Designing a Persuasive Physical Activity Application for Older Workers: Understanding End-user Perceptions

Hazwani Mohd Mohadis[1], Nazlena Mohamad Ali[2], Alan F. Smeaton[3]
[1,2]Institute of Visual Informatics, Universiti Kebangsaan Malaysia, 43600 Bangi, Selangor, Malaysia
[3]Insight Centre for Data Analytics, Dublin City University, Glasnevin, Dublin 9, Ireland
hazwanimohadis@gmail.com[1], nazlena.ali@ukm.edu.my[2], alan.smeaton@dcu.ie[3]

Abstract

Among the factors known to encourage healthy ageing is routine physical activity, a behaviour that is not common among the older age group. A Persuasive System Design (PSD) model offers guidelines for designing and evaluating systems aimed at reinforcing, changing or shaping underlying human behaviour and attitudes. The objective of this study was to investigate the perceptions of older workers towards persuasive principles of PSD that was integrated into an application specifically designed to encourage physical activity. Ten older workers aged 50 to 64 years with different physical activity levels participated in this study. Using a think-aloud technique, the participants interacted with a physical activity application whilst verbally expressing their perceptions towards the persuasive elements. The results indicated that the older worker participants had positive views towards persuasive design principles that fell under the categories of *primary task*, *dialogue support* and *credibility support*. However, the persuasive principle of the *social support* category received contradictory views. Further, it was discovered that the personalization of persuasive principles, the credibility of tailored contents and the establishment of a sense of similarity are imperative in the designing of effective persuasive physical activity applications targeting older workers.

Keywords: persuasive system design; behaviour change support system; physical activity application; older workers; design requirements

1 Introduction

The improvement of healthcare services, longer life expectancy and decline in mortality rates are among the significant factors leading to the increase in the proportion of older workers in the labour workforce across the world (Beach, 2008). In the United States, the percentage of older workers aged 55 years old and above has risen from 12% in 1996 to 20% in 2011 (Johnson, 2012). Likewise, in the United Kingdom, 27% of the workers (equivalent to 7.7 million) were aged between 50 and 64 by June 2013 (Department for Work and Pensions, 2013). A similar phenomenon was also reported across Asia, such as in Singapore, as the share of older workers rose from 14% in 2010 to 16% in 2011 (Ministry of Manpower, 2012). This emergence of an ageing workforce worldwide has been attributed to the ageing of the baby-boomers cohort (i.e. those workers born between 1946 and 1964) who are currently in their fifties and sixties (Toossi, 2012). Besides, higher living costs and financial insecurity are also among the factors leading to the decision of older workers to extend their employment (Helman et al., 2011).

Meanwhile, however, the deterioration in health that is common among individuals aged 50 years old and above has become a major concern in terms of the productivity and work ability of the population (Heidkamp, Mabe and DeGraaf, 2012). A report published by the AARP Public Policy Institute (2009) stated that more than 70 million Americans aged 50 years and older suffer from at least one chronic disease such as diabetes, obesity, hypertension or cardiovascular disease. In fact, in Europe, it is estimated that one out of five patients who died due to these chronic diseases were aged between 50 to 70 years old – which resulted in an estimated cumulative loss of 2.9 million supposedly productive workers (Harbers and Achterberg, 2009).

Clinical researchers suggest that in order to prevent the development of these chronic diseases and to maintain the overall health and well-being of older workers it is necessary that they live a healthy lifestyle and sustain an appropriate level of physical activity (Nunan et al., 2013). Thus, numerous physical activity interventions have been developed in diverse settings, either through traditional counselling sessions or supervised physical training (Semlitsch et al., 2013). A few attempts have also been made to educate chronic disease patients through computer-based interventions, but unfortunately, these have yet to be proven to be effective in increasing their level of physical activity (Saksena, 2010).

One of the potential reasons for the failure of computer-based interventions is that older adults experience age-related disabilities such as visual impairments that potentially cause their interactions with a user interface of a computer system to become more difficult and cumbersome (Caprani, O'Connor and Gurrin, 2011). Furthermore, even though a designated computer system may prove to be usable and have an aesthetically pleasing interface, researchers argue that those factors alone are not effective enough to encourage a sustained behavioural change (Or et al., 2010).

1.1 Persuasive Technology

Fogg (2003) founded a new research area called Persuasive Technology – *"technology that is designed to change the attitudes or behaviours of users through persuasion and social influence, but not through coercion"*. Rather than exogenous persuasion, where users are being persuaded by external factors, persuasive technology focuses on endogenous persuasion i.e. the persuasive intent of the system is delivered through computing products (Fogg, 2003). Furthermore, there are two levels of this endogenous persuasion, i.e. *macrosuasion*, where changing the user's behaviour is the main reason for the development of the system (e.g. the Nike + Running App) or *microsuasion*, where the system is not exclusively developed for a change in behaviour but for integrating persuasive design elements in order to achieve a specific goal (e.g. the one-click shopping features of Amazon.com encourage users to buy more than one product).

In order to assist designers in developing persuasive systems, Oinas-Kukkonen and Harjumaa (2009) introduced a conceptual-theoretical framework called the Persuasive System Design (PSD) model that offers systematic ways of understanding and analysing the persuasion context. Further, the PSD model enlists persuasive design principles that comprised of four categories, i.e. 1) primary task support, 2) dialogue support, 3) system credibility support, and 4) social support.

The design principles in the primary task category involve assisting users in doing primary tasks and accomplishing their goals. The design principles in the dialogue category focus on supporting users by providing some degree of feedback in the form of praise, rewards or reminders that could enhance the user's motivation towards achieving their targeted behaviour. The system credibility support category enlists persuasive principles that can enhance a user's trust in the system, whereas the design principles of the social support category largely manipulate the user's interpersonal relationship with other human beings (family, friends, colleagues) as a way to enhance their motivation and self-confidence in achieving their targeted behaviour (Oinas-Kukkonen and Harjumaa, 2009).

1.2 Older Workers

A review of previous literature indicated that older workers, ageing workers and older employees are similar terms that refer to a worker aged 50 years or above (ILO, 1980; WHO, 1993; Ilmarinen, 2001). The Department for Work and Pension (DWP) in the UK gives a specific age range as they define an older worker as one aged between 50 and 64 years old (DWP, 2010). Meanwhile, the International Labour Organization (ILO), in its Older Workers Recommendation 1980 (No. 162), give a definition beyond chronological age by defining older workers as *"all workers who are liable to encounter difficulties in employment and occupation because of advancement in age"* (ILO, 1980). This implies that an 'older worker' is defined as 15 years younger compared to the chronological age of an 'older adult', i.e. 65 years old and above (WHO, 2009).

The reason behind the younger definition of older worker is mainly based on an

occupational health point of view which argues that "*certain functional capacities necessary for some kind of work have been reported to decrease after 45 years of age and the capacities for some (but not all) jobs have been reported to diminish by 50 to 55 years of age*" (WHO, 1993). Thus, the younger definition of ageing among workers is claimed to be necessary to give better possibilities for preventive measures. Therefore based on previous researches, the term 'older worker' in this study refers to a worker aged 50 years old and above for both men and women.

2 Related Works

Numerous persuasive applications targeting changes in diverse types of health behaviour have been developed. For example, *Quitty* was developed to persuade people to quit smoking (Paay et al., 2014), *MoviPill* was aimed at enhancing medication adherence among elderly patients (de Oliveira et al., 2010), and *SitCoach*, is a persuasive mobile phone application that was developed to reduce sedentary behaviour among office workers (Dantzig et al., 2013). For the purposes of this study, the focus was only on persuasive applications targeting the enhancement of physical activity among individuals aged 50 years and above. Table 1 summarizes the closely related work, the corresponding intervention characteristics, the persuasive design principles utilized (based on the PSD model) and the behavioural change outcomes.

Table 1: Relevant works on persuasive physical activity interventions

Study	Intervention characteristics	Persuasive principles	Behavioural change outcome
Albaina et al. (2009)	Flowie: A persuasive virtual coach consisting of 1) a wireless pedometer (ActiPED), 2) a laptop, and 3) touchscreen (Tablet).	Self-monitoring, social role	Negative: Due to bad weather conditions during intervention, evaluation was not possible as users remained indoors and did not do any physical activity.
Foster et al. (2010)	StepMatron: A Facebook app and a pedometer used to record the number of steps taken by nurses at work.	Self-monitoring, competition, social comparison, recognition	Positive: Participants using StepMatron in social conditions reported higher total step counts compared to those in controlled conditions.
Rodriguez et al. (2012)	CAMMInA: An ambient information system for mobile phones that provide elders with notifications and representations of their physical activity performance.	Reduction, self-monitoring, reminders, rewards	Null: The study conducted a usability evaluation on persuasion strategies. Its efficacy in enhancing the physical activity levels of the elderly is unknown.
Silveira et al. (2012)	Active Lifestyle: A proactive training application run on a tablet, which assists, monitors and motivates the elderly to follow a personalized training plan.	Self-monitoring, personalization, praise, social facilitation, social comparison, recognition	Positive: 73% of participants complied with all 14 trainings.
Irvine et al. (2013)	Active After 55: An Internet-based program to enhance the functional ability, mobility, and physical activity of older adults.	Tailoring, personalization, rehearsal, praise	Positive: Significant improvement on 13 of 14 outcome measures compared to the control participants.

Ayubi et al. (2014)	PersonA: A mobile health app designed to encourage more steps by receiving data from a physical activity sensor, processing the data into meaningful information, and publishing the information in a social networking system (SNS).	Reduction, tunnelling, tailoring, personalization, self-monitoring, rewards, reminders, suggestions, similarities, likings, social comparisons, social learning, social facilitation	Null: The study conducted a usability and feasibility study. Its efficacy in increasing more steps among the elderly is unknown.
Konstanti-nidis et al. (2014)	FitForAll (FFA): An exergaming platform that offers aerobic, strength, balance and flexibility exercises in an engaging gaming environment aimed at promoting physical exercise among the elderly.	Tailoring, personalization, self-monitoring, suggestions, rewards	FFA improved significantly the strength, flexibility, endurance and balance while presenting a significant trend in quality of life improvements.

Flowie, a persuasive virtual coach by Albaina et al. (2009) and *CAMMInA*, a mobile-based ambient information system developed by Rodriguez et al. (2012), implemented several persuasive principles that fell under the primary task and dialogue support category of the PSD model. Both studies, however, ignored the social support component, which this study argues is highly imperative as previous studies had advocated that moral support from family and friends, and social interaction through group-based activities are particularly critical at initiating and maintaining physical activity behaviour (Burgoyne et al., 2008).

StepMatron, developed by Foster et al. (2010) to encourage walking at the workplace among nurses, demonstrated the importance of the social support component by implementing the principles of *social comparison*, *competition* and *recognition*. Whilst the study did show a positive outcome with higher step counts among nurses, it is argued that it might be less effective for participants suffering from chronic diseases with different levels of physiological limitations as the intervention did not implement persuasive principles of the primary task category such as *personalization* of the number of steps that are appropriate for individual users and the *tailoring* of health information.

Meanwhile, *Active Lifestyle,* developed by Silveira et al. (2012), implemented persuasive principles across three categories of the PSD model, namely 1) primary task support: *self-monitoring, personalization* principles, 2) dialogue support: *praise* principle, 3) social support: *social facilitation, social comparison, recognition* principles, but there was a lack of credibility support. Whilst the study did mention that the proposed training program was based on 'best practice recommendations' and 'accepted training principles', it is unclear how this information was made visible to the user of the system. Although, the intervention did show positive results with 73% of the participants showing compliance with all 14 trainings, it is argued that the effectiveness of the intervention could be enhanced by implementing credibility support principles (e.g. by incorporating *expertise* and by providing *third-party endorsement* of the

proposed physical activity training). Similarly, there is lack of credibility support in *Active After 55,* an Internet intervention aimed at encouraging older adults to maintain an exercise regime (Irvine et al., 2013). Besides, the occurrence of fraudulent information in the self-reported data of the study makes the positive outcome of the intervention arguable.

A recent work by Ayubi et al. (2014) was closely related to this study as it evidently utilized the PSD model in determining the relevant persuasive design principles in the development of *PersonA*. As shown in Table 1, various persuasive principles across three categories of the PSD model, i.e. primary task support, dialogue support and social support were utilized. However, it is unclear why credibility support principles had been neglected. Further, the study only conducted evaluations on the usability and feasibility of the application, leaving the question of the effectiveness of *PersonA* in enhancing physical activity levels unanswered.

Another study by Konstantinidis et al. (2014) described the design, implementation and wide pilot deployment of *FitForAll*, an exergaming platform aimed at promoting physical activity among older adults aged 60 years old and above that will subsequently lead to maintenance or improvement in the health status and quality of life. Based on the features of *FitForAll* described in the paper, the intervention applied several persuasive principles from three categories of the PSD model, i.e. 1) primary task: *tailoring, personalization, self-monitoring;* 2) dialogue support: *suggestions, rewards, likings;* and 3) social support category: *social comparison, competition*. Similar with Ayubi et al. (2014), the persuasive principles of the credibility support category were absent. However, understandably, the reasons were probably due to the presence of therapists/carers in the day care centre where the study was conducted, who supervised, and offered support and guidance to the older adults in using the system, which indirectly built their trust in it. Thus, it would be interesting to know whether the use of *FitForAll* without the presence of therapists/carers (e.g. by enabling older adults to use the *FitForAll* exergaming platform at their home) would result in a similar successful outcome.

However, contrary to these previous works, our study was aimed at optimizing the efficacy of a persuasive physical activity application by integrating persuasive principles across the four categories of the PSD model, i.e. primary task support, dialogue support, credibility support and social support. Thus, investigating end-user perceptions toward persuasive principles that fall under these categories was crucial to obtain information on the needs and requirements for the development of persuasive physical activity applications targeting older workers.

In fact, one of the claims of the persuasive system proposed by Oinas-Kukkonen and Harjumaa (2009) was that "*persuasion should always be open*", which implies that the designer's intention of persuading people to change their behaviour through the system should be visible to the user. Besides, we were motivated to investigate the perceptions of older workers, as previous reports on the relationship between the age structure of the workforce and ICT adoption indicated that there is a low level of adoption and acceptance of newly introduced technologies among the population (Meyer, 2007).

Accordingly, the objective of this study was to investigate the perceptions of older workers towards persuasive design principles that had been implemented within the design of a web-based physical activity application. The data were analysed using the Persuasive System Design (PSD) by Oinas-Kukkonen and Harjumaa (2009), a conceptual-theoretical framework that describes the process of designing and evaluating persuasive systems. The remainder of the paper is organized as follows. Section 3 describes the method used in this study. Section 4 presents the results and a discussion of those results, whilst Section 5 describes the limitations of the study and future work. Finally, the conclusion is given in Section 6. It is believed that this study will give valuable insights and assist designers in refining the needs and requirements of users that should be thoroughly understood in designing persuasive physical activity applications targeting older workers.

3 Method

In order to present the concept of persuasive design to the participants, a prototype of *FitSenior,* a non-clinical web-based application designed to encourage physical activity among older workers, was developed. The application is in the form of a low-fidelity prototype developed using *Balsamiq Mockup* (https://balsamiq.com), a wireframing tool that enables designers to sketch the user interface of websites and mobile applications rapidly, and able to generate immediate and meaningful feedback.

Rather than utilize existing commercially available physical activity applications already in the market, this study chose to develop its own prototype in order to reduce bias, as several participants have reportedly used similar applications e.g. *Fitbit* (https://www.fitbit.com) and *RunKeeper* (http://runkeeper.com) which, as reported in an earlier study by Taylor and Todd (1995), can influence the insights of users in favour of the applications that they are currently using or previously used (Taylor and Todd, 1995). Furthermore, the persuasive design principles integrated into these existing applications differ from one another, making it hard to determine which application is most appropriate to gather user perceptions across all four categories of persuasive design principles.

The *FitSenior* app in this study was developed after careful consideration on the multiple factors that influence the physical activity behaviour of older workers such as health concerns, moral support and the availability of recreational facilities (Mohadis and Ali, 2015). Although, the PSD Model originally enlisted a total of 28 persuasive principles, our previous initial study denotes only 23 principles were deemed to be potentially relevant to encourage physical activity among our older workers (Mohadis, 2016). Table 2 describes in detail the 23 relevant persuasive principles that were implemented in the design of the *FitSenior* application.

Table 2 Persuasive principles applied in the FitSenior application

Persuasive Principle	**Description of the principle***	***FitSenior* features**
Primary Task Support		
Reduction	A system that reduces complex behaviour into simple tasks to help users perform the targeted behaviour.	Notifies the older workers of issues that would deter their physical activity routine (e.g. weather forecast).
Tunnelling	Using the system to guide users through a process or experience, while providing opportunities to persuade along the way.	Guides first-time users through a step-by step process to set their personal goal.
Tailoring	Information that is tailored based on potential needs, interests or other factors relevant to a user group will be more persuasive.	Displays information on physical activities i.e. appropriate for older workers' age group.
Personalization	A system that offers personalized content or services has a greater capability for persuasion.	Enables goal setting based on individual age, health status and lifestyle.
Self-monitoring	A system that keeps track of one's own performance or status, thus supporting the user in achieving goals.	Enables monitoring of physical activity performances.
Simulation	Systems that provide simulations can persuade by enabling users to observe the link between cause and effect.	Enables older worker to observe cause-and-effect relationship between physical activity and its outcome.
Rehearsal	A system that enables users to rehearse a behaviour so as to help them change their attitude or behaviour in the real world.	Presents video tutorial on how to perform the physical activity.
Dialogue Support		
Praise	By offering praise, a system can make users more open to persuasion.	Congratulates and praises older workers over their successful performance.
Rewards	Systems that reward targeted behaviours may have great persuasive powers.	Offers virtual rewards for progress and achievement of goals.
Reminders	If a system reminds users of their targeted behaviour, the users will more likely achieve their goals.	Notifies older workers of their daily physical activity schedule.
Suggestions	Systems offering fitting suggestions will have greater persuasive powers.	Suggests optional simple indoor physical activity that they can do if they have constraints about performing their routine outdoors.
Similarity	People are more readily persuaded through systems that remind them of themselves in a meaningful way.	Addresses older workers with first name and uses images of people of the same age group to make them feel familiar.
Social role	If a system adopts a social role, users will more likely use it for persuasive purposes.	Enables older workers to consult a fitness coach online.
Credibility Support		
Expertise	A system that is viewed as incorporating expertise will have increased powers of persuasion.	Displays fitness experts' opinions on the benefits of physical activity.
Real-world feel	A system that highlights people or organizations behind its content or services will have more credibility.	Enables older worker to communicate and complement other users (their colleagues) who are performing their physical activity as well.

Third-party endorsements	Third-party endorsements, especially from well-known and respected sources, boost perceptions on system credibility.	Displays information about the virtual coach's expertise and professional background.
Verifiability	Credibility perceptions will be enhanced if a system makes it easy to verify the accuracy of the site content via outside sources.	Enables older worker to communicate with other users who have successfully enhanced their physical activity through the application.
Social Support		
Social learning	A person will be more motivated to perform a targeted behaviour if he/she can observe others performing the behaviour.	Displays physical activity outcomes of other users of the same age group.
Social comparison	System users will have a greater motivation to perform the targeted behaviour if they can compare their performance with the performance of others.	Older workers are able to compare their performance with their colleagues.
Normative influence	A system can leverage normative influence or peer pressure to increase the likelihood that a person will adopt a targeted behaviour.	Enables older worker with the same goals to connect with each other and observe each other's performances.
Social facilitation	System users are more likely to perform a targeted behaviour if they discern, via the system, that others are performing the behaviour along with them.	Newsfeed showing colleagues doing their physical activity at the same time.
Competition	A system can motivate users to adopt a targeted behaviour by leveraging on the natural drive of human beings to compete.	Enables older worker who have similar physical characteristics and constraints to compete with each other.
Recognition	By offering public recognition, a system can increase the likelihood that a person/group will adopt a targeted behaviour.	Offers recognition by periodically (weekly/ monthly) notifying everyone on the older worker with the best performance.

*The description of each persuasive design principle is as per defined in Oinas-Kukkonen and Harjumaa (2009)

Figure 1 and figure 2 show examples of the *FitSenior* user interfaces integrated with persuasive principles.

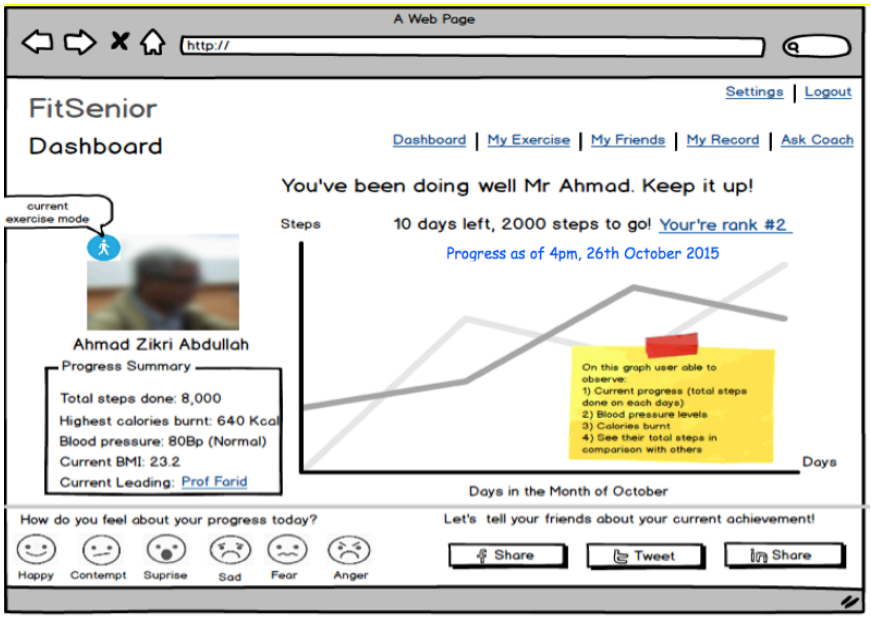

Figure 1: FitSenior displays individual progress (*self-monitoring*) and offers praise for good performance (*praise*)

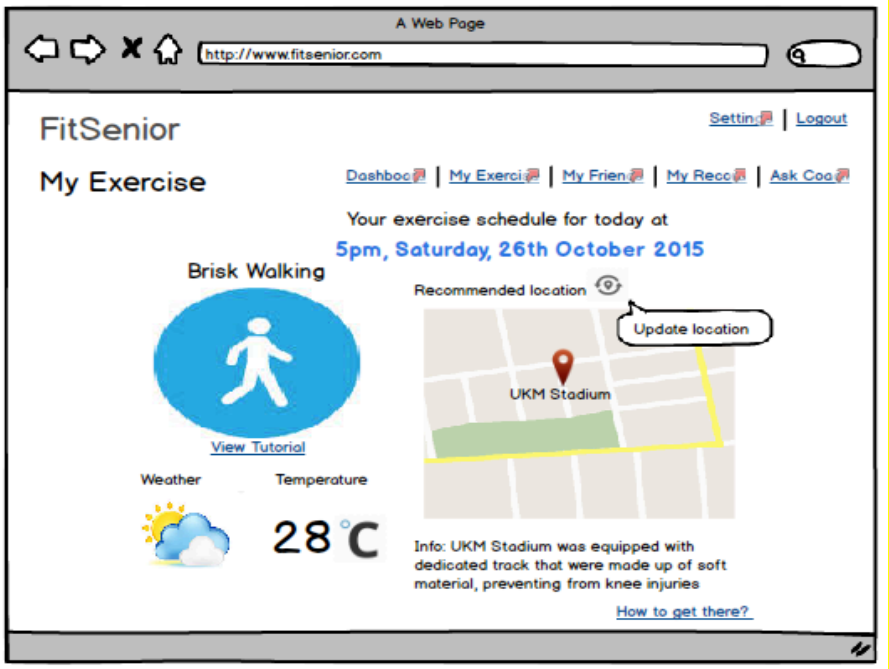

Figure 2: FitSenior notifies user of their daily physical activity schedule (*reminders*) and displays information on the weather forecast (*reduction)*

3.1 Participant recruitment

Using a purposive sampling method, ten older workers (6 males and 4 females), with ages ranging from 50 to 64 years (*Mean age* = 55.5), participated in the study. Nine participants were recruited from previous studies that investigated the socio-ecological factors that influence physical activity behaviour (Mohadis and Ali, 2015). They were re-invited to participate in this study via email. The remaining one participant was personally invited by the researcher due to his interest in enhancing his own level of

physical activity. All the participants in this study gave their consent, including those from the previous studies who were asked for their consent again. The research protocol had been approved by the UKM Medical Ethics Committee.

Out of the 10 participants, 6 of them were administrative staff, whilst another 4 participants were academics from diverse research areas (chemistry, education, language translation, physical education). In terms of exposure to technology, all the participants possessed personal computers and mobile phones, and acknowledged that they were familiar with the use of these devices. In fact, two of the participants admitted that they were using a commercially available smartphone app to track their physical activity level. In addition, each participant was also asked about any form of physical activity that he/she had routinely carried out so that the researcher would have information about their current level of physical activity.

3.2 Procedure

The participants were first presented with a questionnaire on their demographics (age, physical activity level, health issues). Next, they were given a persona, which narratively described the personal characteristics of an older worker, his/her environment, relationships, goals and behavioural patterns (Junior and Filgueiras, 2005). Whilst the older worker character was fictional, the detailed information of the persona was generated based on a previous study, where 25 older workers were interviewed on factors influencing their physical activity behaviour (Mohadis and Ali, 2015). The persona was very useful in informing the participants of the characteristics of the end user, the context of usage and the challenges experienced in using the application, which they had to consider in delivering their thoughts and insights on the persuasive design principles being investigated.

Next, a list of tasks was given to each participant. Each task required the participant to interact with each persuasive design element implemented on *FitSenior*. In this study, the 'persuasive design element' referred to the user interface (UI) feature of the *FitSenior* prototype that was integrated with the persuasive design principles. As none of the older worker participants were experts in persuasive design and may have been unaware of their interaction with a persuasive design element on the prototype, the task list was prepared in the form of a series of screenshots of each *FitSenior* webpage interface, and each persuasive design element was then labelled in alphabetical order.

As the participants interacted with each persuasive design element, a think-aloud technique was used whereby they were required to answer the following question, "*Do you think element [X] on FitSenior would be able to persuade you to do a physical activity?"* Each session lasted for 30 to 45 minutes, and the participants' feedback was audio and video recorded. At the end of each session, the participants were debriefed and a token of appreciation was given to each of them for their cooperation.

Then, the participants' verbalizations that were recorded during the think-aloud session were transcribed and translated. The transcribed data were then coded

deductively based on the PSD model using Nvivo 10 (version 10), a qualitative analysis software package released by QSR International.

4 Results and Discussions

Table 3 summarizes the characteristics of all the 10 older workers who participated in this study. As shown in Table 3, the types of physical activities conducted by the older worker participants ranged from low-intensity (e.g. gardening (seeding)), moderate-intensity (e.g. recreational tennis, aerobic exercises), and vigorous-intensity (e.g. long-distance cycling and squash). Noticeably, the older workers at the low physical activity level were suffering from various health issues (e.g. diabetes, hypertension), whereas those doing vigorous physical activity did not report any health issues. This indicates the importance of enhancing physical activity as a means to prevent the development of chronic diseases among older workers.

Table 3: Participants' characteristics grouped according to physical activity intensity level

ID	Age	Gender	Position	Physical activity intensity*	Physical activity type	Health issues
P01	54	Female	Support staff	Low	Stationary bike (for stroke rehabilitation)	Mild stroke, diabetes, hypertension
P02	56	Male	Support staff	Low	Gardening (seeding)	Overactive bladder
P03	56	Male	Administrative staff	Low	Gardening (seeding)	-
P04	52	Male	Academic	Moderate	Tennis (recreational)	Hypertension
P05	56	Female	Support staff	Moderate	Aerobic exercise	Hypertension
P06	56	Female	Support staff	Moderate	Aerobic exercise	-
P07	50	Male	Academic	Vigorous	Cycling (long-distance)	-
P08	55	Female	Academic	Vigorous	Squash, jogging	-
P09	58	Male	Administrative staff	Vigorous	Squash	-
P10	64	Male	Academic	Vigorous	Cycling (long-distance)	-

*Based on physical activity guidelines by U.S. Department of Health and Human Services (1999)

Further, the findings of this study were presented based on the categories of the PSD model of persuasive system features: 1) primary task support, 2) dialogue support, 3) credibility support, and 4) social support. However, it is important to note that this study only involved older worker participants who were responding to an email invitation and indicated their interest and motivation to enhance their physical activity level through the use of technological interventions. Older workers with no motivation to enhance their physical activity or those with negative attitudes toward the use of technology as a tool to enhance their physical activity behaviour might have different perceptions toward the persuasive design principles being investigated (Peek et al., 2014).

Accordingly, Table 4 presents an example of one participant's excerpt and the corresponding design implications.

Table 4: One user's perceptions on persuasive design elements of *FitSenior*

Persuasive principle	**User perceptions**
Primary Task	
Reduction	Positive: "Weather forecast, yes, this is very important so that we are well prepared. In case if it's raining outside, we can do indoor activities." (P09, 58 years old, vigorous)
Tunnelling	Positive: I think this is useful. For me, it is important for the app to provide a tool or platform that helps us to set the target. When someone has a target, he will try to achieve it." (P04, 52 years old, moderate)
Tailoring	Positive: "Yes, I think it would be very helpful if the application can provide relevant information based on our age, weight, health…But the information must be accurate." (P03, 56 years old, low)
Personalization	Positive: "Yes, one of the reasons why I am attracted to this kind of application is that it will recommend physical activity that is appropriate for me after analysing my health condition, age, and lifestyle. This is very important because most people have no knowledge about it." (P09, 58 years old, vigorous)
Self-monitoring	Positive: "I think this element is encouraging because I can see how the physical activity that I have done improves my health condition…like how many calories burnt? That would make me feel good." (P03, 56 years old, low)
Simulation	Positive: "I think this element is encouraging because I can see how the physical activity that I have done improves my health condition…like how many calories burnt (Cause-and-effect relationship), That would make me feel good." (P03, 56 years old, low)
Rehearsal	Positive: "Instead of text information, maybe you can provide a video explaining, for example, what is brisk walking, and then there is a person demonstrating on how to do it properly." (P08, 55 years old, vigorous)
Dialogue Support	
Praise	Positive: "I think this is good…because it would enhance a person's motivations and self-confidence, and he will become more comfortable to follow any recommendations." (P02, 56 years old, low)
Rewards	Positive: "Yes, there must be some sort of reward like for today's physical activity, what progress made, how good is his performance. Give some reward for that. That will make him work harder." (P07, 50 years old, vigorous) Negative: "Well, I don't really bother about rewards, like a virtual medal here, that's not important. But how the physical activity improved my health is all that matters" (P02, 56 years old, low)
Reminders	Positive: "Yes, it would be great if it can alert or remind me about any planned physical activities because sometimes I forget that I have an aerobics class after work and not bring along my sports attire. So I end up not joining the class." (P06, 56 years old, moderate)
Suggestions	Positive: "The recommended physical activity is not difficult to do, but I think you might need to suggest some sort of precautionary steps, like choosing appropriate shoes, only walk for short distances, because at this age we're quite vulnerable… injuries whilst doing exercises tend to occur." (P04, 52 years old, moderate)
Similarity	Positive: "Feels like being appreciated … and there is a sort of 'personal' connection with the application." (P02, 56 years old, low)
Social role	Positive: "I think this is the right way of doing it. I mean there should be a coach that we can consult, informing us what kind of exercise to do, especially for older adults like us, having a coach to talk to is better than just reading factual information." (P10, 64 years old, vigorous)

Credibility Support	
Expertise	Positive: "Yeah, incorporating an expert view is very important so that we become more confident with whatever recommendations that the system offers." (P04, 52 years old, moderate)
Real-world feel	Positive: "Are we allowed to communicate with each other? I mean it would be good if I can communicate with the coach and other participants as well." (P08, 55 years old, vigorous)
Third party endorsement	Negative: "I don't know who this person is (referring to the virtual coach). I mean what is his expertise? I think I will only follow whatever advice he gives if there is some sort of proof that confirms his expertise. Otherwise I don't feel like I want to trust him." (P03, 56 years old, low)
Verifiability	Negative: "These testimonials are pretty short, and…. I don't see where or how they give the testimonials? The testimony comes from where? I would love to communicate with these people (previous users giving testimonials about the application) to personally ask about their experience." (P08, 55 years old, vigorous)
Social Support	
Social learning	Positive: "The testimonials would be more persuasive if they are coming from users of a similar age group. That's important! For the elderly, they really want to see that there are people of their age that can actually stay healthy. Maybe you can add things like…successful users showing their 'before' and 'after' picture? I think that would be more convincing (instead of just text-based testimonials)." (P04, 52 years old, moderate)
Social comparison	Negative: "Only show successful users, say like 'Top 3' that achieved their target. Don't put everyone in the rank, because it could demotivate those at the bottom of the rank. Then, maybe share with others what makes those 'Top 3' successful so that everyone could exemplify from it." (P04, 52 years old, moderate)
Normative influence	Positive: "Usually people are more encouraged to do physical activity in a group, particularly with their close friends. Like me, I enjoy playing squash with partners rather than alone. I feel more motivated and competitive." (P09, 58 years old, vigorous)
Social facilitation	Positive: "Things like this needs self-discipline (which) could be influenced by our friends. When everyone participates and we can observe that it is good, we will feel motivated." (P02, 56 years old, low)
Competition	Positive: "I do love competition, but I have to choose my partner (competitor) appropriately. I think it would be unfair for me to compete with a younger, healthy individual because obviously they have better fitness and can beat me easily. So, I usually compete with friends who are about my age." (P09, 58 years old, vigorous) Negative: "I think usually only those with good health are interested to compete with others. But those with medical issues would feel insecure of their own illnesses, so any form of competition would become a burden." (P02, 56 years old, low)
Recognition	Positive: "Yes, from time to time, provide some form of recognition, like 'The Best Brisk Walker of the Month'. That would be encouraging." (P07, 50 years old, vigorous)

Besides, based on the thematic analysis of this study, three important issues regarding the perceptions of older workers towards the use of physical activity applications were identified. The issues were a) personalization of persuasive design principles; b) credibility of tailored content; and c) establishing sense of similarity.

4.1 Personalizing persuasive design principles

The findings indicated that all the older worker participants generally had positive views towards persuasive design principles that fell under the primary task, dialogue support and credibility support categories. However, as the data were analysed, there

was an emerging pattern whereby it could be identified that the older workers of different physical activity intensity levels had mixed views toward the *social comparison* and *competition* principles of the social support category. The older workers doing vigorous intense physical activities, who had been physically active since their youth, were very interested in the *competition* strategy, citing that the approach was motivating and encouraging, albeit on condition that their competitors were about the same age as themselves. In contrast, the older workers with low physical activity intensity levels had no interest in this approach, stating that it would potentially make them feel incompetent and demotivated by indicating their lack of self-efficacy in performing physical activities.

There was a lot of evidence in previous studies indicating the pivotal role of self-efficacy in predicting individual physical activity behaviour. McAuley et al. (2011) presented evidence to suggest that more active individuals have higher self-efficacy and are more efficacious, leading to a better physical functional performance. A study by Warner et al. (2011) examining the effects of social support on self-efficacy found that people with high self-efficacy are more likely to be active if they have social support - justifying their favourable perceptions toward *social comparison* and *competition* persuasive principles, which fall under the social support category of the PSD model. In contrast, however, the study found that people with low self-efficacy were less likely to be physically active, even if they had social support. Based on a recent systematic review by French et al. (2014) on effective behaviour change techniques targeting older adults, the phenomenon was due to poor health and lack of physical abilities among fairly inactive individuals, clarifying why interventions involving the reception of normative feedback (*social comparison* persuasive principles) may be demoralizing.

Despite their lack of self-efficacy leading to negative perceptions towards the *social comparison* and *competition* strategy, the older workers with low levels of physical activity did repeatedly mention that they were more interested in the *self-monitoring* design principle, whereby they were able to observe how physical activities that had been done were beneficial or in some way had caused significant improvement in their health condition and physiological status (e.g. calories burnt, reduced blood pressure, weight loss). This finding is consistent with the social cognitive theory which, among its contentions, is that enabling self-monitoring by providing physiological feedback can increase self-efficacy leading to enhanced physical activity levels (McAuley et al., 2011). A systematic review by Michie et al. (2009) on effective techniques in healthy eating and physical activity interventions also discovered that interventions containing self-monitoring or other self-regulation approaches are associated with larger changes in physical activity and healthy eating.

However, French et al. (2014) reported contradictory findings as their review of 24 studies revealed that self-monitoring techniques along with goal-setting, planning for relapses, providing normative information and providing feedback on performance are associated with lower levels of both self-efficacy and physical activity. They argued that the underlying reason is because these techniques, which they described as ‘self-regulatory’, involve higher-order cognitive processes that are essential in the control and instigation of behaviours that require effort, including planning, sequencing of

actions or inhibition of habitual responses, which are very challenging among older adults due to cognitive decline. However, although older workers share similar characteristics to older adults, a study by Hashim and Wok (2012) on older workers aged 55 to 60 years found that older workers are competent, perform well, and are trainable, indicating that *self-monitoring* design principles are still potentially effective at encouraging physical activity, particularly for those with low physical activity levels. Accordingly, as the perceptions of older workers with low and high physical activity levels toward some persuasive design principles contradict each other, it is believed that it is imperative to personalize the persuasive intent based on the intensity of the users' physical activities.

4.2 Credibility of behaviour change intervention

The older workers also highlighted that the credibility of the application did potentially increase the effectiveness of the persuasive application in persuading them to do physical activities. Several persuasive design principles have been mentioned that are directly linked to the credibility aspect of the application mainly *tailoring*, *personalization*, *social role* and *social learning design* principles. Tailored information and personalization of behaviour change content based on the age, physical abilities, health issues, and lifestyle of older workers evidently received a positive impression among the older workers, but on condition that these came from reliable sources and 'made sense'. Several studies have highlighted how these persuasive design principles are able to enhance the credibility of the web. A study by Harjumaa et al. (2009) found that credibility and the *tailoring* principle are indeed closely related as their study discovered that users were more motivated to follow the proposed training program as they knew that it had been tailored based on their personal data. Another study by Ritterband et al. (2009) argued that it is unlikely that behaviour would change without good content. Accurate, clear, and simple information is critical to create and deliver efficacious applications that will be well received.

Sillence et al. (2006), on the other hand, revealed that personalization of behaviour change content enhances a user's trust towards the proposed online health advice, indicating the relevance of using the *personalization* principle to enhance the credibility of a web-based health intervention.

The *social roles* principle, which often involves the integration of a virtual coach, plays a vital role in establishing the expert-user relationship as it becomes the main medium that guides users through behaviour changes by offering advice, suggestions, and praise for successful performance, similar to a real-life coach. Although, in general, the older workers in this study were positive towards this design principle, several potential issues surrounding the expertise and eligibility of the virtual fitness coach emerged. The older workers argued that users should be made aware of the virtual coach's expertise and eligibility as it enhanced their confidence and trust to follow any advice given. Research by Sillence et al. (2007) on the evaluation of online health information supported their concerns as the study discovered that after the initial evaluation of the readily accessible properties of the site, the user subsequently tended

to evaluate the content by making judgments concerning the expertise of the authors and the credibility of the material. Ritterband et al. (2009) also claimed that expertise and trustworthiness are imperative in establishing credibility, adding that providing important information about who gives the content (in this case the virtual coach) is necessary as it dictates its "believability" and ability to induce behaviour change.

4.3 Establishing sense of similarity

The older workers in this study also highlighted the importance of having "a sense of similarity" as they interacted with several persuasive design principles, mainly, *social role*, *social learning*, *social comparison* and *competition design* principles. From their perspective, having a virtual fitness coach that shared similar characteristics (age, physical appearance) would be more persuasive than a younger-looking adult. Likewise, for the *social learning* principle, where they were able to acknowledge testimonials or feedback from other users using the application, the older workers also denoted that they would be more interested to read the testimonials of other users who were about the same age and had similar physical characteristics and health issues as themselves, as it gave the impression that 'if they can do it, why can't I?'. Similar perceptions were also expressed towards the *social comparison* and *competition design* principles, whereby the older workers indicated that both were encouraging on condition that any form of comparison and competition should be again, among those in the same age group, having similar physical abilities and even better, if it could be someone they knew in real-life. In fact, being compared with healthy, younger-looking individuals, as mentioned, would lead to a lack of self-efficacy and would be demotivating.

Establishing 'a sense of similarity' as an effective method to encourage behavioural change has been proven in previous studies. A study by Sillence et al. (2007) found that sites that provide these social identification cues (where the sites were acknowledged to be written by people similar to themselves and were obviously aimed at 'people like them') claimed to encourage more interest and to be more appreciated. French et al. (2014) shared the notion as their study observed that similar others modelled the behaviour associated with increased physical activity.

5 Limitations and future work

This study only focused on older workers in a higher learning institution, specifically academicians, and administrative and support staff, whose job profiles largely involved desk work such as computer operations and clerical jobs that forced them to be engaged in long hours of sitting and sedentary behaviour at the workplace (Pronk et al., 2012). It is argued that older workers in different sectors (engineering, construction, farming and plantation, etc.) may have different perceptions toward persuasive principles leading to different design requirements. Furthermore, a relatively small sample size may make any generalization of the outcomes of this study less feasible. Nevertheless, this study has demonstrated the importance of understanding user perceptions toward various persuasive principles of PSD as these are able to inform and assist designers in determining appropriate design strategies that would potentially lead to successful

behavioural change. Future research should be conducted to evaluate the effectiveness of developing a persuasive system based on this approach and whether user perceptions towards these persuasive principles would change when they interact with full-scale, well-developed persuasive physical activity applications over a prolonged period of time.

6 Conclusions

The present study involved an investigation into the perceptions of older workers toward various persuasive principles of the PSD model. The findings indicate that the perceptions of older workers towards persuasive principles are influenced by their current physical activity levels. Whilst the persuasive principles of the *primary task*, *dialogue support* and *credibility support* categories generally received positive perceptions, the persuasive principles of *social support* were negatively perceived by the older workers with a low level of physical activity, probably due to a lack of self-efficacy. Further, the personalizing of the persuasive design strategies, the credibility of tailored content and the establishment of a sense of similarity are imperative in the design of a persuasive application aimed at enhancing physical activity among older workers. Hence, this study has demonstrated the importance of understanding end-user perceptions, which are not only useful for ensuring acceptance and adoption of the application, but can also assist designers in refining user needs and requirements that potentially lead to successful behaviour change interventions.

Acknowledgements: This work is supported by the E-ScienceFund MOSTI research grant 06-01-02-SF1083 and the Science Foundation Ireland under grant 12/RC/2289.

References

AARP Public Policy Institute. 2009. *Chronic Care : A Call to Action for Health Reform*. Available at http://assets.aarp.org/rgcenter/health/beyond_50_hcr.pdf

Al Ayubi, S. U., B. Parmanto, R. Branch, and D. Branch. 2014. "A Persuasive and Social mHealth Application for Physical Activity: A Usability and Feasibility Study." *JMIR mHealth and uHealth 2*(2): e25. doi:10.2196/mhealth.2902

Albaina, I. M., T. Visser, C. a. P. G. van der Mast, and M. H. Vastenburg. 2009. "Flowie: A Persuasive Virtual Coach to Motivate Elderly Individuals to Walk." In: *Proceedings of the 3rd International ICST Conference on Pervasive Computing Technologies for Healthcar*e, 1 – 7. London, United Kingdom: IEEE. doi: 10.4108/ICST.PERVASIVEHEALTH2009.5949

Beach, C.M., 2008. *Canada's Ageing Workforce : Participation, Productivity, and Living Standards*. Bank of Canada. Available at http://www.bankofcanada.ca/wp-content/uploads/2010/09/beach.pdf

Burgoyne, L. N., C. Woods, R. Coleman, and I. J. Perry. 2008. "Neighbourhood Perceptions of Physical Activity: A Qualitative Study." *BMC Public Health* 8 (101). doi: 10.1186/1471-2458-8-101.

Caprani, N., N. E. O'Connor, and C. Gurrin. 2012. "Touch Screens for the Older User." In: *Assistive Technologies*. Auat Cheein F. A. (Ed.) *InTech*, 95-118. doi: 10.5772/38302. Available at http://www.intechopen.com/books/assistive-technologies/touch-screens-for-the-older-user

Dantzig, S., G. Geleijnse, and A. T. Halteren. 2013. "Toward A Persuasive Mobile Application to Reduce Sedentary Behavior." *Personal and Ubiquitous Computing* 17 (6): 1237-1246. doi:10.1007/s00779-012-0588-0

Department for Work and Pensions. 2013. *Older Workers Statistical Information Booklet 2013*. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/264899/older-workers-statistical-information-booklet-2013.pdf

Department for Work and Pensions (DWP). 2010. *Older Workers Statistical Information Booklet, Quarter Two 2010*. Available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/214353/owsib2010.pdf

de Oliveira, R., M. Cherubini, and N. Oliver. 2010. "MoviPill: Improving Medication Compliance For Elders Using A Mobile Persuasive Social Game." In: *Proceedings of the 12th ACM International Conference on Ubiquitous Computing,* 251-260. Copenhagen, Denmark: ACM. doi: 10.1145/1864349.1864371

Fogg, B. J. 2003. *Persuasive Technology: Using computers to change what we think and do*. San Fransisco: Morgan Kaufmann Publishers.

Foster, D., C. Linehan, and S. Lawson. 2010. "Motivating Physical Activity At Work: Using Persuasive Social Media Extensions For Simple Mobile Devices." In: *Workshop on Nudge & Influence Through Mobile Devices*. Lisbon, Portugal. Available at http://eprints.lincoln.ac.uk/3153/

French, D. P, E. K Olander, A. Chisholm, and J. McSharry. 2014. "Which Behaviour Change Techniques Are Most Effective at Increasing Older Adults' Self-Efficacy and Physical Activity Behaviour? A Systematic Review." *Annals of Behavioural Medicine* 48(2): 225–234. doi: 10.1007/s12160-014-9593-z

Harbers, M. and P. Achterberg. 2012. *Europeans of retirement age : chronic diseases and economic activity*. The Dutch National Institute for Public Health and The Environment (RIVM). Available at http://ec.europa.eu/health/major_chronic_diseases/docs/rivm_report_retirement_en.pdf

Harjumaa, M., K. Segerståhl, and H. Oinas-Kukkonen. 2009. "Understanding Persuasive Software Functionality in Practice: A Field Trial of Polar FT60." In *Proceedings of the 4th International Conference on Persuasive Technology,* Article No. 2. Claremont, USA: ACM. doi: 10.1145/1541948.1541952

Hashim, J. and S. Wok. 2014. "Competence, Performance and Trainability of Older Workers of Higher Educational Institutions in Malaysia." *Employee Relations* 36 (1): 82 – 106. doi: 10.1108/ER-04-2012-0031

Helman, R., C. Copelandm, and J. VanDerhei. 2011. *The 2011 Retirement Confidence Survey: Confidence Drops to Record Lows, Reflecting "the New Normal"*. Issue Brief No. 355. Available at https://www.ebri.org/pdf/briefspdf/ebri_03-2011_no355_rcs-2011.pdf

Heidkamp, M., W. Mabe, and B. Degraaf. 2012. *The Public Workforce System : Serving Older Job Seekers and the Disability Implications of an Ageing Workforce*. Available at https://www.dol.gov/odep/pdf/NTAR_Public_Workforce_System_Report_Final.pdf.

Ilmarinen, J. E. 2001. "Ageing Workers." *Occupational and Environmental Medicine* 58 (8): 546–552. doi: 10.1136/oem.58.8.546

International Labour Office (ILO). 1980. *Older Workers Recommendation, 1980* (No. 162). Available at http://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO:12100:P12100_ILO_CODE:R162

Irvine, A. B., V. A. Gelatt, J. R. Seeley, P. Macfarlane, and J. M. Gau. 2013. "Web-based Intervention to Promote Physical Activity By Sedentary Older Adults: Randomized Controlled Trial." *Journal of Medical Internet Research* 15(2): e19. doi:10.2196/jmir.2158

Johnson, R.W. 2012. *Older Workers, Retirement, and the Great Recession*. New York: Russell Sage Foundation. Available at https://web.stanford.edu/group/recessiontrends/cgi-bin/web/sites/all/themes/barron/pdf/Retirement_fact_sheet.pdf

Junior, P. T. A., and L. V. L Filgueiras. 2005. "User Modeling with Personas." In *Proceedings of the 2005 Latin American Conference on Human-computer Interaction - CLIHC '05*. Cuernavaca, Mexico, October 23-26 2005. doi: 10.1145/1111360.1111388

Konstantinidis, E.I., A.S. Billis, C. A. Mouzakidis, V. I. Zilidou, P. E. Antoniou, and P.D. Bamidis. 2014. "Design, Implementation and Wide Pilot Deployment of FitForAll : An Easy to Use Exergaming Platform Improving Physical Fitness and Life Quality of Senior Citizens." *IEEE Journal of Biomedical and Health Informatics* 20(1): 189 – 200. doi: 10.1109/JBHI.2014.2378814

Michie, S., C. Abraham, C. Whittington, J. McAteer, and S. Gupta. 2009. "Effective Techniques in Healthy Eating and Physical Activity Interventions: A Meta-Regression." *Health Psychology* 28 (6): 690-701. doi: 10.1037/a0016136.

McAuley, E., A. Szabo, N. Gothe, and E. A. Olson. 2011. "Self-efficacy: Implications for Physical Activity, Function and Functional Limitations in Older Adults." *Americal Journal of Lifestyle Medicine* 5(4). doi: 10.1177/1559827610392704

Meyer, J. 2007. *Older Workers and the Adoption of New Technologies*. ZEW Centre for European Economic Research. Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1010288

Ministry of Manpower. 2012. *Retirement and Re-employment Practices, 2011*. Available at http://stats.mom.gov.sg/iMAS_PdfLibrary/mrsd-retirement-re-employ-2011.pdf

Mohadis, H. M. 2016. "Designing Behaviour Change Application for Physical Activity Enhancement Among Older Worker based on Persuasive Approach." PhD diss., Universiti Kebangsaan Malaysia. *(Unpublished)*

Mohadis, H. M., and N. M. Ali. 2015. "Using Socio-ecological Model to Inform the Design of Persuasive Applications." In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*, 1905–1910. Seoul, South Korea: ACM. doi: 10.1145/2702613.2732835

Nunan, D., K. R. Mahtani, N. Roberts, and C. Heneghan. 2013. "Physical Activity For The Prevention and Treatment of Major Chronic Disease: An Overview of Systematic Reviews." *Systematic reviews*, 2(1): 56. doi: 10.1186/2046-4053-2-56

Oinas-Kukkonen, H. and M. Harjumaa. 2009. "Persuasive Systems Design: Key Issues, Process Model, and System Features." *Communication Association Information System* 24(1): Article 28. Available at http://aisel.aisnet.org/cais/vol24/iss1/28

Or, C. K. L., B.T. Karsh, D. J. Severtson, L. J. Burke, R. L. Brown, and P. F. Brennan. 2010. "Factors Affecting Home Care Patients' Acceptance of A Web-Based Interactive Self-Management Technology." *Journal of the American Medical Informatics Association* 18 (1): 51–9. doi:10.1136/jamia.2010.007336

Paay, J., J. Kjeldskov, U. Brinthaparan, L. Lichon, S. Rasmussen, N. Srikandaraja, W. Smith, G. Wadley, and B. Ploderer. 2014. "Quitty: Using Technology to Persuade Smokers to Quit." In: *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational*, 551-560. Helsinki, Finland: ACM.

Peek, S. T. M., E. J. M. Wouters, , J. van Hoof, K. G. Luijkx, H. R. Boeije and H. J. M. Vrijhoef. 2014. "Factors Influencing Acceptance of Technology For Ageing in Place : A Systematic Review." *International Journal of Medical Informatics* 83(4): 235–248. doi: http://dx.doi.org/10.1016/j.ijmedinf.2014.01.004

Pronk, N.P., A.S. Katz, M. Lowry and J. R. Payfer. 2012. "Reducing Occupational Sitting Time and Improving Worker Health : The Take-a-Stand Project, 2011." *Preventing Chronic Disease* 9:110323. doi: http://dx.doi.org/10.5888.pcd9.110323.

Ritterband L. M., F. P. Thorndike, D. J. Cox, B. P. Kovatchev, and L. A. Gonder-Frederick. 2009. "A Behavior Change Model for Internet Interventions." *Annual Behavioral Medicine* 38(1): 18–2. doi: 10.1007/s12160-009-9133-4

Rodriguez, M., J. Roa, A. Moran, and S. Nava-Munoz, 2012. "Persuasive Strategies For Motivating Elders to Exercise." In: *Proceedings of the 6th International Conference on Pervasive Computing Technologies for Healthcare,* 219-223. San Diego: IEEE. doi: 10.4108/icst.pervasivehealth.2012.248774

Saksena, A. 2010. "Computer-based Education For Patients with Hypertension: A Systematic Review." *Health Education Journal* 69(3): 236–245. doi:10.1177/0017896910364889

Semlitsch, T., K. Jeitler, L. G. Hemkens, K. Horvath, E. Nagele, C. Schuermann, N. Pignitter, K. H Herrmann, S. Waffenschmidt, and A. Siebenhofer. 2013. "Increasing Physical Activity For The Treatment of Hypertension: A Systematic Review and Meta-Analysis." *Sports Medicine* 43(10): 1009–23. doi:10.1007/s40279-013-0065-6

Sillence, E., P. Briggs, L. Fishwick, and P. Harris. 2006. "A Framework For Understanding Trust Factors in Web-Based Health Advice." *International Journal of Human-Computer Studies* 64 (8): 697-713. doi:10.1016/j.ijhcs.2006.02.007

Sillence, E., P. Briggs, L. Fishwick, and P. Harris. 2007. "How Do Patients Evaluate and Make Use Of Online Health Information?" *Social Science & Medicine* 64(9): 1853–1862. doi: 10.1016/j.socscimed.2007.01.012

Silveira, P., E. van het Reve, F. Casati, and E. D de Bruin. 2012. "Motivating Physical Exercises in Independently Living Older Adults: A Pilot Study." *International Journal of Medical Informatics* 82(5): 325–334. doi:10.1016/j.ijmedinf.2012.11.01

Taylor, S. and P. Todd. 1995. "Assessing IT Usage: The Role of Prior Experience." *MIS Quarterly* 19(4): 561-570. doi: 10.2307/249633

Toossi, M., 2012. *Labor force projections to 2020: a more slowly growing workforce*. Bureau of Labor Statistics. Available at http://www.bls.gov/opub/mlr/2012/01/art3full.pdf

U.S. Department of Health and Human Services. 1999. *Promoting physical activity*. Human Kinetics, IL, USA.

Warner L. M., J. P. Ziegelmann, B. Schüz, S. Wurm, and R. Schwarzer. 2011. "Synergistic Effect of Social Support and Self-Efficacy On Physical Exercise in Older Adults." *Journal of Aging and Physical Activity* 19(3): 249–261. Available at: http://journals.humankinetics.com/AcuCustom/Sitename/Documents/DocumentItem/07-J3636%20japa_Warner_2010_0019%20249-261.pdf

World Health Organization (WHO). 1993. *Ageing and Working capacity: Report of a WHO Study Group,* WHO Technical Report Series No. 835, 1-49. Geneva, Switzerland. Available at http://whqlibdoc.who.int/trs/WHO_TRS_835.pdf

World Health Organization (WHO). 2009. *Definition of an older or elderly person*. Geneva, Switzerland. Available at http://www.who.int/healthinfo/survey/ageingdefnolder/en/index.html