



E-health for active ageing; A systematic review

Timothy David Robbins^{a,b,1}, Sarah N. Lim Choi Keung^{a,1}, Theodoros N. Arvanitis^{a,*}

^a Institute of Digital Healthcare, WMG, University of Warwick, Coventry, CV4 7AL, United Kingdom

^b University Hospitals Coventry & Warwickshire NHS Trust, Clifford Bridge Road, Coventry, CV2 2DX, United Kingdom



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ABSTRACT

Enabling successful active ageing is an international priority to meet the challenges of increasing life expectancy. Digital strategies, such as telemedicine and e-health, offer the potential to deliver active ageing in a cost-effective manner at scale. This article aims to establish the extent to which the research literature considers e-health-based and telemedicine-based active ageing interventions. A systematic review was conducted according to PRISMA standards. Independently, two authors searched the Cochrane, EMBASE & CINAHL databases, with subsequent independent extraction and semi-quantitative analysis. We report a considerable breadth in digital active ageing research, which is truly international in its scope. There is a diverse range of both interventions and technologies, including a reassuring focus on community-based interventions. Whilst there are a number of quantitative studies, sample sizes are small, with a limited amount of statistical testing of the results. There is significant variation in the outcome measures reported and little consensus as to the most effective intervention strategies. Overall, whilst there is considerable breadth to the research published in the literature, there is a clear restriction in the depth of this research. There is little overall consensus. This lack of depth and consensus may be due to the need to recognize the important role of technical research elements alongside more traditional research methodologies, such as randomized controlled trials. Enabling both technical and clinical research methods to be recognized, in tandem, has enormous potential to support individuals, communities, clinicians and policy makers to make more informed decisions in relation to active ageing.

1. Introduction

Life expectancy is increasing internationally, with World Health Organisation (WHO) estimates suggesting life expectancy increases of 0.9 years per decade for men and 0.8 years per decade for women. In developed countries, the increase in life expectancy has been even more pronounced [1]. Historically, this increase in life expectancy had been driven by reductions in infant mortality, however more recently this gain has been sustained by reductions in mortality from non-communicable diseases, which has specifically reduced mortality amongst older populations [2]. These changes have fundamentally changed population demographics internationally, resulting in increasingly ageing populations. The proportion of older people aged 65 and over is due to double between 2010 and 2050, with the fastest growing age group being those aged over 80 [3]. The WHO recognises that population ageing represents one of humanity's greatest triumph but also its greatest challenge. The challenge emerges from the potential for such ageing populations to place social and economic demands on communities and healthcare systems [4].

Enabling active ageing provides the opportunity for humanity to overcome the challenges of an increasingly ageing population, enabling ageing to be a positive experience for individual, communities and society as a whole. The concept of active ageing was first proposed in 1997 and incorporates previous concepts of healthy ageing that had restricted thinking too much towards healthcare provision [5]. Active ageing can be best described as a concept that “applies to both individuals and population groups. It allows people to realize their potential for physical, social, and mental well-being throughout the life course and to participate in society according to their needs, desires and capacities, while providing them with adequate protection, security and care when they require assistance” [6]. Active ageing can be achieved through a series of policy interventions based around prevention, promotion and care. In particular, prevention of falls and infectious disease through vaccination, promotion of physical activity and social interaction, and care when necessary from both formal and informal care givers.

Matched to the increasing age of the population, is an increase in digital technology use by elderly populations; indeed elderly adults now

* Corresponding author.

E-mail address: T.Arvanitis@warwick.ac.uk (T.N. Arvanitis).

¹ Joint first authorship.

represent the fastest growing population of adopters to internet and computer technologies [7]. There is clear potential therefore to adapt digital technologies, such as telemedicine and telehealth, to the challenge of enabling active ageing. A number of studies have considered exactly this approach [8–10]. However, the research literature lacks an overview of the importance of digital health approaches to enable active ageing. This paper systematically assesses the extent to which the research literature considers the role of digital interventions in active ageing in an international context. This approach is essential to guide and coordinate future research, as well as supporting policy makers, clinicians, communities and individuals to make the best possible active ageing decisions and interventions.

2. Methods

2.1. Prospero registration

The systematic review was prospectively registered on the NIHR Prospero Database (Registration number: CRD42017080840).

2.2. Search strategy

The following search terms were selected following collaborative discussion between all authors: “healthy aging” or “healthy ageing” or “active aging” or “active ageing” AND (telemedicine OR “tele-medicine” OR “telehealth” OR “tele-health” OR “digital health” OR “tele-care” OR “digital” OR “e-health”). The databases used for identification of relevant articles were Cochrane Database, EMBASE and CINAHL. An initial screening of identified papers was performed, through review of title and abstract and removal of duplicates at this point, followed by full extraction of all articles considered to be of possible eligibility. The searches were conducted independently by authors Dr Tim Robbins and Dr Sarah Lim Choi Keung, who compared results of their independent searches. Any discrepancies were resolved through discussion amongst all authors.

2.3. Criteria for study inclusion/exclusion

For inclusion in the paper selection process, articles must include content relevant to both the active ageing and digital elements of the search strategy. Furthermore, articles must be peer reviewed and published in the English language. There was no restriction on the type of article (e.g., conference paper, experimental study, review or comment article), nor was there restriction on the date of publication. Review articles were included to ensure capture of all relevant information within the research literature and to help identify specific subsets of active ageing research areas where there had been sufficient original research articles to justify a review article summarising progress in that area.

2.4. Data collection and analysis

Data extraction was performed to a pre-defined Microsoft Excel proforma (see Supplementary material), which had been pre-determined and piloted by both Dr Tim Robbins and Dr Sarah Lim Choi Keung. Data extraction was similarly performed independently by these two authors and results compared. Data was collected for the following variables: year published, article type, study type, country of study, study population, sample size, descriptor of e-health intervention, care setting, single centre or multi-centre, assessment of whether considering prevention/promotion/care, outcome measure, technology used and any evidence of statistically significance testing. The type of interventions under-examination for each article were extracted, categories were defined as outlined in Table 1. Multi-national studies were specifically assessed for any discussion around cross-boundary research challenges, including language barriers, dealing with diverse cohorts and

information governance challenges. Data synthesis was performed semi-quantitatively, with the collated variables used to provide a measure of bias within the selected studies.

3. Results

3.1. Paper identification

A total of 140 papers were initially identified, using the search strategy described above. The PRISMA flow diagram [60] (Fig. 1) demonstrates that 47 duplicates were excluded, with 53 full text articles extracted for review. A total of 51 of these articles were accepted for use in the final semi-quantitative synthesis described.

3.2. Publication of articles over time

The first identified study was published in 2002, with an increasing number of studies published until 2016, where 13 studies were published (Fig. 2). Five studies were published in 2017.

3.3. Study type

Eleven articles reported experimental quantitative or qualitative studies, with 17 articles representing comment based articles (Table 2). There were 9 review articles described in further details below and 11 articles represented multi-centre studies.

3.4. Study population

The selected articles represented research from 20 different countries, with the most research in this area being published from the United States of America and The Netherlands. The articles had a mean average sample size of 300 participants with a median of 119 participants. Of the quantitative studies, 7 performed statistical significance testing of the results.

Forty-one studies explicitly described the study population under investigation, with 37 studies focused on older adults alone. Fourteen of these studies specified a specific age range to define older adults with the starting age for this category varying from 55 to 65. Two studies focused on interventions during middle age to enable healthy ageing later in life [19,21]. Two studies focused on clinicians involved with the promotion of healthy ageing [28,49] with a further study considering the role of researchers in enabling healthy ageing [32]. A single study considered the roles of carers [30].

3.5. Intervention characteristics

Thirty-four (67%) studies considered health promotion, 31 (61%) considered preventative strategies and 27 (53%) studies considered care interventions. Sixteen (31%) considered all three domains of healthy ageing within the published study. More specifically the most common interventions discussed were telehealth, telecare and tele-education (as defined in Table 1 above). A smaller number of studies considered rehabilitation or cognitive behavioural therapy (Fig. 3). Forty-six (90%) specified a specific location for the active ageing intervention, with 44 of those interventions focused on the community setting. One article specifically considered active ageing interventions in a rural setting [63], and a further article specifically considered active ageing interventions in the developing world [28].

There was a diverse range of technologies utilised for the digital interventions described in each study, with the most common technology being home computer delivery of digital content, followed by sensor-based interventions. A full breakdown of the technologies used in the studies is provided in Table 3.

Forty studies described a specific outcome measure, only 7 studies described a specific outcome measure directly relevant at the individual

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