Malin Andtfolk

The Possibilities for Using Humanoid Robots as a Care Resource

Åbo Akademi
University

Malin Andtfolk

Born 1989

Previous studies and degrees

Master’s degree in Health Sciences, Åbo Akademi University, 2017
Registered Nurse, Bachelor of Health Care in Nursing, 2015
Registered Social Worker, Bachelor of Social Services in Social Care, 2012
Licensed Practical Nurse in Social and Health Care, 2008

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Malin Andtfolk

Health Sciences, Caring Science
Faculty of Education and Welfare Studies
Åbo Akademi University
Vaasa, Finland, 2022

ISBN 978-952-12-4200-7 (printed)
ISBN 978-952-12-4201-4 (digital)
Painosalama, Turku, Finland, 2022

Acknowledgements

The year was 2018. For many years alarm bells had been ringing about the acute situation in healthcare in Finland, such as the lack of care professionals and increasing care needs. It came to my attention that a new project was being formed at the Department of Caring Science, Åbo Akademi University, related to the possibilities of robotic technology in healthcare and robots' specific potential as a care resource. Without further reflection, I jumped at the chance and "signed up" for the adventure of a lifetime. Since that long-ago moment I have learned many things: from what can go wrong when buying robots, to how to build data program scripts, to developing my own understanding of what the core of caring is. I have met skeptical participants and curious participants. I have danced around hospital corridors with a robot and Assoc. Professor Linda Nyholm. And so much more. Despite some doubts and tears along the way, I have never regretted my naivety and enthusiasm at leaping into the unknown, because to this day it has given back so much more than I could ever have expected.

I would like to express my deep and warmest thanks to all of the participants who have made my research possible – the patients, relatives, care professionals and other actors in healthcare who have contributed to this thesis. I have loved every single moment of each face-to-face encounter with every single one of you and truly appreciate your contributions to the research area and your sharing of thoughts and experiences. Your contributions have yielded a much deeper understanding of where welfare technology is not only today, but you have even illuminated the way forward.

It is with great pleasure that I can acknowledge the wonderful support network that has buoyed me in my endeavors. Assoc. Professor Linda Nyholm, thank you for letting me be who I am, both as a person and an academic researcher. You have never controlled my choices but have instead demonstrated trust and motivating tutoring to subtly guide my path, allowing me to develop both personally and professionally. Your academic work and huge interest in developing welfare technology is a significant source of inspiration for myself and the pursual of my research. A tremendous thank you to Professor Lisbeth Fagerström for giving me this opportunity: for pushing me forward and helping me clarify the essentials, especially in the beginning when my research knowledge and self-belief were at times lacking. To Professor Hilde Eide, thank you for your steadfast support during the entire process and to Affiliate Professor Auvo Rauhala, thank you for sharing your generous knowledge of statistical analysis. I am furthermore grateful for all the valuable financial support that I have received during the course of this project, from *Högskolestiftelsen i*

Österbotten, *Stiftelsen för Åbo Akademi forskningsinstitut,* The Swedish Cultural Foundation in Finland, and *Svensk-Österbottniska Samfundet*.

Thank you to all of my other colleagues at Åbo Akademi University, especially the other doctoral candidates, for kindly sharing your knowledge, laughter and at times tears along the way. Without you, this research would not be the same. A tremendous thank you as well to my wonderful ex-colleagues at *Linneahemmet*, the *Fylgia rf* assisted living facility for older persons, who with strength and patience during all stages of caring demonstrate a deeper understanding of what the most important factor is in a caring encounter - love for the other. You are the real heroes of the world.

Thank you to my family and friends, who have faithfully supported me through all trials and tribulations, even though it can be difficult to understand what I actually do for a living (and no, it is not only dancing with robots). A loving home environment provides both strength and builds faith along the way, and you have all contributed to my work by listening and cheering me on. Mom, thank you for teaching me that own happiness comes by giving of oneself. Dad, thank you for teaching me that almost anything can be solved with a little logical thinking.

Finally, my beloved Henrik. From the very first moment, you have supported and believed in me, no matter what. Your deep devotion to all aspects of life has been an immense inspiration for my own curiosity and development. Your love for me and for our four-legged family members strengthens me every day. Thank you for all that you give me.

Vaasa, May 2022

Malin Andtfolk

Abstract

Andtfolk Malin, 2022: The possibilities for using humanoid robots as a care resource
Supervisors: Associate Professor Linda Nyholm, Åbo Akademi University, Professor Lisbeth Fagerström, Åbo Akademi University, Professor Hilde Eide, University of South-Eastern Norway

Aims New multidimensional perspectives are needed to address the challenges arising from the introduction of humanoid robots in healthcare. The overall aim of this thesis was to gain understanding of the possibilities for using humanoid robots as a care resource.
Methods An overall mixed-method approach was used. This approach, involving both quantitative and qualitative methods with specific research questions, was based on a research design relevant to the overall aim. In Sub-study I, multistakeholders' attitudes toward the use of humanoid robots in healthcare were explored in a cross-sectional study. Data were collected through a questionnaire during November and December 2018 (*n*= 264) at a hospital and a university setting. Multiple linear regression was used during analysis. In Sub-study II, how humanoid robots have been used in the care of older persons was examined in a scoping review. Searches in two international bibliographic databases and complementary searches in Google Scholar were undertaken in 2018 for literature published between 2013-2018 alongside an additional search undertaken in 2019, followed by the systematic screening and coding of the data. Qualitative descriptive analysis was used to map the results. In Sub-study III, a humanoid robot-led group physical exercise training program for home-living older persons was developed and evaluated in a qualitative pilot study. A participatory design approach was employed, including a workshop, feedback session, pre-test and testing. Following testing, semi-structured interviews with participants (n= 11) were performed in March 2020, and thematic analysis was used.
Results In Sub-study I, most participants were positive toward the use of humanoid robots in healthcare and the humanoid robots were perceived to be friendly and interesting. Of the participant groups, other relevant actors in healthcare (e.g., politicians, leaders or service personnel), those with a higher educational level, older adults and those whose mother language is Swedish were seen to have a more positive attitude. In Sub-study II, a total of 12 relevant publications were included, resulting in four main categories related to how humanoid robots have been used in the care of older persons: Supports everyday life, Provides interaction, Facilitates cognitive training, Facilitates physical training. Potential for humanoid robots to be accepted as companions for older persons was seen, but technical issues, such as humanoid robots' slow response time or errors, emerged as key challenges.

Older persons' perceived enjoyment of using a humanoid robot might also decrease over time. In Sub-study III, the most common participant experiences were that the humanoid robot-led group physical exercise training program exercises were easy to follow and entertaining but that more person-centered and challenging exercises suitable for home-living older persons in good physical condition were needed. Overall, most healthcare stakeholders were seen to have a positive attitude toward the use of humanoid robots in healthcare. They perceived the humanoid robots they interacted with as being friendly and interesting, and the use of a humanoid robot was rated highly. However, technical limitations linked to both technical and social aspects were seen to be recurring barriers for the use of humanoid robots in healthcare. Older persons' expectations of humanoid robots in terms of utility were seen to be met, but the humanoid robots were perceived less as a support for independent living or a "complement" within care and more as a toy, guide or assistant.

Conclusions The overall aim of this thesis was to gain new understanding of the possibilities for using humanoid robots as a care resource. Derived from the understanding was that most healthcare stakeholders were seen to have a positive attitude toward the use of humanoid robots in healthcare, although questions related to certain groups' more negative perceptions remain. Face-to-face encounters with robotic technologies appear to be linked to positive experiences of such technology, but the many technical limitations must be identified and corrected to ensure more robust and user-friendly technological solutions. A person-centered approach is recommended in further research. As seen in the overall findings, because of technical and ethical limitations (linked to both technical and social aspects), humanoid robots at this point in time lack an inherent capacity for *caring.* Instead, at present, they should be considered an aid or "complement" within care. There is a need to shift the focus of humanoid robot research throughout the world. By incorporating a focus on sustainable robot solutions, face-to-face human-humanoid robot encounters, longer interventions and real-life perspectives, greater understanding and thereby the usability of humanoid robots as a care resource in healthcare can be achieved.

Keywords Humanoid robot, care resource, healthcare, multistakeholder, older persons, attitudes, experiences, enablers, barriers, cross-sectional study, scoping review study, pilot-study, Health Sciences, Caring Science.

Abstrakt

Andtfolk Malin, 2022: Möjligheterna att använda humanoida robotar som vårdresurser
Handledare: Akademilektor Linda Nyholm, PhD, Åbo Akademi, Professor Lisbeth Fagerström, PhD, Åbo Akademi, Professor Hilde Eide, PhD, Universitetet i Sørøst-Norge

Syfte För att möta de utmaningar som uppstår då humanoida robotar introduceras i social- och hälsovården behövs nya flerdimensionella perspektiv. Det övergripande syftet med denna avhandling var därför att få förståelse för möjligheterna med att använda humanoida robotar som vårdresurser.
Metoder En övergripande mixad metod användes, där både kvantitativa och kvalitativa forskningsmetoder inkluderas för att bidra till det övergripande syftet. Delstudie I baserades på en tvärsnittsstudie där olika aktörers attityder gentemot användning av humanoida robotar i vården undersöktes. Enkätdata samlades in under november och december 2018 i sjukhusmiljö och i universitetsmiljö (n = 264). Multipel linjär regression användes för att analysera resultaten. I Delstudie II genomfördes en scoping review för att undersöka hur humanoida robotar har använts i vården av äldre personer. Sökningar utfördes 2018 i två internationella bibliografiska databaser samt kompletterande sökningar i Google Scholar efter publikationer publicerade mellan 2013-2019, följt av en systematisk screening och kodning av data. En kvalitativ deskriptiv analys användes för att analysera resultaten. I Delstudie III utvecklades och utvärderades ett humanoid robot-lett gruppträningsprogram av hemmaboende äldre personer i en kvalitativ pilotstudie. En deltagande design användes där både en workshop, en återkopplingssession, ett för-test och två tester inkluderades. Efter testerna genomfördes semistrukturerade intervjuer med hemmaboende äldre personer (n= 11). En tematisk analys användes för att analysera resultaten.
Resultat I Delstudie I var de flesta deltagare positiva till användningen av humanoida robotar i social- och hälsovården och humanoida robotar uppfattades som både vänliga och intressanta. Bland de grupper som deltog sågs andra relevanta aktörer i hälso-och sjukvården (ex. politiker, ledare eller servicepersonal), deltagare med högre utbildningsnivå, äldre vuxna samt de som hade svenska som modersmål ha en mer positiv attityd gentemot användning av humanoida robotar i social- och hälsovård. I Delstudie II ingick totalt 12 relevanta publikationer, vilket resulterade i fyra huvudkategorier relaterade till användning av humanoida robotar i vården av äldre personer: Stödjer vardagen, Ger interaktion, Underlättar kognitiv träning, Underlättar fysisk träning. Äldre personer visade möjlighet att acceptera humanoida robotar som sällskap, men tekniska begränsningar

kopplade till både tekniska och sociala aspekter ansågs vara återkommande hinder för fortsatt användning. Äldre personers upplevda glädje av att använda humanoida robotar sågs kunna minska med tiden. Äldre personers förväntningar på humanoida robotars användbarhet uppfylldes, men de upplevde humanoida robotar mer som en leksak, assistent eller guide istället för ett komplement till vårdpersonal eller stöd till ett självständigt liv. I Delstudie III upplevde majoriteten av hemmaboende äldre personer att det humanoid robot-ledda gruppträningsprogrammet var både underhållande och enkelt att följa men mer person-centrerade och utmanande fysiska rörelser lämpliga för hemmaboende äldre personer i bättre fysisk kondition borde inkluderas.

Slutsatser Det övergripande syftet med avhandlingen var att få förståelse för möjligheterna att använda humanoida robotar som vårdresurser. Resultaten i avhandlingen identifierade att de flesta grupper inom social- och hälsovården ansågs ha en positiv attityd gentemot användning av humanoida robotar i social- och hälsovård, även om frågor kvarstår relaterade till vissa gruppers mer negativa attityd. Möten ansikte-mot-ansikte med robotar verkar vara kopplade till positiva erfarenheter av sådan teknik, men tekniska begränsningar måste identifieras och korrigeras för att säkerställa mer robusta och användarvänliga tekniska lösningar. Ett personcentrerat tillvägagångssätt rekommenderas i vidare forskning. Som framgår av de övergripande resultaten, på grund av tekniska och etiska begränsningar (kopplade till både tekniska och sociala aspekter), saknar humanoida robotar vid denna tidpunkt den inneboende förmågan att ge omvårdnad. Istället bör humanoida robotar för tillfället betraktas som ett hjälpmedel eller "komplement" inom vård. Resultaten understryker behovet av att ändra fokus för forskning kring humanoida robotar över hela världen. Genom att införliva fokus på hållbara robotlösningar, ansikte mot ansikte människa-humanoid robotmöten, längre interventioner samt mer verkliga livsperspektiv kan ökad förståelse och därmed användbarheten av humanoida robotar som vårdresurser uppnås.

Nyckelord Humanoida robotar, vårdresurser, social- och hälsovård, äldre personer, attityder, erfarenheter, fördelar, utmaningar, tvärsnittsstudie, scoping review studie, pilotstudie, Hälsovetenskap, vårdvetenskap.

List of articles[1]

Article I

Andtfolk, M., Nyholm, L., Eide, H., Rauhala, A., & Fagerström, L. (2021). Attitudes toward the use of humanoid robots in healthcare – A cross-sectional study. *AI & Society: Journal of Knowledge, Culture and Communication.* Published online https://doi.org/10.1007/s00146-021-01271-4

Article II

Andtfolk, M., Nyholm, L., Eide, H., & Fagerström, L. (2021). Humanoid robots in the care of older persons – A scoping review. *Assistive Technology,* 5; 1-9. Published online: https://doi.org/10.1080/10400435.2021.1880493

Article III

Andtfolk, M., Fagerström, L., Eide, H., & Nyholm, L. Home-living older persons' evaluation of a humanoid robot-led group physical exercise training program – A qualitative pilot study. Resubmitted April 2022.

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Table of contents

1. Introduction

Many countries are undergoing significant demographic changes. Worldwide the number of people 60 years of age or older is expected to double between 2015-2050, and most countries will encounter challenges in meeting the increased care needs associated with such a demographic shift (World Health Organization (WHO), 2021). Accordingly, the demand for homecare services has increased (Finne-Soveri et al., 2014). Other challenges, e.g., a shortage of care professionals, have even led to increased pressure on healthcare systems to seek and implement new ways to provide care (Kataja, 2016). The growing population of older persons and subsequent pressure on healthcare (WHO, 2021) are drivers for new developments in robotic technologies (Azeta et al., 2018). Some propose the implementation of robots, e.g., humanoid robots, in healthcare settings to help address some of the challenges being seen (Azeta et al., 2018).

Some researchers define humanoid robots as socially assistive robotics designed to create effective and close interaction with human beings (Feil-Seifer & Matarić, 2005; Korn, 2019). Other researchers define humanoid robots as robots with movable parts and an overall human-like appearance based on the human body and the human face as having inherent social capacity (Mohamed & Capi, 2012). In healthcare settings, humanoid robots can be used to provide physical, cognitive or social interaction or assistance (Feil-Seifer & Matarić, 2005; Niheh et al., 2017). As new technological solutions are designed, developed and implemented in healthcare, human beings will encounter humanoid robots more frequently than ever before. In recent years, general studies on human-robot relationships and interactions (Feil-Seifer & Matarić, 2009; Coeckelbergh, 2010), specific studies on, e.g., the use of robots in light of human touch in care (Parviainen et al., 2019), and studies on whether robots' artificial speech conveys empathy and emotion (James et al., 2020) have been undertaken. In an earlier systematic review (Papadopoulos et al., 2020), enjoyment, usability, personalization and familiarization were linked to the use of humanoid robots in healthcare but even technical problems and limited capabilities. All such research can be compared with a historical view of caring as being something human by nature (Eriksson, 1988; 2001) and care encounters as being a fundamental human-human relationship (Snellman, 2001; Shelton, 2016; Holopainen, 2019).

Deeper knowledge of human-humanoid robot care encounters in which a focus on a nuanced understanding of caring and care is included is lacking. Furthermore, while previous research indicates that there are advantages to the use of humanoid robots in healthcare, humanoid robots have not yet been fully and effectively implemented into and utilized in daily healthcare practice. Many companies are currently developing various types of assistant robots with several care functions (Neumann, 2016; Tanioka et al., 2017). Yet given the lack of deeper understanding on robots in relation to the fundamental elements of caring, whether humanoid robots will be useful in healthcare remains somewhat unclear. There are various barriers to the implementation of humanoid robots in healthcare, e.g., technological limitations or the need for multi-level change within an organization or the healthcare culture itself (Pekkarinen et al., 2020). To ensure that the use of humanoid robots in healthcare is fully viable, further investigation of how a Caring Science approach can be incorporated into humanoid robot development is needed (Tanioka et al., 2019).

The overall aim of this thesis was to gain understanding of the possibilities for using humanoid robots as a care resource. The discipline of Caring Science, and more specifically the theory of caritative caring, which encompasses a human science way of thinking, can be used to provide useful insight into greater understanding of humanoid robots as a care resource. Three sub-studies are included in this thesis. In the first sub-study, multistakeholders' attitudes toward the use of humanoid robots in healthcare were explored in a cross-sectional study (Sub-study I). The second sub-study was a scoping review exploring how humanoid robots have been used in the care of older persons (Sub-study II). The third sub-study was a qualitative pilot study in which a humanoid robot-led group physical exercise training program for home-living older persons was developed and evaluated (Sub-study III). The purpose of such a multistakeholder investigation of humanoid robots in healthcare was to yield deeper understanding that can be used as guidance in welfare technology research and thereby contribute to the overall improvement of both humanoid robots as a care resource as well as the furtherance of a caring perspective in relation to human-humanoid robot care encounters.

2. Background

Both short-term and long-term challenges are being seen throughout the global healthcare sector today. Examples of such challenges include a lack of physicians and other care professionals, challenges related to leadership (Valvira, 2019), the increased need for healthcare services related to an aging population, the introduction of new technologies, rising healthcare costs (Roberts, 2009) and even a lack of community involvement (Lorenzoni et al., 2019). The use of robots, e.g., humanoid robots, in healthcare has been highlighted as one possible way to manage the challenges being seen (Tanioka et al., 2019).

2.1 Healthcare today and future challenges

In accordance with existing resources (WHO, 2000), healthcare systems today should strive to meet three fundamental goals: the improvement of health, responsiveness to a population's legitimate concerns and fairness in financing (financial contribution). Factors such as a country's traditions, history, sociocultural factors (Donev et al., 2013), health policies, economic conditions and social conditions (WHO, 2019) all impact health outcomes. Yet because of limited and insufficient resources, many countries must select which actions are taken and thereby prioritize. More resources from both healthcare organizations and society at large (Donev et al., 2013) and a synthesis between financial demands and care needs in relation to what should be prioritized in healthcare are needed (Frilund & Fagerström, 2009).

Healthcare expenses are increasing globally, linked among other reasons to aging populations (WHO, 2021). Changes to infrastructure and an increase in the prevalence of chronic disease (Roberts, 2009) alongside the aforementioned lack of physicians and other care professionals, especially in hospital, caring center and assisted living community settings (Schillmeier & Doménech, 2010; Chew, 2017), have impacted how healthcare services are organized. By 2030, it is projected that there will be a shortfall of 18 million care professionals throughout the world (WHO, 2019). Time pressures and workload are even increasing (Anskär et al. 2018). It is estimated that care professionals now spend about 8–16% of their time on a variety of non-caring tasks that could be delegated (Yen et al., 2018). This not only impacts healthcare organizations and professionals themselves but even patient care: increased workload in healthcare has been linked to negative outcomes, e.g., a lack of patient safety (Aiken et al., 2012; Fagerström et al., 2018). For example, in Finland the lack of care professionals has been linked to pharmacotherapy failures that endanger patient safety, shortcomings in staff authorizations and pharmaceutical authorization procedures, the absence of written prescriptions, a lack of verified expertise and inappropriate storage of medicines (Valvira, 2019). Time pressures can also lead to patients' needs not being meet (Kitson et al., 2013), e.g., patients not receiving optimal physical or emotional support (Jangland et al., 2017). Optimal workload and care intensity levels could enable healthcare organizations to provide high quality care (Kane et al., 2007; Fagerström et al., 2018).

2.2 Older persons and healthy ageing

As before, the growing population of older persons throughout the world and the associated increased need for support are increasing pressure on care systems (WHO, 2018). It is estimated that by 2050 one in six persons worldwide will be 65 years of age or older, compared to one in 11 for the year 2019; one in five persons in Europe will be considered an older person (United Nations, UN, 2019). Categorical definitions of the terms old, elderly, aged or ageing are neither straightforward nor universally applicable, and different terms and euphemisms for older persons exist in many languages and cultures. Already in the early 1990s, the United Nations Committee on Economic Social and Cultural Rights of Older Persons voted to reject the term "elderly" and replace it with "older persons", stating that such a change better encompassed the inherent personality of each individual human being (UN, 1995). In this thesis the term "older person" in used, defined in accordance with the WHO (1999) definition as a person 65 years of age or older.

Life expectancy and health needs

There are long-standing regional differences in life expectancy and the probability of living to an advanced age (UN, 2019). Asia and Europe have some of the oldest populations in the world, with several European countries having the largest percentages of older persons in the total population (UN, 2016). Finland has one of the fastest growing aging populations in Europe and fewer persons actively participating in working life (Finnish Government, 2019).

While challenges associated with complex health needs are not unique to older persons, health problems are more prevalent at higher ages (John et al., 2008). Older persons have a higher risk of chronic disease (e.g., cardiovascular disease, osteoporosis, dementia), mental illness (e.g., isolation, affective, anxiety disorders), physical impairments or a general decrease in health and well-being (WHO, 2017). Several risk factors for poorer health are increased for older persons, e.g., a lack of social networks, isolation, feelings of loneliness, depression (Comijs et al., 2004), mental health problems (WHO, 2017) or a decline in physical or functional health (Colón-Emeric et al., 2013). Nevertheless, older persons' greater and more complex health needs (WHO, 2021) should not be considered solely linked to a few health factors; older persons' health and well-being should instead be considered a multidimensional whole.

Healthy ageing

There are various factors associated with healthy ageing. Researchers with the WHO (2017) find that a transformed healthcare system and developed healthcare policies are essential to ensuring older persons' physical and mental needs. Transformed healthcare systems and developed healthcare policies support the prevention and delay of care service dependency later in life. By creating an environment through which older persons can access the resources necessary to meet their needs, older persons' physical and mental health can be promoted (WHO, 2017). For example, strong social connections may help older persons remain autonomous for longer in life (Duner, 2006) or support their inclusion in society (Lorenzoni et al., 2019). According to Sanderson and Scherbov (2005, 2010, 2015, 2017), older persons' functional capacity and economic status are diverse, with some remaining an active part of the workforce. Maintaining healthy behaviors throughout life, e.g., physical training, might improve both physical and mental condition, reduce the risk of disease and facilitate healthy aging (WHO, 2018).

The current trend to prioritize home care over institutional care has been seen in many countries (Finnish Institute for Health and Welfare, THL, 2021). Continuing to live in one's own home, even in later life, has been highlighted as facilitating improved autonomy and integrity, with the caveat that good health must be maintained (Mahler et al., 2014). Services that facilitate independent living may enable home-living older persons to maintain their health and physical capacity for a longer period of time (Tøien et al., 2015). However, the provision of appropriate and high-quality healthcare services in a home environment can be challenging (Finne-Soveri et al., 2014). Over the last few decades, an important change in the care of older persons has taken place, with focus moved to creating and improving both facility-based and home-based care in order to increase overall care quality (Grabowski et al., 2014). Care services are increasingly being offered in older persons' own homes (Finnish Institute for Health and Welfare, THL, 2018), and technological advances have made it possible to provide more complex care services in home settings (Ellenbecker et al., 2008; Kataja, 2016). Nevertheless, care professionals and society face a challenge in ensuring that the care given in a person's own home (at-home care) is of as good quality as the care given elsewhere (Finne-Soveri et al., 2014).

2.3 Humanoid robots and multifaceted functions

There is no universal definition of what a robot is, and how robots are defined and the terminology used varies from research context to research context (van Wynsberghe, 2013; Bardaro et al., 2021). For example, within socially assistive robotics research, hardware specifications or capabilities are used to differentiate between and classify various robotic solutions (Feil-Seifer & Matarić, 2005). Terms used in the socially assistive robotics research context include, e.g., socially assistive humanoid robots (Papadopoulos et al., 2020), socially assistive robots (Abdi et al., 2018), assistive robots (Łukasik et al., 2020), social robots (Yousif & Yousif, 2020) and care robots (Frennert et al., 2020). The explicit focus of this thesis is humanoid robots, interpreted in accordance with Feil-Seifer and Matarić's (2005) definition of socially assistive robotics as, "the intersection of [assistive robotics] and [socially interactive robotics]". In an exploration of the taxonomy of socially assistive robotics, Feil-Seifer and Matarić conclude that socially assistive robots are robots capable of creating effective and close interaction with human beings and are used with the purpose of enabling measurable progress and giving assistance with, e.g., rehabilitation, learning or convalescence to human beings in human environments (Feil-Safer & Matarić, 2005). Fong et al. (2003) have sub-classified socially assistive robots into four major groups: anthropomorphic, zoomorphic, caricatured and functional robots. One can extrapolate that humanoid robots, categorized as being anthropomorphic (Fong et al., 2003), belong to the robotic sub-group known as anthropomorphic socially assistive robots. The size, shape and mobility of humanoid robots make them suitable for use in physical environments designed for humans (Ozturkcan & Merdin-Uygur, 2021).

Humanoid robots often have several movable parts, an overall human-like appearance based on the human body and face, and an inherent social capacity (Mohamed & Capi, 2012; Winfield, 2014; Niheh et al., 2017; Kyrarini & Lygerakis, 2021). Generally speaking, humanoid robots can express some human emotions by moving their bodies, hands or heads (Akhtaruzzaman & Shafie, 2010) and carry out some daily tasks usually performed by humans (Azeta et al., 2018). Common to humanoid robots is that they have both human-like and distinctly non-human-like traits, but this is influenced by the context in which the robot is placed (Feil-Safer & Matarić, 2005). Humanoid robots have the capacity to modulate expressions, e.g., posture or gestures, or voice tone and volume (Tanioka et al., 2019). Researchers have found that the goal underlying purposefully designing robots to look like humans is the encouragement of human-robot social interaction, in which robots' learning of relevant knowledge through the observation of and interaction with human beings even occurs (Dautenhahn & Nehaniv, 2002; Yamamoto et al., 2004). The further exploration of the contributions that technological solutions such as humanoid robots can provide in healthcare is motivated because the implementation of such solutions may help correct some of the challenges currently being seen, e.g., the lack of care professionals and the increased need for healthcare services related to aging populations.

3. Previous research and knowledge gaps

Limited resources, demographic changes and increased pressure on reducing costs are some of the short-term and long-term challenges being seen in the healthcare sector globally (Valvira, 2019). For some time, service and other robots had been used in various sectors and laboratories for work that was considered dangerous, dull or dirty, i.e., space-based tasks or cleaning (Barker & Jewitt, 2022). More than a decade ago and as robot technology progressed, researchers started to focus on investigating the use of robots in healthcare (Broadbent et al., 2009; Yousif et al., 2019). Initial tasks performed by robots ranged from simpler procedures, e.g., checking patients' blood pressure (Broadbent et al., 2010) to more complex procedures related to surgeries or prosthetics (Bogue, 2011). In recent years, the potential use of robots to support and assist not only in home (Gross, 2020) or school settings (Leoste et al., 2019) but even healthcare settings (Coco et al., 2018; Khan et al., 2020) has increased. Robots can be considered an effective and efficient technological solution for healthcare, through the provision of physical, cognitive or social work (Kangasniemi et al., 2019; Tanioka et al., 2019) and/or on-demand patient care (Kalb, 2020).

While general and broad research has been undertaken on the use of robots in healthcare, the focus of this thesis was specifically placed on the possibilities for using humanoid robots as a care resource in healthcare and specifically related to the care of older persons. As part of the overall research, a broad scope of literature related to previous understanding on the uses of and experiences of humanoid robots in healthcare as well as enablers and barriers toward their use were sought. For a more detailed description of previous research specifically related to the use of humanoid robots in the care of older persons, including benefits and challenges, please refer to Sub-study II. In the literature found, the majority of studies were seen to employ a focus on robot prototypes or robot testing involving supervised trials; there were only few studies employing a longer-term perspective or investigating humanoid robots in unsupervised care environments. Also, most previous studies had not been based on real-life, face-to-face care encounters with humanoid robots (as seen in this thesis) but were instead based on theoretical measures, e.g., showing pictures or videos of humanoid robots to participants. Furthermore, most previous studies had included a focus on humanoid robots in relation to the care of children, not the care of adults or older persons. Accordingly, a gap in the knowledge on the topic was seen.

3.1 Uses and experiences of humanoid robots in healthcare

The use of humanoid robots to support activities of daily living has been examined in previous studies. In one study, the use of a humanoid robot for feeding assistance was tested in a laboratory setting (healthcare robotics lab) (Park et al., 2020). The researchers found that the robot provided safe and easy-to-use feeding assistance for persons with various motor impairments, e.g., retrieval, delivering and scooping of food. The participants reported that the overall experience was positive and the system was safe, easy to use and effective. However, some of the participants reported that they felt intimidated or overwhelmed at the beginning of the study by the large size of the robot and suggestions were made to develop a user-friendlier feeding robot. In another study (Schweitzer & Hoerbst, 2016), researchers investigated the use of humanoid robots for medication management in a laboratory setting, including drug intake (administration), compliance and assistance during the medication process. The researchers found that using the robot for medication management was viable but suggested longer-term interventions to examine practical use in applied settings.

The use of humanoid robots in pediatric care has been investigated in several studies. For example, support functions related to children's self-management of diabetes in hospital settings through, e.g., education, giving of advice, motivation, monitoring or providing children companionship during hospital visits, has been the subject of several studies (Looije et al., 2016; Canamero et al., 2016; Coninx et al., 2016; Blanson Henkemans et al., 2017). The use of humanoid robots in the care of children with cerebral palsy has also been examined, primarily seen as measures aimed to motivate, encourage and provide children companionship (Rahman et al., 2015; Malik et al., 2016; Swift-Spong et al., 2016; Martí Carillo et al., 2017). In other studies, researchers have assessed the effectiveness of using humanoid robots to provide mental support against pain and distress for children with cancer (Jibb et al., 2018; Alemi et al., 2016). In one such study, children showed reductions in anger, anxiety and depression when a humanoid robot was used (Jibb et al., 2018). With regard to robot acceptability, researchers in one study examined how children perceived and responded to the advice and education that a humanoid robot provided during the management and treatment of their Type-1 diabetes (Al-Taee et al., 2016).

The use of humanoid robots in rehabilitative care has even been examined in various studies. In a study encompassing young children with cerebral palsy, the included children's parents, therapists and researchers designed, developed and evaluated the use of a humanoid robot as a therapeutic aid during rehabilitation (Martí Carillo et al., 2017). In another study, researchers developed an integrated software-humanoid robot solution to improve and assess the digitalization of rehabilitative training tasks for post-stroke patients (Forbrig et al., 2020). Humanoid robots have additionally been used in studies focusing on cardiac rehabilitation for adult patients (Casas et al., 2019) and gait rehabilitation for neurological patients (Cespedec et al., 2020). In a study of the use of humanoid robots in cardiac rehabilitation, researchers found that patients were positive toward human robots regarding the variables trust, usefulness, safety and utility and even more so post-interaction, and that clinicians perceived that humanoid robots were useful in cardiac rehabilitation (Casas et al., 2019). In a study of the use of humanoid robots in gait rehabilitation for neurological patients, researchers have found that evaluated parameters improved for patients who interacted with the robot (Cespedes et al., 2020).

In one study of the use of humanoid robots in the care of children with diabetes, researchers found in initial pilot interactions that children and their parents/caretakers and care professionals were positive toward the robot (Canamero et al., 2016). In another study of children with diabetes, researchers again found again that children and their parents/caretakers and care professionals were positive toward the robot, although the parents/caretakers and care professionals were initially skeptical (Looije et al., 2016). In both studies, the majority of participant comments were related to the humanoid robot's improvement of the children's communication skills (Canamero et al., 2016; Looije et al., 2016). In a different study set in a similar setting, young patients with diabetes and their parents and care professionals were again found to be receptive toward the use of a humanoid robot in diabetes management (Al-Taee et al., 2016). In yet another study of diabetic children, children were seen to actively customize their encounter with a humanoid robot during hospital-based health checkups (Coninx et al., 2016). In a randomized control trial, children with diabetes played a game (a diabetes quiz) with either a person or robot (robot group) or received care as usual (control group) (Blanson Henkemans, 2017). The researchers in that study found that those included in the robot group had better diabetes knowledge and were more engaged and motivated to play than those included in the control group, though cautioned that further research was needed.

In a study of the use of humanoid robots in the care of children with cerebral palsy (physical impairments differed), researchers found that some children did not find planned sessions with the humanoid robot to be sufficiently challenging and interesting. While this was attributed to a lack of module variety, the researchers nonetheless found that the appraisal and encouragement provided by the robot helped ensure that the children remained engaged during a session (Rahman et al., 2015). Researchers in another study of the use of humanoid robots in the care of children with cerebral palsy found that children were positive toward humanoid robots engaging them in physical exercises (Malik et al., 2016). Still, in some studies in which humanoid robots have been tested with children, researchers note a lack of technical robustness as being a major challenge (Rahman et al., 2015; Malik et al., 2016).

Even how the use of humanoid robots in healthcare is perceived and experienced varies. Some researchers have found that participants were positive toward humanoid robots and perceived humanoid robots to be a great companion (Rahman et al., 2015; Malik et al., 2016; Martí Carillo et al., 2017). In a study of the use of humanoid robots as exercise instructors in elderly care centers, researchers found that participants perceived the robot to be more effective and preferred over a human instructor (Shen & Wu, 2016). In a comparison between humanoid robots and computer tablets, researchers saw that participants responded better to robots giving healthcare instructions than computer tablets (Mann et al., 2015).

3.2 Humanoid robots as enablers in healthcare

Some researchers consider humanoid robots to be enablers in healthcare because robots can provide cost-effective arrangements (Tanioka et al., 2019) or on-demand care (Kalb, 2020). Capable of processing large amounts of data, it is anticipated that humanoid robots can act as a 24/7 source of information for care professionals or even execute data-based searches or broad memorization, e.g., storing input, identifying the concepts underlying data input (Tanioka et al., 2019). Policymakers worldwide have embraced the "vision" that humanoid robots can be used to solve challenges in healthcare (Works, 2017). However, advancements in robotic technologies are still needed; to date most robots have been designed to perform repetitive tasks or tasks that entail risks for human beings (Anwar et al., 2019). Researchers have found that, generally speaking, care professionals find using robots helpful when performing physically straining work (Mukai et al., 2010; Beedholm et al., 2015), although using robots to lift heavy goods, e.g., was more preferred than using robots to lift patients, which may be linked to that direct patient care also includes touching (Parviainen et al., 2019). In one systematic review, researchers saw that enablers to the use of socially assistive humanoid robots in healthcare included enjoyment, usability, personalization and familiarization (Papadopoulos et al., 2020). Of the enablers discerned in that study, enjoyment was seen to be crucial and linked to perceptions of engagement and positive experiences of both general (e.g., robots' kindness and friendliness) and specific activities (e.g., robots' playing games). Usability was linked to intuitiveness and ease of use, broadly seen as a lack of technical issues. Personalization was seen to be interlinked with enjoyment and usability and thereby overall use and implementation. Familiarization, i.e., users learning and adapting to the robots, was seen to possibly positively impact implementation. Other researchers have found that humanoid robots in healthcare might contribute to patient safety or supporting patient health and well-being (Cavallo, 2018), enable patient freedom or autonomy in daily activities, provide an increased sense of control and autonomy (Tanioka et al., 2019) or even increase opportunities for social interaction and reduce dependence (Sharkey & Sharkey, 2012).

3.3 Humanoid robots as barriers in healthcare

There are challenges associated with the use of humanoid robots in healthcare, and some researchers find humanoid robots to be barriers in healthcare. In a comparison of the use of humanoid robots in welfare service services and society in Germany, Sweden and Finland, researchers saw that economic elements, e.g., costs associated with robotic technology, still impact decision-making and that questions still arise in relation to cost management (Pekkarinen et al., 2020). In a previously mentioned systematic review, researchers saw that barriers to the use of socially assistive humanoid robots in healthcare included technical challenges, limited capabilities and negative preconceptions (see Section 3.2; Papadopoulos et al., 2020). Of the barriers discerned in that review, technical challenges were found to be mentioned in over half of the studies included. Limited capabilities were linked to limited performance or restricted abilities, while negative preconceptions were linked to care professionals' negative assumptions about older persons' ability to interact with humanoid robots, the dehumanization of care and the stigmatization associated with increased need for help, i.e., "being a dependent individual in decline" (Papadopoulos et al., 2020). This is in line with other findings, in which researchers have found that care professionals' lack of technical experience combined with their fear of making technological mistakes constitute a barrier to the use of humanoid robots in healthcare (Hebesberger et al., 2017). Even care professionals' lack of trust in robots and fear of losing their jobs to robots have been found to be barriers (Pekkarinen et al., 2020).

Ever since robots were first introduced in healthcare the issue of robot ethics has been widely discussed. There are crucial ethical concerns related to the use of humanoid robots in healthcare and relevant legislature and jurisprudence on the subject should be reviewed or instituted, especially before humanoid robots are used in the care of vulnerable persons (Beck, 2016). For example, researchers have found that there are legal challenges associated with the use of robots in healthcare, e.g., related to responsibility (Beck, 2016) or common consumer protection issues: fraud, privacy or data security finances, among others (Woodrow, 2014). Researchers have even seen that care professionals themselves are concerned about privacy and safety issues and have mixed perspectives on the use of robots in healthcare (Papadopoulos et al., 2018). Researchers have furthermore found that, in addition to ethics, relatively unexplored domains within the context of humanoid robots in healthcare are religious values and spirituality and that such should occur before implementation, especially before implementing robots into the care or rehabilitation of children with various mental disabilities (Hashim & Yussof, 2017). Researchers have moreover found that a lack of technical development and socio-institutional adaption (specifically referred to as "remarkable inertia") is a barrier to the socio-technical transition needed to realize the further implementation of humanoid robots in healthcare (Pekkarinen et al., 2020).

While there is a likeness to previous ethical debates on other issues, i.e., positive and negative assumptions are weighed against one another, some researchers maintain that a discussion of robot ethics is speculative in nature (Van Aerschot & Parviainen, 2020). As noted above, some argue that the discussion should be reframed (Coeckelbergh, 2010) because the need exists to define robot ethics and establish common terminology, e.g., in accordance with a definition of those care tasks suitable for humanoid robots and those suitable for human care professionals (van Wynsberghe, 2013).

4. Theoretical perspective

As noted previously, robots have for some time been used in various sectors to perform dull, dangerous or dirty work (Sharkey & Sharkey, 2010). In the healthcare sector, robots are furthermore used in a variety of other ways, e.g., to check patients' blood pressure (Broadbent et al., 2010), perform certain surgical procedures (Bogue, 2011) or provide assistance when lifting heavy materials (Parviainen et al., 2019). Studies in which the possibilities for using humanoid robots as a care recourse are investigated require understanding of the act of caring. Caring consists of a complex combination of processes where a high level of skill, knowledge, ethical sensitivity and commitment to the maintenance of dignity are required (Gallagher et al., 2016). Moreover, "The ultimate purpose of caring is to alleviate the suffering of others through compassion, confirmation of dignity, and a caring communion that is based on 'caritas', or love" (Eriksson, 2006a). Caring should encompass and include broad knowledge of protecting, recognizing and respecting individual needs and desires, because during caring the care professional (whether human or machine) is responding to things that the patient is not capable of doing anymore (Huston, 2014). Given that the act of *caring* is integral to healthcare and the potential use of robots to support and assist has grown (cf. Gross, 2020; Leoste et al., 2019; Khan et al., 2020), questions arise as to whether or not robots could be experienced as a care resource or even experienced as being *caring*. While different disciplines interpret and define the concept of caring in different ways, the theoretical basis of caring as used in this thesis is derived from the discipline of Caring Science and the theory of caritative caring.

4.1 The theory of caritative caring

The theoretical perspective of caring seen in the discipline of Caring Science and the theory of caritative caring (Eriksson, 2006a; Lindström et al., 2014; Fagerström et al., 2020) was considered relevant to the aim of this thesis. Below is a brief overview of the primary concepts and ideas related to the theory of caritative caring, which also form the theoretical perspective from which this thesis and its research is derived.

Developed by Katie Eriksson, the theory of caritative caring is a multifaceted theory that forms the basis for Caring Science at Åbo Akademi University. The theory of caritative caring encompasses the various dimensions of the human being, caring and ethos (Eriksson, 2006a; Lindström et al., 2018; Näsman, 2020; Fagerström et al., 2021). A strong emphasis is placed on *ethos*, which is seen to underlie and permeate these metaparadigm concepts. The ethos of caritative caring is *caritas* (Eriksson, 1987a, 1987b; Lindström et al., 2018), i.e., human love and compassion for the other (Eriksson, 1992, 1994a; Fagerström et al., 2021). Caritas is considered the fundamental motive of caring in Caring Science and comprises a holistic approach that is the motive for all caring. Through caritas, love, faith and hope are mediated to the human being (Eriksson 2006a; Lindström et al., 2006; Eriksson, 2009; Lindström et al., 2016; Eriksson, 2018).

In the theory of caritative caring, caring is defined as something inherently human by nature and is encompassed in the encounter with the patient (Eriksson, 2018). To fully understand caring in the context of healthcare, one should even define what a care encounter is. An encounter can be understood as something that precedes care, realized through a human-to-human relationship and progressing through several stages (Travelbee, 2013). In accordance with the theories of Martinsen (2013), "encounter" as a concept in this thesis is considered an abstract place where the closeness and distance between a care professional and the patient takes place and where the care professional focuses on the patient. Further extrapolating, the concepts "caring encounter" and "care encounter" share some similar characteristics but nonetheless differ somewhat. The concept "caring encounter" can be defined as something unique, as occurring in mutuality, and formed by love and communion between a care professional and the patient: "the attributes are…being there, uniqueness and mutuality" (Holopainen, 2019). Since deeper understanding of robots' possibilities for caring are to date lacking, for the purpose of this thesis the choice was made to focus on and use the concept "care encounter" instead of "caring encounter". Relevant to the concept "care encounter", mutuality, equality, acceptance and confirmation are valued (Snellman et al., 2012). According to Snellman et al. (2012), for a care encounter to occur not only must care professionals be cognizant of such characteristics but even implement them in the encounter with the patient.

4.2 Human beings and humanoid robots

Understanding of the possibilities for using humanoid robots as a care resource requires understanding of how humans understand and relate to humanoid robots. The purpose underlying designing humanoid robots to look as similar as possible to humans is to encourage human-humanoid robot social interaction (Dautenhahn & Nehaniv, 2002; Yamamoto et al., 2004). Nonetheless, however human-like they may appear to be, humanoid robots are machines that cannot convey human emotions (e.g., love) but are instead designed and programmed to perform a complex series of automatic actions; programming controls their actions, albeit programing designed by human beings with a human sense of love and emotions (Dautenhahn & Nehaniv, 2002).

Again, as understood for the purposes of this thesis, despite a human-like appearance and traits, humanoid robots are machines. The differences and similarities between humanoid robots and human beings have in the research underlying this thesis been interpreted through the perspective of Caring Science and the theory of caritative caring. In the theory of caritative caring, respect for each unique human being, including his/her holiness and dignity, forms the goal of communion and participation in a caring culture. Care professionals should strive to uphold each unique human being's dignity and should serve with love for the other, because communion and relationships are sought where a mutual sense of giving and receiving love is valued. Dignity is one of the basic concepts in the theory of caritative caring and is the core of all caring (Eriksson, 1997). Accordingly, caring traditions and philosophies should emanate from the perspective that each human being is valuable and has the right to be confirmed as being unique (Eriksson, 1995; 1997).

Each human being should be understood as a fundamental entity of body, soul and spirit (Eriksson, 1987a, 1988, 2002). This is in contrast to humanoid robots. Although humanoid robots may have a human-like appearance or shape, they do not possess a soul or spirit (Strandbech, 2015). While non-human-like robots may be easier to design and produce (Coeckelbergh, 2010), humanoid robots are becoming ever more life-like, and how or whether they are or can be perceived as sentient beings has been explored in several studies. For example, whether artificial intelligence has the capacity to express or interpret emotions (Wu et al., 2014) and whether machines are capable of making moral decisions (Bastian et al., 2012) have been investigated. In early research on computers and the relationship that human beings have with such artificial intelligence, researchers saw that certain technologies were presented as having "states of mind" and that human beings could even "embody" such technologies (Turkle, 1984). Later, researchers found that human beings experience computers as being something between both an extension of the self and a part of the external world that determines the psychological challenges that interaction with such technology raises (Turkle, 2004). Still other researchers have argued that human beings ascribe life-like attributes to some technological solutions, i.e., perceive a computer as a "teammate" or maintain that a computer has a "personality" (Nass et al., 1996). Furthermore, some researchers have found that human beings are averse to machines making decisions for them (Bigman & Gray, 2018) and that while humans can perceive robots as intentional entities they nonetheless feel "deceived" when such occurs (Tereda, 2010).

In addition to investigating humanoid robots' capacity for human-like intelligence, researchers have even examined whether a life-like physical appearance impacts how robots are perceived (Kouroupetroglou et al., 2017). A phenomenon identified by a Japanese professor of robotics (Mori, 1970), the term "uncanny valley" is used to refer to the relationship between how much a robot resembles a human being in physical appearance and the negative emotional responses such a life-like robot can arouse. In other words, it is hypothesized that a robot with a life-like physical appearance can awaken negative emotions or a sense of uneasiness in human beings (Mori, 1970; Dautenhahn, 2003; MacDorman, 2005). In a study of human-robot interaction linked to social cues and (non-verbal) communication, researchers elected to use a robot that, while emotionally human-like, was not entirely physically human-like, with the aim to eliminate any eventual associations respondents might have with an actual human being or animal, i.e., the "uncanny valley" effect (Saldien et al., 2010). Some researchers (Korhonen, 2017), however, argue against the perception that technological solutions are either "good" or "bad", maintaining instead that technology must be understood in an ethical light (as something, "to promote the human good") and as something that must be tailored to each unique human being. An ethical dimension related to where and for whom a technological solution is used should even be incorporated into technological solutions (Korhonen, 2017).

4.3 The theory of caritative caring in relation to humanoid robots

It is expected that robots in the future will perform numerous care activities and thereby decrease care professionals' workload. It is also expected that robots will be able to provide support for humans and thus be increasingly utilized an integrated into human care activities (Ninomiya, 2015). Some care professionals have expressed concerns that robots will be used to replace human beings in healthcare and that the use of humanoid robots in care will result in the dehumanization of treatment and patients (Coco et al., 2018). The robots used in healthcare should therefore be designed to promote and support the fundamental values of caring, i.e., dignity, safety and well-being (van Wynsberghe, 2013) because these comprise the basic motive of caring (Eriksson, 2006a). Still, when viewed from a Caring Science perspective, the use of robots in healthcare gives rise to the question of whether and to what extent human beings perceive robots in healthcare to be caring.

Researchers have found that robots are perceived in different ways; some human beings perceive robots to be "merely machines" while others feel that robots can provide a sense of human-like caring (Papadopoulos et al., 2020; Parvianen & Pirhonen, 2017). There are even contradictory perspectives on the suitability of the use of robots and Artificial Intelligence (AI) in healthcare. Some researchers argue that robots and AI will never be fully able to replace human care professionals, despite the increased use of robots and AI in healthcare systems throughout the world. For example, some maintain that the technology to truly replicate human expression, i.e., the human conscience or consciousness, may never be developed (Huston, 2014; Tanioka et al., 2019). Consciousness is the prerequisite for ethics (Hildt, 2019), which is a fundamental aspect of caring (Eriksson, 2006a). Nevertheless, it is difficult to define the term "consciousness" and especially so in relation to robots and AI (Hildt, 2019). Other researchers even maintain that consciousness is the most significant factor in what can be defined as humanness (Maeno, 2005). While technological developments are underway whereby researchers seek to provide robots with consciousness (Komatsu & Takeno, 2011), challenges related to such development exist, more specifically, e.g., the ability to meet each unique patient in a caring sense and situation (Tanioka et al., 2017). Some researchers find discussion of such contentious, arguing instead that robots can and should provide effective support for care professionals (Baer et al., 2014) or even prolong patients' independent living (Decker et al., 2011). Still others argue that despite the legitimate objections raised to the use of robots and AI in healthcare, e.g., issues related to a lack of responsibility, attentiveness, competence or reciprocity (Coeckelbergh, 2010; Sharkey & Sharkey, 2012), the discussion should be reframed and the criteria for what constitutes good care clarified (Coeckelbergh, 2010).

5. Aim

The overall aim of this thesis was to gain understanding of the possibilities for using humanoid robots as a care resource. In Sub-study I, multistakeholders' attitudes toward the use of humanoid robots in healthcare were explored in a cross-sectional study. In Sub-study II, how humanoid robots have been used in the care of older persons was examined in a scoping review. In Sub-study III, a humanoid robot-led group physical exercise training program for home-living older persons was developed and evaluated in a qualitative pilot study in which a participatory design approach was employed, including a workshop, feedback session, pre-test and testing. As seen through the following research questions, the three (I-III) included sub-studies answer the overall aim of the thesis:

- What are the attitudes that patients, relatives, care professionals, school actors and other relevant actors in healthcare have toward the use of humanoid robots in healthcare? (Sub-study I)
- What is the association between participants' background variables and attitudes toward humanoid robots? (Sub-study I)
- How have humanoid robots been used in the care of older persons? (Sub-study II)
- What are the benefits and challenges associated with the use of humanoid robots in healthcare from older persons' points of view? (Sub-study II)
- What are home-living older persons' evaluations of a humanoid robot-led group physical exercise training program? (Sub-study III)
- What suggestions do home-living older persons have for the improvement of a humanoid robot-led group physical exercise training program? (Sub-study III)

6. Methodological approach

The population of older persons and the associated pressure on healthcare (WHO, 2021) are drivers for new understanding and developments in robotic technologies (Azeta et al., 2018). To reach new understanding of the possibilities for using humanoid robots as a care resource, an overall mixed method approach involving both quantitative and qualitative methods was used among the three sub-studies (Sub-studies I-III) encompassed by this thesis. The methodological approach expressed in the sub-studies takes the form of various research questions, designs, methods and analyses.

6.1 Overall mixed method approach

To explore the phenomenon being studied, different methodological approaches including various research questions, designs and methods were used in each of the included sub-studies (Sub-studies I-III), i.e., an overall mixed method approach. Such an approach involves both quantitative and qualitative methods with specific research questions based on a relevant research design to contribute to the overall aim (Regnault et al., 2018). The use of several methods either iteratively or simultaneously is recommended when the aim is to explore complex social phenomena in a more comprehensive and detailed way and establish a research outcome that is stronger than any individual method can yield (Rossman & Wilson, 1985). In brief, in a mixed method approach several methods are used to explore a phenomenon, with various methods applied during data collection, analysis and interpretation (Creswell & Plano Clark, 2007). Qualitative research often answers "what", "how" and "why", whereas quantitative research often answers "how often" and "how many" (Creswell & Tashakkori, 2007a). A mixed method approach even facilitates the merging, linking or combining of differing sources of data, "steering them" into a whole and enabling the understanding of a phenomenon to take the same form as, e.g., an independent study or a longitudinal, multiple-phase project (Creswell & Tashakkori, 2007a). Studying a phenomenon from different points of view can even be referred to as triangulation (cf. Creswell & Creswell, 2018; Morse, 1991). Some researchers have found that mixed method or multi-method approaches can be problematic, e.g., if the effect is that results are increased or enhanced (Morse, 2003). Nonetheless, the aim of a mixed method approach is not to weigh methods against one other but instead reveal if concepts are valid results of the phenomenon being examined – regardless of whether qualitative or quantitative methods are used (Salomon, 1991). In addition, the aim of a mixed method approach is neither to restrict the research project to any specific research methodology nor design but to instead find methodologies and designs that are suitable to the overall aim

(Regnault et al., 2018). Consequently, an overall mixed method approach was chosen for the purposes of this thesis.

To yield as broad an understanding as possible on the phenomenon being studied (the possibilities for using humanoid robots as a care resource) different designs and methods were used in the three sub-studies (Sub-studies I-III) included in this thesis (see Table 1). The overall goal was to create a whole from various parts: a cross-sectional study and quantitative approach to yield descriptive information and relationships (Sub-study I); qualitative literature to yield an overview and synthesize earlier research evidence (Sub-study II); a qualitative, multi-step approach to actively involve multistakeholders and evaluate experiences (Sub-study III). All three sub-studies (Sub-studies I-III) were planned independently and conducted in line with the individual study aims.

Table 1. Overview of included studies in this thesis.

Study	Aim	Sample	Design/Method	Analysis
I	To explore attitudes toward the use of humanoid robots in healthcare among patients, relatives, care professionals, school actors and other relevant actors in healthcare and to analyze the associations between participants' background variables and attitudes.	264 participants receiving care or working at a hospital, including patients, relatives, care professionals, school actors in healthcare and other relevant actors in healthcare. In addition, the sample consisted of care professionals, school actors in healthcare and other relevant actors in healthcare visiting a caring conference.	Cross-sectional questionnaire conducted in November and December 2018 in Ostrobothnia, Finland.	Multiple linear regression analysis. Spearman's Rho correlation.

Study	Aim	Sample	Design/Method	Analysis
II	To examine how humanoid robots have been used in the care of older persons and identify possible benefits and challenges associated with such use from older persons' points of view.	12 studies included.	Scoping review Systematic database search: two international bibliographic databases with complementary searches in Google Scholar between February and March 2018. Additional search in January 2019.	Qualitative descriptive analysis. Arksey and O'Malley's methodologi cal framework and PRISMA-ScR.
Sub-study III	To develop a humanoid robot-led group physical exercise training program based on the needs of home-living older persons, and to evaluate home-living older persons' experiences of the program.	Three physiotherapists. Five care professionals working in the care of older persons. 11 home-living older persons aged 65 or older.	Participatory design approach including workshop, feedback session, pre-test and main tests. Semi-structured interviews conducted in March 2020 in Ostrobothnia, Finland.	Thematic analysis by Braun & Clarke (2006).

6.1.1 Sub-study I: Cross-sectional study

To gain understanding of the possibilities for using humanoid robots as a care resource, multistakeholders' attitudes toward the use of humanoid robots in healthcare were explored. To gather a broad range of attitudes toward the use of humanoid robots in healthcare, a cross-sectional design was chosen for Sub-study I. A cross-sectional design is appropriate when a generalized picture of a study population at a certain point in time is sought (Polit, Beck & Hungler, 2001). Such as design even facilitates inferences about possible relationships and/or the gathering of preliminary data to support further research (Polit & Beck, 2014) and allows the simultaneous comparison of many different variables (Polit, Beck & Hungler, 2001). However, a cross-sectional design can be considered limited in that it facilitates the exploration of a single moment in time (a short-term perspective) and as such is not recommended if one seeks to analyze a phenomenon over time or establish long-term trends. In Sub-study I, participants filled in a paper survey on a voluntary basis immediately after interacting with a humanoid robot.

Participants and background variables

Data for this study were randomly collected from patients, relatives, care professionals (care professionals and physicians), school actors (students, PhD students, researchers and teachers in healthcare), and other relevant actors in healthcare (service personnel, politicians, managers, directors, secretaries), all working at, visiting or attending a conference at a hospital setting in Ostrobothnia, Finland. Background variables collected included Participant group, Gender, Age, Mother language, Educational level, Read/heard about humanoid robots before and Have met humanoid robots before. Of the total 264 participants, 27 were patients (10.2%), 20 were relatives (7.6%), 76 were care professionals (25.4%), 75 were school actors in healthcare (28.4%) and 75 were other relevant actors in healthcare (28.4%). The clear majority of participants were women (81%). Most were 15-49 years of age (56%), had a higher educational level (69%), had Swedish as their other language (57%) or had read/heard about humanoid robots before (83%). Only a few participants had met a humanoid robot before (17%).

Study procedure

Sub-study I was conducted in November and December 2018. The Pepper humanoid robot was used (see Picture 1) because it was considered suitable for interaction in healthcare settings (Feingold-Polak et al., 2018). During data collection, the humanoid robot was stationed in a lobby at either the hospital setting or conference center included in the study. The aim was to provide interaction and the humanoid robot had the following three functionalities: greeting the participants (Finnish, Swedish or English); answering basic questions about time, weather, etc.; playing music and interactive games, performing dances and singing.

Picture 1. Pepper by SoftBank Robotics.

Together with colleagues at the Experience Lab at Åbo Akademi University, Vaasa, Finland, and using SoftBank Robotics' own basic perception modules and Choregraphe Setup version 2.5.5 for Windows (Community-static, Aldebaran), an appropriate program was designed for the humanoid robot included in the study. The author of this thesis (MA) created an initial script in three different languages, Finnish, Swedish and English (see Table 2). Together with the Experience Lab colleagues, a final script was created by using software to convert the initial script's sentence modules and movements and choices into choreography. The modules were then combined to form several steps, allowing the humanoid robot to interact with the participants by walking toward them and initiating a discussion.

The humanoid robot began interaction with participants by walking toward them and initiating a discussion. The participants were asked to actively interact with the humanoid robot, either alone or in small groups. First, the robot engaged participants in a dialogue about the research project and data collection, where the dialogue continued (or not) based on the participants' replies and/or questions in response to the humanoid robots' replies and/or questions. After this initial interaction/dialogue, the participants could choose how to interact with the humanoid robot.

Participants were given a list of suggested questions and sentences to facilitate interaction. As previously noted, the humanoid robot included in Sub-study I had three functionalities: greeting the participants (Finnish, Swedish or English); answering basic questions about time, weather, etc.; playing music and interactive games, dancing, singing. Consequently, the function of the humanoid robot depended on its status as well as the participants' own preferences.

Table 2. Example of the initial English-language humanoid robot script

Direction	**Information type**	**Dialogue**
Humanoid robot to participant:	Movement	Welcome. My name is Pepper. Would you like me to tell you more about me?
Participant to humanoid robot:	-	Yes / okay / yes, please
Humanoid robot to participant:	Voice	My task is to interact with you. Would you like to know what my colleagues do?
Participant to humanoid robot:	-	Yes / okay / yes, please
Humanoid robot to participant:	Voice	My colleagues at Health Sciences are studying attitudes toward the use of humanoid robots in healthcare. Would you like to participate in our survey?

All participants were asked to fill in a paper survey (conducted in either Finnish, Swedish or English) on a voluntary basis, immediately after interaction with the humanoid robot. The survey was comprised of eight items from the Robot Attitude Scale (see below) and took about 5-15 minutes to complete. The participants in Sub-study I all met the humanoid robot alone or in smaller participant groups before completing the survey and as such the requirements of a cross-sectional design were upheld, i.e., information was registered without manipulation of the study environment. Depending on how much time the participants had (e.g., appointment with a care professional, lunch break), each participant met the humanoid robot for 15-30 minutes. From the Sub-study I research group, the first and second researchers (MA and LN) were present during all data collection, with the aim to guide participants in their interaction with the humanoid robot and help participants fill in the survey. This was considered necessary because it was assumed that many potential participants would have never met a humanoid robot before.

Measures: the Robot Attitude Scale

Sub-study I included a paper survey comprised of items from the Robot Attitude Scale (RAS). Developed by Broadbent et al. (2016), the RAS can be used to measure attitudes toward robots and has been examined in prior healthcare settings (Broadbent et al. 2009, 2010, 2012; Stafford et al., 2014). The RAS was considered relevant to and suitable for the aim of Sub-study I, an exploration of attitudes toward the use of humanoid robots in healthcare. The original RAS consists of 11 items where negative and positive assumptions are weighed against one another, i.e., friendly-unfriendly, useful-useless, trustworthy-untrustworthy, strong-fragile, interesting-boring, advanced-basic, easy to use-hard to use, reliable-unreliable, safe-dangerous, simple-complicated, helpful-unhelpful. Scores are from 1-8, with a low score indicating a more positive attitude and a high score indicating a more negative attitude. With the aim to minimize participant burden during data collection, approval was given from the original developers of the scale (Broadbent et al., 2009) to modify the RAS. While all 11 items from the original RAS were included in the modified version used during data collection, the scores were shortened from 1-8 to 1-5. Permission was approved for linguistic modification of the RAS; the original RAS is in the English language and was translated into both the Swedish and Finnish languages for the purpose of Sub-study I. The new, modified version used was called the RAS-5.

To achieve equivalence between the various language versions of the paper survey (the instrument used in Sub-study I) (Sperber, 2004), the guidelines for the Process of Cross-Cultural Adaption and validation by Beaton et al.

(2000) were applied. The validation process included six stages: (1) translation, (2) synthesis, (3) back translation, (4) expert committee review, (5) pretesting, (6) submission and appraisal of all written reports. In Stage one, four translators were asked to translate the instrument into Swedish and Finnish: two translators whose mother language is the Swedish language, two translators whose mother language is the Finnish language. All four translators each yielded a written report of the completed translation. In both the Swedish and Finnish languages, only one translator was aware of the study concept (informed) while the other was not (uninformed). In Stage two, the author of the thesis worked with all four translators to synthesize the translation results and, working together, one common translation per language was yielded. In Stage three, two translators whose mother language is the English language performed back-translations; none of them were aware of the concept of the study (uninformed). Accordingly, working from the common Finnish and Swedish translations, two back-translations per language were produced. In Stage four, an expert committee of four persons reviewed all translations and reports and performed a consensus of synthesis, thereby yielding a pre-final version of the RAS-5 for pretesting. In Stage five, pretesting occurred.

During pretesting a total of 34 persons of various nursing experience and ages tested the RAS-5 for comprehensibility and adaption of the survey. In Stage six, the newly translated survey was approved. Both the Swedish and Finnish language versions of the paper survey were considered to retain equivalence in the applied test situations and, accordingly, constitute reasonable translations. As the RAS-5 was translated and used in a new context, its reliability and internal consistency was tested using Cronbach's Alpha (Pallant, 2011), estimated as .87.

Analyses

The background variables collected were: Participant group (patients, relatives, care professionals, healthcare students, PhD students or researchers in healthcare, healthcare teachers, other relevant actors in healthcare), Gender (woman/man/other), Age (15-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80+ years), Mother language (Swedish/Finnish/English/Other), Educational level (basic education, vocational school, higher secondary vocational school, high school, university of applied sciences, university), Read/heard (yes/no, have you read/heard about humanoid robots before), and Have met (yes/no, have you met a humanoid robot before). Prior to analyses, some background variables were dichotomized. The participant groups were reclassified as Patients, Relatives, Care professionals (care professionals and physicians became Care professionals, due to similar context), School actors (students, PhD students, researchers, teachers in healthcare became School actors, due to similar context) and Other (other relevant actors in healthcare). Gender was reclassified as woman/man (no gender type other was seen). Age was reclassified as 15-19, 20-29, 30-39, 40-49, 50-59, 60-69, 70-79, 80-89 (no participant over 90 years old was seen). Mother language was reclassified as Swedish/Finnish/Other (English and other were merged into Other, due to low amount in each category). Educational level was reclassified as lower/higher (due to small amount in each level; categories from higher secondary vocational school upward were included in higher, with the remainder in lower).

Differences in mean RAS-5 scores between background variables were analyzed with a T-test of independent samples when comparing two classes and with one-way analysis of variance (ANOVA) when comparing three or more classes. As a significant F-statistic was seen, post-hoc comparisons with the Scheffe test were also performed. A multiple linear regression analysis method was used to study the association between the background variables and RAS-5 score. The assumptions of multiple linear regression were tested and fulfilled: the variance of residuals was homogenous, their distribution was normal and there was no correlation between them, and there was no significant multicollinearity.

The association between the background variables and dichotomized RAS-5 score was furthermore analyzed with Spearman's Rho correlation analysis. The mean RAS-5 score of 2.3806 was chosen as the cut-off level for dichotomization. Two-tailed analyses were conducted and statistical significance was set at P-values below 0.05. All data were analyzed with SPSS Statistics version 25 (IBM Corporation, Armonk, NY, USA).

6.1.2 Sub-study II: Scoping review study

To gain understanding of the possibilities for using humanoid robots as a care resource, for Sub-study II a scoping review was conducted to explore and synthesize available literature related to the research top (Levac et al., 2010). Scoping review studies have increased in popularity in health science research in recent years because such a method can yield a broad assessment of the area of research being examined and yield an explicit description of the literature selection process (Tricco et al., 2018). A scoping review method can even facilitate the inclusion of studies with a much more complex or broader research area than a systematic review (Levac et al., 2010). Moreover, a scoping review method can enable the examination of the extent, nature and range of research areas, help in the process of summarizing and disseminating research findings, and help identify research gaps (Arksey & O'Malley, 2005).

Yet, despite the increasing use of the scoping review method, no clear criteria exist to guide and evaluate the rigor or reporting of scoping reviews (Arksey & O'Malley, 2005). Also, such a flexible method can require increased resources or result in an over-whelming amount of data (CRD, 2001; Arksey & O'Malley, 2005). Some even find that a scoping review method lacks detailed methodological steps, related to the synthesizing of the data seen in the studies included in the eventual scoping review (O'Brien et al., 2016). Still, even if some maintain that there are challenges associated with a scoping review method, i.e., neither clear quality criteria nor guidelines (Shea et al., 2007), one strength of the method is that it allows for a focus on the state of research activity (especially in upcoming research areas) as opposed to a "mere" evaluation of the quality of existing literature (Mays et al., 2001; Arksey & O'Malley, 2005).

Comprised of six stages, Arksey and O'Malley's (2005) methodological framework as interpreted by Levac et al. (2010) was used in Sub-study II. The six stages included: (1) identifying the research question, (2) identifying relevant studies, (3) study selection, (4) charting the data, and (5) collating, summarizing and reporting results. An optional sixth step involves stakeholders but was not used in Sub-study II. The conduct of scoping reviews as delineated by the Joanna Briggs Institute (2015) and the Preferred Reporting Items for Systematic reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines were even followed throughout the research process.

Search strategy

Following identification of the research question in accordance with stage one of Arksey and O'Malley's (2005) methodological framework (How humanoid robots are used in the care of older persons) the identification of relevant studies was undertaken in Stage 2. Between February 2 and March 31, 2018, a systematic search of two international bibliographical databases, PubMed and CINAHL, was undertaken. To improve the final search, several pilot searches were first performed. In addition to the identification of grey literature, seen as a reviewing of the reference lists of the included literature to screen for potential literature meeting the eligibility criteria missed during the database search, a general Internet search of Google and Google Scholar was completed. In January 2019, an updated electronic database search was performed to screen for new or missed studies. The final search included core concepts related to the research questions and correlated to Medical Subject Headers (MeSH) terms (key terms). The key terms related to the study population included: elder, older, senior, frailty, geriatric, aged. The key terms related to interventions included: humanoid, robot, artificial intelligence. The Boolean operators "OR" (when searching through key terms), "AND" (when combining key terms), and * (the asterisk symbol, used to treat key terms as prefixes) were used in consultation with an experienced librarian (MIT Libraries) (see Table 3).

Table 3. Sub-study II, database, key search terms and search strategy.

Database	**Key terms and search strategy**
PubMed	((elder* or older* or senior* or frailty* or geriatric* or aged*) and (humanoid* or robot* or artificial intelligence*))
CINAHL	((elder* or older* or senior* or frailty* or geriatric* or aged*) and (humanoid* or robot* or artificial intelligence*))

Study selection, screening

Study selection was undertaken in accordance with stage three of Arksey and O'Malley's (2005) methodological framework. The inclusion criteria included that humanoid robots were defined as a robot with movable parts and an overall human-like appearance based on the human body, the human face and an inherent social capacity (Mohamed & Capi, 2012). Older persons were defined as a person aged 65 years or older (WHO, 1999). Also included were studies with a focus on the use of humanoid robots from older persons' points of view after real-life interactions. The exclusion criteria included a study focus on areas concerning surgery, monitoring systems or software, and studies based on thought experiments, where participants relied on their imagination, stimulated by, e.g., pictures or videos. Also excluded were studies in which robotic pets were used, because the determination was made that robotic pets did not fall under the category of humanoid robots (Morovitz et al., 2017).

The eligibility criteria were limited to full-text published studies, to-be-published studies and grey literature. Included studies were published between February 2013 to February 2018 and were written in the English, Swedish or Finnish languages. The choice of start date was inspired by the rapid rate at which robotics technology has developed in recent years. Included grey literature had to be considered a report, a working paper or a practice-oriented development report. First duplicates and records not relevant to the study aim were removed. Two of Sub-study II's authors independently screened the records, followed by all three of Sub-study II's authors independently reading the eligible studies' abstracts and thereafter jointly discussing the studies with regard to inclusion or exclusion.

Data charting

In accordance with stage four of Arksey and O'Malley's (2005) methodological framework, a qualitative descriptive approach (Sandelowski, 2000) was used to chart how humanoid robots were used in the various included studies by category (domain of use) and the benefits and challenges of such use from older persons' points of view. The following data were extracted and charted from each selected study: domain of use by category, author(s), year of publication, country of origin, context, study methods, sample size, robot, duration of the intervention, study aim, benefits and challenges. The studies were also charted with respect to the type of humanoid robot used. The categories related to domain of use were determined based on each included study's aim. The decision was taken to base categorizations on the included studies' aims because it was not always clearly stated in the included studies what the robots' domains of use were and a large variety of and varying robot uses were noted in the included studies.

A total of 12 relevant studies were included in Sub-study II. Most had been published in journals that employed a focus on humanoid robots while some were published in journals that employed a focus on biomedical engineering, the Internet, health technology, rehabilitation or clinical interventions for older persons. Of the twelve relevant included studies, one study (Ikeya, et al., 2018) was identified as grey literature because it was a letter to the editor (LTE).

6.1.3 Sub-study III: Qualitative pilot study

To gain further understanding of the possibilities for using humanoid robots as a care resource, in Sub-study III a humanoid robot function was developed and evaluated in a small-scale qualitative pilot study. The aim of Sub-study III was twofold: to develop a humanoid robot-led group physical exercise training (PET) program based on the needs of home-living older persons, and 2) to evaluate home-living older persons' experiences of the program. Emanating from research in which researchers have found that the need for homecare services for home-living older persons is increasing, linked to both the growing number of older persons and the shortage of care professionals worldwide (WHO, 2015; Kataja, 2016), home-living older persons were identified as relevant end-users. A participatory design approach in accordance with Muller and Kuhn (1993*)* was used to design and evaluate a pilot version of a humanoid robot-led group (PET) program based on home-living older persons' specific needs and experiences.

A participatory design approach was considered relevant to the overall aim of the study; the iterative design process phases that are inherent to such an approach were seen as increasing the usability of the training program. In

Sub-study III, a focus was placed on home-living older persons' average physical conditions and exercise routines and needs throughout the entire study design and development process (Schiau et al., 2018). In general, a participatory design approach can be said to require that end users become active participants in the interventions being examined as well as design and innovation processes (Sanders & Stappers, 2008). Furthermore, the various methods and techniques used during the stages of development facilitate the inclusion of external stakeholders, e.g., relatives or care professionals (Merkel & Kucharski, 2019).

Picture 2. Nao by SoftBank Robotics.

Study procedure

Sub-study III was conducted at a university and an assisted living facility setting in Ostrobothnia, Finland between December 2019 and February 2020. The humanoid robot Nao developed by SoftBank Robotics (Paris, France) was used (see Picture 2). The participatory design approach used in the study included the following phases (see Figure 1): 1) defining user needs, 2) developing the program and 3) testing the program.

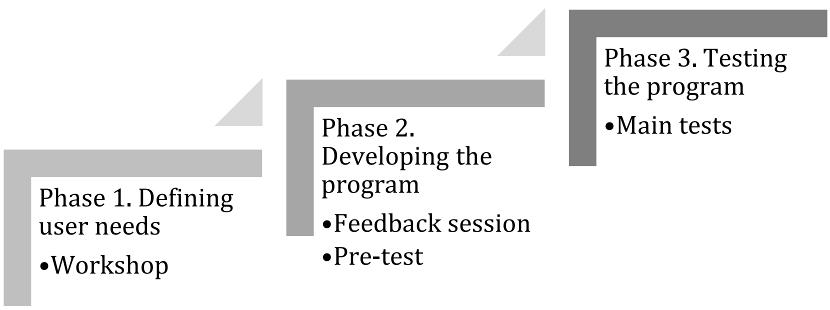

Figure 1. Participatory design approach used in Sub-study III.

Phase 1: Defining user needs

For Phase 1, a workshop was held in December 2019 with the aim to determine and define the average physical condition of home-living older persons and gain insight into their physical exercise routines and needs. Two of the study's authors (MA and LN) and three independent (*N= 3*) physiotherapists attended the workshop. The physiotherapists were considered suitable for inclusion in Phase 1 because they had professional knowledge of home-living older persons' average physical condition and exercise routines and needs. During the workshop, the physiotherapists answered questions about a variety of topics and provided essential insight, e.g., that a focus on upper body and seated exercises should be included and that exercises should be repeated in sets lasting for a minimum of several minutes.

Phase 2: Developing the program

Emanating from the Phase 1 criteria, the author of this thesis and the main author of Sub-study III (MA) designed and animated a first draft of the humanoid robot-led group PET program using the ZoraBots ZBOS software. The program was customized using the Kiosk individual user interface part of the ZBOS software with regard to intuitive interaction (e.g., body language, speed functions, perception modules for recognition of approaching interaction partner, speech recognition and engine in the Swedish language (cohort mother language; Finland has two official languages), Light Emitting Diodes and microphone for multimodal interaction, music per session). The first draft of the program was constructed stepwise and included three four-minute exercise sets, resulting in a program lasting 12 minutes altogether. Each group PET session began with the humanoid robot leading a short warm-up mainly consisting of movements such as stretching the neck, then back and arms. The humanoid robot continued with several various upper body exercises (five repetitions per exercise), e.g., stretches, head rotations, upper body rotations, touching feet or knees with hands, arm exercises. The humanoid robot concluded each group PET session with easier ("cool down") stretches.

Phase 2 of Sub-study III included two steps, a feedback session with physiotherapists (Step 1) and pre-test by care professionals (Step 2). During Step 1, with the aim to receive feedback and thereby test the usability of the humanoid robot-led group PET program, again with a focus on home-living older persons' average physical conditions and exercise routines and needs, a digital (online) first-draft version of the program including open-ended questions was sent to the same physiotherapists *(N= 3*) included in the Phase 1 workshop. During Step 2, to further test the usability of the program with a focus on home-living older persons' average physical condition and exercise routines and needs, a group of care professionals (N = 5) enrolled in an ongoing course at the university setting where the study took place were invited to participate in the study and test the program for usability. Immediately after testing of the program, a paper-based survey including open-ended questions was used to yield responses.

Some minor suggestions were seen in the physiotherapists' (Step 1 feedback session) and care professionals' (Step 2 pre-test) responses, e.g., that the humanoid robot should verbally indicate the start of a new set of exercises or "count down" exercises. Such suggestions were taken into account, with the program being changed accordingly. From the results of Step 1 (feedback session) and Step 2 (pre-test), the program was seen to generally retain overall usability and thereby constitute a reasonable group PET program for home-living older persons.

Phase 3: Testing the program

To test the program with end-users, home-living older persons were invited to participate in Sub-study III by a letter distributed through the assisted living facility setting included in the study. Criteria for inclusion were being 65 years or older and living independently in own home. Criteria for exclusion were being a bedridden older person and an older person with a cognitive disorder affecting memory. During February and March 2020, a group of home-living older persons (N = 11) met to test the program. The group were known to each other, having previously participated together in group-led physical exercise sessions at the same setting. All lived independently at home and had various health conditions that affected their physical needs, e.g., some could drive themselves to the study setting while others arrived by taxi; some could walk unaided while others used walking aids (walker, cane).

The testing phase consisted of group PET sessions at an assisted living facility setting. During testing the participants were asked to freely interact with the humanoid robot both before and after each group PET session but were kindly asked to remain seated in their respective chairs during a session and follow the exercises to the best of their ability. Initially, the inclusion of a larger end-user participant cohort and a total of three once-weekly group PET sessions were planned. However, the ongoing COVID-19 pandemic disrupted such plans; only two once-weekly group PET sessions were undertaken before the self-isolate recommendation was given for all persons aged 70 or older living in Finland.

Eleven interviews were performed in March 2020, about a week after the last group PET session was held. Considered an effective method for collecting qualitative data (Kvale, 1996), semi-structured interviews were used in Sub-study III for data collection (See Table 4). Semi-structured interviews have been found to facilitate participant expression of feelings, thoughts and experiences of the research topic (Kvale, 1996) and even two-way communication, which is considered appropriate when exploring sensitive topics (Silverman, 2000). Semi-structured interviews have also been found to result in high validity, although some researchers express concern over a possible lack of consistency across participants (Ahlin, 2019). To ensure participant safety (due to the COVID-19 pandemic), the semi-structured interviews were held by telephony and lasted for between 25-70 minutes each, during which a less formalized and more conversational structure was followed (Adams, 2015). While telephone interviews can be considered a rapid data collection method, respect for participants' home life is nonetheless required (Block & Erskine, 2012). Like personal interviews, telephone interviews allow for some personal contact between an interviewer and a participant but should be relatively short to inhibit participants' feeling that they are being imposed on (Adams, 2015). The interview topics were related to evaluation of the group PET program and supplemented with follow-up questions (e.g., exercises, format, functions, benefits, challenges, factors that influenced one's evaluation, opportunities, recommendations), all with the aim to address the usability of the humanoid robot-led group PET program among home-living older persons.

Table 4. Examples of the interview questions used during the semi-structured telephone interviews.

- How did you experience your participation in the humanoid robot-led group PET program?
- What factors do you think affected your evaluation of the program?
- How has the program affected you?
- In your opinion, what opportunities are there for using a humanoid robot to lead PET programs?
- In your opinion, what are the challenges associated with using a humanoid robot to lead PET programs?
- What are your recommendations for the further development of the program?

Analysis

Chosen for its simplicity and flexibility, thematic analysis (Braun & Clarke, 2006) was used to analyze the transcribed interviews from Phase 3. The data material was read several times, with the aim to familiarize, analyze and present themes as well as discover semantic meaning units related to home-living older persons' evaluations of the humanoid robot-led group PET program. Emanating from the thematic analysis, the meaning units were condensed and coded before a final organization into themes.

6.2 Ethical considerations

Three sub-studies (Sub-studies I-III) have been undertaken as part of the overall research project that comprises this thesis. The ethical approaches used and methodological limitations and/or challenges seen for each unique study are delineated below. During the entire course of all the research project, including the three sub-studies encompassed by this thesis, compliance with the ethical principles delineated by the Finnish National Board on Research Integrity TENK (Finnish National Board on Research Integrity TENK, 2019) and the guidelines for the conduct of scientific research involving human beings (World Medical Association WMA, 2013) have been followed. The overall aim has been to ensure that the research has been conducted in a responsible manner and to prevent any misconduct. The author of this thesis (MA) declares no conflict of interest with regard to the research topic.

For Sub-study II, a scoping review, no specific ethical approval was required. A population-based data collection method was used for Sub-study I and Sub-study III, thus separate applications for those respective studies were made to the Board for Research Ethics at Åbo Akademi University (FEN). Approval for Sub-study I was granted on June 6, 2018, and approval for Sub-study III was granted on August 10, 2019. In their statement, the Board for Research Ethics noted that the author of this thesis (MA) demonstrated good awareness of research ethics and found that credible attention to research ethics had been demonstrated in the application that encompassed both Sub-study I and Sub-study III. However, the Board for Research Ethics found nothing contained in either Sub-study I or Sub-study III that could be construed as constituting a medical intervention[2], noting that the focus of both studies lay on attitudes toward or experiences of robots. The Board however noted that the research being undertaken could possibly in some manner impact the care being provided in the hospital and assisted living facility settings seen in Sub-study I and Sub-study III and therefore recommended that an application for further permission to perform each study be made to the relevant authorities at the respective settings prior to the start of data collection. Accordingly, such was undertaken prior to data collection, with the relevant setting-based authorities granting approval for Sub-study I and Sub-study III, separately and respectively.

[2] In accordance with the Medical Research Act No. 488/1999, Section 2 (295/2004), Definitions: "For the purposes of this Act: (1) medical research means research involving intervention in the integrity of a person, human embryo or human foetus for the purpose of increasing knowledge of health, the causes, symptoms, diagnosis, treatment and prevention of diseases or the nature of diseases in general (794/2010)" (Finlex, 1999).

Throughout the course of the research project, special attention has been paid to both participant autonomy and confidentiality because the overall research topic (humanoid robots in specific care encounters with older persons) could be considered sensitive. General Åbo Akademi University guidelines for data management, e.g., the handling, storage and protection of data material, have been followed. For example, no names or specific identifying information have been requested. Information about the study aim, research group and main author's contact information has been given to all participants. Additionally, all participants have been informed about their possibility to withdraw from a study and the research project at any time, without penalty. During data collection for Sub-study I and Sub-study III, several research group representatives were stationed at the various study settings (hospital, assisted living facility) to support participants as needed. Moreover, to ensure safety, the humanoid robot was used only under appropriate and competent researcher control and supervision at all times. The humanoid robots used in Sub-study I and Sub-study III were not connected to the Internet or any database and did not collect any personal information from participants. In Sub-study II, a scoping review, no ethical approval was required because the included studies were considered secondary data with own ethical approval. Nonetheless, the guidelines related to the conduct of a scoping review as delineated by the Joanna Briggs Institute and the PRISMA-ScR checklist were followed throughout all Sub-study II research phases whenever ethical considerations, e.g., the inclusion of literature, were considered paramount. Finally, all research material collected throughout the entire research project, including the three sub-studies (Sub-studies I-III) encompassed by this thesis, was respectfully handled with the intent to avoid distortion of the lived experiences of the participants.

7. Results of the sub-studies

During the course of the three sub-studies (Sub-studies I-III) and for the purpose of the overall research aim, understanding of the possibilities for using humanoid robots as a care resource was sought, including the attitudes, needs and experiences of multistakeholders related the use of humanoid robots in healthcare and the care of older persons. This was undertaken through the use of a cross-sectional study (Sub-study I), a scoping review (Sub-study II) and a qualitative pilot study (Sub-study III).

7.1 Sub-study I: Attitudes toward humanoid robots in healthcare

In Sub-study I, attitudes toward the use of humanoid robots in healthcare among patients, relatives, care professionals, school actors and other relevant actors in healthcare were examined. The first research question in Sub-study I was, "What are the attitudes toward the use of humanoid robots in healthcare?" Most participants were more likely to be positive toward the use of humanoid robots in healthcare than neutral and only some were more likely to be negative; differences in participant attitudes were quite small. This was interpreted from and measured through items included in the RAS-5 instrument, expressed as a score from 1 to 5. A low score indicated a more positive attitude, while a high score indicated a more negative attitude. Of the participant ratings, 21.3% were score 1, 32.7% score 2, 34.7% score 3, 32.7% score 4, and 2.3% score 5, thereby showing that most of the participants were more likely to be positive toward the majority of RAS-5 items and thus the use of humanoid robots in healthcare. While Scheffe test analysis showed no significant differences between the RAS-5 items' mean scores, the items Interesting and Friendly had rather lower mean scores, indicating that participants had more positive attitudes toward these two items. The mean scores of the remaining RAS-5 items were above these two items' 95% confidence interval (CI).

The second research question in Sub-study I was, "What are the associations between participants' background variables and their attitudes?" The variables collected were related to, among others things, gender, age, education, reason for visiting the hospital/caring conference and earlier experiences with humanoid robots. Spearman's Rho correlation analysis was used, with higher scores indicating a more negative attitude toward the use of humanoid robots in healthcare. For the variable Participant group, patients had a higher score. For Gender, women had higher score. For Age, the 30-39 age class had a higher score. For Mother Language, those whose mother language is Finnish had a higher score. For Educational level, those with a lower education had a higher score. With regard to earlier experiences, for the background variables Read/heard and Have met, those who previously had not done neither had a higher score.

Looking at associations between participant background variables and attitude conversely, with lower scores indicating a more positive attitude toward the use of humanoid robots in healthcare, other relevant actors in healthcare (e.g., politicians or service personnel) were seen to be more likely to have a positive attitude than patients. Those with a higher educational level were more likely to have a positive attitude than those with a lower educational level. Older adults were more likely to have a positive attitude than younger adults. For Age classes (organized by decade except the first age class, 15-19 years), each decade increase was seen to result in a slightly lower mean value when compared to younger age classes. Still, the Age variable seen in the analysis was not completely linear and univariate analysis showed that the two youngest age classes (15-19 and 20-29 years) had slightly more positive attitudes than those in the 30-39 age class. Lastly, those whose mother language is Swedish were more likely to have a positive attitude than those whose mother language is Finnish.

7.2 Sub-study II: Humanoid robots' areas of use, benefits and challenges in the care of older persons

In Sub-study II, how humanoid robots have been used in the care of older persons was reviewed, with a focus on possible benefits and challenges from older persons' points of view. The first research question in Sub-study II was, "How have [humanoid robots] been used in the care of older persons?" From the results, four domains related to humanoid robots' use in the care of older persons were identified. Humanoid robots were seen to support older persons' everyday life (the largest category; Wu et al., 2014; Doering et al., 2015; Pripfl et al., 2016; Bedaf et al., 2018), provide interaction (Torta et al., 2014; Kouroupetroglou et al., 2017; Abdollahi et al., 2017; Ikeya et al., 2017), facilitate cognitive training (Orejana et al., 2015; Ishiguro et al., 2016; Feingold-Polak et al., 2018) and facilitate physical training (Piezzo et al., 2017).

Larger groups of participants, defined as more than ten participants, were only included in a few studies (Ishiguro et al., 2016: Pripfl et al., 2016; Feingold-Polak et al., 2018). Longer-term perspectives, defined as intervention duration greater than 4 weeks, were only included in four studies (Wu et al., 2014, Torta et al., 2014; Orejana et al., 2015; Abdollahi et al., 2017). Consequently, in most studies a short-term perspective was seen and the average intervention duration was short (30-45 minutes). A wide variety of countries were seen in the included studies: Japan (Piezzo et al., 2017; Ikeya et al., 2018; Ishiguro et al., 2018), Austria (Torta et al., 2014; Pripfl et al., 2016), Israel (Feingold-Polak et al., 2018), the Netherlands (Bedaf et al., 2018), the United States of America (Abdollahi et al., 2017), England (Kouroupetroglou et al., 2017), Germany (Doering et al., 2015), France (Wu et al., 2014) and New Zeeland (Orejana et al., 2015). A wide variety of humanoid robot designs and functionalities were even seen. The most commonly used humanoid robot was Pepper (Ishiguro et al., 2016; Piezzo et al., 2017; Feingold-Polak et al., 2018), while the other humanoid robots seen, Nao, iRobi, HOBBIT, Ryan, PALRO, MARIO, Care-O-Bot, Kompaï and one humanoid-companion type robot without an official model name, were only included in one study each. Some of the humanoid robots were human-size robots on wheels (e.g., Pepper), while others had both legs and arms but were small toy robots (e.g., Nao, iRobi). All of the included studies excepting one (Piezzo et al., 2017) used more than one humanoid robot function during investigation; most used several functions during investigation, e.g., medication management, dancing. The humanoid robots were tested in different settings in the included studies: private homes (Orejana et al., 2015; Doering et al., 2015; Pripfl et al., 2017), nursing homes (Kouroupetroglou et al., 2017; Abdollahi et al., 2017; Ikeya et al., 2018; Piezzo et al., 2017) and home-like test environments (Torta et al., 2014; Wu et al., 2014; Bedaf et al., 2018).

Even seen was the use of humanoid robots to perform a wide variety of tasks for older persons, e.g., checking and updating calendars, playing games, checking weather, online grocery shopping (Wu et al., 2014), and messaging service, medications reminders and facilitating video telephony interaction (Pripfl et al., 2016). Also, monitoring vital signs (Doering et al., 2015), measuring blood oxygen levels (Torta et al., 2014), picking up objects from the floor, transporting objects (Pripfl et al., 2016), recognizing emergencies (Torta et al., 2014) and facilitating fitness programs (Ikeya et al., 2018; Ishiguro et al., 2016). Other tasks seen were the giving of reminders, reminding individuals to hydrate (Bedaf et al., 2018), playing music (Abdollahi et al., 2017), managing external calls (Orejana et al., 2015), reading news headlines (Kouroupetroglou et al., 2017), showing photos and videos, answering quizzes (Wu et al., 2014), facilitating entertainment (Feingold-Polak et al., 2018) and walking together (Piezzo et al., 2016).

The second research question in Sub-study II was, "What benefits and challenges are associated with [the use of humanoid robots] from older persons' points of view?" There were benefits associated with the use of humanoid robots, e.g., using them as assistants (Doering et al., 2015; Abdollahi et al., 2017; Bedaf et al., 2018; Feingold-Polak et al., 2018) and that the presence of a humanoid robot decreased primary care visits and phone calls to care professionals, with older persons feeling that their quality of life increased (Orejana et al., 2015). However, challenges were even revealed. For example, in one included study older persons preferred to walk behind rather than beside a humanoid robot (Piezzo et al., 2017). Technical challenges, e.g., slow response time, errors in the humanoid robots' function (Orejana et al., 2015) and barriers to the adoption of new technologies (Wu et al., 2014; Orejana et al., 2015; Pripfl et al., 2016; Bedaf et al., 2018; Feingold-Polak et al., 2018) were even revealed. Moreover, older persons' perceived enjoyment of using a humanoid robot might decrease over time (Torta et al., 2014; Ikeya et al., 2018) and in one study researchers concluded that humanoid robots cannot replace human care professionals (Abdollahi et al., 2017).

7.3 Sub-study III: Home-living older persons' evaluations of a humanoid robot-led group physical exercise training program

In Sub-study III, a focus on home-living older persons' average physical condition and exercise routines and needs and their evaluations of a humanoid robot used to facilitate a group PET program, originating from a participatory design approach, were investigated in a pilot study in which a humanoid robot-led group PET program was developed and tested.

The first research question in Sub-study III was, "What are home-living older persons' average physical condition and exercise routines and needs and their evaluations of a humanoid robot-led group PET program?" While the participants described both positive and negative experiences in their evaluations, the most common experiences were that the exercises in the group PET program were both entertaining and easy to follow. Furthermore, most participants evaluated the humanoid robot Nao that led the training program as being fun and enjoyable, even if the results showed that they considered the robot to be too small for its intended purpose. Most participants commented that they would rather choose other daily activities over the humanoid robot-led group PET program in its current form but also expressed feelings of higher mental well-being while participating in a group PET session. Participants experienced that their participation in a humanoid robot-led group PET program might become habitual after a time and could increase their social interactions. Many even noted the importance of social interaction with other participants during group PET sessions because they did not want to be alone with the humanoid robot. Some participants stated that they were doubtful before the first humanoid robot-led group PET session but afterwards perceived that they were in a better mental mood and noted that the group PET program was fun. Nonetheless, all but one of the participants stated that other home-living older persons would find the exercises neither useful nor motivating over a longer period of time because the exercises were too easy.

The second research question in Sub-study III was, “What are the included home-living older persons’ suggestions for the improvement of the humanoid robot-led group PET program?” Regarding suggestions for improvement, the participants recommended the inclusion of full-body exercises, not just upper-body exercises, and that the exercises should be performed at a faster tempo. Some also recommended including exercises that can be performed both sitting down and standing up, and one recommendation from a participant was to also include floor push-ups in the training program. Moreover, some described that they rather would perform the exercises without a robot because they did not experience the humanoid robot-led group PET program in its current form to be useful for those older persons in better physical condition. Further suggestions for improvement were that the humanoid robot’s phrasing and speech should be improved when giving instructions and that opportunities to ask the robot questions during an ongoing session should be included. Other suggestions were mainly related to the usability of using a humanoid robot for similar situations. Although the participants stated awareness of the societal challenges linked to the lack of care professionals for the aging population, most highlighted that robots could not replace human trainers in similar PET programs. The participants repeatedly noted the importance of human empathy. The majority expressed that a humanoid robot-led group PET program would better suit those living in assisted living facilities, noting that such programs might be more suitable for those older persons in need of additional physical or mental care or in below-average physical condition, particularly those older persons for whom care professionals have inadequate time to provide such.

8. Discussion

To achieve new understanding of the possibilities of using of humanoid robots as a care resource, both theoretical and empirical research has been undertaken as part of the research project that forms the foundation of this thesis. Among others, patients, older persons, relatives, care professionals, school actors in healthcare and other relevant actors in healthcare have been included as healthcare stakeholders in order to address the continuous challenges arising from the use of humanoid robots in healthcare. The approach employed and the research undertaken have yielded greater insight not only into the use of humanoid robots in healthcare but even multistakeholders' and end users' experiences and attitudes toward such, as well as the factors enabling or creating a barrier to the further implementation of humanoid robots in healthcare. Consistent with the theoretical perspective employed and thus emanating from caring as seen in the discipline of Caring Science and the theory of caritative caring (Eriksson, 2006a; Lindström et al., 2014; Fagerström et al., 2020), the basis for and overall focus of all of the sub-studies included as part of this thesis (Sub-studies I-III) has been on real-life, face-to-face (versus theoretical) human-humanoid robot care encounters.

8.1 Overview of experiences of humanoid robots in healthcare as seen in the sub-studies

The continuous challenges being seen in healthcare, e.g., the lack of care professionals (Valvira, 2019) and the growing aging population (Roberts, 2009) require the creation of new ways of understanding how multidimensional perspectives can be incorporated into research to achieve broader insight into end users' needs, experiences and attitudes. Emanating from a cross-sectional exploration, a systematic and comprehensive review of literature and the use of several iterative phases in relation to the research matter being discussed and resulting in improved understanding of multistakeholder and end-user attitudes and multipractices as seen in healthcare, it can be concluded that most of the participants included in the research underlying this thesis were seen to have a positive attitude toward the use of humanoid robots in healthcare.

Most European citizens have a positive view of robots in healthcare (Eurobarometer, 2016), though such findings relate to robots in general and come from theoretical research in which participants were shown pictures or movies of robots. Although robots have been tested to some extent in real-life, face-to-face interactions with humans (Tiwari et al., 2011; Unbehaun et al., 2019; Carros et al., 2020), a theoretical approach has mainly been employed in previous research on human and humanoid robot interactions. As seen from the results of all three of the sub-studies included in this thesis (Sub-studies I-III), the majority of included participants were considered to have a positive attitude toward the use of humanoid robots in healthcare. Even other researchers have found that robots are experienced more positively after face-to-face encounters (Nomura et al., 2006; Heerink, 2011; Louie et al., 2014; Casas et al., 2019) and that face-to-face interaction might generate more positive feelings toward both the robot one is interacting with and even robots in general (Naneva et al., 2020). Accordingly, this would appear to indicate that humanoid robots can be considered suitable robotic technologies for use in face-to-face care encounters with human beings in healthcare. Nonetheless, further investigation in which participants spend more time interacting with humanoid robots is recommended; earlier research has been seen to encompass short-term perspectives and limited participant interaction with humanoid robots.

Experiences of humanoid robots related to healthcare

As seen in Sub-study I, other relevant actors in healthcare (politicians, leaders, service personnel) were more likely than patients to have a positive attitude toward the use of humanoid robots in healthcare. This is in line with previous research (Coco et al., 2018), in which managers were highlighted as having a key role during the implementation of robots into the care of older persons. Throughout the world other researchers have seen that especially policymakers have discussed and advocated a "vision" where robots solve the challenges being seen in healthcare (Maibaum, 2021; cf. Ford, 2015). Maibaum et al. (2021) argue that such a drive toward the use of robots can be interpreted as the consideration of technological solutions from an organizational perspective. In what Maibaum et al. (2021) call a "socially constructed" "interconnection", politicians and leaders seek and implement technological solutions in healthcare to, e.g., attract new employees (recruit more care professionals), yet without taking into consideration the real-world implications of such. This can even be viewed as a "conflict" between economic interests and professional care, which accordingly indicates that more consideration and critical examination of the topic are needed, i.e., examination of the reasons underlying robot implementation in healthcare. Even other researchers find that although there is great potential in using robotic technology to develop care work in healthcare (Kangasniemi et al., 2019) more research and critical considerations are needed to find sustainable outcomes for such use of humanoid robots.

In contrast to the findings seen in Sub-study I, other researchers have found that patients are more likely than care professionals to have a positive attitude toward the use of robots in healthcare (Broadbent et al., 2012), although it should be noted that the participants in Broadbent et al.'s study did not physically meet a robot while the participants in Sub-study I did. As a group, patients are not homogenous: variables such as age, gender, state of health, experiences, etc. vary. For example, as seen from the results of Sub-study I, vulnerable patient groups would appear to be an unsuitable first target group when implementing humanoid robots in healthcare. However, within the constraints of this research project it was not possible to further explore this finding. Therefore, to better understand why patients as a group are seen to be more negative toward the use of humanoid robots in healthcare and specifically which patient groups are more negative, further research is needed on whether there are associations between certain group attributes, e.g., disease, state of health, preconceptions, etc. Furthermore, a person-centered focus on patients' mixed experiences and a careful evaluation should be employed in future research.

In line with earlier studies (de Graaf & Allouch, 2013; Beedholm et al., 2015), in Sub-study I those included participants with a higher educational level were more likely than those with a lower educational level to have a positive attitude toward the use of humanoid robots in healthcare. Other researchers have found that practical nurses (with lower educational/degree requirements) have the most reserved attitudes toward the use of robots in healthcare when compared to other occupational groups (Turja et al., 2018). Therefore, emanating from the findings in Sub-study I, it is perhaps possible to infer that more negative attitudes might be linked to the lower educational/degree backgrounds for certain care professional groups. If more negative attitudes toward robots can be linked to lower educational levels, it is even possible that also the decision-making processes related to robot implementation and the motivation to do so among decision-makers (often of varying educational backgrounds) may be adversely affected (Tuisku et al., 2022). Consequently, those areas of healthcare where higher educational levels are more common among care professionals might be a more suitable first target group when introducing humanoid robots in healthcare.

One should, however, note that not all care professionals welcome the use of robot technology in healthcare (Katz & Halpern, 2014; Saborowski & Kollak, 2015). In one prior study (Broadbent et al., 2011), researchers found that there were ethical challenges associated with the use of robots in healthcare, e.g., perceptions that robots might cause harm to patients or that robots would replace care professionals. Conversely, in a different and later study (Boman & Bartfai, 2015) the use of robots to reduce care professionals' workload was experienced positively. Care professionals can become more accepting of robots if their fears of being replaced by technology are acknowledged and allayed (Coco et al., 2018). Other researchers have found that although care professionals and older adults were interested in and excited about the use of autonomous robots, they were even afraid of making technological mistakes (Hebesberger et al., 2017). Attitudes and knowledge appear to be strongly interrelated (Tuisku et al., 2022) and those care professionals using and operating robotic technological must possess the technical skills needed to use and operate the robots they are using, regardless of setting (cf. Rantanen et al., 2018). In sum, more (and more recent) research should be undertaken on care professionals' attitudes toward the use of robots in healthcare.

Also seen in Sub-study I were significant differences between participants with different mother languages. Cultural differences might play a considerable role in influencing attitudes toward robots (Haring et al., 2014; Coco et al., 2018) linked to, e.g., previous high or low exposure to robots or a (cultural) capacity for being "easy going" when interacting with new persons (Bartneck et al., 2005). The successful implementation of new technology requires general acceptance in a society (Broadbent et al., 2009). Further studies in which the reasons underlying culturally linked attitudes toward the use of humanoid robots in healthcare are investigated might facilitate further technological development and implementation. Also seen in Sub-study I was that older adults are more likely than younger adults to have a positive attitude toward the use of humanoid robots in healthcare. While this differs from the findings in one earlier study, where younger adults were seen to be more likely than older adults to accept robots for healthcare tasks (Kuo et al. 2009), it is in line with the findings in another earlier study, where older adults were found to be more likely to have a positive attitude toward robots, attributed to an increased need for assistive technology linked to the ageing process (Turja et al., 2019). Such mixed findings might be linked to, e.g., the design or function of the particular humanoid robot used in a study or the amount of time participants spend interacting with a robot. Consequently, further comparative investigations of the different types of humanoid robots suitable for use in healthcare and their suitability with different patient groups are needed.

Experiences of humanoid robots related to the care of older persons

As discerned from the findings in Sub-study II, to date humanoid robots have primarily been investigated in relation to their use with older persons with regard to humanoid robots' ability to support everyday life, facilitate interaction, and provide cognitive and physical training. Since the systematic search of electronic databases included in Sub-study II was undertaken, several studies have been identified in which a focus on using robots to improve participants' physical health was employed (Schneider, 2019; Avoiz-Sarig et al., 2021). Eleven out of the 12 studies included in Sub-study II were based on shorter human-humanoid robot interaction and most studies had a low number of participants. Overall, participants in the studies included in Sub-Study II were seen to be positive toward the use of humanoid robots for a short period of time but expressed some doubts about and/or reservations toward using humanoid robots for a longer period of time. Even other researchers have found that a focus on shorter human-humanoid robot interaction tends to be used in studies (Irfan et al., 2019). Given that most studies are based on short-term interventions and short periods of human-humanoid robot interaction, one therefore wonders whether studies incorporating longer interventions and periods of interaction might yield different results. Further and more comprehensive critical assessment of what generates reservations and/or doubts toward the use of humanoid robots in healthcare and the employment of long-term study perspectives are therefore recommended.

From the overall findings in Sub-study II, the joy of using humanoid robots was rated highly and participants were seen to trust humanoid robots (Torta et al., 2014), which might indicate that certain factors can enable the further implementation of robots in healthcare. This is in line with findings seen in a previous study, where researchers saw that participants did not experience increased fear or anxiety when using a humanoid robot (Broadbent et al., 2013). As seen in the studies included in Sub-study II, as seen in the included studies, participants' expectations of humanoid robots in terms of utility were met but the participants nonetheless tended to view the humanoid robots more as a toy, guide or assistant than a support for independent living and even expressed that humanoid robots cannot replace human companionship. Furthermore, the participants did not experience that humanoid robots increased their feeling of independence or sense of security in the home environment and noted that their enjoyment of the humanoid robot might decrease over time. The presence of competent professionals can increase patients' sense of security (Moore, 2018; Nyholm et al., 2021), and older persons are more likely to consider life meaningful when they feel secure (Fagerström et al., 2011). Accordingly, more assessment of which humanoid robot functions and/or factors generate experiences of trust is needed. Additionally, a focus on how end users' (and especially older persons') sense of security in relation to the use of humanoid robots in healthcare can be improved should be included in further research.

To date, the inclusion of humanoid robots in real-life care encounters is limited. Even if the humanoid robots used in Sub-study II showed multi-domain functionality when being used in the care of older persons in specific settings, comparison studies could yield improved understanding of the benefits and challenges associated with the use of humanoid robots in healthcare. Also seen in Sub-study II, more than one humanoid robot function was examined per study in all but one of the included studies. To better understand associations, it would be beneficial in future research that a focus on individual functions be employed, i.e., that one robot function at a time be studied.

A focus on testing humanoid robots for more specific healthcare tasks (e.g., more advanced caring tasks) and in more specific care situations should be given greater attention. This is in line with a prior study, where outgoing from a multi-level perspective researchers noted that a “remarkable inertia” exists with regard to technological advancements and socio-institutional implementation (Pekkarinen et al., 2020). To advance and improve the implementation of humanoid robots in healthcare, further comparative investigations of the different types of humanoid robots that are suitable for use in healthcare, including suitability with different patient groups, are needed.

As seen in Sub-study II, technical limitations were recurring barriers for the use of humanoid robots in healthcare. This was linked not only to slow response time and errors in the humanoid robots’ functions (technical aspects) but also difficulties with adaption to new technology (social aspects), especially among older persons. There were also concerns about the use of technology in healthcare related to perceived dehumanization of care (Papadopoulos et al., 2020) or patients (Rantanen et al., 2017) and stigmatizing of those patients dependent on technology (Lluch, 2011). There are still many technical limitations preventing the further implementation of humanoid robots in healthcare, and these must be addressed to ensure more robust and user-friendly technological solutions. To realize the benefits of the use of robotic technology in healthcare, and especially with regard to the long-term use of such technology and longer human-humanoid robot interactions, technical barriers must be addressed and rectified. Additionally, social aspects related to common values should be investigated and a focus on end-users’ needs incorporated in further research.

Experiences of humanoid robots related to the care of older persons

In Sub-study III, both positive and negative evaluations of a humanoid robot-led group PET program were seen. The most common evaluations were that the exercises included in the group PET program were easy to follow and enjoyable and entertaining, which suggests the usability of those robot functions in a similar care context. However, all but one of the participants experienced the exercises as being too easy and highlighted that more person-centered and challenging physical exercises suitable for home-living older persons in good physical condition were needed. This is in line with an earlier study (Rahman et al., 2015), where researchers found that participants (children) in a hospital setting perceived humanoid robot-led physical therapy to be insufficiently challenging and interesting because the intensity of the exercises did not increase over time. The participants in Sub-study III also suggested that the humanoid robot's speech and phrasing when giving instructions should be improved, which indicates that those interacting with humanoid robots expect more life-like behavior, at least with regard to the giving of instructions. There is a discernable risk that a robot can become unusable over time if its functions are not developed and if interventions are not based on end-users' needs. Of note is that some of the participants in Sub-study III revealed that they felt better after the second versus the first group PET session because they were more relaxed. This again indicates that repeat face-to-face encounters with a humanoid robot might generate more positive experiences and facilitate habitual use and inclusion in similar interventions over time.

Most participants in Sub-study III experienced the humanoid robot Nao as being too small for its intended purpose and did not consider the group humanoid robot-led group PET program in its current form to be useful for those older persons in better physical condition. Although more research is needed on the matter, one can perhaps extrapolate that smaller robots such as Nao should perhaps not be used in future investigations of group healthcare interventions, although more research is needed on the matter. Further comparative investigations of the different types of larger humanoid robots suitable for use in healthcare are needed. This even includes an examination of specific robot suitability vis-à-vis different patient groups and particular interventions.

One conclusion drawn in Sub-study III was that a more person-centered group PET program might increase older persons' motivation to exercise. In other studies, researchers have seen that older persons were mainly positive toward a robot motivating them to become more active (Melkas et al., 2020) and that older persons experienced humanoid robots as being equal to a human instructor (Shen & Wu, 2016). This suggests the importance of defining the robot function that is needed and/or most important prior to implementation as well as the determining of which robot is most suitable for a specific task and/or intervention.

Even long-term interventions and clearly stated study aims (see Sub-study II), more personalized functions (see Sub-study III; Hashim & Yussof, 2017) and a greater focus on the possible role that variables such as age may have on participant experiences are likewise needed, as well as more experiences from actual end users already during the design phase, which would facilitate a more person-centered approach. The theory of caritative caring, which encompasses a human science way of thinking, might provide useful insight into greater understanding of the unique human being's needs in the care encounter with a humanoid robot in relation to body, soul and spirit (Eriksson, 1987a, 1988, 2001).

Lastly, from the overall findings from all three sub-studies (Sub-studies I-III), one sees that various actors in healthcare practice still do not accept the full use of humanoid robots as a care resource. This is in line with earlier research, where researchers have found that the initial implementation of technology in healthcare can result in a sense that the human nature of care is being "threatened", although attitudes can change once technology familiarization occurs (Pekkarinen et al., 2020). At present, using robots in care activities or for assistive purposes is seen to be more acceptable than using robots in direct patient care. This may be linked to the element of touch that is involved in direct patient care (Parviainen et al., 2019). Even skepticism toward and doubts about the use of robots as a solution to the challenges being seen in healthcare (Maibaum et al., 2021) and a lack of established activities and actual niches for care robots (Pekkarinen et al., 2020) may constitute a barrier. Consequently, to promote the further implementation of robots in healthcare, an initial focus on the use of robots for assistive purposes could be employed, which will facilitate familiarization eventually thereby support the gradual implementation of robots for use in direct patient care. Researchers in an earlier study have revealed that the participants included in that study indicated a desire to see that the assistive technology they were being asked to use had previously been used in other settings or environments prior to their use of and/or interaction with said technology (Hashim & Yussof, 2017). This might indicate a stigma of "being the first". A focus on robotic technology awareness and the investigation of which initiatives might help positively influence general opinion in favor of robotic technology should be included in future research to, e.g., improve attitudes and reduce experiences of stigmatization.

8.2 The theory of caritative caring in relation to the findings

As noted previously, the theoretical perspective of caring seen in the discipline of Caring Science and the theory of caritative caring (Eriksson, 2006a; Lindström et al., 2014; Fagerström et al., 2020), which includes a human science way of thinking and a unique perspective on caring, was considered relevant to the aim of this thesis.

Humanoid robots as a "complement" within care

As the number of robots being used in healthcare increases, so too must care processes, roles and how responsibilities are allocated be updated (van Wynsberghe, 2013). Even if in the future humanoid robot functions are perceived as being equal to the actions of a human being (cf. Shen & Wu, 2016), "Robots do not replace a nurse with a beating heart" (Tuisku et al., 2019). Many researchers examining the use of robots in healthcare and associated experiences of such emphasize that the presence of a care professional – alongside the robot - is crucial (Wolbring & Yumakulov, 2014; Pino, et al., 2015; Parviainen & Pirhonen, 2017; Rantanen et al., 2018; Coco et al., 2018; Nyholm et al., 2021). Patients' needs should always come first and being touched by another human being is fundamental to experiencing well-being (Routasalo & Isola, 1996). Robots, nevertheless, can be used as a care resource and contribute to patients' health and well-being. A solution must be found whereby in (even) the human-humanoid robot care encounter the patient's unique needs and desires constitute a starting point for *not only care but also caring* (cf. Eriksson, 1995; 1997).

Care professionals should even strive to uphold each unique human being's dignity and should serve with love for the other (Eriksson, 1997). Significant deliberation should be undertaken as to whether or not humanoid robots should (or must) be designed to the same "standard". One can even argue that the concept of "knowing the patient" (Locsin & Purnell, 2009) is changed when robots become care professionals; the concept no longer has the same meaning as when human care professionals physically listen to and know patients (Sitzman & Watson, 2014; Locsin & Ito, 2018; Pepito & Locsin, 2019). Subsequently, this suggests that greater understanding of humanoid robots as a care resource in relation to associated care profession and caring concepts, e.g., dignity (cf. Eriksson, 1997) and/or each human beings' right to be confirmed as being unique (cf. Eriksson, 1995; 1997), is needed.

Discussed in more detail previously (see Section 4.1), caritative caring involves the innermost core of caring, i.e., love and compassion for a human being (Eriksson 2006a; Lindström, 2006). According to Eriksson (1987a; 1988; 2001; 2002), "Caring is something human by nature" and each human being should be understood as a fundamental entity of body, soul and spirit. Seen and defined thus, the argument can be put forth that humanoid robots lack the inherent capacity for *caring*. Eriksson considered caring to be a primarily interpersonal care relationship between two human beings, based on the belief that only human beings have the ability to create an ethos and, consequently, caring. Ethos is understood through a human being's manner of being with others, e.g., through love (Hilli & Eriksson, 2019).

Therefore, when examining the use of humanoid robots in healthcare and in accordance with the theory of caritative caring, the consideration of whether or not *some elements of caring* do exist in the meeting between a humanoid robot and a patient should be undertaken, i.e., *does the human-humanoid robot care encounter equate to caring*. With regard to the concept "care encounter", the attributes of mutuality, equality, acceptance and confirmation are valued (Snellman, 2001). Accordingly, extrapolating and emanating from the definitions and nuances presented above and a normative understanding of the concept "care encounter", in order for the meeting between a human being and humanoid robot to be considered a care encounter the robot itself must be not only cognizant of the aforementioned characteristics inherent to a care encounter but even implement them in the encounter with the human being.

While within the limitations of this research project and thesis it is impossible to come to a conclusive answer to the question of whether the care encounter between a human being and humanoid robot constitutes care or even *caring* per se, it is nonetheless possible to seek to address certain aspects of said question. In accordance with the theory of caritative caring, and in view of the determination of caring as delineated above and previously, humanoid robots should *not yet* be considered capable of a care encounter or replacements for human care professionals but should instead be merely considered an aid or a "complement" within care. As discussed previously (see Section 4.1), caritas is the ethos of caritative caring (Lindström et al., 2018; Eriksson, 1987a, 1987b), i.e., human love and compassion for the other (Eriksson, 1992, 1994a; Fagerström et al., 2021), and comprises a holistic approach that is the motive for all caring. Therefore, extrapolating, care professionals are tasked with the responsibility to promote health (Eriksson 2006a; Lindström, 2006). While humanoid robots may have a human-like appearance or shape (Strandbech, 2015) and can be programmed to serve health (Parviainen & Pirhonen, 2017), to date, despite enormous advances in robotic technology, humanoid robots cannot be considered to feel and sense in a truly human-like sense with a soul or spirit (Strandbech, 2015). How or whether robots are or can be perceived as sentient beings, e.g., with a capacity to express or interpret emotions (Wu et al., 2014) or make moral decisions (Bastian et al., 2012) has been somewhat explored in previous studies. Yet robots still today are found to have difficulties in performing simple daily care activities (Doering et al., 2015; Pripfl et al., 2016). Nevertheless, one must note that society, healthcare practice and technology have evolved since Eriksson (1988; 2001) first proposed the theory of caritative caring. Locsin (2018) has argued that the usefulness of robots in healthcare depends on a re-understanding and redefinition of the care professions' ontology and epistemology. It is possible that the need exists to slightly redefine the concepts of care and *especially caring* to better fit current healthcare structures, where humanoid robots are already being used to provide care. Eventually, it might soon be time to move on from discussions and investigations of experiences and attitudes toward the use of robots in healthcare and instead simply commence the implementation of humanoid robots in healthcare through appropriate care models formed from and based on prior studies of human beings' individual needs and wishes regarding robotic technologies.

As described above, humanoid robots have been shown to be treated and experienced as social others. However, once an inner relationship is built human beings tend to experience humanoid robots as being more than "things" (Ishiguro, 2006). The theory of caritative caring and its view of caring can be used to reframe how humanoid robots are designed and developed, all with the aim to integrate elements of caring into realized robotic technology. A care encounter between a human being and a humanoid robot, seen through the lens of caritative caring, could constitute the starting point for the intertwining of caring theory into research on humanoid robots, again with the aim to improve the human-humanoid robot care encounter. For such to occur, the most central elements of the theory of caritative caring must be integrated into and realized in the human-humanoid robot care encounter, because all caring should be based on the needs and experiences of the unique human being (Eriksson 2006a; Lindström, 2006). Regardless of whether care is being provided by a fellow human being or robot, the intertwining of new theoretical perspectives with actual experiences from healthcare practice might contribute to the further exploration of how humanoid robots can be used as a care resource in healthcare. Still, an ethical dimension related to where and for whom a technological solution is used should even be incorporated into technological solutions because technology must be understood in an ethical light: as something, "to promote the human good" (Korhonen, 2017).

In all three sub-studies (Sub-studies I-III), humanoid robots were primarily seen to be used to perform less advanced care activities, e.g., as assistants or in aiding activities of daily living, and no evidence was found that humanoid robots are currently being used to provide more advanced caring practice. While humanoid robots can be used to help provide a solution to current problems in healthcare, as seen in the findings underlying this thesis and in previous and current research, the use of humanoid robots in every care encounter is yet not suitable. Better understanding of how humanoid robots can best be used in healthcare, including in which encounters, is needed. From the overall findings, and especially the findings from Sub-study II, one can discern the potential for humanoid robots to engage in a *caring way* in the human-humanoid robot care encounter. Examples of older persons' experiences of closeness with (Kouroupetroglou et al., 2017) or trust in a humanoid robot (Torta et al., 2014) were revealed. However, emanating from the overall findings presented in this present thesis, further understanding is needed regarding humanoid robots' possibilities for *caring*.

McCreadie and Tinker (2005) stated that if the use of technology will be rejected if it gives rise to more challenges than possibilities it will be rejected.

This thesis not only contributes to a renewed discussion of the theoretical view of caritative caring but also illuminates the need for further development of the theory so as to be relevant in the current – and future - world of healthcare. Caring understood through the theory of caritative caring could comprise the model for the redefining of humanoid robot as a care resource. This in turn could even possibly facilitate the eventual realization of humanoid robots as a *caring* resource.

8.3 Future-oriented reflections in relation to the findings

The overall aim of this thesis was to gain understanding of the possibilities for using humanoid robots as a care resource. Having presented and discussed the overall research findings above, below follows reflection on the form and direction that the future and further use of humanoid robots as a care resource may take.

The human-humanoid robot care encounter: what is the new caring?

The overall aim of this thesis was to gain understanding of the possibilities for using humanoid robots as a care resource, and from the overall findings, it is possible to discern that there is a need to shift the focus of humanoid robotics research throughout the world. It is only by incorporating into research a focus on real-life, face-to-face, human-humanoid robot interactions, longer interventions (both number of encounters and length of interaction) and perspectives from actual practice into research that improved understanding and thereby the usability of humanoid robots as a care resource can be achieved.

A paradigm shift is occurring not only within healthcare robotics research but even welfare technology as a whole. In accordance with the WHO Global Strategy on Digital Health 2020-2025 (WHO, 2021), digital healthcare technologies should be designed and implemented on a broad front and sustainable enough to be used for a longer time. To date, older persons have comprised the primary “target” group for the investigation of the use of robots in healthcare as realized in healthcare research, but to legitimize robots as an integral part of human healthcare further research should even incorporate a focus on multidisciplinary professionals (Betriana et al., 2022). Also, the user involvement of participants from the very beginning of a robot development process is likely to increase favorable robotic technology outcomes. While one sees many research projects in which either an experimental or piloting focus is employed, coordinated and sustainable deep-rooted interventions are still missing (Pekkarinen et al., 2020). To create useful new care models for healthcare practice and research in which robotic technology is integrated, the redefinition or re-understanding of suitable theories and perspectives is needed. A shift should be undertaken within healthcare robotics research, from a focus on experimental studies to a focus on physical, real-life usage in healthcare practice. Continuous dialogue between different sectors and society as a whole together with the involvement of end users might enable the further implementation of robots in healthcare (Pekkarinen et al., 2020).

Regardless of whether one can yet answer whether humanoid robots are a viable "complement" within care or are even caring per se, challenges and demands still exist in healthcare that must be balanced. A discussion of sustainable ethics might provide a path whereby new solutions can be found. The issue of robot ethics has been widely discussed ever since robots were first introduced in healthcare. There are crucial ethical concerns related to the use of humanoid robots in healthcare and relevant legislature and jurisprudence on the subject should be reviewed or drafted regarding, e.g., the care of vulnerable persons (Beck, 2016), the dehumanization of care (Rantanen et al., 2017), responsibility (Beck, 2016), deception (Wagner & Arkin, 2010) or fraud, privacy, finances and data security (Woodrow, 2014). To realize the further implementation of humanoid robots in healthcare, the lack of technical development and socio-institutional adaption must be addressed, which requires a socio-technical transition (Pekkarinen et al., 2020). It is possible that the further implementation of robotic technology in healthcare might increase care professionals' and patients' anxiety and lead to an increased sense of chaos in the (already burdened) healthcare sector (Brunda et al., 2020). It is therefore important that when driving or introducing technological advancements or changes developers seek to ensure that real-life human-humanoid robot care encounters will (or are highly likely to) result in interaction that is respectful, compassionate and person-centered (Tanioka et al., 2019).

Since the caring profession is based on ethical principles, robots should be designed to support and promote the fundamental values of care, i.e., patient dignity, safety and well-being (van Wynsberghe, 2013). As seen from the findings in Sub-study I, vulnerable patient groups would appear to be an unsuitable first target group when implementing humanoid robots in healthcare. Instead, those areas of healthcare where higher educational levels are more common among care professionals might comprise a more suitable first target group. Moreover, further research on the ethical challenges related to the use of humanoid robots in healthcare, in which a caring perspective on dignity (cf. Eriksson, 1997) is included, might be beneficial.

All healthcare services, including those provided by robots and with especial regard to the provision of physical care by robots, should be developed to reflect the wishes of end-users (Rantanen et al., 2017). A reassessment of the ethical and moral aspects inherent to care as seen through the lens of the use of humanoid robots in healthcare should be undertaken to uncover those aspects of sustainable ethics related to the use of robots. This is particularly important if barriers to the further implementation of humanoid robots in healthcare are to be reduced. Future research should also include broad collaboration between different stakeholders, healthcare practices and domains, and employ approaches whereby mutual pathways between practice, research and robotic technology developers can be established. Accordingly, real-life, face-to-face interactions and encounters as an approach should become an integral part of healthcare robotics research. In a recent paper in which, among other things, the rapid increase in funding for the implementation of robotic technology in healthcare and current use of robotic technology were discussed, researchers concluded with the hypothesis that healthcare as a whole will need to be "reinvented" in the near future to facilitate the inclusion of more humanoid robots in assistive and service roles (Ozturkcan & Merdin-Uygur, 2021).

Acceptance is even a necessary element that should be further explored. To help increase acceptance, it is important that end users be included in robotics research already from the design phase so as to safeguard the inclusion of relevant perspectives and improve development. For example, in a study of attitudes to the use of a robot bathtub in eldercare in Denmark (Beedholm et al., 2015), researchers saw that managers, nursing staff and older persons focused on different aspects, used implicitly different quality criteria and ascribed the robot bathtub with different symbolic significance, which the researchers attributed to the participants' institutional role. This reality - that human needs are complex and each human being has specific and unique care needs (cf. Eriksson, 1995; 1997) – should form the basis for the further development of robotic technology and robot functions relevant to healthcare. It would be beneficial for developers and researchers to incorporate current understanding derived from real-life human-humanoid robot care encounters. Still, as seen from the overall findings in this thesis, it would appear that there is some acceptance of humanoid robots in real-life human-humanoid robot care encounters, which indicates that there is potential for further development and, hopefully, further acceptance. While, as previously noted and seen from the overall findings, the use of robots in every care encounter is not yet suitable, further implementation and development could occur with the goal of using robots for assisting purposes to begin with, followed by eventual further discussions of the use of robots in direct patient care.

While the overall aim of this thesis was to gain understanding of the possibilities for using humanoid robots as a care resource, another purpose was to provide inspiration for further health research and initiate discussion around the universal use of humanoid robots in healthcare. Face-to-face (non-theoretical) human-humanoid robot interaction formed the basis for all of the studies and investigations included in the sub-studies (Sub-studies I-III) part of this thesis. Given that the growing aging population is one of the foremost challenges seen in healthcare today and must be addressed, a focus on the use of humanoid robots in the care of older persons was included in this thesis. It is hoped that the findings presented here might provide the impetus for further research in healthcare robotics research, general healthcare research or even other fields and might constitute a catalyst for the intertwining of caring theory into research on humanoid robots or the inclusion of other theoretical approaches. Lastly, it is even hoped that the findings might even contribute to the identification of gaps in the research knowledge on the topic of the use of humanoid robots in healthcare in general and in the care of older persons specifically.

8.4 Methodological considerations

Below follows a general discussion of the methodological considerations relevant to the thesis as a whole.

The present thesis and its associated sub-studies (Sub-studies I-III) are not without limitations. More details on the strengths and limitations specific to each sub-study can be found in the appendices: Sub-study I, appendix 1; Sub-study II, appendix 2; Sub-study III, appendix 3. During the entire course of this research project, a mixed method approach was used to both merge, link and combine differing sources in order to integrate them into a whole and contribute to the overall goal (Creswell & Tashakkori, 2007a). The new understanding yielded and presented in this thesis is supported by the three different interpretive methods used in the sub-studies that form the research basis for the thesis (Sub-studies I-III). For purposes of validity, review by the international scholarly community (Larsson, 2005) and the Committee on Publication Ethics (COPE) has been undertaken for all three sub-studies (Sub-studies I-III). Although the results presented here might be considered of interest for other sectors, transferability should be cautioned. There are ethical challenges associated with using humanoid robots in care encounters, especially so with regard to vulnerable patient groups, and further research is needed.

In Sub-study I and Sub-study III, data collection was undertaken in practice-based settings, e.g., hospital and/or assisted living facility. Studying the phenomenon from multidimensional perspectives allowed for the understanding of the possibilities for using humanoid robots as a care resource in healthcare. The overall findings emanate from collaborative relationships between different healthcare stakeholders, e.g., researchers, patients, relatives, care professionals, politicians, leaders and service personnel. Human beings' face-to-face (non-theoretical) interactions with humanoid robots in different healthcare settings were considered a viable manner whereby to explore realistic care encounters and were thus considered to constitute an appropriate method for data collection. One could perhaps define some of the encounters in the included sub-studies as being "non-care encounters", i.e., encounters where, e.g., a humanoid robot read a book or sang a song. Nevertheless, all encounters included in Sub-study I and Sub-study III and most of the encounters included in Sub-study II were undertaken in healthcare-based care settings, and of those in Sub-study II not adhering to (a stricter definition of) a healthcare or care setting, their context can nonetheless be considered a caring setting: home-like environments (Bedaf et al., 2018) or living labs (Wu et al., 2014; Torta et al., 2014). It would perhaps have been beneficial for the purposes of this thesis to have included a focus on a specific healthcare setting and cultural region, e.g., the Nordic countries or EU member states. Yet background variables alone should not be considered decisive when seeking to explain differences in attitudes. Other factors should even be considered, e.g., how receptive human beings are to new things (John et al., 2008). The further exploration of such factors and others should be included as a research focus in further studies.

As discussed previously, no universal definition of what a robot is currently exists and definitions and the terminology used vary (see Section 2.3; van Wynsberghe, 2013; Bardaro et al., 2021). Humanoid robots have been the explicit focus of this thesis. Some researchers refer to assistive humanoid robots (Papadopoulus et al., 2020), others socially assistive robots (Abdi et al., 2018), assistive robots (Łukasik et al., 2020) or care robots (Frennert et al., 2020). In this thesis, humanoid robots were defined outgoing from Feil-Seifer and Matarić's (2005) definition of socially assistive robotics and perspective that humanoid robots are designed to create effective and close interaction with humans (see Section 2.3) as well as Mohamed and Capi's (2012) definition of humanoid robots (see Section 1, movable parts, overall human-like appearance based on the human body, the human face, inherent social capacity). It is possible that the variation in definitions and terminology used by researchers and seen in research findings might lead to a certain skewing of results. To yield comprehensive assessment and the correct interpretation of results, diligence is needed when reviewing earlier research and comparing research results (cf. Salmela & Fagerström, 2007), which was practiced during the entire course of this research project.

The discipline of Caring Science and the theory of caritative caring, which encompasses a human science way of thinking, were used to provide insight into humanoid robots as a resource in caring and care activities (Eriksson a, 2006; Lindström, 2006; Fagerström 2019 a, b; Fagerström 2021) and thus greater understanding of the overall research topic. With its unique view of caring, the theory of caritative caring was considered to comprise a relevant basis for the aim of this thesis and thus the overarching background theoretical perspective for all of the research encompassed herein. It was furthermore considered to permeate the research as an active and ongoing function during the course of the entire research project and facilitate the formulation of central arguments (Adams & Buetow, 2014). Other theories could have been used to seek understanding of the research topic, e.g., Watson's Caritas Processes® (2008) or Roach's (1987) attributes of caring. In Watson's Caritas Processes®, being authentically present with the other is a key element, which can be actualized as the robot being with a patient both in silence and through speech. Emanating from Roach's (1987) attributes of caring, compassion or competence can be actualized as the robot understanding the patient's experiences and feelings. Even other theories such as Davis' Technology Acceptance Model (Davis, 1986) might offer new insight into the perceived usefulness of humanoid robots in healthcare or facilitate their further implementation.

Sub-study

The use of a cross-sectional survey in Sub-study I allowed for a broad sample of attitudes, gathered using a qualitative method (a paper survey) and including physical, face-to-face (non-theoretical) human-humanoid robot encounters prior to evaluation. The material was randomly collected and the participants volunteered, so selection bias was possible. Accordingly, the findings might not be generalizable to a wider population. Participants with more positive attitudes might have been more likely to participate than those with neutral or negative attitudes. Other researchers have highlighted that those who are interested in robots might be more willing to interact with robots (Wachsmuth, 2018). The findings in Sub-study I were linked to a specific humanoid robot, Pepper, which in earlier studies has been experienced as being, e.g., cute (Piezzo et al., 2017). The findings should therefore be discussed with caution; it is possible that the attitudes expressed were linked to the particular robot the participants interacted with. Also, in Sub-study I participants' attitudes were evaluated after only one interaction with the humanoid robot. Other differences between the participant groups might have been revealed if a greater number of interactions over time had been possible. While a cross-sectional design allows for the simultaneous comparison of many different variables at a single moment in time, it is not recommended for exploring behavior over time or establishing long-term trends (Polit & Beck, 2014). To corroborate the findings from Sub-study I, longer-term trials are needed.

The participant sample in Sub-study I mainly included care professionals, school actors in healthcare (e.g., PhD students, healthcare teachers) and other relevant actors in healthcare (e.g., service personnel, politicians). Even though the data collection period lasted for a couple of weeks, the number of patients and relatives included in Sub-study I was relatively low in comparison to other participant groups, which might be seen as a limitation. The low number of patients might have been due to a lack of interest in the subject or limitations in the methods used. For example, when compared to the other participant groups, it was more challenging to pre-contact patients and relatives. The largest number of participants (N = 75) was the coded population group called Other relevant actors, which may have been too overly mixed to yield common attitudes. In future research it might be advantageous to code such a mixed group into more than one group.

Whether the usage scenario seen in Sub-study I, i.e., the participant-humanoid robot interaction, can be said to be related to healthcare or not can be discussed. Nevertheless, even if the humanoid robot engaged in activities considered atypical for a healthcare context, e.g., answered basic questions, danced or sang, the study sample, context and study measurement were considered relevant to healthcare. In addition to more detailed questions about the robot's appearance, it would have been advantageous to include questions about technology acceptance and digital competence in the survey used in Sub-study I. Two researchers were present during all data collection in Sub-study I, which may have influenced participant behavior. As mentioned above, it is even useful to consider the influence of the robot's appearance on participant behavior. At the time that Sub-study I was undertaken, November - December 2018, there was only one humanoid robot for use at the research project setting, Åbo Akademi University, Vaasa. To enhance greater understanding of suitable robots for different purposes and context, comparison studies in which robots of varying appearance are included could be beneficial.

To achieve equivalence between the various language versions of the instrument (Sperber, 2004) used in Sub-Study I, the RAS-5, the guidelines for the Process of Cross-Cultural Adaption were used and validation in accordance with Beaton et al. (2000), comprised of six stages, was undertaken. Even if both language versions of the RAS-5 were considered to retain equivalence in the applied test situations and were reliability tested (Pallant, 2011), the RAS-5 was not validity tested for psychometric testing. Although participants were not seen to automatically have a tendency to select a score of 3 from the RAS-5 scale of 1-5, the RAS-5 should be validity tested for psychometric testing in a further research (Pallant, 2011). Preliminary analysis was performed with analysis of covariance (ANCOVA), using identical variables as in multiple linear regression analysis to test all pairwise interactions. None were found to be statistically significant, thus multiple linear regression analysis method was used for continued regression analyses. All of the analysis methods used yielded quite similar results: univariate analyses, pairwise correlations between dichotomous RAS-5 and background variables, and both multiple regression models. Such consistency throughout all modes of analyses suggests that the results were method independent (Pallant, 2011). However, it is worth nothing that many of the variables failed to show statistical significance, so the performing of other descriptive analyses could be beneficial. Further research should even be undertaken to confirm whether the RAS-5 scale works in other types of care encounters (i.e., bathing, medication assistance) than those investigated in Sub-study I.

All 11 items from the original RAS (Broadbent et al., 2009; 2016) were included in the modified RAS-5, but the scores were shortened from 1–8 to 1–5. In Sub-study I, a participant's RAS-5 score was calculated as an average of all his/her ratings (1–5) for all individual items to create a total score, where a low score indicated a more positive attitude. One could perhaps question whether the RAS-5 scale measured participants' positive and negative attitudes or whether it measured the *rate* of how participants view robots in general. One could even question whether the measurement of positive and negative attitudes is too simplistic – or too complicated. Such issues should be investigated before new validity tests are undertaken in future research.

Sub-study II

The use of scoping review, as seen in Sub-study II, allowed for a broad data sample (Tricco et al., 2018). Arksey and O'Malley's methodological framework (2005) as interpreted by Levac et al. (2010) was used. The quality of Sub-study II was supported by the inclusion of the included studies' design, sample size, intervention and measurement in accordance with Joanna Briggs Institute (2015) guidelines. However, a quality rating of the twelve studies included in the scoping review was not undertaken.

During the search and screening for literature, multiple reviewers collaborated as a team. To facilitate study transparency and literature consistency (Tricco et al., 2018), the PRISMA-ScR checklist was followed during the reporting of the findings. Instead of using population, intervention, comparator and outcome (PICO) elements as used in systematic reviews, the research questions were based on population, concept and context (PCC) elements in line with the Joanna Briggs Institute (2015) guidelines for scoping reviews. The use of PCC elements allows research questions to remain "open" and facilitates the inclusion of a broad population, concept and context, seen as being beneficial during a scoping review (Joanna Briggs Institute, 2015). As mentioned previously (see Sections 2.3, 8.4), the definitions and the terminology used to describe robots vary (van Wynsberghe, 2013; Bardaro et al., 2021). Consequently, some relevant literature may have been missed. For example, some use the term assistive robots (Łukasik et al., 2020), others the term care robots (Frennert et al., 2020). The inclusion of more key terms (seen as core concepts in the actual study) during the Sub-study II search could have advantageous. Nonetheless, as occurred in Sub-study II, the inclusion of key terms such as robot* and artificial intelligence* (the asterisk symbol (*) is used to treat key terms as prefixes; see Section 6.1.2) could be said to comprise a sufficiently broad search strategy. Still, there may be some advantages to broadening the scope even further in future research through the inclusion of other key terms, e.g., social assistive robots.

A systematic search of the PubMed and CINAHL electronic databases was undertaken, preceded by several pilot searches. The limited number of electronic databases screened (PubMed, CINAHL, Google, Google Scholar) might be seen as a limitation and could have resulted in findings that might be considered narrowed or as representing distorted experiences. However, following Tricco et al.'s (2018) guidelines for inclusion, the first search of the databases and other sources yielded 2569 records, which was considered sufficient. Still, it could be beneficial to include more electronic databases in future research.

Eligibility criteria encompassed full-text published, to-be-published studies and gray literature written in the English, Swedish or Finnish languages and published during February 2013 to February 2018. An updated electronic database search was performed in 2019 to search for new or missed studies, and even the reference lists for all of the identified studies and grey literature were screened. The rapid developments seen in the field of robotics technology inspired the choice of start date and even inspired the search strategy being limited to humanoid robots used in the care of older persons during the last six years. The review furthermore did not encompass domains related to surgery, monitoring systems, software or studies from thought experiments. It is therefore possible that relevant literature on the topic may have been missed.

While three of the included studies included both young and older persons (Bedaf et al., 2018; Feingold-Polak et al., 2018; Ishiguro et al., 2016) and two studies did not explicitly mention participants' ages (Abdollahi et al., 2017; Ikeya et al., 2018), the decision was made to include those studies because the primary target group of the aforementioned studies was older persons. Even if most of the studies included in the Sub-study II scoping review had a limited number of participants and investigated short-term interventions, an overview of the current existing research was achieved. More than one humanoid robot task and function was investigated in eleven of the twelve included studies, which proved to be challenging when charting the tasks that the humanoid robots performed (domain of use). Consequently, the way in which some of the studies were categorized, i.e., the charting of humanoid robot domain of use, may be somewhat open to interpretation. Also, the heterogeneity of the included studies' aims and interventions may have been a fundamental limitation because some robot functions might affect the results more. Lastly, there were ten different humanoid robots seen and investigated in the included studies. Some were human-size robots with no arms and on wheels, while others were small toy robots with both legs and arms. The comparison of the different study results without being aware of such differences might lead to misconstrued assumptions.

Sub-study III

A participatory design approach in accordance with Muller and Kuhn (1993) was used in Sub-study III, a pilot study, because it was considered to facilitate broad assessment and the inclusion of various stakeholders. It was considered a fruitful way to gather varied evaluations from different participants surrounding older persons and reveal the needs, expectations and experiences of home-living older persons' with regard to their average physical condition and exercise routines and needs, which was seen to be lacking in earlier research.

The Phase 1 participants (physiotherapists) and Phase 2 participants (physiotherapists and care professionals) had not met the older persons who participated in Phase 3. Consequently, the Phase 1 and 2 participants' conceptions of older persons' average physical condition and exercise routines and needs were based on preconceptions. Nonetheless, the choice of a participatory design approach was considered to facilitate comprehensive consideration of end users' needs (Sanders & Stappers, 2008), i.e., home-living older persons, throughout the entire design process. Participatory design can lead to the revealing of an "in-between" region or "third space" where diverse participant knowledge can be used to create new insight into a subject and new plans for action while also reflecting real-life situations through, among other things, the inclusion of user practices in the real world (Muller & Kuhn, 1993). While Phase 1 and Phase 2 were conducted in a university setting, Phase 3 was conducted at an assisted living facility setting; a familiar place for the older persons participating in the study and thus constituting a "real world" setting. In this study, the decisions made during the design phase were anticipated to increase humanoid robot-led group PET program's usability among home-living older persons. While home-living older persons were not involved during the first (Defining user needs) or second (Developing the program) design phases, they were included in the third phase (Testing the program).

While a participatory design approach is even considered useful for building empathy for end-users (Muller & Kuhn, 1993), a user-centered design approach as described by Gulliksen et al. (1998), in which end-users are included in a research project from start to end, might be considered for future research. Also, it perhaps should be taken into consideration that it is necessary to understand the context of the use of a system or product before any usability design or evaluation activity is initiated (Maguire, 2001a). Accordingly, prior to the start of the next phase of research (a follow-up study to Sub-study III's pilot study), it is recommended that the research topic context, e.g., where the humanoid robot-led group PET program will be used, be investigated.

The amount of time that the participants in Sub-study III interacted with the humanoid robot during each once-weekly group PET session was limited, and the program was only tested twice before evaluation. The follow-up study should therefore include a focus on longer human-humanoid robot interactions and long-term perspectives (Irfan et al., 2019). Moreover, the use of an iterative process, where feedback from end users is continuously obtained during the course of a study (Merkel & Kucharski, 2019), should be used.

The use of a non-random study sample and the relatively small sample size may have been limitations. It is possible that the Phase 3 participant group included older persons in relatively better physical shape than other home-living older persons when compared to the overall home-living aging population. Also, because participants were given information about the study purpose (among other things) prior to participation, the Phase 3 participant group may have been comprised of older persons relatively more interested in technology and/or robotics than others in the home-living older population. Nevertheless, the sample was comprised of 11 home-living older persons of varying gender, age and health condition, which is typically considered sufficient (Sandelowski, 1995).

Thematic analysis was used to analyze the interviews from Phase 3 (Braun & Clarke, 2006) because it was considered relevant to qualitative research overall and the specific Sub-study III research topic and questions. Qualitative analysis could have been used to elicit "umbrella-concepts" to achieve a deeper understanding of how the participants experienced the humanoid robot-led group PET program (Hsieh & Shannon, 2005). Nonetheless, the use of thematic analysis facilitated flexibility and openness during the research process between the researchers performing the study. Also, the use of thematic analysis was assumed to provide sufficient in-depth knowledge of the research questions and reduce the risk of important empirical data being lost (Braun & Clarke, 2006).

The inclusion of older persons as participants from start to finish in a research project can be challenging, e.g., with regard to practical arrangements (cf. Jokstad et al., 2020), especially so for those in precarious life situations (Aner, 2016). Therefore, the consideration and determination of which care context may be considered most suitable for the study purpose, the development of a humanoid robot-led group PET program for home-living older persons, should be undertaken prior to the start of the next phase of research, the main study. Methods whereby the systematic collection, analysis and prioritization of feedback from others (user subgroups, other stakeholders) can be included might be beneficial, especially when performing research among heterogeneous groups (Revenäs et al., 2020). Consequently, the findings seen in Sub-study III may not reflect the views and perspectives of the entire population of home-living older persons nor be considered applicable in other healthcare contexts. As noted previously, from the findings one sees that the humanoid robot-led group PET program as designed and used in Sub-study III, a pilot study, was not considered useful for those older persons in better physical condition but instead considered suitable for those older persons in below-average physical condition or in need of additional physical or mental care, especially those for whom care professionals have insufficient time to provide such.

9. Conclusions

New multidimensional perspectives are needed to address the continuous challenges arising from the introduction and continued implementation of humanoid robots in healthcare. The overall aim of this thesis was to gain new understanding of the possibilities for using humanoid robots as a care resource. The basis for and overall focus of all of the sub-studies included as part of this thesis (Sub-studies I-III) has been on real-life, face-to-face (non-theoretical) human-humanoid robot encounters. Emanating from a cross-sectional investigation, a systematic and comprehensive review of literature and the use of several iterative phases in relation to the research matter being discussed and resulting in improved understanding of multistakeholder and end-user attitudes and multipractices as seen in healthcare, it can be concluded that experiences of the use of humanoid robots in healthcare were positive for the majority of the participants encompassed by and included in the research underlying this thesis.

Among those most positive toward the use of humanoid robots in healthcare were politicians, leaders and service personnel in healthcare, those with a higher educational level, those whose mother language is Swedish, and older adults. While it is possible that certain care professional groups' lower educational levels might contribute to a more negative attitude, more research should nevertheless be undertaken on the matter before any further conclusions and associations are drawn. This is true even for the link seen between mother language and a more negative attitude; further studies on the reasons underlying such possibly culturally linked attitudes toward the use of humanoid robots in healthcare should be undertaken.

To date, the use of humanoid robots in the care of older persons has primarily been investigated in relation to the ability to support everyday life, facilitate interaction, provide cognitive training and provide physical training. As seen from the overall findings in this thesis, while older persons' expectations of humanoid robots in terms of utility were seen to be met, older persons nonetheless tended to view humanoid robots more as a toy, guide or assistant than a support for independent living, and it was even articulated that humanoid robots cannot replace human companionship. Humanoid robots were not seen to increase older persons' sense of security in the home environment, and older persons' enjoyment of humanoid robots might decrease over time. Accordingly, a focus on end users' (and especially older persons') sense of security in relation to the use of humanoid robots in healthcare, especially how such can be supported and improved, should be included in further research. Furthermore, a person-centered approach may possibly help maintain older persons' motivation to interact with a humanoid robot (cf. Sub-study III).

Technical limitations were found to be recurring barriers for the use of humanoid robots in healthcare. This was linked not only to slow response time and errors in the humanoid robots' functions (technical aspects) but even difficulties with adaption to new technology (social aspects), especially among older persons. The many technical limitations preventing further implementation of humanoid robots in healthcare must be identified and corrected to ensure more robust and user-friendly technological solutions. Also, it is of upmost importance that positive experiences be created for all of those coming into contact with robotic technology in healthcare. Accordingly, a focus on end-user experiences should be included during robotic technology development and implementation stages. While many pilot and experimental studies of care robots have been performed, face-to-face human-humanoid robot encounters have been less studied and the investigation of robots in real-life practice in healthcare appears to be low. As seen in the research underlying this thesis, face-to-face encounters with robotic technologies appear to be linked to positive experiences of such technology. The participant experiences examined as part of this research project were based on non-theoretical, real-life, face-to-face interactions and most participants experienced the humanoid robots they interacted with as being friendly and interesting and their joy of using the humanoid robot was rated highly.

A need for improved understanding of humanoid robots as a care resource was discerned. The theoretical perspective of caring seen in the discipline of Caring Science and the theory of caritative caring was considered relevant to the aim of this thesis. As seen in the overall findings, because of technical and ethical limitations (linked to both technical and social aspects), humanoid robots at this point in time lack an inherent capacity for *caring.* Instead, at present, they should be considered an aid or "complement" within care. It is therefore recommended that future investigation into the use of humanoid robots in healthcare include consideration of whether or not *some elements of caring* exist in the encounter that is the meeting between a human being and a humanoid robot. Sustainable ethics might provide a path through which this issue can be explored and new solutions found. It is even possible that the need exists to slightly redefine the concepts of care and, especially, *caring* to better fit current healthcare structures; the use of humanoid robots in the provision of care has already started.

In conclusion, based on the overall results, including the specific findings from each of the three included sub-studies (Sub-studies I- III), one sees that there is a need to shift the focus of humanoid robotic research throughout the world. It might eventually be time to transcend discussions and investigations of experiences and attitudes toward the use of robots in healthcare and instead support the further implementation of humanoid robots in healthcare through appropriate care models formed from and based on prior studies of human beings' individual needs and wishes concerning robotic technologies. Through the incorporation of a focus on face-to-face human-humanoid robot encounters, longer interventions (number of encounters and length of interaction) and real-life perspectives in research, improved understanding and thereby the usability of humanoid robots as a care resource can be achieved.

10. Sammanfattning

Möjligheterna att använda humanoida robotar som vårdresurser, Malin Andtfolk
Nyckelord: Humanoida robotar, vårdresurser, social- och hälsovård, äldre personer, attityder, erfarenheter, fördelar, utmaningar, tvärsnittsstudie, scoping review studie, pilotstudie, Hälsovetenskaper, vårdvetenskap

Introduktion

Demografiska förändringar pågår i flera länder. Antalet personer i åldern 60 år eller äldre förväntas fördubblas över hela världen mellan 2015-2050. Flera länder kommer därmed att möta utmaningar gällande ökade vårdbehov förknippade med den demografiska förändringen (WHO, 2018). Utmaningar inkluderar även brist på vårdpersonal samt en ökad efterfrågan på hemvård (Finne-Soveri et al., 2014) vilket innebär att social- och hälsovården ser behov av att hitta alternativa lösningar och möjligheter (Kataja, 2016). Implementering av robotar, såsom humanoida robotar i social- och hälsovården anses till viss del kunna svara an på några av utmaningarna (Azeta et al. 2018) genom att bland annat att erbjuda fysisk, kognitiv eller social interaktion (Feil-Seifer & Matarić, 2005; Niheh et al., 2017). Humanoida robotar har definierats som socialt assisterande robotar vars huvudsakliga syfte är att skapa effektiv och nära interaktion med människor (Feil-Seifer & Matarić, 2005). De har flera rörliga delar samt ett övergripande människoliknande utseende baserat på den mänskliga kroppen; så som det mänskliga ansiktet eller den mänskliga sociala kapaciteten (Mohamed & Capi, 2012). Humanoida robotar anses fördelaktiga för mänskliga miljöer eftersom deras storlek, form och rörlighet är anpassade enligt människans behov och omgivning (Ozturkcan & Merdin-Uygur, 2021). Samtidigt som nya tekniska lösningar så som humanoida robotar designas, utvecklas och implementeras i social- och hälsovården ökar också ansikte-mot-ansikte vårdmöten mellan människor och robotar.

Tidigare forskning lyfter att vårdpersonal är mera positiva till att använda robotar vid till exempel. lyft av tunga föremål, än att använda robotar i vårdaktiviteter som vanligtvis involverar mänsklig beröring, så som aktiviteter relaterade till patientens personliga hygien (Parviainen et al., 2019). Tidigare forskning har även sett att vårdpersonal upplever oro gentemot användning av humanoida robotar i social- och hälsovården eftersom de anser att avhumanisering av vården eller stigmatisering av patienten kan ske (Wu et al., 2014; Hebesberger et al., 2017; Coco et al., 2018). Oro bland vårdpersonalen lyfts också gällande att patientens värdighet kan påverkas negativt (Gallagher et al., 2016). En del tidigare forskning har genomförts med fokus på människa-robot-relationer och interaktioner (Feil-Seifer & Matarić, 2009; Coeckelbergh, 2010), med fokus på robotars beröring av patienter (Parviainen et al., 2017) samt med fokus på robotars möjligheter att förmedla empati och känslor (James et al., 2020). Det saknas dock djupare kunskaper gällande ansikte-mot-ansikte vårdmöten mellan människor och humanoida robotar som utgår från en nyanserad förståelse av vård och omvårdnad. Fastän tidigare forskning tyder på att det finns en del fördelar med att använda humanoida robotar i social- och hälsovården, har dessa robotar ännu inte fullständigt utvecklats och implementerats i vårdpraktiken främst på grund av utmaningar som gäller tekniska brister eller sociala aspekter (Neumann, 2016; Tanioka et al., 2017). För att bemöta de möjliga utmaningar som uppstår då humanoida robotar implementeras i social- och hälsovården finns det behov av nya flerdimensionella perspektiv. Det övergripande syftet med denna avhandling är därför att öka förståelsen för möjligheterna att använda humanoida robotar som vårdresurser.

Teoretiskt perspektiv

Avhandlingens teoretiska perspektiv utgörs av den caritativa vårdteorin och dess syn på omvårdnad (Eriksson, 2006a; Lindström et al., 2014; Fagerström et al., 2020). Medan olika discipliner tolkar och definierar begreppet omvårdnad på olika sätt, utgår den teoretiska grunden som används i denna avhandling från ett vårdvetenskapligt perspektiv. Den caritativa vårdteorin ansågs användbar, eftersom avhandlingen forskningsfokus var att få förståelse för nya teknologiska lösningar, så som humanoida robotar i relation till vård och omvårdnad.

Omvårdnad består av en komplex kombination av processer där det krävs både skicklighet, kunskap, etisk lyhördhet och engagemang (Gallagher et al., 2016). Omvårdnad bedrivs utifrån ett ”caritas” som innebär medmänsklig kärlek (Eriksson, 2018). ’Caritas’ yttersta syfte är att lindra lidande genom medkänsla och bekräftelse av värdighet (Eriksson, 2006a). Enligt den caritativa vårdteorin definieras omvårdnad som något i sig mänskligt av naturen. Själva omvårdnaden är en del av mötet med patienten (Eriksson, 2018) och ett möte kan förstås som något som föregår själva vården (Travelbee, 2013). I enlighet med Martinsens (2013) teori betraktas ”mötet” i denna avhandling som en abstrakt plats där närhet och avstånd mellan en vårdare och patient äger rum och där vårdarens fokus är på patienten. Eftersom en djupare förståelse för robotars möjligheter att ge omvårdnad saknas, användes begreppet ”vårdmöte” istället för ”vårdande möte” i denna avhandling. I ”vårdmötet” värderas ömsesidighet, jämlikhet, acceptans och bekräftelse mellan vårdare och patient. Enligt Snellman m.fl. (2012) ska vårdaren inte bara vara medveten om begreppen för att ett vårdmöte ska kunna gestaltas, utan vårdaren ska även implementera begreppen i mötet med patienten.

Syfte och forskningsfrågor

Det övergripande syftet med denna avhandling var att få förståelse för möjligheterna att använda humanoida robotar som vårdresurser. I delstudie I genomfördes en tvärsnittsstudie där multiintressenters attityder gentemot användning av humanoida robotar i social- och hälsovården undersöktes. I delstudie II genomfördes en scoping review studie där användning av humanoida robotar i vården av äldre personer undersöktes. I delstudie III genomfördes en kvalitativ pilotstudie där ett humanoid robot-lett gruppträningsprogram för hemmaboende äldre personer utvecklades och utvärderades.

De tre delstudierna (delstudierna I-III) svarar på det övergripande syftet med följande frågor:

- Vad är attityderna hos patienter, anhöriga, vårdpersonal, skolaktörer i social- och hälsovård samt andra relevanta aktörer i social- och hälsovård gentemot användning av humanoida robotar i social- och hälsovård? (Delstudie I)
- Vad är sambandet mellan deltagarnas bakgrundsvariabler och attityder gentemot humanoida robotar? (Delstudie I)
- Hur har humanoida robotar använts i vården av äldre personer? (Delstudie II)
- Vilka fördelar och utmaningar finns gentemot användning av humanoida robotar i vården ur äldre personers synvinkel? (Delstudie II)
- Vad är hemmaboende äldre personers utvärdering av ett humanoid robot-lett gruppträningsprogram? (Delstudie III)
- Vad är hemmaboende äldre personers förslag på förbättring av ett humanoid robot-lett gruppträningsprogram? (Delstudie III)

Metoder

I Delstudie I genomfördes en tvärsnittsstudie där attityder undersöktes gentemot användning av humanoida robotar i social- och hälsovården bland patienter, anhöriga, vårdpersonal, skolaktörer i hälso-och sjukvården samt andra relevanta aktörer i social- och hälsovården. I samma delstudie jämfördes också deltagarnas bakgrundsvariabler med deras attityder. Datainsamlingen genomfördes både på ett sjukhusområde och på ett universitet i Österbotten, Finland under november och december 2018. Den humanoida roboten Pepper (SoftBanks Robotics), användes i datainsamlingen. Under datainsamlingen stationerades den humanoida roboten antingen i en aula på sjukhusområdet eller i en aula på universitetet med syftet att interagera med deltagare utifrån följande funktioner: välkomna deltagarna (på finska, svenska eller engelska); svara på grundläggande frågor om tid och/eller väder; spela musik, spela interaktiva spel, framföra danser eller sjunga.

Frivilliga deltagare interagerade med den humanoida roboten mellan 15-30 minuter innan de ombads fylla i en enkät på frivillig basis. Enkätdata samlades in från de deltagare som frivilligt ställde upp i datainsamlingen (n = 264); patienter (n = 27), anhöriga (n = 20), vårdpersonal (n = 67), skolaktörer (n = 75) och andra relevanta aktörer i social- och hälsovården (n = 75). Enkäten bestod av Robot Attitude Scale (RAS), som används för att mäta attityder gentemot robotar (Broadbent et al., 2009, 2010, 2012; 2016; Stafford et al., 2014). RAS består ursprungligen av 11 objekt där positiva och negativa antaganden vägs mot varandra, d.v.s. vänlig-ovänlig, användbar-oanvändbar, pålitlig-opålitlig, hållbar-ömtålig, intressant-tråkig, avancerad-grundläggande, lätt att använda-svår att använda, tillförlitlig-otillförlitlig, säker-farlig, enkel-komplicerad, hjälpsam-ohjälpsam. Rankning av objekten i RAS modifierades till enkäten från skala 1-8 till skala 1-5, där en låg poäng indikerade en mer positiv attityd och en hög poäng indikerade en mer negativ attityd. Den modifierade skalan fick namnet RAS-5.

Skillnader i genomsnittliga RAS-5-poäng mellan deltagarnas bakgrundsvariabler analyserades med ett T-test av oberoende prover vid jämförelse av två klasser samt med hjälp av envägs variansanalys (ANOVA) vid jämförelse av tre eller flera klasser. Multipel linjär regressionsanalys användes för att studera sambandet mellan bakgrundsvariabler och RAS-5-poäng. Sambandet mellan bakgrundsvariablerna och de dikotomiserade RAS-5-poängen analyserades med Spearmans rangkorrelation. Tvåsidiga analyser utfördes och statistisk signifikans sattes till P-värden under 0,05. All data analyserades med SPSS Statistics version 25 (IBM Corporation, Armonk, NY, USA).

I Delstudie II användes scoping review utgående från metodologiska riktlinjer av Arksey och O'Malleys (2005) samt Levac et al. (2010) för att undersöka hur humanoida robotar har använts i vården av äldre personer. Systematiska sökningar gjordes i två internationella bibliografiska databaser PubMed och Cinahl samt internetsökningar av Google och Google Scholar för att identifiera grå litteratur. Vid inkludering av publikationer, skulle fokus vara på användning av humanoida robotar i vården av äldre personer samt publicerad i fulltext, publicerad under perioden 1.2.2013–1.1.2018 och publicerad på antingen engelska, svenska eller finska. En uppdaterad sökning gjordes 2019 för att söka efter nya publikationer. Dessutom inkluderades enbart publikationer med fokus på verkliga ansikte-mot-ansikte möten mellan människa och humanoida robot. Exkluderade publikationer berörde bland annat studier som baserades på tankeexperiment så som att deltagare fick se videoklipp eller bilder av humanoida robotar. Exkluderade publikationer berörde även studier gällande kirurgi, mjukvara eller robotdjur.

Screening och beslut gällande inkludering av publikationer utfördes av tre forskare. En kvalitativ deskriptiv analys (Sandelowski, 2000) användes för att kartlägga hur humanoida robotar använts i de inkluderade publikationerna. Samma analys användes även för att kartlägga upplevda fördelar och utmaningar med användningen. Följande data extraherades och kartlades från varje utvald publikation: användningsdomän efter kategori, författare, publiceringsårtal, ursprungsland, kontext, studiemetoder, urvalsstorlek, robot som användes, interventionens varaktighet, studiens syfte, fördelar och utmaningar. Publikationerna kartlades också i enlighet med typen av humanoid robot som användes samt dess funktioner som användes i respektive publikation.

I Delstudie III användes en kvalitativ pilotstudie för att utveckla ett humanoid robot-lett gruppträningsprogram baserat på hemmaboende äldre personers behov samt att utvärdera hemmaboende äldre personers upplevelser gentemot gruppträningsprogrammet. En deltagande design användes där både en workshop, en återkopplingssession, ett för-test och två tester inkluderades. Datainsamling genomfördes både på ett universitet och på en vårdanstalt i Österbotten, Finland. Den humanoida roboten Nao (SoftBank Robotics) användes i studien. En deltagande designmetod (Muller & Kuhn, 1993) användes för att designa, utveckla samt utvärdera gruppträningsprogrammet och inkluderade följande faser: 1) definiera användarbehoven, 2) utveckla gruppträningsprogrammet och 3) testa gruppträningsprogrammet.

I den första fasen hölls en workshop med två av författarna samt tre oberoende fysioterapeuter med syftet att både fastställa och definiera hemmaboende äldre personer genomsnittliga behov gällande fysisk kondition samt få insikt i deras träningsrutiner. Utgående från de kriterier som fastslogs i den första fasen designades och animerades ett första utkast till ett gruppträningsprogram med hjälp av ZoraBots ZBOS-mjukvaruprogram. Gruppträningsprogrammet konstruerades stegvis och inkluderade tre stycken fyra minuters uppsättningar, vilket resulterade i ett gruppträningsprogram som varade totalt 12 minuter. Gruppträningsprogrammet inleddes med att den humanoida roboten höll en kort uppvärmning som huvudsakligen bestod av att stretcha nacke, rygg och armar. Den humanoida roboten fortsatte med olika kroppsrörelser som berörde övre kroppen (fem repetitioner per rörelse), t.ex. stretching, överkroppsrotationer, huvudrotationer, armrörelser, vidrörande av fötter eller knän med händerna. Gruppträningsprogrammet avslutades med lättare stretch av samma kroppsdelar. Den andra fasen av Delstudie III bestod av två steg; först en digital återkopplingssession med samma fysioterapeuter (N= 3) från den första fasen samt ett för-test med en grupp vårdare (N= 5) på universitetet med syftet att få feedback gällande användbarheten av det humanoid robot-ledda gruppträningsprogrammet. Av resultaten från första fasen (återkopplingssession med fysioterapeuter) samt andra fasen (för-test av vårdare) gjordes några justeringar (t.ex. att roboten muntligen räknade antal repetitioner) varav gruppträningsprogrammet sedan ansågs uppnå användbarhet och utgöra ett rimligt gruppträningsprogram för hemmaboende äldre personer.

Den tredje fasen i Delstudie III bestod slutligen av att testa det humanoid robot-ledda gruppträningsprogrammet tillsammans med hemmaboende äldre personer. Kriterier för inkludering var att deltagaren skulle vara 65 år eller äldre samt bo i eget hem. Kriterier för exkludering var hemmaboende äldre personer som var sängliggande samt äldre personer med kognitiva störningar som kunde påverka minnet. En grupp hemmaboende äldre personer (N = 11) anmälde sig frivilligt för att testa gruppträningsprogrammet. Testfasen bestod av gruppträningssessioner på vårdanstalten, och under testerna ombads deltagarna att fritt interagera med den humanoida roboten både före och efter varje gruppträningsprogram, medan de vänligen ombads att sitta kvar i sina respektive stolar under gruppträningssessionen och följa med i rörelserna efter bästa förmåga. Två gruppträningssessioner genomfördes under två veckors tid (en session per vecka). Elva semistrukturerade intervjuer genomfördes via telefon ungefär en vecka efter den sista gruppträningssessionen. Intervjuämnena var relaterade till deltagarnas upplevelser av det humanoid robot-ledda gruppträningsprogrammet (t.ex. format, övningar, funktioner, faktorer som påverkade utvärderingen, möjligheter, utmaningar, fördelar, rekommendationer). De transkriberade intervjuerna från den tredje fasen analyserades med hjälp av tematisk analys (Braun & Clarke, 2006).

Resultat och slutsatser

För att få förståelse för möjligheterna att använda av humanoida robotar som vårdresurser har både teoretisk och empirisk forskning fungerat som grund för denna avhandling. Bland annat har patienter, äldre personer, anhöriga, vårdpersonal, skolaktörer i social- och hälsovård samt andra relevanta aktörer i social- och hälsovård inkluderats. Tillvägagångssättet och den forskning som genomförts har gett större insikt inte bara i användningen av humanoida robotar i social- och hälsovård utan även i multiintressenters och slutanvändares erfarenheter och attityder gentemot humanoida robotar, samt faktorer som möjliggör eller skapar barriärer för fortsatt implementering av humanoida robotar i social- och hälsovård. I överensstämmelse med disciplinen för vårdvetenskap och den caritativa vårdteorin (Eriksson, 2006a; Lindström et al., 2014; Fagerström et al., 2020) ligger grunden för och övergripande fokus för alla delstudier (Delstudier I-III) som ingår i denna avhandling på ansikte-mot-ansikte (icke-teoretiska) människa-humanoid robot vårdmöten. Resultaten är sammanfattade i en resultatöversikt (Se Tabell 5).

Tabell 5. Resultatöversikt

Delstudie	Forskningsfråga	Resultat
I	Vad är attityderna hos patienter, anhöriga, vårdpersonal, skolaktörer i hälso-och sjukvård och andra relevanta aktörer inom social- och hälsovård gentemot användning av humanoida robotar i social- och hälsovården?	De flesta deltagare var positiva till användningen av humanoida robotar i social- och hälsovård, några var neutrala och endast ett fåtal var negativa. Den humanoida roboten uppfattades som både vänlig och intressant.
I	Vad är sambandet mellan deltagarnas bakgrundsvariabler och attityder gentemot humanoida robotar?	Andra relevanta aktörer i social- och hälsovården (t.ex. politiker eller servicepersonal) jämfört med patienter var mer benägna att ha en positiv attityd. Deltagare med högre utbildningsnivå jämfört med deltagare med lägre utbildningsnivå var mer benägna att ha en positiv attityd. Äldre vuxna jämfört med yngre vuxna var mer benägna att ha en positiv attityd. Skillnaderna mellan åldersklasserna (ordnade efter decennium utom första åldersklassen 15-19 år) visade att varje decenniumsökning i åldersklass var något mer benägna att ha en positiv attityd jämfört med yngre åldersklasser. Deltagare med modersmål svenska jämfört med deltagare med modersmål finska var mer benägna att ha en positiv attityd.
II	Hur har humanoida robotar använts i vården av äldre personer?	Humanoida robotar har främst använts för att stödja de äldres vardag och för att ge dem interaktion. Humanoida robotar har också använts för att underlätta kognitiv och fysisk träning för äldre personer, även om temat fysisk träning endast återfanns i en (1) studie. Humanoida robotar har främst använts på äldreboenden, i hemliknande testmiljöer eller i de äldre personernas privata hem. Majoriteten av de använda humanoida robotarna har endast testats under en kortare tid samt med ett mindre antal deltagare.

Delstudie	Forskningsfråga	Resultat
II	Vilka fördelar och utmaningar finns gentemot användning av humanoida robotar i vården ur äldre personers synvinkel?	Äldre personer visade möjlighet att acceptera humanoida robotar som sällskap och en övergripande acceptans gentemot användning av humanoida robotar som assistenter identifierades. Under tiden humanoida robotar var närvarande sågs minskning av vårdbesök och telefonsamtal till vårdpersonal. Äldre personer upplevde att deras livskvalitet ökade under tiden humanoida robotar närvarade. Tekniska utmaningar, såsom långsam responstid, brister gällande funktion samt hinder för införandet av ny teknologi identifierades som huvudutmaningar. Dessutom kan äldre personers upplevda glädje av att använda en humanoid robot minska med tiden. En humanoid robot ansågs inte kunna ersätta en mänsklig vårdare.
III	Vad är hemmaboende äldre personers utvärdering av ett humanoid robot-lett gruppträningsprogram?	Majoriteten av hemmaboende äldre utvärderade rörelserna som både lätta att följa och underhållande. Den humanoida roboten Nao ansågs mindre lämplig för dylika gruppträningsprogram. Gruppträningsprogrammet i sin befintliga form var inte av mervärde för hemmaboende äldre personers fysiska kondition men hade potential att positivt påverka deras psykiska välbefinnande och sociala interaktioner. Majoriteten framhöll att humanoida robotar inte kunde ersätta mänskliga tränare i dylika gruppträningsprogram.
III	Vad är hemmaboende äldre personers förslag på förbättring av ett humanoid robot-lett gruppträningsprogram?	Mer personcentrerade och utmanande rörelser lämpliga för hemmaboende äldre personer med god fysisk kondition borde inkluderas, så som rörelser för hela kroppen samt rörelser i ett snabbare tempo. Den humanoida roboten bör ha förbättrade talmöjligheter samt ha möjlighet att svara på frågor under ett pågående gruppträningsprogram. Gruppträningsprogrammet i dess befintliga form ansågs mera lämpligt för de äldre personer som bor på vårdhem eller äldreboende.

Denna avhandling och dess tillhörande delstudier (Delstudier I-III) är inte utan begränsningar. Här kan bland annat nämnas att Delstudie I utvärderade deltagarnas attityder efter endast ett kort möte med den humanoida roboten. Även om en tvärsnittsdesign möjliggör jämförelse av många olika variabler vid ett enda ögonblick, rekommenderas det inte för att utforska beteende över tid eller för att fastställa långsiktiga trender (Polit & Beck, 2014). För att bekräfta resultaten från Delstudie I föreslås därför studier som utgår ifrån längre tidsperspektiv. Kvaliteten på delstudie II stöds av de inkluderade studiernas design, urvalsstorlek, intervention och mätdata i enlighet med Joanna Briggs Institutet (2015) samt PRISMA-ScR riktlinjer, men kvalitetsbedömning av de tolv studierna som inkluderades i Delstudie II genomfördes inte. Gällande Delstudie III kan resultatet ha sett annorlunda ut om slutanvändarna (hemmaboende äldre personer) hade inkluderats redan i designfasen. Inkludering av systematisk insamling, analys och återkoppling från slutanvändarna kan vara mer fördelaktiga i fortsatt forskning, särskilt gällande forskning som berör heterogena grupper (Revenäs et al., 2020). Även om resultaten som presenteras i avhandlingen kan anses vara av intresse för andra områden i hälso-och sjukvården än de som nämnts, bör överförbarhet ske med försiktighet. Resultatet från avhandlingen tyder på att det finns flera etiska utmaningar förknippade med ansikte-mot-ansikte människa-humanoid robot vårdmöten, särskilt när det gäller mer utsatta patientgrupper.

Den caritativa vårdteorin och speciellt dess syn på omvårdnad (Eriksson, 2006a; Lindström et al., 2014) ansågs relevant för denna avhandling. Som framgår av de övergripande resultaten, på grund av tekniska och etiska begränsningar (kopplade till både tekniska och sociala aspekter), saknar humanoid robotar vid denna tidpunkt en inneboende förmåga att ge omvårdnad. Istället bör den humanoida roboten betraktas som ett hjälpmedel eller "komplement" till vård. Det rekommenderas därför att framtida forskning som gäller användning av humanoida robotar i social- och hälsovård vidare undersöker om det finns element av omvårdnad eller inte i mötet mellan en människa och en humanoid robot. En mera hållbar etisk diskussion kan vara ett angreppssätt för fortsatt forskning i området. Det är även möjligt att det finns behov av att i någon mån omdefiniera begreppen vård och särskilt omvårdnad för att bättre lämpa sig till nuvarande strukturer inom social- och hälsovården.

De övergripande resultaten som framkommit i avhandlingen, tyder på att ansikte-mot-ansikte människa-humanoid robot vårdmöten förefaller vara kopplade till positiva upplevelser, men tekniska begränsningar bör identifieras och korrigeras för att säkerställa mer robusta och användarvänliga robotar. Ett personcentrerat tillvägagångssätt rekommenderas även i vidare forskning. Sammanfattningsvis, baserat på de övergripande resultaten inklusive de specifika resultaten från delstudierna (Delstudier I-III), bör en förändring genomföras inom vård- och robotikforskning; från fokus på experimentella studier till fokus på verklig användning av robotar i vårdpraktiken. Det är endast genom att införliva fokus på ansikte-mot-ansikte människa-humanoid robot vårdmöten, längre interventioner (antal möten och interaktionslängd) samt verkliga perspektiv som förståelsen kan förbättras och därmed även användbarheten av humanoida robotar som vårdresurser kan uppnås.

References

Abdi, J., Al-Hindawi, A., Ng, T., & Vizcaychipi, M. P. (2018). Scoping review on the use of socially assistive robot technology in elderly care. *British Medical Journal Open*, *8*(2). https://doi.org/10.1136/bmjopen-2017-018815

Abdollahi, H., Mollahosseini, A., Lane, J. T., & Mahoor, M. H. (2017, December 7). *A pilot study on using an intelligent life-like robot as a companion for elderly individuals with dementia and depression* [Conference presentation]. 2017 IEEE-RAS International Conference on Humanoid Robots, Birmingham, United Kingdom. https://ui.adsabs.harvard.edu/abs/2017 arXiv171202881A

Adams, P. J., & Buetow, S. (2014). The place of theory in assembling the central argument for a thesis or dissertation. *Theory & Psychology*, *24*(1), 93-110. https://doi.org/10.1177/095935431351 753

Adams, W. C. (2015). Conducting semi-structured interviews. In K. E. Newcomer, H. P, Hatry, J. S. Wholey (Eds.), *Handbook of Practical Program Evaluation* (4th ed., pp. 492-505). Jossey-Bass.

Ahlin, E. M. (2019). Semi-structured Interviews with expert practitioners: Their validity and significant contribution to translational research. *In SAGE Research Methods Cases.* https://dx.doi.org/10.4135/9781526466 037

Aiken, L. H., Sermeus, W., Van den Heede, K., Sloane, D. M., Busse, R., McKee, M. B. Bruyneel, L., Rafferty, A. M., Griffiths, P., Moreno-Casbas, M. T., Tishelman, C., Scott, A., Brzostek, T., Kinnunen, J., Schwendimann, R., Heinen, M., Zikos, D., Sjetne, I. S., Smith, H. L., & Kutney-Lee, A. (2012). Patient safety, satisfaction, and quality of hospital care: cross sectional surveys of nurses and patients in 12 countries in Europe and the United States. *British Medical Journal*, *344*. https://doi.org/doi:10.1136/bmj.e1717

Akhtaruzzaman, M., & Shafie, A. A. (2010). Evolution of Humanoid Robot and contribution of various countries in advancing the research and development of the platform. *Control, Automation and Systems*, 1021-1028. https://doi.org/10.1109/ICCAS.2010.566 9646

Alemi, M., Ghanbarzadeh, A., & Meghdari, A. (2016). Clinical application of a humanoid robot in pediatric cancer interventions. *International Journal of Social Robot*, *8*, 743–59. https://doi.org/10.1007/s12369-015-0294-y

Al-Taee, M. A., Kapoor, R., & Garrett, C. (2016). Acceptability of Robot Assistant in Management of Type 1 Diabetes in Children. *Diabetes Technology & Therapeutics, 18*(9), 551–554. https://doi.org/10.1089/dia.2015.0428

Aner, K. (2016). Discussion paper on participation and participatory methods in gerontology. *Zeitschrift für Gerontologie und Geriatrie, 49*(2), 153–157. https://doi.org/10.1007/s00391-016-1098-x

Anskär, E., Lindberg, M., Falk, M., & Andersson, A. (2018). Time utilization and perceived psychosocial work environment among staff in Swedish primary care settings. *BMC Health Services Research, 18*(1), 166. https://doi.org/10.1186/s12913-018-2948-6

Anwar, S., Bascou, N., Menekse, M., & Kardgar, A. (2019). A systematic review of studies on educational robotics. *Journal of Pre-College Engineering Education Research*, *9*(2). https://doi.org/10.7771/2157-9288.1223

Arksey, H., & O'Malley, L. (2005). Scoping studies: towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19-32. https://doi.org/10.1080/136455703200 0119616

Avioz-Sarig, O., Olatunji, S., Sarne-Fleischmann, V., & Edan, Y. (2021). Robotic System for Physical Training of Older Adults. *International Journal of*

Social Robotics, *13*, 1-16. https://doi.org/10.1007/s12369-020-00697-y

Azeta, J., Bolu, C., Abioye, A. A., & Festus, O. (2018). A review on humanoid robotics in healthcare. *MATEC Web of Conferences, 153*(5), 1-5. https://doi.org/10.1051/matecconf/201815302004

Bardaro, G., Antonini, A., & Motta, E. (2021). Robots for Elderly Care in the Home: A Landscape Analysis and Co-Design Toolkit. *International Journal of Social Robotics.* https://doi.org/10.1007/s12369-021-00816-3

Barker, N., & Jewitt, C. (2022). Filtering touch: an ethnography of dirt, danger and, industrial robots. *Journal of Contemporary Ethnography, 5*(1), 103-130. https://doi.org/10.1177/08912416211026724

Bartneck, C., Nomura, T., Kanda, T., Suzuki, P., & Kennsuke, K. (2005). *Cultural differences in attitudes toward robots* [Conference presentation]. SB Symposium on Robot Companions: Hard Problems And Open Challenges In Human-Robot Interaction, Hatfield, England. https://doi.org/10.13140/RG.2.2.22507.34085

Bastian, B., Loughnan, S., Haslam, N., & Radke, H. R. M. (2012). Don't mind meat? The denial of mind to animals used for human consumption. *Personality and Social Psychology Bulletin*, *38*(2), 247–256. http://doi.org/10.1177/0146167211424291

Beaton, D., Bombardier, C., Guillemin, F., & Bosi Ferraz, M. (2000). Guidelines for the Process of Cross-Cultural Adaptation of Self-Report Measures. *Spine*, *25*(24), 3186–3191. https://doi.org/10.1097/00007632-200012150-00014

Beck, S. (2016). The problem of ascribing legal responsibility in the case of robotics. *AI and Society*, *31*(4), 473-481. https://doi.org/10.1007/s00146-015-0624-5

Beedholm, K., Fredriksen, K., Skovsgaard Fredriksen, A-M., & Lomborg, K. (2015). Attitudes to a robot bathtub in Danish elder care: A hermeneutic interview study. *Nursing and Health Sciences, 17*(3). https://doi.org/10.1111/nhs.12184

Betriana, F., Tanioka, R., Gunawan, J., & Locsin, R. (2022). Healthcare robots and human generations: Consequences for nursing and healthcare. *Collegian.* https://doi.org/10.1016/j.colegn.2022.01.008

Bigman, Y. E., & Gray, K. (2018). People are averse to machines making moral decisions. *Cognition, 181*, 21-34. https://doi.org/10.1016/j.cognition.2018.08.003

Blanson Henkemans, O. A., Bierman, B. P. B., Janssen, J. Looije, R., Neerincx, M. A., van Dooren, M. M. M., de Vries, J. L. E., van der Burg, G. J., & Huisman, S. D. (2017). Design and evaluation of a personal robot playing a self-management education game with children with diabetes type 1. *International Journal of Human-Computer Studies*, *106,* 63–76. https://doi.org/10.1016/j.ijhcs.2017.06.001

Block, E. S., & Erskine, L. (2012). Interviewing by telephone: Specific considerations, opportunities, and challenges. *The International Journal of Qualitative Methods*, *11*(4), 428-445. https://doi.org/10.1177/160940691201100409

Bogue, R. (2011). Robots in healthcare. *Industrial Robot: An International Journal*, *38,* 218–223. https://doi.org/10.1108/01439911111122699

Boman, I-L., & Bartfai, A. (2015). The first step in using a robot in brain injury rehabilitation: Patients' and health-care professionals' perspective. *Disability and Rehabilitation: Assistive Technology*, *10*(5), 365–370. https://doi.org/ 10.3109/17483107.2014.913712

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Broadbent, E., Stafford, R., & MacDonald, B. (2009). Acceptance of healthcare robots for the older population: A Review and future directions. *International Journal of Social Robotics, 1*, 319-330. https://doi.org/10.1007/s12369-009-0030-6

Broadbent, E., Kuo, I. H., Lee, Y. I., Rabindran, J., Kerse, N., Stafford, R., & Macdonald, B. (2010). Attitudes and Reactions to a healthcare robot. *Telemedicine and E-health*, *16*(5), 608-613. https://doi.org/10.1089/tmj.2009.0171

Broadbent, E., Lee, Y.I., Stafford, B.Q., Kuo, H., & MacDonald, B.A. (2011). Mental schemas of robots as more human-like are associated with higher blood pressure and negative emotions in a human-robot interaction. *International Journal of Social Robotics*, 3, 291. https://doi.org/10.1007/s12369-011-0096-9

Broadbent, E., Tamagawa, R., Patience, A., Knock, B., Kerse, N., Day, K., & MacDonald, B. A. (2012). Attitudes towards health-care robots in a retirement village. *Australasian Journal on Ageing, 31*(2), 115-120. https:/doi.org/10.1111/j.1741-6612.2011.00551.x

Broadbent, E., Kerse, N., Peri, K., Robinson, H., Jaywardena, C., Kuo, T., Datta, C., Stafford, R., Butler, H., Jawalkar, P., Amor, M., Robinson, B., & MacDonald, B. (2016). Benefits and problems of health-care robots in aged care settings: A comparison trial. *Australasian Journal of Ageing*, *35*(1), 23-29. https://doi.org/10.1111/ajag.12190

Brunda, R. L., Keri, V., Sinha, T. P. & Bhoi, S. (2020). Re-purposing humanoid robots for patient care in COVID-19 pandemic*.* *International Journal of Health Planning Management*, *35*, 1629-1631. https://doi.org/10.1002/hpm.3052

Canamero, L., & Lewis, M. (2016). Making new "New AI" friends: designing a social robot for diabetic children from an embodied AI perspective. *International Journal of Social Robotics*, *8*, 523–533. https://doi.org/10.1007/s12369-016-0364-9

Carros, F., Meurer, J., Löffler, D., Unbehaun, D., Matthies, S., Koch, I., Wieching, R., Randall, D., Hassenzahl, M., & Wulf, V. (2020). Exploring human-robot interaction with the elderly: Results from a ten-week case study in a care home. *Proceedings of the 2020 CHI Conference on Human Factors.* https://doi.org/10.1145/3313831.3376402

Casas, J.A., Céspedes, N., Cifuentes, C.A., Gutierrez, L. F., Rincón-Roncancio, M., & Múnera, M. (2019). Expectation vs. Reality: Attitudes towards a Socially Assistive Robot in Cardiac Rehabilitation. *Applied Sciences, 9*, 4651. https://doi.org/10.3390/app9214651

Cavallo, F., Esposito, R., Limosani, R., Manzi, A., Bevilacqua, R., Felici, E., Di Nuovo, A., Cangelosi, A., Lattanzio, F., & Dario, P. (2018). Robotic services acceptance in smart environments with older adults: User satisfaction and acceptability study. *Journal of Medical Internet Research*, *20*(9). https://doi.org/10.2196/jmir.9460

Centre for Reviews and Dissemination. (2001). *Undertaking systematic reviews of research on effectiveness: CRD's guidance for those carrying out or commissioning reviews, CRD Report 4, 2nd edition.* NHS Centre for Reviews and Dissemination, University of York.

Cespedes, N., Munera, M., Gomez, C., & Cifuentes, C.A. (2020). Social human-robot interaction for gait rehabilitation. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*, *28,* 1307. https://doi.org/10.1109/tnsre.2020.2987428

Chew, C. M. (2017). Caregiver Shortage Reaches Critical Stage. *Provider*, *43*(5), 14–28.

Coco, K., Kangasniemi, M., & Rantanen, T. (2018). Care personnel's attitudes and fears toward care robots in elderly care: a comparison of data from the care personnel in Finland and Japan. *Journal of Nursing Scholarship*, *50*(6), 634-644. https://doi.org/10.1111/jnu.12435

Coeckelbergh, M. (2010). Health care, capabilities, and AI assistive technologies. *Ethical Theory and Moral Practice*, *13*(2), 181–190.

https://doi.org/10.1007/s10677-009-9186-2

Comijs, H. C., van Tilburg, T., Geerlings, S. W., Jonker, C., Deeg, D. J., van Tilburg, W., & Beekman, A. T. (2004). Do severity and duration of depressive symptoms predict cognitive decline in older persons? Results of the longitudinal aging study Amsterdam*. Aging Clinical and Experimental Research*, *16*(2), 226–232. https://doi.org/10.1007/BF03327388

Coninx, A., Baxter, P., Oleari, E., Bellini, S., Bierman, B., Henkemans, O.B., Cañamero, L., Cosi, P., Enescu, V., Espinoza, R.R., Hiolle, A., Humbert, R., Kiefer, B., Kruijff-Korbayová, I., Looije, R-m., Mosconi, M., Neerincx, M., Paci, G., Patsis, G., Pozzi, C., Sacchitelli, F., Sahli, H., Sanna, A., Sommavilla, G., Tesser, F., Demiris, Y., & Belpaeme, T. (2016). Towards long-term social child-robot interaction: Using multi-activity switching to engage young users. *Journal of Human-Robot Interaction*, *5*(1), 32–67. https://doi.org/10.5898/JHRI.5.1.Coninx

Creswell, J. W., & Plano Clark, V. (2007). *Designing and conducting mixed methods research.* Sage Publications.

Creswell, J. W., & Tashakkori, A. (2007a). Developing publishable mixed methods manuscripts*. Journal of Mixed Methods Research*, *1*(2), 107-111. https://doi.org/10.1177/1558689806298644

Creswell, J. W. & Tashakkori, A. (2007b). Differing perspective on mixed methods research. *Journal of Mixed Methods Research*, *1*(4), 303-308. https://doi.org/10.1177/1558689807306132

Creswell, J. W., & Creswell, J. D. (2018). *Research design: qualitative, quantitative and mixed methods approaches.* Sage Publications.

Dautenhahn, K., & Nehaniv, C. L. (2002). *Imitation in animals and artifacts.* MIT Press.

Davis, F. D. (1986). *A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results.* Sloan School of Management, Massachusetts Institute of Technology.

De Graaf, M. M. A., & Allouch, S. B. (2013). Exploring influencing variables for the acceptance of social robots. *Robotics and Autonomous Systems, 61*(12), 1476-1486. https://doi.org/10.1016/j.robot.2013.07.007

Doering, N., Richter, K., Gross, H-M., Schroeter, C., Mueller, S., Volkhardt, M., Scheidig, A., & Debes, K. (2015). Robotic companions for older people: A case study in the wild. *Annual Review of Cybertherapy and Telemedicine*, 13(219), 147-152. https://doi.org/10.3233/978-1-61499-595-1-147

Doménech, M., & Schillmeier, M. (2010). *New technologies and emerging spaces of care.* Taylor & Francis eBooks, Routledge.

Donev, D., Laaser, U., & Kovacic, L. (2013). The role and organization of health care systems. In G. Burazeri, L. Zaletel-Kragelj (Eds.), *Health: Systems – Lifestyles – Policies, A Handbook for Teachers, Researchers and Health Professionals.* Jacobs Verlag.

Duner, A., & Nordström, M. (2006). The roles and functions of the informal support networks of older people who receive formal support: a Swedish qualitative study. *Ageing & Society, 27*(1), 67-85. https://doi.org/10.1017/S0144686X06005344

Ellenbecker, C. H., Porell, F. W., Samia, L., Byleckie, J. J., & Milburn, M. (2008). Predictors of home health nurse retention. *Journal of Nursing Scholarship*, 40(2), 151-160. https://doi.org/10.1111/j.1547-5069.2008.00220.x

Eriksson K. (1987a). *Pausen. En beskrivning av vårdvetenskapens kunskapsobjekt.* [The break. A depiction of the knowledge object in caring sciences]. Libris.

Eriksson, K. (1987b). *Vårdandets ide.* [The idea of caring]. Almqvist & Wiksell.

Eriksson, K. (1988). *Vårdprocessen.* [The caring process]. Norstedts förlag AB.

Eriksson, K. (1992). Nursing: The caring practice "being there". In D. Gaut (Ed.)*, The practice of caring in nursing* (pp. 201-210). National league for Nursing Press.

Eriksson, K. (1994a). *Den lidande människan.* [The suffering human being]. Liber Utbildning.

Eriksson, K. (1997). Understanding the world of the patient, the suffering human being: The new clinical paradigm from nursing to caring. *Advanced Practice Nursing Quarterly, 3*(1), 8–13.

Eriksson, K. (2002). Caring science in a new key. *Nursing Science Quarterly, 15*(1), 61-65. https://doi.org/10.1177/089431840201500110

Eriksson, K. (2006a). *The suffering human being.* Nordic studies press.

Eriksson, K. (2018). *Vårdvetenskap. Vetenskapen om vårdandet. Om det tidlösa i tiden.* [Caring science. The science of caring. About the timeless in time]. Liber.

Eriksson, K. & Lindström, U. (2003). Klinisk vårdvetenskap. [Clinical caring science]. In K. Eriksson, U. Lindström (Eds.), *Gryning II. Klinisk vårdvetenskap* (pp. 3–20). Åbo Akademi. Institutionen för vårdvetenskap.

Eriksson, K., Lindholm, L., Lindström, U., Matilainen, D., & Kasén, A. (2006). Ethos anger siktet för vårdvetenskapen vid Åbo Akademi. [Ethos gives the direction for caring science at Åbo Akademi university]. *Hoitotiede, 18*(6), 296–298.

Eriksson, K., & Lindström, U. (2009). Vårdvetenskap som caring science. [Vårdvetenskap as caring science]. *Pro Terveys, 37*(4), 9-13.

Eurobarometer. (2012). *Public attitudes towards robots.* Gesis database. http://dx.doi.org/10.4232/1.12265

Fagerström, L. (2009). Developing the scope of practice and education for advanced practice nurses in Finland. *International Nursing Review*, *56*, 269-272. https://doi.org.10.11111/j.1466-7657.2008.00673.x

Fagerström, L., Gustafson, Y., Jakobsson, G., Johansson, S., & Vartiainen, P. (2011). Sense of security amongst people aged 65 and 75: external and inner sources of security. *Journal of Advanced Nursing, 67*(6), 1305–1316. https://doi.org/10.1111/j.1365-2648.2010.05562.x

Fagerström, L., Kinnunen, M., & Saarela, J. (2018). Nursing workload, patient safety incidents and mortality: an observational study from Finland. *British Medical Journal Open, 8*(4). https://doi.org/10.1136/bmjopen-2017-016367

Fagerström, L. (2019a). Caring, health, holism and person-centred ethos-common denominators for health sciences. *Scandinavian journal of caring sciences, 33*(2), 253-254. https://doi.org/10.1111/scs.12732

Fagerström, L., Hemberg, J., Koskinen, C., Östman, L., Näsman, Y., Nyholm, L., & Santamäki-Fischer, R. (2020). The core of Katie Eriksson's caritative caring theory – a qualitative study from a postdoctoral perspective. *Scandinavian Journal of Caring Sciences*, *35*(4), 1240-1249. https://doi.org/10.1111/scs.12942

Fagerström, L. (2021). *A Caring Advanced Practice Nursing Model: Theoretical Perspectives And Competency Domains.* Springer Nature.

Fagerström, L., Hemberg, J., Koskinen, C., Östman, L., Näsman, Y., & Santamäki-Fisher, R. (2021). The core of Katie Eriksson´s caritative caring theory- a qualitative study from a postdoctoral perspective. *Scandinavian Journal of Caring Sciences, 35*(4), 1240-1249. https://doi.org/10.1111/scs.12942

Feil-Seifer, D., & Matarić, M. J. (2005). Defining socially assistive robotics. *Proceedings of IEEE International Conference on Rehabilitation Robotics, USA*, 465–468. https://doi.org/10.1109/ICORR.2005.1501143

Feil-Seifer, D., & Matarić, M.J. (2009). Human-Robot Interaction. In R. A. Meyers (Eds.), *Encyclopedia of Complexity and Systems Science*, Springer. https://doi.org/10.1007/978-0-387-30440-3_274

Feingold-Polak, R., Elishay, A., Shahar, Y., Stein, M., Edan, Y., & Levy-Tzedek, S. (2018). Differences between young and old users when interacting with a humanoid robot: a qualitative usability study. *Journal of Behavioral Robotics*, *9*(1), 183-192. https://doi.org/10.1515/pjbr-2018-0013

Finnish Government. (2019). *Government Action Plan. Inclusive and competent Finland – a socially, economically and ecologically sustainable society*. Finland. http://urn.fi/URN:ISBN:978-952-287-791-8

Finnish National Board on Research Integrity. (2019). *The ethical principles of research with human participants and ethical review in the human sciences in Finland*. Finnish National Board on Research Integrity. https://tenk.fi/sites/default/files/2021-01/Ethical_review_in_human_sciences_2020.pdf

Finnish institute for health and welfare. (2021). *Home care.* Finnish institute for health and welfare. https://thl.fi/en/web/ageing/older-people-services-undergoing-a-change/home-care

Finne-Soveri, H., Mäkelä, M., Noro, A., & Tepponen, M. (2014). *Kotihoitoon on panostettava, jotta huonokuntoinenkin voi voida hyvin ja kuntoutua omassa kodissaan – Case Eksote.* Terveyden ja hyvinvoinnin laitos. [We need to invest in home care so that even people who are unwell can feel well and rehabilitate in their own home – Case Eksote]. https://www.julkari.fi/handle/10024/120382

Fong, T., Nourbakhsh, I., & Dautenhahn, K. (2003). A survey of socially interactive robots. *Robotics and Autonomous Systems, 42*(3–4), 143–166. https://doi.org/10.1016/S0921-8890(02)00372-X

Frilund, M., & Fagerström, L. (2009). Managing the optimal workload by the PAONCIL method – a challenge for care of older people. *Journal of Nursing Management*, 17(4), 426-34. https://doi.org/10.1111/j.1365-2834.2009.01013.x

Frennert, S., Aminoff, H., & Östlund, B. (2020). Technological frames and care robots in eldercare. *International journal of Social Robotics*, *13*, 311-325. https://doi.org/10.1007/s12369-020-00641-0

Jibb, L. A., Birnie, K. A., Nathan, P. C., Beran, T. N., Hum, V., Victor, J. C., & Stinson, J. N. (2018). Using the MEDiPORT humanoid robot to reduce procedural pain and distress in children with cancer: a pilot randomized controlled trial. *Pediatric Blood & Cancer*, *66*(9). https://doi.org/10.1002/pbc.27242

Joanna Briggs Institute. (2015). The Joanna Briggs Institute reviewers´ manual 2015-Methodology for JBI scoping reviews. The Joanna Briggs Institute. https://nursing.lsuhsc.edu/JBI/docs/ReviewersManuals/Scoping-.pdf

Forbrig, P., Bundea, A., & Platz, T. (2020). Assistance App for a Humanoid Robot and Digitalization of Training Tasks for Post-stroke Patients. *Human Centered Intelligent Systems*, 41-51. https://doi.org/10.1007/978-981-15-5784-2_4

Gallagher, A., Nåden, D., & Karterud, D. (2016). Robots in elder care: Some ethical questions. *Nursing Ethics*, *23*(4), 369-371. https://doi.org/10.1177/0969733016647297

Grabowski, D. C., O'Malley, A. J., Afendulis, C. C., Caudry, D. J., Elliot, A., & Zimmerman, S. (2014). Culture change and nursing home quality of care. *The Gerontologist*, *54*, 35–45. https://doi.org/10.1093/geront/gnt144

Gross, J. (2020). Interviewing Roomba: A post human study of humans and robot vacuum cleaners. *Explorations in Media Ecology*, *19*, 285–297. https://doi.org/10.1386/eme_00047_1

Gulliksen, J., Lantz, A., & Boivie, I. (1998). User Centered design in practice - problems and possibilities. Proceedings of CSCW'98, 417, Seattle.

Gulliksen, J., Göransson, B., Boivie, I., Blomkvist, S., Persson, J., & Cajander, Å. (1999). Key principles for user-centred systems design. *Behavior and Information Technology*, *22*(6), 397–409.

https://doi.org/10.1080/01449290310001624329

Hashim, R., & Yussof, H. (2017). Humanizing Humanoids towards Social Inclusiveness for Children with Autism. *Procedia Computer Science*, *105,* 358-364. https://doi.org/10.1016/j.procs.2017.01.234

Haring, K. S., Mougenot, C., Ono, F., & Watanabe, K. (2014). Cultural differences in perception and attitude towards robots. *International Journal of Affective Engineering, 13*(3), 149-157. https://doi.org/10.5057/ijae.13.149

Hebesberger, D., Koertner, T., & Gisinger, C. (2017). A long- term autonomous robot at a care Hospital: a mixed methods study on social acceptance and experiences of staff and older adults. *International Journal of Social Robotics*, *9*, 417–429. https://doi.org/10.1007/s12369-016-0391-6

Heerink, M. (2011). Exploring the influence of age, gender, education and computer experience on robot acceptance by older adults. *The sixth ACM/IEEE international conference on human–robot interaction*, Lausanne, USA, 6-9. https://doi.org/10.1145/1957656.1957704

Hildt, E. (2019). Artificial intelligence: does consciousness matter? *Frontiers in Psychology, 10*, 1535. https://doi.org/10.3389/fpsyg.2019.01535

Hilli, Y., & Eriksson, K. (2019). The home as ethos of caring: a concept determination. *Nursing Ethics*, *26*(2), 425-433. https://doi.org/10.1177/0969733017718395

Holopainen, G., Nyström, L., & Kasén, A. (2013). The caring encounter in nursing. *Nursing Ethics, 26*(1), 7-16. https://doi.org/10.1177/0969733016687161

Hsieh, H-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health research*, *15*(9), 1277-1288. https://doi.org/10.1177/1049732305276687

Huston, C. J. (2014). Technology in the health care workplace: Benefits, limitations, and challenges. In C. J. Huston (Ed.), *Professional issues in nursing: Challenges and opportunities (3rd ed.).* Williams, & Wilkins. https://doi.org/10.3912/OJIN.Vol18No02Man01

Ikeya, K., Aoki, J-I., Ikeda, N., Nimomiya, T., Tashiro, T., Okamura, T., & Suzuki, J-I. (2018). Use of a human-type communication robot to evaluate the categorized communicative ability of older adults with dementia. *Geratric and Gerontology International, 18*(1), 188-190. https://doi.org/10.1111/ggi.13185

Irfan, B., Ramachandran, A., Spaulding, S., Glas, D. F., Leite, I., & Koay, K. L. (2019). Personalization in long-term human-robot interaction. Proceedings of the 2019 14th ACM/IEEE International Conference on Human-Robot Interaction, Daegu, Korea, 685–686. https://doi.org/10.1109/HRI.2019.8673076

Jangland, E., Teodorsson, T., Molander, K., & Muntlin Athlin, A. (2017). Inadequate environment, resources and values lead to missed nursing care: A focused ethnographic study on the surgical ward using the Fundamentals of Care framework. *Journal of Clinical Nursing*, *27*(11–12), 2311–2321. https://doi.org/10.1111/jocn.14095

John, O. P., Naumann., L. P., & Soto, C. J. (2008). Paradigm shift to the integrative Big Five trait taxonomy: History, measurement, and conceptual issues. In O. P. John, R. W. Robins, L. A. Pervin (Eds.), *Handbook of personality: Theory and research, New York, USA* (3rd ed., pp. 114 – 158), Guilford Press.

Jokstad, K., Landmark, B., & Skovdahl, K. (2020). Person-centred research practice: The user involvement in research of older adults with first-hand experience of reablement. *Ageing and Society*, 1-14. https://doi.org/10.1017/S0144686X20000781

Kalb, C. (January 2020). *Could a robot care for grandma*? https://www.nationalgeographic.com/magazine/2020/01/could-a-robot-care-for-grandma-feature

Kane, R. L., Shamliyan, T. A., Mueller, C., Duval, S., & Wilt, T. J. (2007). The association of registered nurse staffing levels and patient outcomes: systematic review and meta-analysis. *Medical Care*, *45*(12), 1195–1204. https://doi.org/10.1097/MLR.0b013e3181468ca3

Kangasniemi, M., Karki, S., Colley, N., & Voutilainen, A. (2019). The use of robots and other automated devices in nurses' work: an integrative review. *International Journal of Nursing Practice, 25*(4). https://doi.org/10.1111/ijn.12739

Kataja, M. P. (2016). Robotiikka tarvitsee lisää osaajia. Teoksessa Teknologia sosiaali- ja terveydenhuollossa. [Robotics needs more experts. In Technology in social- and health care]. Hoitotyön vuosikirja 2016. Helsinki: Fioca Oy (pp. 57-72).

Katz, J. E., & Halpern, D. (2014). Attitudes towards robots' suitability for various jobs as affected robot appearance. *Behavior & Information Technology, 33*(9), 941–953. https://doi.org/10.1080/0144929X.2013.783115

Khan, Z. H., Siddique, A., & Lee, C. W. (2020). Robotics Utilization for Healthcare Digitization in Global COVID-19 Management. *International Journal of Environment Research and Public Health, 17*, 3819. https://doi.org/10.3390/ijerph17113819

Kitson, A., Conroy, T., Kuluski, K., Locock, L., & Lyons, R. (2013). *Reclaiming and redefining the Fundamentals of Care: Nursing's response to meeting patients' basic human needs*. School of Nursing, the University of Adelaide.

Komatsu, T., & Takeno, J. (2011). A conscious robot that expects emotions. *Proceedings of 2011 IEEE International Conference on Industrial Technology*, *USA*, 15–20. https://doi.org/10.1109/ICIT.2011.5754338

Korhonen, E-S. (2017). *Technology and its ethics.* [Doctoral dissertation, Åbo Akademi University].

Korn, O. (2019). *Social Robots: Technological, Societal and Ethical Aspects of Human-Robot Interaction*. Springer.

Kouroupetroglou, C., Casey, D., Raciti, M., Barrett, E., D'Onofrio, G., Ricciardi, F., Giuliani, F., Greco, A., Sancarlo, D., Mannion, A., Whelan, S., Pegman, G., Koumpis, A., Reforgiato Recupero, D., Kouroupetroglou, A., & Santorelli, A. (2017). Interacting with Dementia: The MARIO Approach. *Studies In Health Technology And Informatics*, *242*, 38-47. https://doi.org/10.3233/978-1-61499-798-6-38

Kvale, S. (1996). *Interview Views: An Introduction to Qualitative Research Interviewing.* Thousand Oaks, CA: Sage Publications.

Kyrarini, M., Lygerakis, F., Rajavenkatanarayanan, A., Sevastopoulos, C., Nambiappan, H. R., Chaitanya, K. K., Babu, A. R., Mathew, J., & Makedon, F. A. (2021). Survey of Robots in Healthcare. *Technologies, 9*(8). https://doi.org/10.3390/technologies9010008

Kuo, I. H., Rabindran, J. M., Broadbent, E., Lee, Y. I., Kerse, N., Stafford, R. M. Q., & MacDonald, B. A. (2009). Age and gender factors in user acceptance of healthcare robots. *Symposium on Robot and Human Interactive Communication, Toyama, Japan* (pp. 214-219). https://doi.org/10.1109/ROMAN.2009.5326292

Larsson, S. (2005). Om kvalitet i kvalitativa studier. [On quality in qualitative studies]. *Nordisk Pedagogik*, *25*(1), 16-35.

Lindström, U. Å., Lindholm, L., & Zetterlund, J. E. (2014). Katie Eriksson. Theory of Caritative Caring. In M. R. Alligood, A. M. Tomey, (Eds.), *Nursing Theorists and Their* Work, Missouri, USA (8th ed., pp. 191-223). Mosby Elsevier.

Lindström, U. Å., Nyström, L. L., Zetterlund, J. E., & Eriksson, K. (2018). Theory of caritative caring. In M.R. Alligood (Ed.), *Nursing Theorists and Their Work, Missouri, USA (9th ed.*, pp. 448–461). Mosby Elsevier.

Leoste, J., & Heidmets, M. (2019). The impact of educational robots as learning tools on mathematics learning outcomes in basic education. *Digital Turn in Schools—Research, Policy, Practice*, *Singapore,* (pp. 203-217). Springer.

Levac, D., Colquhoun, H., & O'Brien, K. (2010). Scoping studies: Advancing the methodology. *Implementation Science, 5*(69), 1-9. https://doi.org/10.1186/1748-5908-5-69

Lluch, M. (2011). Healthcare professionals' organizational barriers to health information technologies— a literature review. *International journal of medical informatics, 80*(12), 849-862. https://doi.org/10.1016/j.ijmedinf.2011.09.005

Lorenzoni, L., Marino, A., Morgan, D., & James, C. (2019). Health spending projections to 2030. New results based on a revised OECD methodology. *OECD Health Working Paper, 110.* https://doi.org/10.1787/5667f23d-en

Louie, W. Y. G., McColl, D., & Nejat, G. (2014). Acceptance and attitudes toward a human-like socially assistive robot by older adults. *Assistive Technology, 26,* 140–150. https://doi.org/10.1080/10400435.2013.869703

Locsin, R, & Purnell, M. (2009). *A Contemporary Nursing Process: The (un) bearable Weight of Knowing in Nursing.* Springer Publishing, New York, NY.

Locsin, R. C., & Ito, H. (2018). Can humanoid nurse robots replace human nurses? *Journal of Nursing Research, 5*(1). https://doi.org/10.7243/2056-9157-5-1

Looije, R., Neerincx, M.A., Peters, J. K., & Blanson Henkemans, O.A. (2016). Integrating Robot Support Functions into Varied Activities at Returning Hospital Visits. *International Journal of Social Robotics, 8*, 483-497. https://doi.org/10.1007/s12369-016-0365-8

Łukasik, S., Tobis, S., Kropińska, S., & Suwalska, A. (2020). Role of assistive robots in the care of older people: survey study among medical and nursing students. *Journal of Medical Internet Research, 22*(8). https://doi.org/10.2196/18003

Maeno, T. (2005). How to make a conscious robot-fundamental idea based on passive consciousness model. *Journal of the Robot Society of Japan, 23*(1), 51–62. https://doi.org/10.7210/jrsj.23.5

Maibaum, A., Bischof, A., Hergesell, J., & Lipp, B. (2021). A critique of robotics in health care. *AI & Society.* https://doi.org/10.1007/s00146-021-01206-z

Mahler, M., Sarvimäki, A., Clansy, A., Stenbock-Hult, B., Simonsen, N., Liveng, A., Zidén, L., Johannessen, A., & Hörder, H. (2014). Home as a health promotion setting for older adults. *Scandinavian Journal of Public Health, 42(*15), 36-40. https://doi.org/10.1177/1403494814556648

Mann, J. A., Macdonald, B. A., Kuo, I. H., Li, X., & Broadbent, E. (2015). People respond better to robots than computer tablets delivering healthcare instructions. *Computers in Human Behavior, 43*, 112-117. https://doi.org/10.1016/j.chb.2014.10.029

Malik, N. A., Yussof, H., & Hanapiah, F. A. (2016). Potential use of social assistive robot based rehabilitation for children with cerebral palsy. *Second IEEE International Symposium on Robotics and Manufacturing Automation*, *Ipoh, Malaysia (pp.1-6).* https://doi.org/10.1109/ROMA.2016.7847820

Martinsen, K. (2013). Philosophy of caring. In M.R. Alligood, (Ed.), *Nursing theorists and their work,* St. Louis, USA (8th ed., pp. 147–170). Elsevier Health Sciences/Mosby.

Martí Carrillo, F., Butchart, J., Knight, S., Scheinberg, A., Wise, L., & Sterling, L. (2017). In-situ design and development of a socially assistive robot for pediatric rehabilitation. *ACM/IEEE International Conference in Human-Robot Interaction, Vienna, Austria,* 199–200. https://doi.org/10.1145/3029798.3038382

Mays, N., Roberts, E., & Popay, J. (2001). Synthesizing research evidence. In N. Fulop, P. Allen, A. Clarke, N. Black (Eds.), *Studying the organisation and delivery of health services: Research methods*. London: Routledge.

Medical Research Act (488/1999). Medical Research Act. https://www.finlex.fi/fi/laki/kaannokset/1999/en19990488.pdf

Melkas, H., Hennala, L., Pekkarinen, S., & Kyrki, V. (2020). Impacts of robot implementation on care personnel and clients in elderly-care institutions. *International Journal of Medical Informatics, 134*. https://doi.org/10.1016/j.ijmedinf.2019.104041

Mohamed, Z., & Capi, G. (2012). Development of a new mobile humanoid robot for assisting elderly people. *Procedia Engineering, 41,* 345-351. https://doi.org/10.1016/j.proeng.2012.07.183

Moore, T., McArthur, M., Death, J., Tilbury, C., & Roche, S. (2018). Sticking with us through it all: the importance of trustworthy relationships for children and young people in residential care. *Children and Youth Services Review, 84*, 68–75. https://doi.org/10.1016/j.childyouth.2017.10.043.

Morovitz, M., Mueller, M. K., & Scheutz, M. (2017). Animal–Robot Interaction: The Role of Human Likeness on the Success of Dog–Robot Interactions. *1st international workshop on vocal interactivity in-and-between humans, animals and robots (*pp. 22-26).

Morse, J. (1991). Approaches to qualitative-quantitative methodological triangulation. *Nursing Research 40*, 120-123. https://doi.org/10.1097/00006199-199103000-00014

Morse, J. (2003). Principles of mixed methods and multimethod research design. In A. Tashakkori (Ed.), *Handbook of mixed methods in social & behavioral research*, *Thousand Oaks, USA* (pp. 189-208). Sage Publications.

Mukai, T., Hirano, S., Nakashima, H., Kato, Y., Sakaida, Y., Guo, S., & Hosoe, S. (2010). Development of a nursing-care assistant robot RIBA that can lift a human its arms. *2010 IEEE/RSJ International Conference on Intelligent Robots and Systems, Taipei, Taiwan* (pp. 5996-6001). https://doi.org/10.1109/IROS.2010.5651735

Muller, M., & Kuhn, S. (1993). Participatory Design. *Communications of the ACM, 36*(6), 24-28. https://doi.org/10.1145/153571.255960

Nass, C., Fogg, B. J., & Moon, Y. (1996). Can computers be teammates? *International Journal of Human-Computer Studies, 45*(6), 669-678. https://doi.org/10.1006/ijhc.1996.0073

Naneva, S., Sarda Gou, M., Webb, T. L., & Prescott, T. J. (2020). A systematic review of attitudes, anxiety, acceptance and trust towards social robots*. International Journal of Social Robotics, 12*, 1179-1201. https://doi.org/10.1007/s12369-020-00659-4

Niheh, M., Sakuma, N., Yabe, H., Kamata, M., & Inoue, T. (2017). Design of a behavior of robot that attracts the interest of the mildly demented elderly. *Studies in Health Technology Informatics, 242,* 492-500. https://doi.org/10.3233/978-1-61499-798-6-492

Ninomiya, T. (2015). Introduction of the communication robot. “PALRO” and efforts in “Robot Town Sagami”. *Journal of the Robotics Society of Japan, 33*(8), 607–610. https://doi.org/10.7210/jrsj.33.607

Nomura, T., Kanda, T., & Suzuki, T. (2006). Experimental investigation in to influence of negative attitudes toward robots on human-robot interaction. *AI & Society, 20,* 138– 150. https://doi.org/10.1007/s00146-005-0012-7

Nyholm, L., Santamäki-Fischer, R., & Fagerström, L. (2021). Users’ ambivalent sense of security with humanoid robots in healthcare. *Informatics for Health and Social Care*, 218-226. https://doi.org/10.1080/17538157.2021.1883027

Näsman, Y. (2020). The theory of caritative caring: Katie Eriksson’s theory of caritative caring presented from a human science point of view. *Philosophers for Nursing, 21*(4). https://doi.org/10.1111/nup.12321

O'Brien, K., Colquhoun, H., Levac, D., Baxter, L., Tricco, A. C., Straus, S., Wickerson, L., Nayar, A., Moher, D., & O'Malley, L. (2010). Advancing scoping study methodology: a web-based survey and consultation of perceptions on terminology, definition and methodological steps. *MC Health Services Research, 16,* 305. https://doi.org/10.1186/s12913-016-1579-z

Orejana, J. R., MacDonald, B., Ahn, H. S., Peri, K., & Broadbent, E. (2015). Healthcare robots in homes of rural older adults. In A. Tapus, E, André. J. C, Martin, F, Ferland, M, Ammi (Eds.), *Social Robotics. ICSR 2015. Lecture Notes in Computer Science* (pp. 512-521). Springer, Cham. https://doi.org/0.1007/978-3-319-25554-5_51

Ozturkcan, S., & Merdin-Uygur, E. (2021). Humanoid Service Robots: The Future of Healthcare? *Journal of Information Technology Teaching Cases*. https://doi.org/10.1177/204388692110 03905

Pallant, J. (2011). *SPSS survival manual. 4th edition. A step by step guide to data analysis using SPSS.* Allen & Unwin.

Park, D., Hoshi, Y., Mahajan, H. P., Kim, H. K., Erickson, Z., Rogers, W.A., & Kemp, C. C. (2020). Active robot-assisted feeding with a general-purpose mobile manipulator: design, evaluation and lessons learned. *Robotics and Autonomous Systems, 124*. https://doi.org/10.1016/j.robot.2019.10 3344

Parviainen, J., & Pirhonen, J. (2017). Vulnerable bodies in human-robot interactions: embodiment as ethical issues in robot care for the elderly. *Transformations journal, 29*, 104-115. http://urn.fi/URN:NBN:fi:uta-201703221327

Parviainen, J., Turja, T., & Van Aerschot, L. (2019). Social Robots and Human Touch in Care: The Perceived Usefulness of Robot Assistance Among Healthcare Professionals. In O, Korn (Ed.), *Social Robots: Technological, Societal and Ethical Aspects of Human-Robot Interaction*. Springer. https://doi.org/10.1007/978-3-030-17107-0_10

Papadopoulos, I., Koulouglioti, C., & Ali, S. (2018). Views of nurses and other health and social care workers on the use of assistive humanoid and animal-like robots in health and social care: a scoping review. *Contemporary Nurse, 54*(4-5), 425-442. https://doi.org/10.1080/10376178.2018 .1519374

Papadopoulos, I., Koulouglioti, C., Lazzarino, R., & Ali. S. (2020). Enablers and barriers to the implementation of socially assistive humanoid robots in health and social care: a systematic review. *British Medical of Journal Open, 10*(1). https://doi.org/10.1136/bmjopen-2019-033096.

Pekkarinen, S., Hennala, L., Tuisku, O., Gustafsson, C., Johansson-Pajala, R-M., Thommes, K., Hoppe, J. A., & Melkas, H. (2020). Embedding care robots into society and practice: Socio-technical considerations. *Futures, 122*. https://doi.org/10.1016/j.futures.2020.1 02593

Piezzo, C., & Suzuki, K. (2017). Feasibility Study of a Socially Assistive Humanoid Robot for Guiding Elderly Individuals during walking. *Future Internet, 9*(3), 30. https://doi.org/10.3390/fi9030030

Pepito, J. A., & Locsin, R. (2019). Can nurses remain relevant in a technologically advanced future? *International Journal of Nursing Sciences, 6*(1): 106–110. https://doi.org/10.1016/j.ijnss.2018.09.0 13

Polit, D. F., Beck, C. T., & Hungler, B. P. (2001). *Essentials of nursing research - Methods, appraisal and utilization. 5th edition.* Lippincott.

Polit, D. F., & Beck, C. T. (2014). *Essentials Nursing Research Appraising Evidence for Nursing Practice. 8th edition.* Lippincott.

Pripfl, J., Körtner, T., Bathko-Klein, D., Hebesberger, D., Weniner, M., Gisinger, C., Frennert, S., Eftring, H., Antona, M., Adami, I., Weiss, A., Bajones, M., & Vincze, M. (2016). Results of a real world trial with a mobile social service robot for older adults. *The Eleventh ACM/IEEE International Conference on Human Robot Interaction, Christchurch, New Zealand* (pp. 497-498).

https://doi.org/10.1109/HRI.2016.7451824

Rahman, R. A. A., Hanapiah, F. A., & Basri, H. H. (2015). Use of humanoid robot in children with cerebral palsy: the ups and downs in clinical experience. *Procedia in Computer Sciences, 76,* 394–9. https://doi.org/10.1016/j.procs.2015.12.316

Rantanen, T., Lehto, P., Vuorinen, P., & Coco, K. (2018). The Adoption of Care Robots in Home Care: a survey on the attitudes of Finnish home care personnel. Journal of Clinical Nursing, 27(9-10), 1846-1859. https://doi.org/10.1111/jocn.14355

Regnault, A., Willgross, T., Barbic, S., & Skye Barbic. (2018). Towards the use of mixed methods inquiry as best practice in health outcomes research. *Journal of Patient-Reported Outcomes, 2,* 19. https://doi.org/10.1186/s41687-018-0043-8

Revenäs, Å., Johansson, A-C., & Ehn, M. (2020). Integrating key user characteristics in user-centered design of digital support systems for seniors' physical activity interventions to prevent falls: protocol for a usability study. *Advancing Digital Health & Open Science, 9*(12). https://doi.org/10.2196/20061

Roach, S. (1987). *Caring, the human mode of being: Blueprint for the health professions.* CHA Press.

Roberts, A. (2009). The politics of healthcare reform in post-communist Europe: The importance of access. *Journal of Public Policy, 29*(3), 305–325. https://doi.org/10.1017/S0143814X09990110

Rossman, G. B., & Wilson, B. L. (1985). Numbers and Words: Combining Quantitative and Qualitative Methods in a Single Large-Scale Evaluation Study. *Evaluation review, 9*(5), 627-643. https://doi.org/10.1177/0193841X8500900505

Routasalo, P., & Isola, A. (1996). The right to touch and be touched. *Nursing Ethics, 3*(2), 165-176. https://doi.org/10.1177/096973309600300209

Saborowski, M., & Kollak, I. (2015). "How do you care for technology?" Care professionals' experiences with assistive technology in care of the elderly. *Technological Forecasting and Social Change, 93,* 133–140. https://doi.org/10.1016/j.techfore.2014.05.006

Saldien, J., Goris, K., Vanderborght, B., Vanderfaeillie, J., & Lefeber, D. (2010). Expressing Emotions with the Social Robot Probo. *Journal of Social Robotics, 2*. 377-389. https://doi.org/10.1007/s12369-010-0067-6.

Salmela, S., & Fagerström, L. (2007). Begreppsbestämning av förändring i relation till hälsoprocesser. [Concept determination of the concept change in relation to process of health].*Vård i Norden, 27*(4), 20-25. https://doi.org/10.1177/010740830702700405

Salomon, G. (1991). Transcending the qualitative-quantitative debate: the analytic and systemic approaches to educational research. *Educational Researcher, 20*(6), 10-18. https://doi.org/10.3102/0013189X020006010

Sandelowski, M. (1995). Sample size in qualitative research. *Research in Nursing Health, 18*(2), 179–83. https://doi.org/10.1002/nur.4770180211

Sandelowski, M. (2000). Whatever happened to qualitative description? *Research in Nursing Health, 23*(4), 334-340. https://doi.org/10.1002/1098-240X

Sanders, E. B-N., & Stappers, P. J. (2008). Co-creation and the new landscapes of design. *CoDesign, 4(1),* 5–18. https://doi.org/10.1080/15710880701875068

Sanders, E. B-N., & Stappers, P. J. (2014). Probes, toolkits and prototypes: Three approaches to making in codesigning. *CoDesign, 10*(1), 5-14. https://doi.org/10.1080/15710882.2014.888183

Sanderson, W. C., & Scherbov, S. (2005). Average remaining lifetimes can increase as human populations age. *Nature, 435*, 811–13. https://doi.org/10.1038/nature03593.

Sanderson, W. C., & Scherbov, S. (2010). Remeasuring aging. *Science, 329*, 1287–88. https://doi.org/10.1126/science.1193647

Sanderson, W. C., & Scherbov, S. (2015). Are we overly dependent on conventional dependency ratios? *Population and Development Review, 41*(4), 687–708. https://doi.org/10.1111/j.1728-4457.2015.00091.x

Sanderson, W. C., Scherbov, S., & Gerland, P. (2017). Probabilistic population aging. *PLOS ONE, 12*(6). https://doi.org/10.1371/journal.pone.0179171

Schweitzer, M., & Hoerbst, A. (2016). Robotic assistance in medication management: development and evaluation of a prototype. *Studies on Health Technology Informatics, 225,* 422-426. https://doi.org/ 10.3233/978-1-61499-658-3-422

Sharkey, N., & Sharkey, A. (2010). The crying shame of robot nannies- an ethical appraisal. *Interactions Studies, 11*(2). https://doi.org/10.1075/is.11.2.01sha

Sharkey, A., & Sharkey, N. (2012). "Granny and the Robots: Ethical Issues in Robot Care for the Elderly." *Ethics and Information Technology, 14,* 27–40. https://doi.org/10.1007/s10676-010-9234-6

Shea, B. J., Grimshaw, J. M., Wells, G. A., Boers, M., Andersson, N., Hamel, C., Porter, A. C., Tugwell, P., Moher, D., & Bouter, L. M. (2007). Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Medical Research Methodology, 7(*10). https://doi.org/10.1186/1471-2288-7-10

Shelton, G. (2016). Appraising Travelbee's human-to-human relationship model. *Journal of the Advanced Practitioner in Oncology, 7*(6), 657–661.

Shen, Z., & Wu, Y. (2016). Investigation of practical use of humanoid robots in elderly care centres. *Proceedings of 4th International Conference in Human Agent Interaction*, Biopolis, Singapore (pp. 63–66). https://doi.org/10.1145/2974804.2980485

Schneider, S. (2019). Socially Assistive Robots for Exercising Scenarios. Studies on group effects, feedback, embodiment and adaption. [Doctoral dissertation, University of Bielefeld]. https://doi.org/10.4119/unibi/2934006

Schiau, I., Ivan, L., & Bírá, M. (2018). Involving Older People in Participatory Action Research: An Example of Participatory Action Design. *Editura Comunicare, 20*(1). https://doi.org/10.21018/rjcpr.2018.1.250

Silverman, D. (2000). *Doing qualitative research.* Sage Publications.

Sitzman, K., & Watson, J. (2016). *Watson's caring in the digital world. A guide for caring when interacting, teaching, and learning in cyberspace.* Springer publishing.

Snellman, I., Gustafsson, C., & Gustafsson, L-K. (2012). Patients' and caregivers' attributes in a meaningful care encounter: similarities and notable differences. ISRN Nursing, *2012*(1). https://doi.org/10.5402/2012/320145

Stafford, R. Q., MacDonald, B. A., Jayawardena, C., Wegner, D. M., & Broadbent, E. (2014). Does the robot have a mind? Mind perception and attitudes towards robots predict use of an eldercare robot. *International Journal of Social Robotics, 6*, 17–32. https://doi.org/10.1007/s12369-013-0186-y

Strandbech, M. (2015). *Ethel and her telenoid - toward using humanoids to alleviate symptoms of dementia.* [Doctoral dissertation, Laering & Medier]. https://doi.org/10.7146/lom.v8i14.21990

Sperber, A. D. (2004). Translation and validation of study instruments for cross-cultural research. *Gastroenterology, 126* (1), 24–128. https://doi.org/10.1053/j.gastro.2003.10.016

Swift-Spong, K., Fred Wen, C. K., Spruijt-Metz, D., & Matarić, M. J. (2016). Comparing backstories of a socially assistive robot exercise buddy for adolescent youth. *25th IEEE International Symposium on Robot and Human Interactive Communication, New York, USA* (pp. 1013-1018). https://doi.org/10.1109/ROMAN.2016.7745233

Tanioka, T., Osaka, K., Locsin, R., Yasuhara, Y., & Ito, H. (2017). Recommended design and direction of development for humanoid nursing robots: Perspectives from nursing researchers. *Intelligent Control and Automation, 8,* 96–110. https://doi.org/10.4236/ica.2017.82008

Tanioka, T., Smith, M. C., & Zhao, Y. (2019). Framing the development of humanoid healthcare robots in caring science. *International Journal for Human Caring, 23*(2). https://doi.org/10.20467/1091-5710.23.2.112

Tereda, K. (2010). Can a robot deceive humans? *Proceedings of the 5th ACM/IEEE International Conference on Human Robot Interaction, Osaka, Japan.* https://doi.org/10.1145/1734454.1734538

Tiwari, P., Warren, J., Day, K., MacDonald, B., Jayawardena, C., Kuo, I. H., Igic, A., & Datta, C. (2011). *Feasibility study of a robotic medication assistant for the elderly*. Australian Computer Society.

Tøien, M., Bjørk, I. T., & Fagerström, L. (2015). Older users' perspectives on the benefits of preventive home visits. *Qualitative Health Research, 25*(2), 700-712. https://doi.org/10.1177/1049732314553595

Torta, E., Werner, F., Johnson, O. D., Juola, J. F., Cuijpers, R. H., Bazzani, M., Oberzaucher, J., Lemberger, J., Lewy, H., & Bregman, J. (2014). Evaluation of a small socially-assistive humanoid robot in intelligent homes for the care of the elderly. *Journal of Intelligent and Robotic Systems, 76*, 57-71. https://doi.org/10.1007/s10846-013-0019-0

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., Lewin, S., & Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of internal medicine, 169*(7), 467–473. https://doi.org/10.7326/M18-0850

Tuisku, O., Pekkarinen, S., Hennala, L., & Melkas, H. (2019). "Robots do not replace a nurse with a beating heart": The publicity around a robotic innovation in elderly care*. Information Technology & People, 32*(1), 47-67. https://doi.org/10.1108/ITP-06-2018-0277

Tuisku, O., Pekkarinen, S., Hennala, L., & Melkas, H. (2022). Decision-makers' attitudes toward the use of care robots in welfare services. *AI & Society*. https://doi.org/10.1007/s00146-022-01392-4

Turja, T. (2019). Accepting Robots as Assistants: A Social, Personal, and Principled Matter. [Doctoral dissertation, Tampere University].

Turkle, S. (1984). *The second self: Computers and the human spirit*. Simon and Schuster.

Turkle, S. (2004). Whither psychoanalysis in computer culture? *Psychoanalytic Psychology, 21*(1), 16-30. https://doi.org/10.1037/0736-9735.21.1.16

Unbehaun, D., Aal, K., & Wieching, R. (2019). Creative and Cognitive Activities in Social Assistive Robots and Older Adults: Results from an Exploratory Field Study with Pepper. *Proceedings of the 17th European Conference on Computer-Supported Cooperative Work - Demos and Posters*. https://doi.org/10.18420/ecscw2019_p07

United Nations. (2016). *UNHCR Policy on age, gender and diversity.* United Nations. https://www.unhcr.org/5aa13c0c7.pdf

United Nations. (2017). *World Population Prospects: the 2017 Revision.* United

Nations. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2017_Highlights.pdf

United Nations. (2019). *World Population Prospects 2019. United* Nations. https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf

Valvira. (2019). *Valviran ja aluehallinto-virastojen tarkastuskäynnit vanhusten hoivakodeissa - samanlaiset ongelmat toistuivat monin paikoin*. Inspection visits by Valvira and regional state administration agencies in care homes for the elderly – similar problems were repeated in many places]. https://www.valvira.fi/-/valviran-ja-aluehallintovirastojen-tarkastuskaynnit-vanhusten-hoivakodeissa-samanlaiset-ongelmat-toistuivat-monin-paikoin https://www.valvira.fi/-/valviran-ja-aluehallintovirastojen-tarkastuskaynnit-vanhusten-hoivakodeissa-samanlaiset-ongelmat-toistuivat-monin-paikoin

Van Aerschot, L., & Parviainen, J. (2020). Robots responding to care needs?: A multitasking care robot pursued for 25 years, available products offer simple entertainment and instrumental assistance. *Ethics and Information Technology, 22*(3), 247-256. https://doi.org/10.1007/s10676-020-09536-0

van Wynsberghe, A. (2013). *Healthcare robots: Ethics, design and implementation.* Ashgate Publishing.

van Wynsberghe, A. (2013). Designing Robots for Care: Care Centered Value-Sensitive Design. *Science and Engineering Ethics, 19*(2), 407–433. https://doi.org/10.1007/s11948-011-9343-6.

Wachsmuth, I. (2018). Robots like me: Challenges and ethical issues in aged care. *Frontiers in Psychology, 9,* 432. https://doi.org/10.3389/fpsyg.2018.00432

Wagner, C. (2010). The Japanese way of robotics: Interacting 'naturally' with robots as a national character? In A. Schad-Seifert, S. Shimada (Eds.), *Demographic change in Japan and the EU: Comparative perspective* (pp.131-154). Johann Wolfgang Goethe-University.

Wagner, C., & Arkin, R.C. (2010). Robot deception: Recognizing when a robot should deceive. *Computational Intelligence in Robotics and Automation, USA*. https://doi.org/10.1109/CIRA.2009.5423160

Watson, J. (2008). *Nursing: The philosophy and science of caring.* University Press of Colorado.

Winfield, A. F. T., Blum, C., & Liu, W. (2014). Towards an Ethical Robot: Internal Models, Consequences and Ethical Action Selection. In M. Mistry, A. Leonardis, M. Witkowski, C. Melhuish. (Eds.), *Advances in Autonomous Robotics Systems. TAROS 2014. Lecture Notes in Computer Science*. https://doi.org/10.1007/978-3-319-10401-0_8

Woodrow, H. (2014). Unfair and deceptive robots. *Maryland Law Review, 74*(4), 785.

World Health Organization. (1999). *Ageing – exploding the myths.* https://www.who.int/healthinfo/survey/ageingdefnolder/en/

World Health Organization. (2000). *The World health report, 2000, health systems: Improving Performance.* https://apps.who.int/iris/bitstream/handle/10665/42281/WHR_2000-eng.pdf?sequence=1&isAllowed=y

World Health Organization. (2010). *Global Recommendations on Physical Activity for Health.* http://www.who.int/dietphysicalactivity/publications/9789241599979/en/

World Health Organization. (2015*). The growing need for home health care for the elderly. Home health care for the elderly as an integral part of primary health care services. Regional Office for the Eastern Mediterranean.* https://applications.emro.who.int/dsaf/EMROPUB_2015_EN_1901.pdf?ua=1

World Health organization. (2017). *Mental health of older adults.* https://www.who.int/news-room/fact-sheets/detail/mental-health-of-older-adults

World Health Organization. (2019). *Health workforce. Global Health Workforce Statistics, 2019 update.* https://www.who.int/health-topics/health-workforce#tab=tab_1

World Health Organization. (2020). *Global strategy on digital health 2020-2025.* https://www.who.int/docs/default-source/documents/gs4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf

World Health Organization. (2021). *Aging and health*. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

Wu, Y-H., Wrobel, J., Cornuet, M., Kerherve, H., Damnée, S., & Riguad A-S. (2014). Acceptance of an assistive robot in older adults: a mixed-method study of human-robot interaction over a 1-month period in the living lab setting. *Clinical Interventions in Aging, 8*(9), 801-811. https://doi.org/10.2147/CIA.S56435

Yamamoto, D., Doi, M., Matsuhira, N., Ueda, H., & Kidode, M. (2004). Behavior fusion in a robotic interface for practicality and familiarity: Approach by simultaneous imitations. *Proceedings of the 14th International Workshop on Robot and Human Interactive Communication, New York, USA* (pp. 114–119). Association for Computing Machinery.

Yen, P-Y., Kellye, M., Lopetegui, M., Saha, A., Loversidge, J., Chipps, E. M., Gallagher-Ford, L., & Buck, L. (2018). Nurses' time allocation and multitasking of nursing activities: A time motion study. *AMIA Annual Symposium Proceedin*g, USA (pp. 1137–1146).

Yousif, J. H., Kazem, H. A., & Chaichan, M. T. (2019). Evaluation implementation of humanoid robot for autistic children: a review. *International Journal of Computation and Applied Sciences*, *6*(1), 412-420.

Yousif, M. J., & Yousif, J. H. (2020). Humanoid robot as assistant tutor for autistic children. *International Journal of Computation and Applied Sciences, 8*(2), 8-13. https://ssrn.com/abstract=3616810

ISBN 978-952-12-4201-4