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Home-care professionals' ethical perceptions of the development and use of home-care robots for older adults in Japan

Running head: PERCEPTIONS OF HOME CARE ROBOTS AMONG CARE PROFESSIONALS

Sayuri Suwa[a]*, Mayuko Tsujimura[b], Hiroo Ide[c], Naonori Kodate[d], Mina Ishimaru[e], Atsuko Shimamura[f], and Wenwei Yu[g]

[a]Division of Visiting Nursing, Graduate School of Nursing, Chiba University, Chiba, Japan (https://orcid.org/0000-0003-3693-7455) [b]Division of Visiting Nursing, Graduate School of Nursing, Chiba University, Chiba, Japan (https://orcid.org/0000-0002-3745-1257) [c]Institute for Future Initiatives, The University of Tokyo, Tokyo, Japan (https://orcid.org/0000-0002-2269-7836) [d]School of Social Policy, Social Work and Social Justice, University College Dublin, Dublin, Ireland (https://orcid.org/0000-0002-6480-7327;Twitter: @NaoKody) [e]Division of Community Health Nursing, Graduate School of Nursing, Chiba University, Chiba, Japan (https://orcid.org/0000-0003-2104- 2456) [f]Division of Community Health Nursing, Department of Nursing, Faculty of Health Science, Toho University, Chiba, Japan (https://orcid.org/0000-0003-0802-0228) [g]Center for Frontier Medical Engineering, Chiba University, Chiba, Japan (https://orcid.org/0000-0003-1277-863X)

*Corresponding author: Sayuri Suwa, Graduate School of Nursing, Chiba University, Chiba, Japan; suwa-sayuri@faculty.chiba-u.jp; https://orcid.org/0000-0003-3693-7455

Sayuri Suwa (PhD) is a Professor at the Division of Visiting Nursing at Chiba University Graduate School of Nursing in Japan. She is a director at the Japanese Society for Dementia Care. Her research interests include dementia care, the development of ethics regarding assistive technology for dementia, and community-based integrated care systems.

Mayuko Tsujimura (PhD) is an Associate Professor at the Division of Visiting Nursing at Chiba University Graduate School of Nursing in Japan. Her research interests include home health care for

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older people and support for their families, home care and assistive technology for older people living alone, and educative support for home care nurses.

Hiroo Ide (PhD) is a Project Assistant Professor at the Institute of Future Initiatives at the University of Tokyo. He holds a doctorate in medical science from the University of Tokyo, and has worked both at the University of Tokyo Hospital and Chiba University Hospital. His research interest is health policy.

Naonori Kodate (PhD) is an Associate Professor in Social Policy at University College Dublin in Ireland. His research interests include comparative public policy, gender equality in STEM education, patient safety, and science, technology and society (STS), particularly in the use of eHealth (e.g., home care robots) in social care.

Mina Ishimaru (PhD) is a Professor at the Division of Community Health Nursing at Chiba University Graduate School of Nursing in Japan. Her research interests include community approaches for assisting those with dementia, collaborations and partnerships through research, and community-based integrated care systems.

Atsuko Shimamura (PhD) is a Lecturer in the Division of Community Health Nursing, Department of Nursing at Toho University in Japan. Her research interests include observational skills in home care nurses and caring for older people, including those with dementia.

Wenwei Yu (PhD) is a Professor in Assistive Technology and Robotics at Chiba University in Japan. His chief interests are neuroprosthetics, rehabilitation robotics, home care support systems, motor control, and biomedical signal processing.

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Home-care professionals' ethical perceptions of the development and use of home-care robots for older adults in Japan

Because of the workforce shortage in Japan, the use of home-care robots, or *carebots,* is increasingly perceived as a realistic option. Developing and implementing these carebots requires careful consideration of the ethical implications for all types of users. Few studies, however, have addressed the ethical principles and concepts involved in carebot use, and consequently, the discussion regarding roboethics in the home-care environment has been inadequate. This questionnaire study explored the relationship between the willingness of home-care professionals to use carebots, their experiences with robots, and their ethical perceptions. The principal factors affecting home-care staff perceptions were perceived benefit, use of personal information, the protection of privacy, and perceptions of risk. While perceived benefit was the common predictor affecting home-care staff willingness to use a robot for the care of all user types, concerns regarding the use of personal information were more prominent for older people.

Keywords: home-care robots; assistive technology; ethical perceptions; ageing society; care staff shortage; self-administered questionnaire; factor analysis; logistic regression analysis

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Background

Population aging affects both developing and developed countries (Prince et al., 2015). In Japan, 28.1% of the population was 65 years or older in 2018 (Cabinet Office, Japan, 2019). This accelerated aging phenomenon is frequently referred to as a "super-aging society." The Japanese government estimated that the number of people with dementia in 2020 would be approximately 6 million, of whom nearly half currently live in their own homes. Accordingly, establishing community-based integrated care systems (with full support and service provision) has become a top priority that aims to respect the dignity of older adults and support independent living. These systems—that align with the "aging in place" policies established in many developed countries (Hawley-Hague, Boulton, Pfeiffer, & Todd, 2014)—aim to prolong the length of time people can stay in the communities they are attached to and feel comfortable in, sustaining their own unique way of life until the end of their lives (Ministry of Health, Labour and Welfare [MHLW], 2017). Given the rate and culture of aging, it is nearly guaranteed that there will be insufficient human resources (family caregivers and home-care professionals) to care for older adults if they remain in their own homes. In fact, it is predicted that by 2025 there will be a shortfall of 370,000 nurses and care workers (Hayashi, 2016; MHLW, 2015).

Home-care robots are seen as part of the solution to the caregiver shortage in home and community care settings, even for people with dementia. As early as 2012, the Ministry of Economy, Trade, and Industry (METI) and MHLW announced the development of care robots as a priority for the national government (Ministry of Economy, Trade and Industry & Ministry of Health, Labour and Welfare, 2012). As of 2017, the development of care robots and empirical studies conducted on long-term care facilities have focused primarily on indoor mobility assistance, bathing assistance, communication, and minder robots that were

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developed predominately for older adults who need and receive care (Cabinet Office, Japan, 2017). In 2015, the MHLW introduced a subsidy of 100,000 yen per device to allay costs for insured care facilities and institutions to introduce care robots that meet several criteria, to further the promotion of initiatives intended to lessen the burden of care on care staff. As of 2018, such subsidies have been continued and expanded to the level of 300,000 yen per device (MHLW, 2018). Therefore, most home-care professionals in Japan understand that care robots are strongly promoted as part of the long-term care policy for older adults.

Given that the Japanese population is familiar with certain care robots developed in Japan and tested on people with dementia (Inoue, Wada, & Uehara, 2011; Jones et al., 2018), in the future, robots will likely be deployed rapidly to assist older adults and their families. Assistive technologies like Socially Assistive Robots can potentially enhance the well-being of older people and decrease caregiver workloads (Kachouie, Sedighadeli, Khosla, & Chu, 2014). Social human robots can also improve the emotional, visual, and behavioral engagement of people with dementia (Khosla, Nguyen, & Chu, 2017) . The human-robot interaction evaluation approach for patients suffering from mild cognitive impairments and Alzheimer's Disease was also reported in the field of social robotics (Gerłowska et al., 2018). These authors implied that potential users might refrain from introducing home-care robots because professionals' excessive demands for the potential functions of care-robots affect their decision.

The question remains, however, whether older adults, their families, and home-care staff will welcome the development and social implementation of these care robots. For example, once robot use begins, ethical questions related to proxy consent regarding the use of home-care robots for older people with impaired decision-making ability due to dementia, as well as the privacy and the protection and use of the client's personal information,

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including bioinformation and related risks (i.e., the risk of falling), will likely arise between older adults receiving care and their families. Consequently, home-care staff can be expected to play a role in helping older adults and their families use robots in ethically appropriate ways. As a result, home-care staff can be positioned as users of care robots, and a better understanding of the ethical perceptions of home-care staff related to robot use is needed. As Zwijsen, Niemeijer, and Hertogh (2011) point out, ethical discussions concerning the use of assistive technology in home-based eldercare have not been prioritized. Accordingly, based on their systematic review, this trio clarified the following ethical themes that require further exploration: privacy, self-determination (autonomy), obtrusiveness, stigma, human contact (human interaction), individual approach, affordability, and safety. In the same vein, Peterson and Murray (2006) have highlighted the need for rehabilitation professionals to consider the ethical challenges of providing assistive technology.

The ethical values as factors for the acceptance of new engineering technologies such as smart energy systems have been investigated systematically (Smitesh, 2017). In addition, the importance of raising awareness of ethical issues has been mentioned in studies on acceptance models for health care robots and home care robots (Rantanen, Lehto, Vuorinen, & Coco, 2018; Stahl & Coeckelbergh, 2016; Vandemeulebroucke, Dierckx de Casterlé, & Gastmans, 2018). However, these discussions have failed to adequately consider how ethical considerations should be given to the development and social implementation of home-care robots.

In Lazar, Thompson, Piper, and Demiris (2016), two key ethical issues concerning robotic companions for older adults were raised—older people's understanding of the artificial nature of pet robots and the decrease in real communication with others by introducing the companion pet robots. However, these concerns did not address or evaluate

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the bioethical principles essential for the ethical education of potential users and developers of home-care robots—beneficence, respect for autonomy, and non-maleficence. Accordingly, this study aimed to explore the relationship between Japanese home-care staff's willingness to use home-care robots and their ethical perceptions associated with the bioethical principles regarding the development and social implementation of such robots.

Method

This study used a cross-sectional survey design. The study was conducted in one Japanese prefecture, targeting home-care staff as potential users of home-care robots. Home-care professionals fully assess older adults and their family caregivers and obtain information on the functions and use of care robots from professional organizations, business associations, and academic societies. Home-care professionals also learn care ethics. Therefore, we thought that it was important to understand the ethical perceptions of home-care professionals when introducing home care robots. Moreover, Prefecture A was selected because it has both urban and rural areas (including fishing and agricultural villages), and at the time of the survey, its rate of aging was equivalent to that of Japan generally. Participants were selected from offices in Prefecture A, whose facility names were published in the long-term care service information-publication-system.

Respondents were home-care professionals such as care workers, care managers, home helpers, registered nurses working as visiting nurses, social workers, public health nurses, and licensed practical nurses. These professionals were from offices for long-term care insurance services including comprehensive community support centers, visiting nursing stations, visiting long-term care offices, and home long-term care support offices that assisted older individuals living at home in Prefecture A. Of these, approximately 1,000 were from visiting long-term care offices and home long-term care support offices. To avoid bias in

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location, a letter requesting research participation was sent to the office manager at roughly 30% of these facilities. Each office manager was asked to provide the questionnaire form to two workers in visiting long-term care offices, who were leaders as a full-time home-care professional and a home helper (often a part-time worker), or one home-care staff member at home long-term care support offices with extensive experience in older people's care and request that they complete it. Survey participation was also requested in writing from the managers of all comprehensive community support centers and visiting nursing stations in Prefecture A. Again, each manager was asked to provide the questionnaire form to one home-care professional with extensive experience in older people's care and request their cooperation. Ultimately, a total of 1,729 home-care staff were asked to take part and were sent the questionnaire. The self-administered questionnaire was designed to assess the home-care staff's perception of the use and utility of home-care robots and their willingness to participate in empirical research to develop such robots.

Questionnaire development

To explore the relationship between the willingness of Japanese home-care staff to use robots and their perceptions of ethical issues related to the development and social implementation of this technology, we looked at the user acceptance models developed to date for new technologies. Given that we were unable to find any models specifically associated with the principles of medical ethics, a model for robot use based on ethical principles as well as training programs on the use of robots in health care should be developed. For this study, we developed a basic, simplified conceptual framework of factors that could potentially determine home-care staff's willingness to use a home-care robot (Figure 1).

[Figure 1 near here]

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In this framework, potential determinants for home-care staff members' willingness to use a home-care robot (which consisted of three categories: willingness to use one to care for a family member, willingness to use one for personal care, and willingness to use one for older adults) were home-care staff member's sex; age; and experience with robots, including their personal interest in robots, past experience with using care robot, past experience with the use of animal-like robots, humanoids, and/or robot cleaners. Ethical perceptions related to the three medical ethics principles of respect for patient autonomy, non-maleficence, and beneficence were assessed; and information was collected regarding the expected abilities of home-care robots to meet the needs of the patient, such as enjoying having conversations with older adults, informing the family and support personnel about the intrusion of suspicious persons into the homes of older adults, and observing and recording the cause of deterioration of physical condition. The principles of non-maleficence and beneficence include the perceived benefits and risks, which may not necessarily be tangible and practical benefits or risks (i.e., the contributions of robots to a more comprehensive societal good). Moreover, perceptions related to the remaining ethical principle of justice/fairness were not included in the framework because we were only looking at ethical perceptions related to the personal use of a robot in the home. The extent to which each of these factors was predictive of home-care staff willingness to use a home-care robot was explored.

The categories composing the questionnaire are as follows: willingness to use home-care robots (three items), direct involvement with robots (six items), risks of using home-care robots, participation in robot development/research, and ethical perceptions regarding the development and social implementation of home-care robots including protection of privacy associated with using robots (29 items).

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Specifically, when creating the questions concerning willingness to use home care robots, we referenced questions in survey research (Japan Geriatrics Society, 2010) implemented by the Japan Geriatrics Society in order to decide on “Guidelines for the decision-making process in care for the older adults: Focusing on the use of artificial hydration and nutrition” (Japan Geriatrics Society, 2011; Ouchi et al., 2018). These questions focused on finding differences in the intentional use of artificial hydration and nutrition for the sake of both the family and the person. Referencing this survey, three questions were set to clarify the differences in intended use and related factors for the family, myself, and the older adults cared for by home-care staff. Furthermore, in order to clarify ethical perceptions of home-care robots and to increase the construct validity of the questions, we added factors concerning the ethical principles specified in the Belmont Report (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1978) and Beauchamp and Childress (2001). First, we created four questions focused on the principle of respect for autonomy and addressing the issues of by whom, in what situations, and by what standards participants thought decisions about the use of home-care robots should be made, including in cases in which the older individual’s decision-making ability is reduced. Similarly, as the principle of respect for autonomy stipulates that individuals have the right to control information about themselves, we composed three questions concerning the protection of privacy and four questions about the use of personal information for a total of seven items. We created four items related to perceived risks expected from the use of home-care robots based on the principle of non-maleficence. Considering the principle of beneficence, we also composed 14 questions on the perceived benefits and convenience gained through the use of home-care robots. Ultimately, this yielded a total of 29 questions on the ethical perceptions of home-care robots.

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Questionnaire responses for this study used a Likert scale. The reason for this was to gather information on ethical perceptions of home-care robots in the form of numerical data. Outside of Japan, it is common to use a five-point scale. However, if a scale with an odd number of points is used in Japan, many respondents will select the middle, neutral value, making analysis results unclear. As such, scales with an even number of points are commonly used. Therefore, we used a four-point Likert scale in this study to allow respondents to clearly indicate the extent of their ethical perceptions.

A pilot study was conducted with 18 individuals (older people, families, and home-care staff aged between 20–80 years; 11 females and 7 males) to refine the questionnaire. Based on the results, corrections were made to the questionnaire. Subsequently, a questionnaire with a four-point Likert scale was developed (*acceptable*, *somewhat acceptable*, *not very acceptable*, and *unacceptable*).

Data analysis

Descriptive statistics were used to summarize the data. Next, the principal factor analysis method and Promax rotation were employed to analyze 29 items related to the direct involvement with robots, risks of using robots, participation in robot development/research, and protection of privacy associated with using robots. This analysis illustrated the constituent factors of ethical perceptions concerning the development and social implementation of these robots.

Finally, we conducted a logistic regression analysis. The dependent variables were the willingness to use home-care robots for a family member, willingness to use home-care robots for themselves, and willingness to use home-care robots for older adults. For this logistic analysis, these dependent variables data were converted to two-point responses to provide clear results; “yes” or “yes, to some extent” were placed in the “use group,” and

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those responding “no” or “not really” were placed in the “non-use group.” Age, sex, experience with robots (personal interest in robots, past experience in care robot use, past experience in use of animal-like robots, humanoids, and/or robot cleaners), and the standardized values of the four factors identified by the principal factor method based on the ethical principles of respect for autonomy, non-maleficence, and beneficence were used as the explanatory variables. The analysis was carried out using STATA 14.0 (StataCorp LLC, TX, USA). The statistical significance level was set at 5%. It should also be noted that the results of analyzing the expected abilities of home-care robots to meet the needs of the patient are excluded from this study and will be incorporated into a future report.

Ethical approval

Ethical approval was sought from and granted by Chiba University’s Research Ethics Committee (No. 28-90). The survey was carried out using a self-administered anonymous questionnaire. All respondents were given an information letter explaining the purpose of the study, possible benefits to science and society, and an explanation of the voluntary nature of participation.

Results

A total of 444 valid responses were obtained (response rate: 25.7%). Most respondents were female (*n*=351, 79.1%). In terms of age, the greatest proportion of respondents were in their forties (*n*=136, 30.6%). Most respondents were care workers (n=245, 55.2% in multiple response questions) and from the home long-term care support office (*n*=187, 42.1%), and over half of the respondents lived in urban environments (*n*=252, 56.8%). The numbers of “Yes” responses for owning a home-care robot at the organization and the presence of older adults using home-care robots at the organization were quite low

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(n=7, 1.6%, n=16, 3.6%, respectively). Moreover, with regard to whether they would use home-care robots in various contexts, the number of "Yes" responses was lowest for home-care staff's willingness to use robots to care for their older adult patients (n=52, 11.7%; Table 1).

[Table 1 near here]

Next, we carried out exploratory factor analysis. As we had received responses from 444 home-care professionals, the subjects-to-variable ratio when performing exploratory factor analysis on the 29 ethical perception items was confirmed to be over 10:1. We concluded that we had obtained sufficient data to perform exploratory factor analysis in line with the findings of Pearson and Mundform (2010). The results of exploratory factor analysis relating to ethical perceptions regarding the development and social implementation of home-care robots identified four principal factors: "perceived benefit," "use of personal information," "protection of privacy," and "perceived risk." Cronbach's α coefficients for each factor were .915, .835, .847, and .712, respectively (Table 2). The cumulative contribution rate was 67.9%, and the range of uniqueness for all questions was from 0.281 to 0.580. Questions that loaded on the factors extracted through exploratory factor analysis perfectly coincided with the ethical principles used for construct validity during the development of the questionnaire.

[Table 2 near here]

However, the four questions based on the principle of respect for autonomy and addressing the issues of by whom, in what situations, and by what standards participants thought decisions about the use of home-care robots should be made, including in cases in which the older individual's decision-making ability is reduced, were deleted following the exploratory factor analysis. This included items such as "I want to personally decide whether

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to use a home-care robot" and "If I became unable to decide for myself whether to use a home-care robot, it would be okay if a family member that knows me well made the decision for me." One item about the use of personal information ("I don't mind who uses information about me gathered by a home-care robot as long as they are a medical or nursing professional") and one item based on the principle of non-maleficence ("I worry about whether the home-care robot can be repaired and inspected") were also deleted. Five items concerning the principle of beneficence, including "I don't think older people would be lonely if home-care robots are used," "It would be carefree because you don't have to take the home-care robot's needs into consideration," and "I don't want to use home-care robots that are still being researched/developed because I don't know whether they would have benefits for me" were also deleted. The criterion used to determine the deletion of an item was whether the item showed a high loading on multiple factors.

The results of the logistic regression analysis showed that factors affecting the willingness to use a home-care robot to care for a family member were perceived benefits (odds ratio [OR] = 13.26, 95% confidence interval [95% CI]: 6.96–25.26) and perceived risks (OR = 0.60, 95% CI: 0.41–0.88). Factors affecting the willingness to use a home-care robot for personal care were also perceived benefits (OR = 10.14, 95% CI: 5.67–18.12) and perceived risks (OR = 0.44, 95% CI: 0.30–0.65). On the other hand, factors affecting the willingness to use a home-care robot to care for older adults were perceived benefits (OR = 5.75, 95% CI: 3.52–9.39) and use of personal information (OR = 1.42, 95% CI: 1.02–1.98) (Table 3). Pseudo R^2 for the three analyses were .438, .417, and .332, respectively.

[Table 3 near here]

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Discussion

This study identified the following four principal factors determining home-care staff members' ethical perceptions regarding the development and use of robots in home health care: perceived benefit, use of personal information, protection of privacy, and perceived risk. These factors exhibited a relatively high result for both cumulative contribution rate (67.9%) and Cronbach's α coefficients (over .70; Hair, Black, Anderson, & Babin, 2018). Moreover, the study clarified the issue of the correlation between intention to use home-care robots and factors based on ethical principles not mentioned in previous studies through logistic regression analysis, and further, statistically determined the size of the correlations. Thus, the study's novelty lies in these results.

Meanwhile, the fact that all four questions regarding by whom, in what situations, and by what standards participants thought decisions about the use of home-care robots should be made were deleted through explorative factor analysis is very interesting. This means that no similar trends in the respondents' answers could be identified. Thus, perceptions of who should be making decisions about the use of home-care robots, in what circumstances, and according to what standards differed across individuals and there was no consensus. The results of this study emphasize the need to confirm the intention to use for each individual user, including older individuals, family caregivers, and home-care staff, and to provide decision-making support in order to realize the societal implementation of home-care robots.

Even with the revelations of this research, it is necessary to continue thinking at the individual level about: (1) the kind of care and support necessary to enable older adults, including older adults with dementia who have diminished decision-making capabilities, to live with dignity, and (2) how home-care robots can contribute in that context. Protecting the human rights and dignity of older adults with dementia and similarly vulnerable individuals

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will require the development of guidelines for the appropriate and ethical use of robots; in the context of long-term care, it has been said that human interaction is one of the most important aspects, and this should be considered carefully to ensure the quality of care (Mordoch, Osterreicher, Guse, Roger, & Thompson, 2013). The need for guidelines and ethical education on the use of home-care robots in Japan could be a feature unique to Japan, a country that already has experience of engaging with and using a variety of robots in everyday life. However, this need will likely grow internationally in the coming years in other countries with aging populations. This research, therefore, contributes positively to developing ethical guidelines for the use of care robots internationally. In this regard, the results of this study showed possible relationships between the intention to use home-care robots by home-care staff and factors affecting their intention to use robots. Overall, we have determined that these factors relate most notably to ethical principles. Accordingly, our findings can contribute to developing an ethical guideline for deploying robots in home-care settings.

Up to this point, there has been minimal discussion of the ethical themes related to the use of home-care robots. However, the following studies have been conducted on the ethics involved with health care robotics. As stated previously, Zwijsen, Niemeijer, and Hertogh (2011) have noted that the study of ethics in relation to assistive technology in home-based eldercare has not been prioritized, while Peterson and Murray (2006) reiterate the need for the consideration of ethics for rehabilitation professionals providing assistive technology. Salzmann-Erikson and Eriksson (2016) also argue that although professionals have resisted the implementation of robot-use, robots represent the next step in technological developments in health care. In this regard, the duo points out that such tech-resistance should be challenged through discussion. Yang and Kels (2017) underscore the importance of looking at

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individual needs from the perspective of "a collaborative coalition of care" among care recipients and caregivers when considering ethical issues in the use of monitoring devices for the cognitively impaired.

Users of the new home-care robots consist of older adults, their family caregivers, and home-care staff. Staff members, in particular, will be involved significantly in educating the older users and their family caregivers about the robots, as well as making recommendations about, and explaining and monitoring the use of the robots. For all of these reasons, any home-care robot acceptance model must include the ethical perceptions of home-care staff as they relate to robot use. Recently, a model for user acceptance of social assistive robots for older adults, the Almere model (AM) for assessing acceptance of assistive social agent technology by older adults (Heerink, Kröse, Evers, & Wielinga, 2010), has been developed. In addition, Alaiad and Zhou (2014) have developed a structural model of determinants (SMD) involved in the adoption of home health care robots that includes ethical concerns. However, the ethical concerns in the SMD were not associated specifically with the ethical principles of beneficence, respect for autonomy, and non-maleficence, as they were in our study.

Thus, the fact that this study clarified the relationship between principles of medical ethics and home-care staff willingness to use robots represents a significant step toward the future development of a home-care robot acceptance model that includes home-care staff member perceptions related to the ethical development and use of robots. Each of the four identified factors determining home-care staff ethical perceptions regarding the development and use of robots in home health care was associated with a principle of medical ethics.

The perceived benefit of home-care robot use, the perception associated with the beneficence principle, was consistently the strongest predictor of willingness to use a robot in

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each of the three types of patients. This suggests that the kind of information provided to home-care staff to reinforce this perception may have a major effect on the social implementation of home-care robots. The respondents are familiar with heroic robots in books, manga, and animation, and through the increased opportunities to engage with useful robots around the home, such as robot vacuum cleaners and robot dogs. As these social influences may determine home-care staff ethical perceptions regarding robots and their decisions regarding robot use, these influences seemed to make it easier to decide on using robots for home-care. In the unified theory of acceptance and use of technology model (Venkatesh, Morris, Davis, & Davis, 2003), social influence is a determinant of usage intention for new technologies. Because public policy is expected to promote the use of home-care robots, such promotion could have a social influence on the ethical perceptions regarding robot use by home-care staff and could influence decisions to use robots. We were unable to sufficiently explore in this study what the benefits of using a robot could be for older adults, their family caregivers, and home-care staff. Thus, such a topic will require further careful study.

Protection of privacy, a perception associated with the principle of respect for autonomy, significantly predicted willingness of home-care staff to use robots to care for older adults. The probable explanation for this result is that, in Japan, insurance, health, and welfare professionals are obligated by law to protect the confidentiality of personal information (Minooka, 2017). This study also found that perceived risk, a perception associated with the non-maleficence principle, was related to willingness to use a home-care robot. In other words, the normative attitudes of home-care staff toward privacy explain robot use. In addition, Japanese home-care staff could be overly sensitive to the need to protect the privacy of personal information collected during patient care for two distinct reasons: first,

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because of the government's interest in its usefulness and, second, because of the potential of information and communication technology and artificial intelligence to aid in the development of health care policy (as the collection of big data, including videos, still images, and bioinformation, is indispensable).

In previous studies, perceived risk has been mentioned as a factor in the acceptance of gerontechnology (Pavlau, 2003; Teo, Lee, Chai, & Wong, 2009). This study also found that perceived risk, a perception associated with the non-maleficence principle, was related to willingness to use a home-care robot. Given that older adults with dementia tend to experience greater discomfort from various environmental factors (Boden, 2003), it is likely that the risks associated with home-care robot use for that specific population will be heightened. Therefore, researchers and manufacturers must comply with ethical principles and engage carefully with ethical considerations in robot development and implementation to eliminate anxieties over physical injury and respect for wishes. In other words, development-oriented research must respect the wishes of older adults and verify whether home-care robots are, in fact, low-risk.

Limitations of this Study

As mentioned previously, to date, little research has been conducted in Japan with the specific goal of exploring and understanding ethical issues and home-care staff perceptions regarding the development and social implementation of home-care robots. Given that void, this study will contribute to the field by advancing necessary discussions and improving future research and development of such technologies. Nevertheless, we must recognize some of the limitations of this study. First, respondents were limited to home-care staff in one Japanese prefecture. Second, the response rate of 25.7% was rather low. Third, as many home-care robots are to be developed in the near future, some respondents may have

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responded without properly visualizing what the home-care robots would look like or what they could accomplish. This limitation could be partly ascribed to the future-oriented nature of our questionnaire theme, which was concerned with the social implementation of robotic-aided care, rather than the functionality of that type of care.

Further, because of the limited number of respondents who were home-care staff with experience using home-care robots, such as Socially Assistive Robots, it was not possible to determine if their ethical perceptions differ from those of home-care staff lacking this experience. Additionally, because it is anticipated that the functions expected of home-care robots will differ between older adults, family caregivers, and home-care staff, the intention to use will likely also differ by function. Therefore, in the future, it will be necessary to examine what kind of relationships exist between experience using home-care robots, expected needs, and the ethical perceptions of home-care staff, as well as how the home-care staff's usage experience influences the intention to use in older adults and family members. Due to these limitations, the study results regarding the adoption of home-care robots are not generalizable, as people in other countries, or even in other Japanese prefectures, may respond differently based on differing social influences and their understanding of robot home-care.

Conclusions

In conclusion, this study found that home-care staff perceptions related to the ethical development and social implementation of home-care robots were principally determined by perceived benefit, use of personal information, protection of privacy, and perceived risk. While the factors found to significantly predict home-care staff willingness to use robots for their personal care or the care of a family member were perceived benefit and perceived risk, the significant predictors of willingness to use robots to care for older adults were perceived

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benefit and use of personal information. One major takeaway from these results is that in order to improve the willingness of home-care staff to use home-care robots, efforts to promote and enhance ethical perceptions regarding home-care robot development and implementation must increase.

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Disclosure statement

The authors have no conflicts to disclose.

Data availability statement

All data generated or analyzed during this study are included in this published article (and its supplementary information files).

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Table 1. Characteristics of participants (*N*=444)

		n	%
Sex	Female	351	79.1
	Male	85	19.1
	No answer	8	1.8
Age group	20s	13	2.9
	30s	69	15.5
	40s	136	30.6
	50s	134	30.2
	60s	73	16.4
	70s	10	2.3
	No answer	9	2.0
Location	Urban	252	56.8
	Intermediate	96	21.6
	Rural	88	19.8
	No answer	8	1.8
Professional license (Multiple response)	Care worker	245	55.2
	Care manager	238	53.6
	Home helper	123	27.7
	Registered nurse	104	23.4
	Social worker	50	11.3
	Public health nurse	18	4.1
	Licensed practical nurse	13	2.9
	Others	41	9.2

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Office Affiliation	Home long-term care support office	194	43.7
	Visiting long-term care office	113	25.4
	Visiting nursing station	81	18.2
	Comprehensive community support center	52	11.7
	No answer	4	0.9
Owning a home-care robot at the organization	Yes	7	1.6
	No	424	95.5
	No answer	13	3.0
Presence of older adults using home-care robots at the organization	Yes	16	3.6
	No	410	92.3
	No answer	18	4.1
Use for family	Yes	81	18.2
	Yes, to some extent	165	37.2
	Not really	120	27.0
	Never	52	11.7
	No answer	26	5.9
Use for myself	Yes	107	24.1
	Yes, to some extent	160	36.0
	Not really	100	22.5
	Never	54	12.2
	No answer	23	5.2
Use for older adults as home-care staff	Yes	52	11.7
	Yes, to some extent	197	44.4

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	Not really	100	22.5
	Never	67	15.1
	No answer	28	6.3

Table 2. Component factors and item loadings for ethical perceptions of home-care robots

Factor name Item	Factor 1	Factor 2	Factor 3	Factor 4	Uniqueness
Perceived benefit					
I think that home-care robots have a lot of promise and I would like to try one	0.860	-0.024	-0.096	-0.103	0.288
I would like to try using home-care robots if safety and convenience were confirmed through research	0.821	0.061	0.005	0.037	0.281
I would like to try using home-care robots if they will be covered by long-term insurance	0.818	-0.010	-0.009	0.026	0.353
I would like to decide whether to use home-care robots depending on the expenditure on their purchase and use	0.774	-0.040	-0.126	0.142	0.501
Home-care robots are useful as devices that support nursing care by family members and others	0.738	0.030	-0.078	-0.189	0.380
I would like to try using home-care robots because they work as they are supposed to	0.704	0.093	-0.085	-0.190	0.384

I would like to use home-care robots if function can be changed in response to the needs of the older adults and caregivers	0.652	0.183	-0.010	0.000	0.425
I would like to try using home-care robots even during the R&D phase if they benefited me personally	0.633	-0.189	0.359	0.092	0.476
If the user cannot decide whether to use a home care robot, family members who know the user well should decide	0.515	0.286	-0.094	0.034	0.555
Use of personal information					
I want information collected about me by a home-care robot to be used by care professionals who are familiar with my situation	0.082	0.760	0.056	0.095	0.319
Whenever necessary, I want my family to be informed of any information collected about me by a home-care robot	0.126	0.715	0.042	0.044	0.358
I do not mind if photos or videos of me by a home-care robot are transcribed for nursing care professionals or family members	0.095	0.622	0.141	-0.149	0.394
Protection of privacy					
It doesn’t matter if I’m photographed or filmed by a home-care robot	-0.137	0.093	0.779	-0.044	0.382

I hate to be photographed or filmed by a home-care robot	0.126	-0.044	-0.754	0.123	0.396
As privacy is protected if photos and videos are unclear, it does not matter if I'm photographed or filmed by a home-care robot	0.006	0.186	0.670	-0.003	0.417
Perceived risk					
I worry whether home-care robots will respect the intentions and will of the older adults	-0.100	-0.002	-0.078	0.670	0.465
I worry that the use of home-care robots will lead to less involvement with people	-0.170	-0.047	0.010	0.603	0.554
I worry whether home-care robots might injure older people	0.004	0.159	-0.127	0.597	0.580

Table 3. Results of logistic regression analyses

A. I would like to use home care robots for caretaking of family in home care settings.	**Odds Ratio**	**95% CI**			***P*-value**
Age	0.99	0.97	-	1.02	.604
Sex	0.67	0.30	-	1.49	.325
Personal interest in robots	1.18	0.64	-	2.18	.604
Past experience in care robot use	1.30	0.80	-	2.10	.288
Past experience in use of animal-like robots, humanoids, and/or robot cleaners	1.19	0.89	-	1.60	.239
Perceived benefit	13.26	6.96	-	25.26	<.001
Use of personal information	1.08	0.76	-	1.53	.674
Protection of privacy	1.15	0.79	-	1.68	.477
Perceived risk	0.60	0.41	-	0.88	.009
Constant	1.17	0.07	-	18.59	.911
Pseudo R^2 = .438					

B. I would like to use home care robots for personal caretaking in home care settings.	**Odds Ratio**	**95% CI**			***P*-value**
Age	0.99	0.96	-	1.02	.488
Sex	1.05	0.48	-	2.30	.901
Personal interest in robots	1.19	0.64	-	2.20	.578
Past experience in care robot use	0.86	0.55	-	1.33	.485
Past experience in use of animal-like robots, humanoids, and/or robot cleaners	1.25	0.93	-	1.68	.135
Perceived benefit	10.14	5.67	-	18.12	.000
Use of personal information	0.80	0.56	-	1.14	.220
Protection of privacy	1.13	0.77	-	1.67	.522
Perceived risk	0.44	0.30	-	0.65	<.001
Constant	1.32	0.09	-	19.86	.840
Pseudo R^2 = .417					

C. I would like to use home care robots at my organization.	**Odds Ratio**	**95% CI**			***P*-value**
Age	1.00	0.97		1.02	.720

Sex	0.57	0.27	-	1.19	.134
Personal interest in robots	1.39	0.80	-	2.41	.246
Past experience in care robot use	0.97	0.63	-	1.47	.868
Past experience in use of animal-like robots, humanoids, and/or robot cleaners	0.95	0.73	-	1.24	.721
Perceived benefit	5.75	3.52	-	9.39	<.001
Use of personal information	1.42	1.02	-	1.98	.037
Protection of privacy	1.21	0.86	-	1.71	.263
Perceived risk	0.96	0.68	-	1.35	.813
Constant	1.96	0.17	-	22.35	0.588
Pseudo R^2 = .332					

Figure caption

Figure 1. Theoretical framework