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Staff's Attitudes towards the Use of Mobile Telepresence Robots in Long-Term Care Homes in Canada

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Article

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Résumé

Cette étude transversale a examiné les attitudes du personnel à l'égard de l'utilisation de robots de téléprésence mobiles dans les établissements de soins de longue durée de l'Ouest du Canada. Nous nous sommes inspirés d'un modèle de base d'évaluation des technologies de la santé 3.0 pour concevoir un sondage visant à analyser les attitudes à l'égard de neuf aspects des robots de téléprésence mobiles. Le personnel de deux établissements de soins de longue durée, y compris le personnel infirmier, le personnel soignant et les gestionnaires, a été invité à participer. L'analyse statistique des données du sondage recueillies auprès de 181 participants a révélé que dans l'ensemble, les participants présentaient des attitudes positives à l'égard des fonctions et caractéristiques de ces outils, de l'auto-efficacité de leur utilisation, de leur efficacité clinique, ainsi que des aspects organisationnels et sociaux, y compris les aspects propres aux résidents. Parallèlement, les données du sondage ont révélé des attitudes neutres à l'égard de la capacité des résidents d'utiliser la technologie et des coûts, ainsi que des attitudes négatives à l'égard de la sécurité et de la confidentialité. Les participants qui ont déclaré leurs données démographiques avaient tendance à afficher des attitudes plus positives que ceux qui ne l'ont pas fait. L'analyse de contenu des données textuelles a permis de cerner des préoccupations et des bienfaits précis liés à l'usage de ces robots. Nous discutons des possibilités de mise en œuvre des robots de téléprésence mobiles dans les établissements de soins de longue durée.

Abstract

This cross-sectional study investigated staff's attitudes towards the use of mobile telepresence robots in long-term care (LTC) homes in western Canada. We drew on a Health Technology Assessment Core Model 3.0 to design a survey examining attitudes towards nine domains of mobile telepresence robots. Staff, including nurses, care staff, and managers, from two LTC homes were invited to participate. Statistical analysis of survey data from 181 participants revealed that overall, participants showed positive attitudes towards features and characteristics, self-efficacy on technology use, organizational aspects, clinical effectiveness, and residents and social aspects; neutral attitudes towards residents' ability to use technology, and costs; and negative attitudes towards safety and privacy. Participants who disclosed their demographic backgrounds tended to exhibit more positive attitudes than participants who did not. Content analysis of textual data identified specific concerns and benefits of using the robots. We discuss options for implementing mobile telepresence robots in LTC.

Introduction

Social isolation and loneliness among older adults have long been identified as a social issue in Canada (Federal/Provincial/Territorial Ministers Responsible for Seniors, 2017; National Seniors Council, 2014), and the public health orders of physical distancing and restrictions on social gatherings during the COVID-19 pandemic exacerbated the issue (Statistics Canada, 2021). According to the Canadian Health Survey on Seniors, conducted between September and December 2020, 31 per cent of Canadians 65 years of age and older reported that they wanted to engage in more social, recreational, and group activities, compared with 18 per cent who reported this in 2019 (Statistics Canada, 2021). That survey also revealed that of the 31 per cent of older adults who wanted more social, recreational, and group activities, 76 per cent identified the

COVID-19–related restrictions and public health orders as barriers to participating in such activities. In 2019, health conditions and busy schedules were identified as the primary barriers to participation in these types of activities.

The COVID-related restrictions have also affected the ability of residents in long-term care (LTC) homes to interact with their loved ones and participate in social activities (Chu, Donato-Woodger, & Dainton, 2020). Previous studies highlight that families play a critical role in LTC settings, including advocating for residents' care needs and preferences, communicating with care staff to explain those needs and coordinate support and services for residents, discussing issues that affect residents' health and well-being, and making collaborative decisions about residents' care plans (Hado & Feinberg, 2020; Reinhard, Feinberg, Houser, Choula, & Evans, 2019). The restrictions on family and volunteer visits therefore made it particularly challenging for residents to access support for their physical and social well-being during the COVID-19 pandemic (Chu et al., 2020; Hado & Feinberg, 2020). Additionally, prior to the pandemic, certain systemic and structural aspects of LTC, such as lack of community integration, were identified as factors that can increase social isolation among residents (Boamah, Weldrick, Lee, & Taylor, 2021). The National Seniors Council (2014) reported that more than 40 per cent of older adults in LTC have either been diagnosed with depression or have not been diagnosed but present symptoms of depression. The restrictions on visits from family and volunteers to prevent the spread of COVID-19 exacerbated residents' vulnerability to isolation and loneliness.

Previous studies have consistently indicated that social isolation and loneliness are associated with higher health risks, including cardiovascular diseases, falls, a compromised immune system, depression, anxiety, dementia, and premature death (Alliance for a National Seniors Strategy, 2020; Federal/Provincial/Territorial Ministers Responsible for Seniors, 2017; Nania, 2021; Sutin, Stephan, Luchetti, & Terracciano, 2020; Tomás, Pinazo-Hernandis, Oliver, Donio-Bellegarde, & Tomás-Aguirre, 2019). It is therefore imperative to enable residents of LTC homes to sustain interactions with their loved ones to alleviate and address social isolation and loneliness. When various ways of minimizing residents' experiences of social isolation and loneliness were identified, created, and discussed during the pandemic, numerous studies conclusively highlighted the value of using technologies to facilitate interactions between residents and their loved ones (Chu et al., 2020; Eghtesadi, 2020; Gorenko, Moran, Flynn, Dobson, & Konnert, 2021; Hado & Feinberg, 2020; Ickert, Rozak, Masek, Eigner, & Schaefer, 2020; Nania, 2021).

Social robots are one of the technologies that have been used widely to help older adults alleviate isolation and loneliness in LTC. Although they are often characterized primarily as machines with an ability to interact socially with humans (Henschel, Laban, & Cross, 2021), Dautenhahn and Billard (1999) defined social robots as "embodied agents" that can recognize, communicate with, socially interact with, and learn from each other. In addition, they use their experiences to help them interpret the world around them.

Previous studies have investigated care workers' perceptions of the use of companion social robots (Dinesen et al., 2022; Moyle, Bramble, Jones, & Murfield, 2018) in health care settings. The findings suggest that social robots could facilitate staff interactions with residents living with dementia (Dinesen et al., 2022) and help increase residents' quality of life (Moyle et al., 2018).

Mobile telepresence robots have been attracting increasing attention in the LTC sector, particularly since the COVID-19 disease control orders restricted social gatherings (e.g., Cardona, Cortez, Palacios, & Cerros, 2020; Isabet, Pino, Lewis, Benveniste, & Rigaud, 2021). These robots are equipped with a monitor, Web camera, speaker, microphone, and wheels, and enable individuals to interact without being in the same location. Some examples of mobile telepresence robots are Double (Double Robotics, n.d.), Giraff (TelepresenceRobots.com, n.d.), temi (temi, n.d.), and VGo (VGo Communications, n.d.). One particular advantage of mobile telepresence robots is that their remote-control function can be operated via an Internet connection, which allows users (e.g., family, care staff) to operate them remotely. Therefore, mobile telepresence robots relieve older adults who may have low levels of technological literacy of the burden of trying to learn how to operate the robots themselves. The use of mobile telepresence robots has therefore been identified as a way not only for residents to interact with their loved ones, and so alleviate residents' social isolation and loneliness, but also for care staff to monitor residents' conditions without direct contact in LTC settings to prevent the spread of diseases such as COVID-19 (Cardona et al., 2020).

Although the potential benefits of using mobile telepresence robots in an aged-care context have been recognized, we have yet to identify how to successfully implement them in LTC settings. Previous research identified facilitators of and barriers to the use of mobile telepresence robots in health care settings (Hung et al., 2022). Some of the identified facilitators and barriers were related to users' attitudes to the robots, such as how easy they thought it would be to use the robots (Koceski & Koceska, 2016; Niemelä, van Aerschot, Tammela, & Aaltonen, 2017), feelings of physical presence of people during interactions (Aaltonen, Niemelä, & Tammela, 2017; Moyle, Jones, & Sung, 2020), and concerns about privacy issues and costs (Moyle et al., 2014, 2020). The use of mobile telepresence robots was viewed as beneficial for promoting social engagement and reducing loneliness in some studies (Niemelä et al., 2017; Niemelä, van Aerschot, Tammela, Aaltonen, & Lammi, 2021), whereas other studies found that users preferred to use telephones for interactions and communication because of hearing issues (Aaltonen et al., 2017; Korblet, Karreman, van Rompay, & Korblet, 2019). Previous studies also highlighted that users felt they needed training in how to operate the robots and that there should be guidelines and planning in place for their effective use (Niemelä et al., 2017; Reis et al., 2018). However, to the best of our knowledge, no studies to date have explored users' perceptions of telepresence robots in more detail, and stakeholders, such as administrative staff, have not been included in any studies to date (Hung et al., 2022). The latter point is particularly noteworthy because that group plays a key role in the implementation of the robots in health care settings. It is crucial to engage with key stakeholders more inclusively to understand, support, and integrate their perspectives (CFIR Research Team – Center for Clinical Management Research, n.d.). This article therefore aims to answer the following research question: What are staff's attitudes towards the use of mobile telepresence robots in Canada's LTC settings? As this study was exploratory, no hypotheses were proposed with regards to the association between staff's attitudes and demographic factors. It should be noted that although this study was conducted while restrictions on visitors at LTC homes were in effect, the objective was to investigate staff's attitudes towards the use of robots in general and not in the specific context of the COVID-19 pandemic.

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Methods

In this cross-sectional study, we developed survey questions that examined staff's attitudes towards the use of mobile telepresence robots in LTC homes in Canada and administered the survey to staff at two LTC homes in western Canada. A total of 181 participants responded to all questions. This project was approved by the University of British Columbia Behavioural Research Ethics Board.

Throughout the research process we applied a transdisciplinary approach, which encourages researchers to collaborate with multidisciplinary and multisectoral members (e.g., older adults living with dementia, family caregivers, clinicians, academics) to exchange and integrate ideas to develop and produce research outputs that would have positive impacts in a real-world context (Boger et al., 2017; Grigorovich, Fang, Sixsmith, & Kontos, 2019; Grigorovich, Kontos, Sixsmith, Fang, & Wada, 2021; Wada, Grigorovich, Fang, Sixsmith, & Kontos, 2020; Wada, Grigorovich, Kontos, Fang, & Sixsmith, 2021). The process of collaboratively creating research output is known as co-creation. It is defined as "collaborative knowledge generation by academics working alongside other stakeholders" (Greenhalgh, Jackson, Shaw, & Janamian, 2016, p. 393) and is critical for innovative, meaningful output. Our team was therefore composed of relevant key stakeholders, such as clinician researchers, patient and family partners, and LTC site leaders, who were involved at every stage of the project, from developing and planning the survey to collecting and analyzing data, reporting findings, and translating and disseminating the knowledge. We had regular meetings with the stakeholders to discuss and make collaborative decisions about how to design the survey, collect and analyze data, and disseminate the research findings. For example, our patient and family partners actively assisted us in crafting and refining the survey questions. Additionally, we exchanged ideas about ways to encourage LTC staff to participate in the study.

Participants

Eligible participants were staff members at two LTC homes in Metro Vancouver, British Columbia, Canada. Both homes were located in urban areas and were large institutions. Site 1 was publicly funded, and Site 2 was privately funded. In both sites, residents had a wide variety of ethnic backgrounds and complex care needs, and more than 85 per cent of the residents had cognitive impairment or dementia. Site 1 had approximately 200 employees and 150 residents. Site 2 had 60 employees and 20 residents. Most staff (80.0%) were female and came from a variety of ethnic backgrounds; for example, immigrants with European, North American, and Asian origins, and descendants of immigrants with European, North American, and Asian origins. The leaders at both sites, who were part of our research team, were supportive of and open to the use of assistive technology in LTC homes. We identified the LTC homes as data collection sites because they agreed to be community partners in this project as they had a shared understanding of the issues of disconnection and loneliness that residents were experiencing after social distancing and restrictions on family visits to LTC homes were implemented to control the spread of COVID-19. The LTC homes indicated their interest in the potential use of mobile telepresence robots to address the issues in their homes not only during the COVID-19 pandemic but also afterwards.

Survey Development and Administration

We designed a survey by drawing on questions used in previous studies investigating attitudes towards adopting new technologies in health care and educational settings (Chen, Jones, & Moyle, 2020; Christoforou, Avgousti, Ramdani, Novales, & Panayides, 2020; Han & Conti, 2020; Latikka, Turja, & Oksanen, 2019; Niemelä et al., 2017; Rantanen, Lehto, Vuorinen, & Coco, 2018).

Theoretical Framework

In the process of generating and refining the survey questions, we drew on a Health Technology Assessment (HTA) Core Model 3.0 to identify, specify, and clarify a domain of telepresence robots and an associated set of questions that were focused on assessing attitude. The HTA is a registered, evidence-based model developed by the European Network for Health Technology Assessment to determine the value and application of health technologies. It focuses on nine domains: health problem and current use of technology, description and technical characteristics, safety, clinical effectiveness, costs and economic evaluation, ethical analysis, organizational aspects, patients and social aspects, and legal aspects (EUnetHTA Joint Action 2 Work Package 8, 2016). We chose HTA as a guiding theoretical framework for the study because it is publicly accessible, designed specifically for health technology assessments, flexible in its use, and well developed in terms of guidance and instructions. Additionally, information generated from the HTA is considered to be transferrable knowledge for supporting the effective use of technologies in healthcare (EUnetHTA, 2015).

Survey Development

Our survey focused on the following nine domains of technology adopted from the HTA Core Model 3.0: features and characteristics, self-efficacy on the use of technology, residents' ability to use technology, clinical effectiveness, residents and social aspects, organizational aspects, costs, safety, and privacy (Table 1). For clarity, we renamed the HTA's "ethical analysis" domain "privacy", and divided the description and technical characteristics of the technology domain into features and characteristics, self-efficacy on the use of technology, and residents' ability to use technology. Two HTA domains were outside the scope of this study and therefore were not included: legal aspects (legal issues that must be considered when implementing a health technology) and health problem and current use of the technology (target conditions/groups of the technology) (EUnetHTA Joint Action 2 Work Package 8, 2016). Three open-ended questions regarding concerns, foreseen benefits, and general comments were also developed and included in the survey. The survey was developed in English and Chinese.

The selection of the domains and languages used for the questions was based on a collaborative decision-making process within the research team, and involved clinician researchers and patient and family partners. The goal was to make the survey easy to read for LTC staff and hence encourage as many of them as possible to participate in the study. For example, we have an ethics-related question in the privacy section. We conducted a small pilot test with two nurses and two care workers to ensure that the language and structure were accessible for the intended participant population—LTC staff—and the readability of the Chinese version was validated by a family partner who spoke Chinese fluently.

Survey Administration

The survey was administered online and on paper between June and August 2021. We advertised it through a flyer outlining its

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Table 1. Statements about nine domains of technology for the assessment of attitudes

Domain	Description	Statement
Features and characteristics	Features of the technology and its characteristics	The sound quality of the mobile telepresence robot is important for communication.
		I feel comfortable with how mobile telepresence robots generally look.
Self-efficacy on the use of technology	Long-term care staff's confidence about their ability to use technology	I would be comfortable making mistakes while getting used to operating a mobile telepresence robot.
		I am confident that I would be able to operate a mobile telepresence robot if I received the necessary training.
		I consider myself technologically competent.
		I would be confident in helping residents use a mobile telepresence robot if I received the necessary training.
Residents' ability to use technology	Residents' ability to use technology	It would be easier for residents to use a mobile telepresence robot than other technologies.
		I am concerned that residents will be unable to operate a mobile telepresence robot.[a]
Clinical effectiveness	Benefits of the use of technology to residents' health, quality of life, and social engagement as well as to staff's work	The use of a mobile telepresence robot in my health care setting would provide more benefits than risks.
		Mobile telepresence robots will be used in the healthcare setting in the future.
		A mobile telepresence robot could reduce anxiety among residents.
		A mobile telepresence robot could reduce loneliness among residents.
		The use of a mobile telepresence robot in long-term care homes would reduce the risk of infection among residents and staff.
		A mobile telepresence robot would help care workers monitor residents' conditions remotely.
		Using mobile telepresence robots will increase the efficiency of care in long-term care homes.
		Residents would be able to interact with their families and friends via a mobile telepresence robot.
		I am concerned that the option to use a mobile telepresence robot would replace family visits.[a]
		Residents' families would benefit if long-term care homes had mobile telepresence robots.
		The use of a mobile telepresence robot will increase residents' engagement in social activities.
Residents and social aspects	Residents' and their family members' experiences and perspectives	I am concerned that the option to use a mobile telepresence robot would replace family visits.[a]
		Residents' families would benefit if long-term care homes had mobile telepresence robots.
Organizational aspects	An organization's ability, systems, and structures that impact resources required to implement a technology include human skills and attitudes	My workplace would be able to provide Wi-Fi to operate a mobile telepresence robot.
		I would expect a mobile telepresence robot to be available 24/7 if there was one in my workplace.
		Mobile telepresence robots will be used in the health care setting in the future.
		My institution / organization would support the use of a mobile telepresence robot in my workplace.
		Employees in my workplace would support each other in using a mobile telepresence robot if one were available.
		I am enthusiastic about adopting new technologies in my workplace.
		I am confident that I would be able to operate a mobile telepresence robot if I received the necessary training.
		I would be comfortable making mistakes while getting used to operating a mobile telepresence robot.
		I would be confident in helping residents use a mobile telepresence robot if I received the necessary training.
		A mobile telepresence robot would make my job more interesting.
		If a mobile telepresence robot is used in my workplace, my workload would increase.[a]

(Continued)

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Table 1. *Continued*

Domain	Description	Statement
Costs	Examination of the costs and economic efficiency outcomes of using the technology	Using a mobile telepresence robot would reduce the cost of long-term care in the long run.
		I am concerned about the cost of mobile telepresence robots.[a]
Safety	Residents' safety	If a mobile telepresence robot is operated remotely, there will be concerns about residents' safety (e.g., injury).[a]
Privacy	Protection of the privacy of both the residents who are using the technology and the residents in the surroundings	I am concerned that the use of a mobile telepresence robot could affect residents' privacy in long-term care homes.[a]
		Operating a mobile telepresence robot in health care spaces could create privacy concerns.[a]

Note. This study focused on the following nine domains of technology adopted from a Health Technology Assessment Core Model 3.0 (EUnetHTA Joint Action 2 Work Package 8, 2016): features and characteristics, self-efficacy on the use of technology, residents' ability to use technology, clinical effectiveness, residents and social aspects, organizational aspects, costs, safety, and privacy.
[a]The rating on the statements were reverse-coded.

purpose and eligibility criteria. The flyer was e-mailed to staff members and posted on bulletin boards in staff rooms at the participating LTC homes. Our team members who had access to the sites encouraged staff to participate in the survey, made hard copies available on site, and collected completed surveys.

When participants accessed the online survey, they read introductory information that explained the survey's purposes and inclusion criteria and gave contact information for the principal investigator. Participants were then shown a brief description of two kinds of mobile telepresence robots (Giraff and Double) before taking the survey. Photographs and short video clips of the robots were included in the survey. The description included the features, size, functions, and price of the robots, and the video clips demonstrated how they move. Participants who chose to complete the survey on paper were given a URL and QR code to access the Web page where the above-mentioned information about the robots was located. They were encouraged to visit the page before starting the survey.

Measures

Demographic characteristics (independent variables)

Age. Participants were asked to identify their age as "19 or below," "20–29," "30–39," "40–49," "50–59," "60 or above," or "Prefer not to answer."

Gender. Participants identified their gender as "Female," "Male," "Non-binary person," or "Prefer not to answer."

Education level. Participants' education level was identified by selecting a single item from the following eight items: "Less than high school," "High school or equivalent," "Trade/technical/vocational school," "College/university degree," "Professional degree (e.g., M.D.)," "Post-graduate degree (e.g., Master's degree, Ph.D.)," "Other," or "Prefer not to answer."

Profession or role. Participants identified their profession or role at the time of responding to the survey by selecting one item from the following 13 options: "Dietitian," "Health Care Assistant/Support Worker," "Manager/Administrative roles," "Licensed/Registered Practical Nurse; Registered Nurse; Registered Psychiatric Nurse," "Physiotherapist/Occupational Therapist," "Recreational Therapist," "Physician," "Psychologist," "Social Worker," "Other," or "Prefer not to answer." Due to small sample sizes, "Dietitian," "Physiotherapist/Occupational Therapist," "Recreational Therapist," "Psychologist," and "Social Worker" were combined as a new group named "Other Allied Health Professionals," in which music therapists specified in "Other" were included. "Physician" was included in "Other" because of the small sample size. Student nurses specified in "Other" were included in "Licensed/Registered Practical Nurse; Registered Nurse; Registered Psychiatric Nurse," which was renamed "Nurse & Student Nurse." The final groups used for the analyses were "Health Care Assistant/Support Worker," "Nurse & Student Nurse," "Other Allied Health Professionals," "Manager/Administrative roles," "Other," and "Prefer not to answer."

Experience with robots in health care settings. Participants were asked to indicate their experience with robots in health care settings by choosing one of the following: "I have never heard of or seen robots being used in health care settings," "I have heard of or seen robots being used in health care settings," and "I have used robots in healthcare settings."

Work experience in the profession identified at the time of survey. Participants identified how long they had worked in the profession they identified with at the time of participating in the survey by selecting one item from the following six: "less than 3 months," "3 months to 1 year," "2–5 years," "6–9 years," "≥10 years," and "Prefer not to answer."

Work experience in LTC homes. The extent of participants' work experience in their identified profession was indicated by selecting one item from the following six: "Less than 3 months," "3 months to 1 year," "2–5 years," "6–9 years," "≥10 years," and "Prefer not to answer."

Attitudes (dependent variables)

Attitudes towards the use of telepresence robots were assessed using 31 statements focusing on nine domains of technology adopted from the HTA (EUnetHTA Joint Action 2 Work Package 8, 2016). Table 1 presents the domains, their descriptions, and the statements categorized within them. Some statements are categorized in more than one domain. Participants were asked to rate each statement by using a five-point Likert scale: "strongly disagree," "somewhat disagree," "neither agree nor disagree," "somewhat agree," and "strongly agree."

Features and characteristics. In this study, this domain specifically involved the sound quality and aesthetics of telepresence robots, and two statements were developed to explore attitudes towards this domain in the survey. Regarding other features and characteristics, we created two questions about the ideal height for a mobile telepresence robot and the ideal size for its screen. These questions appeared before the 31 statements in the survey but are not part of the analysis for this article.

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Self-efficacy on the use of technology. This domain referred to LTC staff's confidence about their ability to use telepresence robots. We developed four statements investigating staff's sense of comfort not only with making mistakes while mastering the use of the robots but also with helping residents use the robots if training was offered.

Residents' ability to use technology. This domain focused on staff's perceptions of residents' ability to use telepresence robots and was examined by two statements. One examined the usability of the robots compared with other technologies, and the other explored residents' perceived technological competence in operating the robots.

Clinical effectiveness. Clinical effectiveness refers to how using telepresence robots benefits residents' health (e.g., reduces anxiety or risk of infection), quality of life (e.g., counteracts loneliness), and social engagement (e.g., facilitates interactions with family and friends) as well as staff's work (e.g., improves care efficiency). Eleven statements were developed to assess attitudes towards the clinical effectiveness of telepresence robots. For example, the statements that speak to their effectiveness in terms of residents' social engagement include "Residents would be able to interact with their families and friends via a mobile telepresence robot" and "The use of a mobile telepresence robot will increase residents' engagement in social activities."

Residents and social aspects. This domain delineates residents' and their families' experiences of and perspectives on the use of telepresence robots and includes two statements focusing specifically on how residents' families perceive the use of mobile telepresence robots in LTC homes (e.g., "Residents' families would benefit if LTC homes had mobile telepresence robots.").

Organizational aspects. Defined as an organization's ability, systems, and structures that impact resources required to implement a technology, the organizational aspects domain included 11 statements. The resources include colleagues' and participants' own skills and attitudes. Four statements focused on an organization's/institution's adaptation level (e.g., "My institution/organization would support the use of a mobile telepresence robot in my workplace."), and one statement explored participants' perceptions of the level of their colleagues' motivation for and interest in adopting telepresence robots ("Employees in my workplace would support each other in using a mobile telepresence robot if one were available."). Six statements highlighted participants' interests in and perspectives on adopting the robots at their work, including the impacts on their workload (e.g., "If a mobile telepresence robot is used in my workplace, my workload would increase.").

Costs. The costs domain focused on the cost of telepresence robots and perceived costs and economic efficiency outcomes of using the robots in LTC homes. Two statements spoke to this domain (e.g., "Using a mobile telepresence robot would reduce the cost of long-term care in the long run.").

Safety. The safety domain is defined as a risk to residents' physical well-being when telepresence robots are operated. This domain included one statement focusing on foreseen concerns about residents' safety when the robots are remotely operated and moving around in care settings.

Privacy. This domain focuses on the privacy of both the residents who are using the technology and the residents in the surrounding areas. Two statements are included in this domain (e.g., "I am concerned that the use of a mobile telepresence robot could affect residents' privacy in long-term care homes.").

Open-ended questions

Three optional, open-ended questions were included in the survey to help us understand the above-mentioned numerical data: (1) "Do you have any concerns about the use of mobile telepresence robots in your workplace? If so, please describe them briefly." (2) "How do you think a mobile telepresence robot would benefit residents in your workplace?" (3) "Do you have any comments about the use of mobile telepresence robots in long-term care homes in Canada? For example, do you have any comments about the type or level of support needed to use a robot in your workplace?"

Data Analysis

For the numerical data, we coded each participant's rating on 31 statements using a five-point Likert scale—"strongly disagree," "somewhat disagree," "neither agree nor disagree," "somewhat agree," and "strongly agree"—from "1" to "5." The higher the number, the more positive participants' attitudes were towards that domain. Three represents neutral attitudes. Of the 31 statements, 25 indicated that the rating "strongly agree" signified the most positive attitudes and that "strongly disagree" signified the most negative attitudes. Therefore, the codes "5," "4," "3," "2," and "1" were assigned to the order from "strongly agree" to "strongly disagree." The rating on the remaining six statements indicated that "strongly agree" signified the most negative attitudes and "strongly disagree" signified the most positive attitudes. Accordingly, the rating was reverse-coded: from "1" on "strongly agree" to "5" on "strongly disagree." The statements required for the reverse-coding are indicated in Table 1. We then summed all the participants' ratings for each statement and collated the summed rates according to the nine domains.

Descriptive statistics were used to characterize the sample and summarize the characteristics of the data set and to compare two groups: one comprising participants who fully disclosed their demographic backgrounds, and the other comprising participants who selected "Prefer not to answer" in response to demographic questions. The one-way analysis of variance (ANOVA) was used to explore if there were statistically significant differences in attitudes towards the use of mobile telepresence robots (dependent variables) between the groups according to demographic characteristics (independent variables). Version 28.0 of the SPSS Statistics software (IBM Corp., Armonk, NY, USA) was used for all analyses.

For the qualitative data, we used a content analysis approach (Hsieh & Shannon, 2005) to identify key themes in response to each open-ended question. Given that all the textual data were provided in English, we analyzed all of them together. The analysis started with coding textual data for the respective questions. Author M.W. identified the initial codes by using both sensitized concepts in the literature (deductively) and emergent codes (inductively), and author E.T. independently read the textual data and validated the codes that M.W. assigned to them. M.W. and E.T. then collated similar codes into categories and iteratively discussed and compared the data, codes, and categories. Our clinician researchers and patient and family partners also used their lived experience perspectives to help interpret the data to enrich our analysis. Finally, the whole team, including both authors, discussed, agreed on, and refined the key themes that address (1) concerns about the use of mobile telepresence robots, (2) benefits to residents, and (3) any comments about the use of mobile telepresence robots in LTC in Canada.

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Results

A total of 181 staff completed the survey (168 completed the English version and 13 completed the Chinese version) that was used for analyses. Of the total 181, 143 participants (132 using the English survey and 11 using the Chinese) fully disclosed their demographic backgrounds, and the remaining 38 (36 English and 2 Chinese) selected "Prefer not to answer" in response to at least one demographic questions.

Approximately 60.0 per cent (n = 107) of the total number of respondents were in their 40s or 50s (Table 2). About 74.0 per cent (n = 134) were female, and more than 66.5 per cent (n = 121) of the total number of participants reported that they had college/university degrees or higher degrees. More than 65.0 per cent of the participants (n = 118) identified themselves as being a health care assistant/support worker or nurse (including student nurses). More than half of the participants (n = 94, 51.9%) reported that they had been working in LTC homes for 10 years or longer.

Figure 1 shows participants' attitudes towards the use of telepresence robots according to nine domains in three groups: all participants, demographics fully disclosed, and demographics undisclosed. The value represents the mean rates for each domain. The higher the number, the more positive participants' attitudes

Table 2. Participant demographics (n = 181)

		Demographics Fully Disclosed				Demographics Undisclosed			
		English (n = 132)		Chinese (n = 11)		English (n = 36)		Chinese (n = 2)	
Characteristic		n	%	n	%	n	%	n	%
Age	≤ 19	0	0.00	0	0.00	0	0.00	0	0.00
	20-29	13	7.18	2	1.10	2	1.10	0	0.00
	30-39	27	14.92	1	0.55	4	2.21	0	0.00
	40-49	34	18.78	1	0.55	8	4.42	0	0.00
	50-59	53	29.28	7	3.87	3	1.66	1	0.55
	60 or above	5	2.76	0	0.00	2	1.10	0	0.00
	Prefer not to answer	0	0.00	0	0.00	17	9.39	1	0.55
Gender	Male	28	15.47	1	0.55	2	1.10	0	0.00
	Female	104	57.46	10	5.52	18	9.94	2	1.10
	Non-binary	0	0.00	0	0.00	0	0.00	0	0.00
	Prefer not to answer	0	0.00	0	0.00	16	8.84	0	0.00
Education level	High school or equivalent	19	10.50	1	0.55	0	0.00	0	0.00
	Trade/technical/vocational school	11	6.08	3	1.66	2	1.10	0	0.00
	College/university degree	85	46.96	6	3.31	10	5.52	1	0.55
	Professional degree (e.g., MD)	3	1.66	0	0.00	1	0.55	0	0.00
	Post-graduate degree	14	7.73	1	0.55	0	0.00	0	0.00
	Prefer not to answer	0	0.00	0	0.00	23	12.71	1	0.55
Profession /roles	Health care assistant/support worker	54	29.83	3	1.66	8	4.42	1	0.55
	Nurse & student nurse	43	23.76	5	2.76	4	2.21	0	0.00
	Other allied health care professional	18	9.94	1	0.55	0	0.00	0	0.00
	Manager/administrative roles	9	4.97	2	1.10	1	0.55	0	0.00
	Other	8	4.42	0	0.00	1	0.55	0	0.00
	Prefer not to answer	0	0.00	0	0.00	22	12.15	1	0.55
Work experience in long-term care homes	Less than 3 months	5	2.76	0	0.00	0	0.00	0	0.00
	3 months to 1 year	14	7.73	1	0.55	0	0.00	0	0.00
	2-5 years	23	12.71	2	1.10	3	1.66	0	0.00
	6-9 years	14	7.73	1	0.55	1	0.55	1	0.55
	≥ 10 years	76	41.99	7	3.87	10	5.52	1	0.55
	Prefer not to answer	0	0.00	0	0.00	22	12.15	0	0.00
Experience with robots in health care settings	Have never heard of or seen	72	39.78	5	2.76	19	10.50	1	0.55
	Have heard of or seen	58	32.04	4	2.21	13	7.18	1	0.55
	Have used	2	1.10	2	1.10	4	2.21	0	0.00

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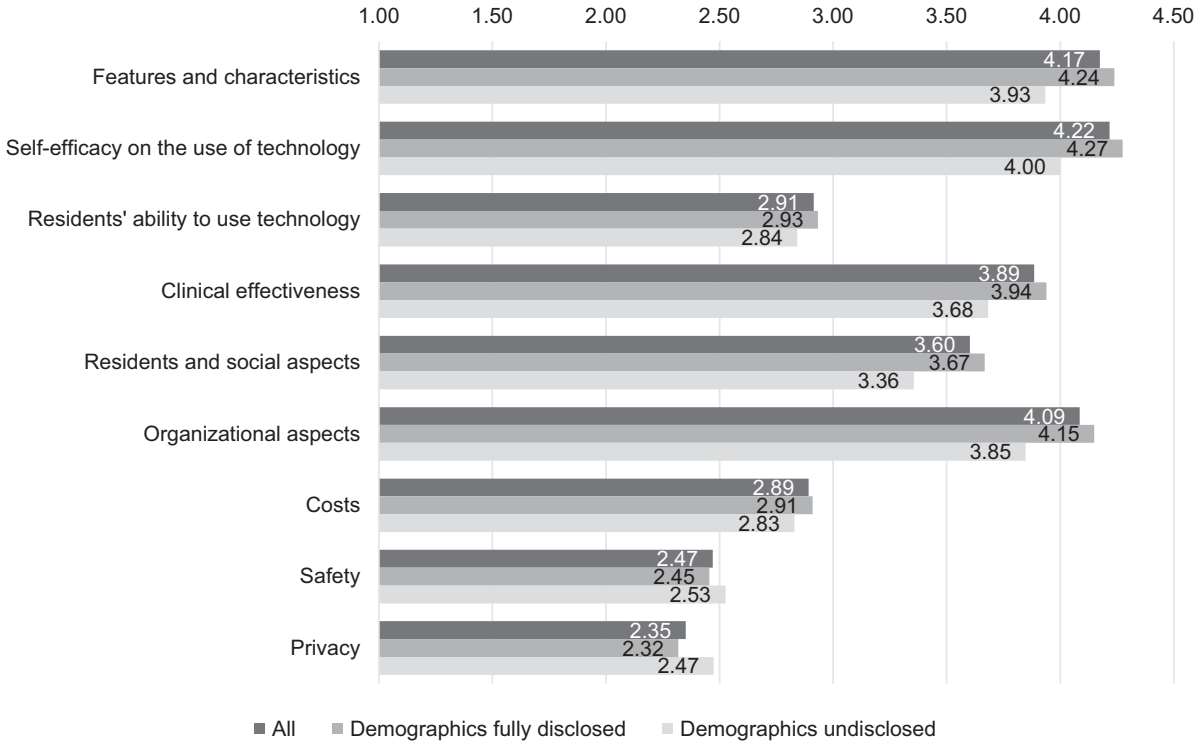

Figure 1. Participants' attitudes towards the use of mobile telepresence robots across nine domains in three groups: all participants, demographics fully disclosed, and demographics undisclosed.

were towards them. In the demographics fully disclosed group, among nine domains, participants presented positive attitudes (mean score above 3.5) towards features and characteristics, self-efficacy on the use of technology, clinical effectiveness, residents and social aspects, and organizational aspects; neutral attitudes (mean score between 2.5 and 3.5) towards residents' ability to use technology and costs; and negative attitudes (mean score below 2.5) towards safety and privacy. In the demographics undisclosed group, participants presented positive attitudes towards features and characteristics, self-efficacy on the use of technology, clinical effectiveness, and organizational aspects; neutral attitudes towards residents' ability to use technology, residents and social aspects, costs, and safety; and negative attitudes towards privacy.

Table 3 presents participants' responses to the statements categorized in the nine domains by number and percentage.

Features and Characteristics

Among the nine domains of the telepresence robots, features and characteristics is one of the two domains towards which participants presented the most positive attitudes. Table 3 shows that among all the participants, more than 90.5 per cent (n = 164) strongly or somewhat agreed on the importance of the sound quality of the telepresence robot, while approximately 60.8 per cent (n = 110) felt comfortable with its appearance. The one-way ANOVA, presented in Table 4, suggested a statistically significant difference between groups according to age (F[5,175] = 4.148, p = 0.001), profession or roles (F[5,175] = 2.403, p = 0.039), work experience in LTC (F[5,175] = 2.342, p = 0.043), work experience in a profession (F[5,175] = 3.227, p = 0.008), experience with robots in health care (F[2,178] = 4.267, p = 0.015), and education level (F[5,175] = 3.697, p = 0.003). Table 4 shows that the mean scores of the participants who selected "Prefer not to answer" for the demographic questions were consistently the lowest among the demographic sub-groups, indicating that the "Prefer not to answer" groups presented the most negative attitudes towards the features and characteristics (i.e., importance of the sound quality and the general appearance of telepresence robots).

Participants who fully disclosed their demographic backgrounds presented more positive attitudes towards the features and characteristics when compared with participants in the demographics undisclosed group (Figure 1). Table 5 shows that approximately 92.0 per cent of participants in the demographics fully disclosed group either strongly or somewhat agreed that the sound quality of the telepresence robots is important, compared with 84.2 per cent in the demographics undisclosed group. In terms of comfort with how telepresence robots look, 63.7 per cent strongly or somewhat agreed in the fully disclosed group, compared with 50.0 per cent in the undisclosed group.

Self-Efficacy on the Use of Technology

Participants consistently presented positive attitudes towards their self-efficacy on the use of telepresence robots (Table 3). Two-thirds of participants (74.6%, n = 135) strongly or somewhat agreed that they considered themselves technologically competent, and a similar number assumed that they would feel comfortable making errors in the process of getting used to operating the robots. Approximately 91.2 per cent (n = 165) felt confident that they could operate the robots if they received the necessary training, and approximately 85.0 per cent (n = 154) agreed that if they received training, they could confidently help residents use the robots.

The one-way ANOVA determined a statistically significant difference between the demographic sub-groups in participants'

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Table 3. Response to statements (%) (English *n* = 168, Chinese *n* = 13)

		Strongly Agree		Somewhat Agree		Neither Agree nor Disagree		Somewhat Disagree		Strongly Disagree	
		English	Chinese	English	Chinese	English	Chinese	English	Chinese	English	Chinese
Domain	Statement	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Features and characteristics	The sound quality of the mobile telepresence robot is important for communication.	114 (63.0)	8 (4.4)	37 (20.4)	5 (2.8)	15 (8.3)	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.6)	0 (0.0)
	I feel comfortable with how mobile telepresence robots generally look.	47 (26.0)	2 (1.1)	57 (31.5)	4 (2.2)	53 (29.3)	6 (3.3)	6 (3.3)	1 (0.6)	5 (2.8)	0 (0.0)
Self-efficacy on the use of technology	I would be comfortable making mistakes while getting used to operating a mobile telepresence robot.	66 (36.5)	5 (2.8)	62 (34.3)	3 (1.7)	20 (11.1)	3 (1.7)	9 (5.0)	0 (0.0)	11 (6.1)	2 (1.1)
	I am confident that I would be able to operate a mobile telepresence robot if I received the necessary training.	108 (59.7)	9 (5.0)	47 (26.0)	1 (0.6)	10 (5.5)	3 (1.7)	3 (1.7)	0 (0.0)	0 (0.0)	0 (0.0)
	I consider myself technologically competent.	65 (35.9)	4 (2.2)	61 (33.7)	5 (2.8)	26 (14.4)	4 (2.2)	14 (7.7)	0 (0.0)	2 (1.1)	0 (0.0)
	I would be confident in helping residents use a mobile telepresence robot if I received the necessary training.	89 (49.2)	6 (3.3)	55 (30.4)	4 (2.2)	20 (11.1)	2 (1.1)	4 (2.2)	1 (0.6)	0 (0.0)	0 (0.0)
Residents' ability to use technology	It would be easier for residents to use a mobile telepresence robot than other technologies.	39 (21.6)	3 (1.7)	49 (27.1)	5 (2.8)	65 (35.9)	4 (2.2)	14 (7.7)	1 (0.6)	1 (0.6)	0 (0.0)
	I am concerned that residents will be unable to operate a mobile telepresence robot.	49 (27.1)	5 (2.8)	69 (38.1)	6 (3.3)	27 (14.9)	2 (1.1)	15 (8.3)	0 (0.0)	8 (4.4)	0 (0.0)
Clinical effectiveness	Residents would be able to interact with their families and friends via a mobile telepresence robot.	78 (43.1)	7 (3.9)	67 (37.0)	4 (2.2)	11 (6.1)	2 (1.1)	9 (5.0)	0 (0.0)	3 (1.7)	0 (0.0)
	Mobile telepresence robots will be used in the health care setting in the future.	80 (44.2)	7 (3.9)	57 (31.5)	3 (1.7)	25 (13.8)	3 (1.7)	3 (1.7)	0 (0.0)	3 (1.7)	0 (0.0)
	The use of a mobile telepresence robot in my health care setting would provide more benefits than risks.	65 (35.9)	5 (2.8)	64 (35.4)	6 (3.3)	33 (18.2)	1 (0.6)	5 (2.8)	1 (0.6)	1 (0.6)	0 (0.0)
	A mobile telepresence robot could reduce anxiety among residents.	43 (23.8)	3 (1.7)	69 (38.1)	6 (3.3)	43 (23.8)	3 (1.7)	12 (6.6)	1 (0.6)	1 (0.6)	0 (0.0)
	The use of a mobile telepresence robot in long-term care homes would reduce the risk of infection among residents and staff.	45 (24.9)	5 (2.8)	43 (23.8)	6 (3.3)	61 (33.7)	1 (0.6)	15 (8.3)	1 (0.6)	4 (2.2)	0 (0.0)
	A mobile telepresence robot could reduce loneliness among residents.	74 (40.9)	5 (2.8)	58 (32.0)	8 (4.4)	27 (14.9)	0 (0.0)	6 (3.3)	0 (0.0)	3 (1.7)	0 (0.0)
	I am concerned that the option to use a mobile telepresence robot would replace family visits.	15 (8.3)	0 (0.0)	52 (28.7)	3 (1.7)	37 (20.4)	3 (1.7)	29 (16.0)	5 (2.8)	35 (19.3)	2 (1.1)
	Residents' families would benefit if long-term care homes had mobile telepresence robots.	62 (34.3)	3 (1.7)	71 (39.2)	7 (3.9)	27 (14.9)	3 (1.7)	3 (1.7)	0 (0.0)	5 (2.8)	0 (0.0)
	A mobile telepresence robot would help care workers monitor residents' conditions remotely.	40 (22.1)	5 (2.8)	71 (39.2)	5 (2.8)	40 (22.1)	2 (1.1)	13 (7.2)	0 (0.0)	4 (2.2)	1 (0.6)
	Using mobile telepresence robots will increase the efficiency of care in long-term care homes.	29 (16.0)	4 (2.2)	59 (32.6)	1 (0.6)	68 (37.6)	6 (3.3)	11 (6.1)	0 (0.0)	1 (0.6)	2 (1.1)
	The use of a mobile telepresence robot will increase residents' engagement in social activities.	40 (22.1)	5 (2.8)	75 (41.4)	5 (2.8)	38 (21.0)	2 (1.1)	12 (6.6)	1 (0.6)	3 (1.7)	0 (0.0)

(Continued)

Table 3. *Continued*

		Strongly Agree		Somewhat Agree		Neither Agree nor Disagree		Somewhat Disagree		Strongly Disagree	
		English	Chinese	English	Chinese	English	Chinese	English	Chinese	English	Chinese
Domain	Statement	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Residents and social aspects	I am concerned that the option to use a mobile telepresence robot would replace family visits.	15 (8.3)	0 (0.0)	52 (28.7)	3 (1.7)	37 (20.4)	3 (1.7)	29 (16.0)	5 (2.8)	35 (19.3)	2 (1.1)
	Residents' families would benefit if long-term care homes had mobile telepresence robots.	62 (34.3)	3 (1.7)	71 (39.2)	7 (3.9)	27 (14.9)	3 (1.7)	3 (1.7)	0 (0.0)	5 (2.8)	0 (0.0)
Organizational aspects	My workplace would be able to provide Wi-Fi to operate a mobile telepresence robot.	107 (59.1)	9 (5.0)	44 (24.3)	2 (1.1)	11 (6.1)	2 (1.1)	2 (1.1)	0 (0.0)	4 (2.2)	0 (0.0)
	I would expect a mobile telepresence robot to be available 24/7 if there was one in my workplace.	79 (43.7)	5 (2.8)	55 (30.4)	4 (2.2)	23 (12.7)	3 (1.7)	7 (3.9)	0 (0.0)	4 (2.2)	1 (0.6)
	I would be comfortable making mistakes while getting used to operating a mobile telepresence robot.	66 (36.5)	5 (2.8)	62 (34.3)	3 (1.7)	20 (11.1)	3 (1.7)	9 (5.0)	0 (0.0)	11 (6.1)	2 (1.1)
	Mobile telepresence robots will be used in the health care setting in the future.	80 (44.2)	7 (3.9)	57 (31.5)	3 (1.7)	25 (13.8)	3 (1.7)	3 (1.7)	0 (0.0)	3 (1.7)	0 (0.0)
	I am confident that I would be able to operate a mobile telepresence robot if I received the necessary training.	108 (59.7)	9 (5.0)	47 (26.0)	1 (0.6)	10 (5.5)	3 (1.7)	3 (1.7)	0 (0.0)	0 (0.0)	0 (0.0)
	I am enthusiastic about adopting new technologies in my workplace.	93 (51.4)	6 (3.3)	50 (27.6)	5 (2.8)	23 (12.7)	1 (0.6)	1 (0.6)	1 (0.6)	1 (0.6)	0 (0.0)
	My institution / organization would support the use of a mobile telepresence robot in my workplace.	62 (34.3)	2 (1.1)	61 (33.7)	5 (2.8)	43 (23.8)	5 (2.8)	2 (1.1)	0 (0.0)	0 (0.0)	1 (0.6)
	Employees in my workplace would support each other in using a mobile telepresence robot if one were available.	61 (33.7)	3 (1.7)	56 (30.9)	5 (2.8)	44 (24.3)	4 (2.2)	7 (3.9)	1 (0.6)	0 (0.0)	0 (0.0)
	I would be confident in helping residents use a mobile telepresence robot if I received the necessary training.	89 (49.2)	6 (3.3)	55 (30.4)	4 (2.2)	20 (11.1)	2 (1.1)	4 (2.2)	1 (0.6)	0 (0.0)	0 (0.0)
	A mobile telepresence robot would make my job more interesting.	63 (34.8)	5 (2.8)	52 (28.7)	3 (1.7)	47 (26.0)	4 (2.2)	4 (2.2)	1 (0.6)	2 (1.1)	0 (0.0)
	If a mobile telepresence robot is used in my workplace, my workload would increase.	18 (9.9)	4 (2.2)	56 (30.9)	1 (0.6)	53 (29.3)	5 (2.8)	22 (12.2)	3 (1.7)	19 (10.5)	0 (0.0)
Costs	Using a mobile telepresence robot would reduce the cost of long-term care in the long run.	29 (16.0)	2 (1.1)	37 (20.4)	5 (2.8)	64 (35.4)	3 (1.7)	26 (14.4)	3 (1.7)	12 (6.6)	0 (0.0)
	I am concerned about the cost of mobile telepresence robots.	29 (16.0)	5 (2.8)	57 (31.5)	4 (2.2)	56 (30.9)	3 (1.7)	14 (7.7)	1 (0.6)	12 (6.6)	0 (0.0)
Safety	If a mobile telepresence robot is operated remotely, there will be concerns about residents' safety (e.g. injury).	27 (14.9)	0 (0.0)	71 (39.2)	4 (2.2)	49 (27.1)	7 (3.9)	12 (6.6)	1 (0.6)	9 (5.0)	1 (0.6)
Privacy	I am concerned that the use of a mobile telepresence robot could affect residents' privacy in long-term care homes.	33 (18.2)	4 (2.2)	75 (41.4)	1 (0.6)	28 (15.5)	6 (3.3)	20 (11.1)	2 (1.1)	12 (6.6)	0 (0.0)
	Operating a mobile telepresence robot in health care spaces could create privacy concerns.	31 (17.1)	3 (1.7)	77 (42.5)	7 (3.9)	45 (24.9)	2 (1.1)	10 (5.5)	1 (0.6)	5 (2.8)	0 (0.0)

Table 4. One-way analysis of variance (ANOVA)

		Features and Characteristics		Self-Efficacy on the Use of Technology		Residents' Ability to Use Technology		Residents and Social Aspects		Organizational Aspects		Clinical Effectiveness		Costs		Safety		Privacy	
	N (%)	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*
Age																			
20-29	17 (9.4)	4.29 (0.85)	0.001	4.47 (0.54)	<0.001	2.62 (0.57)	0.043	3.62 (0.65)	<0.001	4.20 (0.55)	<0.001	3.87 (0.61)	0.003	2.91 (0.62)	0.972	2.18 (1.01)	0.039	2.47 (1.05)	0.243
30-39	32 (17.7)	4.28 (0.54)		4.47 (0.54)		2.80 (0.86)		3.61 (0.73)		4.16 (0.47)		3.95 (0.55)		2.86 (0.76)		2.00 (0.95)		2.14 (0.83)	
40-49	43 (23.8)	4.08 (0.82)		4.16 (0.58)		2.85 (0.88)		3.21 (0.75)		4.03 (0.66)		3.76 (0.65)		2.98 (0.87)		2.56 (1.16)		2.42 (1.05)	
50-59	64 (35.4)	4.29 (0.59)		4.20 (0.52)		3.16 (0.80)		3.94 (0.80)		4.18 (0.52)		4.05 (0.53)		2.88 (0.79)		2.67 (0.96)		2.26 (0.72)	
≥60	7 (3.9)	4.50 (0.41)		4.46 (0.44)		2.93 (0.53)		4.00 (0.50)		4.34 (0.47)		4.01 (0.63)		2.79 (0.81)		2.57 (0.79)		2.93 (1.24)	
Prefer not to answer	18 (9.9)	3.56 (0.70)		3.63 (0.74)		2.67 (0.54)		3.17 (0.51)		3.53 (0.70)		3.44 (0.57)		2.83 (0.34)		2.61 (0.78)		2.56 (0.92)	
Profession or roles																			
Health care assistant/ support worker	66 (36.5)	4.23 (0.70)	0.039	4.21 (0.53)	<0.001	3.11 (0.92)	0.016	3.67 (0.90)	0.056	4.11 (0.63)	0.005	3.96 (0.62)	0.004	2.99 (0.80)	0.726	2.42 (1.22)	0.860	2.26 (0.91)	0.088
Nurse & student nurse	52 (28.7)	4.20 (0.72)		4.30 (0.61)		2.88 (0.80)		3.60 (0.70)		4.20 (0.53)		4.00 (0.53)		2.84 (0.89)		2.52 (0.98)		2.30 (0.92)	
Other allied health care professional	19 (10.5)	4.29 (0.45)		4.36 (0.52)		2.42 (0.58)		3.61 (0.89)		4.07 (0.57)		3.74 (0.63)		2.95 (0.57)		2.26 (0.81)		2.24 (0.87)	
Manager/ administrative roles	12 (6.6)	4.33 (0.49)		4.63 (0.38)		3.13 (0.61)		3.88 (0.86)		4.24 (0.49)		3.95 (0.72)		2.67 (0.91)		2.50 (0.80)		2.79 (0.92)	
Other	9 (5.0)	4.28 (0.91)		4.17 (0.50)		2.94 (0.73)		3.89 (0.60)		4.26 (0.34)		4.00 (0.37)		2.83 (0.35)		2.78 (0.67)		3.06 (0.98)	
Prefer not to answer	23 (12.7)	3.72 (0.74)		3.75 (0.74)		2.72 (0.42)		3.15 (0.32)		3.64 (0.62)		3.45 (0.53)		2.83 (0.32)		2.52 (0.85)		2.33 (0.72)	
Education level																			
High school or equivalent	20 (11.0)	4.48 (0.64)	0.003	4.19 (0.60)	0.008	3.58 (0.89)	0.004	4.20 (0.78)	0.003	4.41 (0.49)	0.005	4.24 (0.42)	0.031	3.25 (0.70)	0.060	2.40 (0.88)	0.534	2.05 (0.69)	0.341
Trade/ technical/ vocational school	16 (8.8)	3.91 (0.55)		4.05 (0.67)		2.79 (0.38)		3.47 (0.62)		3.86 (0.52)		3.75 (0.53)		2.59 (0.80)		2.89 (1.26)		2.53 (0.78)	
College/ university degree	102 (56.4)	4.25 (0.68)		4.31 (0.53)		2.87 (0.85)		3.55 (0.80)		4.13 (0.58)		3.90 (0.61)		2.92 (0.77)		2.37 (1.03)		2.30 (0.96)	
Professional degree	4 (2.2)	3.88 (0.63)		4.06 (0.47)		2.50 (0.58)		3.38 (0.85)		3.98 (0.54)		3.55 (0.29)		3.13 (0.48)		2.50 (0.58)		2.50 (0.71)	
Post-graduate degree	15 (8.3)	4.33 (0.72)		4.43 (0.58)		2.80 (0.62)		3.83 (0.82)		4.18 (0.49)		3.90 (0.66)		2.57 (0.75)		2.60 (0.83)		2.70 (1.13)	

(Continued)

Table 4. *Continued*

		Features and Characteristics		Self-Efficacy on the Use of Technology		Residents' Ability to Use Technology		Residents and Social Aspects		Organizational Aspects		Clinical Effectiveness		Costs		Safety		Privacy	
	N (%)	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*	Mean (SD)	*p*
Prefer not to answer	24 (13.3)	3.75 (0.75)		3.84 (0.74)		2.83 (0.55)		3.29 (0.55)		3.76 (0.70)		3.67 (0.63)		2.83 (0.62)		2.58 (1.02)		2.44 (0.74)	
Experience with robots in health care																			
I have never heard of or seen robots being used in health care settings	97 (53.6)	4.27 (0.65)	0.015	4.22 (0.53)	0.147	2.89 (0.86)	0.894	3.66 (0.76)	0.479	4.11 (0.59)	0.159	3.96 (0.57)	0.062	2.86 (0.74)	0.727	2.26 (1.03)	0.009	2.21 (0.90)	0.070
I have heard of or seen robots being used in health care settings	76 (42.0)	4.12 (0.72)		4.25 (0.62)		2.95 (0.76)		3.55 (0.85)		4.09 (0.55)		3.84 (0.60)		2.91 (0.78)		2.72 (0.95)		2.49 (0.86)	
I have used robots in health care settings	8 (4.4)	3.56 (0.90)		3.81 (1.09)		2.88 (0.44)		3.38 (0.52)		3.69 (0.94)		3.48 (0.88)		3.06 (0.78)		2.63 (0.92)		2.69 (1.22)	
Work experience in long-term care																			
Less than 3 months	5 (2.8)	4.70 (0.45)	0.043	4.80 (0.33)	<0.001	2.70 (0.27)	0.637	3.80 (0.27)	0.165	4.82 (0.06)	0.001	4.20 (0.17)	0.256	2.80 (0.27)	0.965	2.60 (0.89)	0.031	2.70 (0.27)	0.384
3 months to 1 year	15 (8.3)	4.10 (0.91)		4.30 (0.58)		2.60 (0.74)		3.90 (0.78)		4.20 (0.43)		3.96 (0.31)		3.00 (0.68)		2.20 (0.86)		2.77 (1.05)	
2-5 years	28 (15.5)	4.29 (0.69)		4.41 (0.55)		2.88 (0.82)		3.57 (0.92)		4.09 (0.53)		3.87 (0.62)		2.98 (0.69)		2.14 (0.85)		2.32 (0.94)	
6-9 years	17 (9.4)	4.15 (0.75)		4.37 (0.46)		2.97 (0.67)		3.71 (0.59)		4.18 (0.44)		3.96 (0.49)		2.88 (0.60)		2.18 (1.01)		2.32 (0.88)	
≥10 years	94 (51.9)	4.22 (0.64)		4.20 (0.56)		2.98 (0.89)		3.62 (0.83)		4.10 (0.61)		3.91 (0.65)		2.87 (0.89)		2.71 (1.09)		2.26 (0.90)	
Prefer not to answer	22 (12.2)	3.77 (0.74)		3.75 (0.73)		2.91 (0.55)		3.23 (0.53)		3.68 (0.66)		3.61 (0.61)		2.84 (0.39)		2.23 (0.75)		2.45 (0.86)	
Work experience in a current profession																			
Less than 3 months	4 (2.2)	4.63 (0.48)	0.008	4.75 (0.35)	<0.001	2.75 (0.29)	0.493	3.63 (0.85)	0.204	4.41 (0.59)	0.003	3.77 (0.78)	0.062	2.38 (0.95)	0.584	1.75 (0.96)	0.017	2.25 (0.65)	0.932
3 months to 1 year	18 (9.9)	4.14 (0.85)		4.32 (0.61)		2.69 (0.84)		3.64 (0.72)		4.20 (0.51)		3.97 (0.37)		3.00 (0.66)		1.94 (0.73)		2.47 (0.88)	
2-5 years	23 (12.7)	4.35 (0.76)		4.40 (0.58)		2.78 (0.89)		3.52 (0.87)		4.06 (0.57)		3.80 (0.63)		2.83 (0.65)		2.26 (0.86)		2.48 (1.02)	
6-9 years	19 (10.5)	3.97 (0.68)		4.21 (0.60)		2.89 (0.68)		3.58 (0.58)		4.01 (0.51)		3.87 (0.52)		2.76 (0.79)		2.32 (1.00)		2.21 (0.63)	
≥10 years	99 (54.7)	4.25 (0.62)		4.24 (0.53)		3.02 (0.85)		3.70 (0.85)		4.17 (0.58)		3.97 (0.63)		2.95 (0.83)		2.70 (1.08)		2.33 (0.97)	
Prefer not to answer	18 (9.9)	3.67 (0.77)		3.64 (0.74)		2.78 (0.43)		3.17 (0.34)		3.58 (0.65)		3.49 (0.55)		2.81 (0.30)		2.33 (0.77)		2.36 (0.78)	

Note. SD = standard deviation.

Table 5. Comparison of the responses between the demographics fully disclosed group (n = 143) and the demographics undisclosed group (n = 38)

Domain	Statement		Strongly Agree (%)	Somewhat Agree (%)	Neither Agree nor Disagree (%)	Somewhat Disagree (%)	Strongly Disagree (%)
Features and characteristics	The sound quality of the mobile telepresence robot is important for communication.	Disclosed	74.1	18.2	7.0	0.0	0.7
		Undisclosed	42.1	42.1	13.2	2.6	0.0
	I feel comfortable with how mobile telepresence robots generally look.	Disclosed	30.1	33.6	28.7	4.2	3.5
		Undisclosed	15.8	34.2	47.4	2.6	0.0
Self-efficacy on the use of technology	I would be comfortable making mistakes while getting used to operating a mobile telepresence robot.	Disclosed	42.0	37.1	9.1	3.5	8.4
		Undisclosed	28.9	31.6	26.3	10.5	2.6
	I am confident that I would be able to operate a mobile telepresence robot if I received the necessary training.	Disclosed	68.5	25.9	4.2	1.4	0.0
		Undisclosed	50.0	28.9	18.4	2.6	0.0
	I consider myself technologically competent.	Disclosed	40.6	36.4	12.6	9.1	1.4
		Undisclosed	28.9	36.8	31.6	2.6	0.0
	I would be confident in helping residents use a mobile telepresence robot if I received the necessary training.	Disclosed	58.0	28.7	10.5	2.8	0.0
		Undisclosed	31.6	47.4	18.4	2.6	0.0
Residents' ability to use technology	It would be easier for residents to use a mobile telepresence robot than other technologies.	Disclosed	25.2	29.4	37.1	7.7	0.7
		Undisclosed	15.8	31.6	42.1	10.5	0.0
	I am concerned that residents will be unable to operate a mobile telepresence robot.	Disclosed	32.9	37.8	15.4	8.4	5.6
		Undisclosed	18.4	55.3	18.4	7.9	0.0
Clinical effectiveness	Residents would be able to interact with their families and friends via a mobile telepresence robot.	Disclosed	51.7	40.6	2.1	4.2	1.4
		Undisclosed	28.9	34.2	26.3	7.9	2.6
	Mobile telepresence robots will be used in the health care setting in the future.	Disclosed	51.7	34.3	11.2	0.7	2.1
		Undisclosed	34.2	28.9	31.6	5.3	0.0
	The use of a mobile telepresence robot in my health care setting would provide more benefits than risks.	Disclosed	42.7	38.5	15.4	2.8	0.7
		Undisclosed	23.7	39.5	31.6	5.3	0.0
	A mobile telepresence robot could reduce anxiety among residents.	Disclosed	27.3	40.6	25.9	5.6	0.7
		Undisclosed	18.4	44.7	23.7	13.2	0.0
	The use of a mobile telepresence robot in long-term care homes would reduce the risk of infection among residents and staff.	Disclosed	27.3	28.0	32.2	9.8	2.8
		Undisclosed	28.9	23.7	42.1	5.3	0.0
	A mobile telepresence robot could reduce loneliness among residents.	Disclosed	46.9	35.0	14.7	2.8	0.7
		Undisclosed	31.6	42.1	15.8	5.3	5.3
	I am concerned that the option to use a mobile telepresence robot would replace family visits.	Disclosed	8.4	30.1	17.5	20.3	23.8
		Undisclosed	7.9	31.6	39.5	13.2	7.9
	Residents' families would benefit if long-term care homes had mobile telepresence robots.	Disclosed	39.2	42.7	13.3	1.4	3.5
		Undisclosed	23.7	44.7	28.9	2.6	0.0
	A mobile telepresence robot would help care workers monitor residents' conditions remotely.	Disclosed	27.3	42.0	21.0	7.0	2.8
		Undisclosed	15.8	42.1	31.6	7.9	2.6
	Using mobile telepresence robots will increase the efficiency of care in long-term care homes.	Disclosed	18.2	34.3	39.9	6.3	1.4
		Undisclosed	18.4	28.9	44.7	5.3	2.6
	The use of a mobile telepresence robot will increase residents' engagement in social activities.	Disclosed	26.6	44.1	19.6	7.7	2.1
		Undisclosed	18.4	44.7	31.6	5.3	0.0
Residents and social aspects	I am concerned that the option to use a mobile telepresence robot would replace family visits.	Disclosed	8.4	30.1	17.5	20.3	23.8
		Undisclosed	7.9	31.6	39.5	13.2	7.9
	Residents' families would benefit if long-term care homes had mobile telepresence robots.	Disclosed	39.2	42.7	13.3	1.4	3.5
		Undisclosed	23.7	44.7	28.9	2.6	0.0

(Continued)

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Table 5. *Continued*

Domain	Statement		Strongly Agree (%)	Somewhat Agree (%)	Neither Agree nor Disagree (%)	Somewhat Disagree (%)	Strongly Disagree (%)
Organizational aspects	My workplace would be able to provide Wi-Fi to operate a mobile telepresence robot.	Disclosed	67.1	25.9	4.2	0.7	2.1
		Undisclosed	52.6	23.7	18.4	2.6	2.6
	I would expect a mobile telepresence robot to be available 24/7 if there was one in my workplace.	Disclosed	49.0	32.9	11.2	4.2	2.8
		Undisclosed	36.8	31.6	26.3	2.6	2.6
	I would be comfortable making mistakes while getting used to operating a mobile telepresence robot.	Disclosed	42.0	37.1	9.1	3.5	8.4
		Undisclosed	28.9	31.6	26.3	10.5	2.6
	Mobile telepresence robots will be used in the health care setting in the future.	Disclosed	51.7	34.3	11.2	0.7	2.1
		Undisclosed	34.2	28.9	31.6	5.3	0.0
	I am confident that I would be able to operate a mobile telepresence robot if I received the necessary training.	Disclosed	68.5	25.9	4.2	1.4	0.0
		Undisclosed	50.0	28.9	18.4	2.6	0.0
	I am enthusiastic about adopting new technologies in my workplace.	Disclosed	60.1	28.0	10.5	0.7	0.7
		Undisclosed	34.2	39.5	23.7	2.6	0.0
	My institution / organization would support the use of a mobile telepresence robot in my workplace.	Disclosed	37.8	39.2	21.7	0.7	0.7
		Undisclosed	26.3	26.3	44.7	2.6	0.0
	Employees in my workplace would support each other in using a mobile telepresence robot if one were available.	Disclosed	38.5	33.6	23.8	4.2	0.0
		Undisclosed	23.7	34.2	36.8	5.3	0.0
	I would be confident in helping residents use a mobile telepresence robot if I received the necessary training.	Disclosed	58.0	28.7	10.5	2.8	0.0
		Undisclosed	31.6	47.4	18.4	2.6	0.0
	A mobile telepresence robot would make my job more interesting.	Disclosed	39.9	29.4	26.6	2.8	1.4
		Undisclosed	28.9	34.2	34.2	2.6	0.0
	If a mobile telepresence robot is used in my workplace, my workload would increase.	Disclosed	12.6	31.5	29.4	14.0	12.6
		Undisclosed	10.5	31.6	42.1	13.2	2.6
Costs	Using a mobile telepresence robot would reduce the cost of long-term care in the long run.	Disclosed	16.8	24.5	32.9	17.5	8.4
		Undisclosed	18.4	18.4	52.6	10.5	0.0
	I am concerned about the cost of mobile telepresence robots.	Disclosed	16.8	34.3	31.5	9.1	8.4
		Undisclosed	26.3	31.6	36.8	5.3	0.0
Safety	If a mobile telepresence robot is operated remotely, there will be concerns about residents' safety (e.g., injury).	Disclosed	16.1	39.9	32.2	6.3	5.6
		Undisclosed	10.5	47.4	26.3	10.5	5.3
Privacy	I am concerned that the use of a mobile telepresence robot could affect residents' privacy in long-term care homes.	Disclosed	21.7	41.3	16.8	12.6	7.7
		Undisclosed	15.8	44.7	26.3	10.5	2.6
	Operating a mobile telepresence robot in healthcare spaces could create privacy concerns.	Disclosed	21.0	48.3	23.1	4.9	2.8
		Undisclosed	10.5	39.5	36.8	10.5	2.6

attitudes towards their self-efficacy on the use of telepresence robots according to age ($F[5,175] = 6.304$, $p < 0.001$), profession or roles ($F[5,175] = 4.690$, $p < 0.001$); work experience in LTC ($F[5,175] = 4.918$, $p < 0.001$), work experience in a profession ($F[5,175] = 4.992$, $p < 0.001$), and education level ($F[5,175] = 3.223$, $p = 0.008$). No statistically significant difference was found between the demographic sub-groups according to participants' experience with robots in health care ($F[2,178] = 1.938$, $p = 0.147$).

Participants in the demographics fully disclosed group exhibited more positive attitudes towards their self-efficacy on the use of technology than participants in the demographics undisclosed group (Figure 1). In the responses to all four questions, the prevalence of participants who presented positive attitudes towards their technological competence in the fully disclosed group was consistently higher than that in the undisclosed group (Table 5). For example, approximately 94.5 per cent in the fully disclosed group strongly or somewhat agreed that they had confidence in their ability to operate a telepresence robot if they received the necessary training, compared with 78.9 per cent in the undisclosed group. However, whereas the prevalence of the participants who agreed that they considered themselves technologically competent was higher in the fully disclosed group than in the undisclosed

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group, the prevalence of the participants who disagreed with that statement was higher in the fully disclosed group (10.5%) than in the undisclosed group (2.6%).

Residents' Ability to Use Technology

Participants perceived residents' ability to use telepresence robots more negatively than they perceived their own technological competence. Whereas approximately 53.0 per cent ($n = 96$) agreed that it would be easier for residents to use telepresence robots than other technologies, more than 71.0 per cent ($n = 129$) were concerned that residents would not be able to operate them (Table 3). One-way ANOVA determined that there was a statistically significant difference in participants' attitudes towards residents' ability to use telepresence robots between the demographic sub-groups based on participants' age ($F[5,175] = 2.346$, $p = 0.043$), profession or role ($F[5,175] = 2.887$, $p = 0.016$), and education level ($F[5,175] = 3.620$, $p = 0.004$) (Table 4).

Compared to the group of participants who did not disclose their demographic backgrounds, the group of participants who did fully disclose their demographic backgrounds presented slightly more positive attitudes towards residents' ability to use telepresence robots (Figure 1). Whereas the prevalence of participants who agreed that they were concerned about residents' lack of ability to operate telepresence robots was only slightly lower in the fully disclosed group (70.7%) than in the undisclosed group (73.7%), almost twice as many participants in the fully disclosed group (14.0%) as in the undisclosed group (7.9%) said that they had no concerns about this factor (Table 5).

Clinical Effectiveness

Clinical effectiveness was another domain towards which participants presented positive attitudes. Overall, participants expressed a positive perception of the effectiveness of mobile telepresence robots in affecting residents' health, quality of life, and social engagement (Table 3). More than two-thirds of participants either strongly ($n = 46$; 25.4%) or somewhat ($n = 75$; 41.4%) agreed that telepresence robots could reduce residents' anxiety; and more than 80.0 per cent either strongly ($n = 79$; 43.6%) or somewhat ($n = 66$; 36.5%) agreed that the use of robots could alleviate loneliness among residents. Furthermore, more than 86.0 per cent ($n = 156$) agreed that the robots would enable residents to interact with their loved ones, while approximately 69.0 per cent ($n = 125$) either strongly agreed or somewhat agreed that the use of the robots would increase residents' engagement in social activities. In terms of how effective telepresence robots would be at reducing the risk of infection among residents and staff, the highest response was "neither agree nor disagree" ($n = 62$; 34.3%), followed by "strongly agree" ($n = 50$; 27.6%) and then "somewhat agree" ($n = 49$; 27.1%). Whereas just over two thirds of participants ($n = 121$; 66.9%) agreed that the robots would help care workers monitor residents remotely, approximately half ($n = 93$; 51.4%) viewed the robots as contributing to reducing the efficiency of care, and approximately 41.0% ($n = 74$) took a neutral position, choosing "neither agree nor disagree." One-way ANOVA suggested a statistically significant difference between the demographic sub-groups according to age ($F[5,175] = 3.723$, $p = 0.+$), profession or roles ($F[5,175] = 3.576$, $p = 0.004$), and education level ($F[5,175] = 2.525$, $p = 0.031$) (Table 4).

Participants in the demographics fully disclosed group perceived the clinical effectiveness of the use of telepresence robots slightly more positively than those in the undisclosed group (Figure 1). The prevalence of participants who agreed that the use of telepresence robots could bring about positive outcomes in alleviating residents' anxiety and loneliness and facilitating social interaction and engagement was consistently higher in the fully disclosed group than in the undisclosed group (Table 5).

Residents and Social Aspects

Participants' views on how the use of telepresence robots would affect residents' families were mixed (Table 3). Most participants (79.0%; $n = 143$) agreed that the robots would benefit the families. However, 38.7 per cent ($n = 70$) agreed that they were concerned that the use of the robots would replace family visits, and approximately 39.0 per cent ($n = 72$) were not concerned about this prospect. One-way ANOVA suggested statistically significant differences between the demographic sub-groups in participants' attitudes towards residents and social aspects, based on participants' age ($F([5,175] = 6.873$, $p = < 0.001$) and education level ($F[5,175] = 3.814$, $p = 0.003$) (Table 4).

The group of participants who fully disclosed their demographic information presented more positive attitudes towards residents and social aspects than the group of participants who did not (Figure 1). Whereas 44.1 per cent of the participants in the demographics disclosed group said they were not concerned that the use of telepresence robots would replace family visits, 21.1 per cent of participants in the undisclosed group held this same opinion (Table 5).

Organizational Aspects

The data (Table 3) show that, overall, participants perceived their organizations as being supportive of adopting telepresence robots, with 71.8 per cent ($n = 130$) assuming that their organization would support the use of the robots in their workplace. Approximately 90.0 per cent ($n = 162$) assumed that their organization would be willing to provide the Wi-Fi services required to operate the robots, and approximately 69.0 per cent ($n = 125$) agreed that their colleagues would help each other use the robots. Considering the health care setting in general, more than 81.0 per cent ($n = 147$) assumed that robots would be used in health care settings in the future. In addition, the analysis suggested that participants were interested in using new technologies at work. More than 85.0 per cent ($n = 154$) agreed that they were enthusiastic about adopting new technologies in their workplace. Approximately 68.0 per cent ($n = 123$) assumed that telepresence robots would make their job more interesting, while more than one quarter ($n = 51$; 28.2%) took a neutral stance. In terms of foreseen workload after the implementation of mobile telepresence robots, 43.6 per cent of participants ($n = 79$) assumed that their workload would increase and approximately 32.0% ($n = 58$) took a neutral stance.

One-way ANOVA (Table 4) suggested that there was a statistically significant difference between the demographic sub-groups according to age ($F[5,175] = 4.396$, $p = < 0.001$), profession or roles ($F[5,175] = 3.520$, $p = 0.005$), education level ($F[5,175] = 3.489$, $p = 0.005$), work experience in a profession ($F[5,175] = 3.702$, $p = 0.003$), and work experience in LTC ($F[5,175] = 4.135$, $p = 0.001$).

In terms of differences in attitudes towards organizational aspects, participants in the demographics fully disclosed group exhibited more positive attitudes than those in the demographics undisclosed group (Figure 1). The prevalence of participants who assumed that their workplace would provide support for the use of telepresence robots (e.g., provision of Wi-Fi, help from colleagues)

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was consistently higher in the group who fully disclosed their demographic information than in the group who did not (Table 5). Whereas the prevalence of participants who assumed that their workload would increase if a telepresence robot was used in their workplace was similar between the demographics fully disclosed and demographics undisclosed groups (44.1% and 42.1% respectively), the prevalence of participants in the fully disclosed group who did not assume it would increase was 26.6 per cent compared with 15.8 per cent in the undisclosed group (Table 5).

Costs

In terms of the costs, the data showed that participants' responses were mixed (Table 3). For example, half of the participants ($n = 95$; 52.5%) were concerned about the costs of the robots, while approximately 15.0 per cent ($n = 27$) were not and approximately 33.0 per cent ($n = 59$) took a neutral stance. In response to the statement "Using a mobile telepresence robot would reduce the cost of LTC in the long run," approximately 37.0 per cent ($n = 67$) selected "neither agree nor disagree" while approximately 40.0% ($n = 73$) either strongly or somewhat agreed and approximately 23.0 per cent ($n = 41$) either somewhat or strongly disagreed. One-way ANOVA did not indicate any statistically significant differences in the responses according to demographic characteristics (Table 4).

Participants who fully disclosed their demographic backgrounds viewed the costs associated with the use of telepresence robots slightly more positively than those in the undisclosed group (Figure 1). The analysis of participants' responses to each of the relevant statements revealed that whereas the prevalence of participants who assumed that the use of telepresence robots would reduce the cost of LTC in the long run was higher in the fully disclosed group (41.3%) than in the undisclosed group (36.8%), the prevalence of participants who disagreed was also higher in the fully disclosed group (25.9 vs.10.5%) (Table 5).

Safety

Safety was one of the domains to which participants responded negatively compared with other domains. Table 3 shows that the highest response to the statement "If a mobile telepresence robot is operated remotely, there will be concerns about residents' safety" was "somewhat agree" (41.4%; $n = 75$); when this is combined with "strongly agree" (14.9%; $n = 27$), 56.4 per cent ($n = 102$) expressed concern about the safety implications. A statistically significant difference between the demographic sub-groups was determined by one-way ANOVA (Table 4) based on age ($F[5,175] = 2.406$, $p = 0.039$), experience with robots in health care ($F[2,178] = 4.791$, $p = 0.009$), work experience in the profession participants identified holding at the time of the survey ($F[5,175] = 2.851$, $p = 0.017$), and work experience in LTC ($F[5,175] = 2.530$, $p = 0.031$).

In a departure from the pattern shown in other domains, participants who fully disclosed their demographic information presented slightly more negative attitudes towards safety than those who did not disclose their demographic information (Figure 1). The prevalence of participants who were concerned about the safety of the use of robots was slightly lower (56.0%) in the fully disclosed group than in the undisclosed group (57.9%) (Table 5). However, the prevalence of participants who said that they were not concerned was also lower in the fully disclosed group (11.9%) than in the undisclosed group (15.8%).

Privacy

Participants' attitudes towards the privacy domain were the most negative among the nine domains. As Table 3 shows, approximately 65.0 per cent of the participants ($n = 118$) agreed that operating telepresence robots in health care spaces in general could create privacy concerns, and approximately 62.5 per cent ($n = 113$) were concerned about residents' privacy in LTC settings. One-way ANOVA did not indicate any statistically significant differences in the responses according to demographic characteristics (Table 4).

The responses to the privacy domain questions were similar to those in the safety domain in that participants who fully disclosed their demographic information perceived privacy in the context of the use of telepresence robots more negatively than those who did not disclose their demographic backgrounds (Figure 1). The prevalence of participants who agreed that the use of telepresence robots could interfere with residents' privacy was higher in the fully disclosed group (69.3%) than in the undisclosed group (50.0%), and the prevalence of participants who did not perceive it to be a concern was lower in the fully disclosed group (7.7%) than in the undisclosed group (13.1%) (Table 5). However, the prevalence of participants who agreed (63.0%) and disagreed (20.3%) with the statement "I am concerned that the use of a mobile telepresence robot could affect residents' privacy in long-term care homes" was higher in the fully disclosed group than in the undisclosed group (agreed: 60.5%, disagreed: 13.1%).

Themes Generated from Responses to Open-Ended Questions

Table 6 encapsulates key themes generated from the content analysis of the textual data in response to the open-ended questions. Participants identified five main areas of concern about the use of mobile telepresence robots. (1) The risk of residents' privacy being compromised—for example, confidential conversations between residents and their loved ones being overheard—when mobile telepresence robots were being operated in shared spaces. (2) Safety; for example, one participant noted, "I wonder if it [mobile telepresence robot] detects presence around it since our residents are elderly and may cause accidents when robots just go around." (3) Concern that mobile telepresence robots could "confuse," "scare," "cause increased anxiety and paranoia," and be "threatening" to residents living with dementia. (4) A potential increase in workload; for example, one participant noted, "Increase workload to staff for operating the robots and especially when residents have communication problems or have difficulty in using the robots." 5) Logistical and operational concerns; for example, one participant observed, "Instructions and manuals have to be in both English and Chinese."

Three key benefits of using mobile telepresence robots in LTC were identified. (1) Many participants noted that mobile telepresence robots would help residents connect, interact, and communicate with their loved ones; for example, "Socialization. Family can communicate. It's the future." (2) Increased social engagement and connection for residents would have a positive impact on their mental health; for example, "Residents can socialize with family & friends so it's good for their mental health." (3) Some participants highlighted that mobile telepresence robots would provide residents with virtual access to medical support; for example, "provide immediate access to health professionals."

Additional comments about the use of mobile telepresence robots in LTC included suggestions for who should operate mobile telepresence robots, the need for both technical support and

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Table 6. Themes generated from the responses to open-ended questions

Theme	Example Excerpt
Q1. Do you have any concerns about the use of mobile telepresence robots in your workplace? If so, please describe them briefly.	
Privacy (English: *n*=14, Chinese: *n*=2)	"Privacy concerns. If a telerobot was in a main area, such as [the] dining room, near the nursing station while a resident is on a call with a family member[,] other confidential conversations may be overheard." (English)
	"My only concern is when they are used in double occupancy rooms, they could hinder the privacy of [one] resident when the other is using it and vice versa." (English) "[O]ther residents may have privacy concerns." (Chinese)
Safety (English: *n*=15)	"Safety concerns [–] a resident may trip over the device, or…other residents …[may] interfere with the device and the intended resident." (English)
Stress to residents (English: *n*=8)	"A concern for me is when working with individuals with cognitive impairment, confusion and not used to technology having a screen coming towards them, has in my experience caused increased anxiety and paranoia." (English)
	"Given the age of our residents, I am not sure if these robots would be somewhat scary. I think about how my mom would have reacted when she was in LTC." (English)
Staff's workload (English: *n*=7, Chinese: *n*=1)	"Workers use their own cell phones to control [the] robot. Personally, I don't have time to operate this robot. I have 10 residents to look after. My workload would increase more than it already has. I prefer to check on my residents in person. … Who cleans/ sanitizes the robot after coming out of each resident's rooms?" (English)
Operation (English: *n*=8)	"Language translation or multiple language options would be important for us in LTC." (English)
Q2. How do you think a mobile telepresence robot would benefit residents in your workplace?	
Social engagement (English: *n*=44, Chinese: *n*=1)	"I think it would benefit residents by giving them another outlet for social engagement with their loved ones." (English)
	"Residents could use Robots socially & feel less alone." (English)
Mental health (English: *n*=6)	"Opportunities for families out of town to connect with their loved ones, help with anxiety and loneliness." (English)
Health and safety (Monitor and observation) (English: *n*=11)	"Assist nurses to monitor a particular resident at the nursing station (eg a person is at a falls risk monitoring at night time)" (English)
	"Improve access to physicians and Nurse Practitioners, specialists, and other professional support." (English)
Q3. Do you have any comments about the use of mobile telepresence robots in long-term care homes in Canada? For example, do you have any comments about the type or level of support needed to use a Robot in your workplace?	
Operation (English: *n*=9, Chinese: *n*=1)	"These robots definitely will have to be operated mostly by care staff and residents often with dementia would not be able to operate the equipment." (English)
	"Please do not increase any workload to staffs who handles tremendous works nowadays." (Chinese)
Operational support (English: *n*=4)	"Make sure that there is one knowledgeable working in the unit all the time." (English)
Training (English: *n*=8)	"Proper training would definitely be needed for this to be properly implemented in long-term care homes." (English)
Staff vs. technology (English: *n*=3)	"I don't think this is the right way to meet the needs of a resident. We need more qualified staff rather than new technology to use." (English)

training, and concern about technology being used as an alternative to staff. On the topic of training, one staff member noted, "The staff would have to receive proper training for utilizing the robots to its best efficiency."

Discussion

This cross-sectional study investigated via a survey how staff in LTC homes perceived the use of mobile telepresence robots in such settings in Canada. Based on our analysis of 181 data sets, overall participants presented positive attitudes towards five domains of mobile telepresence robots (i.e., features and characteristics, self-efficacy on the use of technology, organizational aspects, clinical effectiveness, and residents and social aspects), negative attitudes towards the privacy and safety domains, and neutral attitudes towards the remaining two domains (residents' ability to use technology, and costs). It should be noted that participants overall exhibited positive attitudes towards the use of mobile telepresence robots possibly because many of the survey questions were framed positively and therefore might have influenced participants' perspectives.

Although 60.8 per cent (n = 110) of the participants presented positive attitudes towards the features and characteristics, concerns about how mobile telepresence robots generally look are worth discussing, given that approximately 39.0 per cent (n = 71) of participants exhibited either a neutral or a negative attitude to this aspect of the robots. As some participants pointed out in response to open-ended questions, a mobile telepresence robot moving around residents' surroundings may be intimidating to people living with dementia; for example, the Double mobile telepresence robot model stands between 47 and 60 inches (119–152 cm) high, so it is relatively tall. Similar concern was highlighted in Moyle et al.'s (2014) study that used Giraff (67 inches/170 cm), although no residents reacted negatively, and the fear that some residents

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experienced appeared to decrease as they observed other residents' responses to mobile telepresence robots. Previous research suggested that older adults with mild cognitive challenges seem to prefer robots that have human functional traits but are small (Cesta, Cortellessa, Orlandini, & Tiberio, 2016) and do not look like human beings (Wu, Fassert, & Rigaud, 2012).

Our results on participants' attitudes towards their self-efficacy on using technology highlight that providing staff with appropriate training is critical to the successful implementation of mobile telepresence robots in LTC settings. Although 74.6 per cent (n = 135) of participants considered themselves to be technologically competent, approximately 91.0 per cent (n = 165) agreed that they would feel confident operating a mobile telepresence robot if they received the appropriate training. Previous studies emphasized the need to train users—particularly health care professionals and family members—to develop their technological competence and ability to use mobile telepresence robots (Hung et al., 2022; Isabet et al., 2021; Moyle et al., 2013, 2014; Niemelä & Melkas, 2019). A user's level of understanding and ability (or lack thereof) to operate mobile telepresence robots has been identified as a major influence on the adoption or rejection of mobile telepresence robots (Korblet et al., 2019; Niemelä et al., 2017).

The survey results suggest that although several participants expressed concerns that mobile telepresence robots might cause stress to residents, overall, the participants assumed that using mobile telepresence robots could help mitigate residents' anxiety and loneliness and promote social engagement in LTC settings, which is in accordance with previous study findings. For example, research has highlighted that staff in LTC homes had positive attitudes towards the use of social robots, because they perceived them as offering companionship for residents and benefiting their mental health in LTC homes (Chen et al., 2020; Moyle et al., 2018). Mobile telepresence robots' effectiveness in promoting social engagement and addressing loneliness in older adults has been consistently identified as an important factor that supports their use in care settings (Moyle et al., 2014, 2020; Niemelä et al., 2017). Therefore, the results of our study suggest that staff's positive attitudes would contribute to the successful implementation of mobile telepresence robots in LTC homes. In contrast, staff's attitudes towards efficiency of care were mixed, with some staff expressing concern about the workload associated with operating mobile telepresence robots (e.g., technical support for residents and family, sanitizing mobile telepresence robots), as indicated by the qualitative data. A previous study conducted by Niemelä et al. (2017) in long-term care homes in Finland highlighted that care workers viewed mobile telepresence robots as "a very non-effortful device" for them. Although this may be true in terms of the technological competence required to use mobile telepresence robots, the logistics can affect staff's day-to-day responsibilities and task demands and therefore make the robots less attractive. This may be a particular issue if residents have severe cognitive decline and require staff's assistance to operate the robots. It is therefore imperative to establish designated technical support roles for residents in day-to-day practice, which would ensure the necessary timely assistance for residents and prevent staff from becoming overburdened.

The survey results also suggested that although the majority of participants agreed that mobile telepresence robots would benefit residents' families, more than one third were concerned that the use of mobile telepresence robots would result in fewer family visits. This reflects concern expressed elsewhere that as technology that provides human-like interactions and care becomes more prevalent in care settings, it may change and ultimately replace human-driven communication and care practices (Niemelä & Melkas, 2019). The participants in our study may have believed that mobile telepresence robots should be used to assist resident–family interactions only when family cannot visit residents—rather than as a primary means for residents to communicate and socially connect—considering that they prefer in-person interaction.

Our analysis showed that, overall, participants had a positive perception of their organization's ability to provide the resources required to implement mobile telepresence robots in their LTC site. Most of the participants assumed that their organization would offer adequate resources (e.g., Wi-Fi), while approximately 69.0 per cent (n = 125) agreed that their peers would support each other when operating mobile telepresence robots. These findings point to an organizational culture and structure that support the adoption of mobile telepresence robots. Previous studies highlight that the successful implementation of mobile telepresence robots depends on access to adequate and sustainable resources to operate them, such as a reliable Internet connection (Aaltonen et al., 2017; Hung et al., 2022; Moyle et al., 2013, 2014, 2020; Niemelä et al., 2017, 2021) and training (Koceski & Koceska, 2016; Moyle et al., 2013; Niemelä et al., 2017). Therefore, participants' positive perceptions of their organizations' ability to provide the required resources suggest cultural and systemic support for the implementation of mobile telepresence robots. Similarly, our analysis showed that the majority of participants were enthusiastic about adopting mobile telepresence robots and that approximately 70.0 per cent (n = 99) expected that mobile telepresence robots would make their work more interesting. Similar findings were presented in Moyle et al.'s (2018) study. More than 75.5 per cent (n = 137) of participants had pessimistic or neutral views on how adopting mobile telepresence robots could affect their workload. Isabet et al. (2021) conducted a narrative review of the literature on mobile telepresence robots and indicated that implementing technology for day-to-day usage in health care settings is time consuming and therefore can become another chore for both health care staff and family members. Participants in our study might have had concerns about the workload, given that more than 71.0 per cent (n = 129) expressed that it would be a challenge for residents to operate mobile telepresence robots. In addition, the content analysis also identified participants' concerns that cleaning and sanitizing the robots might be added to their work. Careful planning to navigate strategic implementation of mobile telepresence robots is warranted.

Participants' attitudes towards the cost of mobile telepresence robots and perceived economic benefits of using the robots in LTC homes were mixed. Although half (n = 95) were concerned about the cost of mobile telepresence robots, approximately 40.0 per cent (n = 73) assumed that mobile telepresence robots could contribute to reducing the cost of care. More positive findings emerged in Chen et al.'s (2020) study, in which half of care staff agreed that the use of mobile telepresence robots could reduce the cost of care and the other half took a neutral stance. The price of mobile telepresence robots depends on the size and brand; smaller robots are usually around CAD2,400, while larger ones can range from CAD6,700 to CAD8,000 (e.g., Double Robotics, n.d.; VGo Communications, n.d.). Information about the cost of maintenance is not available. It is unclear from our study how participants perceived mobile telepresence robots as potentially contributing to reducing care costs. Future research is warranted to examine how

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using mobile telepresence robots in aged-care settings can affect costs (Chen et al., 2020; Moyle et al., 2014; Vermeersch, Sampsel, & Kleman, 2015).

Our analysis showed that more than half of participants (n = 102) had concerns about residents' safety if mobile telepresence robots were operated remotely. The participants' attitudes towards safety were the second lowest among the nine domains. The findings of one-way ANOVA suggest that experience with robots in health care settings ("Never heard or seen" and "Have heard or seen") may inform staff's concerns about safety issue arising from mobile telepresence robots being operated remotely. Future research is needed to further examine the association between staff's attitudes towards safety and their experience with robots, given that in this study the number of participants who reported that they had used robots in health care settings was inadequate to conduct meaningful statistical analysis. Although safety concerns were previously raised in the context of mobile robots (Christoforou et al., 2020), little attention has been paid to discussing them in the context of mobile telepresence robots (Hung et al., 2022).

Our results highlighted that privacy was the primary concern associated with the use of mobile telepresence robots in LTC, which was consistent with the findings of previous research (Christoforou et al., 2020; Niemelä et al., 2017). Participants in our study were concerned about residents' privacy being compromised, particularly when mobile telepresence robots are used in shared spaces or double-occupancy rooms in an LTC environment. When navigating mobile telepresence robots in these areas, family members interacting with their loved ones may inadvertently observe other residents or overhear their private conversations (Aaltonen et al., 2017; Niemelä et al., 2017, 2021; Vermeersch et al., 2015). This issue would be a primary barrier to the implementation of mobile telepresence robots in LTC (Hung et al., 2022).

Our analysis indicated that participants who selected "Prefer not to answer" in response to demographic questions tended to exhibit more negative attitudes than participants who disclosed their demographic backgrounds. The participants in the disclosed group (n = 143) exhibited more positive attitudes than those in the undisclosed group (n = 38) towards all but two domains: safety and privacy. The sample size for our study was small, and the staff from the LTC homes who participated were all known to each other. We therefore assume that some participants, particularly those who exhibited negative views on the use of a mobile telepresence robots, opted not to share their demographic details to avoid the prospect of being identified by the researchers. Future research will require careful planning around data collection so that participants feel secure enough to share both their opinions and their demographic information, which will enable us to perform statistical analyses in a meaningful way (e.g., the examination of the associations between attitudes and demographic factors).

Implications for Implementing Mobile Telepresence Robots in Practice

Our study provides three key suggestions for successfully implementing mobile telepresence robots in LTC. First, developing and delivering mobile telepresence robot training programs tailored to various levels of technological skill, experience, and confidence is critical. Our findings indicated that whereas 74.6 per cent (n = 135) identified themselves as being technologically competent, 91.2 per cent (n = 165) would feel confident operating a mobile telepresence robot if they were trained. For developing the content and delivery of training programs, collaborating with staff with multidisciplinary backgrounds (e.g., health care assistant/support worker and manager/administrative roles) and multi-level experiences of working with robots in health care settings may be an effective approach (Koceski & Koceska, 2016; Reis et al., 2018). This type of collaborative approach to developing training may help to support staff within and across various disciplines and roles when using the robots. Second, a mobile telepresence robot implementation plan should be carefully developed by negotiating and integrating perspectives and needs of staff from various roles and disciplines. Given that staff foresaw a potential increase in their workload if mobile telepresence robots were introduced into their workplace, it is crucial to discuss, identify, and clearly describe staff's roles and responsibilities associated with operating mobile telepresence robots—including scheduling and booking residents' calls and sanitizing mobile telepresence robots.

Finally, to address staff's concerns about safety and privacy, it is essential to develop guidelines to ensure safety and privacy when mobile telepresence robots are being used, as suggested in previous studies (Aaltonen et al., 2017; Niemelä et al., 2021; Niemelä & Melkas, 2019). It is particularly important to consider how to sustain residents' privacy when mobile telepresence robots are being operated in shared spaces.

Strengths and Limitations

This study had two primary strengths and a few limitations. Collecting and analyzing both qualitative and quantitative data via the survey complemented interpreting the data as a whole, which bolstered our understanding of staff's attitudes. In addition, our transdisciplinary research approach enabled us to integrate multidisciplinary and multi-sectoral perspectives when designing the survey and analyzing the survey data, which helped us improve the accessibility level of the survey (e.g., language readability, bilingual design), involve a broader population in the survey, and better understand staff's attitudes. The key limitation of the study is that because of the small sample size and limited research sites (i.e., two LTC homes in an urban area of a single province), the results cannot be generalizable. Convenience sampling for data collection (from partnered LTC homes) might have yielded results that presented more positive attitudes and were therefore more favourable than if the data collection sites had been randomly selected. Future research needs to involve broader selections of LTC sites. Another limitation of the study is the positive wording of survey questions, which may have biased the ratings and interpretation of the results. Our intention was to keep the language clear and easy to understand to minimize the drop-out rate. The survey did not include specific questions about the benefits and concerns of the robot's camera. We did not have validation data for the Chinese translation version of the survey. Future studies on validation can help to ensure that the survey questions are psychometrically sound. Although the staff participants had diverse ethnic backgrounds, all but 13 participants submitted the English version of the survey. Finally, the cross-sectional nature of the study did not allow us to investigate how staff's attitudes change over time. Because this study was part of a larger project that explores the implementation of mobile telepresence robots in LTC settings, staff's attitudes towards the use of the robots may change as the project unfolds. To examine how participants' attitudes towards acceptability and usability change and how training programs contribute to the change, a follow-up study after several weeks or

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months of interactions between residents and their loved ones via mobile telepresence robots is required (Gerłowska et al., 2018).

Conclusions

Mobile telepresence robots have been identified as an innovative technological solution to residents' social isolation and loneliness (e.g., Cardona et al., 2020; Isabet et al., 2021). This study suggested that LTC staff had positive attitudes towards five domains of mobile telepresence robots (i.e., features and characteristics, self-efficacy on the use of technology, organizational aspects, clinical effectiveness, and residents and social aspects), and particular concerns about the risk to residents' privacy and safety, costs, and residents' ability to use the robots. To ensure and maximize the benefits of mobile telepresence robots, it is critical to address all the concerns identified in the study. Using a multidisciplinary team to develop mobile telepresence robot training sessions, guidelines for ensuring safety and privacy, and an implementation plan (e.g., identifying roles and responsibilities for professionals to operate mobile telepresence robots in daily practice) is key to the successful adoption of mobile telepresence robots in LTC settings.

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