetitus app. Health care professionals acknowledged the importance of having a solid understanding of nutrition to feel sufficiently confident in the supervisor role. Some health care professionals expressed uncertainty or insecurity about whether or not their nutrition knowledge was good enough, and this became a barrier to nutrition follow-up, resulting in them focusing on the technical follow-up rather than on nutrition-specific follow-up. Time constraints and part-time work schedules also presented barriers for health care professionals in this trial.

Based on their experience with Appetitus, health care professionals suggested using electronic tools to assess and document the nutritional situation of a larger patient group in home care, such as older adults with cognitive decline. They assumed that tools like Appetitus could support a more systematized nutrition practice with assessment that was more detailed and that supported precise documentation.

6.2 Paper II

The aim of this paper was to explore the experiences of older adults who used the Appetitus app in home care settings.

Pictures in the app worked as an inspiration and a reminder of available and relevant meal options and inspired the older adults to have a more varied diet. Using Appetitus encouraged the participants to reflect on their dietary habits. Some said they received confirmation that their diet was healthy; others were inspired to eat healthier. Furthermore, the app presented food that some participants considered unhealthy, such as energy-rich meals, desserts, and cakes.

Visualization of goal achievement for energy and protein consumption in the figure and graphs stimulated the older adults to reflect on nutritional value in their diet. Some participants used the graph visualization actively and became in general more concerned with selecting food alternatives that ensured they consumed sufficient protein or energy. Others gave examples of how they ate or drank more in the evening during the trial period as an effort to fill the figure. However, there were also those who rarely experienced coming close to recommended goals for energy, protein, and fluids, and they had not actively tried to change this by eating more or differently in the trial.

The experience with follow-up support from health care professionals varied among the older adults, from reporting to only receiving technical support to those who experienced a change in the way health care professionals attended to their nutritional needs. Support from health care professionals added meaning and assurance when using Appetitus.

6.3 Paper III

The aim of this paper is to explore home-dwelling older adults' use of Appetitus and discuss factors that affect their engagement in technology-mediated diet self-monitoring.

The log data demonstrated that the majority of participants consistently used the app for 8 weeks, although there was a decline in use at the end of the trial period. From the log data, we could delineate three different user patterns in our data set: daily use, weekly use, and occasional use of the Appetitus app. Fourteen participants met the criteria of daily users: They record their consumption 7 days per week in the majority of the weeks in the trial period. The

six participants who were categorized as weekly users also used the app regularly, but had fewer recording days each week. The five participants categorized as occasional users used the app irregularly, often with more than a week pause between the user days.

The majority of older adults in this study expressed that they considered the tablet computer and Appetitus app easy to use, and technological experience was not related to this result or to older adults' use pattern in the app.

As explained by the older adults, personal interest in nutrition and commitment to contributing to research was highlighted as important drivers to keep recording throughout the project period for those who used Appetitus regularly. Perception of little personal relevance to using a nutrition app and experiencing poor health led to irregular self-monitoring. However, a common experience across the three different user patterns was that using the Appetitus app provided the participants an opportunity to reflect on their diet.

Using Appetitus increased inexperienced technology users' confidence and engagement with technology. Participation in this project thus became a springboard to using touch technology and the Internet. Learning to use social platforms and the iPad for entertainment was appreciated. In addition to the follow-up, the participants received from health care professionals, several of them said they obtained additional support from family members when learning to use the iPad.

7 Discussion

This discussion chapter is organized as follows: In the first section (Section 7.1), I discuss the feasibility of Appetitus as a technology-mediated nutrition intervention in home care settings. In Section 7.2, I adopt the socio-ecological perspective as the lens to discuss opportunities with Appetitus in supporting early interventions to prevent undernutrition and manage nutritional challenges among home-dwelling older adults. In Section 7.3, I discuss methodological considerations. I discuss findings across the three sub-studies in all three sections.

7.1 Feasibility of technology-mediated nutrition interventions in home care

A core purpose in this study was to assess the feasibility of technology-mediated nutrition interventions such as Appetitus in home care. Acceptability is a key consideration for feasibility of technology-mediated interventions in health care (Sekhon et al., 2017). Successful implementation and actual use depends on acceptability of the intervention, both from the recipients (older adults) and the intervention deliverer (health care professionals) (Sekhon et al., 2017). Experiencing the technology as useful and user friendly are recognized as central factors influencing older adults' user acceptance and engagement in technological health interventions (Cole-Lewis et al., 2019; O'Connor et al., 2016; Wildenbos et al., 2018).

Feasibility of Appetitus as part of nutrition care services in home care depends on factors at the organizational level and on health care professionals' abilities and willingness to make it a part of their nutrition care practice (Nilsen et al., 2016). Identifying facilitators and barriers for uptake of new practices in health care is therefore considered a crucial element of feasibility evaluation (Giangregorio & Thabane, 2015). Considerations regarding recruitment and drop-out is also an important aspect of feasibility evaluations as this can provide valuable information to future studies seeking to investigate effects of interventions of similar nature (Treweek, 2015).

To address feasibility, I discuss user acceptance of the intervention from the perspective of older adults in Section 7.1.1. I discuss recruitment and drop-out in section 7.1.2. In Section 7.1.3, I address user acceptance of the APPETITT intervention from the perspective of health

care professionals, as well as barriers and facilitating factors for health care professionals providing support to older adults who use Appetitus in home care settings.

7.1.1 User acceptance of the intervention: Perspectives from older adults

Paper III included results that demonstrated how 80% of older adults used Appetitus on a daily or weekly basis for several weeks. These results suggest that the majority of older adults in this study considered Appetitus as an acceptable intervention. Design aspects of the Appetitus app, support structures in the interventions, and individual factors such as experiencing personal relevance of the interventions can be factors that contributed to the high user acceptance among older adults.

Design aspects in the Appetitus app influencing user acceptance

Perceived ease of use is a critical aspect of technology adoption and is especially so among older adults (Wildenbos et al., 2018). The majority of older adults who participated in this study expressed that they considered the tablet computer and Appetitus app easy to use (Paper II and III). Studies have reported that technical problems or low usability for the intended user group can negatively affect older adults' motivation to continue using health technology (Grindrod et al., 2014; Lindhardt & Nielsen, 2017; O'Connor et al., 2016). Older adults can have difficulties recognizing icons and navigating in apps that are developed and designed with younger adults in mind. Fear of doing something wrong or ruining the technological device can hinder learning by trial or error (Takemoto et al., 2018). Furthermore, functional limitations, such as those caused by arthritis and other rheumatic conditions, can complicate interactions in apps on touch screen devices if it causes reduced fine motor and sensory function in the hands (Wildenbos et al., 2018). We followed recommendations to involve older adults early on in the development phase and to test the technology with individuals from the group the intervention targeted before implementing the study (Matthew-Maich et al., 2016). This led to an app with a user interface designed so that all the parts that were essential for use (i.e., the meal plan, inspiration area presenting pictures of meals and beverages, and feedback on recorded consumption in the figure) were visible on the screen all the time (main surface). Furthermore, in development of the app, common design issues, such as appropriate size of interaction elements and text and good contrasts, were addressed (Fuglerud et al., 2018). Based on feedback from older adults on the content, several new

dishes were added to the last version of the app. The majority of the older adults included in the last trial highlighted that the app presented meal choices they knew well or that they could familiarize themselves with (Paper II). The commonly held perspective that Appetitus had content considered relevant could have also contributed to the high acceptability of the app.

Lack of technological experience was not identified by participants as a barrier to using Appetitus regularly, which further suggest that Appetitus was easy to navigate (Paper II and III). Making the Appetitus app available on a tablet computer could have also been a factor, because tablets are considered user friendly to navigate in and allows for larger font size and touch areas in apps compared to apps running on a smartphone (Ramprasad et al., 2019; Vaportzis et al., 2018). A Norwegian survey from 2018 on older adults' technology use revealed that older adults received less assistance from family and friends with technology on a daily basis compared to a survey 4 years earlier (Slette-meås et al., 2018). It is assumed that this is partly related to increasing use of tablet technologies, because tablets are more user friendly and programs are easier to install and update on them compared to computers (Slette-meås et al., 2018). Our findings support this as we saw that several of the participants started to use the iPad beyond the Appetitus app (Paper III).

In addition to careful considerations of the interaction design, demands on activity levels in nutritional interventions (e.g., how often is it required for the participant to record weight or dietary patterns) will impact on user acceptance. In addition, how demanding these activities are to perform within the technology also impact on whether or not a nutrition app is perceived as easy to use (Hingle & Patrick, 2016; Takemoto et al., 2018). Some of the participants who used Appetitus regularly reported experiencing the recording as a burden (Paper III), which is a factor that can threaten acceptability of the intervention and lead to discontinuation of use (Sekhon et al., 2017). This might also explain why some participants did not use Appetitus on a regular basis and explain the discontinuation of use among a few of the daily users (Paper III). In the context of adopting nutrition apps in clinical practice, some have suggested having clearly defined time periods for dietary recordings or reducing the recording to include only selected meals or selected elements in the diet, such as fruits and vegetables, as a way to bypass the burden associated with dietary recordings (Bonilla et al., 2015; Chen et al., 2018). The clearly defined time frame of 8 weeks could have positively affected the acceptability of dietary recording among the participants.

In development of the app, we also addressed the issue of burden by minimizing the detail level in the recording of food and beverages to make the logging activity as quick and easy as possible. This is in contrast to common approaches to dietary recording in most nutrition apps (Chen et al., 2015; Hingle & Patrick, 2016). The level of detail was decided based on careful considerations in the project group on the level of detail in dietary assessment that could be regarded as “good enough” or sufficient in the context of addressing the topic of undernutrition among older adults in home care. Emphasis was put on mapping dietary variance, meal types, and meal frequency rather than accuracy in energy, protein, and fluid consumption. However, this coarse level of accuracy in the dietary assessment function came with a downside. Some of the older adults experienced large discrepancy between their need for energy as presented in the app and energy in the food and beverages they reported as eaten and drunk (Paper II). This presents a threat to acceptability and trust in the intervention.

The influence of research commitment

The older adults who participated in this project presented positive attitudes towards participating in a nutrition intervention, either because they considered it personally relevant or because they regarded nutrition among older adults as a valuable topic for research and well worth their time (Paper III). Both consideration of personal relevance and altruistic reasons have been shown to be key motivational factors for research participation among older adults in other studies (Coley & Andrieu, 2012; Coley et al., 2019; Fearn et al., 2010). Coley and colleagues (2019) investigated what motivated older adults to participate in an eHealth prevention trial. Maintaining autonomy and postponing functional dependency was a key concern driving participation: The intervention offered medical follow-up and opportunities for individuals to improve their lifestyles, and these intervention components was considered personally relevant (Coley et al., 2019).

As in this current study, interest in contributing to scientific progress and helping other older people have been reported as important reasons for older adults’ willingness to participate in research (Coley et al., 2019; Fearn et al., 2010). Although older adults can be more difficult to recruit to research projects, studies have also revealed that they tended to have high adherence to research protocols when they agreed to participate (Valenzuela et al., 2018). This tendency may also indicate their strong moral commitment to contributing to research (Coley et al., 2019).

While being committed to supporting research can have influenced on older adults willingness and engagement in self-monitoring of diet, this current study also revealed that older adults made deliberate considerations regarding research engagement. Although we encouraged all older adults in the study to use Appetitus daily in the trial period, there were a few participants who took a conscious decision that they did not want to use Appetitus for recording purposes on a daily basis (paper III).

Older adults who depended on help with food preparations on a daily basis were less likely to use Appetitus regularly, and this tendency might be related to the lack of experience of personal relevance (Paper III). However, it is also likely that those in need of considerable help with food preparations on a daily basis also experienced poorer health, which has been recognized as a factor that hinder participating in research activities (Coley & Andrieu, 2012; Michelet et al., 2014). Older adults with poorer health experiences might have to portion out their energy and tend to make careful considerations on what activities to engage in on a day-to-day basis (Witsø et al., 2012).

Influence of support structures

We offered older adults access to a tablet computer and regular follow-up to ensure that they managed to use it. This could have been factors that motivated some of the older adults to participate in the project, both because tablets computers are costly and because of the support structures in the project (Howard et al., 2020; Kampmeijer et al., 2016; Wildenbos et al., 2018). Some of the participants might have been interested in this project because they received access to the iPad and opportunity to continue to borrow it from the municipality after the trial if they used it regularly. Training and regular follow-up support in trials can also be vital for older adults' willingness and abilities to overcome initial usability barriers in these technologies (Grindrod et al., 2014; van Doorn-van Atten, de Groot, et al., 2019; Wildenbos et al., 2018). In particular, older adults with low computer literacy and low confidence in their own abilities in learning to use new technologies are likely to need extensive technical and mental support when introduced to health technology (Wildenbos et al., 2018). Some of the older adults who participated in this study demonstrated little interest in using digital technology and the Internet before the study started. The close follow-up of health personnel can be considered a crucial element for their willingness to participate and also a factor that contributed to consistent use of Appetitus (Papers II and III).

Several of the participants said they also received some technical support from their relatives (Paper III). This may have also been an important contributor to the high acceptance of the technology in this study. Although use of digital technology and the Internet has increased sharply among older adults in Norway, where 65% of older adults aged 71–80 years use the Internet daily in 2018, their adoption of technology still depends on extensive support from family or friends (Slette-meås et al., 2018).

7.1.2 Considering challenges in recruitment of older adults

This study indicated that that recruitment for a technology-based nutrition intervention in home care can be demanding: 23% declined participation prior to the trial, and another 13% withdrew their consent early in the trial and did not participate in the study (Paper III). This project required active involvement from the user on a daily basis for 8 weeks, and the extensive nature of this project likely influenced the decision not to participate for some of the older adults.

Research projects can in general be considered as time consuming (Provencher et al., 2014). Poor health experiences are known to be a significant factor for older adults declining to participate in research projects (Coley & Andrieu, 2012; Provencher et al., 2014; van Doorn-van Atten, de Groot, et al., 2019). We also experienced this (Paper III). Some studies that have recruited for nutrition interventions among older adults have also found that older adults to be hesitant to participate in interventions that focus on undernutrition and target weight gain and maintenance. This can be explained by older adults' interpretation of weight loss as positive, even if associated with an illness episode or simply that the topic of undernutrition seems irrelevant to them (Locher et al., 2013; Piantadosi et al., 2015; Terp et al., 2018). We did not explicitly focus on weight gain, but more generally on nutrition in the information to the older adults about the study. However, undernutrition was the challenge we put forward, and possibly, some older adults refused to participate because they found the topic irrelevant or contending with their personal goals.

Other studies where a technological intervention (nutrition apps or similar) targeting undernutrition has been piloted or studied with regard to feasibility have reported that only 10-30% of those who were considered eligible conducted the study (Kraft et al., 2012; Lindhardt & Nielsen, 2017; van Doorn-van Atten, Haveman-Nies, et al., 2019). In Lindhardt and Nielsen (2017) and Kraft et al. (2012), the recruitment procedure was somewhat different

from ours. They screened all patients in a hospital ward for eligibility and approached them. We on the other hand asked the health care professionals to consider eligibility based on nutrition and technology criteria. It is therefore likely to assume that the older adults who were asked to participate reflect only a segment of older adults who experience better health and were more independent compared to the wider population of older adults who receive home care services (Helvik et al., 2015). Furthermore, is it conceivable that health care professionals failed to recruit all relevant candidates to this project. The health care professionals who work in home care know their patients well, and it is likely that they excluded the most frail older adults based on the nature of the project, which required active involvement from the end user on a daily basis for several weeks (Coley & Andrieu, 2012).

7.1.3 Feasibility of the APPETITT intervention in home care: Perspectives of the health care professionals

Health care professionals were responsible for the technical and nutrition-related follow-up support to the older adults who used Appetitus in the study. Regarding the feasibility of the intervention, their completion of this process matters. In this study, health care professionals indicated time pressure and poor nutrition-related knowledge as prominent barriers for follow-up of patients in the trial period (Paper I).

Providing support to older adults: Barriers and facilitating factors

Some health care professionals stated that time pressure was a barrier that had displaced the follow-up of patients who used Appetitus (Paper I). Time pressure and conflicting tasks are barriers to high quality nutrition care practice and has been consistently reported in the literature (Hestevik et al., 2020; Lannering et al., 2017; van Doorn-van Atten, de Groot, et al., 2019; Watkinson-Powell et al., 2014).

Some of the health care professionals in this study expressed uncertainty or insecurity about their own nutrition knowledge, and this became a barrier to providing nutrition follow-up to the older adults in this study (Paper I). Poor nutrition knowledge among health care professionals is reported in the literature as a significant barrier for good nutrition practices and should be taken into account in interventions (Eide et al., 2015; Merrell et al., 2012; Watkinson-Powell et al., 2014).

More training of health care professionals prior to the intervention could potentially have been a useful measure to ensure higher compliance in intervention delivery. Van Doorn-van Atten and colleagues (2019) studied a technology-supported nutrition intervention developed for older adults. As in this study, health care professionals in home care were responsible for follow-up support in the trial. However, in the study of Van Doorn-van Atten et al. (2019) a dietitian held a workshop for the health care professionals on how to provide nutrition support prior to the study. High work load among health professionals was reported as a barrier in the study as with the current research, but uncertainties with how to provide nutrition support was not a reported barrier (van Doorn-van Atten, Haveman-Nies, et al., 2019). Furthermore, the authors reported that health care professionals implemented the intervention according to protocol. Other studies have demonstrated that training programs or nutrition courses can positively influence health care professionals' skills, self-efficacy, and attitudes in nutrition-related care activities (Bjerrum et al., 2012; Mogre et al., 2016).

Health care professionals did not report on technical difficulties, limited knowledge, or low self-efficacy in providing technical support to older adults in this study (Paper I). This can be seen as a result of stable technology in combination with high technical experience among the health care professionals. Almost all adults in Norway own and use smartphones or tablet computers on a regular basis (Schiro, 2020). In addition, several of the municipalities where we held the trials health care professionals in home care used smartphones to access care plans. They did not have access to care plans in paper formats and so relied on the smartphone in their daily work routine.

Acceptance of Appetitus is strengthened by recognition of opportunities to improve nutrition care practice

In this study, the health care professionals expressed a generally positive attitude toward Appetitus as they acknowledged opportunities to strengthen their nutrition care practice with tools such as Appetitus (Paper I). A new practice or an intervention presenting advantages in comparison to current ones can serve as a strong facilitator for acceptability and successful implementation (Sekhon et al., 2017).

Health care professionals described that evaluation of food and beverage consumption related to patients need for nutrition was not a part of their current nutrition assessment practice in home care. Although health care professionals were divided in their opinion on whether the

current level of detail in the nutrition assessment functionality in Appetitus was sufficient, they pointed to the added value of such a tool in supporting their nutrition care practice (Paper I). They had experience in recognizing nutritional challenges and addressing risk factors for undernutrition at early stages as a result of implementing Appetitus in home care (Paper I).

There are also examples in the literature on how technology can support health care professionals in their nutrition care practice and increase their attention to prevention and early intervention (Johansson et al., 2017; Paulsen et al., 2020). Paulsen and colleagues developed and implemented a digital decision support system about nutrition for severely ill patients while in a hospital setting. In this system, patient and/or health care personnel could record food and beverage consumption in an app and the nurses had access to a web-based portal where they could receive tailored recommendations to strengthen the nutrition treatment offered to patients. Although this intervention did not impact the patient's weight development during the hospital stay, it had a significant positive effect on nurses' nutrition care practice. The nurses started to evaluate dietary intake in their patients and created nutrition care plans (Paulsen et al., 2020). Johansson and colleagues examined how health care professionals in the municipality care sector in Sweden documented nutrition-related care activities in older adults newly diagnosed with dementia in a quality register called Senior Alert. Among the older adults assessed in their study to be at risk of malnutrition or who were malnourished, 73% and 65% respectively had records on performed interventions. This indicates that health care professionals to a great extent paid attention to the challenge of undernutrition. The authors compared their results to earlier research from Sweden that suggested that nutrition risk assessment and treatment was an underprioritized area of care, and they argued that the Senior Alert system worked as a pedagogic tool that supported health care professionals focusing on improving and establishing high quality nutrition care (Johansson et al., 2017). These two examples substantiate the findings of this study, which indicate that technological tools to support the nutrition care process can mediate a nutrition care practice that is proactive and more in line with guidelines for prevention and management of undernutrition (Guttormsen et al., 2009; NICE Guideline, 2006; Volkert, et al., 2019).

However, lack of interoperability to existing health care records was identified as barrier to implement Appetitus in larger scale (Paper I, Table 4). Health care professionals had strong expectations for a program that seamlessly connected with the other electronic systems they

used (Paper I). Lack of interoperability between mobile health interventions and other existing electronic health care systems is in general a large barrier for the implementation of health technology as part of standardized practice (Odendaal et al., 2020; Paulsen et al., 2019).

This study demonstrated the feasibility of implementing patient-facing technology for older adults in the home care settings. Health care professionals play an important role for older adults' opportunities to adopt and make use of such tools. Furthermore, this study suggests that health care professionals' nutrition care practice can be strengthened if they have access to tools that can support the nutrition care process. The Appetitus app supported health care professionals in evaluating older adults' diet, which lays the foundation for nutrition interventions. Moreover, the Appetitus app could support them when they advised older adults in regard to dietary alterations.

7.2 Use value of patient-facing technologies in nutrition care: Reflections from a socio-ecological perspective

The Appetitus app inspired many of the older adults to include more variation in their diet and they reported becoming more conscious of their food choices. By examining how such dietary changes occur through a socio-ecological lens, one assumes that changes are not only a result of internal microlevel processes but also influenced by factors around the individual (Figure 1, p. 32). In this section, I have structured the discussion to examine the opportunities with and influences of introducing Appetitus in home care from a micro-, meso-, and macrolevel perspective. In Section 7.2.1, I discuss the ways in which the Appetitus app could influence microlevel factors and thereby possibly mediate dietary behavioral change in older adults. In Section 7.2.2, I discuss influences of the Appetitus app on health care professionals' nutrition care practice and also their role in supporting dietary change in older adults. Section 7.2.3 includes discussion on the implications for healthy aging policy on older adults and health care professionals and how this can be understood as influencing the adoption and use value of tools like Appetitus.

7.2.1 Technology-mediated dietary change: Reflections from a microlevel perspective

The Appetitus app was primarily developed as a microlevel intervention, seeking to serve as a source of information on how to maintain and gain weight in old age, while inspiring older adults at risk of undernutrition to implement dietary changes to prevent and manage weight loss. Even small self-care and lifestyle improvements can yield significant benefits in older adults who are at risk of undernutrition or who are undernourished (Sheats et al., 2015). In this section, I discuss the potential in nutrition apps, like Appetitus, to influence dietary behavioral change.

Raising awareness and providing information: Enabling age-friendly dietary choices

The majority of older adults used the app individually (as intended) to log food and beverage consumption on a regular basis (Paper III). Through the app, they obtained access to information about their needs for energy, protein, and fluid and tips to adjust their consumption to meet their nutrient needs (Paper II). Awareness and knowledge of how personal consumption of food and beverage reflects one's individual needs for nutrients are an important part of allowing people to evaluate their eating habits (Bonilla et al., 2015; Brug, 2008). This is where the most promise in nutrition apps lies, and the Appetitus app demonstrated potential in this regard. Without tools like Appetitus, good arithmetic skills to evaluate energy, protein and fluid levels in one's consumption of food and beverages, and knowledge to interpret and compare to recommended values are required. The app presented the older adults with a tool that replaced the need for this skill set, which most individuals do not possess, but which can be very useful when preventing or treating nutritional problems like undernutrition (Brug, 2008).

Several of the participants in this study said they had implemented changes in their diet in efforts to meet their personalized, recommended goal for energy, protein, and fluids, as presented in the Appetitus app (Paper II). Numerous studies have investigated the effects on people's diet of being introduced to nutrition apps, and they have indicated significant effects on targeted nutritional changes for health promotion, such as increasing fruit and vegetable intake or reducing energy or salt intake (El Khoury et al., 2019; Mandracchia et al., 2019). Mummah and colleagues (2017) investigated the effects of a smartphone app called Vegethon, which was developed to support behavioral change related to vegetable

consumption. Participants who used the Vegethon app reported consuming an average of two more servings of vegetables per day than controls, which was a significant change (Mummah et al., 2017).

Several reviews have indicated that the feature of dietary self-assessment with immediate personalized feedback on consumption as the potent element in nutrition app interventions and an important contributor to intervention success (El Khoury et al., 2019; Mandracchia et al., 2019; McCarroll et al., 2017). This specific point was demonstrated in a pilot study that investigated opportunities in commercial apps to reduce sodium intake in healthy adults and compared it to more traditional dietary education methods (Ipjian & Johnston, 2017). They gave one group access to the MyFitnessPal app and set up the app to provide feedback on sodium intake. The control group received traditional education material on how to reduce sodium intake. The control group were also instructed to record their food and beverage consumption in a journal. The authors found that the group that used the nutrition app had a significant reduction in their urinary sodium excretion compared to the control group (Ipjian & Johnston, 2017).

Many older adults who used the Appetitus app said they became more conscious of their food choices and dietary patterns. They reported increased variation and eating more regularly. Several became more aware of the importance of proteins in their diet through the information in the app and the visualization of protein consumption. They reported becoming more conscious about food choices to ensure sufficient intake of proteins (Paper II and III). These are all important aspects of recommendations to diet alterations for those who are at risk of undernutrition. Having a varied diet can be an important measure to maintain appetite in old age, and increasing variation in meals can also lead to increased energy consumption (Pilgrim et al., 2015; Wijnhoven et al., 2015). Reduced appetite is identified as an important influencer of low food consumption and a significant determinant for undernutrition development. Measures to uphold the appetite therefore holds potential to prevent undernutrition (Clegg & Williams, 2018; van der Pols-Vijlbrief et al., 2014). One of the most common ways for older adults to alter their meal structure was eating more regularly throughout the day and having an evening meal (Paper II). People who need to increase their energy intake can benefit from altering their diet in this way. Having frequent meals with smaller servings has proven to increase energy intake among those who struggle with poor appetite and who have risk of undernutrition (Nieuwenhuizen et al., 2010).

Appetitus content, especially about how to fortify servings with energy and protein from regular food products such as oil, cream and egg, sought to offer knowledge to help maintain weight or prevent weight loss. Studies have demonstrated that interventions where older adults are provided with advice from registered dietitians on how to alter their diet with regular food can positively affect their weight development after hospitalization (Munk et al., 2016). A study by Terp et al. (2018) found that a nutritional intervention program consisting of individual dietary counseling from a dietitian followed by nutrition support from nurses in home care affected nutrition status, health experiences, and weight development. The individual dietary conversations focused on giving advice to older adults based on everyday food adjusted to their preferences (Terp et al., 2018). This result indicates that information content in Appetitus focusing on providing advice for food fortification with regular food can potentially have a positive clinical effect. A strength in Appetitus is that it provides specific tips for energy and/or protein fortification for the individual meal suggestions. For example, it gives advice to fortify porridge with cream or yoghurt with oil. This is a strategy to make dietary recommendations more relevant and applicable and thereby easier to put in to action (Vasiloglou et al., 2019).

Personalization: A critical aspect to strengthen motivation for dietary change

Goal setting is a central element in behavioral change and nutrition interventions

(Bodenheimer & Handley, 2009; Sahyoun et al., 2004). The literature suggests that when patients participate in goal setting and decisions regarding their own care, they are more likely to adopt the behaviors decided upon (Bodenheimer & Handley, 2009; Kampmeijer et al., 2016). Self-monitoring in apps is considered as a convenient and effective approach that can support older adults achieving their health-related goals (Kampmeijer et al., 2016; Steinert et al., 2016).

Although prevention and management of weight loss was the underlying goal in the Appetitus app and APPETITT project, we did not explicitly ask the older adults to set a behavioral goal, such as gaining or maintaining weight and did not adjust the recommendations for energy and protein consumption accordingly. This may be considered as a limitation of the intervention. Furthermore, the Appetitus app did not support alternatives for feedback on goal achievement beyond energy, protein, and fluid consumption. For some older adults, increasing meal frequency or eating dinner more regularly can be more realistic and personally important goals. Nutrition interventions appear to be most successful when interventions are tailored to

the individual; for example, by identifying the participants' intentions by letting them set their own goals (Sahyoun et al., 2004).

Motivation to change behavior is strongly connected to personal beliefs in whether or not the person has the ability to perform the intended behavior, often referred to as self-efficacy (Bodenheimer & Handley, 2009; Brug, 2008). If the dietary change looks like it requires a large reorientation of food habits, it is less likely that the individual will have a positive attitude towards dietary change compared to changes that require less comprehensive change (Brug, 2008; Kampmeijer et al., 2016). We saw examples of this in this study. Those for whom the app suggested the need to implement large alterations to their diet for goal achievement were less likely to implement changes compared to those who obtained feedback from the app that suggested that only small changes were necessary to meet their recommended nutritional requirements (Paper II). This can be interpreted as the app's goal setting influences participants' attitudes and motivation towards behavioral change both positively and negatively.

Trust in the dietary assessment functionality may have also affected whether or not participants were motivated to make dietary changes. A consequence of coarse detail level in the nutrition assessment functionality in Appetitus was that the app probably did not reflect all of the users' requirements for nutrients or realistic consumption of food and beverages, and this may have affected whether or not they chose to act upon the feedback from the app.

The topic of weight was given little attention in the interviews with older adults (Paper II). However, for a few of the participants, the dietary changes they implemented led to a weight increase they expressed being uncomfortable with (Paper II). It has also been reported in other studies that several older adults' attitude towards weight gain can be negative, especially for women (Locher et al., 2013; Winter et al., 2016). This can be a challenge in interventions targeting undernutrition. Both because it can make older adults difficult to recruit to interventions (Locher et al., 2013; Piantadosi et al., 2015), but more so if their awareness of the negative consequences of undernutrition remains absent (Jensen et al., 2019). This finding further points out the importance of clarifying individual goals when patients are introduced to tools like Appetitus and for health care professionals to discuss these goals as part of nutrition interventions to enable long-lasting behavioral change (Bodenheimer & Handley, 2009; Sahyoun et al., 2004).

The results from this study suggest that the Appetitus app represented a diet many of the participants felt they could identify themselves with (Paper II). Healthy diet can be understood as a core value underpinning many of the participants' dietary habits, with emphasis on eating fish, fruit and vegetables, and whole grain products (Paper II). If the behavioral change aligns with the personal values of the individual, this can positively affect the motivation for behavioral change (Brug, 2008). Dietary habits and food preferences are shaped by past choices. Dietary patterns are also culturally sensitive and have been recognized as being rooted in childhood (Bloom et al., 2017; Winter et al., 2016). Previous research has also identified intentions of maintaining a healthy diet as one of the most influential factors on food choices among older home-dwelling adults because eating is regarded as an investment to ensure independence (Lundkvist et al., 2010; Nyberg et al., 2015; Vesnaver et al., 2012). When the Appetitus app reflected a diet the user could identify themselves with and that was in line with their self-identity and core values, such as being healthy, the technology demonstrated potential in strengthening the motivation to make a change as suggested in the feedback from the app (Brug, 2008).

7.2.2 The role of health care professionals to support dietary change: A mesolevel perspective

Nutrition status is typically a self-managed condition in healthy older adults. However, in the context of home care many older adults receive some form of nutrition support, ranging from nutrition counseling to preparation of meals and delivery of hot meals. Since undernutrition is widespread among older adults in home care, the role of health care professionals can be vital. Nutrition counselling is recommended as a key intervention in prevention and management of undernutrition in older adults (Vasiloglou et al., 2019).

In this section, I discuss influences of the Appetitus app on health care professionals' nutrition care practice and also their role in supporting dietary change in older adults.

Health care professional found the information generated in the Appetitus app about older adults' meal frequency, dietary variation, and estimates for energy, protein, and fluid consumption to support and strengthen their nutrition assessment (Paper I). They experienced becoming aware of risk factors for undernutrition and initiated more discussions about nutrition with a preventative and health promoting focus (Paper I). The increasing attention health care professionals started to pay to core elements in the diet, such as low number of

meals eaten during the day or long night fasting, can be vital in preventing and managing undernutrition. Undernutrition development often starts with subtle and small changes in the diet, such as reducing snack meals or less regular dinner meals (van der Pols-Vijlbrief et al., 2017). Health care professionals can constitute an important factor in older adults becoming aware of risk factors for undernutrition (Vasiloglou et al., 2019). Health care professionals can also be crucial sources for nutrition-related information, and especially important is concrete advice where they suggest specific actions and steps towards dietary alterations (Vasiloglou et al., 2019).

Health care professionals indicated that the Appetitus app could support them when they provided dietary advice. The functionalities in the app, such as energy and protein consumption visualized in graph and the list presenting the older adults recorded meal and beverage choices, enabled them to alter their advice to more closely to meet individual patients' needs and preferences (Paper I). Furthermore, the older adults reported that they experienced a shift in the way health care professionals attended to their nutrition needs. They indicated that health care professionals set aside more dedicated time to discuss nutrition and had a more individualized approach (Paper II). These results suggest that the Appetitus app supported communication based in a mutual understanding of dietary challenges in line with patient-centered care practice (Constand et al., 2014; Lusk & Fater, 2013; Mead & Bower, 2000).

A patient-centered approach is recognized as the best way of providing nutrition support (Vasiloglou et al., 2019). Health care professionals also described how they sought to stimulate patients' awareness and motivation for dietary change by building on their resources (Paper I). This can be viewed as health care professionals taking a facilitating role in nutrition care and putting the patient's preferences and values at the center of their care in line with patient-centered care models (Constand et al., 2014; Lusk & Fater, 2013; Mead & Bower, 2000). However, some health care professionals felt challenged in this role because they lacked confidence in their nutrition knowledge. This resulted in them withdrawing from the situation and rather direct their follow-up to deal with technical aspects of the project (Paper I).

Barken and colleagues (2017) stated that technological decision-support systems rarely reflected the complex reality in which health care professionals make decisions; therefore, they tended to advance beyond the decision-support systems and based their clinical advice

on a broader assessment that included the consideration of patients (Barken et al., 2017). This indicates the importance of paying attention to the high level of competence and skills required of health care professionals when introducing welfare technology, such as Appetitus, to a care setting. Konttila et al. (2019) emphasize that health care professionals' clinical experience and competence in the area the technology support is a critical factor when introducing welfare technologies, which was also the case in this research: Shorter work experience appeared to be related to insecurities in providing nutrition-related follow-up to patients (Paper I). Such a relationship may indicate that for health care professionals to present competence in using welfare technological solutions like Appetitus, they also need to have strong clinical skills in addition to a good professional knowledge base (Konttila et al., 2019).

In this study, the older adults were provided with a technology that could make them better informed about their dietary needs (Paper II). Older adults were responsible for conducting nutrition assessment, and they had access to the same information as health care professionals in the Appetitus app. This led to the older adults taking a more active role in nutrition care. They initiated nutrition dialogs by asking questions and thereby set the direction of the nutrition conversation (Paper I). This shift in patient role can be seen as technology-mediated empowerment of the older adults and partnership establishment. According to the patient-centered care perspective, a partnership moves the balance of power from the classical health care professional as an expert towards more mutual distribution of power and shared responsibility (Constand et al., 2014; Lusk & Fater, 2013; Mead & Bower, 2000). Furthermore, other studies have shown that the introduction of patient-facing technologies can lead to changes in communication and interaction patterns between health care professionals and patients (Frennert & Baudin, 2019; Qudah & Luetsch, 2019). Studies that have investigated older adults' experiences of using welfare technologies to report their health concerns and disease-related health measurements have indicated that such technologies can support establishment of a mutual clinical language between health care professionals and patients (Barken et al., 2018; Göransson et al., 2018). In line with the current study, these studies also reveal opportunities in technologies to increase patients' active involvement in care, and this can in turn strengthen their self-care abilities and independence (Barken et al., 2018; Göransson et al., 2018).

Health care professionals follow-up and support are considered crucial for older adults' sustained use of nutrition apps, and support from health care professionals can also strengthen the individual's motivation for behavioral change (Chen et al., 2018). This study indicated some asymmetry in terms of the importance of health care professionals follow-up support: While health care professionals regarded their role as important and viewed themselves as translators of information generated in the app, the majority of older adults generally reported greater independence in using Appetitus as a tool to evaluate their nutrition status (Papers I and II). However, the older adults who experienced that health care professionals devoted greater attention to their nutrition in the follow-up saw this as an important aspect of the study. They felt that health care professionals generally demonstrated concern about their health and well-being when they paid attention to their diet and nutrition status (Paper II). Having a caring attitude emerged as a recurring quality in the literature when operationalizing patient-centered care (Lusk & Fater, 2013). A review indicated that patients who used technologies to report their health concerns and communicate with health professionals expressed feeling taken care of because being remotely monitored could foster a sense of security and connectedness with health care professionals (Qudah & Luetsch, 2019). In this current study, support from healthcare professionals was considered important for the older adults to build confidence to use the app, and for some as experiencing it as meaningful to use Appetitus.

7.2.3 Appetitus: A tool to realize healthy aging policy? Reflections from a macrolevel perspective

Core components in healthy aging policy include efforts to strengthen opportunities of the individual to utilize their resources and create environments where all people despite old age and disabilities can live active and meaningful lives and age in place (WHO, 2015). For health and social care services, this includes placing greater emphasis on proactive services focusing on health promotion and early intervention to support everyday coping.

Reorganization of home care services with emphasis on patient-centered care and increased use of welfare technology are considered important aspects of developing sustainable health care services that can face the challenges of demographic change (Meld.St. 15 (2017-2018); NOU 2011:11).

The APPETITT project can be placed in the political landscape of healthy aging. For many participants in this study, Appetitus worked as a welfare technology tool that could strengthen

their self-care abilities (related to nutrition) and their autonomy in health-related discussions with health care professionals (Paper I and II). As seen in this current study, other researchers have suggested that older adults are positive about engaging in healthy lifestyle activities; for example, being physically active and having a balanced and healthy diet (Coley et al., 2019; Klugar et al., 2016). They consider such healthy lifestyle activities as crucial factors for good health experiences in old age (Klugar et al., 2016; Wallack et al., 2016). When older adults emphasize the value of engagement and health-promoting behavior, this can be seen as an expression of how the policy of active and healthy ageing are inscribed into the lives of older people (Lassen, 2015).

Another pervasive perspective in today's health care policy is the one that expects older adults to take an active role in their care (Jacobsen, 2017). This study revealed some of the opportunities in introducing welfare technology to strengthen patients' engagement in care. However, this study also demonstrated that involvement in self-care through technology could be a demanding activity, which might exclude older adults with severe health burden (Paper III). There are large numbers of patients who receive home care services who do not have the cognitive capacities or energy to use welfare technologies intended for stimulation of self-care and healthy lifestyles. Some patients also highlight their concern for technological interventions in the health care sector that aim to support patients' activity and independence because they potentially displace human contact (Göransson et al., 2018).

The APPETITT project also demonstrates some of the challenges in the health care system in terms of innovation and technology adoption, as well as reorientation towards focusing on health promotion and early intervention strategies. Health care professionals indicated organization of home care services with predefined tasks and high time pressure as barriers to prioritizing health-promoting care activities (Paper I).

The topic of time constraints raised discussions in the focus groups, and some managers and clinical leaders claimed that health care professionals should argue for time use with clinical reasoning (Paper I). Although home care is often organized so that allocation of services to older adults are structured as predefined tasks reflecting service needs assessment, the health care professionals who provide services still have a professional responsibility to assess the needs of the patients when they provide care (Lunde & Otterlei, 2020). However, there are several studies that have revealed that health care professionals experience a gap between the overall political guidelines and their implementation, professional standards, and the working

conditions they encountered on a day-to-day basis (Hestevik et al., 2020; Olsen et al., 2019; Watkinson-Powell et al., 2014). Creating a culture for health-promoting care activities might depend on providing health care professionals with more freedom to assess patients' needs on an everyday basis and more liberal time frames (Lunde & Otterlei, 2020).

This study demonstrates that tools such as *Appetitus* can put health promotion on the agenda. Health care professionals claimed that they started to recognize and address risk factors for undernutrition at an earlier stage when patients recorded their food and beverage consumption in *Appetitus* (Paper I). This was both related to a more thorough assessment of diet being available to them as well as changed interactions between health care professionals and patients. When older adults are at the center of the intervention, they request more dialog-based support and show more interest in information and care that focus on how they can strengthen their self-care abilities to maintain their independence and to age in place (Göransson et al., 2018; Klugar et al., 2016; Little et al., 2001; McGilton et al., 2018).

7.3 Methodological considerations

In this section, I will address methodological considerations regarding conduct of the research, with emphasis on the sampling strategy, data material, analysis, and presentation of findings. The emphasis was on qualitative methods in this thesis. Therefore, I have chosen to place the methodological discussion of the data, analysis and presentation of study results within the qualitative tradition under the concept of trustworthiness (Graneheim & Lundman, 2004; Korstjens & Moser, 2018).

7.3.1 Considerations regarding study design, sampling, and conduct of the study

The design of this study was explorative, with emphasis on using qualitative methods, while also including descriptive quantitative methods.

In an explorative qualitative study, recruiting a sample that provides the researcher insights in various experiences within the field studied is recommended (Patton, 2002). As the aim of this study was to explore the feasibility of introducing *Appetitus* for nutrition care and opportunities in supporting early interventions to prevent undernutrition and manage nutritional challenges among older adults, the home care setting was considered appropriate because older adults in this setting have high risk of undernutrition (Crichton et al., 2019).

When recruiting study sites, we used purposeful sampling strategy (Polit & Beck, 2012). This strategy, which aimed for variation, was considered appropriate as we sought to maximize variation to explore opportunities in introducing and using Appetitus in the home care setting. Home care services are organized in various ways in Norway (Holm et al., 2017). We also included a senior center as one of the study sites. This inclusion was to broaden perspectives in terms of the opportunities of using Appetitus in the broader context of primary care, focusing more explicitly on health promotion and preventative health care.

In this thesis, I emphasized exploring feasibility and opportunities with Appetitus in the context of home care. The opportunities with Appetitus within a senior center setting is not explored specifically. This can be considered a limitation since I included data material from the older adults in this study site in Paper III. However, older adults that are recipients of home care services frequently use senior center services. Moreover, among the older adult recruited to the trial set up in the senior center, several had home care services.

The combination of interviews with older adults and health care professionals and capture of log data can be argued as providing strong data to explore feasibility and opportunities with the APPETITT intervention. However, this study could have been strengthened by including more quantitative measurements of the effects of the intervention, such as focusing more on older adults' diet and nutrition status. Such preliminary effect investigations are relevant aspects of feasibility studies and can provide insight for potential future evaluation studies (Giangregorio & Thabane, 2015).

When we recruited health care professionals and older adults we had less control in the recruitment process compared to when we recruited study sites. The managers in each study site recruited health care professionals who they believed were suitable to participate in this particular project. This suitability assessment was based on knowledge (e.g., health care professionals with nutrition course), interest in the topic (either nutrition or technology), or the fact that the health care professionals they recruited were not engaged in other projects at the time of the trials. The health care professionals who participated in the study recruited older adults. We asked health care professionals to recruit individuals who they considered were likely to benefit from participation in a nutrition intervention and who could learn to use the application and the tablet computer independently. This strategy aligned with how health care professionals in home care districts worked when deciding on offering other welfare technology solution to their patients. This recruitment strategy was considered suitable since

the focus was on feasibility aspects and also because we wanted the trials to reflect a realistic implementation of Appetitus in home care.

I will highlight a significant strength in this study regarding the sample of older adults: They presented diversity in terms of the forms of technology experience, functional and nutrition care dependency, and nutrition status. Likewise is the sample of health care professionals diverse, including health care professionals with various educational backgrounds and professional roles. This allowed for a broad exploration of the feasibility of implementing Appetitus among home dwelling older adults in the context of home care services.

However, the choice of recruitment strategy can also be considered a limitation in light of feasibility exploration. We lacked control of the recruitment process, so this study did not provide insights about the number of patients in home care who were eligible and willing to participate in studies of a similar nature in the future. Such insights about recruitment can be a valuable part of feasibility studies, as many effect studies fail to provide conclusive results because they experience difficulties with recruiting enough patients (Treweek, 2015).

Difficulties understanding the recruitment message can be a challenge when recruiting for health care interventions (Coley & Andrieu, 2012; Provencher et al., 2014). In interventions that include technology, this can be particularly prominent if the older adults lack a technological reference frame (O'Connor et al., 2016). In this study, health professionals experienced this as a barrier in the recruitment of older adults to the first trial period. They started to bring the iPad with Appetitus installed when they asked participants to participate in the second trial in efforts to strengthen older adults' understanding of what the project entailed. This indicated a significant strength of this study in light of it being a feasibility study. The two trial periods and the strong involvement of health care professionals to shape the recruitment process allowed for revision in recruitment procedure. This led to valuable insights in how to overcome older adults' difficulties in understanding recruitment message when exploring opportunities with innovative technology-based interventions.

Another strength of this study was that the Appetitus app was developed in several interactions with end-user involvement in all phases, and much of the usability and content feedback from older adults was implemented before the second trial period. This positively affected user acceptance of the interventions and compliance in line with study plans.

However, the health care professionals' compliance with the intervention delivery was less

successful. Some health care professionals said they had not provided the intended nutritional follow-up support to older adults in the study because they felt insecure of their own knowledge regarding nutrition. In hindsight, I see that in the planning of the study, I failed to acknowledge and understand that the Appetitus app would not work solely as a source of information for the health care professionals and support their practice. For example, when the discrepancy between the estimated needs for energy in the app and the energy estimated in the reported food and beverage consumption was large, this could be a source for confusion for both health care professionals and patients. I had not discussed this with the research team and addressed this challenge in advance of the trials. This presents an ethical issue as it could lead to challenging situations for the older adults if they struggled to interoperate the feedback from the app, but did not receive the intended support from health care professionals. I therefore considered it a weakness that we did not have a plan to support health care professionals who struggled with the role they were assigned.

7.3.2 Trustworthiness

Trustworthiness refers to the quality of the whole study and how it is presented to the reader so that they can assess if the research presents accurate and insightful research results (Graneheim et al., 2017; Polit & Beck, 2012).

Trustworthiness reflections related to data collection and material

My two supervisors and I had a dual role in the APPETITT project. By its nature, the APPETITT project was a research and development project set up to drive regional innovation. Hence, we were both researchers and contributed to the development of the Appetitus app. We took several practical measures to minimize researcher influence in data collection. The most important was that the health professionals recruited and provided follow-up support to participants; therefore, we had less control in that phase. We used semi-structured interview guides in all interviews. This ensured that the data collection covered the same topics in all interviews despite different data collectors and preconceptions (Patton, 2002). We also emphasized to the older adults and health care professionals the importance of obtaining all kinds of feedback: both criticism and praise to further develop the app and explore opportunities with imbedding Appetitus as part of nutrition care.

The active use of the Appetitus app in the individual interviews with older adults to demonstrate what they did and their experiences with specific functionality can be considered

a strength in our data collection. This allowed focusing attention to experiences related to actual use of the app in the interviews, and reflections of usability and opportunities with such an app are thus closely linked to the user's actual experiences (Malterud, 2012).

We collected data from both health care professionals and older adults to explore opportunities of Appetitus in the home care context from different perspectives. In addition, we used both interview data and log data from Appetitus to explore older adults' use of Appetitus. This combination of data sources is a strength of this study as it contributed to gaining broad insight regarding opportunities and feasibility of implementing the Appetitus app as part of nutrition care in home care. Such a combination of data and mixed-method approach can also be a measure to strengthen credibility of explorative studies because different data sources or methods to collect data can reveal different aspects of an empirical reality (Korstjens & Moser, 2018; Patton, 2002). In this study, I would argue that different perspectives on reality were revealed. For example, the inclusion of both health care professionals who were directly involved in follow-up of older adults, and their managers in the focus groups generated data on several viewpoints regarding time constraints as barriers to implementing Appetitus and prioritizing nutrition discussions with patients (Paper I).

On that note, I should mention that the combination of managers and staff in focus groups can be considered a limitation. We could have been more sensitive to power dynamics between the informants when we planned the focus groups. Although we experienced open communication about barriers in the focus groups, more homogeneous groups could have strengthened the association effect among participants and create a safer milieu for sharing experience of work environment barriers for health care professionals who provided follow-up to older adults (Malterud, 2012). As such, it can be hypothesized that a different organization of focus groups could have opened for other topics, and potential emphasis in the material where other perspectives could have been presented.

Measures to establish trustworthiness of analysis and results

Being more than one researcher in the analytic process of qualitative data and openly reflecting about preunderstandings are strategies that can strengthen credibility and dependability of qualitative research (Graneheim et al., 2017; Korstjens & Moser, 2018). This is based on the understanding that interview material is a result of co-creation between the researcher and the interviewee and that all text always entail more than one meaning

(Graneheim et al., 2017). By including more than one researcher to analyze the text, the opportunity to become aware of different meanings in the material are strengthened. In the analysis of data presented in the three papers, I had several analytic seminars with my supervisors and was crucial in bringing such different understandings forward.

For the reader to consider the trustworthiness of the qualitative data analysis, some measures are recommended. Giving a rich description of the analysis process is the first step (Tong et al., 2007). We have referred to Graneheim and Lundman (2004) when presenting our analysis and also provided tables that exemplified how we practically adopted this method. However, in Paper III our description of the qualitative analysis was less detailed. This can be considered a limitation.

We used quotes to raise give prominence to the voices of informants in reporting the study results. This is important in demonstrating the credibility of the results to the reader (Graneheim & Lundman, 2004; Patton, 2002; Tong et al., 2007). However, limited space in the article format influenced to some degree our use of quotes, and I believe more quotes could further strengthen credibility in the result presentation; for example, by more actively presenting the various views of the participants within each theme.

When considering transferability of the results, it is important to provide the reader with information about the context of the study (Korstjens & Moser, 2018). One example of how we focused on this is in our discussion regarding the sample of older adults. As discussed in Section 7.1.2. and Papers II and III, older adults recruited to this study represent a more cognitively fit and healthy sample compared to the full range of the population who receive home care services in Norway (Helvik et al., 2015). Another important aspect of transferability includes providing international readers with some contextual information of the Norwegian health care system. In my experience, one of the great advantages of publishing in international peer reviewed journals is that reviewers explicitly ask for more contextual details if the context is not sufficient described. However, whether or not an international reader could fully comprehend the context of Norwegian home care based on our descriptions without prior knowledge about it remains an open question.

Although we have discussed the chance of being excessively positive in favor of the Appetitus app in analysis seminars and in the process of writing the articles, there is a risk that our preconceptions influenced the analysis and introduced bias in the presentation of the study

results. However, we have taken care to ensure transparency and balance roles. Furthermore, in the published articles we are explicit about our dual roles in the project. This allows readers to include our preconceptions in their assessment of the study results as a way to strengthen trustworthiness (Tong et al., 2007).

8 Conclusions and further studies

The results of this study presented in the three papers suggest that it is feasible to implement patient-facing nutrition apps in home care settings and that such welfare technology solutions have potential to support nutrition care in this setting, with increased focus on early interventions and health promotion.

The majority of the older adults who participated in this study used the Appetitus app regularly in the trial period. The most engaged users recorded their food consumption daily for eight weeks. The Appetitus app served as a source of inspiration for a more varied diet, and many older adults became more conscious of their diet and made efforts to ensure sufficient protein, energy, and fluids in their food and beverage consumption. However, some participants did not alter their diet despite understanding that the feedback from the app suggested eating more.

Often, small and unconscious changes in dietary habits lead to high vulnerability for undernutrition in old age. A greater awareness among older adults themselves can therefore have enormous potential as an early intervention to manage nutrition challenges and prevent undernutrition, and thereby support maintenance of health and function in old age.

From the perspective of health care professionals, the Appetitus app offered a thorough nutrition assessment and provided health care professionals a detailed overview of the older adults' dietary patterns. This could reveal potential risk factors for undernutrition or highlight nutrition problems for the health care professionals at an early stage. The overview of the older adults' diet in the Appetitus app also supported the health care professionals in providing dietary advice to them. These results suggest that a more widespread use of technological tools to support health care professionals' nutrition care practice could improve quality of care and strengthen the focus on health promotion and early interventions. However, the study identified some barriers for sustainable adoption of Appetitus as part of nutrition care practices in home care. These included organization of how health care professionals work in home care, knowledge barriers, and lack of priority to spend time on health promoting care activities.

It is a political ambition to reorient health care systems towards increased attention to health promotion to postpone older adults' care dependency, and welfare technology is considered a

central part of the solution. This study indicates opportunities with welfare technological solutions to activate the older adults in self-care activities and promote a patient-centered care practice. Nutrition is of special relevance in health promotion initiatives, as an area for self-care and early interventions because good nutrition status is considered central in health experiences and independence in old age.

8.1 Implications for practice

For older adults, the results from this study are relevant as it shows that nutrition apps, like Appetitus, can be a relevant tool to manage diet in ways that can reduce the risk of developing undernutrition, which in turn can support aging in place. The majority of the older adults included in this study demonstrated a positive attitude to use self-management technology that focuses on prevention of undernutrition. This supports previous research indicating that older adults show interest in participating in health promoting activities in efforts to maintain independence and experience good health (Coley et al., 2019; McGilton et al., 2018). Older adults are resourceful, and many have a proactive approach to changing life conditions, such as physical limitations related to chronic disease (Klugar et al., 2016). Older adults call for more health-related information in plain language and desire to participate in health-related decisions regarding their own health (McGilton et al., 2018). Having access to sources for dietary advice that is based on research and expertise advice, such as the Appetitus app, can therefore be valuable to older adults. This study also show that using self-management tools can strengthen the older adult's voice in health related discussion and facilitate patient-centered care that are responsive to values and concerns of the older adults.

Technology experience was not a critical factor for use of the Appetitus app among older adults. If health technologies are considered intuitive and easy to use, older adults are willing and able to use them. This result is relevant for older adults, as it can contribute to lowering the threshold for the uptake of health technology. Likewise, for health care professionals and managers, this finding may help to reduce barriers to introducing patient-facing technologies into health care services.

This project became a gateway to broader technology adoption for some of the older adults who participated in the study. They started to use Internet, and some used social media to keep in contact with their family. The oldest adults and those with reduced health still lagged behind the rest of the society in terms of adopting technologies (Keränen et al., 2017;

Slettemeås et al., 2018). Technology supported health interventions can thus be a gate opener for older adults to become digital citizens (Østensen et al., 2017). With the ongoing Covid-19 pandemic societal and social connectedness through Internet have become even more relevant for older adults.

Another practical implication of this study is that nurses and other health care professionals in home care might embrace the opportunities of using nutrition apps and other decision-support systems to strengthen their nutrition care practice. However, this study also revealed that implementation and use of self-management technology is not straightforward. Addressing challenges regarding health care professionals' nutrition competence and using organizational structures that can support them to fully make use of the technology is important (Kleiven, 2017; Konttila et al., 2019). Self-management technologies, like nutrition apps, can also be considered demanding for older adults to use, especially for older adults who experience high disease burden or who have cognitive decline.

From a health policy perspective, paying more attention to health promotion, prevention, and rehabilitation in home care are the stated goals (Meld.St. 15 (2017-2018)). This study indicated that the organization of home care service affects whether health promotion receives attention and priority. A clarification of the importance and responsibility to include prevention and health promotion as part of home care with, for example, the use of a quality indicator can be a way to bring attention to the value of this type of work and put it on the agenda (Johansson et al., 2017). Through the patient safety program (2014-2018) and the implementation of quality indicators for nutrition, focus has been placed on mapping nutritional risk in patients who receive home care services (Deloitte, 2019). This is important because identifying risk is the first step towards focusing on nutrition as a significant challenge that threatens aging in place, health experiences, and quality of life (Volkert, et al., 2019). This study suggests opportunities to strengthen health care professionals' nutrition care practice through access to tools that can support the nutrition care process when risk of or a state of undernutrition is discovered. It further serves as an example of how implementation of welfare technology in home care services can potentially strengthen older adults' self-care abilities for active involvement in care.

8.2 Implications for further research

This study has contributed new knowledge about older adults and health care professionals' experiences of using the nutrition app, Appetitus. The current study focused on understanding the feasibility and opportunities of the Appetitus app supporting early interventions to prevent undernutrition and manage nutritional challenges among home-dwelling older adults.

However, it did not aim to measure how the Appetitus app directly influenced older adults' risk of undernutrition in terms of end-points, such as weight development, energy and protein consumption related to estimated needs for nutrients or dietary patterns related to meal types, meal frequencies, or diet variance. The value of nutrition apps in terms of these issues should be evaluated further.

How health care professionals considered opportunities with and their perspective on Appetitus' influence on nutrition practices were explored in this study. Health care professionals discussed the potential of apps like Appetitus to strengthen nutrition care for patients with dementia and cognitive decline. Potential for improved information sharing between health care professionals and family caregivers was one of the opportunities highlighted (Paper I). This patient group receives help from many different health care professionals throughout the day, as well as frequently from family members (Hestevik et al., 2020). This involves the risk of care fragmentation. Exploring opportunities in technologies, such as the Appetitus app, to support daily communication of food intake would be an important study.

Informal caregiving from family members or friends often constitutes a substantial part of the total care older adults in home care receive (Marshall et al., 2017; Moholt et al., 2020). Family members are also considered as important contributors for many older adults in terms of practical assistance in grocery shopping and other nutrition-related activities (Marshall et al., 2017). However, family caregivers' nutrition knowledge is often insufficient in cases where older adults require a diet high in protein and energy (Marshall et al., 2017). It is therefore recommended that health care professionals consider family carers' influence on older adults' diet and strengthening family carers' abilities to take a supportive role to prevent dietary challenges among older adults. In addition, family and friends often play an important role when older adults learn to use new technologies, and they also provide support after initial introduction (Slette-meås et al., 2018). Investigating the perspective of family members

and their contribution when nutrition apps such as Appetitus are introduced to older adults would therefore be of interest.

Technology development is rapid. Nutrition apps, such as Appetitus, will need continuous updates if they are to be established as tools in health promotion and clinical practice. Sustainability is one of the biggest challenges when such tools are developed in research. Funds and incentives are seldom available to maintain the technology, and it is thus rarely adopted in practice. Given the increased pace of technology adoption among older adults, exploring opportunities with the use of commercial apps in this cohort could be more relevant in the future. This study can contribute important knowledge about design elements in apps that can strengthen the acceptance and use of nutrition apps, as well as revealing the structures that should be in place to make use of such services in health care settings. I will highlight that inspiration with appealing and appetizing pictures of meals that are culturally and seasonally sensitive, quick and easy recording of food and beverage consumption, and follow-up support from health care professionals appear to be especially relevant for older adults' acceptance and experience of the use value of Appetitus.

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Original papers

- I. Farsjø, C., Kluge, A. & Moen, A. (2019) Using a tablet application about nutrition in home care—Experiences and perspectives of healthcare professionals. *Health & Social Care in the Community*, 27, (3), 683–692. <https://doi.org/10.1111/hsc.12685>
- II. Aure, C.F., Kluge, A. & Moen, A. (2020) Promoting dietary awareness: Home-dwelling older adults’ perspectives on using a nutrition application. *International Journal of Older People Nursing*, 15, (4), e12332. <https://doi.org/10.1111/opn.12332>
- III. Aure, C.F., Kluge, A. & Moen, A. Older Adults’ Engagement in Technology-Mediated Self-Monitoring of Diet: A Mixed-Methods Study. *Journal of Nursing Scholarship*. Advance online publication. <https://doi.org/10.1111/jnu.12619>

Paper I

Using a tablet application about nutrition in home care—Experiences and perspectives of healthcare professionals

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Abstract

Undernutrition is an extensive problem among patients in community care services. The literature identifies several barriers that hinder health professionals in identifying nutritional problems and providing nutrition interventions. We developed Appetitus, a tablet application (app) focused on nutrition for older adults. Patients used the app, advised by healthcare professionals. In this study with qualitative design, we explored experiences and perspectives of healthcare professionals who used Appetitus when providing home care. We interviewed 24 healthcare professionals individually and in focus groups. We subjected the data to qualitative content analysis. Healthcare professionals used Appetitus as a mediator in dialogues with patients about nutrition. Giving the older adults an active role in nutrition assessment afforded opportunities to strengthen their involvement in care. Registrations of food and drink consumption gave the healthcare professionals insight into patients' situations and revealed problems of which the healthcare professionals had not been aware. Based on their experience with Appetitus, healthcare professionals suggested using electronic tools to assess and document the nutritional situation of a larger patient group in home care. In future use of Appetitus, healthcare professionals' levels of knowledge and confidence when advising patients about nutrition must be emphasised and addressed. Barriers such as time constraints and limited continuity of care are also areas that require attention when new nutrition practices are implemented.

KEYWORDS

handheld computers, health personnel, health promotion, home-care services, protein-energy malnutrition, qualitative research

1 | INTRODUCTION

Internationally, health policy calls for support of active and healthy ageing to meet the projected challenges that follow increased life expectancy and a growing population of older adults whose age exceeds 80 years (Walker, 2002; World Health Organization, 2002, 2015). Adopting technological advances in healthcare services is important to enable older adults to live independently and safely in their homes for as long as possible (World Health Organization,

2002, 2015). Community healthcare is shifting away from compensatory services, placing more emphasis on early intervention and prevention with a focus on health maintenance and rehabilitation (Cochrane et al., 2016; World Health Organization, 2015). Engaging the patient in goal setting and personalisation of care is at the core of this policy (Cochrane et al., 2016). Good nutrition status, social and physical activity are important facilitators for healthy, active ageing (World Health Organization, 2015). Unfortunately, nutritional risk and undernutrition are prevalent

among older patients, negatively impacting many areas of health, including quality of life, physical and cognitive functioning, and complications during acute illness (Agarwal, Miller, Yaxley, & Iсенring, 2013; Kaiser et al., 2010).

Primary responsibilities of healthcare professionals in community healthcare include identification of patients with nutritional risk, follow-up with dietary support, and interventions to alleviate nutrition problems (National Institute for Health & Care Excellence, 2006). In Norway, dietary counselling by certified dietitians is a scarce resource in community care, and nurses and nurse aides assume responsibility to support patients at risk. However, this group reports limited knowledge and experience in evaluating nutritional status in their patients and in addressing identified nutritional problems (Bauer, Halfens, & Lohrmann, 2015; Mowe et al., 2008).

Several studies point out that healthcare services also lack routines and guidelines to support good nutrition practices (Aagaard & Grøndahl, 2017; Merrell, Philpin, Warring, Hobby, & Gregory, 2012; Schindler et al., 2010). When risk of undernutrition among older adults is identified, the suggested approach is a high-calorie, protein-rich diet (National Institute for Health & Care Excellence, 2006). Low-threshold interventions, like adding full-fat dairy products or vegetable oils to meals, are practical strategies for food fortification to increase energy and protein density of food (Dunne, 2007). Several studies report that interventions that include dietary counselling can increase patients' knowledge about adequate nutrition and improve their nutrition and functional status (Agarwal et al., 2013; Bandayrel & Wong, 2011; Young, Bunn, Trivedi, & Dickinson, 2011). Combining self-assessments, written information, and nutritional counselling is another promising strategy for nutritional support (Ha, Hauge, Spennig, & Iversen, 2010; Pedersen, 2005).

Tablet computers and smartphones allow for new delivery modalities in assessing dietary intake and providing personalised dietary advice (Hingle & Patrick, 2016). Tablet computers is considered to be intuitive and easy to use for older adults who receive support and training when introduced to the tool (Gjevjon, Øderud, Wensaas, & Moen, 2014; Watkins & Xie, 2015). However, costs, privacy concerns, and usability problems are important topics to address ahead of introducing older adults to tablet computers because these are factors that may be of concern (Peek et al., 2014). There is a scarcity of studies reporting on healthcare providers' role and efforts when introducing older adults with specific needs to the adoption of technology-supported care.

In our study, we developed *Appetitus*, a tablet application (app) about nutrition, and introduced it to health providers and patients in home care. This paper explores the experiences and perspectives of healthcare professionals who used our nutrition app for home-care services. We addressed the following research questions:

1. How are healthcare professionals embedding and considering the relevance of *Appetitus* in nutrition care practice?
2. What are barriers and facilitators for use of *Appetitus* in nutrition care?

What is known about this topic

- Older adults are at high risk of undernutrition, which negatively impacts cognitive and functional status.
- By focusing on nutrition healthcare professionals can play an important role in postponing health decline among older adults.
- Technology affords opportunities for innovation in provision of nutrition care, enabling support through flexible solutions to assess dietary intake and provide personalised dietary advice.

What this paper adds

- This study highlights the importance of giving healthcare professionals tools that support their nutritional care.
- Data-driven dialogues about nutrition between patients and healthcare professionals can strengthen nutrition care.
- Creating and adopting health technologies that are easy to use can support active patient engagement in care.

2 | METHODS

2.1 | Study design

This paper is part of the report from a larger exploratory feasibility study of *Appetitus*. This is an example of complex intervention in home-care services to improve nutritional care for home-dwelling older adults at risk for undernutrition (Richards & Hallberg, 2015).

2.2 | Recruitment and sample descriptions

We recruited five home-care districts in three Norwegian municipalities to be study sites. A home-care district is part of the publicly funded community care services and serves the population within a defined geographical area with services such as home-care and rehabilitation services. Our study sites represent diversity in departments, including home healthcare departments, nonmedical home-care departments, and rehabilitation services. Initially, we established contact with supervisors in the home-care districts, who decided on capacity to participate in the study. One home-care district declined to participate because of high staff turnover.

Twenty-four healthcare professionals and 29 patients participated in this study. We used convenience sampling to recruit them (Polit & Beck, 2012). Supervisors in the participating home-care districts identified healthcare professionals whom we then recruited to participate in the study. Participating healthcare professionals included personnel directly involved with patient follow-up, and supervisors who facilitated the trial. Our sample demonstrates diversity in

informants' professional roles and educational backgrounds (Polit & Beck, 2012). Table 1 provides information about the sample.

Healthcare professionals recruited patients to participate in the study. We asked them to recruit patients 65 years or older, whom they believed would benefit from participating in a nutrition intervention and could manage to use the application and tablet computer independently. One recruited patient was 40 years old, but was considered suitable candidate because she had nutritional challenges. Table 2 presents information about the patient sample.

2.3 | The Nutrition App Appetitus

Commercial nutrition apps focus on weight loss and require users to record food and beverage consumption in detail (Hingle & Patrick, 2016; Shriver, Roman-Shriver, & Long, 2010). Therefore, they are less relevant to older adults at risk of malnutrition or to healthcare professionals who work with this patient group (Hingle & Patrick, 2016). The Appetitus app was developed to encourage and advise on weight gain or maintenance. The project team included dietitians and nurses with considerable experience in community care and researchers with expertise in universal design. In designing the app, a focus on good contrasts, appropriate text size, and large size of interaction elements was addressed (Kascak, Rëbola, & Sanford, 2014). We also took special consideration to minimise the work of detailed recording of food and beverage consumption.

TABLE 1 Characteristics of the sample (healthcare professionals)

Gender	
Female	23
Male	1
Age	
Years, mean (range)	43 (23–65)
Type of position	
Home health aide	4
Nurse	6
Nursing student	2
Other	1
Professional development nurse ^a	5
Social worker	1
Supervisor	5
Experience with geriatric patients (nursing students excluded)	
Years, mean (range)	12.3 (1–29)
Employment (nursing students excluded)	
Part-time	36% (n = 8)
Full-time	64% (n = 14)

^aProfessional development nurses are working with continuous staff development and quality improvement, often in combination with clinical duties. Professional development nurse may have master's degrees, with specialisation in for example geriatrics, or many hold a bachelor degree in nursing and draw on extensive experience to fulfil the role.

Appetitus presents a meal plan that suggests adding snacks and reduce night fasting to less than 12 hr. Appetitus offers pictures of 147 dishes. Practical tips on how to make meals and beverages more energy and protein dense are available. The user can log food and drink consumption and receive personalised feedback about energy, protein, and fluid based on personal requirements (graph visualisation). Calculation of the users' requirements for energy, protein, and fluids is based on the algorithm: 30 kcal, 1.2 g protein, and 30 ml fluid per kilogram of body weight. The user can percentwise adjust the portion size when logging consumption, but not the contents in the presented dish. We organised two 8-week trial periods (Autumn 2015 and Autumn 2016) with improvements and adjustments of app design and content between the trial periods.

2.4 | Implementation of the intervention

Prior to the trial periods, we met with the healthcare professionals, introduced them to Appetitus, and discussed and outlined their advisory role in the project. The patients were provided with iPads with Appetitus and 3G Internet. Healthcare professionals were responsible for introducing them to the iPad and Appetitus, follow-up on initial introduction, and encouraging patients to use the app daily for 8 weeks. We asked healthcare professionals to meet with patients a minimum of three times in order to effectively introduce the iPad and Appetitus and to discuss nutrition. Recording food and beverage consumption was encouraged, and 75% of patients used the app daily to log their food and beverage consumption. The rest used this functionality more sporadically, either because they decided not to record or because they did not master it due to cognitive challenges.

2.5 | Data collection

We interviewed healthcare professionals at study sites during work hours. We held nine focus group interviews and three individual

TABLE 2 Characteristics of patient sample

Gender	
Female	72% (n = 21)
Male	28% (n = 8)
Age	
Years, mean (range)	78 (41–96)
Nutritional status according to Mini Nutritional Assessment – Short form (MNA-sf)	
Malnourished or at risk of malnutrition	76% (n = 22)
Normal nutrition status	24% (n = 7)
Living arrangements	
Living alone	69% (n = 20)
Living with spouse	31% (n = 9)
Experience with touch technology (1 missing)	
No prior experience	61% (n = 17)
Prior experience (smartphone or tablet)	39% (n = 11)

TABLE 3 Information about interviews

Study site 1 Combined home healthcare and nonmedical home-care department	seven informants:	Focus group, midway trial 1	Four informants	106 min
	• Nurses	Focus group, after trial 1	Six informants	120 min
	• Home health aides • Professional development nurse • Supervisor	Focus group, after trial 2	Six informants	83 min
Study site 2 Home healthcare department	four informants:	Focus group, midway trial 1	Three informants	100 min
	• Home health aides	Focus group, after trial 1	Two informants	68 min
	• Professional development nurse • Supervisor	Focus group, after trial 2	Three informants	58 min
Study site 3 Rehabilitation department	five informants:	Individual interview, after trial 1	One informant	50 min
	• Nurses	Individual interview, after trial 1	One informant	61 min
	• Supervisor	Individual interview, after trial 1	One informant	48 min
	• Social worker	Focus group, after trial 2	Four informants	61 min
Study site 4 Home healthcare department	three informants: • Professional development nurses • Supervisors	Focus group, after trial 2	Three informants	54 min
Study site 5 Home healthcare department	five informants: • Professional development nurses • Supervisors	Focus group, after trial 2	Five informants	42 min

interviews. We conducted these three individual interviews due to unexpected practical challenges in gathering health professionals in the data collection period. In focus groups, discussions are encouraged with the aim to generate rich and nuanced data (Polit & Beck, 2012). Average duration of focus groups was 77 min and 53 min for individual interviews. See Table 3 for information about interviews at each of the study sites.

We used a thematic, semi-structured interview guide, addressing the following themes: recruitment, training, and supervision of patients, design and usability reflections, and user experiences. We recorded and transcribed the audio from interviews. Either the first author (C.F.) or the last author (A.M.) led the interviews. The second author (A.K.) and a research assistant (A.L.J.) participated as assisting moderators in four of the focus groups. Ethical approval for the study was obtained by the University's Institutional Review Board "Norwegian Centre for Research Data" (project number 44004). Healthcare professionals and patients gave written consent after receiving written and oral information about the study.

2.6 | Analysis

We used qualitative content analysis based on the work of Graneheim and Lundman (2004). We read the interviews several times to get a sense of the material before an initial sorting of the material, separating out information relevant to our research questions. Then, we condensed the extracted text and added descriptive codes (Graneheim & Lundman, 2004). We organised these codes in five categories, each containing several subcategories. The categories and subcategories are presented in Table 4.

The categories were further refined and focused based on discussions between the authors as we worked with the analytic text. Three prominent themes emerged from the collected material:

1. Experiences with the advisor role.
2. Nutrition assessment practice in home care.
3. Organisational barriers.

Table 5 illustrates the process of data analysis.

The prominent themes represent analytic abstractions of findings across the cases. In addition, when different perspectives in the theme were present we investigated further if characteristics like professional role, educational background, or work experience, could clarify and explain these different viewpoints (Polit & Beck, 2012). We used the software program HyperRESEARCH version 3.7.1 in the first stages of analysis.

3 | FINDINGS

3.1 | Experiences with the advisor role

The majority of healthcare professionals talked about nutrition with patients who had used Appetitus to register food and beverage consumption. App information about food choices and meal frequency formed the basis of the dialogues. Healthcare professionals explained to us how they sought to stimulate and increase patients' awareness about diet and health, trying to motivate patients to make nutritional changes and to eat enough to meet their daily needs. Healthcare professionals highlighted the importance of giving encouraging feedback and modelling advice for diet alterations on patients' existing habits. As one informant said:

TABLE 4 Categories and subcategories

Category	Sub-categories
Descriptions of follow-up and role	Nutrition-specific follow-up
	Technical support
	Graphs support conversations
	Correcting guidance
	Importance of follow-up
	Nutritional challenges made clear
Effects seen in the patients	Mastering technology
	Cognitive challenges hinder registrations
	Attention from healthcare professionals motivates patients
	Activates patients to ask for advice
	Problem areas made clear for patients
	Inspiration
Tools to support nutrition assessment and documentation	Limitations in current nutrition practice
	Opportunities for strengthened dialogue around patients with cognitive decline
	Perspectives on level of detail of food/beverage registration
	Potential for better documentation practice
	Wish for integrating with documentation systems
	Knowledge tool
Suggestions for more details in output information	
Output from patient registration gives information to healthcare professionals	
Personal and work environment barriers and facilitators	More training of healthcare professionals
	Lack of nutrition knowledge
	Time restrictions
	Preplanned work list limits flexibility
	Part-time work as barrier
	Many other focuses
	Freedom to decide how to prioritise time as facilitator

You can build on what they do well ... It is not so that they have to change their entire diet, but rather build on what they already manage to eat and drink.
(Professional development nurse, study site 1)

They found that their dialogues with patients about nutritional habits were strengthened by the app's visualisation of how registered food and drink intake related to protein, energy, and fluid requirements. Several healthcare professionals expressed that this functionality gave them confidence and authority when they offered advice. Healthcare professionals thought many of the patients became more

conscious of what they ate and drank when they participated in the trial. They ascribed this increased consciousness to patients inputting diet recordings themselves and to the dialogues they had with patients about nutrition.

Using Appetitus engaged the patients and drew their attention to nutrition. They asked questions and sought nutrition advice from healthcare professionals. As Appetitus spiked patient questions and concerns, most of the healthcare professionals saw themselves in the role of interpreters of the information the patients received from the app when recording their intake of food and drink. Some healthcare professionals expressed uncertainty about how to give nutrition advice, and those who expressed insecurities about their knowledge of nutrition hesitated to take on advisory roles. Accordingly, in their follow-ups and support to Appetitus users, they focused less on nutrition and more on technical use of the app and general use of the iPad. Among health professionals who expressed this insecurity, shorter work experience in the present job seemed more important than professional background. In the interviews, they requested support in the form of nutritional education and concrete tips on how to proceed in dietary dialogues.

The supervisors agreed that many home-care staff members need continuing education on nutrition, and they advocated for inclusion of a nutrition course as part of the introduction to Appetitus, should the app be implemented as an integral part of home-care services.

3.2 | Nutrition assessment practice in home care

Healthcare professionals established a more detailed picture of patients' dietary habits when patients registered their food and beverage consumption in the app. The registrations could display and draw attention to low food intake and the potential severity of that situation.

I would say we have focused more on nutrition with the patients that have used this. And much of that is because we do not exactly have those who are undernourished [very skinny] in the project. But I will focus on: Is it malnutrition, or do you eat too little or too rarely? We can focus on that part when we see that is only two meals per day, or that they start eating at noon and eat so little that it's too little. And then we actually discuss that when we come to see them and we spend some time on that. (Home health aide, study site 2)

As explained by this informant, reviewing registered food and beverage intake can reveal potential risk factors and problems of which a healthcare professional has been unaware and can enable a dialogue with a patient. Problems that healthcare professionals discovered and addressed in the course of the study include low fluid consumption and extensive fasting time between the evening meal and breakfast.

Meaning unit	Yes, I—it gave me something. And I think that when I tell the patients: “You know what, see here, it’s written how much protein you’ve got in you today, and you know that when you grow older you need more protein.” “Yes, yes, yes, I know that.” [imitating patient] “And see how little you’ve been drinking.” “Oh, I have drunk so little that I’m well below that.” [imitating patient] So there’s something to use, you show—you can show that that’s the way it is. It’s not something I’ve made up, coming in like this
Condensed content	Used the registrations in the app to talk to patients about their need for protein and fluids. Visualisation supported dietary advice
Coding	<ul style="list-style-type: none"> • Dialogue based on registrations • Graphs support dietary advice
Subcategory	Nutrition-specific follow-up
Category	Descriptions of follow-up and role
Theme	Experiences with the advisor role

TABLE 5 Illustration of the process of data analysis

The municipalities where we conducted this study routinely screened their patients with standardised assessment tools such as the Mini Nutritional Assessment (MNA) (Vellas et al., 1999). Assessment and documentation of energy, protein, and fluid consumption were not common practice. Informants problematised how the evaluation of patients' eating and drinking habits is based on the subjective opinion of healthcare workers:

There is so much guesswork around nutrition ...
One [health care worker] thinks he [a patient] eats well, while the other thinks he doesn't eat enough.
(Professional development nurse, study site 4)

Healthcare professionals argued for more systematised nutrition practices with more detailed assessments and documentation. They discussed the opportunities Appetitus affords them and whether the current version of the app is suitable for assessing and documenting nutrient intake. Some healthcare professionals advocated for a more detailed recording of food and drink consumption to ensure accurate assessments, while others saw the level of detail as satisfactory and pointed out the value of quick and easy recording.

A recurring theme in the interviews was how Appetitus could be a resource for patients who cannot handle logging food and beverage consumption independently, such as patients with cognitive decline. Healthcare professionals described patients with cognitive decline as a vulnerable group at high risk for undernutrition. Patients with cognitive decline often receive extensive help with nutrition (e.g., having all meals prepared for them) and therefore are assisted by several different healthcare workers each day. In addition, many attend adult day care and receive support from family members. Healthcare professionals identified opportunities to use Appetitus as a tool to monitor and document nutritional intake for patients with cognitive decline, suggesting that the app's ability to present a cohesive picture of daily nutrition information could support communication across locations, personnel, and family members. One manager presented her idea as follows:

Many of these patients attend a day centre as well, so it should not be a system only for home care. Because then the day centre, for example, cannot register what they have eaten. And then we must guess what they have eaten. So it should be a system that more people can use.
(Supervisor, study site 5)

As this quote demonstrates, healthcare professionals saw Appetitus' potential for monitoring and documenting nutritional intake among people with cognitive decline, strengthening nutritional care for that population.

3.3 | Organisational barriers

The most prominent reported barrier to use of Appetitus was time constraints, with experiences varying among informants. Some health professionals explained how they planned their daily schedules during the study to allow time for follow-up. Others described their struggles to allocate enough time to nutritional dialogues with patients during the trials. Those healthcare professionals who worked according to preplanned daily schedules constituted the primary group expressing these time constraints. They described their work environment as busy and task oriented, with little room for unscheduled tasks.

I must honestly admit that at the beginning we were much more engaged. I felt that. And then there was also allocated time for it [supervisors made time for the project in the daily schedules]. But eventually ... I felt there was not allocated time for this. And other tasks have displaced the whole project. (Nurse, study site 3)

The topic of time constraints spiked discussions and exchanges of different perspectives between informants. Some professional development nurses and supervisors pointed out that staff could be proactive, ask for dedicated time to work with prevention-focused care activities, and support requests with professional reasoning and

competent judgement. Other supervisors noted that financial restrictions hinder allocation of time for nutritional follow-up. Working part-time presented another set of challenges for some participating health-care professionals because it limited their opportunities to provide continuity in follow-up.

4 | DISCUSSION

The patients had an active role in the nutrition care process, performing their own diet registrations. This offered healthcare professionals new insight into patients' situations. Insecurity about nutrition knowledge was a barrier to nutrition follow-up for some healthcare professionals. Time constraints and part-time work schedules also presented challenges. Healthcare professionals suggested extending the use of *Appetitus* to include vulnerable patient groups such as patients with cognitive decline for assessment and documentation of their nutritional situations.

4.1 | *Appetitus* as a mediator in dialogues about nutrition

Appetitus offered healthcare professionals insight into patients' dietary habits, providing a basis for more personalised dialogues about meal habits and food selections. Dietary habits are often based on lifelong traditions, and changes in diet can be difficult for older adults. Individualising suggestions with reference to the patient's dietary habits is therefore recommended (Beelen et al., 2017; Locher et al., 2009). The diet recording in the app revealed or highlighted challenges related to nutrition. Healthcare professionals emphasised how the patients became more attentive to their own dietary needs when actively involved in diet recording, with access to app information combined with professional advice. They reported increasing interest among their patients, who began to ask for nutritional guidance. As other studies have reported, older adults have found paper-based logging of food and beverage consumption useful and interesting and can increase their engagement in nutrition care (Ha et al., 2010; Holst, Rasmussen, & Laursen, 2011). However, paper-based logging does not provide instant feedback to the user on nutritional value, which is an advantage of the *Appetitus* app. Active ageing policies focus on preventative activities older adults can engage in to prevent ill health or disabilities. Health care services that are facilitating patient engagement and increasing patient empowerment through knowledge development supports that focus (Walker, 2002). Our findings suggest that an app like *Appetitus* can strengthen patient involvement in care. Studies have shown that when nutrition interventions include discussions between patients and healthcare professionals, patients can increase their knowledge about nutrition and improve their nutritional and functional status (Agarwal et al., 2013; Bandayrel & Wong, 2011; Young et al., 2011). Discussions with healthcare professionals also motivate patients to maintain diet recordings and to consider this as a meaningful activity (Holst et al., 2011; Watkins & Xie, 2015). The role of patients in the

study was that of participating partners, while the role of healthcare professionals was to support patients. As an intervention in home care, *Appetitus* can reinforce a practice model in which healthcare professionals adopt a facilitating role, seeking to empower patients, as opposed to practice models in which patients are passive recipients of care (Trede & Higgs, 2008).

4.2 | Conditions for adopting *Appetitus* in home-care services

Our results suggest that the levels of time constraints faced by healthcare professionals affected their opportunities to focus on nutrition. This resonates with the literature arguing that time constraints, understaffing, and conflicting assignments are barriers to a healthcare professionals' nutrition practice (Lannering et al., 2017; Watkinson-Powell, Barnes, Lovatt, Wasielewska, & Drummond, 2014). In addition, healthcare providers may give nutrition a lower priority than practical predefined care activities or medical tasks which makes it crucial to establish organisational routines and requirements that ensure good nutritional practices (Bonetti, Bagnasco, Aleo, & Sasso, 2013; Eide, Halvorsen, & Almendingen, 2015; Meyer, Velken, & Jensen, 2017).

Some informants hesitated to take on an advisory role. Healthcare professionals' uncertainty and low confidence in their nutrition knowledge may be barriers to taking practical advantage of *Appetitus* or similar interventions. In addition, it is an ethical challenge to give patients access to a self-monitoring tool, which may raise questions and concern without sufficient professional support. Poor nutrition knowledge is a recognised challenge in the healthcare sector and a known barrier to good nutrition practices (Eide et al., 2015; Merrell et al., 2012; Watkinson-Powell et al., 2014). Bauer et al. (2015) found a significant difference in knowledge about nutrition among nurses and nurse aides, and they suggest that this can be explained by differences in their education. We did not observe this pattern in our data, and the supervisors pointed at the need for additional training in nutrition among home-care staff in general. Since the advisor role of healthcare professionals was acknowledged as a crucial component of the *Appetitus* intervention, it will be important to ensure that all healthcare professions have the skills, knowledge, and dedicated time to fulfil that role. Arranging local courses that provide additional training in nutrition can be a good solution to strengthen knowledge among healthcare professionals (Bauer et al., 2015).

4.3 | Opportunities to strengthen nutrition practices in home care

This trial focused on patients as primary users of *Appetitus*, but healthcare professionals also showed an interest in how they could use the app as a tool for assessing and documenting food and beverage consumption in vulnerable patient groups depending on their help with nutrition. Although the municipalities where this study took place had routines for assessing nutrition risk with screening tools, healthcare professionals pointed out the value of getting



FIGURE 1 Main functions for selection of food and beverages (left) and visualisation of energy, protein, and fluid consumption (right). Screenshots from Appetitus

specific information about patients' diet variation, number of meals eaten per day, and the estimate of energy, protein, and fluid consumption. Appetitus' support for individualised assessments made healthcare professionals aware of problematic situations they previously had overlooked. Healthcare professionals often consider food preferences, variety, and quantity in day-to-day conversations with patients. However, this practice entails the risk of overlooking undernutrition (Merrell et al., 2012; Meyer et al., 2017; Watkinson-Powell et al., 2014). Energy intake is rarely calculated and documented (Mowe et al., 2006; Persenius, Hall-Lord, Baath, & Larsson, 2007), possibly because tools to assess energy intake are unavailable or because healthcare professionals are not expected to perform this type of nutrition assessment. Various studies have examined poor knowledge and attitudes, conflicting tasks, and time restrictions as important barriers to good nutrition practice (Bauer et al., 2015; Bonetti et al., 2013; Watkinson-Powell et al., 2014). Our results suggest that the tools available to healthcare professionals also influence their nutrition practices.

4.4 | Strengths and limitations

The researchers were active partners in developing Appetitus before testing it in the trials, and this may have influenced our data collection and analysis. In the information, we gave participants about the study and interviews; we sought to prevent bias in the study by emphasising the importance of learning from their experiences to inform further development of the app and nutrition care practices. Despite our efforts, feedback informants gave us may have been influenced by our dual role in the project.

Including both supervisors and staff with various professional backgrounds and roles in the study allowed us to gain a broad understanding of how best to implement Appetitus for home-care services. However, the fact that supervisors and staff participated in the same focus groups may have influenced the discussions and reduced richness of the content we gathered. If a focus group is more

homogeneous, participants may be more comfortable with expressing their opinions (Polit & Beck, 2012). In our focus groups' discussions, supervisors, professional development nurses, and other staff had different viewpoints on the subject of barriers. Had we interviewed leaders and staff separately, we might have gained a greater diversity and multiple perspectives on organisational barriers, for example, time and priorities. We also found that experiences of time constraints varied within the staff group. Healthcare professionals who actively participate in planning their own daily schedules were less focused on time as a barrier than those who work according to preplanned, task-oriented daily schedules. This distinction emerged because we collected our data from home-care districts with diverse organisations, which is a significant strength of our study.

A limitation in this study is that the dietary assessment functionality in the Appetitus app was not validated prior to the trials. The development team and healthcare professionals participating in this study discussed advantages and disadvantages in the detail level of this functionality in the app. Healthcare professionals suggested expanding the use of systematic dietary assessment with electronic tools in home care. Therefore, based on the trials of Appetitus, a validation study comparing traditional approaches to dietary assessment and Appetitus' functionality is needed. Another limitation in the present study is that healthcare professionals recruited what they saw as suitable patients directly, and they may have given more focus to anticipated ability to use technology than nutritional risk. This strategy may have led to bias in the patient sample. It can also be argued that the patient sample represents a healthier and more cognitive fit group than the majority of older adults receiving home-care services in Norway.

5 | CONCLUSION

Nutrition care is one of the core responsibilities of healthcare professionals working in home-care services in Norway. In 2009, the

Norwegian Directory of Health issued national professional guidelines for prevention and treatment of undernutrition. The guidelines emphasise the need for more stringent approaches to ensure good nutrition practices, recommending the assessment of nutritional risk, the examination of underlying causes, and the development and delivery of tailored interventions. By making the nutrition assessment more thorough and by presenting nutritional value, Appetitus app was instrumental to increase healthcare professionals' insights into patient nutrition and can increase awareness to identify problematic situations earlier.

Our study shows that when patients have access to technologies that allow them to play an active role in self-monitoring health-related activities, their opportunities for involvement in care will increase. Key issues to meet that goal are to: create or adopt a technology solution that is easy to use, provide support for use of that technology, and offer relevant content.

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CONFLICT OF INTEREST

We declare no conflict of interest.

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Paper II



Promoting dietary awareness: Home-dwelling older adults' perspectives on using a nutrition application

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Abstract

Aims and objectives: This study investigated older adults' experiences of using the Appetitus app with support from healthcare professionals.

Background: Good nutrition status is important for good health when ageing. However, as undernutrition remains a prevalent and persistent problem among older adults, the study explored whether technology affords innovative support for nutritional self-care among older adults.

Design: The study was explorative and qualitative in approach.

Methods: Appetitus was developed as a tablet-based application to prevent and alleviate undernutrition among older adults. Eighteen home-dwelling older adults used the app for 8 weeks. Older adults received home care, and local healthcare professionals introduced the app and gave support during the study.

Results: Appetitus served as a source of inspiration and a reminder of available, relevant food options. Appetitus encouraged some participants to eat or drink more by the end of the day while others became more aware of selecting food options to ensure sufficient protein, energy and fluids. However, some participants made no active effort to change their diet despite feedback from the app that suggested they did not eat or drink enough. Technical support from healthcare professionals facilitated participants' use of the app and tablet. Some participants also received more specific nutritional follow-up that helped to make their experience of using the app more meaningful.

Conclusion: Older adults' awareness about the importance of keeping a diet that helps prevent undernutrition was reinforced through the use of Appetitus and discussing nutrition with healthcare professionals.

Implication for practice: The findings affirm feasibility of using technology in nutritional interventions enhancing self-care among older adults.

KEYWORDS

computers, handheld, health promotion, home care services, older adults, protein-energy malnutrition, qualitative research

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1 | INTRODUCTION

Good nutrition status is a core premise for good health, well-being and independence in old age (Heflin, 2019). Eating enough and having a varied diet is important to ensure sufficient intake of micro- and macronutrients (Lorenzo-López et al., 2017). Unfortunately, the prevalence of malnutrition is high among older adults. Studies reports that close to 50% of older adults who receive home care services are at risk of developing malnutrition, and almost 9% are malnourished. It is often a result of a protein-energy deficit in their diet that leads to such undernourishment (Cereda et al., 2016). Reduced appetite is a major risk factor for undernutrition, as this is coupled with reduced food consumption and less interest in food (Jadczak & Visvanathan, 2019; van der Pols-Vijlbrief, Wijnhoven, Schaap, Terwee, & Visser, 2014). Changes in physical or cognitive function that increase older adults' dependence on others leave them vulnerable to reduced dietary variation and less able to maintain their habitual diet (van der Pols-Vijlbrief, Wijnhoven, & Visser, 2017; Tomstad, Söderhamn, Espnes, & Söderhamn, 2012).

Studies indicate that older adults frequently lack awareness of the importance of maintaining their weight as an important self-care activity in old age. They may lack sufficient or balanced knowledge of how unintended weight loss can start to impact their health negatively (Beelen et al., 2017; Craven, Lovell, Pelly, & Isenring, 2018; Winter, McNaughton, & Nowson, 2016). Technology-based interventions, including mobile applications (apps), are identified as promising strategies for promoting healthy eating and supporting positive changes in health behaviour (Bonilla et al., 2015; McCarroll, Eyles, & Mhurchu, 2017). Here are unique opportunities for self-monitoring and personalised, immediate feedback (Chen, Gemming, Hanning, & Allman-Farinelli, 2018). Dietary mobile apps are increasingly being used to support nutrition interventions. Two recent reviews indicate that self-monitoring dietary mobile apps can be efficient to support weight loss and promote positive dietary change among adults with obesity or chronic conditions such as diabetes and heart failure (El Khoury et al., 2019; McCarroll et al., 2017). Some tele-monitoring solutions and apps that target undernutrition among older adults have also been studied (van Doorn-van Atten et al., 2018; Kraft et al., 2012; Lindhardt & Nielsen, 2017). In these solutions, the users recorded their weight, appetite or selected items in their diet as part of a nutrition intervention. Paulsen et al. (2018) developed a more comprehensive self-monitoring dietary app for use in the hospital setting. These studies indicate that activating the older adults in self-care activities by the means of technology is feasible. However, to the best of our knowledge, self-monitoring dietary mobile apps with direct, personalised feedback have not been studied to address the specific challenge of undernutrition among home-dwelling older adults.

When this project was first initiated (2015), we reviewed available nutrition apps for use in Norway. They focused on weight loss, and they required users to record food and beverage consumption in great detail. The challenges with detailed recordings are recognised

What does this research add to existing knowledge in gerontology?

- Health technologies that are easy to use can support older people's engagement in nutrition self-care and enhance awareness of dietary measures to prevent malnutrition.
- Older adults manage and are interested in adoption of relevant health technologies.

What are the implications of this new knowledge for nursing care with older people?

- Tools with opportunities for self-evaluation of diet increase older adults' interest and awareness of appropriate dietary habits in old age.
- Technology for self-evaluation of diet can innovate nutrition care provision by activating the patient and support individualised and focused dialogs between healthcare professionals and their patients.

How could the findings be used to influence policy or practice or research or education?

- Adoption of health technologies in home care services can support active ageing initiatives that focus on preventative activities and patient engagement in care.
- Studies of this kind can guide and expand the development of self-care interventions among older adults.

in the literature, concluding that freely available apps are less relevant or feasible to older adults at risk of undernutrition (Hingle & Patrick, 2016; Shriver, Roman-Shriver, & Long, 2010). Therefore, our research project included development of a tablet-based nutrition app named *Appetitus*. The goals of *Appetitus* were to provide older adults with nutritional advice to encourage weight gain or weight maintenance.

A recent review points out how ease of use and perceived value of the technology is crucial for older adults' engagement with, uptake of and adherence to using health technology (Matthew-Maich et al., 2016). Furthermore, sufficient support to overcome potential learning difficulties is considered important for older adults when they are introduced to health technologies (Wildenbos, Peute, & Jaspers, 2018). In this study, we explored the experiences of home-dwelling older adults who used the *Appetitus* app in a home care setting. Norwegian home care services are offered on a need bases and the system seeks to support independent living despite increasing care needs. Older adults receive home care services while living in their own private home or in supervised, independent living arrangements as local authority housing tenants.

To capture older adults' user experience and perceived value of using *Appetitus*, we asked the following research questions:

1. What was older adults' experience of using the Appetitus app with support from healthcare professionals?
2. How did older adults consider influence on their diet when using Appetitus?

2 | METHODS

2.1 | Study design and sampling

This study has an inductive, explorative qualitative design with convenience sampling (Polit & Beck, 2012). The study was conducted between November 2016 and January 2017. Eighteen older adults from three Norwegian municipalities used the Appetitus app for 8 weeks. We recruited older adults that received home care services. Local healthcare professionals were asked to recruit individuals over 65 years of age, which they considered could benefit from participation in a nutrition intervention. We sought participants without pronounced cognitive decline, who could learn to use Appetitus on the tablet computer independently. Our sample demonstrates diversity in age, care needs, technological experience and nutrition status (Table 1).

Initially, 28 older adults were recruited. Of these, six decided not to participate before the study started; one died, and three others withdrew shortly after the study started. Two explained their withdrawal with increased illness burden, and one found reporting food and beverage consumption too tiring.

Participants were provided with an iPad with the Appetitus app and mobile Internet (3G) installed. Thirteen local healthcare professionals were responsible for training and supporting the participants during the study period. Healthcare professionals included nurses, nurse aids and nursing students. We met with healthcare professionals prior to the trial period to clarify recruitment and follow-up procedure. To foster understanding of what project participation entailed, Appetitus was shown to the older adults when they were asked to participate. We expected healthcare professionals to meet with the participants at least three times to support use of the iPad and Appetitus and to discuss nutrition. In the follow-up, emphasis was primarily placed on providing training in basic functions of the tablet (turn on and off, charge the tablet) and how to use the Appetitus app. In line with common practice in Norwegian home care, nurses and nurse aids were responsible for nutritional follow-up, as certified dietitians is a limited resource in the municipalities. However, the healthcare professionals' reported time constraints and personal insecurities in nutritional knowledge as barriers for follow-up (Farsjø, Kluge & Moen, 2019).

2.1.1 | Appetitus

The recommendations in Appetitus are derived from the Norwegian nutritional guidelines for prevention and treatment of undernutrition (Findalen et al., 2012; Guttormsen et al., 2009). Appetitus suggests a

TABLE 1 Information about participating older adults ($n = 18$)

Gender	
Female	12
Male	6
Age	
Years, mean (range)	81 (68–95)
Living arrangements	
Living alone	12
Living with spouse	6
Experience with touch technology	
No prior experience	10
Prior experience (tablet or smartphone)	8
Organisation of grocery shopping	
Independent	6
Receiving help from family or home care organisation	12
Dependence in food preparation	
Independent; make dinner regularly	8
Partly independent;	
Heats precooked dinner or eat at senior centre	7
Dependent; need all meals prepared and served	3
Nutritional status according to Mini Nutritional Assessment–Short form (MNA-sf)	
Malnutrition	3
Risk of malnutrition	10
Normal nutrition status	5
Body mass index (BMI)	
Mean (range)	25 (19–37)
Weight development during trial	
Stable weight or weight gain	11
Weight loss	6
Missing	1

meal plan, with four main meals and two snack meals a day. By covering the full day, the meal plan implies that night fasting should be <2 hr (Jadczak & Visvanathan, 2019). The version of Appetitus tested here included pictures of 147 dishes. Pictures of meals and beverages sought to present common, varied and easily available meals in appetite-friendly presentations. The app user could record their food and beverage consumption. They could adjust the portion size (by percentage) to better reflect consumption when calculating nutritional value, but the content in the image of the dish was not adjustable. Calculation of recommended, daily intake is based on the algorithm 30 kcal energy, 1.2 g protein and 30 ml fluid per kilogram body weight (Findalen et al., 2012). The calculated nutritional value of the recorded meals and beverages is presented as filling in a figure (Figure 1, left) and as graphs that visualises protein, energy and fluid consumption relative to recommended, daily intake (Figure 1, right). Users who reached their energy and fluid goals for the day received feedback in the form of a full figure smiling and making a cheering sound.



FIGURE 1 Screenshots from the Appetitus app

Category	Sub-category	Theme
Dietary habits persist	Well-established routines persist, even from childhood	Mobilisation of self-reflection on dietary habits
Inspiring variety	Pictures stimulate appetite Dishes are familiar	
Insights regarding own diet	App illustrates a healthy diet App legitimises unhealthy choices	
Increased focus on food	Increased attention to food and diet Attention paid to figures and graphs Reactions to feedback from figures and graphs Reflections on weight gain	Stimulation of reflections on nutritional value in user's diet
User experience with the app	Reflections on registration: accuracy, representativeness Patterns of registration	
Follow up from health professionals	App intuitive to learn and use A shared focus on nutrition A technical focus in follow-up	Support from healthcare professionals' added meaning and assurance when using Appetitus

TABLE 2 Categories, subcategories and themes

In design of Appetitus app's user interface, special care was taken to make it attractive and usable for older adults. This included compensation for potential vision limitations by ensuring good contrast, large interaction elements (buttons) and large text (Kascak, Rébola, & Sanford, 2014). All the main functionalities were included in the app's home screen: possibility to browse meal and beverage suggestions, consumption reporting and feedback on energy and fluid requirements (Figure 1, left). To access additional functions, the user had to perform a planned activity, pressing on the cutlery symbol for 2 s. This was deliberately implemented to keep it easy to orient in the app and to prevent users from unintentionally accessing additional functions, which was an identified challenge in testing a previous version of the app.

2.2 | Ethical considerations

The Norwegian Centre for Research Data approved the study (project number 44004). Older adults received oral and written information before providing their written consent.

2.3 | Data collection

Data were collected by the first author (CF) or by a research assistant (ALJ). The researchers met study participants in their home, prior to starting using the app, for structured interviews to gather demographic, nutritional and care needs information. Participants

were interviewed a second time after they had used the app for 8 weeks. These interviews were semi-structured and were supported by a thematic interview guide (Polit & Beck, 2012). Each interview began with an open question about the participant's experience of participating in the study. To learn more about user patterns and experiences, participants were invited to show how they had used the app. In addition, the researcher elicited participant's views on the healthcare professionals' role and the support they provided.

Interviews lasted from 19 to 49 min, on average 33 min. All interviews were audio-recorded and transcribed. The recorder malfunctioned in one interview, and the first author took detailed field notes immediately afterwards for use in the subsequent analysis.

2.4 | Analysis

Qualitative content analysis of the data was based on the procedure described by Graneheim and Lundman (2004). To begin analysis, we gained an overview by reading the interview transcripts. We used the research questions to focus the selection of meaning units (sentences and paragraphs) in the material. The identified meaning units were sorted into six categories. Next, the meaning units were condensed and we created subcategories. In the final stage of the analysis, three main themes were identified: (a) mobilisation of self-reflection on dietary habits; (b) stimulation of reflections on nutritional value in user's diet; and (c) support from healthcare professionals' added meaning and assurance when using *Appetitus*. The analysis process is presented in Table 2.

HyperRESEARCH version 3.7.1 supported the first part of the analysis. Excel 2016 and Word 2016 were used in the later stages.

3 | RESULTS

A majority of the participants explained that they used the app daily to log their food and beverage consumption, except when sick or travelling. The rest used the app more sporadically, often with support from the healthcare professionals. The results capture the participants' various perspectives and experiences within the specified themes. The study sought insight into how the various perspectives related to nutritional status and weight development, or how often the participants said they used the app, but no clear patterns were identified in this regard.

3.1 | Mobilisation of self-reflection on dietary habits

The *Appetitus* app presents pictures of a selection of meals, snacks and beverages, reminding participants of meals they might like but had not eaten for a while. Many participants described how their diet had become more varied as a result of inspiration by the app,

and some reported that they actively used it for meal planning and grocery shopping. As one informant put it:

The presentation of dishes is nicely set up. I find it very inspiring. I make my lunch every day, and I use suggestions from the app.

(Male, 85 years)

However, they also emphasised that key elements of their diet, such as eating fish twice a week, were based on well-established routines and habits. When talking about their nutritional practices, participants tended to focus on healthy parts of their diet, such as fruit and vegetables, fish and whole-grain bread:

I think it [*Appetitus*] can be an encouragement to eat a better and more balanced diet. But I think these [as suggested by the app] are dishes I have eaten my whole life. It is much the same as what we ate at home when I was a child. Only whole-grain bread. I grew up with a variety of fruit and vegetables. My mother was very concerned about food and making good choices—that we should eat healthily.

(Female, 95 years)

As this quotation illustrates, several participants found the dishes suggested by the *Appetitus* app as healthy and felt that using the app confirmed that their diet was good. For others, the app increased consciousness of more healthy choices. Suggestions for greater dietary variation were perceived as an important benefit of study participation. As one participant explained:

I think I eat a little healthier. I snack on some salad and cucumber and put it in my sandwich. Before, it was only brown cheese [Norwegian sweet cheese] or jam.

(Male, 85 years)

The app presents traditional desserts such as puddings, cakes and candy as choices for the afternoon snack. A few participants expressed surprise to find suggestions that they considered unhealthy:

And there were pictures of several different cakes. That surprised me a little. I used it [*Appetitus*] to remind me about what's OK to eat.

(Male, 78 years)

As this quote illustrates, the app served to legitimise what participants regarded as unhealthy choices. Some participants said they reinstated previously abandoned food options after using the app. Two participants told about various efforts to lose weight during adult life, and now both struggled with unintended weight loss and poor appetite. They described how using *Appetitus* led to reflection on their dietary choices in the light of the current situation.

3.2 | Stimulation of reflections on nutritional value in user's diet

Participants commonly used positive expressions to describe the feedback on energy and fluid consumption presented in the figure. Many were able to achieve their daily energy and fluid goals, and some reported instances of how the visualisation functions had led them to eat or drink more than usual in efforts to fill the figure. One participant described it as follows:

I think it's very amusing, yes! And it has happened that I only had the head left to fill, so I ate an orange or something in the evening, and then he cheered.

(Male, 91 years)

While most participants reported that they found it very rewarding to record their food and beverage consumption, others did not find this meaningful or even tiring. One informant described this experience as follows:

It takes some time. And when I'm not feeling well, then it feels like work— like: 'Oh, no, I don't want to do it'.

(Female, 72 years)

Some participants reported that their registrations rarely filled the figure. They understood this to mean that they had not consumed sufficient energy or fluids from food and beverages to reach their personal requirements, but they had not actively tried to change this.

Since getting diabetes, I have been constantly concerned about eating healthily. So, I have a fairly good overview, yes, about what I should eat. But I see that, according to this, I might not be getting enough energy.

(Female, 71 years)

As this quote illustrates, the participant's that showed lack of initiative to change explained that they based this consideration on common sense or on prior nutritional knowledge guiding their dietary patterns.

Participants also reflected on the accuracy of the feedback received from the app.

Then it's like [picture of sandwich with] eggs and tomato, but I only eat [sandwich with] tomato. I also eat caviar on its own, but here they show eggs with the caviar. It's not just simple things, and then it gets a little inaccurate [when I log my consumption].

(Female, 80 years)

At the beginning of the study, participants discussed with the healthcare professionals how to report their meals when they could not find exactly what they had consumed. They viewed this as learning

to be flexible by identifying something similar for registration purposes. Despite the challenges of exact registration, participants indicated that the visualisation function (the filling figure and the graphs) served to increase their focus on nutrition.

Yes, I was more attentive to what I had eaten, and I look at [graphs for] energy and protein consumption. One day, I was low on proteins, and I thought: 'Yes, well, I should pay more attention to what I choose to eat' because protein is important.

(Female, 84 years)

As this quote illustrates, participants felt that using the Appetitus app made them more aware of and interested in the nutritional value of their food. A few participants had also noticed a weight increase.

I paid more attention to what I eat. And I understand that I have put on some weight, I notice that on the waistband on my pants.

(Male, 90 years)

As this quote illustrates, they related weight gain to increased attention to diet and the alterations they made in dietary habits when using the Appetitus app. However, some participants carefully sought to maintain a steady weight.

Usually I don't eat in the evening. But I thought, I have to fill this [figure]. So I actually ate a piece of bread in the evening, just to fill the figure. But I don't want to continue with this, because I don't want to gain weight.

(Female, 95 years)

And as this quote illustrates, some participants expressed reluctance to maintain newly established habits, such as eating an evening meal or more snack meals, simply because they did not want to gain weight.

3.3 | Support from healthcare professionals added meaning and assurance when using Appetitus

Some participants experienced a change in how the healthcare professionals responsible for technical and nutrition-specific follow-up attended to their nutritional needs, with greater individual focus and more time dedicated to talking about nutrition. Those who felt that the healthcare professionals devoted greater attention to their nutrition in the follow-up saw this as an important aspect of the study.

I think it [the follow-up from the healthcare professional] was nice. Yes, and useful! And that was maybe most important, because then I didn't feel that this

was something I was doing alone. There was someone who was interested –that things were going OK.
(Female, 84 years)

As this quote illustrates, participants characterised the attention as positive and as an opportunity to share. In attending to the participants' nutritional situation, the healthcare professionals were also, in a broader sense, showing concern about their health and well-being. In contrast, several participants said that the follow-up focused mainly on technical training on the iPad and Appetitus app, with little to no discussion or knowledge sharing regarding the app's nutritional information. These participants did not reflect further on this, but emphasised that they had managed to use the app independently since it was easy to use. They also noted that it was important to be able to call a healthcare professional if they had a technical problem. This was especially the case for those with less experience with the technology and helped them to gain confidence in using Appetitus and the iPad.

4 | DISCUSSION

Many subtle, small changes in the diet, often caused by increased dependency on others and decreased appetite, can leave older adults nutritionally vulnerable and at high risk of developing undernutrition. Reduced dietary variety, prolonged overnight fasting and less snacking are examples of such dietary changes (Jadczak & Visvanathan, 2019; van der Pols-Vijlbrief et al., 2017; Tomstad et al., 2012). Our results point to how the core elements in the designs of the app, meal plan that suggests spreading the meals throughout the entire day, presentation of meals and snacks in appetite-friendly pictures, and self-assessment with direct personalised feedback, can strengthen older adults' nutrition self-care and support positive dietary changes that can prevent undernutrition development. For example, several participants included extra snack or light meal in the evening. Such reduction of the overnight fasting can be important to prevent undernutrition, especially for those struggling with early satiation and low appetite (Jadczak & Visvanathan, 2019).

Giving the user instant feedback, as the Appetitus app does, seemed to motivate some of the participants to eat and drink a little more or make slight alterations to their diet to reach personal goals. Our findings concur with other studies reporting such effects of dietary registration. In a review of mobile health interventions that promotes healthy eating, McCarrroll et al. (2017) noted that self-monitoring functionality in combination with tailored feedback was important components of the most successful interventions. For those at risk of under-consuming, self-assessment can also build awareness of nutritional needs and motivate sufficient eating and drinking (Holst, Rasmussen, & Laursen, 2011; Paulsen et al., 2018).

In contrast, some users reported that they rarely reached or got close to their recommended intake goals for energy, protein and fluids. This group said that they did not alter their diet despite receiving feedback suggesting that their food and beverage intake was too low to meet their personal recommended requirements. One

possible explanation for reluctance to change is that they were confident in current dietary choices, happy with their weight or even reluctant to gain weight. Therefore, they saw no need to change. This was also reflected in the results where weight was given little attention, and weight gain was not necessarily considered positive by the participants. There is evidence that older adults may express disbelief when faced with having risk of malnutrition or being undernourished, as they do not perceive themselves as nutritionally challenged (Beelen et al., 2017; Piantadosi et al., 2015; van der Pols-Vijlbrief et al., 2017; Reimer, Keller, & Tindale, 2012). The majority of the participants in this study was at malnutrition risk or malnourished as shown by the Mini Nutritional Assessment score (Table 1). However, they all had body mass index (BMI) levels within healthy, overweight or obese ranges for adults (Findalen et al., 2012). This may explain why they were not concerned about weight changes, or in some cases reluctant to gain weight.

It is important to acknowledge that introducing changes in long-standing behavioural patterns is a complex process. For example, some participants' registrations suggested need for major changes if they should reach recommended energy and protein goals. For those who did not reach the suggested goal, this might have a demotivating effect. Moreover, it is important to consider this issue in terms of the accuracy and relevance of feedback the users received. In Appetitus, the algorithm for personalised feedback on energy, protein and fluid consumption did not adjust for other individual factors, such as activity level (Findalen et al., 2012). Another concern is that registered food and beverage consumption may not fully reflect users' actual consumption, as the app only supported registration of predefined meals and beverages. Underreporting of energy intake is a known challenge in self-reported dietary data for reasons that may include limited specificity and difficulties in estimating or remembering portion size (Subar et al., 2015). As a measure of actual energy intake, self-reported energy intake should therefore be used with caution (Subar et al., 2015).

Healthcare professionals can play a vital role in supporting Appetitus users to interpret and understand the app's information output, and in suggesting dietary alterations and give professional nutritional support if the app points towards problematic situations, for example insufficient energy intake (Farsjø et al., 2019). However, healthcare professionals acknowledge that limited nutrition knowledge, competing tasks and time restrictions are potential barriers to good nutrition practices, leading to insufficient follow-up for those in need of support (Farsjø et al., 2019; Bauer, Halfens, & Lohrmann, 2015; Chen & Allman-Farinelli, 2019; Mowe et al., 2008). Despite the untapped potential with using nutrition apps to support individualised person-centred nutrition care, the uptake of app use in clinical practice is challenged, often attributed to lack of technical infrastructure, low awareness and mixed motivation to use nutrition apps among healthcare professionals (Chen et al., 2018; Paulsen, Varsi, Paur, Tangvik, & Andersen, 2019).

With the increasing use of technology in healthcare services and everyday life, a pressing concern is that the older adults may miss out because they are less likely to use Internet and health information

technologies (Fischer, David, Crotty, Dierks, & Safran, 2014). However, recent surveys point to growth in Internet use by older adults, and studies indicate that age becomes less important if tools are easy to use and training and support is provided when introducing new technologies (Anderson & Perrin, 2017; Göransson et al., 2018; Østensen, Gjevjon, Øderud, & Moen, 2017; Vaportzis, Giatsi Clausen, & Gow, 2017). In this study, a majority of informants reported to use the app regularly for 8 weeks to register their food and beverage consumption. Technical experience and competence were not identified as a major influencer nor barrier for participants' app use. This suggests that *Appetitus* is easy to use, and that participants received sufficient support from the healthcare professionals during the study.

The participants' experiences with the daily recording varied, while some found it rewarding, others indicated that they were glad when the study ended because they found it tiring to record their consumption. The fact that these participants nevertheless chose to continue their participation may be explained by their feelings of obligation to follow through and to show their commitment to participation. It can also be argued that the regular follow-up by healthcare professionals was important in maintaining their involvement over time. Previous research also points out the importance of healthcare professional attention in helping older adults to engage in self-reporting as a meaningful activity (Göransson et al., 2018; Holst et al., 2011).

4.1 | Limitations

We sought to recruit a varied sample of older adults receiving home care services in Norway. However, we acknowledge that our sample is small and may represent older adults that are experiencing better health, are cognitively fit and concerned with maintaining their health and more interested in technology. This may be partially supported by participants that dropped out of the study in an early phase, pointed to increased illness burden and experiencing the recording of their diet tiring. Another limitation in this study is that degree of accuracy in the feedback from the *Appetitus* app was not validated prior to study.

5 | CONCLUSION

This study reports on feasibility of using technology for early intervention to strengthen nutrition self-care among nutritionally vulnerable older adults. Most participants used the self-monitoring dietary function in the app regularly for 8 weeks. Support from healthcare professionals was considered important to build confidence to use the app and experiencing it as meaningful. Based on the results from this study, we suggest that dietary awareness is reinforced when dietary intake is visualised relative to personal need for nutrients and fluids. Our study suggests that such awareness can mobilise the user to implement dietary changes to make them less nutritionally

vulnerable, hence prevent a state of undernutrition. This is a hypothesis in need of further enquiry and warrants further investigation in larger studies with experimental design.

Implications for practice

- Dietary self-assessment with direct feedback supports awareness of healthy nutrition in old age.
- Tools developed specifically for older adults can increase opportunities active participation when interacting with healthcare services.

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Paper III



Older Adults' Engagement in Technology-Mediated Self-Monitoring of Diet: A Mixed-Method Study

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Geriatrics, information technology, nutrition, primary health care, qualitative methodology, quantitative methodology

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Abstract

Purpose: This feasibility study explored older adults' use of a nutrition app called *Appetitus* (<https://apps.apple.com/us/app/appetitt/id1001936854?ign-mpt=uo%3D2>; <https://play.google.com/store/apps/details?id=no.nr.appetitt&hl=e>) and addressed their engagement in technology-mediated self-monitoring of diet. Undernutrition is a significant challenge among older adults and is associated with poorer health experiences. Digital health for self-monitoring of diet has the potential to increase awareness of personal nutrition, and the scarcity of research reporting older adults' ability and willingness to engage in technology-mediated dietary self-monitoring warranted this study.

Design and Methods: An explorative mixed-methods design combining descriptive analysis of log data with qualitative analysis of interviews with *Appetitus* users was implemented.

Findings: Twenty-five older adults self-monitored their diet using *Appetitus* over an 8-week trial period. Eighty percent of the participants used the app regularly in the trial period. The most engaged users recorded their food consumption daily for 8 weeks. Personal interest in nutrition and commitment to the project facilitated regular use of *Appetitus*. Poor health and the perception that using a nutrition app lacked personal relevance contributed to irregular self-monitoring. For inexperienced technology users, participation in this project became a springboard to using tablet technology and the Internet beyond the *Appetitus* app.

Conclusions: The majority of the participants regularly used *Appetitus* for self-monitoring of diet; they found the tablet technology and *Appetitus* app easy to use.

Clinical Relevance: Older adults are able and willing to use self-monitoring tools. Nutrition apps can empower older adults to make better informed decisions about their diet. Patients' self-monitoring can provide valuable and detailed health-related information to healthcare professionals and mediate patient-centered care practices.

The increasing deployment of digital health is a central part of the solution to the challenges of rising demands on healthcare systems as greater numbers of older adults live with chronic conditions (Storeng, Vinjerui, Sund, & Krokstad, 2020). Technology can alleviate some of the pressure on healthcare systems by providing flexible solutions in patients' homes that support patients' self-care abilities (Kruse et al., 2020).

Malnutrition, particularly protein-energy undernutrition, is prevalent among older adults, dramatically

increasing their need for advanced services. Older adults who receive home care services are at a high risk for developing undernutrition (Cereda et al., 2016). It is therefore relevant to explore opportunities in preventative strategies and early interventions in the area of undernutrition in the home care setting. Good nutrition can be ensured through a varied diet, with energy levels adapted to body weight and activity levels (Findalen et al., 2012). Increasing older adults' awareness of undernutrition and offering support for a varied

diet with meals spread throughout the day can be initial steps to stimulate appetite and prevent undernutrition (Findalen et al., 2012).

Technology holds great potential when it comes to increasing people's awareness of health-related behaviors because it can offer immediate personalized feedback on an individual's behavior (Chen, Gemming, Hanning, & Allman-Farinelli, 2018). There are numerous commercial apps for self-assessment of diet; however, these apps are less appropriate for targeting undernutrition among older adults because they thematically focus on weight loss, require detailed food and beverage recording, and tend to have complex user interfaces (Hingle & Patrick, 2016). Poor usability experiences are a major barrier for technology adoption among older adults (Takemoto et al., 2018; Wildenbos, Peute, & Jaspers, 2018). Through a literature search, we identified four studies that developed and tested technological self-assessment solutions, such as apps, to target the explicit challenge of undernutrition among home-dwelling older adults (Astell et al., 2014; Kraft et al., 2012; Lindhardt & Nielsen, 2017; van Doorn-van Atten, Haveman-Nies, Heery, de Vries, & de Groot, 2018). Only Astell et al. (2014) included a comprehensive self-assessment of diet. In the other studies, the users recorded their weight, appetite, or selected items in their diet as part of a nutrition intervention. None of the interventions focused explicitly on stimulating appetite, varying diet, or providing information about enriching meals and beverages with protein and energy.

We developed a tablet computer application about nutrition called *Appetitus* with older, inexperienced technology users in mind. In this article, we explore older participants' use of *Appetitus* and discuss factors that affect their engagement in technology-mediated self-monitoring of diet.

Methods

Study Design and Sampling

Our feasibility study used a mixed-methods approach with 25 older adults 68–95 years of age from four municipalities in Norway. We provided them with a 3G-connected iPad with *Appetitus* installed; we encouraged them to use *Appetitus* regularly for 8 weeks.

We collaborated with local healthcare professionals in three home care organizations and one senior center in Norway to recruit participants. We asked the professionals to approach older adults whom they anticipated would benefit from participating in a nutrition intervention and would manage to use *Appetitus* independently. We recruited 39 participants in October

and November of 2016, 14 of whom withdrew. Nine withdrew their consent prior to the start of the trial, and one died. Four participants withdrew shortly after the trial started. Two explained that their withdrawal was due to illness burden, and one found the reporting of food and beverage consumption too tiring after the initial introduction. One did not want to explain.

In the home care setting, the healthcare professionals gave the participants introductions to and follow-up support for the *Appetitus* app and iPad (Farsjø, Kluge, & Moen, 2019). We asked the professionals to meet with the participants three times to support their use of the app and the iPad. The participants began using *Appetitus* after their first meeting with the healthcare professionals. We expected the professionals to introduce *Appetitus* to the older adults shortly after we initially met with them; however, we cannot guarantee that all of the participants recruited from home care services had access to *Appetitus* for 8 weeks. At the senior center, we organized introductions, and follow-ups were organized as an 8-week course with five group meetings. Senior volunteers gave technical support related to the iPad and *Appetitus* app. A nurse with special nutritional expertise offered nutrition care follow-up in two of the group meetings. See Table 1 for information about participants.

The Nutrition App: *Appetitus*

Thematically, *Appetitus* focuses on supporting weight gain or weight maintenance. The Norwegian guidelines on preventing and treating undernutrition guided the structuring of advice embedded in the app (Guttormsen et al., 2009). The app's main screen presents a meal plan with four main meals and two snack meals (Figure 1, left). Users can browse through 147 meal suggestions and log their food and beverage consumption. The users receive personalized feedback in the form of a gradually filling figure that visualizes energy and fluid in daily consumption. The feedback is individualized to reflect users' needs based on the common recommendation of 30 kilocalories energy, 1.2 g protein, and 30 mL fluid per kilogram of body weight (Findalen et al., 2012) (Figure 1, right). Meal serving size can be adjusted in the app, but the content of the meal as presented in the pictures is not adjustable.

We applied user-centered design, prototype testing with older adults, and empirical evaluation to develop *Appetitus*. The user interface aligned with recommendations for app development for older adults: a stable user interface, no menu function, large touch fields,

Table 1. Information About Participating Older Adults

Gender	n (%)
Female	18 (72)
Male	7 (28)
Age, years	
Mean (range)	79.48 (68–95)
Nutritional status according to mini nutritional assessment–short form, n (%)	
Malnutrition	4 (16)
Risk for malnutrition	13 (52)
Normal nutrition status	8 (32)
Grocery shopping, n (%)	
Independent	13 (52)
Receiving help from family or healthcare services	12 (48)
Dependence in food preparation, n (%)	
Independent: make dinner regularly	13 (52)
Partly independent: heat precooked dinner or eat dinner at senior center	8 (32)
Dependent: need all meals prepared and served	4 (16)
Experience with touch technology, n (%)	
No prior experience	15 (60)
Prior experience (tablet or smartphone)	10 (40)
Internet user pattern, n (%)	
Daily	12 (48)
Weekly	4 (16)
Never	9 (36)

Note. N = 25.

good contrast, and large text size (Fuglerud, Leister, Bai, Farsjø, & Moen, 2018).

Data Collection

When the participants used Appetitus to record food or beverage consumption, log data were automatically transferred to the University of Oslo's IT platform

(Service for Sensitive Data), developed for research purposes in compliance with Norwegian privacy regulations. The log data from Appetitus included an automatically generated user ID, time stamp, which item the user recorded as consumed, and action (specified as “add” or “undo”). The user ID could not be linked to an individual participant due to privacy concerns.

We collected demographics in structured interviews with participants prior to the test period. We interviewed all of the participants a second time in their homes on average 8 weeks and 5 days after the first interview. In this semistructured interview, we obtained their general experience of study participation, duration of the testing period, and use pattern of the app and iPad. We recorded and transcribed the interviews.

Ethical Considerations

Older adults received oral and written information about the study before providing their written consent. The Norwegian Centre for Research Data approved the study (project number 44004) according to the pre-General Data Protection Regulation (GDPR) rules.

Analysis

We used SPSS version 26 (IBM Corp., Armonk, NY, USA) and Excel 2016 (Microsoft Corp., Redmond, WA, USA) to process and analyze the log data. We used descriptive statistics to summarize the participants' demographics and to describe usage patterns in the log data. We summarized the log data at the individual level and created the variables “number of recording periods per day,” “number of total use days,” and



Figure 1. Screenshot from Appetitus.

“use days per week.” Based on the variable “use days per week,” we created the variable “user pattern,” which contained three user pattern categories: daily use, weekly use, and occasional use. Figure 2 is a flowchart that describes the cut points we set for the three categories. We encouraged the healthcare professionals to introduce the users to Appetitus shortly after we met them the first time; however, we cannot guarantee that all of the participants had access to Appetitus for 8 weeks. Thus, we considered weekly recording in Appetitus for 6 weeks or more as regular use. Based on findings regarding use pattern in digital tools, we differentiated between daily and weekly use (Slette-meås, Mainsah, & Berg, 2018).

We inductively analyzed the interview data based on the procedure Graneheim and Lundman (2004) described. We extracted meaning units (sentences and paragraphs) from interview transcripts that were relevant to our research questions and sorted the coded and condensed text into categories. For privacy, we could not code log data with demographic variables and interview data; however, our qualitative interviews included descriptions of user patterns. Fourteen of the informants described daily Appetitus use, whereas the others described their use as less regular, consistent with weekly or occasional use patterns. In the final stage of the analysis, we examined specific characteristics in the interview data and demographics from the perspective of the three use patterns: daily use, weekly use, and occasional use. We present the results in three themes: (a) user patterns, (b) engagement in self-monitoring, and (c) increasing confidence with digital technology.

Results

User Patterns

The majority of the participants used the Appetitus app over an 8-week period (Figure 3); however, there

was a decline in the number of participants who used the app in the last weeks of the trial. This is probably related to a combination of decline in use at the end of the trial and the possibility that professionals delayed in introducing participants to the app. Figure 4 visualizes the three different user patterns in a scatterplot with regression and trend lines (Loess line). Fourteen participants met the criteria of daily users, using Appetitus 7 days per week for the majority of the weeks in the trial period. The trend line (see Figure 4) visualizes the daily users' consistent high use of Appetitus over time. The negative regression line is affected by those participants' whose trial periods were less than 8 weeks. Six participants were weekly users; they also recorded their consumption in the app regularly in the trial period, but they had fewer days of use per week (Table 2). Five participants occasionally recorded consumption in the app; their use was characterized by 1 or 2 user days 1 week, followed by a week or 2 where they did not use the Appetitus app.

The number of times per day that participants used the app to record their consumption varied from one to nine. The daily users employed the app to record their consumption more regularly throughout the day compared to the weekly and occasional users (Figure 5). This indicates that those using Appetitus daily had consistent use of the app over time.

Engagement in Self-Monitoring

The interviews illuminated the participants' reflections on what contributed to or hindered their regular use of Appetitus over time. Those who stated that they used Appetitus daily took it very seriously, with several describing how they strived to record throughout the day to ensure they remembered to record everything they consumed. Most daily users found

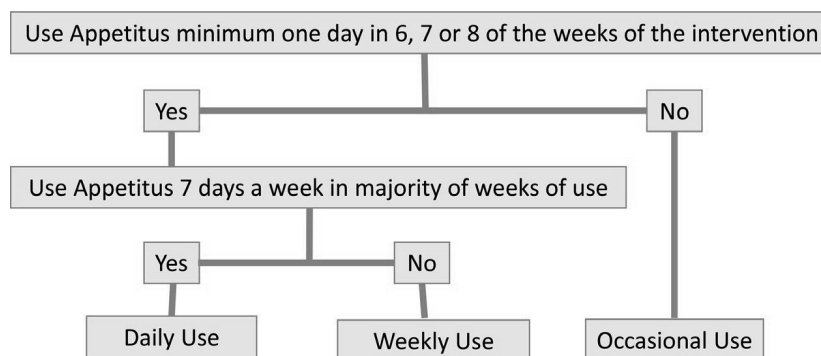


Figure 2. Flowchart of cut points for user pattern categories.

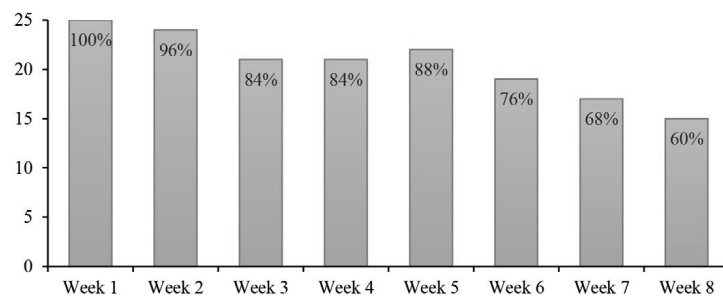


Figure 3. Percentage of participants who used the app each intervention week (N = 25).

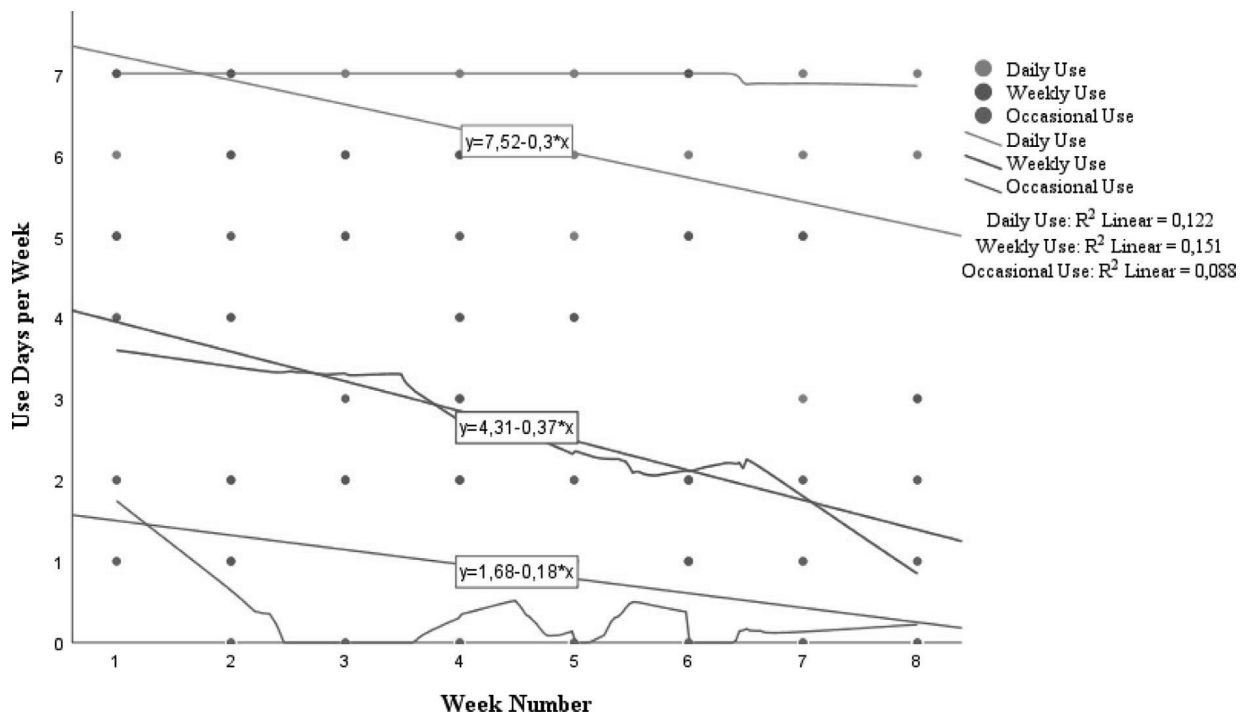


Figure 4. Grouped scatter plot of “use days per week” by week number.

Table 2. Mean Weekly User Days During the Trial Period

	Daily use (n = 14)	Weekly use (n = 6)	Occasional use (n = 5)
Weekly user days mean (range)	6.5 (5.2–7.0)	3.0 (1.4–4.8)	1.1 (0.5–2.0)

self-assessment of diet to be an interesting activity, stating that daily recording of food and beverage consumption led to increased awareness of their food intake: “I think this has been very interesting. I have to pay attention [to my diet] every day. I cannot record everything in the evening, because then I would forget. I record after each meal. I think that’s fine” (Male, 84 years).

Those who described their recording pattern in Appetitus as less regular appreciated that recording their food and beverage consumption in Appetitus had given them an overview of their diet. One participant explained that he intentionally used the app to record his consumption on select days: “I have not done it consistently, but I have done it in periods... . I don’t have to do it every day for a long time—my eating habits are still displayed [in Appetitus]” (Male, 69 years).

Many participants explained that desire to contribute to research was a strong reason to participate in the project and use the app for the whole trial period. They believed that nutrition for older adults was an important topic to study and well worth their time and dedication.

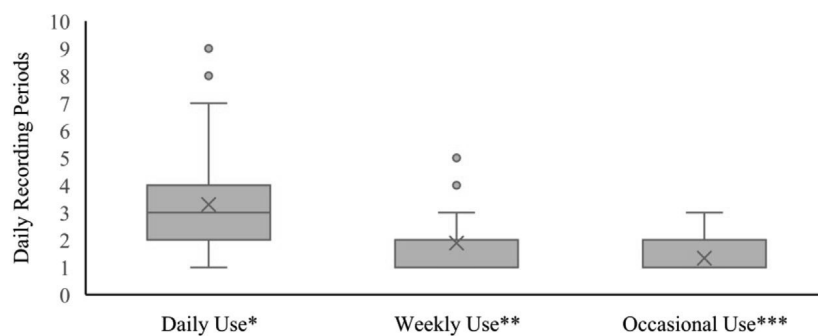


Figure 5. Boxplot of daily recording periods. * Number of recording days for this group = 712. ** Number of recording days for this group = 133. *** Number of recording days for this group = 39.

Most of the participants described it as quick and easy to record their daily consumption in Appetitus; however, some participants expressed relief that the project period was over so that they could stop recording. One participant who used the app daily described how it restricted her: “I think in a way I felt a little bit tied up. If I was going out one afternoon, I had to bring this [iPad] with me” (Female, 95 years).

Several of the participants who described their user pattern as less regular shared the feeling that recording was a burden, which might explain their irregular recording patterns. Several also described their health as fragile, explaining that low energy levels had negatively affected their use of the app. They could not always record as planned simply because they forgot about it or did not have the energy to do it.

Among the older adults who described their use pattern as occasional, several said that they only used the app for recording purposes when they were with healthcare professionals. One participant explained that he struggled to understand the purpose of using the Appetitus app independently:

I have not really understood my role in this project. What was I supposed to do? Look at the content [pictures and suggestions for enriching food and beverages] in Appetitus? I entered and checked [my consumption], and we [the participant and the nurse] concluded that I didn't consume enough. (Male, 78 years)

Two participants who only used Appetitus with healthcare professionals received help regularly from home care personnel or family members to prepare most of their meals. They were therefore not self-reliant in planning and preparing meals. This may build upon the experiences of little personal relevance

of using this app as expressed in the quote above and influence use pattern.

Increasing Confidence With Digital Technology

The participants described learning to use the Appetitus app and iPad as easy; this was a shared experience between the experienced and inexperienced technology users. Experience with touch technology did not seem to influence whether the participant used Appetitus on a regular basis. Among those who described using the app daily, only half had prior experience with touch technology. One participant described her previous reservations toward using technologies, such as tablets, and how the project changed her attitude:

But I discovered that it was not that difficult after all. I've thought I've been too old. It hasn't been necessary, that's been my reasoning. But that was stupid, I could have started long ago! But now I make the effort to learn to use it. (Female, 89 years)

As this quote points out, many of the participants experienced increased confidence in using technology, and the project became a springboard to further technology use. One participant who got access to the Internet for the first time expressed her enthusiasm: “It is life before and after the tablet!” (Female, 71 years).

Learning to access information on the Internet and use social platforms to connect with family were appreciated additional activities on the iPad. Some participants downloaded games such as chess or solitaire and used the iPad as a source of entertainment. Several of the participants pointed out that their relatives were engaged in their use of the iPad, and this generated additional support when they learned to use the iPad beyond using Appetitus.

Discussion

The majority of the older adults who participated in this study regularly used the Appetitus app during the trial period. Older adults' adoption of technology is dependent upon both individual and social factors as well as the qualities of the technology and delivery modality (Kruse et al., 2020). Experiencing Appetitus as easy to use, finding its use personally relevant, and being committed to supporting research all facilitated the use of Appetitus over time. Coley et al. (2019) found altruistic reasons were a strong motivator for older adults' participation in an eHealth study with a preventative focus. Similar to our study, participation was tightly connected to experiencing the study topic as relevant to themselves personally or to their age group (Coley et al., 2019). Research suggests that older adults show interest in measures that can help improve diet and lifestyle, maintain an active lifestyle, and stay independent (Bloom et al., 2017; Coley et al., 2019).

Perception of usefulness is a key factor in older adults' adoption of technology (Wildenbos et al., 2018). Interest in nutrition and the recognition of a personal nutritional challenge might have motivated the older adults in this study to regularly self-monitor their diet in Appetitus. Further, using self-monitoring technology also has the potential to make people aware of health challenges and support people to make better informed decisions and adopt health-promoting behavior. Studies indicate that regular self-monitoring of diet can have a positive impact on food choices and contribute to dietary change (El Khoury et al., 2019). For example, studies have demonstrated that recording fruit and vegetable consumption in an app can be a powerful tool to increase awareness of low consumption levels, leading to increased consumption (Mummah et al., 2017; Steinert, Haesner, Tetley, & Steinhagen-Thiessen, 2016). This article as well as our previous work suggests that interest in and awareness of an age-friendly diet increased among older adults as they used Appetitus to self-monitor their diets—many implemented dietary changes (Aure, Kluge, & Moen, 2020). It is still unclear how long and how often it is necessary to engage in dietary self-monitoring to foster long-standing eating habits that are beneficial for health (Michie, Yardley, West, Patrick, & Greaves, 2017).

Having knowledge and skills in using tablet technology was not crucial to the older adults' ability to use Appetitus or whether they used it regularly. This indicates that the app was user friendly and that the participants received sufficient training and support from the healthcare professionals during the trial (Aure

et al., 2020; Wildenbos et al., 2018). The app's interface is the outcome of an extensive co-design process accompanied by iterative evaluations and a pilot study with potential users, ensuring that the final version of the interface was suitable for older adults, including those without prior technology use (Fuglerud et al., 2018). Getting access to the tablet technology might have motivated participation in the project, as tablets are costly (Kruse et al., 2020). However, some of the older adults agreed to participate despite having little interest and low confidence in their ability to master the tablet technology. Our results illustrated that many of those without technology experience increased their confidence in their own abilities to use modern technologies when introduced to the iPad and Appetitus app through this project. Other studies in which older adults are given access to tablet technologies through research projects report similar findings (Østensen, Gjevjon, Øderud, & Moen, 2017; Vaportzis, Gow, & Giatsi Clausen, 2018).

In the same vein, we found that the older adults appreciated opportunities to access information on the Internet and to keep in touch with family. Although use of digital technology and the Internet has increased sharply among older adults in Norway, where 65% of older adults 71 to 80 years of age used the Internet daily in 2018, their adoption of health-related technologies may still depend on their perceptions of the technology as relevant and useful (Slette-meås et al., 2018; Takemoto et al., 2018). Poor usability experiences (e.g., where entering data is considered to be cumbersome) can negatively influence the sustained use of digital health technology (Wildenbos et al., 2018). Older adults can therefore benefit from technology developed especially for their needs regarding both user interface and content (Takemoto et al., 2018). In this way, digital health can be a gateway to technology use for inexperienced users.

Our results indicate that older adults who depend on help for food preparation might experience using Appetitus to self-monitor and evaluate their diet as less personally relevant, affecting their adherence to using the app. In addition, poor health with reduced energy levels hindered daily use of Appetitus. Narrowing the self-monitoring of diet to specific meals (e.g., dinner) or using more limited time periods could help those who struggle to use the app regularly (Chen et al., 2018). Steinert et al.'s (2016) study on using an app to record health-promoting activities, such as eating fish twice per week, suggests that limited and personally adapted goal-setting of dietary behavior can lead to behavioral change.

There are emerging technical advances in more automatic methods to assess diet using image analysis and wearable sensors (Hassannejad et al., 2017). This creates opportunities for user adoption, including among those who are not benefitting from self-assessment technologies, such as older adults with declining health. Adopting such technologies in real-life settings is not uncomplicated regarding feasibility, and also ethical and privacy concerns will constrain the uptake of such innovations.

Strengths and Limitations

The results of this feasibility study must be interpreted with some caution. Our sample is small, the participants were a group of older adults with good cognitive functioning, and they do not represent the full spectrum of patients receiving home care in Norway (Helvik et al., 2015). Cognitive health can therefore be considered as a factor that influences the uptake of Appetitus. Declining cognitive health negatively influences the ability of older adults to use digital health applications (Wildenbos et al., 2018). A strength of the study was the stability of the Appetitus app during the test period, which contributed to focused data collection over the entire test period.

Implications for Research

Further studies need to evaluate the effect of using digital health tools and technology-mediated self-monitoring to prevent and treat undernutrition among older adults. Recruiting eligible participants in this cohort is challenging (Lindhardt & Nielsen, 2017; Locher et al., 2013). By integrating findings from quantitative and qualitative analysis, we can draw inferences on how factors such as personal interest, health experiences, and care dependency affect older adults' engagement in self-monitoring their diet.

Clinical Implications

Our results suggest that the structure of the research project, with regular follow-up from healthcare professionals, positively influenced participants' motivation to continue self-monitoring over time. Our study indicates that defined periods of use and structured follow-up can be a strategy to gain acceptance of use among patients in other real-life settings. Self-reporting of eating can be visualized to increase both patients' and healthcare professionals' awareness of dietary challenges. Digital health self-monitoring tools

can thus be a mediator for focused health dialogs that promote patient-centered practice (Chen et al., 2018).

Conclusions

Older adults with good cognitive health are able and willing to record their diet for several weeks. When the digital health technology is considered easy to use, previous technological experience is not crucial to their ability to use self-monitoring technology. When properly introduced, digital health technology can be an enabler for aging in place, empowering older adults to be active participants in ongoing health discussions, and facilitating health-promoting activities, such as maintaining a healthy diet.

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Clinical Resource

- Geriatric nutrition: Nutritional issues in older adults. <https://www.uptodate.com/contents/geriatric-nutrition-nutritional-issues-in-older-adults>

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Appendices

- I. Brukerveiledning iPad
- II. Brukerveiledning for individuelle justeringer av porsjonsstørrelser
- III. Intervjuguide fokusgruppe, midtveis første utprøvningsperiode
- IV. Intervjuguide fokusgruppe, etter første utprøvningsperiode
- V. Intervjuguide fokusgruppe, etter andre utprøvningsperiode
- VI. Intervjuguide individuelle intervju eldre

Appendix I

Enkel

Brukerveileder iPad

APPETITT



Høst 2015

Utprøving av nettbrett

Dette er en enkel veiledning for å kunne begynne å bruke et nettbrett av typen iPad. Veiledningen tar for seg:

- Komme i gang
- Hvordan finne APPETITT(Appetitus)

Skjermen er en såkalt berøringsskjerm, som betyr at du ikke bruker «mus» eller tastatur, men berører skjermen i stedet.

Skjermen er varmefølsom.

Bruk derfor fingeren til å berøre skjermen, ikke neglen. Bruker du neglen eller en vanlig penn, vil ikke nettbrettet reagere på berøringen.

Du kommer alltid ut av programmet igjen ved å trykke på hovedknappen som ligger i fordypningen i rammen rundt skjermbildet. Se bildet for forklaringer:

- 1 Av/på-knapp (obs. du må holde den inne noen sekunder)
- 2 Slå av og på lyd (på bildet er lyden slått av)
- 3 Justere lyd opp/ned
- 4 Inngang for sim-kort
- 5 Inngang for hodetelefoner

Ved å trykke på hoved-knappen vil du lukke programmet som er åpent. Du kommer tilbake til «forsiden» hvor alle programmene vises.



Dette er hoved knappen

Denne knappen kan være vanskelig å se, men du kan kjenne den ved at du kjenner en fordypning på midten, helt nederst på nettbrettet.

Bilde: corrupteddevelopment.com





Begynne å bruke nettbrettet - «Lås opp»

For å begynne å bruke nettbrettet, skyv pilen på skjermen til høyre - i den retningen pilen peker:



> skyv for å låse opp

SIM mangler 

100% 

13.28

torsdag 24. september

> skyv for å låse opp

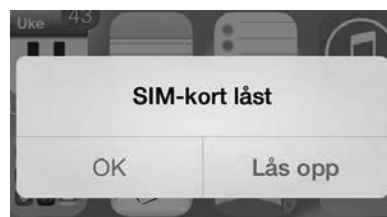


Nettbrettet og mobilt internett.

Dersom nettbrettet går tom for strøm eller det har vært slått av, må du taste inn en kode når du slår nettbrettet på igjen (på samme måte som på mobiltelefon).

Når dette skjer må du gjøre følgende:

1. Trykk «Lås opp»



Det vil nå komme opp et nytt bilde med et talltastatur hvor du skal taste inn sim-koden.

2. Tast inn sim-koden - 4 tall - (se baksiden)

3. Trykk OK (rød ring på bildet)



Hvor finner jeg APPETITT(Appetitus)?



Her finner du Appetitus. Trykk på bildet og du er inne i programmet

Kontaktperson:

Appendix II

Veiledning

Porsjonsstørrelser og individuelle justeringer

Til helsepersonell og andre hjelpere

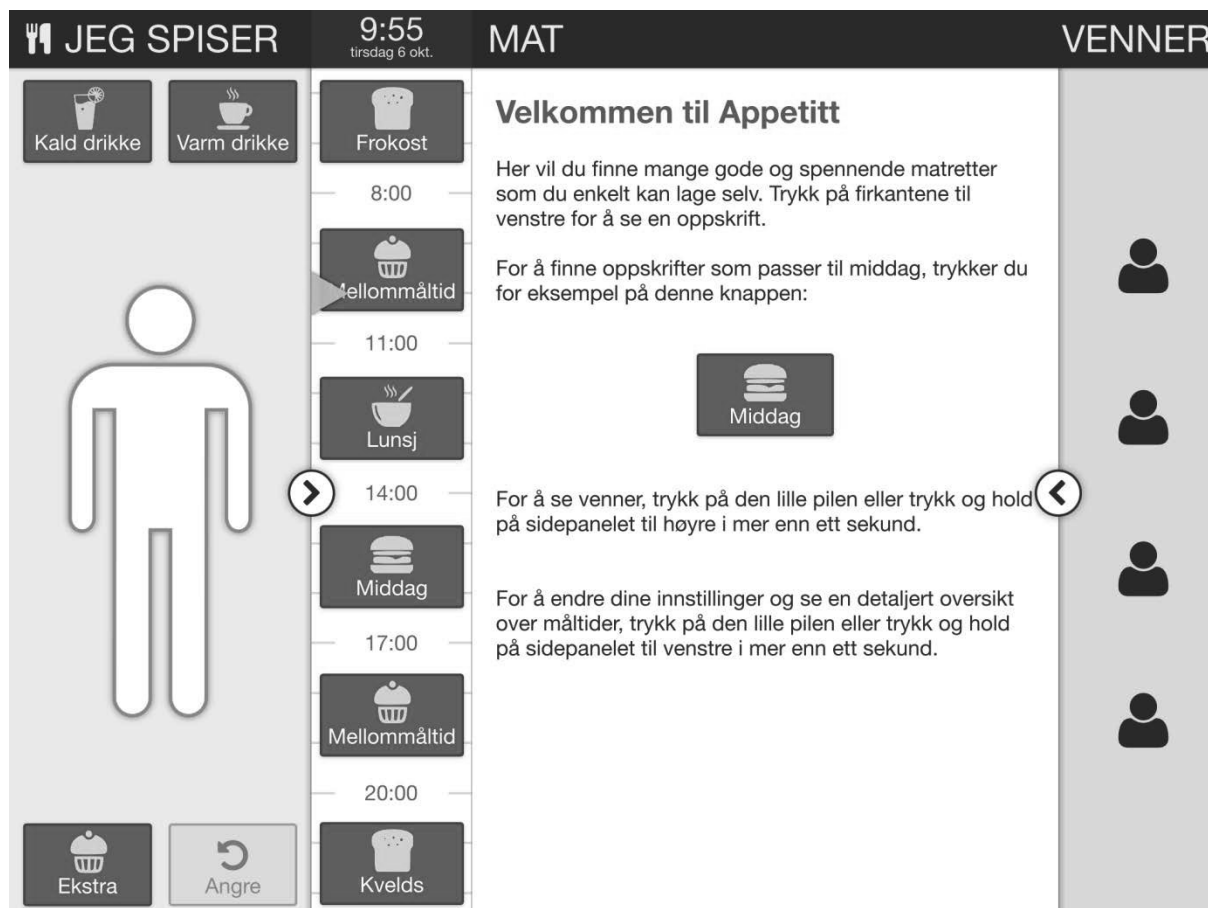
APPETITT



Når en bruker skal starte å bruke APPETITT for første gang, er det viktig å legge inn noen grunnleggende innstillinger:

1. Bakgrunnsinformasjon om bruker
2. Porsjonsstørrelser som normalt spises

Startsiden («hjem») i APPETITT ser slik ut:



Du kan alltid komme tilbake til startsiden ved å «tappe» på gaffel- og knivsymbolet.

Når du trykker på pilen ved figuren åpner du panelet «jeg spiser».

JEG SPISER 9:57 tirsdag 6 okt. VENNER

Kald drikke Varm drikke

Har spist Dag Uke Innstillinger

Personalia

Fødselsdato 20.08.1940 dd.mm.yyyy

Vekt 68.00 kg

Kategori justering

Frokost 200 %

Mellommåltid1 100 %

Lunsj 100 %

Middag 75 %

Mellommåltid2 100 %

Kvelds 100 %

Ekstra Angre

Frokost 8:00

Mellommåltid 11:00

Lunsj 14:00

Middag 17:00

Mellommåltid 20:00

Kvelds

Personalia:

Tast inn fødselsdato og vekt til brukeren som skal bruke APPETITT. Dette er nødvendig for å gjøre en grov estimering av behov for energi, protein og væske.

Kategori justering:

Under overskriften «Kategori justering» anslås hvor store porsjoner brukeren normalt spiser til de ulike måltidene. Det er lagt opp til en måltidsrytme med 4 hovedmåltider: Frokost, lunsj, middag og kvelds, og 2 mellommåltider. Dersom brukeren vanligvis ikke spiser alle disse måltidene setter du inn 0 % på det eller de måltider som normalt ikke spises. F.eks. dersom en bruker aldri spiser noe mellom frokost og lunsj, tastes 0 inn for Mellommåltid1.

For de måltidene som brukeren normalt sett spiser på en vanlig dag, er det i det følgende illustrert med bildeeksempler hvordan du kan angi prosent for hvor mye av måltidet som spises. Høyere eller lavere prosenter enn vist i eksempelbildene kan angis. Disse prosentene bør da vurderes opp mot prosentene som er gitt for eksempelbildene.

Det skal kun angis et tall for prosent for hver måltidstype. Prosenttallet er en omtrentlig verdi for hvor mye mat som antas spist til vanlig.

FROKOST

- **Brødskiver med smør/margarin og pålegg**

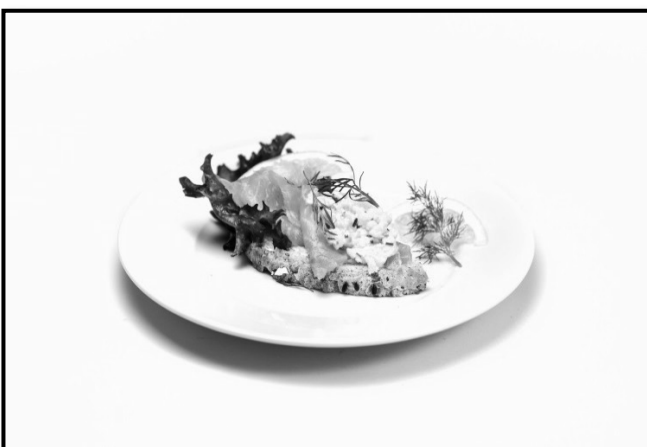
- **100 %:** De fleste bildene i APPETITT er av to halve brødskiver. Dette regnes som 100 %.



- **200 %:** Dersom bruker normalt spiser 2 brødskiver til frokost, dvs. 4 halve skiver, skal dette angis som 200 %:



- **50 %:** Dersom bruker normalt spiser en halv skive til frokost skal dette angis som 50 %.



- **Frokostblanding**

- **100 %:** En porsjon frokostblanding (bruk den skålen som ligner mest den du har hjemme for å anslå mengde. Det er kun innholdet i én av skålene som teller med i porsjonsstørrelsen)



- **50 %:** En halv porsjon frokostblanding (bruk den skålen som ligner mest den du har hjemme for å anslå mengde. Det er kun innholdet i én av skålene som teller med i porsjonsstørrelsen)



MELLOMMÅLTID 1

- **Frukt**

- **100 %:** En hel frukt



- **50 %:** En halv frukt



- **Yoghurt**

- **100 %:** Et fullt lite porsjonsbeger (125 ml)
- **50 %:** Et halvt lite porsjonsbeger

- **Nøtter**

- **100 %:** En håndfull



- **Knekkebrød**

- **100 %:** Et knekkebrød med smør/margarin og pålegg.



LUNSJ

- **Brødskiver:** Se bilder under «Frokost».
- **Suppe:**
 - **100 %:** En full porsjon (bruk den skålen som ligner mest den du har hjemme for å anslå mengde. Det er kun innholdet i én av skålene som teller med i porsjonsstørrelsen)



- **35 %:** En liten porsjon (bruk den skålen som ligner mest den du har hjemme for å anslå mengde. Det er kun innholdet i én av skålene som teller med i porsjonsstørrelsen)



MIDDAG

➤ Middagsporsjon

➤ **100 %:** En full porsjon



➤ **35 %:** En liten porsjon



MELLOMMÅLTID2

➤ **Kake**

- **100 %:** Ett kakestykke



- **50 %:** Et halvt kakestykke



- Iskrem

➤ **100 %:**



➤ **50 %:**



KVELDSMAT

- **Brødskiver:** Se bilder under «Frokost».

Oppdatering av innstillinger

Innstillingene for porsjonsstørrelser bør jevnlig oppdateres, slik at en eventuell endring i inntak/måltidsstørrelser blir fanget opp. Dette bør tilpasses den enkelte bruker, men en generell anbefaling for en person som er i ernæringsmessig risiko er oppdatering én gang per uke.

Uten oppdaterte porsjonsstørrelser, vil dataene for daglig og ukentlig inntak av energi og protein i for liten grad gi et grunnlag for å sammenligne med beregnede behov.

Viktig om grafer og overskrifter for dag-dag og uke

Det er forbundet stor usikkerhet knyttet til de beregnede dataene for inntak av energi, protein og væske under «Dag» og «Uke». Tallene kan kun gi en indikasjon og må brukes med forsiktighet og ikke som absolutte resultater eller en fasit. Selv om en bruker har trykket på «spist», så er det ikke sikkert at all maten faktisk er spist. Loggen under «Har spist» bak kniv- og gaffelsymbolet viser en oversikt over hva som er rapportert spist og drukket. Denne funksjonen muliggjør en dialog om mat, drikke og måltider med den enkelte bruker.

Det viktigste målet på om den enkelte bruker får i seg tilstrekkelig mat og drikke er vektutvikling over tid samt personens allmenntilstand. I tillegg kan observasjon av trivsel ved måltidene gi holdepunkter for om matlysten er økende.

Appendix III

Intervjuguide fokusgruppe, midtveis første utprøvningsperiode

Innledningsspørsmål:

Kan dere begynne med å fortelle om deres erfaring så langt med å være med i prosjektet APPETITT?

Rekruttering:

Kan dere begynne med å fortelle hvordan dere gikk frem for å finne aktuelle kandidater til prosjektet?

Var det mange som ble spurt som ikke ønsket å være med?

Hva var avgjørende for utvelgelse?

- Hvor de bor?
- Underernæring?
- Datakyndighet/interesse?
- Kognitivt nivå?

Hva var viktig når dere skulle introdusere prosjektet for brukere?

Har noen trukket seg fra studien?

- Vet dere hvorfor?

Oppfølgingsrollen:

Hvordan har det vært å følge opp disse eldre så langt?

Hva snakket dere med brukeren om?

- Veiledning bruk av APPETITT?
- Ernæring?
- Nettbrettbruk?
- Laste ned apper?

Har tiden dere har satt av til dette vært for mye eller for lite tid?

Fikk dere møtt brukeren like ofte som dere hadde planlagt?

Har bruker tatt kontakt utover de avtalte tidene for oppfølging?

Har pårørende vært involvert?

Hva skal til for å introdusere eldre hjemmeboende for Appetitus appen og nettbrett?

Opplæring:

Hadde dere fått den opplæringen dere hadde behov for i forkant av introduksjonen til eldre?

- Nettbrettkunnskaper og Appetitus appen

Hvordan fungerte det med individualiseringen i APPETITT?

- Var det noe usikkerhet i forhold til innstillingene?

Hvordan fungerte veilederen dere hadde fått?

Utforming, brukerinteraksjon:

Har dere sett noe brukerne ofte sliter med å få til?

Er det spesielle ting dere har måtte gjenta ofte for brukerne for at de skal lære det?

Hvilken tilbakemelding har dere fått av brukerne på appen?

Hva er nytten av en slik app for de brukerne dere har introdusert den for så langt?

- Er det individuelle forskjeller, hva er i så fall disse?

Appendix IV

Intervjuguide fokusgruppe, etter første utprøvningsperiode

Innledningsspørsmål:

Kan dere begynne med å fortelle om deres erfaring så langt med å være med i prosjektet APPETITT?

Rekruttering:

Hva ville dere gjort annerledes, om noe, i forhold til rekruttering?

Hva var viktig når dere skulle introdusere prosjektet for brukere?

Hvem mener dere at dette er aktuelt for?

Oppfølgingsrollen:

Hvordan har det vært å følge opp de eldre i denne siste delen av utprøvingen?

Hva snakket dere med brukeren om?

- Veiledning bruk av Appetitus?
- Ernæring?
- Nettbrettbruk?
- Laste ned apper?

Har tiden dere har satt av til dette vært for mye eller for lite tid?

Fikk dere møtt brukeren like ofte som dere hadde planlagt?

Har bruker tatt kontakt utover de avtalte tidene for oppfølging?

Designrefleksjoner:

Har dere noen tilbakemeldinger på utformingen av Appetitus appen?

- Innhold og funksjon i de tre panelene:
 - o måltidsforslag og -rytme, variasjon, mat, drikke, beriking
 - o visualisering og oversikt
 - o navigering i appen

Har dere sett noe brukerne ofte sliter med å få til?

Hva som skal til for at appen blir enda mer nyttig?

Refleksjoner om nytteverdier:

Hva synes dere Appetitus har bidratt med i de sammenhengene dere har brukt den?

Er Appetitus et attraktivt hjelpemiddel for dere som helsepersonell?

Har dere brukt Appetitus hos noen andre brukere enn de dere følger opp som er rekruttert til dette prosjektet?

- Hvilke situasjoner har dere tatt frem Appetitus?
- Hva skjedde når dere tok fram Appetitus?
- Hvorfor har dere valgt å ta frem Appetitus hos bruker

Hva er nytten av en slik app for de brukerne dere har introdusert den for så langt?

- Er det individuelle forskjeller?

Appendix V

Intervjuguide fokusgruppe, etter andre utprøvningsperiode

Innledende spørsmål:

Hva er deres erfaring med å være med i prosjektet APPETITT?

Rekruttering:

Kan dere fortelle hvordan dere gikk frem for å finne aktuelle kandidater til prosjektet?

Hva var avgjørende for utvelgelse?

- Datakyndighet?
- Underernæring?
- Kognitiv funksjon?

Var det mange som ble spurt som ikke ønsket å være med?

Hva var viktig i møte med brukerne i rekrutteringsprosessen?

- Vise appen?
- Fortelle om oppfølgingen?
- Forskning?

Ville dere gjort noe annerledes basert på de erfaringene dere har nå?

Har noen trukket seg fra studien?

- Vet dere hvorfor?

Oppfølgingen av de eldre:

Kan dere fortelle hvordan dere har fulgt opp de eldre?

Innholdet i opplæringen

- Bruk av Appetitus
- Ernæring
- Nettbrettbruk
- Laste ned apper

Var det ting de eldre trengte gjentagende opplæring av?

Hvor mye tid tar det å følge opp brukere med Appetitus?

Fikk dere møtt brukeren like ofte som dere hadde planlagt?

Har bruker tatt kontakt utover de avtalte tidene for oppfølging?

Hva skal til for å introdusere eldre hjemmeboende for Appetitus og nettbrett?

Har pårørende vært involvert?

Opplæring:

Fikk dere den opplæringen dere hadde behov for i forkant av introduksjonen til de eldre?

- Hva savnet dere?

Hvordan fungerte det med individualiseringen i Appetitus?

Var det noe usikkerhet i forhold til innstillingene?

Refleksjoner om Appetitus appen:

Hva synes dere om Appetitus appen?

Hvordan fungerte Appetitus for de eldre?

- Hva får brukerne til?
- Hva er vanskelig?

På hvilken måte kan Appetitus gjøres mer brukervennlig?

- For helsepersonell/brukere
- Forslag til forbedringer?
- Forslag til nye funksjoner?

Refleksjoner om ernæringsarbeid:

Kan dere fortelle litt om rutinene for ernæringsarbeid hos dere?

- Har dere faste rutiner?
- Kartlegging?
- Screening?
- Nattfaste?

Hvordan går dere frem med ernæringsarbeidet hos brukere i ernæringsmessig risiko?

Har Appetitus endret tilnærmingen til ernæringsarbeidet i prosjektperioden?

- Fortell om hvordan du har brukt Appetitus, gi gjerne et eksempel
- Hva syns dere Appetitus har bidratt med i de sammenhengene dere har brukt appen?
- Er det situasjoner der Appetitus har endret hvordan brukeren ser på sin egen ernæringsstatus?

Har dere sett på/fulgt med på ukesrapportene/dagsrapportene?

- Hvilke erfaringer har dere med dette?
- Har dere eksempler på situasjoner der registreringen har gitt overraskende resultater?

Kan Appetitus være et hjelpemiddel for dere som helsepersonell?

Har deres forståelse av hva Appetitus appen kan bidra med endret seg fra introduksjonen og frem til i dag?

Nytteverdier:

Hva er nytten av en slik app for de brukerne dere har introdusert den for så langt?

Er det individuelle forskjeller?

- Hva er i så fall disse?

Hvem mener dere Appetitus er aktuelt for?

Kan Appetitus være aktuelt for andre grupper/andre deler av helsetjenesten?

Hvilke forutsetninger tenker dere må ligge til grunn for at appen skal bidra i ernæringsarbeidet?

Hvilke utfordringer har dere møtt i løpet av utprøvningsperioden?

Appendix VI

Intervjuguide eldre

Innledningsspørsmål:

Hvordan har det vært for deg å være med i dette prosjektet?

- Hvordan var det å ta i bruk nettbrett?
- Hvordan var det å ta i bruk Appetitus appen?

Beskrivelser og refleksjoner knyttet til bruk:

(Appetitus appen tas frem og brukes aktivt i denne delen av intervjuet)

Kan du vise meg hvordan du bruker Appetitus?

Hva har du brukt Appetitus til?

- Se på bilder/oppskrifter?
- Planlegge innkjøp?
- Lære om beriking?

Har du registret mat- og drikkeinntak?

- Hvor ofte?
- Hvordan synes du det har vært å legge inn hva du spiser og drikker?
- Har du brukt registreringen til noe?
 - o Følge med selv
 - o Samtale med helsepersonell/pårørende?
- Hva synes du om varigheten på utprøvingen?
- Ønsker du å fortsette å bruke Appetitus til å registrere mat og drikke?

Hvordan forstår du det som skjer i figuren når du registrerer inn mat/drikke?

Har du sett på oversiktene/grafene?

Fant du det du vanligvis spiser?

- Hva savnet du?

Har du brukt oppskriftene?

- Hvilke oppskrifter har du brukt? (enkel/fra bunn?)

Har det vært nyttig for deg å prøve Appetitus appen?

- Hvordan?
- Hvorfor ikke tror du?

Har det påvirket matvanene dine å bruke Appetitus appen??

Har du noen forslag til forbedringer?

Er det noe annet du kunne ønsket deg i appen?

Synes du vi skal introdusere appen til andre som er i lignende livssituasjon som deg?

Refleksjoner om bruk og oppfølging av helsepersonell:

Har det vært nyttig for deg å prøve Appetitus appen?

- Hvordan?
- Hvorfor ikke tror du?

Hvordan synes du opplæringen til nettbrettet og Appetitus fungerte?

- Synes du det var satt av nok tid til opplæringen?
- Var det noe du savnet i opplæringen?
- Hadde du noen å spørre om hjelp hvis du sto fast?
 - o Hvem spurte du?

Har du hatt samtaler om mat og drikke med hjemmesykepleien? Eller pårørende?

- Er dette nytt for deg?

Teknisk:

Har Appetitus appen fungert som det skulle hver gang?

- Hvordan fungerte den ikke?
- Hva gjorde du da?

Har det oppstått noen problemer med nettbrettet?

- Tom for strøm?
- Manglet internett?
- Er det noe du synes er vanskelig med nettbrettet?

Har du brukt nettbrettet til noe annet enn Appetitus appen?

- Ønsker du å fortsette å bruke nettbrettet og Appetitus appen?