High-quality RMD rehabilitation and telehealth: Evidence and clinical practice

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Abstract
Within rheumatology, telehealth is essential to modern rehabilitation due to the demographic development with more and more elderly people. At present, telehealth solutions are used as part of the rehabilitation process in assessment, interventions and evaluation. Telehealth interventions are as effective as conventional follow-ups or self-management assessments, but the evidence on the effect is still sparse. Telehealth interventions seem to support a physically active lifestyle in the short term. In general, telehealth solutions are well received by patients, but the development must be based on user involvement, behaviour theory and the World Health Organization principles of creating health literate organisations in order to ensure usability, effectiveness and further implementation.

Key words
Rheumatology, telehealth, rehabilitation, health literacy
Why do we need telehealth in rheumatological rehabilitation?
Due to an ageing population, the prevalence of rheumatic and musculoskeletal diseases (RMDs) in developed countries has increased by 60% from 1990-2010 [1, 2]. At the same time, there is a lack of rheumatologists and other healthcare professionals [3, 4]. This has created new demands from patients and healthcare systems that point towards alternative solutions to conventional rehabilitation interventions and pre-scheduled outpatient follow-ups. According to the World Health Organization (WHO), the use of digital technologies may offer one such new opportunity to improve people’s health[5]. The basic principle of most telehealth interventions is that the technology supports a dialogue between the patient and the healthcare provider; it relies on monitoring predefined data to enable a timely intervention [6].

What is telehealth?
Telehealth is a term that has many different definitions and many different names, e.g. telemedicine, digital health, and tele-rehabilitation [6]. In this paper, we will use the term ‘telehealth’, which WHO has defined as: ‘the use of telecommunications and virtual technology to deliver health care outside of traditional health-care facilities’ [7]. According to WHO, telehealth can improve healthcare access and outcomes, particularly in the treatment of chronic diseases and in vulnerable groups, by reducing the demands on crowded facilities and by making the health sector more resilient [7]. This means that telehealth interventions often match up to the linked goals in the so-called Triple Aim model proposed in 2008 by the US Institute for Healthcare Improvement: ‘aiming at improving the individual experience of care; improving the health of populations; and reducing the per capita costs of care for populations’ [8].

Box 1 Definition telehealth [7]

The use of telecommunications and virtual technology to deliver health care outside of traditional health-care facilities.

In this paper, we present an update of current evidence about the effect of telehealth, with a focus on telehealth follow-up self-management interventions and interventions to promote physical activity and exercise. Finally, we present central elements in the development of telehealth interventions and requirements for organisations wanting to implement telehealth solutions.

What exactly is rehabilitation?
Health care literature has increasingly focused on the importance of rehabilitation, likely because there is a growing understanding that the impact of a disease extends beyond biomedical understanding. The growth of an ageing population over the last several decades also calls upon an
increased need to support people in managing the impact of their disease as well as managing the 
disease itself.

As Derick Wade stated, ‘Rehabilitation should be central to all healthcare at all times. People working 
in healthcare should give as much attention to a patient’s functional activities, social roles and distress 
as they do to diagnosing and treating disease. Rehabilitation processes should run in parallel with 
medical care at all times and in all settings’[9]. In the acute stage of a disease, the focus is on 
diagnosis and treatment, and, following this, more attention should be given to how activities are 
performed and to social participation .

There is as yet no agreed definition of what rehabilitation is and thus the concept is interpreted 
differently by various disciplines and people. In 1992, the WHO defined rehabilitation as: ‘...a 
problem-solving and educational process aimed at reducing the disability and handicap experienced 
by someone as a result of disease, always within the limitations imposed by available resources and 
the underlying disease’ [10].

In the European White Book on Physical and Rehabilitation Medicine in Europe, rehabilitation is 
defined as ‘a set of measures that assist individuals, who experience or are likely to experience 
disability, to achieve and maintain optimum functioning in interaction with their environments’ [11].

Both definitions highlight that rehabilitation involves a person’s biological, psychological and social 
functioning and not just the medical aspects of a condition. This also means that a medical diagnosis 
is not enough to determine a person’s function and disability. People with the same diagnosis often 
experience different levels of functioning and disability, and similar problems with functioning may 
have different aetiology. Thus, rehabilitation is based upon the biopsychosocial model of health and 
ilness instead of the biomedical model.

A biopsychosocial approach and the ICF

The biopsychosocial model represents a systems approach to illness. This involves the pathology, 
impairment, disability, social participation, the personal and social context and temporal context in 
ilness and life [9]. Rehabilitation aims to improve an individual’s functioning, and it also includes 
changes to the person’s environment to bring about functional improvements. Thus, to understand 
disability in a patient, it is necessary to identify all factors affecting an activity, especially the ones 
necessary to improve performance.

The International Classification of Functioning, Disability and Health (ICF) is based on a 
comprehensive biopsychosocial model. The ICF was developed by WHO in 2001[12]. (Figure 1)
Figure 1: [12]

The ICF provides a framework to assess and understand the complete picture of a person’s functionality, disability and health, and provides a common language for professionals working together with the person in need of rehabilitation.

Various ICF core sets have been developed (https://www.icf-core-sets.org/), and a number of musculoskeletal ICF core sets exist both in comprehensive and abbreviated versions. These include musculoskeletal acute, musculoskeletal post-acute, ankylosing spondylitis, chronic widespread pain, low-back pain, osteoarthritis, osteoporosis, rheumatoid arthritis (RA) and acute inflammatory arthritis.

**High-quality rehabilitation?**

High-quality rehabilitation should involve a person-centred approach, support active participation, and include shared decision making and clearly set goals. Correctly performed, these elements can improve patient satisfaction, reduce the length of hospital stay and cut healthcare costs [13-15].

*Person-centred rehabilitation as a learning process*

Rehabilitation encompasses a learning process, where a person has to learn new skills to manage and cope with a disease and its impact, and thus patient education is a core component of rehabilitation. Behavior change theories underpinning the interventions to support behavioural change are relevant in this discussion.

In addition, a holistic, person-centred approach in rehabilitation is considered an important condition for successful rehabilitation [16]. The definition of ‘person-centredness’ varies, but we agree with the perspective that an individual is an expert on the difficulties he or she experiences in his or her everyday life, and they should be respected as a unique individual who can participate in social life and be empowered to manage their life with the disease [16].

Active participation in rehabilitation is important: the person is not a passive recipient but needs to be interested in learning and be willing to practice and change their behaviour [17]. Shared decision-making (SDM) in rehabilitation is a collaborative approach between the person and the healthcare professionals. The person’s values and preferences are integrated with the best available evidence and practice in a three-step approach: 1) invite the person to participate, prepare for collaboration and clarify that a decision needs to be made, 2) exchange information about options, values and preferences, and clarify and correct perceptions about options, and 3) affirm and implement the agreed-upon plan [18].
The rehabilitation process

The rehabilitation process includes four key aspects: assessment, goal setting, intervention and evaluation [9]. A holistic assessment encompasses collection and analysis of data to achieve an understanding of the patient’s situation so that action can be taken. Here, the ICF model can be used as a common framework. The assessment includes obtaining information about activities and roles, and reaching an understanding of personal factors, such as emotions, beliefs, goals, expectations and information concerning the person’s context (personal, social and physical). The assessment process often involves input from different health professionals to interpret observations and assessments.

Goal setting concerns planning what is needed to resolve the problem and should involve the patient directly in a shared-decision process as the goals need to be meaningful for the individual. Interventions are all the actions that follow based on the assessment and goal-setting process. Finally, the patient needs feedback on their performance so they can improve further [9].

Digital health in rehabilitation settings

Telehealth can be relevant to consider for different parts of the rehabilitation process. Patient education, physical activity and exercise, comorbidities and lifestyle are factors of rheumatic diseases that should be taken into account when designing rehabilitation interventions. These interventions can be delivered face-to-face in groups or individual sessions, and telehealth interventions can also be used.

Patient reported outcomes

Three types of data are frequently monitored through telehealth interventions: (i) symptoms (e.g. fatigue or pain); (ii) behaviour (e.g. adherence, lifestyle or self-efficacy), and (iii) biological data (e.g. tender and swollen joint counts, body mass index, physical activity) [6]. Data are often collected in the form of patient reported outcomes (PROs). The US Food and Drug Administration (FDA) has defined a PRO as: ‘any report of the status of a patient’s health condition that comes directly from the patient, without interpretation of the patient’s response by a clinician or anyone else’ [19]. Thus, PRO is an umbrella term that covers a broad range of different constructs such as symptoms; physical, social, and mental function; health perceptions; and health-related quality of life (HRQOL)[20]. These aspects cover different levels of a patient’s health status or outcomes, and they are often non-observable subjective aspects (e.g. pain, fatigue or depression) which can only be assessed by the patients themselves. As a result, these aspects need to be operationalised to be assessed. Such non-observable constructs can be measured in standardised questionnaires called PRO measures (PROMs) [21].
Evidence regarding telehealth solutions for self-management and digital follow-ups

To handle the size and complexity of empirical findings in this massive research field, reliance on systematic reviews is necessary. In a systematic review from 2017, Piga et al. described the widespread use of telehealth solutions within different rheumatological diseases [22]. The review concluded that telehealth solutions are well accepted by patients; however, high-quality, randomised controlled trails (RCTs) demonstrating the effectiveness of different telehealth interventions are needed in order to recommend their use [22]. Srikesavan et al. drew the same conclusion in a recent systematic review examining the effect of web-based rehabilitation interventions for people with RA [23]. In the following section, we present the studies included in the reviews by Piga et al and Srikesavan, et al complemented by more recent RCTs.

Rheumatoid arthritis

Both reviews present one of the largest single RCTs within telehealth [22, 23], which was performed by Lorig et al. [24]. The efficacy of an internet-based Arthritis Self-Management Program (ASMP) was evaluated among 855 patients with RA, osteoarthritis or fibromyalgia. Patients were randomised to either an internet-based self-management programme or the standard care process. After one year, statistically significant differences in favour of telehealth were found regarding health distress, physical activity and pain. The internet-based intervention was, however, an add-on to usual care [24]. One additional RCT study involved people with RA between 1990-2016 [25]. In this study, a total of 106 patients were randomised to either an online self-management programme or wait-list control group. The selected outcomes were self-efficacy, HRQOL and disease activity. After nine months, a small, beneficial effect was observed in self-efficacy and quality of life in the telehealth group [25]. However, the quality of the evidence was considered low or very low for both outcomes [23].

Two additional studies were conducted after the reviews by Piga and Srikesvan [26, 27]. In a French multicentre study, a total of 320 patients were randomised to either an online interactive electronic e-health platform, developed to allow patients to carry out self-assessment and self-monitoring, or to the standard care routine [26]. The primary outcome was a change in patient-physician interaction, indicated by the Patient-Physician Interactions questionnaire (PEPPI-5) [28]. Patients who used the e-health platform achieved a small improvement in PEPPI-5 compared to the control group. No difference between groups was found in disease impact as indicated by the RA Impact of Disease questionnaire (RAID). Although patient satisfaction was high, approximately one-fourth of the patients in the intervention group did not access the e-health platform during the follow-up period [26].

In a Danish non-inferiority RCT study, a total of 294 patients with RA were randomised to either a telehealth follow-up carried out by a nurse or a rheumatologist, or conventional outpatient follow-up with rheumatologists [27]. Like the French study [26], the patients included had approximately 12
years of disease duration and low disease activity [27]. Patients in the intervention group received a PRO-based telehealth follow-up. Every fourth month, the patients completed a questionnaire through the generic configurable tele-PRO system, AmbuFlex [29]. The Flare-RA instrument [30] served as decision support to assess disease activity. Based on a pre-defined algorithm in AmbuFlex, the patients were contacted by telephone if needed. Non-inferiority was established for the disease activity score (DAS-28-CRP) and the degree of disease control did not differ between the patients followed by rheumatologists or rheumatology nurses. Neither was any between-group difference detected in physical function nor quality of life or self-efficacy [27]. The patients’ experience was investigated in a later qualitative study with a special focus on the patients’ perceptions of their active role and responsibility for disease control [31]. Patients generally had positive perceptions towards telehealth follow-up. However, two typologies, the keen patient and the reluctant patient, represented opposite perspectives and preferences regarding the core value of and approach to telehealth follow-up, indicating that patients have different needs, wishes, and abilities to take part in telehealth follow-up [31].

Osteoarthritis

In a study by Umapathy et al., a statistically significant difference in self-management and weight reduction in favour of a web-based intervention was seen after 12 months [32]. Due to the high risk of bias, the evidence was, however, considered low for both outcomes [22]. A study by Cupurus et al. was considered to be of high quality [22], but failed to detect a difference in any of the outcomes of daily function, quality of life, self-efficacy or fatigue after six, 26 and 52 weeks [33].

One additional study identified after the Piga et al. review evaluated the effect of a telephone-based weight management programme in patients with osteoarthritis [34]. A total of 120 patients with a BMI ≥ 27 kg/m² and < 40 kg/m² were randomised to either telephone-based advice or the usual care practices. No difference between the groups was found in any of the outcomes (weight reduction, pain or disability). Furthermore, in a parallel cost-effectiveness study, it was concluded that the telephone-based intervention was not cost-effective compared to the usual care [35].

Juvenile idiopathic arthritis

Three studies – a feasibility study [36] and two pilot studies [37, 38] – regarding telehealth interventions in children and adolescents were carried out in the period 1990-2016 [22]. The feasibility and usability of the internet-based self-management and education interventions were found to be good, but the three studies were not designed to assess effectiveness.

When updating the evidence, two additional studies were identified. In a crossover RCT study, 55 children were randomised to either a monthly telephone call from a nurse or the standard care routine of a medical consultation every third month [39]. After 12 months, children in the telephone intervention group showed significant improvements in satisfaction, morning stiffness and pain [39].
In a six-month RCT study, 72 adolescents were randomised to a web-based self-management intervention or followed the usual care practices [40]. The intervention was appreciated by the adolescents and their parents. However, no significant differences were found in self-efficacy, quality of life or self-management [40].

In summary, most of the telehealth interventions used self-assessment and self-monitoring, and the interventions were offered to patients with low disease activity and long disease duration. Although no statistically significant differences were observed in most outcomes, patients were generally satisfied with the telehealth interventions or mode of control.

It may be that the patients who declined to be included into these studies felt uncertain about taking part in a telehealth intervention. However, there are no data to support this and, therefore, it is advisable to investigate how any large-scale implementation of telehealth interventions might affect patients more broadly, including the patients’ perception of the service, personal control, decision making and relationships between the patients and health professionals.

**Telehealth to monitor physical activity and exercise**

Since people with RMDs are less physically active compared to the general population, interventions to facilitate physical activity are recommended as part of standard care [41]. Telehealth is widely used as an intervention in rehabilitation to monitor and support adherence to physical activity and exercise in people with RMDs, and the number of studies evaluating their effectiveness is growing. The remote communication support is delivered by smartphone apps, sensors, video and social media platforms, or a combination of these mechanisms. Telehealth is often used as a complement to prescribed therapy to monitor physical function and physical activity, to enable and facilitate exercise treatment after surgery, and to follow up after rehabilitation interventions [42, 43]. Telehealth is also used to support lifestyle changes through improvement in self-management, where maintenance of health-enhancing physical activity is the final goal [42]. Digital intervention programs can be fully delivered over the internet, while some interventions are blended, with a mix of digital and face-to-face meetings.

When using telehealth to support exercise maintenance, behavioural change theories should guide the intervention programme to enhance the effect [42, 44, 45], and the development process should be performed in close collaboration with end users to facilitate acceptance and usability.

When asking patients for their preferred modes of delivery to support lifestyle changes such as improved physical activity, they prefer a mix of communication modes: printed material, email, telephone calls and face-to-face communication [46, 47]. The use of telehealth in rehabilitation interventions are well received by most patients, but a concern regarding the lack of physical contact
with the therapist has been raised both by patients and by health professionals [46, 48]. From the physiotherapists’ point of view, telehealth saved time and offered privacy advantages for the patients. The therapists preferred video calls to telephone-delivered care [48].

*Rheumatoid arthritis*

Systematic reviews focusing on interventions to improve physical activity delivered by telehealth in people with RA are scarce and encompass only a few RCTs with a limited number of participants, resulting in inconclusive effectiveness [22, 23]. Only two RCTs where physical activity was included as an outcome measure were included in the published reviews [49, 50]. Reducing sedentary time to promote health is the other side of the coin, and this has been studied in two RCTs not included in the systematic reviews. Below is a more detailed description of these studies.

Allam et al. conducted a five-arm parallel RCT with four different intervention groups and one control group to study the effects of a web-based, two-month intervention focusing on knowledge and empowerment and their effect on the improvement of physical activity, healthcare utilisation and medication adherence [50]. The four intervention groups (n=28-30 per group) had different levels of access to the web-based information while the control group (n=40) did not have any access. A number of PROMs were included at baseline, post intervention and after another two months as follow-up online questionnaires for the four intervention groups and as a paper-and-pencil version in the control group. The Exercise Behaviors Scale [51] was used to measure time spent on pre-defined exercise tasks during the previous week. The results showed that patients with complete access to the web-based intervention improved more in mean minutes spent on exercise compared to the control group with no access, indicating that social support and gaming was of importance [50].

An RCT performed by Van den Berg et al. compared the effect of two 12-month internet-based interventions aiming to promote physical activity in people with RA [49]. Participants were randomised to either individual guidance on exercise (n=82) or general information only (n=78). Individual guidance included a tailored, supervised and graded personal programme with strengthening, range-of-motion, and aerobic exercises to be performed five times per week and reported to the physiotherapist by email. The group who received general information only had access to web pages with general information about strengthening, range-of-motion, and aerobic exercises. It was recommended that the general information group perform physical activity on at least five days per week, gradually increasing to a health-enhancing level of 150 minutes per week. The proportion of patients reaching health-enhancing recommendations for physical activity was the primary outcome, while time spent on moderate and vigorous activity per week, measured with activity monitors, was the secondary outcome. Measured by self-report, a larger proportion of participants in the intervention group was physically active at a moderate and vigorous level compared to the reference group at a six- and nine-month follow-up. The proportion of participants exercising at a
vigorouls level was also higher in the intervention group at a 12-month follow-up. Results from activity monitors did not reveal any differences in physical activity levels between the two groups [49]. A later 24-month follow-up study (i.e. no intervention for 12 months following the one-year intervention) revealed that the proportion meeting a health-enhancing moderate physical activity level was higher in both groups compared with baseline. Data from 72% of the participants were available for analysis. However, the proportion of participants who reported being physically active at a vigorous level was only higher in the group who had received individual guidance [52].

Reducing sedentary time by improving time spent in light physical activity may have a positive effect on a person’s cardio-vascular health [53]. An RCT by Thomsen et al. studied the effect on daily sitting time through a 16-week, individually tailored, behavioural intervention (n= 75) vs. no intervention (n=75) in sedentary people with RA and a known sitting time extending to four hours per day [54]. The intervention included three motivational counselling sessions and text messages sent as reminders to decrease sitting time. The primary outcome, change in sitting time, was evaluated by accelerometers and secondary outcomes were self-reported; these secondary outcomes included time spent sitting, pain, fatigue, physical function, quality of life, self-efficacy and cardio-metabolic biomarkers. At the end of the intervention, the intervention group had reduced their sitting time significantly more than the control group, and the intervention group had greater changes in pain, fatigue, physical function, quality of life and self-efficacy [54]. Recent results from the 18-month follow-up study (intervention group n=71 and control group n=64), revealed a greater reduction in daily sitting time in the intervention group compared to the control group. Differences in favour of the intervention group were also found in pain, fatigue, physical function, quality of life, self-efficacy and in some of the cardio-metabolic biomarkers [54].

**Osteoarthritis**

The role of telehealth in the management of knee osteoarthritis has been evaluated in three systematic reviews, where evidence from telehealth after total knee arthroplasty (TKA) [55, 56] and efficacy of home exercise interventions [57] were evaluated.

Telehealth was compared to face-to-face rehabilitation after TKA in two reviews by Shukla [55] and Jiang [56]. In total, six RCTs were included in the analysis, and no differences in outcomes for range of motion, strength, level of physical activity [55], pain and self-reported function [56] were found. A more recently published RCT concludes that the satisfaction of patients does not differ between telehealth and face-to-face interventions [58]. Delivering patient information via an app as a complement to face-to-face information may facilitate patient education compared to face-to-face information only [59, 60]. Below is a more detailed description of the separate studies.

Kramer et al. randomly assigned people after TKA due to knee osteoarthritis to a face-to-face 12-week rehabilitation programme, either as outpatients (n=80) or to a home programme supported by
telephone calls from physiotherapists (n=80) [61]. Data were collected pre-surgery, and at 12 and 52 weeks post surgery. Both PROs and functional performance (gait performance and range of motion) were measured. No differences between groups were found in any of the outcome measures at week 52 [61]. Russel et al. also randomly assigned people with TKA to a six-week outpatient rehabilitation programme (n=34) or a video-linked rehabilitation programme (n=31) [62]. The outcomes were a mix of PROMs and functional performance measures (gait performance, muscle strength and range of motion), and the results did not differ between the groups at six weeks [62]. Piqueras et al. randomised people admitted for TKA to either a ten-day interactive virtual telehealth intervention (n=72) or standard rehabilitation (n=70) after surgery [63]. The study outcomes were a mix of PROMs and functional performance measures (gait performance, muscle strength and range of motion) assessed pre-surgery, at the end of the rehabilitation, and three weeks post intervention. There were no differences between the groups in the chosen outcome measures [63]. Tousignant et al. and Moffet et al. studied the effectiveness of telehealth in home rehabilitation vs. conventional outpatient clinic rehabilitation for people post TKA in two different RCTs [64, 65]. In the 2011 study, the intervention (n=21) was supervised by a physiotherapist using videoconferences with the participants, two sessions per week over eight weeks. The control group (n=20) received the usual home care services. There were no differences between the two groups in range of motion, balance, and muscle strength or gait performance after the intervention or at a follow-up four months post intervention compared to baseline. However, at four months post intervention, the control group reported better function and health status compared with the intervention group [64]. In a later but similar RCT on telehealth, people post TKA were randomised to two-months telehealth rehabilitation (n=104) or standard care (n=101) [65]. There were no between-group differences in any of the studied outcomes [65]. Moffet et al. also studied patient satisfaction with the different rehabilitation interventions four months post intervention and found an overall high satisfaction, with no differences between the groups, supporting the usefulness of telehealth [58]. Another RCT studying the effect of telehealth after TKA compared a web-based mobile application (n=13) to in-person outpatient rehabilitation (n=15, standard care). No differences between groups were found at a three-month follow-up in any of the outcomes (self-reported function, pain and health status) [66]. Timmers et al. studied the effect of education and information delivered via an app (n=114) vs. information given by health professionals as part of standard care (n=99) after TKA about pain, physical function, exercise, satisfaction with information and healthcare consumption [60]. Self-reported online questionnaires were completed weekly for four weeks after discharge. After four weeks, participants in the intervention group had reduced their pain level and improved their physical function and health status compared to the control group [60]. The study was preceded by an RCT studying the effect of the app on patient knowledge concerning knee pain in people with knee osteoarthritis referred to an orthopaedic surgeon [59]. By using the app, the intervention group received push notifications in addition to standard care (n=91) vs. a control group who received standard care only (n=122). The
authors concluded that delivering knowledge and information daily by the app improved patients’ knowledge more than standard care alone [59].

In people with knee osteoarthritis, home exercises to improve pain, function and quality of life are recommended. To facilitate adherence, several modes of telehealth have been studied. A systematic review by Schäfer et al. included seven RCTs [57]: home exercise interventions supported by telehealth compared with no or another intervention resulted in small, favourable outcomes in pain, physical function and health-related quality of life but adherence was a significant problem. Four of the seven included studies comprised data on physical function and three of the studies provided long-term follow-up. Additional RCTs reveal similar outcomes compared to face-to-face traditional care and supplementary telephone or web-based support in terms of improvement in function and exercise performance [67, 68]. Below is a detailed description of the separate studies.

Bossen et al. carried out an RCT investigating the short-term (three months) and long-term (12 months) effect of a web-based intervention on physical function and physical activity in people with self-reported knee- or hip-osteoarthritis[69]. The participants were randomly assigned to either the intervention (n=100) or wait-list control group (n=99), and 84% returned the questionnaires at the three-month follow-up and 76% at the 12-month follow-up. Self-reported physical function was higher in the intervention group at the three-month follow-up and self-reported physical activity was higher in the intervention group at the 12-month follow-up compared to the control group [69].

Bennell et al. tested a 12-week physiotherapist-prescribed home exercise programme delivered via Skype, together with training in pain management skills and delivery of educational materials to people with chronic knee pain (intervention group, n=74) vs. educational materials only (control group, n=74) [70]. Improvement in pain and physical function were evaluated at three- (n=70 vs. 68 participants) and nine-month follow-ups (n=66 vs. 67 participants), and both outcomes improved more in the intervention group than in the control group at both follow-ups [70]. A later publication from the same study concluded that participants in the intervention group who were employed and who scored higher in self-efficacy at baseline reduced their pain at the three-month follow-up [48].

Bennell et al. also performed an RCT to study if the addition of telephone coaching to a physiotherapist-delivered home exercise programme was more effective at reducing pain and improving physical function compared to only five clinical physiotherapy sessions over six months (n=84), with follow-up at six, 12 and 18 months [70]. The intervention group (n=84) had six telephone-delivered coaching sessions over six months. In following up at six (n=72 vs. 70), 12 (n=70 vs. 66) and 18 (n=66 vs. 62) months, there were no between-group differences in pain and physical function, while self-reported physical activity improved more in the intervention group at six months but not at later follow-ups [70].
Yet another RCT from the same group of researchers studied the effect of exercise advice and support by physiotherapists in addition to a nurse-led telephone service on pain and physical function in people with knee osteoarthritis [67]. The groups (intervention group n=87 vs. control group n=88) were evaluated at six (n=83 vs. 82) and 12 months (n=82 vs. 76). Between-group differences at six months favoured the intervention group in self-reported function, while self-reported physical activity was favoured at 12 months [67]. An RCT from the Netherlands studied the effect of a blended web-based exercise intervention to promote physical function and physical activity in people with hip- or knee-osteoarthritis compared to standard physiotherapy [68]. The blended web-based intervention aimed to support a physically active lifestyle, extended over 12 weeks and included five face-to-face consultations with a physiotherapist and additional web-based educational material (graded activity, strength and stability, and information) in accordance with the Dutch osteoarthritis guidelines (n=109). The group receiving the usual physiotherapy (n=99) had an unrestricted number of face-to-face sessions and it was also recommended they follow the Dutch guidelines for osteoarthritis. Evaluations were performed at 12 weeks (n=89 vs. 87) and 12 months (n=66 vs. 69) post intervention. There were no between-group differences in physical function or in levels of physical activity at either the 12-week or 12-month follow-up [68].

In summary, telehealth interventions to support improved function, physical activity and exercise show a short-term effect and are well received by most patients compared to general information only. Replacing face-to-face rehabilitation with telehealth rehabilitation seems to be just as effective, and the mode of delivery should be based on patients’ preferences to facilitate adherence. However, most studies lack information regarding what behavioural theory and the degree of user involvement has guided the telehealth development process.

The development of telehealth interventions
Rehabilitation interventions need to be individually tailored and thus a ‘one-size-fit-all’ strategy is not appropriate. Telehealth solutions must be able to adapt to this complexity to be successful [71]. In Norway, general telehealth solutions have been implemented for several years to address the healthcare needs of those living in remote areas [72]. Despite a degree of telehealth adoption, a recent audit in Norway showed that the actual rate of telehealth consultations was low (approximately 1%) compared to standard outpatient consultations [72].

It is acknowledged that some of the problems with poor adoption and implementation of telehealth interventions is due to a lack of clear and accepted standards for the development process [71]. As many telehealth solutions may form the basis for critical clinical decisions throughout the entire rehabilitation process, it is important that they are accurate and reliable in order to promote safe use [73]. The risk of harm increases with greater complexity [73]; high-risk solutions are represented by
medical devices such as clinical-decision support technology, whereas lower risk solutions could be wellness and fitness apps [73].

Greenhalgh developed a framework for the development and implementation of telehealth solutions: the non-adoption, abandonment, scale-up, spread and sustainability (NASSS) framework [71]. NASSS includes seven domains: (i) the condition, (ii) the technology, (iii) the value proposition, (iv) the adopters, (v) the organization, (vi) the wider context, and (vii) the interaction and adaptation between all of these domains over time. All domains must be taken into consideration in the development of a new telehealth intervention, but they can also be used to evaluate existing interventions [71]: Why is this intervention not used as intended? Are the health conditions among the targeted patients too complex? Is the technology too demanding for the users, the aim of the intervention unclear, or is the intervention not supported by the management?

Effective user involvement can help understand the problem and context of telehealth solutions, and may potentially overcome usability issues [74]. According to a qualitative review of young users’ experiences of mobile health technologies to manage non-communicable diseases, co-design was an important issue, together with functionality to support self-management, self-efficacy and empowerment, and acceptance in terms of technical usability and feasibility [75]. The Oxford Academic Health Science Network (AHSN) also emphasised user involvement in the Digital Health Roadmap and guide for innovators when developing digital health products [76]. However, despite the widespread knowledge regarding the importance of user involvement in the development of telehealth interventions, a recent systematic literature review has shown that patients were involved in approximately 15% of the studies describing mobile health apps for self-management of RMDs. In general, the development process was considered insufficient or not described in most studies [77]. User involvement can be ensured through different types of evaluation methods such as scripted user-centred design workshops, user testing in the wild, interviews, and participatory design (PD) [78, 79]. We will describe PD in more detail below.

**Participatory design**

PD, the practice of collective creativity in design, is a methodology that originates from action research in the early 1970s [80]. PD combines computer technology with health research and is well suited for today’s e-health research [79]. The goal is to develop useful and effective technology from the end users’ perspective. All stakeholders work in close collaboration with the technicians and the companies involved throughout the design process. Participation is the key in PD, and genuine participation of end users requires acknowledgement of the participants in the design process, not only seeing participants as informants [80]. Genuine participation is important to develop good design and to meet the needs of the end users, and it facilitates a mutual learning process for all stakeholders. The PD process is iterative and includes clarification of user needs (needs assessment), suggested
solutions (idea generation), practical trials (testing and retesting) and evaluation (effectiveness, quality of care and cost-effectiveness). In every cycle the design process moves closer to a desired result. If performed correctly, the PD development process is time consuming and demanding since it challenges the power distribution between the different stakeholders (researchers, patients, healthcare organisations), which may affect participation [80]. Clemensen et al. pose four general recommendations to guide the PD process in telehealth: (i) include healthcare staff, patients and their relatives to balance power between all stakeholders, (ii) work in clinical practice to understand needs, actions and technology, (iii) by creating a learning environment, a common understanding among technicians, researchers and users is enhanced, and (iv) use different tools and techniques to find a common language among all stakeholders [80].

**Electronic health literacy**

A study of the use of telehealth solutions from the US pointed out that approximately one-fifth of the patients were considered inappropriate for the use of telehealth, mainly due to an unclear diagnosis or a high degree of complexity (including co-morbidity), non-adherence and previous failed attempts with telehealth rehabilitation [81, 82].

A Danish population-based study showed that 10 to 20% of the general population perceived difficulties in key health literate (HL) tasks [83]. Compared with the general population, people with chronic conditions reported more difficulties in understanding health information and engaging with healthcare providers than people without chronic conditions [83]. Perceived HL difficulties were markedly higher in people with low income and low education level, people who lived alone and in people with non-Danish ethnicity [83].

Patients present with great differences in digital literacy and computer skills, the so-called electronic health literacy (eHL) [84]. A recent UK study on the association between socio-economic factors and internet use showed that people with low health literacy were less likely to use the internet or use the internet to gather health information [85]. eHL can be defined as ‘the ability to seek, find, understand, and appraise health information from electronic sources and apply the knowledge gained to addressing or solving a health problem’ [84].

One of the problems using PD in designing telehealth interventions might be that participants in the development phase do not represent all potential users in terms of skills and needs, which may lead to non-adoption of the developed telehealth interventions if they are too complicated or difficult to use [86]. As with many other health advances, the result will be that those with the most needs will benefit the least.

Due to the development and advances in digital technology, access to technology and digital literacy skills will have a significant influence on the determinants of health for future populations, and health
professionals of tomorrow must be prepared to assess and support patients at risk of disparity due to technical inequity [87]. WHO emphasises that the capability for patients to understand and manage their health calls upon a strong focus on health literacy skills and the formation of so-called health literate healthcare organisations [87], characterised by the elements shown in Box 2.

Box 2 Ten Attributes of Health Literate Healthcare Organisations [87]

1. Has leadership that makes health literacy integral to its mission, structure, and operations.
2. Integrates health literacy into planning, evaluation measures, patient safety, and quality improvement.
3. Prepares the workforce to be health literate and monitors progress.
4. Includes populations served in the design, implementation, and evaluation of health information and services.
5. Meets the needs of populations with a range of health literacy skills while avoiding stigmatization.
6. Uses health literacy strategies in interpersonal communications and confirms understanding at all points of contact.
7. Provides easy access to health information, services and navigation assistance.
8. Designs and distributes print, audiovisual and social media content that is easy to understand and act on.
9. Addresses health literacy in high-risk situations, including care transitions and communications about medicines.
10. Communicates clearly what health plans cover and what individuals will have to pay for services.

The telehealth solutions described in this paper address assessment (e.g. baseline PROMs and measures of physical function and physical activity), intervention (e.g. self-management programme, weight reduction programme, telephone follow-up based on PROMs, reminders, self-monitoring, outpatient follow-up), and evaluation (e.g. PROMs and assessment of physical function and physical activity) as part of the rehabilitation process. In the future, telehealth solutions may also apply to the goal-setting process. There is also a need to include information concerning the development process of telehealth and, if applied, the behavioural change theory used. Furthermore, telehealth solutions may encompass technological aids, solutions to compensate for reduced physical function and robotic technology to deliver care and practical support.

Telehealth may be useful to reach people who are not able to go to the hospital for rehabilitation interventions and may support people in becoming more independent, thus reducing the need for homecare. Telehealth solutions seem to be able to support behavioural change and maintenance of a healthy lifestyle, especially regarding physical activity. This is supported by a Cochrane review where the authors concluded that interactive health communication applications may have a positive effect on health behaviours [88].
In this paper, we have not addressed the storage and management of data from apps and other types of telehealth solutions owned by companies outside the healthcare system, and the accompanying ethical dilemmas. For example, app-development companies that sell the collected data, or the data are collected in extensive clinical registries to be used for research are not infrequent occurrences [89]. The management of data is a patient safety issue that needs special attention, and health professionals need to inform patients about what happens to the data they help collect. Therefore, the ethical issues around collection and storage of data is also emphasised in the Oxford Digital Health Roadmap [76]. Furthermore, cost-effectiveness studies have only been touched upon briefly. However, cost effectiveness is an essential element in the Triple Aim model [8] and thus both cost-effectiveness and patient safety should also be part of the evaluation in future telehealth studies.

**Conclusion**

Telehealth encompasses the use of telephone, apps, sensors, video, social media platforms and web-based programmes and is used as part of the rehabilitation process in assessment, intervention and evaluation. Although user involvement is recommended in the development of telehealth solutions, there is still a lack of telehealth studies where user involvement and behavioural change theories have guided the development. Complementary studies are needed to explore reasons for non-participation and non-adherence in telehealth as well as cost-effectiveness and patient safety.

Telehealth shows promising results, especially to monitor and facilitate physical activity in patients with eHL. Although patients are satisfied with telehealth in general, some are reluctant to engage with the technology or are non-adherent. This may be due to the lack of patient involvement in the development process, or that some patients may have different needs or lack the ability to use the telehealth solution in full, potentially due to low eHL. With regards to rehabilitation and telehealth, one size does not fit all and different modes of delivery are still needed.

**Research agenda**

- Randomized controlled trails and cost-effectiveness studies are still needed to explore the effectiveness of telehealth interventions.
- Complementary studies are needed to explore reasons for non-participation and non-adherence in telehealth.
- The development of telehealth interventions must be based on user involvement, behaviour theory and the World Health Organization principles of creating health literate organisations in order to ensure usability, effectiveness and further implementation.

**Conflict of Interest**

All authors declare no conflict of interest. All authors have been involved in the editorial processes and decisions regarding the manuscript.
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