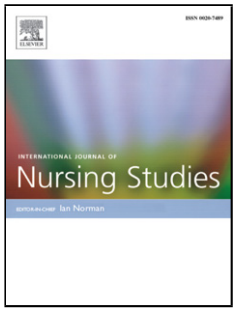

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Attitudes and perceptions of adults of 60 years and older towards in-home monitoring of the activities of daily living with contactless sensors: an explorative study.

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Abstract

Background and objectives

Contactless monitoring is increasingly used to enhance qualitative and cost-effective care for older persons. Succesful integration of this technology in older peoples' daily lives, depends on their acceptance of these systems. The primary purpose was to explore attitudes and perceptions of adults of 60 years and older towards contactless monitoring of the activities of daily living.

Design, participants and methods

A questionnaire was developed, validated and used in a cross-sectional survey with a convenience sample (n = 245). The results were presented using descriptive statistics and bivariate analyses to explore variables associated with willingness to install the technology.

Results

Descriptive statistics indicate that adults of 60 years and older find contactless monitoring useful for various purposes (e.g. to remain living at home longer, safely and independently; for timely detection of emergency situations and gradually emerging health problems). They agree to share collected information with professional caregivers and own access to the data is valued. Respondents like to take part in diverse decisions about the monitoring (e.g. about the rooms in which it is installed, the type of sensors used and access of third parties to collected information). However several concerns were expressed related to the functioning and financing of contactless monitoring. Bivariate analyses show that both socio-demographic factors (e.g. age, receiving professional home care) and attitudes and

perceptions towards contactless monitoring (e.g. on its potential usefulness, on the availability of collected information, on the functional requirements and financial costs of the system and on the use of video cameras) can promote or impede acceptance of the technology.

Conclusions

This exploratory study indicates that older adults are willing to incorporate contactless monitoring in later life or when their health declines. They agree to share collected information with professional caregivers and clearly demand for participation in decisions about the technology. Various concerns and requirements provide implications for clinical practice and future research. Thereby, researchers, technology developpers and professional caregivers can promote the implementation of contactless monitoring in the care for older adults.

Keywords: activities of daily living, aged, attitude, perception, technolog

Introduction

Demographic changes with an aging population are creating growing demand for care for older people (Steele et al., 2009, van Hoof et al., 2011, Sponselee et al., 2013). Figures concerning the population projections up to and beyond 2050 illustrate that the segment of individuals aged 70 and older, which bring along high expenditures and pressure on health care, will keep increasing substantially (United Nations, 2003). Therefore the provision of qualitative and cost-effective care for older persons will become more and more important (Steele et al., 2009, Sponselee et al., 2013).

Aging can be associated with physical, sensory and cognitive decline and related (chronic) health problems. It can interfere with the performance of activities of daily living and the maintenance of health, safety and a social network. However, retaining of independence is of great importance for many older people. The majority of the older persons want to live safe in their familiar home environment as long as possible (Demiris, Hensel et al., 2008, Peek et al., 2014, Wild et al., 2008). In order to meet these challenges, there's a growing interest in the development of technologies for the in-home monitoring of older people (Peek et al., 2014, Sponselee et al., 2013, Townsend et al., 2011). Different types of contactless sensors can be integrated into the infrastructure of a house, such as motion, temperature, pressure or bed sensors, video cameras and sensors on public utilities (e.g. water, gas and electricity). They do not require control by the residents, attachment to clothing or implantion in the human body (Courtney, Demiris et al., 2008, Demiris, Hensel et al., 2009, Ding et al., 2011).

Herewith it is possible to map the activities of daily living (ADL) of older persons, such as personal hygiene, sleeping, toilet visits, cooking, making a phone call or managing medication (Devriendt et al., 2012, Ding et al., 2011, Katz et al., 1970). The ability to live independently and the security of the older persons are mapped and both acute and gradual abnormal changes can be detected. Examples of acute changes are emergency situations, such as a fall, the sudden absence of activity in the home or a gas stove that remains turned on. Gradual changes include a progressive decrease in the ADL activities and sleep or behavioural disturbances (Ding et al., 2011). By sharing this information with (professional) caregivers, help can be offered timely in emergency situations, or various health problems - such as dementia - can possibly be detected in an early stage and assistance for the older person can be started or adapted timely. Furthermore, institutionalisation can possibly be delayed, the quality of life can be improved and the workload for the caregivers can be reduced (Devriendt et al., 2012, van Hoof et al., 2011, Wild et al., 2008).

Several researchers have explored the use of contactless monitoring in the care for older persons (Alwan et al., 2006, Chan et al., 2009, Ding et al., 2011). In Flanders this has recently been done through the research projects Automatic monitoring of activities of daily living using contactless sensors (AMACS), FallCam and Care4Safety (Christelijke Mutualiteit, 2012, Devriendt et al., 2012, Vlaeyen et al., 2013). The succesfull integration of contactless long-term monitoring in older people's daily lives, strongly depends on the acceptance of these systems, which is influenced by attitudes and perceptions towards these technologies (Beckwith, 2003, Sponselee et al., 2013, Townsend et al., 2011). Systems that are perceived negatively by their users, are more likely to be rejected and vice versa. The

acceptance of contactless monitoring systems can be promoted by exploring the needs, concerns and possible prejudices of older people as end-users and adapting the technologies to these requirements during their development and implementation (Demiris, Parker Oliver et al., 2008, Demiris, Parker Oliver et al., 2009, Steele et al., 2009).

Despite the importance of the above-mentioned topics for technology developers, healthcare professionals and policy makers, many research projects focus mainly on technical and clinical aspects (Courtney, 2008, Demiris, Hensel et al., 2009, Sponselee et al., 2013). In our recent systematic review, we only could find a limited number of mainly qualitative studies paying attention to the attitudes, perceptions and needs of older people as the potential or actuel end-users of contactless in-home monitoring and their willingess to accept these technologies. Most of these studies have a limited profundity and methodological quality (Claes et al., 2013).

Given the above-mentioned reasons and because there is a scarcity of explorative studies with quantitative research methods on this research topic, the purpose of this study was twofold: (1) to develop and validate a questionnaire to explore the attitudes and perceptions of adults of 60 years and older towards contactless in-home monitoring of the activities of daily living and to explore variables associated with willingness to install the technology and (2) to conduct a survey by using this questionnaire.

Materials and methods

Development and validation of the questionnaire

Development

Relevant themes and questions for the questionnaire were formulated based on existing literature about the attitudes and perceptions of older persons towards contactless monitoring (Claes et al., 2013). An initial questionnaire was developed by one of the authors (V.C.). This version was independently reviewed by all authors (E.D., J.T. and K.M.). The various suggestions about the selection, wording and arrangement of the themes and items were discussed by all the authors until consensus was reached on a provisional version of the questionnaire.

Content validity

A panel of 19 Dutch-speaking experts was selected and asked to judge the content validity of the provisional Dutch version of the questionnaire (Lynn, 1986, Polit, Beck et al., 2007). To guarantee their expertise, the members of the panel were chosen among the partners and the users commission of the AMACS project, a research project on contactless in-home monitoring for older persons (Devriendt et al., 2012). The experts were contacted and asked to return the questionnaire by e-mail within one month. After two weeks, a reminder was sent when needed. The experts were asked to rate each item of the provisional questionnaire on its relevance using a 4-point Likert-type scale, ranging from “not relevant” (score 1), “somewhath relevant” (score 2), “relevant” (score 3) to “highly relevant” (score 4). Experts were also asked to indicate whether an item was formulated clearly and understandable using the answers: “yes” or “no”. In addition, they were encouraged to give their

recommendations for the revision of the wording and/or elimination of the items (Lynn, 1986, Polit, Beck et al., 2007).

An item content validity index (I-CVI) was calculated for each item of the provisional questionnaire as the proportion of experts who rated its content as valid (a relevance rating of the item of 3 or 4). Different methods were used to calculate a scale content validity index (S-CVI) for the full questionnaire. Using the first method, the average of all the I-CVIs of the individual items of the questionnaire was calculated ($S\text{-}CVI_{Ave}$). In the second method 'universal agreement' among the experts is required by calculating the proportion of items on an instrument that achieved a relevance rating of 3 or 4 by all the experts ($S\text{-}CVI_{UA}$). Indexes for content validity were rated as good when the I-CVI, $S\text{-}CVI_{Ave}$ and $S\text{-}CVI_{UA}$ were at least 0.78, 0.90 and 0.80, respectively (Polit, Beck et al., 2007). A modified kappa statistic (k*) was calculated to counter the limitations of the I-CVI. It is an index of agreement among experts that an item is relevant with a correction for chance agreement. Recommendations of Polit, Beck et al. (2007) were used to compute and evaluate the modified kappa (Appendix 1, available online). The value of k* for each item of the questionnaire was evaluated as fair (between 0.40 and 0.59), good (between 0.60 and 0.74) or excellent (more than 0.74).

Face validity

The face validity of the provisional questionnaire was tested by a convenience sample of Flemish adults of 60 years and older living at home (n = 8), selected by two of the authors (V.C. and E.D.). They were asked to fill out the questionnaire and indicate the time required. In addition, they could give their opinion and suggestions on the clarity of the instructions for users and on the amount, clarity and relevance of

the individual items of the questionnaire (Polit, Beck et al., 2012). The results of the face validity were discussed by three of the authors (V.C.; E.D. and K.M.) and a final version of the questionnaire was established based on their consensus.

Survey of the attitudes and perceptions towards contactless monitoring

Design and population

A prospective, cross-sectional design was used to answer the primary research question. Flemish adults, selected through convenience sampling, were asked to participate in the study. Inclusion criteria were: (1) being able to understand and write Dutch, (2) being 60 years or older and (3) living at home. Reasons for non-participation were problems with vision, hearing or cognitive functioning that hindered filling out the questionnaire.

Procedure and ethical considerations

National and local representatives from 15 Flemish patient and consumer organisations were contacted by one of the authors (V.C.) by e-mail and telephone to request the participation of their members in the study. Data collection meetings were organized between January and March 2013. All meetings started with a presentation of approximately 20 minutes to inform the respondents about the use of in-home contactless monitoring, about participation in the study and to give instructions for filling out the questionnaire after written informed consent was obtained. Questionnaires were collected anonimously at the end of the meeting. The study was approved by the Medical Ethics Committee of the Leuven University Hospitals in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki) for experiments involving humans.

Statistical analysis

Descriptive statistics (mean, standard deviation, frequencies) were used to describe the sample characteristics and the item-level results of the questionnaires (Field, 2009). Bivariate analyses were used to determine which socio-demographic characteristics and items from the questionnaire (attitudes and perceptions towards contactless monitoring) are associated with willingness to install the technology. Three items from the questionnaire, asking respondents when they would be willing to have contactless monitoring installed in their home (item 17a, b and c; table 1), were recoded into a new dependent variabele in order to compare two groups of respondents. The first group consisted of all respondents who answered 'strongly agree' on at least one of the above-mentioned items (n = 113, 53.3%). Thus, they represent adults of 60 years and older who would strongly agree to have contactless monitoring installed in at least one occasion (at this point in life, in later life or when the own health declines). The second group were the respondents who never answered 'strongly agree' to any of the above-mentioned items (n = 99, 46.7%). All socio-demographic variables and items from the questionnaire (exept for item 17a, b and c and open-ended questions) were used as independent variables (table 2 and 3). Depending on the measurement level of the independent variable and statistical test assumptions, two-sided Chi²-tests, Fisher's exact tests or independent t-tests were used (Field, 2009, Polit & Beck, 2012, Vocht, 2012). Given the exploratory nature of the study, no multivariate analyses were used. For all analyses, a significance level of 5% and the statistical software SPSS for Windows, version 20.0 (SPSS, Inc., Chicago,IL) were used.

Results

Development and validation of the questionnaire

Development

The questionnaire was adapted and discussed by all the authors four times before consensus was reached about a provisional version to be tested for its content validity. This provisional questionnaire was designed as a 4-point Likert-type scale and contained 73 questions grouped under 17 main questions. It contained questions about 10 broad themes: (1) the potential usefulness of contactless monitoring, (2) availability of the information collected through contactless monitoring, (3) functional system requirements of contactless monitoring, (4) user participation in decisions about the technology, (5) concerns related to the use of contactless monitoring, (6) the experience of false alarms, (7) the use of video cameras for contactless monitoring, (8) the financial costs of the technology, (9) arguments in the decision to accept contactless monitoring and (10) the acceptance of the technology.

Additional data were collected on socio-demographic characteristics such as age, gender, nationality, marital status, living situation, education level, professional career, the use of professional care, received and provided informal care, technology used in daily life and health status.

Content validity

The content validity of the provisional questionnaire was rated by 13 of the 19 selected experts. Seven had a background in engineering, two in biomedical ethics and law, one in physiotherapy, one in medicine, one in philosophy and one in welfare work.

Sixty-six of the 73 items (90,4%) had an excellent content validity (I-CVI ≥ 0.78 and k* > 0.74), 4 items (5.5%) had a good content validity (I-CVI < 0.78 and 0.60 ≤ k* ≤ 0.74) and 3 items (4.1%) were considered as fair (I-CVI < 0.78 and 0.40 ≤ k* ≤ 0.59). None of the items had a very low modified kappa value (< 0.40) and was considered content invalid. The scale content validity universal agreement ($S\text{-}CVI_{UA}$) was 0.33. and the average scale content validity (S-CVIAve) was 0.90 (Appendix 1, available online).

Based on the recommendations of the experts, several adjustments to the provisional questionnaire (Appendix 1, available online) were made. The wording and/or the sequence of some items was slightly changed to promote their comprehensibility. Four items were added. Six items with an excellent content validity were deleted on substansive grounds: one due to an overlap with another question (item 1d); two due to their low comprehensability (item 9e and 11f) and three due to their redundancy since systems for contactless monitoring are supposed to work automatically (item 11b, 12c and 12d). Two other items were deleted due to their merely fair content validity (item 3f and 9g). As a result, the final version of the questionnaire (Appendix 2 and 3, available online) contained 69 items with a slightly different wording and sequence than the provisional version that was validated by the experts.

Face validity

No major remarks were given by the eight older persons who evaluated the provisional version of the questionnaire for its face validity. No problems with the time needed to fill out the questionnaire and the amount of questions were indicated. Minor suggestions on the lay-out and the wording were given to improve the clarity of the questions. Suggestions on less relevant items (item 13a-c and 16c) were not taken into account because they were only made by one or two respondents respectively and all these items scored excellent for their content validity.

Exploration of the attitudes and perceptions towards contactless monitoring

Sample characteristics

The questionnaire was filled out by 245 members from seven different Flemish patient and consumer organisations for adults and older people. The average age was 72.4 years (range = 60-90, standard deviation SD = 6.39) and most respondents were women (n = 162, 67.8%). Educational levels varied considerably, but most respondents (n = 215, 90.4%) at least completed secondary education and were currently retired (n = 232, 97.1%). The majority did not provide informal care (n = 139, 67.8%) neither received informal or professional care at home (n = 157, 68.3%). At least half of the sample had experience with using technologies such as a computer (n = 146, 61.6%) or the Internet (n = 141, 59.5%), but only eight respondents (3.4%) indicated using a personal alarm system. Most respondents perceived themselves as being in very good or good health (n = 190, 77.5%), being as active as peers (n = 127, 51.8%) and as having only occasional memory problems (n = 143, 58.4%) (table 2).

<Approximate place for table 2>

Descriptive analyses of the questionnaire

Potential usefulness, availability of information and user participation in decisions about contactless monitoring (theme 1, 2 and 4)

A majority of the respondents (80,7% or more) agreed about the potential usefullness of contactless monitoring for the various purposes indicated in the questionnaire. The technology was found most useful to remain living at home longer (94.3%), both safely (93.7%) and independently (94.8%). Timely detecting and receiving assistance for both emergency situations (93.6%) and gradually emerging health problems (86.5%) was also found valuable and monitoring did not seem redundant to the use of other aids (90,7%). In general, contactless monitoring was embraced for its usefullnes in later life (95.5%), only a minority of respondents (25.3%) indicated it could already be useful at this moment in their life (table 3).

Most respondents indicated the information collected through contactless monitoring could be useful for both professional (94.7%) and informal (86.9%) caregivers and were willing to share the information with these third parties (94.2% and 85.7% respectively). In contrast, more than half of the respondents indicated that avoiding unnecessary worries (56.8%) and control of daily activities (54.4%) could be reasons to forbid access to informal caregivers. The possibility to have access to the data themselves was also highly valued (90.4%) (table 3).

Furthermore, respondents cleary indicated the importance of their own participation in a diversity of decisions when installing or using contactless monitoring (for each decision, 85,3% or more of respondents found this important). Most priority went to

deciding in which rooms the monitoring would be installed (96.4%), the type of sensors that would be used (95.9%) and which third parties would get access to the collected information (95.3%) (table 3).

Functional system requirements and concerns related to the use of contactless monitoring (theme 3 and 5)

Respondents found it very important that professional caregivers or installers would be able to answer their questions about the monitoring (96.7%) and that they could temporarily switch off the technology if desired (93.0%). Most respondents found it important that the monitoring should function automatically (92.1%) and that it should still be operable by the older end-user (81.8%).

All concerns about to the use of contactless monitoring listed in the questionnaire were endorsed by 30% or more of the respondents. Most concerns were expressed regarding the possibility that the technology would give unintelligible error messages (71.7%), would be maladjusted to limitations that may arise when aging such as problems with vision, hearing, manipulating small buttons (70.3%) or would infringe on the own privacy (64.4%). A possible feeling of stigmatization (35.1%) or visibility for visitors (30.6%) were seen as minor concerns.

Experience of false alarms and the use of video cameras for contactless monitoring (theme 6 and 7)

However false alarms were a cause for concern (60.3%); there was no unanimity whether they would be experienced as a burden (68.3%) or as a positive sign that the monitoring works (56.3%). Moreover, mixed attitudes and perceptions were associated with the use of video cameras in a system for contactless monitoring.

Most respondents (82.3%) would find video cameras useful. On the contrary, 41,1% would not accept this type of sensors due to privacy infringement. The acceptation rate rised considerably when various measures for privacy protection were suggested, such as video images that are anonymous (70.3%), images that are only visible after explicit permission of the older end-user (77.9%) or in emergency situations (88.2%) and participation in decisions about where in the house camera's are placed (90.3%) (table 3).

The financial costs and acceptance of contactless monitoring (theme 8-10)

Regarding the decision to accept contactless monitoring, each questioned argument would be taken into account by 69% or more of respondents. Opinions or advices of professional caregivers would be allowed for by most respondents (94.4%), more than those of family, friends or acquaintances (69.4%). When questioning the financial costs of contactless monitoring, 70.5% of respondents (n = 148) would not want to pay maintenance costs for the system themselves. Furthermore, there was a notable difference between whether respondents would want the government and social security system (96.2%) or their family or other relatives (n = 25, 11.7%) to co-finance the technology. Finally, only a minority of respondents would accept contactless monitoring at this point in their life (15.5%). The willingness to accept the technology in later life (82.4%) or when the own health declines (91.8%) was remarkably higher (table 1).

<Approximate place for table 1 and 3>

Bivariate analyses of the questionnaire

As indicated above, two groups of respondents were compared in these analyses. Slightly more than half of the respondents (n = 113, 53.3%) belonged to the first group of adults of 60 years and older: those who would 'strongly agree' to have contactless monitoring installed in at least one occasion (at this point in life, in later life or when the own health declines). The second group were the respondents (n = 99, 46.7%) who would never 'strongly agree' to install the technology.

The analyses showed a significant difference ($p<.05$) between both above-mentioned groups of respondents for two socio-demographic variables and ten variables from the questionnaire about contactless monitoring (table 2 and 3).

Respondents who where younger (mean age = 70.89 vs 72.73, p=.029) and who received professional care at home (p=.035) more frequently agreed to install contactless monitoring. The same was found for respondents who found contactless monitoring at home usefull to timely receive emergency assistance (p=.041), to timely adjust assistance to changing needs (p=.020) or to follow up and support medication use (p=.003) and for those who agreed that the information collected through monitoring should be available for professional caregivers (p=.015).

On the other hand, respondents who found that the information collected through monitoring should not be available for informal caregivers since it could create needless worries (p=.036), who were worried that the system would be difficult to use for themselves (p=.035) or that it would be visible for visitors (p=.023) were less likely to agree to install the technology. This was similar for respondents who would experience false alarms as a burden (p=.001), who would not accept monitoring with

video cameras due to privacy infringement (p=0.011) and who found that monitoring may not bring along maintenance costs for themselves (p=.032) (table 2 and 3).

Discussion

To the best of our knowledge, this is one of the first explorations of the attitudes and perceptions of adults of 60 years and older towards contactless monitoring using quantitative research methods and the first study in this research domain with a validated questionnaire.

In accordance with previous qualitative studies (Claes et al., 2013, Heinz et al., 2013, Morris et al., 2013), respondents agreed that the technology could be useful for various medical and non-medical purposes. None of the proposed functions was clearly rejected. Considering that most respondents also want to participate in decisions about the type of sensors that are used and the kind of information that is collected, it might be preferable to develop monitoring systems that can incorporate a diversity of functions and that can be flexibely adopted to the changing level of functioning, goals, needs and preferences of its end-users (Peek et al., 2014, Sponselee et al., 2013). The finding that contactless monitoring was not only valued for responding to emergencies, but also for the detection of gradually emerging health problems, contrasts with earlier research (Claes et al., 2013). It might partially be explained by the clear examples that were given during data collection. Without such clarification, older adults might not understand how the technology can benefit them in these situations.

Most respondents reported willingness to share the information collected through contactless monitoring both with professional and informal caregivers. For the latter, this is both congruent (Boise et al., 2013) and in contrast (Claes et al., 2013) with previous research and there are also discrepancies within the current study findings, since most respondents (85.7%) in general agreed that informal caregivers should

get access to the information, whereas more than half of the respondents would forbid access of informal caregivers to avoid unnecessary worries or control over their daily activities. Therefore, further research should explore in more detail which barriers might make older adults reluctant for sharing information with informal caregivers and how they can possibly be resolved. Taking into account that most respondents also wish to participate in decisions about the sharing of collected information (Boise et al., 2013, Claes et al., 2013), they should be invited and supported to do so when installing the technology. Systems that are not flexible in this matter or exclude the older adult from decision making should be avoided.

The desire to take part in a diversity of decisions about contactless monitoring was emphasized and this is consistent with previous findings (Claes et al., 2013). As found in other studies (Claes et al., 2013, Peek et al., 2014), most respondents indicate that they would allow for advice of professional caregivers and family or other relatives when making decisions about the monitoring and that both technicians and professional caregivers must also be able to answer any questions about the system. As a consequence, there is a need for recommendations that professional caregivers and technicians can use to actively involve older adults and their relatives in informed decision-making about contactless monitoring (Boise et al., 2013). This should include guidelines for situations in which the older adult is unable to express his/her own will (e.g. in case of moderate to severe cognitive problems) (Claes et al., 2013). The scarcity of such recommendations (Courtenay, Bruce, 2011) for use in both clinical practice and research projects highlights the need to invest in this area. Furthermore, it is necessary to provide support systems and educational opportunities for all involved parties while introducing and using the technology (Heinz et al., 2013, Peek et al., 2014, Sponselee et al., 2013).

Respondents expressed various concerns related to the use of contactless monitoring, which is in accordance with existing research (Claes et al., 2013, Heinz et al., 2013, Morris et al., 2013, Peek et al., 2014). The finding that different aspects of the technology created worries, implies that designers have an important role in avoiding these concerns (Sponselee et al., 2013). This might be done by ensuring that error messages are intellegible for older adults, that the system is easy to use and adjusted to limitations that may arise with aging and by avoiding false alarms, sounds, light flashes and interference with the functioning of other appliances as much as possible. To allow for older adults perspectives, technicians can also incorporate a temporarily switch off modus and develop adaptive systems where the extent to which the system functions automatically is in concordance with the preferences and needs of a specific older adult (e.g. a more automated system for an older adult with cognitive impairment) (Sponselee et al., 2013). Furthermore, providing clearly understandable information tailored to older adults can also be an important strategy for the prevention or early resolution of other concerns. Examples are informing about the measures that are taken to protect the privacy of the older adult and on technological limitations of the system (e.g. the possibility that some emergency situations remain undetected) (Sponselee et al., 2013, Peek et al., 2014). The finding that visibility of the system for visitors, a feeling of stigmatization and a decrease of personal assistance seemed less of a concern, contradicts with previous research (Claes et al., 2013, Heinz et al., 2013, Peek et al., 2014, Wilkowska, Ziefle, 2012). However, the information given during data collection probably influenced the responses, which suggests that these worries should not be minimized and discussed with the potential users of these systems.

Financial costs have previously been identified as a major concern of older adults regarding technologies and non-electronic assistive devices to support aging in place, including contactless monitoring (Heinz et al., 2013, Peek et al., 2014, Steel et al., 2009). This is in line with the present studies findings, in which respondents explicitely indicated that the government or social security system should co-finance the technology, and that they were reluctant to pay maintenance costs themselves or to ask their family or other relatives for financial support. The fact that Belgian older adults are accustomed to the paradigm of the 'welfare state' (e.g. the Belgian social security system already provides various measures to reimburse health-related costs) might be explanatory for our studies finding. As emphasized in earlier research (Claes et al., 2013, Morris et al., 2013) and following recommendations of Sponselee et al. (2013), a transparant and comprehensive funding strategy should be developped based on future research that explores whether these monitoring systems are cost-effective.

Consistent with past research (Boise et al., 2013, Claes et al., 2013, Heinz et al., 2013, Peek et al., 2014) including both pre- (e.g. by users who have not yet used contactless monitoring) and post-implementation technology evaluations (e.g. by users who have used and experienced the technology), most respondents indicated that they would only accept contactless monitoring in later life or when their health declines. The discomfort with using video cameras is an exeption to this general willingness to accept contactless monitoring and is comparable with earlier research (Boise et al., 2013, Claes et al., 2013, Morris et al., 2013). Presumably, for part of the respondents the potential usefulness of video monitoring does not outweigh concerns of privacy infringement. However, the results also indicate that various measures for privacy protection are useful strategies to promote the acceptance rate of this type of

technology. Therefore, they should be considered for use in implementation research and clinical practice.

The results of the bivariate statistical analyses considerably resemble to qualitative factors in a recent systematic review by Peek et al. (2014) and partially in line with several theoretical models on technology acceptance. The importance of key constructs in the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) is confirmed. These constructs include 'perceived usefulness of a technology' (e.g. finding contactless monitoring usefull for various purposes), 'perceived ease of use' (e.g. the concern that contactless monitoring would be difficult to use), 'social influence' (e.g. agreement to share collected information with professional and informal caregivers) and 'moderating factors' (e.g. age). The moderating effect of other socio-demographic factors in UTAUT (e.g. gender and experience with technology use) contrasts with our findings. However valuable, both TAM and UTAUT are general and static models: there is no focus on technology acceptance by older adults, and no differentiation is made between technology acceptance in the pre- and post-implementation phase (Peek et al., 2014). Moreover, some important acceptance determinants are not included in these models, such as an older adult's subjective health status, concerns regarding a technology (e.g. visibility of a contactless monitoring system for visitors, privacy infringement through video cameras, experiencing false alarms as a burden) and financial costs (e.g. being unwilling to pay maintenance costs) (Peek et al., 2014). These criticisms have recently led to the development of the 'Telecare Acceptance and Use Model' (TAUM) (Sponselee et al., 2013), detailing determinants of the acceptance of technologies for aging in place by older adults (Sponselee et al., 2013).

Further quantitative research on the factors that influence acceptance of technologies for aging in place is warranted for several reasons. As previously stated, there is a dearth of quantitative research on this topic, underscoring the importance of the present study. Secondly, not all hypotheses underlying the TAUM could be supported by our results, and only limited other research (Sponselee et al., 2013, Wilkowska, Ziefle, 2012) is available for validation, operationalization and refinement of the TAUM or the development of new acceptance models (Sponselee et al., 2013). Providing that modifications are made, the questionnaire developped in this study can be a useful instrument for this kind of research. Such a thorough theoretical approach can further the interpretation and comparison of findings between studies (Peek et al., 2014). Thirdly, the acceptance of specific types of technology for aging in place has to be studied, to explore whether or not a differentiation can be made between core and technology specific acceptance determinants (Peek et al., 2014).

Several methodological considerations have to be taken into account when interpreting the findings of this study. First, the relatively small sample (n = 245) was obtained through convenience sampling. The majority of the respondents were female, perceived themselves as being in good health, received no (in)formal care and had experience using computers. This indicates we mainly assessed the attitudes and perceptions of older adults who currently might not need contactless monitoring but might benefit from using it in the near future. This limits generalization of the findings since varying populations of older adults may have different attitudes and perceptions towards the technology. On the other hand, it makes these findings highly relevant for developping monitoring systems that are adapted to the needs and concerns of its future users. As monitoring technology develops at a rapid pace, continuing research should explore the attitudes and perceptions of the next

generation of older adults as future users of contactless monitoring and new related technologies, including younger respondents (e.g. aged 50 and older).

Second, this study concerns the pre-implementation phase of technology use only. Future studies need to integrate a real end-user perspective through longitudinal implementation research. Thereby, it can be explored how the attitudes and perceptions of older adults as actual end-users of contactless monitoring differ from the pre-implementation phase and if they evolve over time while using the technology. As previously stated (Peek et al., 2014, Sponselee et al., 2013), the scarcity of post-implementation and combined pre- and post-implementation evaluations of in-home monitoring technologies underscores the need for further research in this area. Thereby, a modified version of the questionnaire developed in the current study can be used in concordance with other needs' assesment methods (e.g. workshops, demonstration trials, role plays) (Sponselee et al., 2013). Furthermore, multiple stakeholders besides older adults are involved in the process of designing and implementing contactless monitoring (e.g. professional and informal caregivers, technology designers). As such, investigating similarities and discrepancies between the goals, attitudes and perceptions of older adults and other stakeholders regarding contactless monitoring in both the pre- and post implementation phase of the technology is needed to increase its acceptance (Sponselee et al., 2013).

Third, due to practical constraints, we have done only one round of expert review to evaluate the content validity of our questionnaire. Performing a second round after the initial adaptations is recommended (Polit, Beck et al., 2007). Although the S-CVI_{Ave} of the final questionnaire indicated a good content validity, the more stringent

calculation using S-CVI$_{UA}$ showed that the amount of items with unanimity about their relevance among experts was low. The face validity was tested only on a small group of older adults. We provided an English version of the questionnaire for non-Dutch speaking readers, but a translation using a recommended translation method (Cha et al., 2007), validation and a cross-cultural adaptation of the English questionnaire are required before using it in future research.

Fourth, there was a considerable proportion of missing data for some items of the questionnaire (up to 17.1%). Some respondents (n = 33) were not taken into account for the bivariate analyses, due to missing data for the items (17a, 17b and 17c) that were recoded into a new dependent variable. Three other items (7c, 13b, 13c; ≥ 15% missing data) might have been difficult to fill out, because this study concerns the pre-implementation phase in technology use. For one item (14e), the meaning of 'explicit permission' might have been unclear. These items should be explained in greater detail when using the questionnaire in further research.

Finally, we did not correct for multiple testing in the bivariate analyses due to the explorative nature of this study. Furthermore, it was not feasible to perform a multivariate analysis of the questionnaire (e.g. binary logistic regression) due to missing data and the relatively small sample size compared to the high number of items on the questionnaire. Therefore, we could not validate the findings of the bivariate analyses or control for confounding variables. More research with larger sample sizes and strategies to reduce missing data is needed to refine the findings of this study.

Conclusions

This article reports the results of an explorative study regarding the attitudes and perceptions of adults of 60 years and older towards contactless in-home monitoring of the activities of daily living. The results indicate that older adults are in general willing to accept and incorporate contactless monitoring into their daily life. They agree to share the collected information with professional caregivers and clearly demand for their own participation in decision making. Furthermore, various concerns and requirements related to the use, functioning and financing of the monitoring have to be considered since they might hinder acceptance of the technology. These findings both confirm and contrast the results of prior foreign research and require further exploration with designs that allow for the methodological limitations of the current study. By taking into account the implications for future research and clinical practice, researchers, technology developpers as well as professional caregivers can promote the acceptance and implementation of contactless monitoring in the care for older adults on a larger scale.

Ethical approval, conflicts of interest and funding

The study was approved by the Medical Ethics Committee of the Leuven University Hospitals. No conflicts of interest, sources of funding and financial or material assistance are applicable.

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Research highlights

What is already known about the topic?

- Successful implementation of contactless in-home monitoring in the care for older adults depends on their acceptance of the technology. This is influenced by their attitudes and perceptions towards these systems.
- The attitudes and perceptions of older persons towards contactless in-home monitoring include perceptions on the potential usefulness of contactless monitoring, on the communication of information obtained through the monitoring, on the involvement and participation of the older adult in decisions about the monitoring and several concerns related to the technology.

What this paper adds

- This is one of the first explorations of the attitudes and perceptions of older adults towards contactless monitoring using quantitative research methods and a validated questionnaire.
- Older adults are willing to accept contactless monitoring, they agree to share information collected through these systems with professional caregivers and they clearly demand involvement in informed decision-making about the technology.
- The acceptance of contactless monitoring can be promoted through the design of the system, by taking various measures for privacy protection and by developing recommendations for informed decision making and funding of the technology.

Tables

Table 1:

Descriptive results of the questionnaire: acceptance of contactless monitoring

Table 2:

Socio-demographic variables associated with willingness to install contactless monitoring

Table 3:

Attitudes and perceptions towards contactless monitoring associated with willingness to install contactless monitoring

Table 1
Descriptive results of the questionnaire: acceptance of contactless monitoring*

Item† ‡	n (%) of total sample who strongly disagree_ n (%) of total sample who slightly disagree_ n (%) of total sample who slightly agree_ n (%) of total sample who strongly agree_
17a. At this point in life	130 (61.0) 50 (23.5) 26 (12.2) 7 (3.3)
17b. Only in later life	16 (7.4) 22 (10.2) 116 (53.7) 62 (28.7)
17c. When health declines, regardless of age	9 (4.1) 9 (4.1) 99 (45.4) 101 (46.4)

Legend
* Indicating valid percentages; response categories 'strongly disagree', 'slightly disagree', 'slightly agree', strongly agree'
† Concise description of the item; see Appendix 3 for an English translation of the questionnaire
‡ These items were recoded into one dependent variable for the bivariate analyses

Table 2
Socio-demographic variables associated with willingness to install contactless monitoring†

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
Age (years), M ± SD_	72.41 +/- 6.4	72.73 ± 5.9	70.89 ± 5.8	t = 2.202¶	*.029**
Gender				χ^2 = 1.693**	.193
Male, n (%)	77 (32.2)	40 (40.8)	35 (32.1)		
Female, n (%)	162 (67.8)	58 (59.2)	74 (67.9)		
Marital status				n/a††	.238
Married or living with someone, n (%)	154 (64.4)	71 (72.4)	67 (61.5)		
Not married, n (%)	15 (6.3)	6 (6.1)	7 (6.4)		
Divorced, n (%)	7 (2.9)	1 (1.0)	5 (4.6)		
Widow or widower, n (%)	63 (26.4)	20 (20.4)	30 (27.5)		
Education‡‡				χ^2 = 4.020**	.564
No education, n (%)	1 (0.4)	0 (0.0)	0 (0.0)		
Primary education, n (%)	21 (8.8)	8 (8.2)	5 (4.6)		
Secondary education, n (%)	118 (49.6)	50 (51.0)	51 (46.8)		
Bachelor's degree, n (%)	69 (29.0)	26 (26.5)	38 (34.9)		
University, n (%)	28 (11.8)	13 (13.3)	15 (13.8)		
Other, n (%)	1 (0.4)	1 (1.0)	0 (0.0)		
Living situation				n/a††	.246
Home, alone, n (%)	80 (33.6)	26 (26.5)	39 (35.8)		
Home, together with husband/wife or partner, n (%)	149 (62.2)	68 (69.4)	67 (61.5)		
Home, together with family, friend or acquaintance, n (%)	6 (2.5)	2 (2.0)	3 (2.8)		
Other, n (%)	3 (1.3)	2 (2.0)	0 (0.0)		
Type of residence/dwelling				n/a††	.172
House, n (%)	193 (81.4)	77 (78.6)	96 (88.1)		
Apartment, n (%)	40 (16.9)	19 (19.4)	11 (10.1)		
Service flat, n (%)	2 (0.8)	1 (1.0)	1 (0.9)		
Other, n (%)	2 (0.8)	1 (1.0)	1 (0.9)		
Work situation				n/a††	1.000
Currently unemployed, n (%)	2 (0.8)	1 (1.0)	1 (0.9)		
Part-time or full-time work, n (%)	2 (0.8)	1 (1.0)	1 (0.9)		
Retired, n (%)	232 (97.1)	95 (96.9)	106 (97.2)		
Other, n (%)	3 (1.3)	1 (1.0)	1 (0.9)		
Informal care provided by respondent				χ^2 = 0.332**	.633
No informal caregiver, n (%)	139 (67.8)	62 (71.3)	66 (67.3)		
Currently or previous informal caregiver, n (%)	66 (32.2)	25 (28.7)	32 (32.7)		

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
Help at home**				n/a††	*.035**
No help at home, n (%)	157 (68.3)	70 (73.7)	72 (67.9)		
Informal care, n (%)	10 (4.3)	6 (6.3)	1 (0.9)		
Professional/formal care, n (%)	63 (27.4)	19 (20.0)	33 (31.2)		
Nursing care received by respondent				n/a††	1.000
Yes, n (%)	14 (6.0)	4 (4.2)	4 (3.7)		
No, n (%)	218 (94.0)	91 (95.8)	104 (96.3)		
Domestic help received by respondent				$\chi^2 = 0.209$**	.744
Yes, n (%)	62 (26.7)	22 (23.2)	28 (25.9)		
No, n (%)	170 (73.3)	73 (76.8)	80 (74.1)		
Meals on wheels received by respondent				n/a††	1.000
Yes, n (%)	6 (2.6)	2 (2.1)	2 (1.9)		
No, n (%)	226 (97.4)	93 (97.9)	106 (98.1)		
Telephone used by respondent				$\chi^2 = 0.215$**	.810
Yes, n (%)	215 (90.7)	88 (89.8)	99 (91.7)		
No, n (%)	22 (9.3)	10 (10.2)	9 (8.3)		
Mobile phone used by respondent				$\chi^2 = 3.288$**	.090
Yes, n (%)	191 (80.6)	77 (78.6)	95 (88.0)		
No, n (%)	46 (19.4)	21 (21.4)	13 (12.0)		
Computer (including portable) used by respondent				$\chi^2 = 0.068$**	.882
Yes, n (%)	146 (61.6)	67 (68.4)	72 (66.7)		
No, n (%)	91 (38.4)	31 (31.6)	36 (33.3)		
Use of the Internet				$\chi^2 = 0.052$**	.884
Yes, n (%)	141 (59.5)	65 (66.3)	70 (64.8)		
No, n (%)	96 (40.5)	33 (33.7)	38 (35.2)		
Use of personal alarm system§§				n/a††	.349
Yes, n (%)	8 (3.4)	3 (3.1)	1 (0.9)		
No, n (%)	229 (96.6)	95 (96.9)	107 (99.1)		
Health status compared with peers_ _				n/a††	.246
Very good or good, n (%)	190 (80.6)	78 (79.6)	96 (88.9)		
Not too bad, n (%)	44 (18.6)	19 (19.4)	11 (10.2)		
Bad, n (%)	2 (0.8)	1 (1.0)	1 (0.9)		
Frequency of memory problems_ _				n/a††	.650
Never, n (%)	74 (32.2)	35 (35.7)	31 (29.5)		
Sometimes, n (%)	143 (62.2)	58 (59.2)	68 (64.8)		
Regularly, n (%)	12 (5.2)	5 (5.1)	5 (4.8)		
Continuously, n (%)	1 (0.4)	0 (0.0)	1 (1.0)		

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
Activity level compared with peers_ _				χ^2 = 4.042**	.129
Less active, n (%)	40 (17.5)	16 (16.7)	12 (11.3)		
As active as peers, n (%)	127 (55.7)	59 (61.5)	58 (54.7)		
More active, n (%)	61 (26.8)	21 (21.9)	36 (34.0)		

Legend

* P-values of statistically significant associations ($p < .05$) are shown in *italics*

† Indicating valid percentages; absolute values of the compared groups of respondents (column 3 and 4) may not round up to the value of the total sample (column 1) due to missing data (ranging from 2.4% to 16.3% of the total sample per item)

‡ Respondents answering 'strongly agree' for at least one of the following items (17a, 17b or 17c) of the questionnaire; n = 33 respondents were not taken into account for the bivariate analyses, due to missing data for item 17a, 17b or 17c

§ Respondents never answering 'strongly agree' for item 17a, 17b and 17c of the questionnaire

_ Mean (M); standard deviation (SD)

¶ Independent t-test for independent variable at ratio measurement level

** Chi²-test for independent variable at nominal or ordinal measurement level

†† Fisher's exact test for independent variable at nominal or ordinal measurement level and small cell sizes; n/a (not applicable): a test value is not provided when computing this bivariate test using the statistical software SPSS for Windows, version 20.0 (SPSS, Inc., Chicago, IL)

‡‡ Highest level of education of which the respondent holds a certificate

§§ A small portable device (necklace or bracelet) to call for informal or formal care in emergency situations (24h/24h)

_ _ As perceived by the respondent

Table 3
Attitudes and perceptions towards contactless monitoring associated with willingness to install contactless monitoring†

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
Theme 1: Potential usefulness of contactless monitoring _¶					
1a. Living at home in a safe way				$\chi^2 = 4.197$**	.070
Disagree, n (%)	15 (6.3)	9 (9.4)	3 (2.7)		
Agree, n (%)	211 (93.7)	87 (90.6)	108 (97.3)		
1b. Living at home for a longer time				n/a††	.307
Disagree, n (%)	13 (5.7)	6 (6.3)	3 (2.7)		
Agree, n (%)	216 (94.3)	89 (93.7)	108 (97.3)		
1c. Maintenance of independence in daily life				n/a††	1.000
Disagree, n (%)	12 (5.2)	4 (4.1)	4 (3.6)		
Agree, n (%)	219 (94.8)	94 (95.9)	107 (96.4)		
2. Supplementation or support of other aids				$\chi^2 = 1.753$**	0.203
Disagree, n (%)	21 (9.3)	10 (10.3)	6 (5.4)		
Agree, n (%)	206 (90.7)	87 (89.7)	105 (94.6)		
3a. Timely receipt of emergency assistance				$\chi^2 = 5.266$**	*.041**
Disagree, n (%)	15 (6.4)	10 (10.3)	3 (2.7)		
Agree, n (%)	218 (93.6)	87 (89.7)	110 (97.3)		
3b. Detection of gradually emerging health problems				$\chi^2 = 1.497$**	.230
Disagree, n (%)	31 (13.5)	16 (16.5)	12 (10.7)		
Agree, n (%)	198 (86.5)	81 (83.5)	100 (89.3)		
3c. Adjustment of assistance due to changing needs or requirements				$\chi^2 = 5.694$**	*.020**
Disagree, n (%)	18 (7.9)	12 (12.4)	4 (3.6)		
Agree, n (%)	211 (92.1)	85 (87.6)	108 (96.4)		
3d. Follow up of vital signs				$\chi^2 = 0.457$**	.594
Disagree, n (%)	44 (19.3)	20 (20.6)	19 (17.0)		
Agree, n (%)	184 (80.7)	77 (79.4)	93 (83.0)		
3e. Follow up and support of medication use				$\chi^2 = 9.157$**	*.003**
Disagree, n (%)	38 (16.6)	24 (24.5)	10 (9.0)		
Agree, n (%)	191 (83.4)	74 (75.5)	101 (91.0)		
3f. Safe use of household appliances				$\chi^2 = 0.150$**	.839
Disagree, n (%)	32 (14.3)	14 (14.6)	14 (12.7)		
Agree, n (%)	192 (85.7)	82 (85.4)	96 (87.3)		
3g. Reminder to activities or appointments				$\chi^2 = 2.960$**	.091
Disagree, n (%)	38 (17.1)	20 (20.4)	13 (11.7)		
Agree, n (%)	185 (82.9)	78 (79.6)	98 (88.3)		

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
4. Useful at this moment in life				$\chi^2 = 0.124$**	.746
Disagree, n (%)	166 (74.7)	75 (77.3)	82 (75.2)		
Agree, n (%)	56 (25.3)	22 (22.7)	27 (24.8)		
5. Useful in later life				n/a††	.263
Disagree, n (%)	10 (4.4)	5 (5.1)	2 (1.9)		
Agree, n (%)	215 (95.5)	93 (94.9)	105 (98.1)		
Theme 2: Availability of the information collected through contactless monitoring_¶					
6a. Availability for professional caregivers				$\chi^2 = 6.521$**	*.015**
Disagree, n (%)	13 (5.8)	10 (10.1)	2 (1.8)		
Agree, n (%)	210 (94.2)	89 (89.9)	107 (98.2)		
6b. Availability for informal caregivers				$\chi^2 = 0.117$**	.844
Disagree, n (%)	32 (14.3)	15 (15.3)	15 (13.6)		
Agree, n (%)	192 (85.7)	83 (84.7)	95 (86.4)		
6c. Availability for the person him/herself				$\chi^2 = 0.599$**	.468
Disagree, n (%)	21 (9.5)	10 (10.3)	8 (7.3)		
Agree, n (%)	200 (90.4)	87 (89.7)	102 (92.7)		
7a. Usefulness for professional caregivers				$\chi^2 = 0.273$**	.759
Disagree, n (%)	12 (5.3)	6 (6.1)	5 (4.5)		
Agree, n (%)	212 (94.7)	92 (93.9)	106 (95.5)		
7b. Usefulness for informal caregivers				$\chi^2 = 0.374$**	.680
Disagree, n (%)	31 (13.1)	14 (14.6)	13 (11.7)		
Agree, n (%)	192 (86.9)	82 (85.4)	98 (88.3)		
7c. Usefulness for the person him/herself				$\chi^2 = 1.183$**	.365
Disagree, n (%)	23 (11.3)	13 (14.0)	9 (9.0)		
Agree, n (%)	181 (88.7)	80 (86.0)	91 (91.0)		
8a. No access for informal caregivers – unnecessary worries				$\chi^2 = 4.472$**	*.036**
Disagree, n (%)	95 (43.2)	34 (35.8)	56 (50.5)		
Agree, n (%)	125 (56.8)	61 (64.2)	55 (49.5)		
8b. No access for informal caregivers – no control of daily activities				$\chi^2 = 0.950$**	.398
Disagree, n (%)	98 (45.6)	41 (43.2)	54 (50.0)		
Agree, n (%)	117 (54.4)	54 (56.8)	54 (50.0)		
Theme 3: Functional system requirements of contactless monitoring_‡‡					
10. Possibility to temporarily switch off				$\chi^2 = 0.057$**	1.000
Find this less important, n (%)	16 (7.0)	7 (7.1)	7 (6.2)		
Find this important, n (%)	211 (93.0)	92 (92.9)	105 (93.8)		

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
12a. System that functions automatically				χ^2 = 0.910**	.448
Find this less important, n (%)	17 (8.0)	6 (6.3)	11 (10.0)		
Find this important, n (%)	196 (92.0)	89 (93.7)	99 (90.0)		
12b. System that can still be operated by the person him/herself				χ^2 = 2.354**	.139
Find this less important, n (%)	38 (18.2)	12 (12.9)	23 (21.1)		
Find this important, n (%)	171 (81.8)	81 (87.1)	86 (78.9)		
12c. Professional caregivers or installers must be able to answer questions about the monitoring				n/a††	1.000
Find this less important, n (%)	7 (3.3)	3 (3.1)	4 (3.6)		
Find this important, n (%)	205 (96.7)	94 (96.9)	106 (96.4)		
Theme 4: User participation in decisions about the technology_‡‡					
9a. Type of sensors				n/a††	.257
Find this less important, n (%)	9 (4.0)	5 (5.1)	2 (1.8)		
Find this important, n (%)	215 (96.0)	93 (94.9)	109 (98.2)		
9b. Rooms where monitoring is installed				n/a††	.051
Find this less important, n (%)	8 (3.6)	6 (6.2)	1 (0.9)		
Find this important, n (%)	214 (96.4)	91 (93.8)	111 (99.1)		
9c. Kind of information				n/a††	.520
Find this less important, n (%)	11 (5.1)	6 (6.2)	4 (3.7)		
Find this important, n (%)	206 (94.1)	90 (93.8)	105 (96.3)		
9d. Moments at which information is collected				χ^2 = 0.002**	1.000
Find this less important, n (%)	20 (9.3)	8 (8.5)	9 (8.3)		
Find this important, n (%)	194 (90.7)	86 (91.5)	99 (91.7)		
9e. Accessibility of the information				n/a††	.736
Find this less important, n (%)	10 (4.6)	5 (5.3)	4 (3.6)		
Find this important, n (%)	206 (95.4)	90 (94.7)	106 (96.4)		
9f. Adjustments needed to the house				χ^2 = 0.043**	.844
Find this less important, n (%)	32 (14.7)	13 (13.5)	16 (14.5)		
Find this important, n (%)	185 (85.3)	83 (86.5)	94 (85.5)		
Theme 5: Concerns related to the use of contactless monitoring_§§					
11a. Difficult to use				χ^2 = 4.668**	*.035**
Not concerned about this, n (%)	89 (40.3)	32 (32.7)	53 (47.3)		
Concerned about this, n (%)	132 (59.7)	66 (67.3)	59 (52.7)		
11b. Unintelligible error messages				χ^2 = 2.593**	.123
Not concerned about this, n (%)	61 (28.3)	22 (23.2)	37 (33.3)		
Concerned about this, n (%)	154 (71.7)	73 (76.8)	74 (66.7)		

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
11c. Maladjusted to limitations that may arise when aging				$\chi^2 = 0.411$**	.541
Not concerned about this, n (%)	63 (29.7)	26 (27.4)	34 (31.5)		
Concerned about this	149 (70.3)	69 (72.6)	74 (68.5)		
11d. Infringement on privacy				$\chi^2 = 3.565$**	.080
Not concerned about this, n (%)	77 (35.6)	28 (29.2)	46 (41.8)		
Concerned about this, n (%)	139 (64.4)	68 (70.8)	64 (58.2)		
11e. Feeling of stigmatization				$\chi^2 = 2.804$**	.113
Not concerned about this, n (%)	144 (64.9)	58 (58.6)	78 (69.6)		
Concerned about this, n (%)	78 (35.1)	41 (41.4)	34 (30.4)		
11f. Visible for visitors				$\chi^2 = 5.365$**	*.023**
Not concerned about this, n (%)	150 (69.4)	59 (61.5)	84 (76.4)		
Concerned about this, n (%)	66 (30.6)	37 (38.5)	26 (23.6)		
11g. Decrease of personal assistance				$\chi^2 = 0.060$**	.889
Not concerned about this, n (%)	120 (56.1)	56 (57.1)	61 (55.5)		
Concerned about this, n (%)	94 (43.9)	42 (42.9)	49 (44.5)		
11h. No detection of emergency situations where monitoring is not installed				$\chi^2 = 1.403$**	.264
Not concerned about this, n (%)	95 (43.6)	38 (39.2)	53 (47.3)		
Concerned about this, n (%)	123 (56.4)	59 (60.8)	59 (52.7)		
11i. False alarms				$\chi^2 = 3.409$**	.088
Not concerned about this, n (%)	85 (39.7)	32 (33.3)	51 (45.9)		
Concerned about this, n (%)	129 (60.3)	64 (66.7)	60 (54.1)		
11j. Unwanted sounds or light flashes				$\chi^2 = 2.884$**	.096
Not concerned about this, n (%)	110 (51.2)	44 (45.8)	64 (57.7)		
Concerned about this, n (%)	105 (48.8)	52 (54.2)	47 (42.3)		
11k. Interference with functioning of other appliances				$\chi^2 = 0.080$**	.781
Not concerned about this, n (%)	96 (45.5)	43 (44.3)	50 (46.3)		
Concerned about this, n (%)	115 (54.5)	54 (55.7)	58 (53.7)		
Theme 6: Experience of false alarms_¶					
13a. False alarms – experience as a burden				$\chi^2 = 11.188$**	*.001**
Disagree, n (%)	68 (31.7)	20 (20.6)	47 (42.3)		
Agree, n (%)	146 (68.3)	77 (79.4)	64 (57.7)		
13b. False alarm – would not mind				$\chi^2 = 1.058$**	0.311
Disagree, n (%)	125 (61.5)	61 (65.6)	62 (58.5)		
Agree, n (%)	78 (38.5)	32 (34.4)	44 (41.5)		

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
13c. False alarms – experience as a positive sign				$\chi^2 = 2.172$**	.156
Disagree, n (%)	90 (43.7)	47 (50.0)	42 (39.6)		
Agree, n (%)	116 (56.3)	47 (50.0)	64 (60.4)		
Theme 7: Use of video cameras for contactless monitoring_¶					
14a. Useful				$\chi^2 = 2.141$**	.197
Disagree, n (%)	37 (17.7)	21 (21.9)	15 (14.0)		
Agree, n (%)	173 (82.3)	75 (78.1)	92 (86.0)		
14b. Not acceptable – infringement on privacy				$\chi^2 = 6.825$**	*.011**
Disagree, n (%)	126 (58.9)	47 (49.0)	73 (67.0)		
Agree, n (%)	88 (41.1)	49 (51.0)	36 (33.0)		
14c. Acceptable – even with non-anonymous video				$\chi^2 = 1.898$**	.202
Disagree, n (%)	123 (57.8)	60 (63.2)	59 (53.6)		
Agree, n (%)	90 (42.2)	35 (36.8)	51 (46.4)		
14d. Acceptable – only with anonymous video				$\chi^2 = 0.821$**	.441
Disagree, n (%)	63 (29.7)	25 (26.3)	35 (32.1)		
Agree, n (%)	149 (70.3)	70 (73.7)	74 (67.9)		
14e. Acceptable – if video only visible after explicit permission				$\chi^2 = 0.055$**	.864
Disagree, n (%)	46 (22.2)	19 (20.7)	24 (22.0)		
Agree, n (%)	162 (77.9)	73 (79.3)	85 (78.0)		
14f. Acceptable – if video only visible in emergency situation				$\chi^2 = 0.576$**	.510
Disagree, n (%)	25 (11.8)	9 (9.5)	14 (12.8)		
Agree, n (%)	187 (88.2)	86 (90.5)	95 (87.2)		
14g. Acceptable – only if participation in decision where cameras are placed				$\chi^2 = 0.362$**	.640
Disagree, n (%)	21 (9.7)	8 (8.3)	12 (10.8)		
Agree, n (%)	196 (90.3)	88 (91.7)	99 (89.2)		
Theme 8: Financial costs of contactless monitoring_¶					
16a. Co-financing by government or social security system				n/a††	.152
Disagree, n (%)	8 (3.8)	6 (6.1)	2 (1.8)		
Agree, n (%)	207 (96.2)	93 (93.9)	109 (98.2)		
16b. Co-financing by family or other relatives				$\chi^2 = 2.001$**	.194
Disagree, n (%)	189 (88.3)	90 (91.8)	95 (85.6)		
Agree, n (%)	25 (11.7)	8 (8.2)	16 (14.4)		
16c. No costs for the person him/herself					*.032**
Disagree, n (%)	62 (29.5)	21 (21.6)	39 (35.8)		
Agree, n (%)	148 (70.5)	76 (78.4)	70 (64.2)		

Independent variable	Total sample n = 245	Respondents who would never agree to install contactless monitoring§ n = 99	Respondents who would agree to install contactless monitoring‡ n = 113	Test value	p-value (two-sided)
Theme 9: Arguments in the decision to accept contactless monitoring_ _ _					
15a. Perceived usefulness for the person him/herself				χ^2 = 0.575**	.582
Take this not into account, n (%)	15 (6.9)	8 (8.1)	6 (5.5)		
Take this into account, n (%)	202 (93.1)	91 (91.9)	104 (94.5)		
15b. Experience of health at that time				χ^2 = 0.613**	.451
Take this not into account, n (%)	16 (7.4)	6 (6.1)	10 (9.0)		
Take this into account, n (%)	201 (92.6)	92 (93.9)	101 (91.0)		
15c. Possible changes in health when aging				χ^2 = 0.166**	.772
Take this not into account, n (%)	13 (6.0)	5 (5.1)	7 (6.4)		
Take this into account, n (%)	203 (94.0)	94 (94.9)	103 (93.6)		
15d. Concerns about privacy				χ^2 = 1.338**	.257
Take this not into account, n (%)	32 (14.8)	12 (12.2)	20 (18.0)		
Take this into account, n (%)	184 (85.2)	86 (87.8)	91 (82.0)		
15e. Opinions or advices of family, friends or acquaintances				χ^2 = 0.001**	1.000
Take this not into account, n (%)	65 (30.5)	31 (31.3)	34 (31.5)		
Take this into account, n (%)	148 (69.4)	68 (68.7)	74 (68.5)		
15f. Opinions or advices of professional caregivers				χ^2 = 0.643**	.554
Take this not into account, n (%)	12 (5.6)	7 (7.1)	5 (4.5)		
Take this into account, n (%)	203 (94.4)	91 (92.9)	105 (95.5)		
15g. Type of monitoring installed				χ^2 = 1.835**	.191
Take this not into account, n (%)	23 (10.7)	14 (14.3)	9 (8.3)		
Take this into account, n (%)	190 (89.3)	84 (85.7)	99 (91.7)		

Legend

* P-values of statistically significant associations ($p < .05$) are shown in *italics*

† Indicating valid percentages; absolute values of the compared groups of respondents (column 3 and 4) may not round up to the value of the total sample (column 1) due to missing data (ranging from 3.7% to 17.1% of the total sample per item)

‡ Respondents answering 'strongly agree' for at least one of the following items (17a, 17b or 17c) of the questionnaire; n = 33 respondents were not taken into account for the bivariate analyses, due to missing data for item 17a, 17b or 17c

§ Respondents never answering 'strongly agree' for item 17a, 17b and 17c of the questionnaire

_ Concise description of the items; see Appendix 3 for an English translation of the questionnaire

¶ Dichotomized response categories: 'agree' includes respondents answering 'strongly agree' or 'slightly agree'

** Chi²-test for independent variable at nominal or ordinal measurement level

†† Fisher's exact test for independent variable at nominal or ordinal measurement level and small cell sizes; n/a (not applicable): a test value is not provided when computing this bivariate test using the statistical software SPSS for Windows, version 20.0 (SPSS, Inc., Chicago, IL)

‡‡ Dichotomized response categories: 'find this important' includes respondents answering 'I find this important', 'I find this very important' or 'I find this a priority'

§§ Dichotomized response categories: 'concerned about this' includes respondents answering 'I am concerned about this' or 'I am very concerned about this'

_ _ Dichotomized response categories: 'take this into account' includes respondents answering 'I take this into account' or 'I certainly take this into account'