Modeling the Oldest Old: Personas to Design Technology-Based Solutions for Older Adults

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Abstract

There is a recognized need to develop information technology for the delivery of care services to older adults. However, little attention has been paid to the design of information technology for the oldest old demographic. We made novel use of data from observations, focus groups and cluster analysis of oldest old participant characteristics from a pilot study in a community setting to iteratively construct personas for the design of information technology for the oldest old. The resulting two personas, “Hazel” and “Rose”, capture different abilities of members of the oldest old demographic group. In addition, we provide a list of eleven design recommendations to guide the design of technology that supports the abilities of people like Hazel and Rose. The resulting personas, design recommendations and persona construction method can be useful tools for informaticians and designers of new systems for the oldest old.

Introduction

The growing segment of the population over 65 years of age and the health care workforce shortage have led to the recognition that there is a need to provide innovative tools to deliver new or improve existing services to older adults. Information technology (IT) has the potential to provide such a delivery platform by bridging geographic distance and improving delivery of care services. In such discussions the focus of activity has been on current baby-boomers or older adults who have recently left the workforce. Less emphasis has been placed on the oldest old, namely adults 85 years of age or older. This group is the fastest growing segment of the US population[1,2]. Thus far, the oldest old have not been thought of as potential IT users. As this segment of the population continues to grow and IT is increasingly integrated as part of services for older adults, technology must be designed to meet the specific needs of the oldest old. The oldest old have different requirements, expectations, and backgrounds, as well as cognitive and physical constraints, than other adults and therefore need a design process tailored to meet those needs. Personas are a proven design tool[3-6] that, when coupled with user-centered and participatory design techniques, can ground the design process to model the specific needs of the oldest old.

During a pilot study that engaged older adults in a community-based setting to determine the feasibility of an integrated informatics platform for assessing cognitive, functional, physiological and social aspects of wellness[7,8], we recognized a mismatch in the interactions of study participants with commercially available IT solutions used in the study. The recognition of this mismatch between IT designs and interactions led us to develop personas and design recommendations for the oldest old based on our experiences and novel use of study data. In this paper, we describe a method for persona generation through a combination of observations, focus group results and statistical clustering of study participant data, present two oldest old personas that result from the method and discuss design recommendations to support the two personas.

<u>Oldest Old and Information Technology</u>

There are many different types of older people in modern society[9]; the “oldest old” are those individuals who are 85 years old or older[1,10]. The oldest old often have co-existing cognitive and physical conditions that influence their quality of life and functional status[10]. Older and younger people differ in the way they use computers and IT[11,12] and this gap in IT use has been widely noted[12,13]. Although this gap is often attributed to anti-technology attitudes on the part of older adults[14], older adults have a positive attitude toward IT and will use technology if they consider it useful or satisfying a perceived need[11,15-19]. Information technology has been shown to enhance quality of life in older adults[13]. Given the proliferation of IT, the rising number of oldest old and the potential of IT to improve quality of life for aging adults, we must find ways to design for the specific needs of the oldest old.

In the context of age-friendly web site design, recommendations highlight the need to accommodate the decrease of physical, visual and cognitive skills[20,21]. When designing graphical interfaces for software, these same recommendations are only adhered to if the product is to be dedicated to older adult use. Unfortunately, even in these cases, the target audience is assumed to be between 50 and 65 years of age, with a few studies allowing for adults up to 80 years of age[22-24]. As of the writing of this article, there is a gap in published works that discuss or suggest software technology design concepts for the oldest old. Though recent studies show an increased focus on socio-technical issues and exploratory studies of technology use by the elderly, health informatics efforts with regard to the oldest old demographic are still in their infancy[25]. Qualitative data collection and longitudinal observation have been successful in describing activities in health-related work settings[26,27], but prolonged observations in a person's living space are difficult to obtain[28]. Designers need a way to abstract key elements and challenges of design implications for the oldest old by leveraging the experience of other researchers without having to engage in a formal cohort study at every step of a new design project.

Personas and Design

A persona is a hypothetical archetype, used during the design process, that represents a person who will interact with an information technology or system[3]. Personas have been used as part of large and small participatory and user-centered design efforts to inform design of information systems distributed across groups and organizations[4-6]. Personas are constructed using a variety of methods including interviews, focus groups and analysis of existing data sets based on the recognition that personas must be believable and informed by data from the real world[4,29-32]. In recent years, the need to construct personas that are meaningful representations of people from different age groups, including children[33] and older adults[28], has been emphasized. Although personas have been created for older adults based on statistical data[34], there is a gap in the design literature for personas developed from interactions specifically with the oldest old. Our goal in constructing different personas for the oldest old is to illustrate that people experience variation in the decline of health and wellness as they age and that these variations must be taken into consideration during technology design efforts to support them. Given the past lack of efforts to design for the oldest old and the success of personas with different groups in other contexts, oldest old personas can provide useful tools for the design of better technology interactions for this demographic.

HEALTH-E Project

Health informatics research to meet the needs of older adults is still in relatively early stages and requires inter-disciplinary collaborative research to design technology to support this demographic[25]. The Home-based Environmental Assisted Living Technologies for Healthy Elders (HEALTH-E) project is a research team based at the University of Washington. The HEALTH-E group takes a holistic approach to applied health and wellness research, integrating diverse technologies to improve quality of life, independence and wellness for older adults. The HEALTH-E research team includes members with informatics, technology design, computer science, gerontological and clinical expertise.

Methods

All study procedures were approved by the University of Washington Institutional Review Board (IRB). Detailed accounts of the pilot study, wellness framework and informatics platform that generated the data for this persona study has been previously reported[7,8]. A description of the informatics platform, its feasibility and participant acceptance within the wellness community has been reported by Demiris et al.[7] while the results of the holistic assessment of older adults' wellness through use of the informatics platform has been reported by Thompson et al.[8]

Setting and Technology

The setting for the 8-week pilot study was a community room within an independent retirement community in the Pacific Northwest. The community is comprised of a mix of approximately 150 private apartment homes for persons 62 and older. Study participants were able to access three commercial technologies: *WebQ* (Catalyst Web Tools), a survey tool used to collect and automatically download data from functional, social and spiritual assessments; *Health Station* (Healthanywhere, Inc.), a telehealth kiosk used to capture and automatically transfer blood pressure, heart rate, glucose level, blood oxygen level and weight to a personal health record; *CogniFit Personal Coach* (CogniFit Inc), a web-based cognitive fitness system that automatically collects data to allow for cognitive assessments over time. These commercial solutions were chosen for reliability/validity, to minimize development time and maximize time spent on analysis of integrated data. Participants performed cognitive training three times per week and used the telehealth kiosk one time per week. Surveys were completed at baseline and exit of the study. Study participants had daily on-site access to technical support from members of the six person research team at the beginning of the study. Most participants became independent within a week. Support coverage was reduced thereafter but with continued on-site support. Researchers would remind participants to use all technologies each week to ensure complete data and would share observations of study participants with the research team at weekly meetings. A full description of the feasibility and acceptance of the informatics platform is reported by Demiris et al.[7] and holistic assessment of older adults' wellness is reported by Thompson et al.[8]

Participants

Participants in the pilot study were drawn from a convenience sample recruited from the retirement community. The complete pilot study sample (n=25) was comprised of male (n=8) and female (n=17) participants for which we had the most complete data. Study participation was voluntary; all participants were consented into the study. Four participants between the ages of 78 and 84 were excluded from the complete pilot study sample to create an oldest old study sub-sample for our persona design effort. The resulting oldest old sub-sample (n=21) was comprised of male (n=8) and female (n=13) participants. The age range for oldest old participants was 85-94 years with an average age of 89.2 years. Most oldest-old participants had prior experience with computers; only two had no prior experience with computers. Of those oldest old with prior computer experience, participants rated their comfort level using computers as: highly comfortable (n=3), moderately comfortable (n=11) and slightly comfortable (n=5). Race for the oldest old sample was reported as white (n=20) or other (n=1). In general, oldest old participants were highly educated with education levels reported as: graduate degree (n=13), baccalaureate degree (n=5) and community, trade or technical college (n=3).

Persona Construction

From our observations in the wellness community setting, we observed that off-the-shelf technology used during the study did not always appropriately support interactions for our study participants. Based on prior design experience in other health settings, our group recognized the interaction mismatch between participants and technology artifacts as an opportunity to inform design for the oldest old. With this recognition, one researcher (BR) proposed two initial personas based on observations from the study setting: a younger persona with greater independence and an older persona that had recently experienced changes in wellness and difficulties with independence. The personas were presented to the research team as an initial test of face validity. The group discussed and listed conditions related to aging that should be accounted for when designing for the oldest old. These characteristics were recorded for later assignment to the personas.

Using our oldest old participant sample, we then made secondary use of background and survey data that resulted from the primary study to further refine the personas and inform design recommendations for the oldest old as a population that uses IT. To identify distinct groups of older adults sharing similar demographic, physiological, social and cognitive characteristics that would ultimately inform our personas, we performed hierarchical clustering modeling using PASW Statistic18 software for those study participants who were 85 years of age or older as our cases (n=21).

Cluster analysis is a pair-wise comparison of individuals based on estimated distance measurements, which are then clustered together according to a predefined algorithm[35]. We used Pearson correlation scores to construct a distance matrix that illustrates the strength and the direction of correlation between each pair of observations according to the following characteristics: age, level of education, co-morbidities, previous experience with computers, general health, cognitive status and perceived social support. A list-wise deletion method was used for missing data for some participants in order to maintain large enough totals for cluster analysis. 6 cases were dropped due to missing data. The resulting final sample size for cluster analysis, after list-wise deletion, was 15 cases. We then applied an agglomerative hierarchical approach, namely a complete linkage method, to form clusters. Dendrogram and icicle plots were used to visually inspect levels at which clusters merged and to identify the final number of clusters. Final analysis yielded two major clusters. See Figure 1 for a dendrogram with an overlay of labels for cases and custom cluster names. Note that Cluster I is the result of the combination of two clusters that were similar in average characteristics upon inspection.

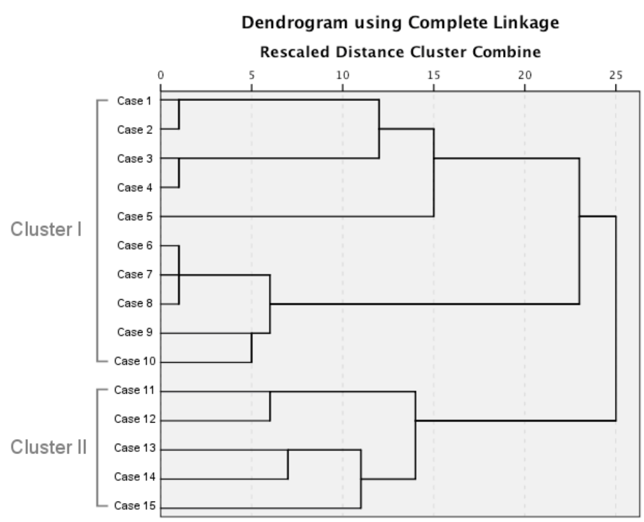

Figure 1. Dendrogram of cases of oldest old participants (n=15) with custom cluster labels.

The average characteristics of the final two clusters from the cluster analysis correlated with the idea of a younger persona with greater independence and an older persona with decreased capabilities. Based on these findings, observations in the HEALTH-E study setting, results from three post-study focus group sessions with 17 participants and notes from the initial validation of the personas, two researchers (OZ and BR) created more detailed descriptions for two different personas: Hazel and Rose. Descriptions were developed from these data sources with the aim of increasing the believability of each persona. After the detailed descriptions were drafted, both personas were presented to the rest of the HEALTH-E team as a second test of face validity and to solicit additional details. Each persona was modified based on team feedback to create a “true” story about the lives of both Hazel and Rose. The resulting personas were then used as a reference to inform design recommendations for future IT solutions for the oldest old.

Results

Characteristics from Cluster Analysis

The average characteristics of the individuals that were grouped into the two clusters based on our cluster analysis are presented in Table 1. A comparison of these two clusters shows greater cognitive changes, a higher number of co-morbidities and perceived decreases in social support with increased age among oldest old participants.

Table 1. Two clusters of characteristics based on cluster analysis of the oldest old sub-sample.

Characteristic	Cluster I	Cluster II
Age	89	93
Education	Graduate education	Undergraduate education
Co-morbidities	Moderate health conditions	Major health conditions
Experience with computers	Some experience	Some experience
Self-rated health	Good	Good
Functional status	Good	Good
Cognition	Minor cognitive changes	Moderate cognitive changes
Perceived social support	Strong	Weak

Two Personas: Hazel and Rose

Hazel and Rose are the two personas. The descriptions of Hazel (see Table 2) and Rose (see Table 3) capture the diversity in the range of abilities of participants from our study in the wellness community setting. We note that the study participants came from upper socio-economic status and tend to have higher degrees of education than the majority of the population. These characteristics are reflected in the persona descriptions of Hazel and Rose.

Table 2. Hazel: An eighty-nine-year-old persona to inform design for the oldest old.

Hazel
Hazel has a master's degree in journalism and managed a local office for a national publishing house for twenty years until she retired. She is eighty-nine years old and has enjoyed a lengthy, healthy retirement. Hazel has been married to her husband, Robert, for fifty years. They raised three children in the same house where they lived for their entire marriage. With the occasional help of a housekeeper, they were able to take care of themselves and were autonomous until recently when she and Robert moved into a retirement community.

Hazel would have loved to live in their house longer, but as they got older, their children became more concerned about their health. Although Hazel feels her health is still good, she recognizes she is not as vital and energetic as she was a decade ago. She now needs to see her doctor routinely every few months to take care of diabetes and high blood pressure. Hazel sometimes feels light headed and tired from her blood pressure medication. Hazel is thankful that Robert still enjoys good health. She and Robert monitor their blood pressure and weight together on a regular basis. Hazel's diabetes is currently well controlled with diet and exercise, so as part of her daily routine she and Robert take a daily 2 mile "constitutional". Luckily, the retirement community is not too far from their family and friends with whom they visit during these walks.

Hazel enjoys the facility's amenities and likes to use a computer to research family history and search for health information. Unfortunately, using a computer is not as easy as it used to be. She often finds it demanding to focus her attention when a lot of information appears on the screen quickly. Although she used to use a computer as part of her job as a professional manager, Hazel now feels that common tasks in familiar software programs are more difficult to use.

Table 3. Rose: A ninety-three-year-old persona to inform design for the oldest old.

Rose Ninety-three-year-old Rose holds a bachelor's degree in psychology and enjoyed a thirty year career as a school counselor to children. Rose did part-time volunteer work in community centers for many years after she retired, but eventually stopped due to health reasons. Rose has seen her health deteriorate progressively during the last decade. She now suffers from arthritis, diabetes, tremor, osteoporosis and declines in vision due to macular degeneration. Rose sometimes suffers from upset stomach from her arthritis medication and bone pain from her osteoporosis medication. Rose uses a walker to prevent her from falling. In addition, Rose had a stroke two years ago which left her with some short-term memory problems. Although the memory issues have been difficult for her, she considers herself in good health as she uses compensatory strategies like lists and a day planner. Rose married in college but is a recent widow. The loss of her husband has left her feeling very lonely as she has no other immediate family. She moved to the retirement community two months ago to regain a sense of community after the death of her husband. Although Rose is happy with her transition, she sometimes gets depressed when she thinks of the many friends and family members who have passed away in recent years. Rose is relieved by the help she gets with housekeeping, cooking and transportation in her new home. Because she has a lot of free time and has few visitors, Rose finds different ways to keep herself busy. She is learning to use a computer and this has been more difficult than she expected. Unfortunately, her arthritis limits her ability to control the mouse and her poor vision makes it difficult for her to follow the cursor. Learning new tasks is not as easy as it used to be but Rose is still positive about learning. Though she easily understands the explanation of how to manipulate the mouse, she tends to forget what she has learned. Her reaction time when trying to time mouse clicks is sometimes off. She has difficulty sitting for a complete 20 minute training session. Rose often complains of pain in her hands and back when using the computer, despite an "ergonomic" keyboard and chair. Rose sometimes gets frustrated and wishes technology were easier to use.

Comparing Hazel and Rose

Hazel is younger than Rose and has higher cognitive and physical functioning. However, both Hazel and Rose are independent in activities of daily living and both self-report their health as "good". Each is a member of a retirement community that has regularly scheduled social events. Both Hazel and Rose have a positive attitude toward technology in that each believes technology may help her assess her own wellness. Neither Hazel nor Rose express concerns about potential privacy risks regarding their personal information, and both believe that the potential benefits of health IT outweigh potential privacy concerns. Both Hazel and Rose are interested in the ways that self-monitoring can help them make personal changes to improve their wellness status. They both agree that the ability to share their health information within their support networks and with their health care providers might lead to improvements in their health and well-being.

Limitations

Our study sample is drawn from a sample that is more highly educated than the general older adult population and thus may not be representative of all oldest old to make these findings generalizable to a larger population. Furthermore, our study participants had to be independent in most activities of daily living and mentally competent to provide consent, both requirements further limiting the generalizability of findings to all oldest old. Other limitations of this study are that we did not validate the personas with the study participants because the persona work emerged from observations and secondary use of study data nor did we validate the personas with designers outside of our team.

Discussion

Both the Hazel and Rose personas are female. We did not include a male persona, because participants in the study from which we drew data to model these personas were primarily female. Given the age group, a majority of females is representative of the oldest old population. Further work is needed to generate additional personas that will capture community-dwelling oldest old including representatives of lower socio-economic status and those in dwelling in rural settings.

Assessment data from the primary study covered multiple aspects of well-being (functional, physiological, mental and social) and observations were conducted by members of our team while documenting the clinical, ergonomic, and psychological aspects of the lived experience of the oldest old in our study, their information needs and their experiences as they interacted with numerous hardware and software applications. Our work with persona construction highlights the need for interdisciplinary collaboration to capture the complexity of the context in which IT can affect older adults' lives. In addition, the Hazel and Rose personas illustrate the need for informaticians and researchers to expand their focus when designing IT based solutions to support aging.

Design recommendations for software applications targeting the oldest old

We offer eleven recommendations for the design of technologies that appropriately support the abilities of people like Hazel and Rose. These design recommendations emerged from observations of technology interactions of oldest old study participants in an independent retirement community while members of the research team provided technical support during the study. The recommendations are informed by notes from the research team, ad hoc feedback from study participants, focus groups and exit interviews after the study. These recommendations are intended to help information designers to ground new designs by conceptualizing technology uses by the Hazel and Rose personas.

1. Consider the input device to be used

Although for many years, the mouse has been the *de facto* input device for software applications, variations on mouse design and other input technologies should be considered. For example, for someone learning to use a mouse, a one-button mouse (or forcing a standard mouse to emulate single-button behavior) is a preferred input device (as shown by personal observation in our study). Additionally, a touch sensitive device maybe more intuitive to a novel computer user than a mouse, and software should be developed in a way that is not dependent on a two-button mouse.

2. Maintain a consistent interface throughout applications

It is generally good design practice to maintain consistent interfaces for the navigation and use of information systems and devices. Consistent interface design is particularly important when designing for the oldest old because cognitive and physical abilities decrease with age. The oldest old may have increased difficulty in navigating interfaces as instructions vary within a system. For example, although the words "back" and "return" could be used interchangeably to instruct a person to move backwards within a set of software screens, the inconsistent use of terms could raise questions for an older person who is an inexperienced computer user. In addition, navigation controls, such as buttons, should be consistent shapes, formats and colors to promote ease of recognition and increased focus on the intended uses of a system.

3. Allow images and text to be resized

Older people may have the cognitive ability to complete a task, but may lack the visual acuity to do so if text or an image is too small and the display cannot be resized. All products that are dependent on visual components should implement a zoom feature.

4. Give clear instructions about how to control the interface during tasks

When systems and devices introduce application or product-specific features or uses, it is important to give clear instructions about how to complete the goals of tasks in computer screens. For example, if a PC-based application implements the F10 key to both pause and play a video tutorial, the instructions should be displayed prominently or be easily retrievable from an obvious help system.

5. Clearly delineate what is expected behavior during a task

When presenting new tasks to older people, it is important that the tasks and the goals of the tasks be clearly described and understandable. For example, if a personal health record allows a person to post messages for her support network, it should be obvious how to draft a message and who will see the message when posted.

6. Clearly delineate tutorials from actual training tasks

Older people using new information systems can become confused by automatic tutorials that run before actual tasks. Tutorials should be clearly marked as tutorials so that the oldest old do not mistakenly attempt to interact with the demonstration task and become frustrated by lack of response to their attempted interactions.

7. Show demonstration tasks in tutorials that match the difficulty of actual tasks

The tasks demonstrated in tutorials should match the difficulty of actual tasks to set expectations. When demonstrated tasks are much easier than actual tasks, it can create frustration and annoyance with the system. If there is a specific need to begin tutorials at a more simplified level in order to demonstrate the concept, these initial phases should be brief followed by exemplars of the more difficult task.

8. Allow adequate time between instructions and the start of tasks

Due to changes in speed of processing that occur with normal aging, it is important to allow adequate time between the end of any spoken instructions and the start of a task. A blank start screen, in addition to more time than may be needed for a younger person, might help alleviate this type of problem. The oldest old can be thrown off when tasks begin too quickly after audio cueing, making it difficult to readjust and get back on track for the rest of the task. Furthermore, audio based cues can sometimes be distracting and disorienting, rather than support the person in completing tasks. The value of speech output for older people who use information systems has been shown by prior research[36]. Our design recommendation illustrates the need to implement audio cues appropriately.

9. Display progress through a task

The oldest old may have trouble tracking progress through a newly learned or longer task when interacting with a system or device. For this reason, it is important to “anchor” them as they perform tasks with by displaying progress toward completion of a goal. For example, in a series of cognitive tests, a prominently displayed status bar with percentage of tasks toward session completion would be helpful.

10. Allow tasks to be skipped

Older people can become frustrated with certain tasks in training software after repeated, failed attempts to arrive at the right solution (such as the cognitive assessment software used in our project). Inability to skip tasks can increase this frustration. Although completeness of data for all tasks is important, patterns of who does and does not complete certain tasks can tell us how to design for different cognitive and physical levels of function in new technologies.

11. Clearly delineate when a task is complete

When tasks are completed, there should be an obvious indication that such is the case. For example, when a message to a support network in a personal health record is posted, the completion of the task should be indicated by some form of feedback like a completion alert.

Conclusion

The contributions of this study are design recommendations and two personas for informaticians and system designers. These contributions were developed from secondary analysis of study data that included demographic data, functional, physical, social, cognitive and spiritual parameters, focus group data regarding IT and researcher observations during engagement with the oldest old. The persona construction method used in this study ties real-world findings from participants in a longitudinal study to create new design suggestions for support of IT solution development for the oldest old. In doing so, it follows recommended user-centered design practices to connect people to the creation of technology that supports their daily lives. In addition, it follows the recognition that not all people are the same, particularly within the oldest old as a group, by making novel use of several sources of data to construct personas. Our study participants had positive attitudes towards IT solutions as tools that they would use to support their own health and wellness. Given these attitudes, it is important to design technology for this growing demographic to support independence and maintenance of quality of life. Future work will include validating the Hazel and Rose personas with different older adult groups in diverse settings (including retirement communities, rural settings and long term care facilities) to facilitate generalizability across a larger population, assessing the personas with other designers for feedback about improvements and comparison of our design recommendations to different PC-based technologies.

Conflicts of interest

The authors have no conflicts of interest to report at this time.

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References

[1] Campion EW. The Oldest Old. N Engl J Med 1994 June 23, 1994;330(25):1819-20.
[2] James BD, Schneider JA. Increasing incidence of dementia in the oldest old: evidence and implications. Alzheimers Res Ther;2(3):9.
[3] Cooper A. The inmates are running the asylum. Indianapolis, IN: Sams; 1999.
[4] Pruitt J, Grudin J. Personas: practice and theory. Proceedings of the 2003 conference on Designing for user experiences; San Francisco, California: ACM; 2003.
[5] Grudin J, Pruitt J. Personas, Participatory Design and Product Development: An Infrastructure for Engagement. Proceedings of the Participatory Design Conference 20022002. p. 144-61.
[6] Markensten E, Artman H. Procuring a usable system using unemployed personas. Proceedings of the third Nordic conference on Human-computer interaction; Tampere, Finland: ACM; 2004.
[7] Demiris G, Thompson HJ, Reeder B, Wilamowska K, Zaslavsky O. Using Informatics to Capture Older Adults' Wellness. International Journal of Medical Informatics (in press).
[8] Thompson HJ, Demiris G, Rue T, Shatil E, Wilamowska K, Zaslavsky O, et al. A Holistic Approach to Assess Older Adults' Wellness Using e-Health Technologies. Telemedicine and e-Health 2011;In Press.
[9] Bernard M, Phillipson C, Phillips J, Ogg J. Continuity and Change in the Family and Community Life of Older People. Journal of Applied Gerontology 2001;20(3):259-78.
[10] Blazer DG. Psychiatry and the oldest old. The American journal of psychiatry 2000;157(12):1915-24.
[11] Wagner N, Hassanein K, Head M. Computer use by older adults: A multi-disciplinary review. Computers in Human Behavior 2010;26(5):870-82.

[12] Richardson M, Weaver C, Zorn T. 'Getting on': older New Zealanders' perceptions of computing. New Media & Society 2005;7(2):219-45.
[13] Carpenter BD, Buday S. Computer use among older adults in a naturally occurring retirement community. Computers in Human Behavior 2007;23(6):3012-24.
[14] Koch S. Ubiquitous care in aging societies - a social challenge. Studies in health technology and informatics 2008;134:89-95.
[15] Czaja SJ, Sharit J. Age differences in attitudes toward computers. The journals of gerontology Series B, Psychological sciences and social sciences 1998;53(5):329-40.
[16] Phang CW, Sutanto JKALY, et al. Senior Citizens' Acceptance of Information Systems: A Study in the Context of e-Government Services. IEE IEEE Transactions on Engineering Management2006. p. 555.
[17] Daniel KM, Cason CL, Ferrell S. Emerging Technologies to Enhance the Safety of Older People in Their Homes. Geriatric Nursing 2009;30(6):384-9.
[18] Hanson VL. Influencing technology adoption by older adults. Interacting with Computers 2010;22(6):502-9.
[19] Courtney KL. Privacy and senior willingness to adopt smart home information technology in residential care facilities. Methods of information in medicine 2008;47(1):76-81.
[20] Demiris G, Finkelstein SM, Speedie SM. Considerations for the design of a Web-based clinical monitoring and educational system for elderly patients. J Am Med Inform Assoc 2001 Sep-Oct;8(5):468-72.
[21] Morrell RW. Older adults, health information, and the World Wide Web. Mahwah, NJ: Lawrence Erlbaum Associates; 2002; Available from: http://www.netlibrary.com/urlapi.asp?action=summary&v=1&bookid=66182.
[22] Morris JM. User interface design for older adults. Interacting with Computers 1994;6(4):373-93.
[23] Worden A, Walker N, Bharat K, Hudson S. Making Computers Easier for Older Adults to Use: Area Cursors and Sticky Icons. CHI -CONFERENCE- 1997:266-71.
[24] Wallace J, Mulvenna MD, Martin S, Stephens S, Burns W. ICT Interface Design for Ageing People and People with Dementia. In: Jain L, Wu X, editors. Supporting People with Dementia Using Pervasive Health Technologies: Springer London; 2010. p. 165-88.
[25] Koch S, Hägglund M. Health informatics and the delivery of care to older people. Maturitas 2009;63(3):195-9.
[26] Malhotra S, Jordan D, Shortliffe E, Patel VL. Workflow modeling in critical care: Piecing together your own puzzle. Journal of Biomedical Informatics 2007;40(2):81-92.
[27] Unertl KM, Weinger MB, Johnson KB, Lorenzi NM. Describing and Modeling Workflow and Information Flow in Chronic Disease Care. J Am Med Inf Assoc 2009/12//;16(6):826-36.
[28] Blythe M, Dearden A. Representing older people: towards meaningful images of the user in design scenarios. Universal Access in the Information Society 2009;8(1):21-32.
[29] Junior PTA, Filgueiras LVL. User modeling with personas. Proceedings of the 2005 Latin American conference on Human-computer interaction; Cuernavaca, Mexico: ACM; 2005.
[30] Johansson M, Messeter Jr. Present-ing the user: constructing the persona. Digital Creativity: Routledge; 2005. p. 231-43.
[31] Sinha R. Persona development for information-rich domains. CHI '03 extended abstracts on Human factors in computing systems; Ft. Lauderdale, Florida, USA: ACM; 2003.
[32] McGinn J, Kotamraju N. Data-driven persona development. Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems; Florence, Italy: ACM; 2008.
[33] Antle AN. Child-personas: fact or fiction? Proceedings of the 6th conference on Designing Interactive systems; University Park, PA, USA: ACM; 2006.
[34] Casas R, Marín RB, Robinet A, Delgado AR, Yarza AR, Mcginn J, et al. User Modelling in Ambient Intelligence for Elderly and Disabled People. Proceedings of the 11th international conference on Computers Helping People with Special Needs; linz, Austria: Springer-Verlag; 2008.
[35] Bartholomew DJ, Steele F, Moustaki I, Galbraith JI. Analysis of Multivariate Social Science Data CRC Press; 2008.
[36] Zajicek M. Successful and available: interface design exemplars for older users. Interacting with computers 2004;16(3):411-30.