Exploring Perceptions toward Home-Care Robots for Older People in Finland, Ireland, and Japan: A Comparative Questionnaire Study

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Abbreviations: ICT, Information and Communication Technology; ICF, International Classification of Functioning, disability and Health; HSCP, Health and social care professional; IGS, Irish Gerontological Society; JIK, Joint of Ilmajoki and Kurikka; MHLW, Ministry of Health, Labour and Welfare

Abstract

Purpose: To clarify potential users' perceptions toward the development and social implementation of home-care robots in Japan, Ireland, and Finland.

Methods: Unsigned, self-administered questionnaires were distributed to adults aged 65 or older, family caregivers, and home-care/health and social care professionals. A total of 1,004 responses were collected.

Results: In Japan, many people were already familiar with robots in their daily lives. The most notable finding about their perspectives on home-care robots was related to safety. Moreover, 93.7% of the Japanese respondents said, "If the user cannot decide whether to use a home-care robot, family members who know the user well should decide," followed by 76.4% in Ireland and 83.1% in Finland ($p < .001$). In Ireland, 81.8% of the respondents said, "I want to help other people and society by participating in the research and development of home-care robots" (Japan: 69.9%; Finland: 67.5%) ($p = .006$). In Finland, many people had a negative impression of robots compared to the other two countries. Finland had the highest percentage (75.4%) of respondents who said, "Health care professionals should be allowed to use secondary information collected by a home-care robot" (Japan and Ireland: 64%) ($p = .024$). Moreover, Ireland and Finland emphasized the need to guarantee the entitlement to receive human care.

Conclusions: Devising optimal strategies for the development and social implementation of home-care robots by incorporating various perspectives while valuing human dignity will require examination of each country's characteristics with respect to history, culture, policies, and values related to robots.

Keywords: ageing society, home-care robots, international joint research, research & development, social implementation, self-administered questionnaire

1. Background

Social ageing is expected to rapidly progress globally in the next 50 years. The United Nations' estimations by region show that social ageing will rapidly progress in both developing regions and in the developed regions (Prince et al., 2015). This means that there will be an increase in the number of older people who require health and social care, including older people with dementia. The Sustainable Development Goals promote social inclusion of all segments of society across national borders, with a particular focus on the most vulnerable, including older adults (UNDP, 2017).

Given this background, and in tandem with the aims of Ageing in Place (Hawley-Hague, Boulton, Hall, Pfeiffer, & Todd, 2014), there have been growing expectations for the development and social implementation of assistive technologies, including home-care robots that make use of Information and Communication Technology (ICT) and sensing technology. Various assistive technologies, therefore, have been developed to support older people (Brims & Oliver, 2019; De Luca, Bramanti, DeCola, & Leonardi, 2016; Fukuda et al., 2016; Hammar, Alastalo, & Mielikäinen, 2018; Kawamoto et al., 2013). Brims and Oliver's (2019) systematic review and meta-analysis clarified that supportive technologies, though not necessarily effective in reducing the number of admissions to care facilities, can still improve safety by reducing falls, accidents, and other dangerous movements. Additionally, a study using the International Classification of Functioning, Disability and Health (ICF) framework reported that socially assistive robots can improve older people's quality of life by promoting communication and self-care (Obayashi, Kodate, & Masuyama, 2018).

However, assistive technologies have not yet been widely implemented in society, with some exceptions, such as Denmark (Alaiad & Zhou, 2014; Granja, Janssen, & Johansen, 2018; Liddy, Dusseault, Dahrouge & Hogg 2008; Postema, Peeters & Friele, 2012; Schreiweis et al., 2019). Previous studies (Kitinoja et al., 2002; 2003) have shown that in

Finland and Japan, while older clients had positive opinions regarding telematics care, nurses were more reluctant, requiring a change of mindset regarding telematics care and computer equipment before information regarding the technology could be disseminated. It was suggested that clients and nurses would be more consistent in the use of telematics care if interactive communication was proved to be possible and insurance coverage was available. With the ageing rate increasing and various assistive technologies being developed, it remains unclear whether the current perceptions and circumstances are consistent with the preceding ones.

Until now, researchers have developed various models regarding the acceptance of new technologies (Ajzen, 1991; Davis, 1989; Davis, Bagozzi, & Warshaw, 1989; Eishbein, 1975; Venkatesh, Morris, Davis G.B., & Davis F.D., 2003). Venkatesh's unified theory of acceptance and use of technology model is especially well known. This model designates "performance expectancy," "effort expectancy," and "social influence" as factors that determine "behavioral intention," whereas it considers "facilitating conditions" as the determining factor of the "use" of new technologies. This model can account for 70% of the acceptance of new technology.

Several researchers have also developed a care-related, new technology acceptance model (Alaid & Zhou, 2014; Heerink, Krose, Evers, & Wielinga, 2010). It has been reported that the rate of older people's acceptance of wearable technology remains low despite technological improvements (Laitinen, Niemelä, & Pirhonen, 2016; Li, Ma, Chan, & Man, 2019; Rantanen, Lehto, Vuorinen, & Coco, 2018; Turja & Oksanen, 2019). Meanwhile, Suwa et al. (2020) clarified that ethical perception based on ethical principles affects home-care staff members' willingness to use home-care robots.

However, these models have been developed using data collected mostly in a single jurisdiction. A study comparing Finnish and Japanese care workers' individual opinions and

fears concerning the use of care robots indicated the significant influence of cultural factors (Coco, Kangasniemi, & Rantanen, 2018). In addition, the results of the latest public opinion poll concerning the use of digital technology in Germany showed that over 80% of people (N=1986) in Germany had “negative” impressions or “ambivalent feelings” about the use of care robots (Technik Radar, 2018). The latest Eurobarometer (European Commission, 2017) showed that while 61% of the respondents had a positive view of robots and artificial intelligence, 88% agreed that robots and artificial intelligence are technologies that require careful management. There was a slight decline (from 30% to 26%) in the proportion of the respondents who were comfortable having a robot to provide them services and companionship when infirm or elderly. Moreover, across EU member states, there is a great variation, from Poland (45%) and the Czech Republic (42%) to Greece (12%) and Portugal (11%). In Finland and Ireland, 25% and 26% of the respondents, respectively, answered that they were comfortable with robots providing them services, and the EU average was 26%. One major finding from that questionnaire was that the respondents with a positive view of robots and artificial intelligence were more likely to have used a robot, compared to those with a negative view. However, this questionnaire was targeted at the public at large and no care-specific questions were asked.

It is predicted that the perception toward assistive technology for older people, including home-care robots, differs not only among care workers but also among older adults and family caregivers in Europe and Japan. Further, the characteristics of these perceptions are likely to differ from country to country. Therefore, to realize Ageing in Place amid global ageing through the use of assistive technologies, including home-care robots, it is necessary to engage appropriately in the development and social implementation of assistive technology in each country. To do so, it will be necessary to first elucidate the similarities and differences between countries through international comparative research.

Therefore, the present research aims to elucidate the perceptions toward the development and social implementation of home-care robots held by potential users in Japan, Ireland, and Finland. In Japan, the functional definition of a robot is “an intelligent machine that combines sensing, thinking/controlling, and acting technologies” (Robot Policy Research Group, 2006). Care robots employ robot technology to help users remain independent and reduce the burden on caregivers; as a result, Japan is promoting their development and implementation (Ministry of Economy, Trade, and Industry [METI], 2018). Considering that many people had never seen or dealt with home-care robots before, this study provided participants with the following definition of home-care robots: “Home-care robots come in many forms. The term ‘home-care robot’ used in this survey is a general expression for devices and systems that perform functions such as monitoring of older people and their surroundings, and provision of support for older people and/or their caregivers (including communication that enables interactive conversation, assistance with activities of daily living, or managing medications).” Thus, the present study defined home-care robots as things that use assistive technology to assist in the home-care of older people. The questionnaire form included images and illustrations of home-care robots, as shown in Figure 1.

Figure 1. *Illustrations of home-care robots in the questionnaire form*

Ireland and Finland were compared with Japan for the following reasons. Although the pace of ageing and prevalence of dementia vary, these three countries are all facing an ageing population and have nationwide dementia strategies. As previously mentioned, people in Finland and Ireland seem to be fairly positive (compared to the EU average) toward robots but the two countries are in sharp contrast with regard to welfare policies, with Finland supporting universalism and Ireland having been heavily reliant on the voluntary sector. In terms of the countries' images around technologies, Japan is at the forefront of technology-assisted social care, whereas Finland is known for ICT education and Ireland is known for hosting major multinational ICT corporations in its capital city. Therefore, it is predicted that these similarities and differences would create different sets of expectations and demands for home-care robots. The current situation of geriatric care in Japan, Ireland, and Finland is described in Table 1.

Table 1

Timeline of care policies for older people in Ireland, Finland, and Japan

	Ireland	Finland	Japan
Population	4,784,383 (2017)[a]	5,570,722 (2019)[a]	126,181,000 (2019)[a]
Ageing Rate	13.4 % (2016)[b]	21.9% (2018)[b]	28.4% (2019)[b]
Care Policy for Older People	Historically, institutional care has been the norm In 2006, the Home Care Package Scheme was introduced In 2009, the Nursing Home Support Scheme was introduced In 2013, the National Positive Ageing Strategy was published; vulnerability, including the risk of poor health or loss of independence, financial vulnerability, and social isolation were highlighted	In 2011, the Socially Sustainable Finland 2020: Strategy for Social and Health Policy was published In 2012, the National Memory Program 2012-2020 (national Dementia Strategy) was launched Between 2016 and 2019, the National Key Project for Home-Care and Informal Care was implemented; cost-effectiveness of the services, multidisciplinary rehabilitation, support services to the homes of older people, as well as establishing support for family carers and informal carers were highlighted	In 2000, Long-term Care Insurance scheme was introduced Community-based integrated care system was promoted In 2012, the Orange Plan (5-year dementia measures) was published In 2015, the New Orange Plan was introduced In 2018, Guidelines regarding decision-making support for people with dementia were implemented In 2019, the Dementia Policy Promotion Charter

In 2014, the Dementia Strategy was issued was issued

Note. [a]year of the latest OECD Population Data collection; [b]year of the latest Census Data collection

1.1 Japan

In Japan, the "Comprehensive Strategy to Accelerate Dementia Countermeasures" (the "New Orange Plan") was approved for inter-ministerial collaboration (Ministry of Health, Labour and Welfare, 2015; Postema et al., 2012). Of the seven pillars outlined by the New Orange Plan, one specifically entails support for the development of equipment that makes use of robotics and ICT as well as the promotion of the dissemination of results. Therefore, in the wake of the New Orange Plan, the development of home-care robots for older adults is now being promoted as a focus of national policy to ameliorate the shortage of care workers and reduce the burden on them (Nakagawa, Yamada, & Nasu, 2014). Some care robots developed in Japan are widely known and have been tested on people with dementia (Granja et al., 2018; Inoue, Wada, & Uehara, 2011; Jones et al., 2018; Schreiweis et al., 2019).

Moreover, in 2015, the Ministry of Health, Labour and Welfare introduced a subsidy of 100,000 yen per device to allay costs for insured care facilities and institutions in introducing care robots that meet several criteria. This could advance the promotion of initiatives for reducing the care personnel's burden. Since 2018, such subsidies have been increased to 300,000 yen per device (Ministry of Health, Labour and Welfare, 2018). In 2018, the Ministry of Health, Labour, and Welfare established the "Care Robot Development and Promotion Office." The Dementia Policy Promotion Charter established in 2019 also emphasizes the development and social implementation of care robots.

1.2 Ireland

In 2013, the National Positive Ageing Strategy was published (Department of Health, 2013). This strategy was put forward as "a new departure in policy-making for ageing in

Ireland" by addressing the broader determinants of health and requiring "stronger engagement, interaction and joint working" across government departments and society (Department of Health, 2013, p. 11). The strategy highlights particular issues of vulnerability for some older people, including the risk of poor health or loss of independence, financial vulnerability, and social isolation.

Regarding dementia care, "Creating Excellence in Dementia Care: A Research Review for Ireland's National Dementia Strategy" (Cahill & Pierce, 2012) was published in 2012 and was funded by the Atlantic Philanthropies. Based on this review, the Dementia Strategy was published in 2014 by the Department of Health.

1.3 Finland

Regarding care policy for older people in Finland, a policy called Socially Sustainable Finland 2020, Strategy for Social and Health Policy, was published in 2011 (Ministry of Social Affairs and Health, 2011). The Finnish ageing policy concentrates on promoting the ageing population's ability to live independently at home and actively participate in different activities. This has been the policy since the beginning of 2000. One of the aims is to promote the functional ability of the individuals.

Additionally, a National Key Project for home-care and informal care took place in 2016-2019 (Ministry of Social Affairs and Health, 2016; Noro, 2016). The development was coordinated by the Ministry of Social Affairs and Health. It introduced cost-effectiveness of services for the ageing people, multidisciplinary rehabilitation, support services to homes of the ageing people, as well as support for the family carers and informal carers (Vehko, Ruotsalainen, & Hyppönen, 2018). The first Finnish national strategy for applying information technology to healthcare and social welfare was introduced in 1995 by the Ministry of Social Affairs and Health. The strategy was built around the principle of citizen-

centered and seamless service structures.

The Ministry of Social Affairs and Health and the Association of Finnish Local and Regional Authorities issued quality recommendations for developing services for older people in 2001, 2008, and 2013. In 2017, the quality recommendation was updated to accommodate ongoing changes in the policy and operational environment and the objectives of the Government Program and the General Government Fiscal Plan. The objective of the Quality Recommendation is to guarantee optimal health and functional capacity for the entire older population as well as high-quality, effective services for older people who need them.

1.4 Main contents of the Quality Recommendation are:

1. Working together to secure optimal functional capacity for older people
2. Putting client and service counselling at the center
3. High-quality services are provided by competent professionals
4. Age-friendly service structure
5. Making the most of technology

(Ministry of Social Affairs and Health, 2018)

Based on the above, it can be seen that these three countries differ greatly in their social security systems, the current demographics, and national cultures, whereas all three have dementia countermeasures in place.

2. Method

This study used a cross-sectional survey design. The study was conducted in one Japanese prefecture, the whole of Ireland, and one region (including three cities and one island) in Finland. The sampling methods used in the three countries are described below.

2.1 Japan

In Japan, the participants of this research were people aged 65 and over, family caregivers, and home-care staff in Prefecture A. Prefecture A belongs to the national capital region. It is composed of cities, agricultural communities, and fishing communities. In 2018, its ageing rate was 28.1%, which is almost the same as the national average. Thus, Prefecture A closely represents the current condition of Japan. Home-care offices in Prefecture A were systematically sampled from the offices listed in the Ministry of Labour, Health, and Welfare's Long-Term Care Insurance service information disclosure system. Questionnaire forms were created and distributed to 1,936 older people, 2,652 family caregivers, and 730 home-care staff. Older people and family caregivers received the questionnaire forms from the home-care staff. Additionally, an online version of the questionnaire, whose responses could be sent by postal mail or over the Internet, was created for older people, family caregivers, and home-care professionals.

2.2 Ireland

In Ireland, the targeted participants in this study were potential users of home-care robots. Questionnaire data were collated from the following three participant groups:

1) People aged 65 years or older who were or might be using health or social care services;

2) Family caregivers of people aged 65 years or older who were or might be using services related to nursing care; and

3) HSCPs, including nurses and care providers.

2.2.1 Recruitment and data collection for older people/family caregivers

Age Action Ireland agreed to act as a gatekeeper organization and distributed the

questionnaire to their members (N=1,154). Completion and return of the questionnaire were viewed as consent to participate. The diverse membership of Age Action facilitated the recruitment of both older people and family caregivers.

The respondents were invited to fill out the survey questionnaire, place it in the attached stamped self-addressed envelope, and send it back to Kodate/Donnelly, School of Social Policy, Social Work and Social Justice, University College Dublin.

2.2.2 Recruitment and data collection of HSCP

The Irish Gerontological Society (IGS) agreed to support the distribution of the HSCP professional questionnaire to HSCPs in Ireland. The IGS is one of the oldest multidisciplinary societies in the world concerned with gerontology. The members of the IGS come from across Ireland, representing professions and disciplines involved in areas such as health and social care, economics, the social and built environments, and technology.

To comply with General Data Protection Regulation, the IGS agreed to forward a briefing to their IGS mailing lists with an opt-in option for those interested in participating in the study to go on a new mailing list (which would be held and managed by the research team, Kodate/Donnelly). Once the email list of interested participants was shared by the IGS with the research team, a link to an online version of the questionnaire was administered to HSCPs via SurveyMonkey.

2.3 Finland

In Finland, the study participants were the potential users of home-care robots in B Region, including three cities, and C region, the island where older residents speak Swedish. The participants included adults aged 65 years or older, family caregivers of people aged 65 years or older, and home-care professionals.

The B region is situated in Western Finland. The region is largely rural and has about 200,000 inhabitants. The regional capital has 65,000 inhabitants (Statistic Finland, 2019). C island is situated in the Southwest Finland archipelago.

The questionnaires were distributed in the three cities by mail, in co-operation with the capital City and Joint of Ilmajoki and Kurikka (JIK) Joint Municipal Authority. Altogether, 775 questionnaires and 500 online questionnaires were distributed by the University in the capital city and 210 questionnaires were distributed by the municipality of C region. The questionnaires were systematically distributed to the representatives of the different target groups. The respondents were invited to complete the survey questionnaire, place it in the attached stamped self-addressed envelope, and send it back to the University in B region and to the municipality of C region. Additionally, an online version of the questionnaire was created for the home-care professionals.

The data collection period of the three countries was from November 2018 to February 2019.

2.4 Questionnaire development

For this study, we developed a basic, simplified conceptual framework based on a literature review, referring especially to the articles by Alaiad and Zhou (2014), Heerink, Krose, Evers, and Wielinga (2010), Suwa et al. (2020), and the proposal presented by the Japan Association for Clinical Ethics (2019) (Figure 2). The conceptual framework of the research is as follows. First, we considered the willingness and decision to use home-care robots by potential users, who were adults aged 65 and over, family caregivers, and home-care/HSPCs and how they were influenced by the nation's history, culture, progression of ageing, and long-term care policy for older adults. Potential users' willingness to use home-care robots is affected by their familiarity with the robots, their perceived risks and benefits

of use, and their attitudes toward protecting privacy, since home-care robots can acquire private data and images. These viewpoints should be regarded as important when considering the use and desirable functions of home-care robots. Moreover, we showed that the willingness to use home-care robots influences potential users' decision-making as well as that of the proxies or surrogates of older people without decision-making capacity. Furthermore, older adults will participate and use home-care robots even when the robots are still in the process of research and development. At the implementation stage, older adults will begin and continue to use home-care robots.

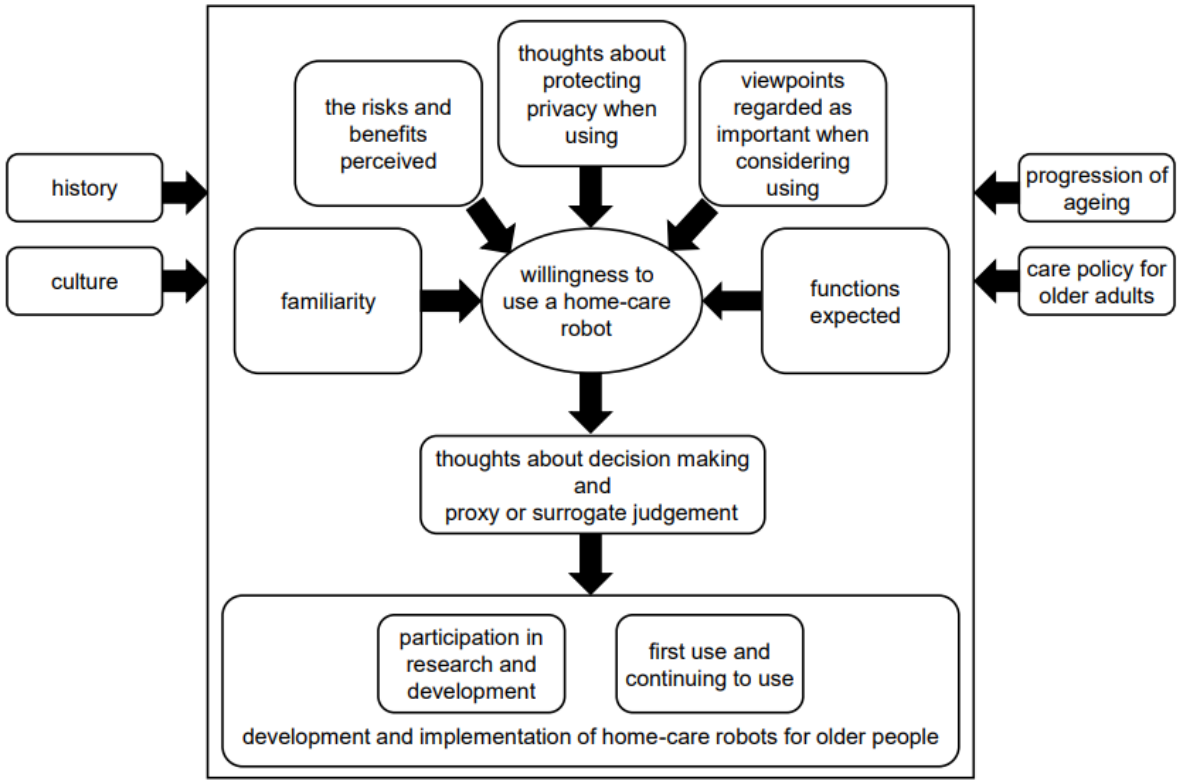


Figure 2. *Conceptual framework of the research*

To develop the questionnaire to explore potential users' perceptions about the development and implementation of home-care robots for older people, we examined the user acceptance models described above, developed for new technologies (i.e., Robotics in Care Services: A Finnish Roadmap, published in 2017 by a ROSE consortium [2017] led by Aalto

University). Further, the present study reviewed an article by Jacobs, Bigdeli, Annear, and Van Damme (2012), which identified access barriers to health services in terms of "geographic accessibility," "availability," "affordability," and "acceptability;" and an article by Lee and Coughlin (2015) which designated "usefulness," "usability," "affordability," "accessibility," "technical support," "social support," "emotion," "independence," "experience," and "confidence" as facilitating and determinant factors for older people's adoption of technologies.

Additionally, to develop survey items on the willingness of use, risks and benefits, proxy, protection of privacy, and other items related to ethical perception, the present study referred to the ethical principles specified in the Belmont Report (United States, 1978) and by Childress and Beauchamp (2001). The development of survey items also considered the proposal on the ethics of research in which participants have dementia, presented by the Japan Association for Clinical Ethics (2019). This is because many older people have dementia and, despite their gradual decline in decision-making capacities, they may be required to make decisions about participating in the implementation and development of home-care robots. Further, the present study used an article by Suwa et al. (2020) as reference, which clarified that ethical perceptions based on ethical principles affect home-care staff's willingness to use home-care robots.

Moreover, we developed question items designed to investigate people's perceptions related to the theory of common good (McCormick, 1974) and altruism (Lishner & Stocks, 2008), which are the bases for the justification of proxies for older adults with dementia in research that does not benefit the concerned person, as well as self-interest (Edward, Lilford, & Hewison, 1998), which can be considered as a motive for participation in the research. In addition, to develop survey items concerning functions expected or desired from home-care robots, the present study referred to a study by Darragh et al. (2017), which specified "daily

challenges (including reminders),” “safety and security,” “monitoring health and wellbeing,” “therapeutic intervention,” and “communication” in relation to needs for home-care robots. For the same purpose, the present study also referred to “Robotics in Care Services: A Finnish Roadmap,” which clarifies four assistive system categories: hospital logistics, rehabilitation, physical assistance, and cognitive assistance. Concerning the functions expected or desired from home-care robots, the present study also considered Korchut et al. (2017), which was conducted in Poland with patients diagnosed with mild cognitive impairment and early-stage dementia, family caregivers, and medical staff as its subjects.

An anonymous and self-administered questionnaire was developed in the Japanese, English, Finnish, and Swedish languages, while bearing in mind that there were differences among countries in matters such as culture and social security systems. The questionnaire consisted of basic attributes (background, age, gender) and familiarity with robots (seven items), willingness to use a home-care robot (two items), thoughts about the risks and benefits when participating in the development of a home-care robot (two items), viewpoints regarded as important when considering using a home-care robot (16 items), thoughts about decision-making and proxy or surrogate judgment regarding using a home-care robot when decision-making capacities have declined (four items), thoughts about protecting privacy when using a home-care robot (eight items), and functions expected from a home-care robot (15 items). In addition, the definition of “home-care robot” was reported on both the survey request letter and the cover page of the questionnaire form to ensure the participants’ understanding.

The questionnaire used a Likert scale to collect information in the form of numeric data regarding the perceptions toward home-care robots. Countries other than Japan generally use a five-point scale. However, the use of odd-number-point scales in Japan tends to invite respondents to choose the middle, neutral values, which can affect the results. A Likert scale

with even-number points is commonly used in Japan for this reason. The present study also used a four-point Likert scale so that not only the respondents in Japan, but also the respondents in Ireland and Finland, could clearly indicate their degrees of perceptions. A pilot study was conducted with 13 individuals (older people, families, and home-care staff aged between 40 and 80 years; nine females and four males) to refine the questionnaire in Japan.

Based on the results, corrections were made to the questionnaire. Subsequently, a questionnaire with a four-point Likert scale was developed.

2.5 Data analysis

Descriptive statistics were used to summarize the data. The respondents were divided into two groups based on their responses to all questions. The purpose of performing this analysis was to produce a clear analysis of the results for each country.

To clarify the characteristics of the three countries, statistical analysis was performed using SPSS (ver. 26). The chi-square test was used. The statistical significance level was set at 5%.

2.6 Ethical approval

In Japan, ethical approval was sought from and given by XXXX Research Ethics Committee (No. 30-19). All respondents were given an information letter explaining the purpose of the study, the possible benefits to science and society, and the voluntary nature of participation. It also clearly stated that by completing the questionnaire, they provided their consent to participate in the study. Informed consent was deemed to have been obtained with the return of a completed questionnaire and indication of the informed consent checkbox in the questionnaire.

In Ireland, ethical approval was granted by the University College YYYY Ethics

Committee – Humanities (ZZZZ) on October 25, 2018. The information sheet was inserted in the questionnaire envelope. For the online survey, it was included in the questionnaire. The sheet explained the purpose of the study, possible benefits to science and society, and the voluntary nature of participation.

In Finland, two separate ethical approvals were sought from the organizations whose customers participated in the research. City of AAA and the BBB Municipal Authority (JIK) providing the social and health care services to Ilmajoki and Kurikka municipalities granted the necessary permits to implement the research. The survey was carried out according to the Japanese model with a translated self-administered anonymous questionnaire. Accompanying the form, the respondents were given an information letter in Finnish, explaining the purpose of the study and the possible benefits to science and society. It was also explained that the participation to the survey was voluntary.

3. Results

A total of 1,004 valid responses were obtained. The basic characteristics of the participants in the three countries are shown in Table 2. In all three countries, there were participants who provided multiple responses for adults of age 65 years and above, family caregivers, and home-care/HSPCs.

Table 2

Basic characteristics of participants

	Japan n=528	Ireland n=296	Finland n=180
Background (Multiple Answer)			
Older person	176 (33.3)	128 (43.2)	107 (59.4)
Family caregiver	169 (32.0)	90 (30.4)	85 (47.2)
Home-care/Health and social care professionals	319 (60.4)	136 (45.9)	67 (37.2)
Age			
39 or younger	57 (10.8)	16 (5.4)	26 (14.4)
40-44	50 (9.5)	13 (4.4)	9 (5.0)
45-49	53 (10.0)	8 (2.7)	10 (5.6)
50-54	66 (12.5)	6 (2.0)	6 (3.3)
55-59	67 (12.7)	9 (3.0)	10 (5.6)
60-64	59 (11.2)	10 (3.4)	9 (5.0)
65-69	43 (8.1)	14 (4.7)	25 (13.9)
70-74	37 (7.0)	26 (8.8)	24 (13.3)
75-79	41 (7.8)	23 (7.8)	18 (10.0)
80-84	28 (5.3)	23 (7.8)	16 (8.9)
85 or older	27 (5.1)	18 (6.1)	21 (11.7)
No answer	0 (0.0)	130 (43.9)	6 (3.3)
Gender			
Male	122 (23.1)	38 (12.8)	54 (30.0)
Female	405 (76.7)	122 (41.2)	121 (67.2)
Not specified	0 (0.0)	7 (2.4)	1 (0.6)
No answer	1 (0.2)	129 (43.6)	4 (2.2)

N=1,004

3.1 Familiarity with robots

As shown in Figure 3, in Japan, approximately 61% of the participants had been exposed to robots through news, anime, manga, and other media. Twenty-five percent of the respondents also had experience using animal-form robots, humanoid robots, and cleaning robots. In contrast, in Finland, the highest percentage of people (46%) had a negative impression of robots. In all three countries, approximately 30% of the respondents answered that they had actually seen robots developed for care. In Japan, however, people who answered that they had used a robot that was developed for caregiving were estimated at 9.3%, followed by Ireland (5.5%) and Finland (4.7%).

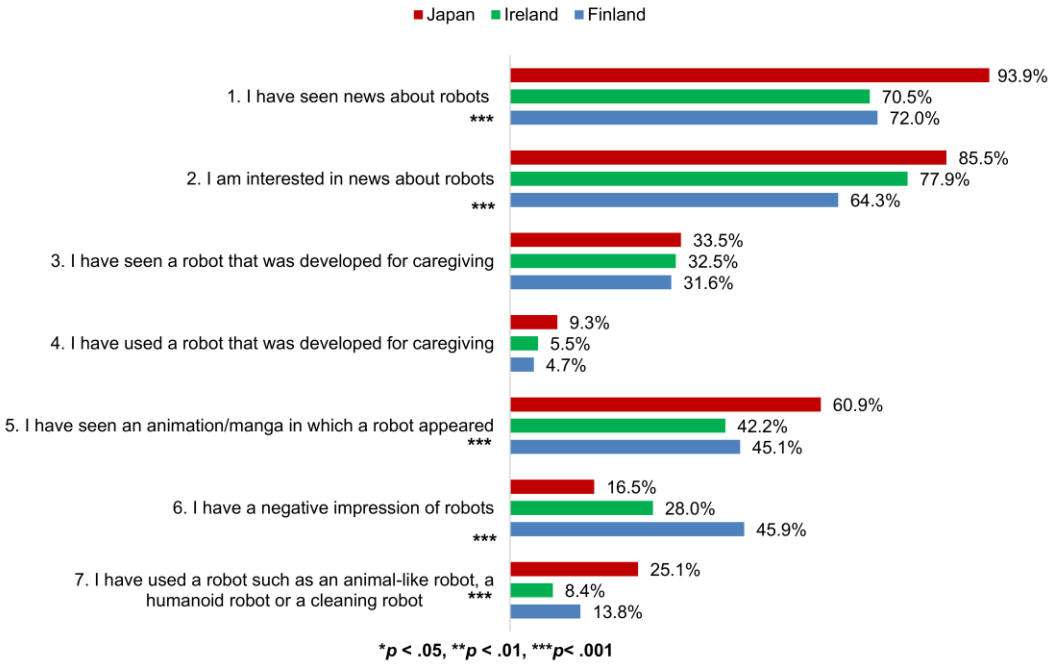


Figure 3. *Familiarity with robots by country*

Note. Familiarity with robots expressed by percentage of respondents in each research country who answered "yes" and "yes, to some extent" to the items presented in the figure; N=1,004.

3.2 Willingness to use home-care robots

As shown in Figure 4, 50% to 70% of the respondents in each country would like to

use a home-care robot "when providing care for family" or "when receiving care themselves." Japan had the highest approval ratio (70%, 72%), followed by Ireland (67%, 69%), and Finland (53%, 53%) ($p < .001$). However, 22% to 39% of the respondents were uncomfortable with using a home-care robot, most of whom were from Finland (39%) ($p < .001$).

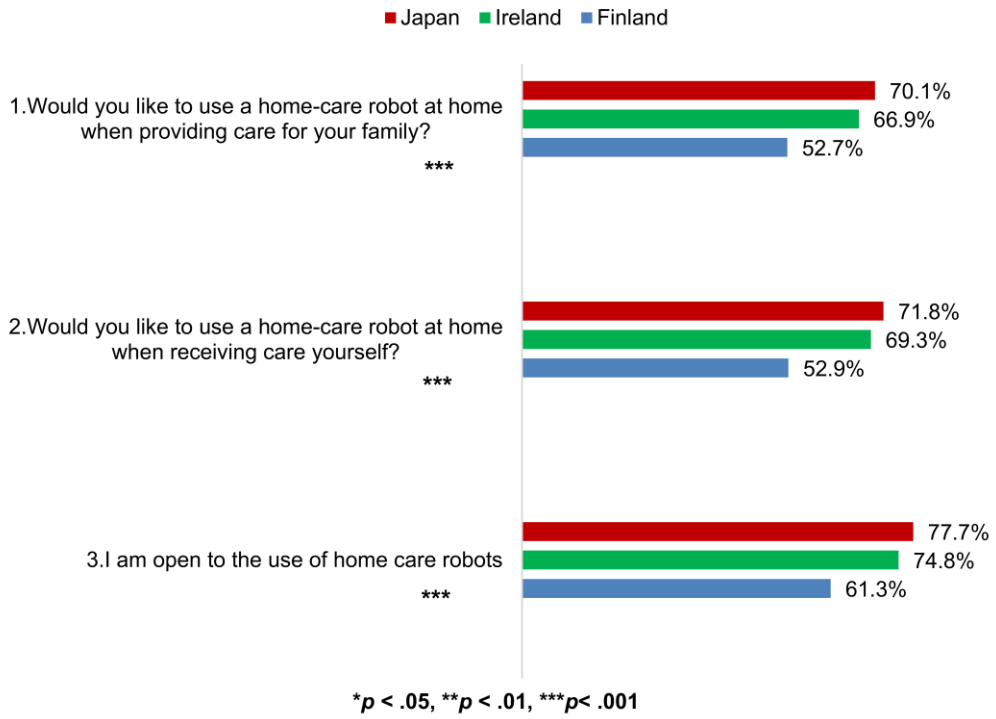


Figure 4. *Willingness to use home-care robots by country*

Note. Willingness to use home-care robots expressed by percentage of respondents in each research country who answered "yes" and "yes, to some extent" to the items presented in the figure; N=1,004.

3.3 Decision-making on using home-care robots

Regarding the decision to use a robot, as shown in Figure 5, approximately 90% respondents from all three countries agreed that "The user should decide whether to use a

home-care robot"; Ireland was the highest at 96.9% (p = .007). Japan had the lowest percentage of those who answered, "Whether to use a home-care robot should be decided based on its usefulness for family members," at 66.9% (approximately 80% in Ireland and Finland), and 44.6% of Japanese respondents said, "A health care professional should assess and decide whether a home-care robot should be used" (Ireland: 74%; Finland: 61%) (p < .001). However, 93.7% of the respondents in Japan said, "If the user cannot decide whether to use a home-care robot, family members who know the user well should decide," followed by 76.4% in Ireland and 83.1% in Finland (p < .001).

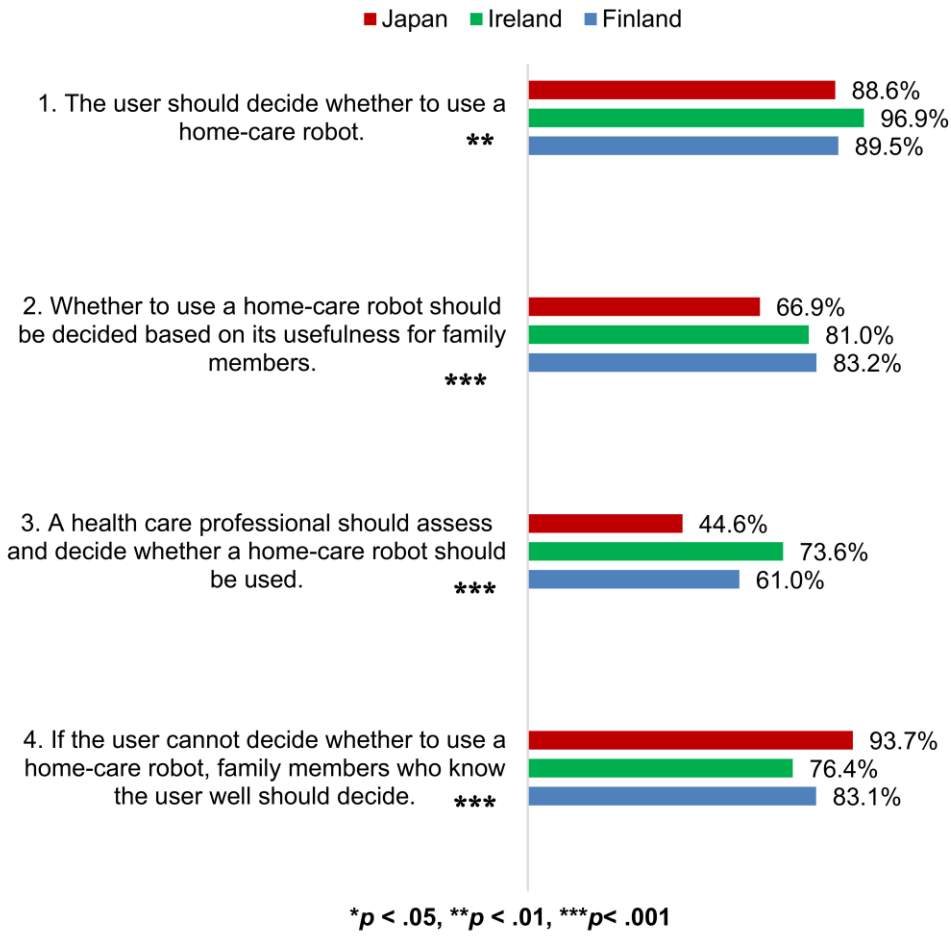


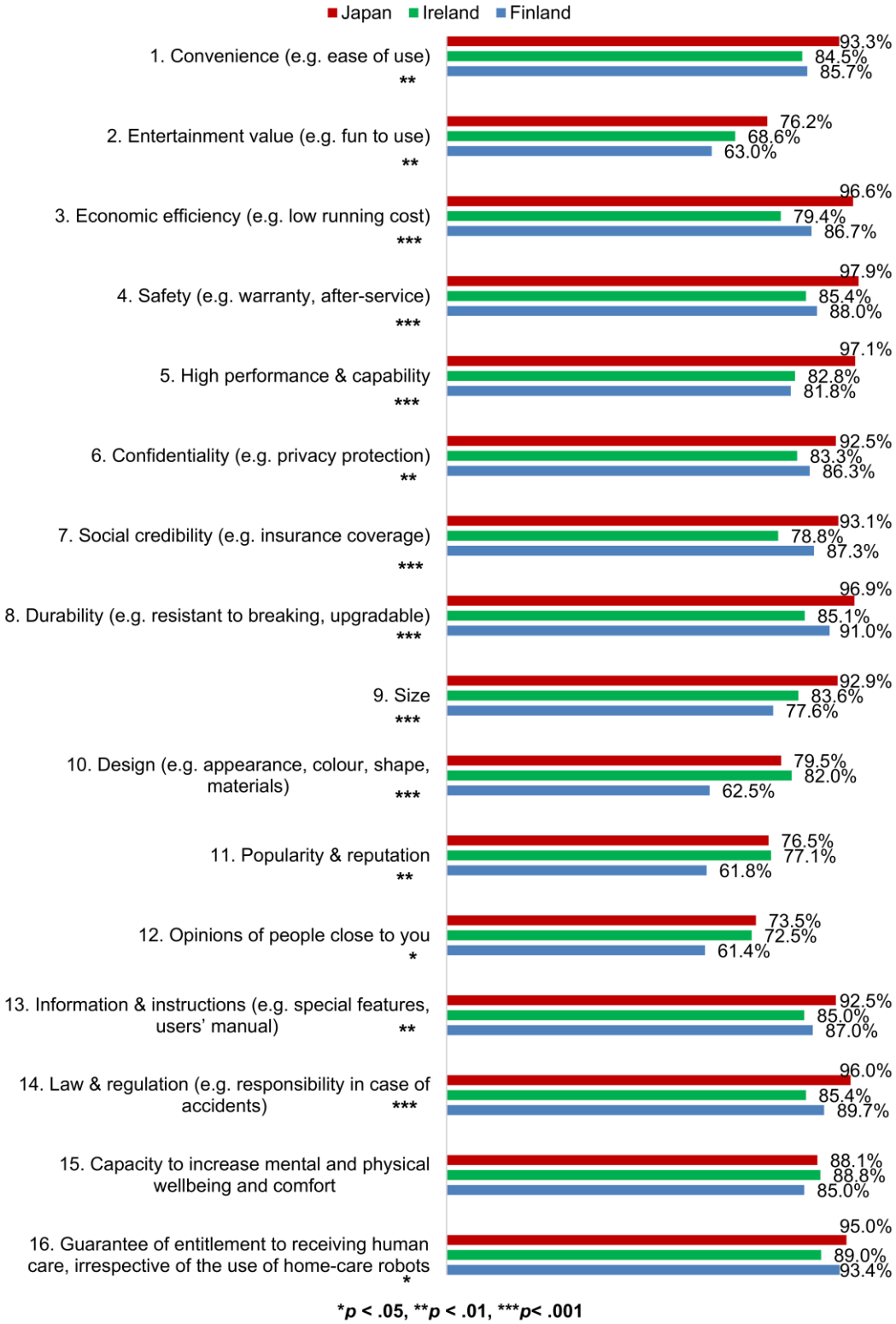
Figure 5. *Decision-making regarding the use of home-care robots by country*

Note. Decision-making regarding the use of home-care robots expressed by the percentage

of respondents in each country who answered “yes” and “yes, to some extent” to the items presented in the figure; N=1,004.

3.4 Importance of viewpoints regarding home-care robots

As shown in Figure 6, as for the guiding principles regarding what is important when using a home-care robot, the highest in Japan was safety at 97.9%, followed by high performance and capability at 97.1% and economic efficiency at 96.6%. In Ireland, the highest guiding principle was the “Guarantee of entitlement to receiving human care, irrespective of the use of home-care robots” at 89.0%, followed by “Capacity to increase mental and physical wellbeing and comfort” at 88.8%, and “Law and regulation” at 85.4%. In Finland, “Guarantee of entitlement to receiving human care, irrespective of the use of home-care robots” was at 93.4%, followed by “Durability” at 91.0% and “Law and regulation” at



89.7%.

Figure 6. *Importance of home-care robots' features by country*

Note. Importance of home-care robots' features expressed by the percentage of respondents in each research country who answered "yes" and "yes, to some extent" to the items presented

in the figure; N=1,004.

3.5 Expected functions of home-care robots

The top five expected/desirable functions of home-care robots in the three countries were quite similar, as indicated in Figure 7. In all three countries, “Notifying family members and support personnel when an unexpected change occurs in an older person,” “Informing an older person of the things he/she should be doing at the scheduled time or date (for example, take medications),” and “Notifying family members or support personnel of a home intrusion by a suspicious individual(s)” were among the top five functions. In Japan and Finland, “Confirming that an older person has taken his/her medication as prescribed by a physician” was one of the top five functions. “Providing support for the movements/mobility that older people regularly carry out in their daily lives” was listed in Japan and Ireland, and “Detecting obstacles on the floor to prevent falls” was included in Ireland and Finland.

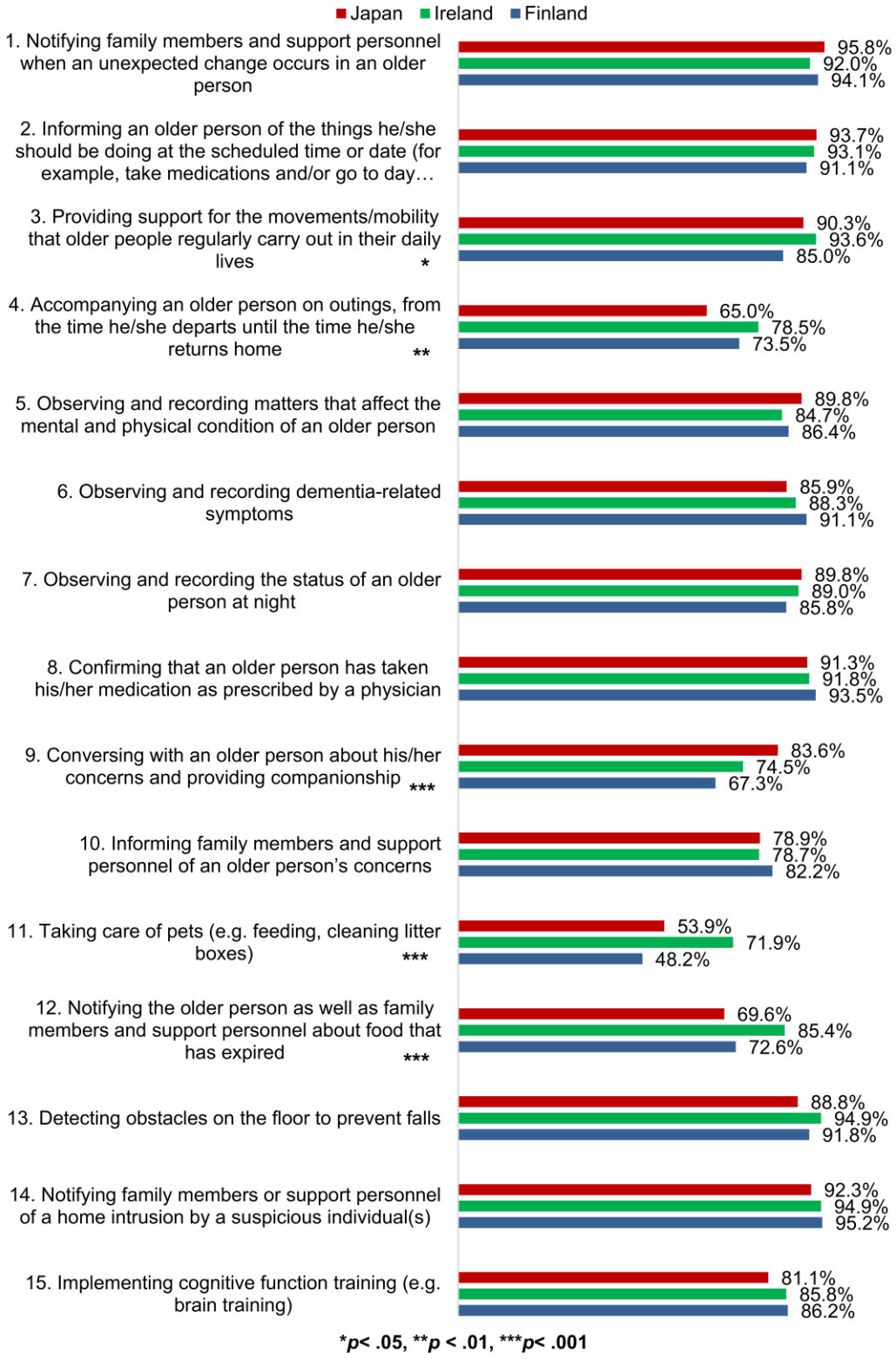


Figure 7. *Expected functions of home-care robots*

Note. Expected Functions of home-care robots expressed by percentage of respondents in each country who answered "absolutely desirable" and "somewhat desirable" to the items

presented in the figure; N=1,004

3.6 Recognition of decision-making and privacy protection for home-care robots' research and development and social implementation

As shown in Figure 8, regarding the information obtained by home-care robots, Japan had the highest percentage of respondents (55.2%) who said, "Home-care robots should be allowed to take photos or record videos that can identify the user, with his/her permission," whereas in Ireland and Finland, the responses were around 45% with a significant difference ($p = .035$). Those who responded, "Home-care robots should be allowed to take photos or record videos as long as the individual cannot be identified" only rose a few percentage points in all three countries, and there was no significant difference. Furthermore, approximately 70% to 90% of the respondents in all three countries claimed that health care professionals should be allowed to use information on vital signs, verbal information, and information on the users' location. Finland had the highest percentage (75.4%) of respondents who said, "Health care professionals should be allowed to use secondary information (e.g., blurred images, analyzed data) collected by a home-care robot" (Japan and Ireland: 64%) ($p = .024$).

In addition, approximately 70% of the respondents in all three countries said, "The person you can trust (non-family member), if agreed by both parties, should be allowed to use information obtained by a home-care robot for the purpose of safety monitoring." Among the three countries, Ireland was the highest with 74.4%, although no significant difference was found.

As for the participation in research and development, 81.8% of the respondents in Ireland said, "I want to help other people and society by participating in the research and development of home-care robots" (Japan: 69.9%; Finland: 67.5%) ($p = .006$) based on the

theory of common good and altruism, however, the percentage of respondents who said, "I am open to using a home-care robot even during the research and development stage if it would benefit me" based on self-interest was low for all three countries (Japan: 66.3%; Ireland: 75.0%; Finland: 58.6%) ($p = .009$).

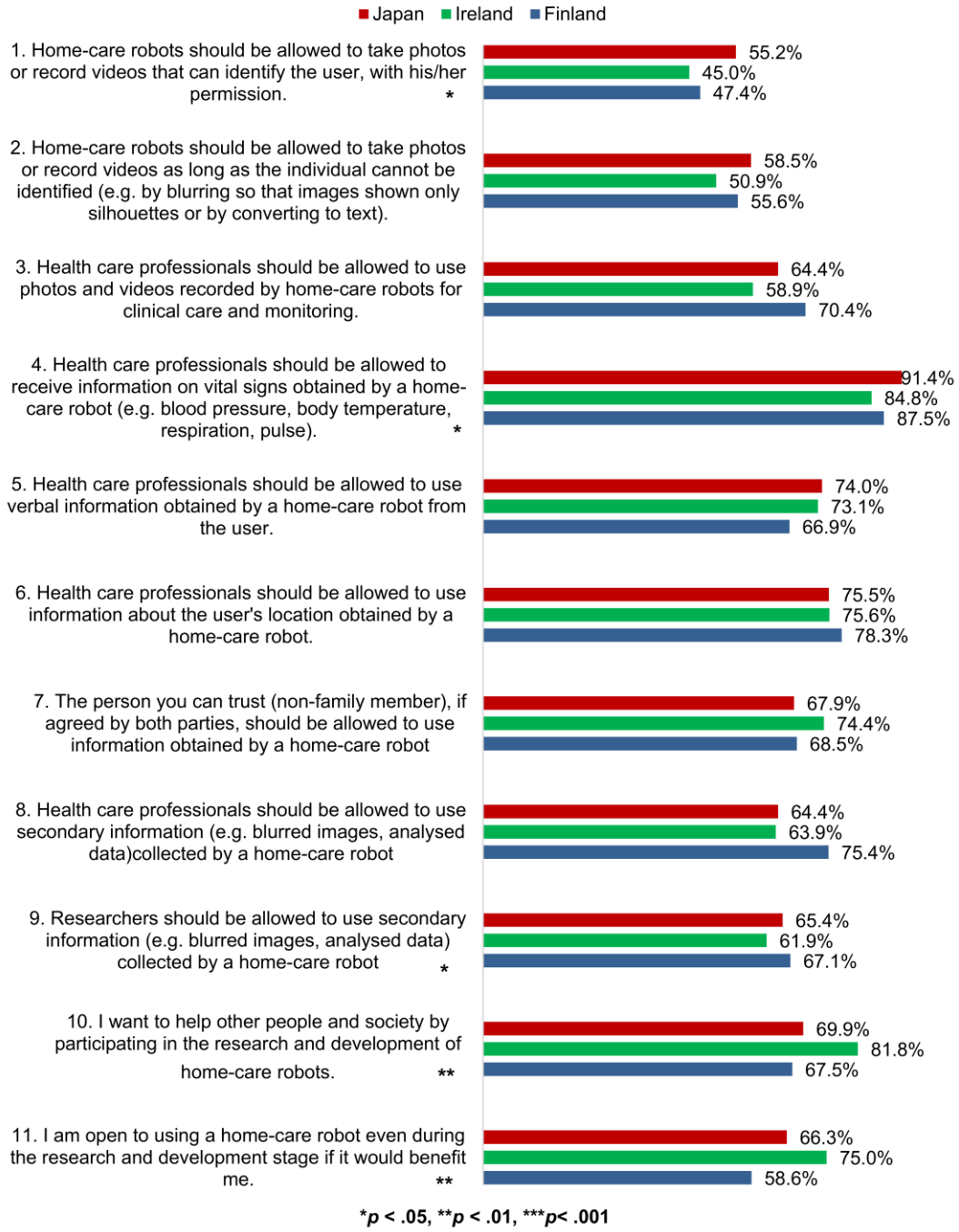


Figure 8. *Recognition of decision-making and privacy protection regarding home-care robots' research and development and social implementation by country*

Note. Recognition of decision-making and privacy protection regarding home-care robots' research and development and social implementation expressed by the percentage of respondents in each research country who answered "agree" and "somewhat agree" to the items presented in the figure; N=1,004

4. Discussion

4.1. Exploring the differences across the three countries

Some participants provided multiple responses for adults aged 65 and above, family caregivers, and home-care staff in the three countries, indicating that the population is ageing. In Japan, a super-ageing society where late marriage is common, the severe burden on a family member who takes care of both a child and an older adult is regarded as a problematic issue of double care (Gender Equality Bureau, 2016). Under the circumstances of an ageing society, people must play several care roles.

The results showed a significantly high rate of "Familiarity with Robots" in Japan compared with both Ireland and Finland. Moreover, it was confirmed that robots or robot-related things existed in the same space as humans in daily life in Japan, such as in anime. In Japan, people have a sense of familiarity with robots and use cleaning robots and animal-form robots in daily life; therefore, the rate of acceptance of home-care robots was relatively high and many showed willingness to use robots for the care of their family members or themselves.

Turja, Van Aerschot, Särkikoski, and Oksanen (2018) clarified that Finnish healthcare professionals' prior experience with robots correlates with the acceptance of robots. It also clarified that healthcare professionals have less experience with robots than ordinary people and that they have a negative stance toward robots. In Finland, robots have until now been used for distribution of goods and logistics (Directive 2010/40/EU, 2017), but not usually to directly provide services to people. This was likely the reason why the rate of willingness to

use home-care robots in Finland was the lowest among the three countries. In the Eurobarometer, however, 23% of the respondents had negative impressions in Finland and 26% in Ireland. Irish data are comparable, but Finnish data are much more negative than the Eurobarometer. A possible reason for this result is that there are big differences between the regions in Finland in using technology that supports independent living in home-care. In the South Ostrobothnia Region, approximately 23% of the home-care users use this kind of technology, while in many other regions, the number is even as high as 60 to 80%. The highest percent can be seen in the regions in Eastern Finland and in Lapland (Hammar, Mieklikänen, & Alastalo, 2018). It appears that participants of this research, older people and their caregivers, in these regions are not familiar with or accustomed to using health care technology. People's impression of robots is socially influenced in each country.

In Ireland, there has not yet been a government-wide coordination around artificial intelligence and robotics in connection with health or social care. However, the Department of Health initiated a blue skies policy project looking at the potential for artificial intelligence and robotics to transform the health workforce and health services (Government of Ireland, 2014). This reflects the government's commitment shown in the national Health Reform Program, SláinteCare, published in 2018. In Ireland, there have recently been news reports about the possibilities of care robots and technology (Purtill, 2019). As such, there appears to be more interest in the news about robots than in Finland. The survey observed that about 70% of the respondents in Ireland expressed willingness to use home-care robots for their family members or themselves.

Regarding "Decision-making on using home-care robots," about 90% of the respondents in all three countries responded that the potential user should make his or her own decision regarding the use of home-care robots, thus placing value in self-determination. Japan had the lowest rate of responses saying that the decision should be made based on the

usefulness for the family members. In recent years, Japan's healthcare policies have promoted Advance Care Planning (ACP) in response to a rapid rise in the number of households composed only of older people, including solitary living, and of older people with dementia (Cabinet Office, Japan, 2018). For this purpose, the Ministry of Health, Labour and Welfare published guidelines concerning the medical and long-term care-based decision-making process at the end of life (Ministry of Health, Labour and Welfare, 2018). The present study's survey results appeared to reflect how, amid such circumstances, the people in Japan had come to learn the importance of self-determination. In contrast, in Europe, there have been national and international policy advances about the capacity and decision-making underpinned by the move toward a human rights based approach to the issue of supported and assisted decision-making for older people (Donnelly, Begley, & O'Brien, 2018). In the Irish context, the Assisted Decision-Making (Capacity) Act (2015) ratified the United Nations Convention on the Rights of People with Disabilities and established a legal framework for assisted decision-making and ACP (Davies et al., 2019). Simultaneously, there has also been an increased focus on the safeguarding and protection of older people. Thus, there has been increased attention paid to the participation, empowerment, and self-determination of older people in care planning and decision-making. In Finland, patients' right to self-determination is also based on the legislation (Ministry of Social Affairs and Health, Act on the Status and Rights of Patients 1992).

Meanwhile, Japan had the highest rate (93.7%) of responses saying that family members who know the potential user well should be allowed to make decisions on her or his behalf, in particular, regarding the use of home-care robots, in cases of a decline in the person's decision-making capacities, or due to dementia or other causes. This result suggests that the importance of self-determination has not permeated Japanese society. Japan's Civil Code obligates family members to supervise members who cannot make decisions, including

older people with dementia, people with mental disabilities, and children (Civil Code Act, 1896). Matters concerning family members' obligation of supervision are sometimes taken to court when an older family member with dementia causes an accident (News Commentators Bureau, 2016). As mentioned above, this is a legacy of Japan's family-system. The results appeared to reflect the fact that the spread of ACP and of placing value in the self-determination of older people with dementia have been hindered by such deep-rooted circumstances.

Regarding "Importance of viewpoints regarding home-care robots," there was a large gap between Japan and the two European countries. Japan has traditionally taken pride in its abilities to develop, produce, and modify precision instruments (Shimura, 2012), and there is a commonly held belief in Japan that gods reside in everything in the universe, including machines (Ueta & Kimura, n.d.). There is even a shrine in Japan worshiping a god of machines. Such a national mentality has likely caused Japanese people to place importance on the safety, accuracy, and economic efficiency of home-care robots.

In contrast, in Ireland and Finland, the greatest importance was placed on the guarantee of the entitlement to receive human care, irrespective of the use of home-care robots, which again indicates a strong human rights' underpinning to attitudes, policy, and practice. The term "robot" was coined from the Czech word "*robota*," which means "forced labor" and the Slovak word "*robotnik,*" which means "labor" (Capek, 2003). Finland, which is ahead of most of the world in ICT (World Economic Forum, 2016), uses robots for purposes such as distribution (Directive 2010/40/EU Progress Report, 2017), but rarely uses them to serve humans directly. This has likely caused people in Ireland and Finland to place importance in human-centered values related to interpersonal exchange and to strongly care about the durability and laws and regulations that ensure the safety of humans in relation to home-care robots. Robotics in Care Services: A Finnish Roadmap (Hennala et al., 2017) also

refers to the conceptual framework of "nursing home residents' concept of dignity" discussed by Pleschberger (2007), stressing the importance of interpersonal dignity. This is a trend observed in Europe as a whole, including Germany. Issues of autonomy and control and the professional identity of care professionals also need to be examined further (Share & Pender, 2018).

4.2 Expected functions of home-care robots

"Familiarity with robots" and policies concerning home-care robots differ among the three countries. Interestingly, however, the top five expected/desirable functions for home-care robots in the three countries were quite similar. Prior surveys on the needs related to care robots conducted in several countries produced similar results (Bedaf et al., 2014; Fiorini et al., 2019). The results are broadly in line with the technology acceptance model (Teo, 2009). Many older people suffer multiple chronic diseases, and WHO has promoted telemedicine and telenursing (WHO, 2005), which have proven effective in shortening the periods of hospitalization and improving quality of life (Kamei, 2013). A systematic review and a meta-analysis by Brim and Oliver (2019) clarified that these methods have been effective in improving safety by reducing falls, accidents, and other dangerous movements.

Additionally, a study using the ICF framework reported that socially assistive robots can improve older adults' quality of life by promoting communication and self-care (Obayashi, Kodate, & Masuyama, 2018). In particular, loneliness and safety risks are among the biggest problems for older adults living alone at home in all three countries. Of the three countries, products in Finland using ICT for geriatric care have been developed and socially implemented; the effectiveness of technologies, such as location-based alarm and access control technology, have been verified (Perälä, Mäkelä, Salmenaho, & Latvala, 2013). By using Effica, an electronic medical record system, the country has also realized centralized

management and inter-professional sharing of information on pharmacotherapy (Ovaskainen, et al., 2003).

Based on this survey, it can be recognized that robots would be acceptable in Finland, Ireland, and Japan to notify an unexpected change, inform older people of concerns, observe dementia-related symptoms, prevent falls, and supporting medication.

4.3 Recognition of decision-making and privacy protection for home-care robots' research and development and social implementation

In the 2000s, the utilization of cameras to monitor older people was not allowed because it violated privacy in Japan. Today, however, monitoring people with dementia is one of the focus areas related to the use of robotic technology for care (Ministry of Economy, Trade and Industry, 2017). Systems using silhouette images and other technologies to monitor the behavior of older people in their homes have been released in the market. Additionally, since governmental policies began to promote the development and social implementation of safety monitoring systems, people's perceptions have shifted, resulting in a higher rate of acceptance of safety monitoring that uses photographs and videos. In the present study's results, this rate was 55%, which was the highest ever in Japan.

Safety monitoring that uses photographs and videos captures not only the older person but also his or her surrounding environment as well, hence, there is a high risk of violating privacy. However, many people in Japan have had opportunities to interact with robots in their daily lives, and under the auspices of the government, the development of care robots aimed for the realization of Society 5.0 is underway. Such circumstances may have raised Japanese people's expectations for home-care robots, while making it difficult to perceive the underlying ethical issues related to the principles of respecting autonomy and protecting privacy. For this reason, it will become important in the future to duly confirm with older

people about their will and inform them in advance of the risks and benefits in a clearly understandable way.

Meanwhile, the results from Japan, Ireland, and Finland all exhibited high rates of perception that healthcare professionals' use of photographs, videos, vital signs, audio information, and locational information of older people is acceptable. This suggests that the use of personal information necessary for healthcare staff to monitor older people has been understood and accepted. In addition, in Finland, a relatively high percentage of respondents claimed that it is acceptable to use users' secondary information obtained by healthcare professionals. This percentage was 10% higher than those of the other two countries, showing a significant difference. People in Finland are supposedly less opposed ethically to obtaining information through home-care robots because, in addition to the fact that the use of home-care services is common in Finland (Vehko, Ruotsalainen, & Hyppönen, 2019), trusted healthcare staff have already been offering remote home-care services, checking home-care users' status, and using such information in ICT.

Further, aiming at the maintenance and improvement of Social Quality while promoting Ageing in Place, the connections among local residents become important from the perspective of social cohesion (Walker, Van Der Maesen, & Laurent, 2012). Approximately 70% of the participants in all three countries approved the use of personal information by persons other than healthcare professionals as long as the older person consents to it. Thus, the discussion on sharing and using personal information from the perspective of Social Quality will be called for in the future.

The results from Ireland were distinct from those of the other two countries in that there were more people who responded, "I want to help other people and society by participating in the research and development of home-care robots" and "I am open to using a home-care robot even during the research and development stage if it would benefit me." The

participation in research and development of home-care robots involves risks of accidents, such as falls. There is no problem if the older person can autonomously decide to participate in a research that involves risks. However, in cases in which his or her decision-making capacity has declined, due to dementia or other causes, the necessity arises to seriously deliberate with a proxy, such as a family member, about the risks and benefits of participating in the research. The theories of common good (McCormick, 1974) and altruism (Lishner & Stocks, 2008) justify proxies in the context of research that does not benefit the user.

The present study's results showed that the perceptions of a relatively high proportion of people in Ireland agreed with these theories along with self-interest (Edward, Lilford, & Hewison, 1998), which is considered a motive for research participation. This supposedly reflected the fact that Ireland is a country with many devout Catholics, where care for older people has been supported by nongovernmental volunteerism. As such, the present study's results suggested that the theory of common good, altruism, and self-interest widely apply in Ireland, whereas more careful deliberation would be called for in Japan and Finland.

Based on the results and considerations of this study, all three countries were able to gain valuable insights from each other. The Finnish results revealed that high-quality care by home-care professionals can facilitate the implementation of home-care robots and that the education of home-care professionals is crucial. These findings were also relevant for Ireland and Japan. From the Irish results, Finland and Japan learned that fostering voluntarism in people can raise awareness about participation in the research and development of home-care robots. Moreover, both Finland and Ireland emphasized the importance of receiving human care, irrespective of the use of home-care robots, which was relevant for Japan. In Japan, it has been recognized that advocacy awareness is necessary for the development and implementation of home-care robots. In addition, the results in Japan show that it is important to create opportunities for Finnish and Irish people to become familiar with robots and home-

care robots. Finally, whereas the study highlighted several benefits, including mutual learning for each participating country, it also revealed several challenges.

For example, it was pointed out that potential users of home-care robots, including older adults and family caregivers, but mainly home-care professionals, did not have a familiarity with assistive technology. To overcome this issue, potential users will have the opportunity to encounter and learn about assistive technologies and home-care robots, considering their knowledge, experience, and values, as well as their country's history, culture, and policies concerning home-care robots. Care practitioners need to develop an informed and critical orientation toward emergent technologies so that they can be part of the social shaping of technology (MacKenzie & Wajcman, 1985), rather than being socially determined by it (Share & Pender, 2018). Xu et al. (2014) have also begun to provide potential users with a high-tech environment to elicit their preferences for future technologies in Singapore. Melkasa et al. (2020) also pointed out that the implementation of the care robot needs to ensure proper orientation. Moreover, inadequate information on the purpose and tasks of the robot may lead to unrealistic expectations and unmet needs.

In Ireland, 81.8% of the respondents said, "I want to help other people and society by participating in the research and development of home-care robots" (Japan: 69.9%; Finland: 67.5%) ($p = .006$). This meant that respondents in Finland and Japan were not more proactive in participating in research than in Ireland. However, research is indispensable for the development and social implementation of home-care robots. Developers and users may learn and consider the social significance of the research and research ethics, such as volunteerism, the voluntary nature of participation, and the risks and benefits associated with participation.

Finally, as Laitinen, Niemelä, and Pirhonen (2016) suggested, the important issue that measures must be taken to guarantee the entitlement to receive human care, irrespective of the use of home-care robots, was considered. To challenge this issue, it is necessary to be sure

that the willingness of the older adults and family caregivers are respected and that care professionals can suggest using home-care robots or not according to an assessment of older people and family caregivers.

4.4 Limitations and future directions

The present study is an international comparative research conducted in Japan, Ireland, and Finland. However, these three countries differ with regard to their total population and the rates of ageing. They also differ in languages as well as systems providing care services to older people and systems related to the education and training of care staff. Therefore, it was impossible to bring total uniformity to the sampling and the contents of the questionnaire forms.

Moreover, there was a difference between the study's regional coverage in Finland and Japan on one hand and Ireland on the other, as it was limited to specific regions within the first two while it covered the national constituency in the latter. The numbers of collected questionnaire responses differed among the three countries as well. Therefore, the data cannot be generalized as representative of the respective countries. Additionally, clarification of the respective characteristics of older people, family caregivers, and care professionals is a task for future analysis. Further, although the present study clarified the definition of home-care robots to its participants, there remains a possibility that some participants responded to the questions without sufficient understanding and familiarity with the topic, as the development and spread of home-care robots are still in progress.

Moreover, the results of the present study reveal a need to further examine the relationships between the characteristics of each country in terms of history, culture, policies, and values concerning home-care robots and robots in general. Further, it implies that there is a need to establish educational and continuous professional development support for HSPCs

and develop pedagogical approaches in the areas of home-care and social care robots.

5. Conclusions

The present study's results suggested the necessity to devise optimal and desirable strategies for research and development and the social implementation of home-care robots by incorporating various perspectives, while valuing the dignity of human individuals. This will require an examination of the characteristics of each country's history, culture, policies, and values concerning home-care robots and robots in general. This field of enquiry will become more important and will be of interest for everyone involved in health education and social care professions in the years to come. Therefore, it appears that there is a need to establish educational and continuing professional development support for those in the health and social care professions and develop pedagogical approaches in the areas of home-care and social care robots.

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Disclosure statement

None.

Data availability statement

All data generated or analyzed during this study are included in this published article (and its

supplementary information files).

Author contributions

Sayuri Suwa: Conceptualization, Methodology, Writing original draft, Project administration, Funding acquisition. **Mayuko Tsujimura:** Methodology, Formal analysis, Investigation, Data Curation, Visualization. **Naonori Kodate:** Conceptualization, Methodology, Investigation, Writing original draft. **Sarah Donnelly:** Methodology, Investigation, Writing original draft. **Helli Kitinoja:** Conceptualization, Methodology, Writing original draft. **Jaakko Hallila:** Methodology, Investigation. **Marika Toivonen:** Methodology, Investigation. **Hiroo Ide:** Methodology, Validation, Data curation. **Camilla Bergman-Kärpijoki:** Investigation. **Erika Takahashi:** Investigation. **Mina Ishimaru:** Methodology, Reviewing and editing. **Atsuko Shimamura:** Methodology, Reviewing and editing. **Wenwei Yu:** Validation, Supervision.

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