

Can we manage frailty at individual level by the use of information and communication technologies: a narrative literature review

Ali lahko s pomočjo informacijsko-komunikacijskih tehnologij obvladujemo krhkost na ravni posameznika: narativni pregled literature

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Abstract

An increase in age-related disability and dependence is an almost inevitable consequence of population ageing, whereas frailty seems to be highly prevalent among older adults with prevalence ranging from 5 % to more than 45 %. Among the potential ways to face the challenges of ageing society are healthcare services supported by the use of information and communication technologies. The aim of this research was to define the information and communication technologies used to support the management of frailty, its effects and related challenges within joint action Advantage. A narrative literature review of peer-reviewed literature, using PubMed, Cochrane, Embase, Cinahl and UpToDate databases was carried out. The search resulted in a total of 124634 articles. After excluding duplicates and taking into account inclusion and exclusion criteria, 33 sources remained for analysis. The results indicate multidimensional usage of information and communication technologies and show that a wide range of potentially beneficial information and communication technology solutions have been developed, covering prevention, screening, diagnosis, treatment and monitoring to enable older adults to remain independent at home, support caregivers, facilitate remote monitoring and self-management, provide decision support, improve information sharing and coordination of services, support daily activities etc. Many information and communication technologies have a potential to prevent and manage frailty, especially in the domain of physical activity and exercise, social resources and psychological state, falls prevention, support to daily activities and overall well-being. However, there is a lack of evidence on the outcomes of information and communication technologies' use related to older adults, and their adoption and implementation seem to remain problematic as well. Therefore, strategic approach should be used to support further research as well as to address and foster implementation and (wider) adoption of health-related information and communication technologies.

Izvleček

Porast s starostjo povezane oslabelosti in odvisnosti velja za skoraj neizogibno posledico demografskega staranja, medtem ko krhkost velja za zelo prevalentno stanje med starejšimi odraslimi s prevalenco od 5 % do več kot 45 %. Eden možnih načinov soočanja z izzivi starajoče se družbe so zdravstvene storitve, podprte z uporabo informacijsko-komunikacijskih tehnologij. Namen raziskave je bil opredeliti informacijsko-komunikacijske tehnologije, ki služijo kot podpora obvladovanju krhkosti, njihove učinke in s tem povezane izzive v okviru projekta skupnega ukrepanja *Advantage*. Opravili smo t. i. narativni pregled recenziranih znanstvenih prispevkov z uporabo podatkovnih baz PubMed, Cochrane, Embase, Cinahl in UpToDate. Skupno število člankov v iskalnih rezultatih je bilo 124.634. Po izključitvi duplikatov in po upoštevanju vključitvenih in

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Key words:

ageing; older adults; information-communication technologies; ICT; frailty management; Joint Action Advantage

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izključitvenih kriterijev je bilo v analizo vključenih 33 prispevkov. Rezultati kažejo na večdimenzionalno uporabo informacijsko-komunikacijskih tehnologij. Kažejo tudi, da je bila razvita široka paleta potencialno koristnih tehnoloških rešitev za preprečevanje, presejanje, diagnosticiranje, zdravljenje in spremljanje, kar starejšim ljudem lahko omogoča, da ostanejo neodvisni v svojem domačem okolju, služi kot podpora skrbnikom, omogoča oddaljeni nadzor in samoobvladovanje, zagotavlja podporo pri odločanju, izboljša izmenjavo informacij in usklajevanje storitev, podpira dnevno dejavnost itd. Številne informacijsko-komunikacijske tehnologije imajo potencial za preprečevanje in obvladovanje krhkosti, zlasti na področju telesne dejavnosti in gibanja, socialnih virov in duševnega stanja, preprečevanja padcev, podpore vsakodnevnih dejavnosti in splošnega dobrega počutja. Vendar primanjkuje dokazov o izidih uporabe informacijsko-komunikacijskih tehnologij, povezanih s starejšimi odraslimi. Prav tako njihovo sprejetje in uporaba ostajata problematična. Zato potrebujemo strateški pristop za podporo nadaljnjemu raziskovanju, kot tudi za spodbujanje uvajanja ter (širšega) sprejetja z zdravjem povezanih informacijsko-komunikacijskih tehnologij.

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1 Introduction

Population ageing is one of the greatest challenges we are currently facing. The proportion as well as an absolute number of older adults in populations around the world is rapidly growing due to an increased life expectancy and decreased fertility rates. By 2060 the percentage of European Union citizens aged over 65 is expected to increase from 18–28 % and the percentage of people aged over 80 is predicted to more than double (5–12 %) (1). Therefore, an increase in age-related disability and dependence is almost an inevitable consequence of population ageing (2), which will have an impact on the affected individuals' well-being, as well on the healthcare systems' sustainability (3). Frailty, which can be defined as "a progressive age-related decline in physiological systems that results in decreased reserves of intrinsic capacity, which confers extreme vulnerability to stressors and increases the risk of a range of adverse health outcomes" (1) is highly prevalent among older adults. According to a recent systematic review, the preva-

lence of frailty ranges from 5 % to more than 45 % depending on the definition and age group (4). Despite that the prevalence of frailty seems to increase with age (5), this health condition is not an inevitable consequence of ageing, while it can be identified, prevented or its onset can be delayed and it is potentially reversible, whereas early and appropriate interventions play an important role (6). Therefore, there is a strong need to reshape current healthcare systems by implementing a new conceptual framework in order to better address and tackle this public health issue. Namely, the majority of existing healthcare services are still traditional, i.e. symptom-oriented and fragmented, while growing evidence suggests that person-centered and integrated care with focus on prevention, patient empowerment and online services should be adopted (1). Among the potential interests in facing the challenges that come with the ageing society are healthcare services supported by the use of information and communication

technologies (hereinafter referred to as ICT) (7). ICT may play an essential role in “improving the functional ability of future generations, integrating and managing the care of older persons, assessing the impact of interventions and ensuring accountability for services provided” (1). ICT seem to be a tool for enhancing the transformation of health-care systems and services in order to deliver patient-centered and integrated care appropriate for older adults (1), and may play an important role in supporting complex care of older frail adults in terms of screening, assessment, monitoring, and follow-up (2). ICT are known to improve access to healthcare as well as their quality and safety (8), influence the wellbeing, quality of life and empowerment of older adults (9), and “are increasingly offering innovative avenues to boost the health and social participation of older adults” (8).

There has been a great progress made in the implementation of ICT in several healthcare services and a wide range of ICT-supported solutions are available for the care of older adults. However, there are still some open issues that limit ICT implementation into healthcare environment and daily practice, such as (poor) infrastructure (10), financial and technical challenges (11), as well as a variety of possible ICT tools without proven clinical effectiveness, and acceptance of the service (12). Limitations not only refer to low system usability and lack of personalization and flexibility (13), but also to an increased though still limited adoption of technology by older adults, many of whom doubt in possible ICT-related positive outcomes (14).

Despite a high number of research that focuses on different aspects of ICT in relation to older adults, there is not much research being done in the field of ICT and frailty, and specifically the man-

agement of frailty. Therefore, the aim of this paper is to identify the ICT used to support the management of frailty, its effects and related challenges through a narrative literature review of relevant literature for the last 15 years.

2 Methods

Descriptive research methodology was used to review peer-reviewed medical literature, and thus obtain data from various sources to provide holistic understanding of the research subject. Protocol for background information collection, which was prepared in the frame of Joint Action on Frailty Prevention (JA Advantage) co-funded by the third Health Programme of the European Union (2014–2020) for the whole project consortium, was used. Accordingly, the review was conducted between March and June 2017. The literature search was carried out between March and April 2017 in the PubMed, Cochrane, Embase, Cinahl and UpToDate databases using Google Chrome web browser by means of several combinations of selected key words in the English language and their synonyms, using Boolean operators AND or OR, searching in the title, key words and abstract (Table 2). A 15-year timeframe was taken into account and therefore articles published between 2002 and 2017 were included in the search/review.

Keywords were selected from a proposal of keywords prepared by the task leader and the working group focusing on ICT within JA Advantage Work Package 6 that deals with management of frailty at an individual level (Table 1). They proposed the keywords according to three components, namely frailty, ICT and function component, which is in line with the ICT task description in the project’s grant agreement and men-

tioned protocol for background information collection. The keywords selection followed the inclusion criteria that at least one key word for each component should be used for the literature search.

In addition to language (English) and publication time criteria, the main inclusion criteria were also peer-reviewed scientific journals, international documents, professional guidelines, standards and research studies performed in the EU, which comprehensively investigate and describe the management of frailty with the support of ICT. Additionally grey documents (e.g. government reports, non-governmental organizations' reports, theses, technical reports, white papers etc.) were included, so documents that are not published commercially or are otherwise hard to find were reviewed. Grey literature was identified by means of opportunistic search, meaning a targeted or focused search, based on the information that each partner in the project Consortium could give regarding their own country. The exclusion criteria were editorials, letters, interviews, posters and sources with no access to full text. Full texts were assessed for eligibility against the mentioned prespecified inclusion and exclusion criteria. Final selection was based on a consensus

made by the authors taking into account different levels of research evidence (15). Therefore, 9 review works, 13 qualitative works, 9 quantitative works and 2 mixed method works were included. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) protocol (16) was used for the search strategy and literature selection process as shown in Figure 1.

3 Results

The literature review was carried out according to the PRISMA protocol, whereas in the identification phase there were 124634 records identified through database searching, out of which 91 were selected. Additionally, 6 records were identified through other sources (e.g. grey literature). After duplicate removal, there were 56 records left to be included in the screening phase. Inclusion and exclusion criteria were taken into account and thus 19 records were excluded and 37 records included further on in the eligibility phase. After assessing all full-text records for eligibility, 4 of them were excluded. Thus, 33 articles/sources remained to be included in the analysis.

Several ICT solutions and health technologies have been identified to support older frail adults. ICT solutions present-

Table 1: Keywords proposed by the task leader and the working group focusing on ICT.

Components	Key words
Frailty	Elderly, Aged, Older adult, Older person, Geriatric, Frailty, Frail, Vulnerable, Disability, Functional decline, Function disability, Deterioration
ICT	Information and communication technology, ICT, Smartphone, E-health, Mobile health, Internet, Web application, Telemonitoring, Telecare, App
Function	Management, Detection, Screening, Support, Diagnosis, Prevention, Treatment and/or monitor frailty, Resilience, maintain function and activities, Empowerment, Self-care

Table 2: Search table.

	Keyword	No. of hits	Chosen hits	Repeated chosen hits	Final selection
PubMed	Elderly Mobile health	8499	14	12	5
	Geriatric Mobile health	492	4	4	1
	Frailty ICT	8	0	0	0
	Vulnerable App	166	2	2	1
	Disability App	128	2	2	1
	Information and communication technology Frail	27	0	0	0
	ICT Elderly	1010	7	7	3
	Mobile health Aged	8259	12	5	4
	E health Elderly	5486	8	2	2
	Older adult Tele care	251	4	2	1
	Screening Application	88755	8	4	4
	Support	2221	8	8	2
	ICT Older person	82	0	0	0
	Treatment Monitor frailty	55	0	0	0
Cochrane	Geriatric Mobile health	11	0	0	0
	Frail ICT	1	0	0	0
	E health	8211	14	4	2
	Tele care Function	23	0	0	0
	Elderly App	8	0	0	0

	Keyword	No. of hits	Chosen hits	Repeated chosen hits	Final selection
Embase	Frail ICT	0	0	0	0
	Functional decline App	788	10	4	1
	Elderly	71	0	0	0
Cinahl	Disability App	19	0	0	0
	Prevention ICT	27	0	0	0
UpToDate	Tele care Function	30	0	0	0
	Frail ICT	0	0	0	0
Other sources (e. g. grey documents)		6			6
Total		124634	91		33

ed in the selected reviewed documents can be categorised as synchronous communication technologies (videoconferencing, online and ICT platforms); asynchronous communication technologies (web portals with health-related information); sensor-based technologies (monitoring biosignals such as electrocardiogram, oxygen saturation, heart rate, blood pressure, motion detection, and monitoring and feedback on biosignals such as electromyography); exercise applications to actuate patients to exercise or rehabilitate (web-based exercise programme); and virtual reality and gaming technologies (interactive game applications) (7,12,17).

Results have shown that ICT offer a variety of opportunities; in terms of clinical purposes for which they can be used, technological tools that can be chosen,

and in the way of services' implementation into everyday practice (7). ICT solutions can be used to promote social interaction and communication, physical activity and exercise, better dietary habits, as well as support other daily life activities of older frail adults. There have been many technological solutions developed that enable older frail adults to stay independent in their homes, to support carers, facilitate remote monitoring and self-care/self-management, provide support with decision making and enhance data sharing and coordination of services. The following key themes were identified when reviewing the literature: quality of life improvement (1), physical activity and exercise (7,18-24), social interaction promotion (25,26), supportive ICT with special focus on motion detection and falls prevention, diagnosis

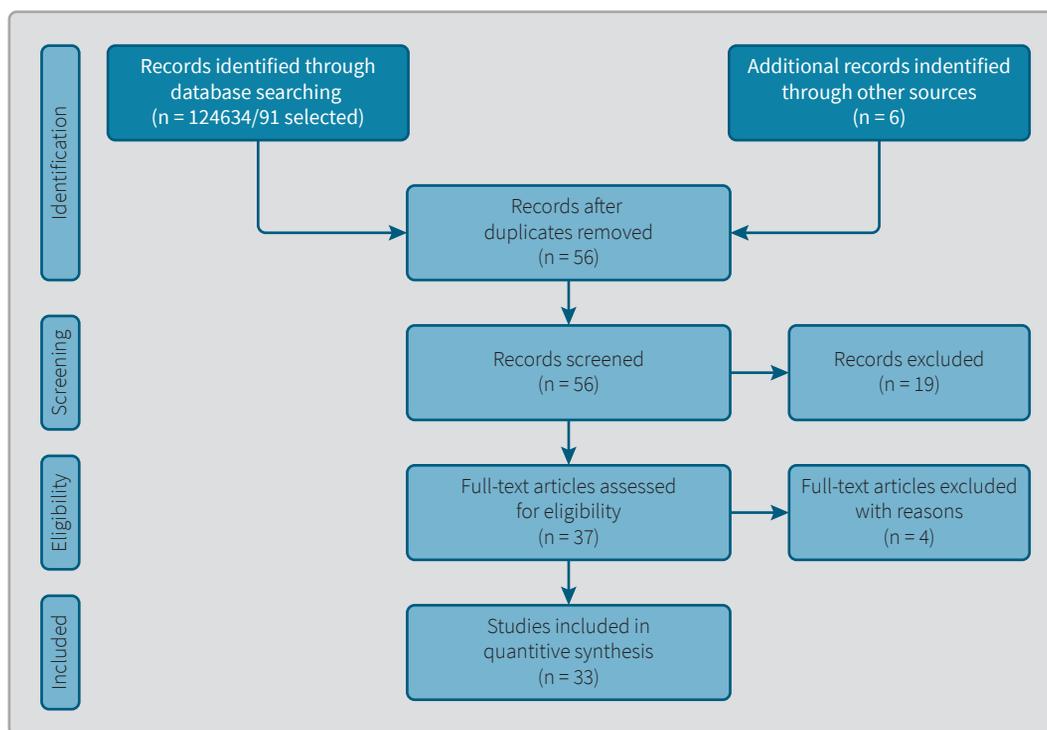


Figure 1: Flowchart of search strategy and literature selection process.

and assessment (9,13,27-34), telecare and telehealth services, support to healthcare systems (35-39), and ICT adoption and implementation (7,9,14,40,41).

4 Discussion

4.1 Quality of life improvement

The ultimate goal of using ICT in older frail adults is to improve their quality of life (1), which can be done in many ways and areas. In general, ICT are meant to ease living and increase productivity, which is important for older frail adults as well. However, ICT can offer much more to older frail adults. Not only because the older frail adults are more dependent on services provided by the others and ICT can improve

their accessibility, but also because ICT may help to reduce their frailty level by improving their independence and self-care. Being a self-caring person may improve the quality of life and increase positive self-esteem. On the other hand, health and social costs may be reduced. With respect to lifestyle enhancement, ICT may have direct profound effects on the quality of life in older frail adults. They may promote social interaction and communication, physical activity and exercise, nutrition, and support other activities and aspects of daily life. However, issues related to difficult introduction of ICT-supported services into the healthcare environment remain among the biggest obstacles, requiring the transformation of healthcare systems' business models that seem to be rigid, doctrinary and unchanged for decades.

4.2 Physical activity and exercise

While frailty mostly stems from reduced physical performance and regular physical activity (20), it is believed that exercise can improve physical performance and reduce physical frailty (18,19). Therefore, ICT promoting physical activity and exercise seem to be of special importance. Adherence and compliance to the exercise and to the use of ICT are also important issues, while independent adherence to preventive and rehabilitative programmes outside the clinic setting is low (21). ICT may help older frail adults to comply with the programme better. It is important since frequency of ICT use is related to clinical outcomes (7). Adherence to exercise may be improved by introducing ICT to promote group exercises, social networks, regular contacts with caregivers, involvement of relatives as caregivers etc.; gaming principles can be introduced as well to support the exercise (22). To use ICT in older frail adults, it should be introduced in everyday life well before impairments occurred (23). ICT should promote successful lifespan development at all ages and should not be orientated solely to impairment (24). To our knowledge, there is a lack of reports in the literature on the effectiveness of ICT use in physical exercise programmes in older frail adults. From our own experience, ICT can support group and individual exercise sessions, improve adherence to the programme and enable caregivers more individual approach. Importantly, after a short course on the execution of an ICT supported exercise programme given by a professional, it can be efficiently performed under supervision of non-pro-

fessionals (relatives, peers, volunteers etc.) in institutional or home settings.

4.3 Social interaction promotion

Social isolation is an important issue related to older adults (26) resulting in depression, re-hospitalization, falls, unhealthy behaviours (e.g. heavy drinking and smoking), being sedentary, lack of adherence to medical treatment or medication and an increased susceptibility to infectious diseases. ICT could be an effective tool to tackle social isolation among older adults, while it can be a vector of treatment against it (e.g. sports videogames and cognitive training programmes etc.) (42). However, it is not suitable for every older adult alike (25). ICT were found to alleviate the older adults' social isolation through four mechanisms, namely, connecting to the outside world, gaining social support, engaging in activities of interest, and boosting self-confidence. However, the positive effect of ICT use on social connectedness and social support seemed to be of a short-term nature and did not last for more than six months after the intervention. Despite the possible positive outcomes regarding social interaction promotion, some issues related to problematic use of the ICT might arise as well. Although this research field is rather new and underdeveloped, and focuses mainly on the younger populations, researchers believe excessive use of the Internet could possibly impact older adults' health risk factors, by triggering more isolation, psychiatric comorbidities, increasing suicidality and deteriorating prognosis (42).

4.4 Supportive ICT with a special focus on motion detection and falls prevention

Supportive ICT solutions mainly include assistive technologies (e.g. for disabilities, home care) and the monitoring of different data and activities (e.g. fall detection, kinematics, position, physiological data, etc.). Monitoring ICT have been shown effective in positive health attitude, health literacy, improved technical confidence, etc. (34). It can reduce burden of formal and informal caregivers worrying about the safety of the older adult living alone and may be assistive in home care delivery (33). Most adults prefer to age in place (32), and supportive ICT can enable them more independence and security. Frail and pre-frail older adults are a target group that would likely benefit from these technological solutions. Smart homes are becoming one of the most important fields of ICT application and are complex solutions including monitoring home activities as locomotion and the use of appliances that can empower older adults for self-management for independent living (31). They can also help to maintain physical and cognitive status (30). Smart homes provide solutions that enable older adults and, in many cases, frail people to prolong their living in their »preferred environment by increasing their autonomy, monitoring their actions and providing care« (13), and therefore promote healthy and active ageing. Frail persons are at high risk of falls, declining mobility or causing disability in daily activities, hospitalization, and death (9). As falls and their consequences seem to be amongst the most important events requiring transition from independ-

ent living to institutional care for older adults (34), monitoring for fall prevention and detection is a specific task especially for the older frail adults. It can be incorporated into smart home solutions (29) or can work as a stand-alone application (43). It covers many areas including fall risk assessment, home environment assessment, and most often fall detectors. The latter are based on sensors attached to the body (trunk, wrist) and continuously monitor the activity of a person to detect their fall and automatically call for help (29,34). This increases older frail adults' confidence and sense of security (29). Smart wrist watches, as they are used to wearing them, may be an acceptable solution for on-line fall detection (27,28).

4.5 Diagnosis and assessment

ICT may play an important role with the objective identification of pre-frail and frail persons. It has been shown that walking parameters (stride length, double support, and walking bout duration variability) were the most sensitive to discriminate frailty levels (44,45), however there seems to be the challenge on how to obtain these data from simple measurements in daily life. Regarding this, a method for gait parameters assessment with two microphones put on calves and connected to smart phone (46) was presented. According to our personal laboratory experiences, a single dimensional accelerometer placed on the top of the foot may be an alternative solution. Furthermore, in order to add objectivity to the assessment of frailty, accelerometer data (based on smart phone) gained during physical activity can be combined with clinical indicators (47).

4.6 Telecare and telehealth services, and support to the healthcare systems

ICT are effectively implemented at an individual level while they also support healthcare systems' functions and administration. New design and implementation of new strategies to improve the quality of services are needed. These strategies require investment in ICT tools, promotion of patient empowerment in the management of their disease and a better integration of health and social care services (39). Integrative healthcare ICT support is based on electronic health record, electronic prescription, personal health folder and web portal interface. This can help to provide better health and social care services' coordination, monitoring, patients' self-management and informal caregivers' involvement. Telecare and telehealth are additional ICT support to healthcare systems. Although according to one of the reviews (38) included in the analysis, which suggests that the most effective home telecare interventions (for older frail adults and for patients with chronic conditions) are automated vital signs monitoring (in order to reduce health service use), there is a lack of evidence about the interventions' cost-effectiveness and the effects of home safety and security alert systems. Clinical decision support systems to remotely evaluate patients can generate safe advice about therapy adjustments, substantially reduce number of visits and help physicians to identify the patients that need an urgent or more exhaustive examination (37). Additionally, telegeriatric services in rural and remote communities are cost effective (36), but their implementation is slow and fragmented (35).

4.7 ICT adoption and implementation

Results of the review suggest that ICT implementation into healthcare services is scarce, whereas barriers to the implementation can be technical, behavioural, economic and organizational (48). Or said differently, they can arise at the individual (e.g. users' lack of awareness of the benefits, low e-health literacy, a shortage of evidence of cost-effectiveness and interoperability, security concerns), organizational (e. g. financial, legal, social and ethical barriers to implementation) and wider levels of the healthcare systems (49). The results also suggest that the acceptance and employment of these new technologies remain problematic, especially for older adults. Many of them do not believe that ICT can significantly improve the quality of their life (14). The number of older adults adopting the Internet (41) is indicative of their preparedness to accept health related ICT (14). ICT use of frail persons was lower than that of the non-frail ones (9). Even more, the frail or pre-frail ICT nonusers also held the most negative opinions on the usefulness or usability of mobile ICT. The main reasons why older adults are more reluctant to accept ICT originate from their performance and effort expectancy, and social influence (41). Additionally, education, gender, income and age also have an important impact. It is suggested (14) healthcare related ICT for older adults to be simple and to demonstrate benefits in order to increase older adults' readiness to adopt them. Special focus should be put on training and support, and personal characteristics should be taken into account. Some of the reasons for scarce ICT adoption and implementation into

daily practice can be related to the fact that clinicians and patients are lost in the variety of services that apparently exist, that they doubt about the clinical effectiveness and acceptance of the services, and they do not know how to start the implementation in the clinical practice (7). Thus, there is a necessity to incorporate specific trainers for the use of ICT by older adults, to develop technologies that would be more unobtrusive and intuitive (7), and do further research in order to achieve market impact and practice to become a routine use. Furthermore, in order to improve older frail adults' acceptance of ICT, the latter should be easy to use, non-obstructive, automated and effective. One way to increase the use of ICT in frail older adults is to improve their user experience by adopting user interfaces to their needs. Instead of computers, smart phones or tablets, a TV set might be preferable option. For example Senior-TV is a way to provide a platform that might be closer to experiences of older adults (50).

5 Conclusions

The aim of this research was to define the ICT used to support the management of frail people, and its effects by using the narrative literature review method. The method proved to be appropriate and the aim was achieved. The results of this review indicate the multi-dimensional usage of ICT and show that a wide range of substantially potentially beneficial ICT solutions have been developed, covering prevention, screening, diagnosis, treatment and monitoring, to enable older adults to remain independent at home, support caregivers, facilitate remote monitoring and self-management, provide decision support, improve information sharing and coordination

of services, support daily activities etc. Namely, many ICTs have a potential to prevent and manage frailty, especially in the domain of physical activity and exercise, social resources and psychological state, falls prevention, support to daily activities and overall well-being. However, it seems their adoption and implementation remain problematic. There is also a lack of evidence whether the beneficial outcomes of using ICT in the provision of care for older adults with disabilities expand to older frail adults as well. We assume that the remaining challenge is also the fact that the speed of technology development exceeds the healthcare systems' adaptive ability. Therefore, strategic approach should be used to support further research within this research field as well to address and foster implementation and (wider) adoption of health-related ICT.

Although we provided a comprehensive insight into the concepts studied in the present work, namely ICT used to support the management of frailty, and its effects and related challenges, we would also like to draw attention to the important limitations of the research. While it is a narrative review, which includes different types of sources, the results cannot be compared instantly due to inconsistent research design. Furthermore, while conducting this review, we were facing the challenge to obtain literature that would address the studied topic directly. Namely, there is a lot of research on ICT within social and healthcare systems, as well as on different aspects, related to older adults. However, there seems to be the lack of studies in this specific research subarea that focuses on the older frail adults. We assume the latter can be due to the novelty of the field and can reflect rather new and underdeveloped ICT research

area. So additional research on this topic would be warranted in order to get an even better insight into the studied topic and furthermore develop target public specific prevention and management interventions.

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