Information and communication technology used by people with lower limb loss in Slovenia

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World demography is changing as the population ages and there are more people with disabilities having problems to stay independently at home. Innovative technologies could help extend the independence of older people living at home. As part of a collaborative project, we investigated ownership and use of information and communication technologies (ICT) among older people with lower limb loss (LLL) using questionnaires and retrospective analysis. Our aim was to analyse factors associated with ICT use among people with LLL. We identified age as the main factor that limits ownership and use of ICT among older people with LLL in Slovenia. Cause of amputation also appears to be relevant, whereby those who had amputation because of peripheral vascular disease are more likely to use a personal or tablet computer, social networks, messaging apps, email and internet than those who had amputation because of diabetes. In addition, those living in the suburbs are more likely to use a health monitoring device than those living in the countryside. *International Journal of Rehabilitation Research* XXX: 000–000 Copyright © 2020 The Author(s). Published by Wolters Kluwer Health, Inc.

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Introduction

World demography is changing as the population ages and there are more people with disabilities (World Health Organization, 2011; GBD 2015 Risk Factors Collaborators, 2016). Those people have limitations of their functioning, so it is a challenge to enable them to live at home as independently and for as long as possible.

Current studies show that information and communication technology (ICT) and smart-home technology can improve the quality of life of older people or assist them to live at home (Morris *et al*., 2013; Siegel and Dorner, 2017). ICT, smart-home technologies and the internet of things (IoT) are becoming an important and ever-growing part of eHealth which includes hardware, computing devices, physical objects and software that interact with each other and with users (Morris *et al*., 2013; Farahani *et al*., 2018). ICT is the basis for IoT, which is about extending the power of the internet beyond computers and smartphones to a whole range of other things, processes and environments, that is, taking all the things in the world and connecting them to the internet. A systematic review and meta-analysis show that the use of a tablet by older people in a clinical environment is associated with high satisfaction (Ramprasad *et al*., 2019). Regarding IoT and the elderly, Park *et al*. (2017) described the development of an IoT proactive health-monitoring system for older people that enables emergency medical assistance in case of stroke or similar cardiovascular diseases, while Chen *et al*. (2018) talk about IoT system for early detection of dementia. There are many other studies on IoT and ICT for older people (Burger and Rudel, 2016), but to our knowledge none focused on older people with lower limb loss (LLL) living independently at home.

As a part of research within the European Union research and innovation programme Horizon 2020, project SAAM – Supporting Active Ageing through Multimodal coaching, we were interested in the state-of-art (ICT and IoT) and openness to new technologies in the population of older people with LLL. The aim of SAAM is, as the name suggests, supporting older people to age actively and stay independently at their homes as long as possible with the help of ICT, IoT and social circles.

Our target group was older people with LLL. The aim of our study was to identify how open those people are to ICT and new technologies, and whether that has any association with comorbidities, level and cause of amputation, as well as basic demographic characteristics. At the same time, the results of the study are meant to be the starting point for developing user-centred designed system with ambient and wearable sensors that would be affordable for older people and support them in their independence in living at home with effective coaching by leveraging the user's social support networks.

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Methods

Data collection and participants

Questionnaires and retrospective analysis from medical records were used to collect the data among people with LLL who were admitted for rehabilitation after LLL at the University Rehabilitation Institute (URI) in Ljubljana in 2017. The majority of data were acquired through a questionnaire prepared for the first phase of the SAAM project (SAAM Project, 2019). It comprises 27 questions divided into two parts: demographics part (age, sex, level of education, area of living and number of people in the household) and part with questions about ICT (television, radio, landline phone, mobile phone, smartphone, tablet, computer, smartwatch, etc.) ownership and use, satisfaction with social life and comorbidities. Additional information regarding health condition (level of amputation, cause of amputation, comorbidities, phantom limb pain and major hearing/vision problems) was added with a retrospective audit of medical records for the people who sent back the filled-in questionnaires and signed informed consent. We sent out packages containing the questionnaire, an accompanying letter, an information sheet, an informed consent form and envelope with a stamp and our address on it (to send back filled-in questionnaires and informed consents) by regular mail to all (296 in total) people who were admitted for rehabilitation with LLL at the URI in 2017.

The study was approved by the local medical ethics committee and by the National Medical Ethics Committee of the Republic of Slovenia (motion no. 0120-56/2018/9). All the participants gave informed consent to participate in the study.

Data analysis

Descriptive statistics were used to describe the sample characteristics. Multiple logistic regression models followed by univariate statistical tests were used to assess the association of health and demographic characteristics with ICT ownership and use, whereby we had to simplify the dataset in order to be able to gain meaningful insight:

(1) Amputation level and side were combined into three categories: (i) transtibial, (ii) transfemoral (including hip disarticulation) and (iii) bilateral (including bilateral transtibial, transfemoral and transtibial and bilateral transfemoral).
(2) Cause of amputation was categorised as diabetes mellitus, peripheral vascular disease (PVD) or other.
(3) The answers to the question of the SAAM questionnaire that was composed of many subquestions were combined into a single technology acceptance rating (on the 1–5 scales; the average of the individual items was used because not all participants answered all the items).
(4) Within each ICT type, the answers to the extensive questions were combined into four ordered categories (does not know it, does not have it, has it but uses it rarely, has it and uses it regularly).
(5) For the purpose of regression modelling, the answers on ICT use were further combined into two categories (in two ways – either the first three categories were combined or the first two vs. the last two categories).

The association of each version of the dichotomised response for each ICT type with the participants' characteristics was tested using logistic regression with Firth's bias correction (because of the large number of predictors as compared to the sample size and to avoid the problem of complete separation; Firth, 1993; Heinze and Schemper, 2001). Age, cause of amputation, residence, technology acceptance rating, number of comorbidities, level of amputation, level of education and sex were entered as predictors into all regression models. The predictors indicated by the logistic regression models to be associated with the responses were afterwards univariately tested for association with the four-category version of the responses using Fisher's exact test or analysis of variance (for categorical or numerical predictors, respectively) to clarify those associations. Data analyses were performed using Microsoft Excel 2010 (Microsoft Corps, Redmond, USA, 2010) and IBM SPSS Statistics 23 (IBM Corp., Armonk, USA, 2015).

Results

Forty participants (14 %) returned a legible signed informed consent and completely filled-in the questionnaire (5 women, 35 men). The demographic characteristics of the responders are presented in Table 1.

Health condition

Levels of amputation are presented in Table 2. The cause of LLL was diabetes mellitus in 60% of the responders,

Table 1 Demographic characteristics of the people who sent back filled-in questionnaires

Characteristic	Descriptive statistics or frequencies	
Response rate	40/296 (14%)	
Sex	Female	5 (13%)
	Male	35 (87%)
Age (years)	Range 44–94, mean 70, median 70	
Education	Elementary school	7 (18%)
	Vocational or high school	28 (70%)
	College degree or more	5 (13%)
Area of living	Rural	22 (55%)
	Suburban	12 (30%)
	City	6 (15%)
Household size	1 Person	8 (20%)
	2 Persons	22 (55%)
	3 or more	10 (25%)

Table 2 The level of amputation of the responders

Level	Frequency (%)
Transfemoral	20 (50%)
Transtibial	12 (30%)
Bilateral transtibial	3 (8%)
Transfemoral and transtibial	2 (5%)
Bilateral transfemoral	1 (3%)
Hip disarticulation	1 (3%)

PVD in 32%, while other causes accounted for the remaining 8%. The responders had from one to four comorbidities (median and mode 3). The most common were chronic heart diseases (92%); heart failure and lower limb injury were present in 20%; 18% survived myocardial infarction; 10% had chronic renal failure, rheumatic diseases and upper limb impairments; 8% had stroke, chronic obstructive pulmonary disease and other pulmonary diseases and other comorbidities were present in 68% of the patients. Almost half of the responders experienced phantom limb pain (48%). Only 10% of the responders had major problems with vision and 8% with hearing.

Technology use

Eleven responders (28%) do not have a landline phone; however, all but one of them have and regularly use a mobile phone. Radio and television are present in all but one responder's home (that person is 76 years old) and are used daily. Only one responder owns a smartwatch (aged 57 years, rating the technology preference with an average of 4.9 points out of 5), the others do not have it or do not know it. Health monitors (e.g. a pressure monitor or a blood sugar monitor) are regularly used by half of the participants (20 out of 40), and their use is not statistically significantly associated with the cause of amputation (Fisher's exact test: $P = 0.254$). An activity tracker is owned and regularly used by only three participants (52, 57 and 71 years old, respectively; their causes of amputation differ; the 57-year-old is the technology-savvy only participant with a smartwatch).

Regression models and univariate tests

The results of the regression models and subsequent univariate tests are summarised in Table 3. Landline telephone, television and radio were not analysed because practically every participant has and uses them (or mobile phone instead of in case of landline telephone). Smartwatch and activity tracker were not analysed because too few participants have and use them to enable meaningful inference.

Discussion

We investigated possible associations of ICT use among older people with LLL with various chronic diseases and demographic characteristics. The most evident and expected finding from our study is that age is strongly associated with the use of ICT – the older the participant with LLL, the less they are likely to use ICT. In case of the internet, less advanced age is especially relevant for regular use. The observation that age is probably the main factor that limits ownership and use of ICT among older people with LLL in Slovenia coincides with published research that studied willingness and use of ICT by people with low back pain (Niknam *et al.*, 2019).

The next most relevant factor appears to be the cause of amputation. Those who had amputation due to PVD are more likely to have and use a personal computer or a tablet computer than those who had amputation due to diabetes mellitus. The same goes for the use (at least occasional, if not regular) of social networks, instant messaging or email, and for regular use of the internet. We presumed that people who have been amputated due to diabetes would use a health monitor for the blood sugar level, but our hypothesis was not confirmed. The percentage of diabetes mellitus as the cause for LLL among the responders in our study was similar to other studies in Europe (Fosse *et al.*, 2009; Claessen *et al.*, 2018), as well as in Australia (Lazzarini *et al.*, 2011).

Table 3 Summary of regression models and subsequent univariate tests (see Methods section for details)

		Firth logistic regression models				Univariate tests
		Regular use vs. other		Has vs. does not have or know		Means or proportions are listed for the four categories in the following order: does not know it, does not have it, has it but uses it rarely, has it and uses it regularly
ICT	Most likely associated predictors	*b* (95% CI)	*P*	*b* (95% CI)	*P*	
Basic mobile or smartphone	None	Not applicable		Not applicable		Not performed
Personal computer or tablet computer	Age	–0.17 (–0.54 to –0.04)	0.009	–0.12 (–0.30 to 0.01)	0.073	$P = 0.004$; means 78, 75, 73, 64 years
	Technology acceptance rating	1.09 (0.05 to 2.69)	0.038	1.30 (0.28 to 3.09)	0.010	$P = 0.003$; means 2.7, 2.7, 3.6, 3.8 rating points
	Cause of amputation (PVD vs. diabetes mellitus)	1.54 (–0.47 to 6.25)	0.141	2.02 (0.05 to 5.13)	0.044	$P = 0.054$; proportions 0, 38, 8, 54 vs. 8, 54, 4, 33%
Health monitor	Age	–0.10 (–0.25 to 0.01)	0.092	–0.08 (–0.20 to 0.01)	0.086	$P = 0.036$; means 73, 77, 72, 66 years
	Residence (suburbs vs. countryside)	1.56 (–0.12 to 3.61)	0.070	1.58 (–0.07 to 3.55)	0.061	$P = 0.005$; proportions 0, 17, 0, 83 vs. 41, 9, 9, 41%
Social networks, messaging and email	Age	–0.14 (–0.59 to 0.01)	0.077	–0.13 (–1.19 to 0.00)	0.054	$P = 0.008$; means 75, 74, 63, 64 years
	Cause of amputation (PVD vs. diabetes mellitus)	2.36 (–0.19 to 9.37)	0.073	2.59 (0.43 to 10.61)	0.016	$P = 0.036$; proportions 23, 23, 15, 38 vs. 25, 54, 0, 21%
Internet	Age	–0.14 (–0.59 to 0.01)	0.077	–0.06 (–0.18 to 0.05)	0.286	$P = 0.032$; means 75, 73, 69, 64 years
	Cause of amputation (PVD vs. diabetes mellitus)	2.36 (–0.19, 9.37)	0.073	1.08 (–0.53 to 2.89)	0.188	$P = 0.064$; proportions 23, 30, 8, 38 vs. 25, 46, 8, 21%

ICT, information and communication technologies; PVD, peripheral vascular disease.

Residence turned out to be clearly independently associated only with the use of a health monitor, whereby those living in the suburbs are more likely to have and use it than those living in the countryside. Finally, a generally positive attitude towards technology appears to be an independent predictor only for the ownership of a personal or tablet computer.

In addition to relatively small sample size (in the light of the multitude and variety of potentially relevant personal characteristics), possible nonresponse bias is the main limitation of our study. With only a 14% response rate, it is quite possible that ICT use and associated characteristics among the nonresponders differ from the responders. In addition, some parts of the questionnaire, especially those regarding the ICT, may have been misunderstood or poorly understood by some of the responders, as we observed during the later stages of the project when we carried out qualitative research with in-depth interviews with some of the participants.

Further research is needed to obtain a more precise picture of ICT use among people with LLL. Such research should preferably be carried out via personal interviews. Nevertheless, we can probably conclude that technology use among people with LLL decreases with age. Eventually, the present middle-aged population that uses ICT more regularly will be more willing to use new and innovative technologies as they age.

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