



# Predictors in starting and stopping Internet use between 2002 and 2012 by Dutch adults 65 years and older

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**Abstract**

Research has indicated the need to consider the ageing process with technology adoption by older adults. This study examined psychological, health, social and demographic predictors with starting and stopping Internet use by older adults (2002–2012). Data were used from the Longitudinal Aging Study Amsterdam, and Cox regression analyses were done to test predictors over time with starting or stopping Internet use. The results indicated that older adults starting to use the Internet (11.6%) outnumbered those who stopped (3.1%). Psychological, health, social and demographic predictors separately predicted starting and stopping Internet use. Starting use was predicted by lower age, higher education, normal cognition and living alone. The predictors in stopping use were being younger, having a high sense of mastery and being higher educated. The results need to be interpreted as indicative due to the small number of stoppers. Suggestions are made on how to improve usability.

**Keywords**

ehealth, health information on the Web, information and knowledge management, longitudinal study, older adults, starting–stopping Internet use

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## Introduction

According to the World Health Organization, if ageing is to be a positive experience, longer life must be accompanied by continuous opportunities for health, participation and security.

This can be achieved through active ageing, which is 'the process of optimising (these) opportunities ... in order to enhance the quality of life as people age'.<sup>1</sup>

The Internet is considered important for older adults to include in their lives for this purpose.<sup>2,3</sup> It can be a tool for older adults to participate and potentially have quicker access to healthcare services,<sup>4</sup> have increased communication opportunities with society, family and friends,<sup>5</sup> to compensate for age-related decline and be able to live independently.

On average, 46 per cent of people between the ages of 55 and 74 years are currently using the Internet.<sup>6</sup> However, as age increases, there is less Internet use,<sup>7,8</sup> and there are still a majority of older people (65 years and older) who are not going online.

As the Internet promises a facilitation to a healthier, more active and social life for older adults, the reasons for – or barriers to – Internet use need to therefore be investigated.

Within active ageing, determinants to start using the Internet can be driven by both external factors (such as social contacts)<sup>9</sup> and internal factors (for example, a want to learn more about a chronic illness). Similarly, stopping Internet use can be triggered, for example, by the loss of a spouse or being too frail.<sup>10</sup>

The reasons for an older person's technology use (or not) often stem from two models:<sup>11</sup> technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT). They tend to be powerful in explaining parts of the reasons why a person will use technology as they explain how users accept the technology. For example, TAM claims perceived ease of use and usefulness are the main causal variables in explaining the degree to which a person believes using a particular system will enhance their professional performance, and that using the system will be free of effort.<sup>12</sup> UTAUT has indicated significant effects on the intention and actual use of the Internet,<sup>13</sup> and on top of perceived ease of use and usefulness adds a few more predictors, namely social influence, facilitating conditions such as a good PC, gender, age and experience and voluntariness of use. These variables allow a more precise explanation (about 70%) of a person's intention to use the technology.<sup>14</sup>

However, it is agreed that these models do not account for individual change in acceptance and attitudes towards technology over time, and they lack essential predictors specific for older adults.<sup>11,15</sup> For example, after the age of 75 years, the rate of Internet adoption decreases significantly, suggesting that age is a predictor in technology acceptance.<sup>16</sup> However, a recent review indicated that it is actually an encompassing ageing process, change in vision or one's psychological ageing, which affects usage.<sup>17</sup> Specifically for Internet use/non-use by older adults, psychological, biological, social and demographic changes need to be taken into account.<sup>7,18</sup> Including these factors may establish and determine more correctly the usability of the technology by older adults and improve the interaction with the Internet leading to better user experience.<sup>19</sup> As mentioned, the perceived usefulness of the Internet is something that partly explains late adoption by older adults,<sup>12</sup> where over time older adults may finally use the Internet as it now has a purpose in their lives, which it did not have before.

Due to the rapid change and pace of Internet adoption by societies, longitudinal studies on ageing have not had a chance to extensively investigate older adults' Internet use, which is necessary for causal conclusions. Many previous studies have so far investigated predictors in cross-sectional studies. Understanding what makes an older adult start or stop to use the internet can lead to either focused help to go online or alternative options catering to the older adult. The aim of this study was therefore to examine a combination of psychological, health, social and demographic

predictors in whether an older person would start or stop to use the Internet on a computer, between the years 2002 and 2012.

## Literature review

### *Psychological influences*

Self-efficacy has been related to learning and performance accomplishments of Internet use.<sup>20,21</sup> The concept has three components, including initiative, effort and persistence,<sup>22</sup> each of which may feed into one's belief about learning and ability to use the Internet. One study shows that older adults who perceived themselves as capable of using and grasping the Internet were more likely to engage in learning to use the Internet.<sup>23</sup>

The concept 'sense of mastery' indicates the extent to which a person perceives himself or herself to manage and be in control of events and situations.<sup>24</sup> It has often been investigated in association with health, where a decrease in health and well-being has been explained, in part, by a decrease in available psychological resources.<sup>25</sup> Its impact on Internet use has, to the authors' best knowledge, not been directly investigated. Similarly, self-esteem is a predictor that has not often been investigated as a predictor in Internet use by older adults. The term in itself is often used in connection with well-being or self-efficacy. Research has found that functional and social losses may lead to a decline in self-esteem in later life.<sup>26</sup> In this study, the authors wanted to investigate whether self-esteem impacts someone who starts or stops to use the Internet.

### *Health influences*

Physical changes affecting an older person's health can impact the use of technology. The higher the age, the more likely that chronic diseases are present. Ill health may affect the ability to use the Internet. Musculoskeletal disorders are common with increasing age where arthritis, for example, can be painful and debilitating; it could indicate a potential hinder to Internet use due to the pain and stiffness. A recent European population-based study investigating persons between 65 and 85 years of age found that 33.8 per cent had self-reported osteoarthritis in their hands.<sup>27</sup> From a cross-sectional study, however, disability from arthritis was not associated with Internet use in older adults.<sup>28</sup> Alternatively, having a chronic disease might be a trigger to go online to search for health information, which could provide support and good information, suggesting that an older adult would want to start to use the Internet.

Furthermore, chronic illnesses can make reading a challenge, which hinders going online.<sup>29</sup> Low vision, overall, can be a possible barrier to starting to use the Internet. It can also be a reason to stop using the Internet. Being older and having vision impairment are usually strongly correlated. A recent study on computer and cellular phone use by older adults indicated that visual impairment was a strong reason not to use the technology.<sup>30</sup>

Self-rated health (SRH) is a subjective measure summarising how an individual perceives their health. A study on tablet computers and Skype use by frail older adults indicated that if an older person felt too frail or ill, this was a barrier to starting to use new technology.<sup>10</sup>

Cognitive function has often been reported as a strong predictor in new technology adoption and to influence whether an older adult uses the Internet,<sup>20,29</sup> where a normal level of cognitive functioning is necessary. Having any cognitive problems such as learning a new task or retrieving how to find a webpage or an application online will influence usage. Older adults may not want to go online due to a change in needs or having forgotten how to.<sup>10,17</sup>

## **Social influences**

Beyond individual factors, starting to adopt the Internet has been suggested to be moderated by a social diffusion process and familial influence.<sup>31,32</sup> Having grandchildren may have a strong impact on the older adults' Internet adoption. Internet is also a tool to communicate among grandchildren and grandparents, for example. Living with someone has been noted as a factor associated with Internet use.<sup>33</sup> A support system is important, through a spouse or a family member, as they can make it easier to start to use the Internet. With using new technology, support is critical for learning, exploration and uptake of new technology by older people.<sup>34</sup> Having someone close by to ask if something goes wrong technically is important. Therefore, network size, living with someone, instrumental and emotional support may be pivotal for the older adult to start or stop using the Internet.

## **Demographic influences**

Rural living has often been shown to be associated with less computer usage.<sup>35</sup> Rural living has also been shown to be related to less Internet use due to worse access to the Internet.<sup>36</sup> Other studies indicated that differences in gender, education and age also affect Internet use in rural areas;<sup>37</sup> belonging to the demographic groups of the oldest old, females and lower educated are already strong predictors of not using or less usage of the Internet by older people.<sup>38–40</sup>

In view of the spread of the Internet in society, and the importance for older adults to actively engage in society, this study aims to contribute and deepen the knowledge on predictors affecting stopping and starting Internet use. Gaining a further understanding of this will hopefully help the older adults who are and those who are not able to actively and healthily participate in the Internet society. Previous research has explored Internet use and non-use. This research attempts to prospectively explore elements of psychological, health, social and demographic processes of ageing with Internet starting or stopping use.

## **Research question**

How do psychological, health, social and demographic processes of ageing predict starting or stopping Internet use?

## **Methodology**

### **Sample**

The study sample was taken from the Longitudinal Aging Study Amsterdam (LASA). This is a population-based ongoing study that began in 1992 with an aim to provide a basis for developing and evaluating policies within the field of ageing.<sup>41</sup> The study is multi-disciplinary and has as overall aim to explore, study and understand changes in the physical, emotional, cognitive and social functioning of older adults.<sup>42</sup>

The participants were selected from the registries of 11 municipalities in three geographical regions: the protestant north, the catholic south and the secular west.

The first cohort recruited was between the ages of 55–85 years ( $N=3107$ ; response rate 62%), where face-to-face interviews were held at baseline with a follow-up every 3 years. More details on the LASA study itself can be found elsewhere.<sup>42</sup>

For this study, a selection of adults 65 years and older were followed from 2001/2002 onwards as they were the first to receive the questions on Internet use. The following four waves were

investigated: baseline 2001/2002 (T1), follow-up 2005/2006 (T2), follow-up 2008/2009 (T3) and follow-up 2010/2012 (T4).

### *Dependent variable*

*Internet use: starting and stopping.* At each wave, Internet use was a question with a yes or no answer possible. Starting to use the Internet during the follow-up was constructed based on the number of non-Internet users at T1 (2001/2002). Each new person who started to use the Internet was taken into account for every wave T2, T3 and T4. An exact timing variable was created to indicate whether an older adult started to use the Internet or not; this set the starting time half-way of each time period, so a person could start at 2, 5.5 or 8.5 years. The new time variable was 'time to start'.

Stopping to use the Internet was constructed based on the number of Internet users at T1 (2001/2002). The procedure was the same as described above. A new variable was created to indicate whether an older adult stopped using the Internet or not. The new time variable was 'time to stop'.

### *Independent variables: psychological, physical, social and demographic measures*

*The psychological measures.* Self-efficacy is measured based on a shortened version of the General Self-Efficacy Scale (GSES). It is a 12-item scale (a shortened version of the original 17-item scale), where three domains of the self-efficacy beliefs were found fitting for the older adult population: initiative (willingness to initiate behaviour), effort (willingness to put the effort into behaviour) and persistence (against any adversity).<sup>22</sup> The higher the score, the most positive the self-efficacy. The authors dichotomised the self-efficacy score at the 50th percentile of the mean for the descriptive and chi-square test and entered it as a continuous variable in the prediction model.

Sense of mastery is measured using the Pearlin Mastery Scale, who proposed a seven-item scale.<sup>24</sup> In this study, the abbreviated five-item version was used, where the higher the score (from 5 to 25), the better the sense of mastery. An example of an item is 'I have little control over the things that happen to me'. The authors dichotomised the sense of mastery at the 50th percentile of the mean for the descriptive and chi-square test and entered it as a continuous variable in the predictive model.

Self-esteem is measured with a reduced version of the Rosenberg self-esteem scale<sup>43</sup> from 10 to 4 questions. The scale score is the sum of the ratings, where a higher score indicates a higher self-esteem. Self-esteem was dichotomised at the 50th percentile of its mean for the descriptive and chi-square test and entered as a continuous variable in the predictive model.

*The health measures.* Vision was investigated by a self-reported measure based on the OECD long-term disability indicator,<sup>44</sup> with questions regarding how much difficulty a person has in seeing. There were two questions on vision and the possible answers were scored on a self-reported Likert scale. The authors then created a dichotomous variable with either 'difficulty to see' or 'no difficulty' (corrected vision through glasses or lenses was taken into account).

Chronic diseases were investigated through respondents' self-reports, and for this study arthritis (rheumatoid arthritis or osteoarthritis) was selected. The authors specifically focused on pain and stiffness complaints in the hand, fingers and shoulders. A yes or no answer was possible for each and included in the univariate analysis (Tables 1 and 2). For the prediction analyses, a new variable

**Table 1.** Descriptives of the samples 65years and older (2002–2012).

	E	F	G	H
	N= 1295	N=853	N= 691	N=488
	2001/2002	2005/2006	2008/2010	2011/2012
Internet use	Total N (%)	Total N (%)	Total N (%)	Total N (%)
Yes	143 (11)	185 (21.7)	185 (26.8)	188 (38.5)
No	1152 (89)	668 (78.3)	506 (73.2)	300 (61.5)
Demographics				
Mean age (years)	76.5	79	81	83
Minimum age (years)	65	69	72	75
Max age (years)	94	99	100	104
Sex male	575 (44.4)	368 (43.1)	295 (42.7)	204 (41.8)
Sex female	720 (55.6)	485 (56.9)	396 (57.2)	284 (58.2)
Education lower	1087 (84.0)	705 (82.6)	562 (81.3)	392 (80.3)
Education higher	207 (16.0)	148 (17.4)	129 (18.7)	96 (19.7)
Social				
Network (mean p/person)	14.8	15.2	15.0	14.9
Instrumental support mean p/year	15	15.9	15.9	16.1
Emotional support mean per year	21.7	21.9	21.9	21.7
Rural	539 (41.7)	356 (41.8)	298 (43.1)	202 (41.4)
Urban	754 (58.3)	496 (58.2)	393 (56.9)	286 (58.6)
Living alone	553 (42.9)	373 (43.7)	341 (49.4)	255 (52.3)
Living +1	736 (57.1)	480 (56.3)	349 (50.6)	233 (47.7)
Health				
(Arthritis) hand complaint	211 (16.8)	157 (19.0)	146 (22.1)	92 (19.9)
Hand no complaint	1044 (83.2)	670 (81.0)	516 (77.9)	371 (80.1)
(Arthritis) fingers complaint	254 (20.2)	191 (23.1)	179 (27.1)	133 (28.8)
Fingers no complaint	1002 (79.8)	637 (76.9)	482 (72.9)	329 (71.2)
(Arthritis) shoulder complaint	236 (18.8)	168 (20.4)	144 (21.8)	107 (23.1)
Shoulder no complaint	1021 (81.2)	657 (79.6)	517 (78.2)	357 (76.9)
Vision difficulty	222 (17.1)	140 (16.4)	139 (20.1)	108 (22.1)
Vision no difficulty	1072 (82.8)	659 (77.3)	497 (71.8)	344 (70.5)
Subjective health fair/poor	532 (41.1)	367 (43.0)	280 (40.7)	213 (43.8)
Subjective health good	762 (58.9)	486 (57.0)	408 (59.3)	273 (56.2)
Cognition <26 (mean cut-off)	248 (19.2)	178 (20.0)	152 (22.0)	107 (22.0)
Cognition ≥26	1047 (80.8)	674 (79.1)	539 (78.0)	380 (78.0)
Psychosocial				
Low mastery <17	534 (41.9)	337 (40.0)	302 (44.1)	224 (46.9)
17 ≤ high mastery	740 (58.1)	506 (60.0)	383 (55.9)	254 (53.1)
15 < low self-esteem	847 (65.9)	585 (69.2)	440 (64.2)	338 (69.5)
High self-esteem score ≤15	439 (34.1)	260 (30.8)	245 (35.8)	148 (30.3)
Self-efficacy low <41	538 (41.7)	320 (37.9)	305 (44.7)	209 (43.2)
41 ≤ high self-efficacy	752 (58.3)	525 (62.1)	378 (55.3)	275 (56.8)

Education lower (until secondary school – not completed); education higher (secondary school and higher); instrumental support: total score (range 0–36) receiving help with chores around the house; emotional support: total score (range 0–36) advice or mental support received; rural living: up to an area of maximum 1000 addresses/km<sup>2</sup>; urban living: living in an area with 1000 addresses/km<sup>2</sup> or more; cognitive score between 0 and 26: low, score 26 and above: normal/good cognition; sense of mastery – score 5–16: low, 17 and above: high mastery; self-esteem – score 0–14: low, score 15 and above: high self-esteem; self-efficacy – 0–40: low, score 41 and above: high self-efficacy.

**Table 2.** Starting and stopping use throughout 10 years.

	T1: 2001/2002	T2: 2005/2006	T3: 2008/2009	T4: 2010/2012
N (%)	No internet use 1152 (88.9)	Started using 86 (6.1)	Started using 38 (2.9)	Started using 33 (2.6)
N (%)	Internet users 143 (11)	Stopped using 11 (0.8)	Stopped using 21 (1.6)	Stopped using 9 (0.7)

Total N = 1295.

was created where arthritis was combined into one variable with the total sum of complaints in hand, fingers or shoulders. It was entered as a continuous variable in the prediction model.

Cognitive functioning was measured using the Mini-Mental State Examination (MMSE), which intends to measure the presence of normal cognitive functioning versus the presence of cognitive impairment.<sup>45</sup> In this study, a cut-off point at the mean of the selected sample was used for the chi-square test, yet entered as a continuous variable for the prediction model.

SRH is a subjective evaluation of one’s health status in general and has been recommended as an indicator for predicting mortality.<sup>46</sup> It is a single question with an answer that can range on a 5-point Likert scale, from poor to excellent. For this study, this variable was dichotomised into poor or good health. It was used as a dichotomous variable in all the analyses.

*The social measures.* Living alone or not was dichotomised into either yes or no. A person who was living in an institution/home, with family or with their spouse was considered as living with someone. It was used as a binary variable in all analyses.

Network size is based on a set of questions asking to name persons who are important to the respondent and with whom the respondent has regular contact. The questions specifically asked about the domains ranging from the household to organisations so that a person would not be forgotten.<sup>47</sup> The total number of persons named was dichotomised from the original question, with a cut-off point at the mean for the chi-square test. It was used as a continuous variable in the predictor model.

Questions about instrumental and emotional support received in the last year were used as measures of support. Instrumental support is built on three questions enquiring about the subject’s amount of (if any) help received with chores in and around the house such as preparing meals, cleaning the house and transportation. Emotional support is built on three questions pertaining to advice or mental support received. A total composite score between 0 and 36 is possible, based on a maximum of nine possible relationships in one’s network, derived from a previous question in the interviews.<sup>48</sup> Both instrumental and emotional support were dichotomised at their mean for descriptive purposes. They were entered as continuous variables in the predictor model.

*The demographic measures.* Age was used as a binary variable in the chi-square test, with the cut-off point at the mean age (76 years old). In the predictor model, age was entered as a continuous variable.

Education level was dichotomised into lower and higher educated (secondary school and above) for the chi-square test. It was entered as a continuous variable in the predictor model, so as to obtain more range (low, middle and high).

Living rural or urban was indicated by the number of addresses per square kilometre. The authors dichotomised this variable into those living up to 1000 addresses/km<sup>2</sup> as living rural and those who were living more than 1000 addresses/km<sup>2</sup> as living urban. It was used as a dichotomous variable in the predictor model.

## Statistical analyses

The data were first examined through univariate analyses, for a descriptive analysis was done to get an overview of the data. This was then followed by chi-square tests to explore how each predictor was associated with Internet use per wave.

Cox regression analysis was selected as a method to account for the time until either starting or stopping to use the Internet. It provides a hazard function, which gives a conditional probability of the event (starting or stopping to use the Internet) for each time interval.

Each variable was first tested for the proportional hazard assumption. Five Cox regression analyses were run for the starters and five Cox regressions for the stoppers. Each time, the first four incorporate psychological, health, social and demographic variables separately. These four models preliminarily explored the predictors using a liberal significance level of  $p < 0.20$  so as not to miss important predictors.<sup>49</sup> A fifth regression model was then run with the significant variables from each previous regression for the starters and stoppers, testing for final significant predictors using  $p < 0.05$ .

## Results

Table 1 describes each variable per wave including all participants. Throughout the 10 years there is an increase in Internet use, from 11 per cent in 2002 to 38.5 per cent in 2012.

The chi-square tests of Internet users with each predictor indicated different associations. Within the psychological predictors, self-efficacy and sense of mastery were associated with Internet use during the whole period, whereas self-esteem was only significantly associated with Internet use in the second wave T2 (2005/2006).

Within the health predictors, SRH was significantly associated with Internet use only in 2001/2002. Vision was associated with Internet use throughout three of the four waves; cognition was associated with Internet use throughout the 10 years. The social variables indicated an association with Internet use with those living with someone and having a larger network size. Instrumental and emotional support did not show any significant associations with Internet use. Age, gender and education were all strongly related to Internet use throughout the 10 years. Rural and urban living were also associated with Internet use.

Table 2 indicates the number of people who started and stopped to use the Internet. There were fewer respondents who stopped (3.1%) compared to those who started (11.6%) to use the Internet. From those who did not use the Internet in 2002 (89%), 6.1 per cent began in 2006, 2.9 per cent in 2009 and 2.6 per cent in 2012. From those who were using the Internet in 2002 (11%), 0.8 per cent stopped in 2006, 1.6 per cent in 2009 and 0.7 per cent in 2012.

Table 3 indicates the Cox regression models for starting to use the Internet. The first model explores the psychological predictors: sense of mastery, self-efficacy and self-esteem with starting to use the Internet. All three were significant predictors in starting to use the Internet. Sense of mastery (hazard ratio (HR): 1.095; confidence interval (CI) 95%: 1.031–1.163) and self-efficacy (HR: 1.057; CI 95%: 1.020–1.095) were both predictive of starting to use the Internet. A lower self-esteem negatively influenced starting to use the Internet (HR: 0.923; CI 95%: 0.851–1.001).

Within the health model, cognition was the strongest predictor, as seen by the improvement of the model by including it with the Wald statistic of 40.416. The HR was more than 1, indicating the stronger the person's cognitive functioning, the more a person would start to use the Internet (HR: 1.382; CI 95%: 1.247–1.532). Good vision was significant in predicting whether a person would start to use the Internet or not (HR: 2.528; CI 95%: 1.244–4.098). However, the range of the CI is large, suggesting the effect should be tested further.



**Table 3.** Cox regressions starting Internet use between 2002 and 2012 (65 years and older).

	HR	CI 95%	Wald statistic
Psychological model			
Sense of mastery	1.095**	1.031–1.163	8.738
Self-efficacy	1.057**	1.020–1.095	9.393
Self-esteem	0.923†	0.851–1.001	3.772
Health model			
Cognition	1.382***	1.247–1.532	37.961
Vision	2.528**	1.244–4.098	7.179
Self-perceived health	0.923	0.767–1.109	0.733
Arthritis	1.015	0.845–1.219	0.025
Social model			
Network size	1.006	0.986–1.026	0.328
Emotional support	1.019	0.995–1.044	2.397
Instrumental support	0.970*	0.942–0.999	4.122
Living alone/not	0.370***	0.254–0.540	26.635
Demographic model			
Sex	1.090	0.789–1.506	0.273
Age	0.876***	0.850–0.902	74.845
Education	1.755***	1.425–2.162	27.914
Rural/urban living	0.843	0.606–1.172	1.003
Age	0.899***	0.870–0.928	41.390
Education	1.607***	1.309–1.974	20.505
Cognition	1.195***	1.078–1.324	11.499
Living alone/not	0.576**	0.393–0.845	7.984

HR: hazard ratio; CI: confidence interval.

Combined model: age, education, cognition, living alone, self-efficacy, sense of mastery, vision, instrumental support and self-esteem.

Significant levels at \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; † $p < 0.20$ .

In the social model, instrumental support (having someone help around the house, for example) and living with someone were significant predictors in Internet starting. They both were, however, negatively influencing starting use, where the less instrumental support the older adult had (HR: 0.970; CI 95%: 0.942–0.999), the more likely they would start to use the Internet. If someone lived alone (HR: 0.370; CI 95%: 0.254–0.540), it was more likely that they would start to use the internet. The Wald statistic is the largest for the living alone variable with  $W = 26.635$ .

In the demographic model, age and education were significant predictors in starting to use the Internet; age was the strongest contributor in the model with a Wald statistic of 74.845. The HR indicated that the older the age, the less likely the people are to start using the Internet (HR: 0.876; CI 95%: 0.850–0.902). Higher education indicated an increase in likelihood to start using the Internet (HR: 1.755; CI 95%: 1.425–2.162).

Combining the models, the significant predictors from the four previous regressions were incorporated into one forward Cox regression, by strongest predictor first: age, education, cognition,

**Table 4.** Cox regressions stopping Internet use between 2002 and 2012 (65 years and older).

	HR	CI 95%	Wald statistic
Psychological model			
Sense of mastery	1.177**	1.045–1.329	6.988
Self-efficacy	1.009	0.943–1.080	0.069
Self-esteem	0.947	0.802–1.093	0.560
Health model			
Cognition	1.290**	1.077–1.546	7.629
Vision	3.811†	0.910–15.957	3.352
Self-perceived health	1.264	0.907–1.763	1.912
Arthritis	0.754	0.496–1.145	1.758
Social model			
Network size	0.987	0.944–1.031	0.347
Emotional support	0.999	0.952–1.047	0.003
Instrumental support	0.979	0.922–1.039	0.510
Living alone/not	0.336**	0.159–0.713	8.086
Demographic model			
Sex	1.445	0.758–2.757	1.249
Age	0.921***	0.877–0.968	10.508
Education	1.783**	1.203–2.642	8.308
Rural/urban living	0.567†	0.282–1.139	2.542
Age	0.933*	0.885–0.984	6.526
Sense of mastery	1.118*	1.011–1.236	4.707
Education	1.867**	1.274–2.735	10.248

HR: hazard ratio; CI: confidence interval.

Combined model (age, cognition, living alone, sense of mastery, education, vision and living rural/urban).

Significant levels at \* $p < 0.05$ ; \*\* $p < 0.01$ ; \*\*\* $p < 0.001$ ; † $p < 0.20$ .

living alone/not, self-efficacy, sense of mastery, vision, instrumental support and self-esteem. The first four predictors were significant when combined into one model. The higher the age, the less likely an older person will start to use the Internet (HR: 0.899; CI 95%: 0.870–0.928). The higher the education, the more likely a person will start to use the Internet (HR: 1.607; CI 95%: 1.309–1.974). Good cognitive functioning (HR: 1.195; CI 95%: 1.078–1.324) and living alone (HR: 0.576; CI 95%: 0.393–0.845) also increase the likelihood of starting to use the Internet.

In Table 4, the Cox regression models are shown for those who stopped using the Internet. The psychological model indicated that a higher sense of mastery predicted stopping of Internet use (HR: 1.177; CI 95%: 1.045–1.329). The health model showed that those with better cognition (HR: 1.290; CI 95%: 1.077–1.546) and bad vision (HR: 3.811; CI 95%: 0.910–15.957) were more likely to stop using the Internet. Although there was a four times higher likelihood that someone would stop using the Internet due to bad vision, the CI is large, indicating a wide spread and more information is needed to fully judge vision's impact.

Within the social model, living alone was predictive of stopping to use the Internet (HR: 0.336; CI 95%: 0.159–0.713). In the demographic model, age, education and living rural or urban were

predictive of whether someone would stop using the Internet. The older adults who were younger in age were more likely to stop using the Internet (HR: 0.921; CI 95%: 0.877–0.968), and those who were higher educated (HR: 1.783; CI 95%: 1.203–2.642) were more likely to stop using the Internet. And finally those who were living rural were more likely to stop using the Internet (HR: 0.561; CI 95%: 0.282–1.139).

Combining the highest with lowest Wald statistic, a forward Cox regression was done with age, cognition, living alone/not, sense of mastery and education. Finally, those younger in age (HR: 0.933; CI 95%: 0.885–0.984), having a higher sense of mastery (HR: 1.118; CI 95%: 1.011–1.236) and those who were higher educated (HR: 1.867; CI 95%: 1.274–2.735) were the ones more likely to stop using the Internet.

## Discussion

This study aimed at investigating predictors in starting and stopping Internet use by older adults. The findings indicated that between the years 2002 and 2012, there were 11.6 per cent older adults starting to use the Internet, compared to 3.1 per cent who stopped using the Internet. According to European statistics, 59.9 per cent of 65- to 74-year olds were using the Internet in 2012.<sup>50</sup> This indicates that there is a slow uptake of Internet use among older people, and this coincides with the percentages in this study, which are low considering the ease of access and spread of the Internet since 2002.

Combining the psychological, health, social and demographic predictors into one model, for those starting to use the Internet, younger in age, higher educated, better cognition and living alone were the most predictive factors over time. For the older adults who were already using the Internet, being younger, having a higher sense of mastery and higher education were all indicative of stopping to use the Internet.

Age and education still seem to be predictors in older adults' starting and stopping Internet use. The importance of socio-demographic variables in older adults' Internet adoption has recently been reported in a study on the technology acceptance theories for understanding the Internet adoption by older adults.<sup>51</sup> The research demonstrated how extending the theories with the demographic variables, age, gender, income and ethnicity gave stronger predicting models. This study confirms that age is a predictor to include when considering older adults' acceptance (starting use) but also rejection (stopping use) of technology. In each case, it was the younger older adults who were starting and stopping use, which could be that they were more exposed to the Internet compared to the oldest old.

Education was also a significant predictor of Internet starting and stopping. Those who were higher educated were more likely to start and also to stop using the Internet. Those who were already using the Internet usually have been noted to be higher educated;<sup>23</sup> other studies claim older adults who are less educated are often late adopters of the Internet.<sup>52</sup> This is sometimes due to the fact that lower educated have lower paid jobs in which they do not routinely use computers and which do not provide them with the money to pay for a computer connected to/or an Internet subscription. It follows, therefore, from this study that those who are using the Internet tend to be more educated and will be the ones therefore to stop use first.

The impact of health decline on a person has been shown to be a significant factor with new technology adoption. In this study, specifically good cognitive functioning and vision were significantly influencing starting to use the Internet. This corroborates with previous studies indicating that a decline in cognition, vision and motor skills were obstacles to computer use.<sup>53,54</sup> When cognition and vision were included in the multivariate model, only cognition remained as a significant

predictor for starting to use the Internet. This suggests that finding ways to maintain good cognitive functioning in the later years would be of value.

From the social model, instrumental support and living alone were predictive of starting to use the Internet. When combined into the multivariate model, only living alone impacted starting. It was assumed that having someone close would make it easier to go online because of possible immediate support. Studies found that being in an active group or surrounding has the potential to involve an older person more with information and communications technology (ICT).<sup>55</sup> Any family member can play a critical role in motivating and teaching older adults the use of the Internet.<sup>56</sup> However, our findings suggest that living alone may create a need to go online socially or to be able to handle independent living. Hence, the fact that there are more people starting Internet use who live alone can be seen as a positive finding.

The three psychological variables were influential when investigated in their own model with starting to use the Internet. Scoring higher on sense of mastery, self-esteem and self-efficacy together indicated more Internet starting. This confirms partly what has been found in other studies. Psychological variables are strong predictors in engaging in learning to use computers and Internet, according to a study on computer classes by older adults.<sup>57</sup> More specifically, higher self-efficacy has been observed as a marker for an older adult to bridge the digital divide.<sup>58</sup> An indication of wanting to engage and learn is important when considering starting to use the Internet. When combined with other variables in our study, however, no psychological predictor influenced whether someone would start using the Internet.

For the older adults who were already using the Internet, stopping use was significantly related to sense of mastery, as were age and education. Sense of mastery is an indicator of the perception of influence over one's environment and life. There is a level of comfort in being in control.<sup>24</sup> If an older adult feels less in control, they are more likely to stop using the Internet. With regard to intervention programmes, it would be useful to know what triggers a decline in sense of mastery for an older adult. One study indicated that a high sense of mastery had a strong impact on maintaining better health in older adults over time, but also that mastery declined with worse health.<sup>59</sup> If health is a reason for a decline in mastery, a focus should be on establishing how the Internet might provide support so as to counteract a decline in sense of mastery. Conversely, studies have indicated that not knowing how to use the Internet well can be stressor in itself for an older adult,<sup>10,60</sup> which could trigger a decline in mastery.

## Implications

There are ways to push and pull<sup>61</sup> older adults into using the Internet. For example, the Dutch mandatory health insurance is provided by insurance companies who now mainly give information and maintain contact with their clients online. Similarly, banks and governmental services provide most information online, where using their services offline requires an extra fee. The more an older adult 'has to' go online access to the Internet will become important in so far that it should be made easy. This would be an enticing way to pull a new older adult user towards the Internet.

Our findings highlight that there are still people who are just starting to use the Internet but also that there are some who are stopping. Many variables coincide with previous research, such as age, which has been shown to influence whether an older person will be using the Internet.<sup>7,18</sup> In this study, it is also a very significant predictor in both starting and stopping. This could mean that there will always be a digital gap, which is important to consider as all services in society are becoming digitalised. It is still those who are higher in age, lower educated and with worse cognition who are not starting to use the Internet. These predictors can also translate to other technologies. In a recent review, 10 factors were identified in technology adoption of older adults.<sup>62</sup> They suggested to

increase intuitiveness in usage and letting the older adult feel the affective benefits of the technology, which would be helpful for the late adopters of the Internet. Furthermore, it is important to tackle cognitive decline, as with increasing age learning becomes difficult due to memory retrieval problems. Interventions, learning and teaching techniques can help where age-specific designed learning courses may be needed. Living in communities/homes and having low mastery are also factors, which can be supported. For example, a recent study suggested that it is useful to maintain Internet usage as one can forget or lose interest in usage.<sup>63</sup> Many older adults are unaware of the advantages that the Internet can provide, therefore tools to facilitate use and technical support may be important to get and to keep older adults online.

## Future research and limitations

Studies have pointed out that there are older adults who are not adopting to new ICT. Older adults may have alternative solutions, for example, having younger family members taking care of online administration for their older family member, or due to generational differences they do not see the point in certain technologies.<sup>63</sup> Future research should include data on these conditions in addition to the predictive factors that emerged from our study.

It would also be valuable to study the people who stopped using the Internet also through qualitative designs. Perhaps some are afraid of scams and non-credible online sources. Conducting a study on what exactly an older adult was using the Internet for may be a more solid ground to understand why someone would stop to use the Internet. Exploring the user's experience and usability of the Internet can give an indication where the Internet did not achieve a satisfactory level or reach the older adults' expectations (if there were any to begin with).

There are a few limitations in this study. First, change in the predictors was not investigated over time. Knowing at what cognitive score, for example, someone starts or stops to use the Internet could provide valuable information in adapting virtual environments for older people.

Second, due to the small number of older adults stopping use, the results are more indicative than definitive. There were only 41 people who stopped using the Internet throughout 2002–2012; other predictors may also be influential in a larger sample.

Finally, the time frame is also a limitation. New devices, appearing mainly since 2010 (such as tablet computers or smart phones), could indicate more starting as they are easier to move and have around and have no wires. The questions in this study were only based on computer Internet use. Alternatively, new devices can also create more stopping, if the technology is not straightforward for an older person.

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