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Assistive technologies to overcome sarcopenia in ageing

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ABSTRACT

Sarcopenia is an age-related decline in skeletal muscle mass and function that results in disability and loss of independence. It affects up to 30% of older adults. Exercise (particularly progressive resistance training) and nutrition are key strategies in preventing and reversing declines in muscle mass, strength and power during ageing, but many sarcopenic older adults fail to meet recommended levels of both physical activity and dietary nutrient intake. Assistive technology (AT) describes devices or systems used to maintain or improve physical functioning. These may help sarcopenic older adults to maintain independence, and also to achieve adequate physical activity and nutrition. There is a paucity of research exploring the use of AT in sarcopenic patients, but there is evidence that AT, including walking aids, may reduce functional decline in other populations with disability. Newer technologies, such as interactive and virtual reality games, as well as wearable devices and smartphone applications, smart homes, 3D printed foods, exoskeletons and robotics, and neuromuscular electrical stimulation also hold promise for improving engagement in physical activity and nutrition behaviours to prevent further functional declines. While AT may be beneficial for sarcopenic patients, clinicians should be aware of its potential limitations. In particular, there are high rates of patient abandonment of AT, which may be minimised by appropriate training and monitoring of use. Clinicians should preferentially prescribe AT devices which promote physical activity. Further research is required in sarcopenic populations to identify strategies for effective use of current and emerging AT devices.

1. Introduction

Recent international consensus operational definitions have enabled researchers to elucidate the prevalence and functional consequences of sarcopenia, the age-related decline in skeletal muscle mass and function. According to the European Working Group on Sarcopenia in Older People (EWGSOP) definition, 30% of community-dwelling older adults have sarcopenia [1] and this is associated with almost 60% greater hazard for hospitalisation and three-fold increased likelihood of disability [2]. Sarcopenia defined according to both the EWGSOP and Foundation for the National Institutes of Health (FNIH) definitions is associated with 60–70% higher falls rates in community-dwelling Australian older men [3]. FNIH-defined sarcopenia has also been associated with almost four-fold greater risk of mortality [4]. Assessment and treatment pathways are poorly implemented in clinical settings with only one in five health care professionals knowing how to correctly diagnose sarcopenia [5]. In 2016, the condition was recognised with its own International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) code (M62.84). This may result in significant increases in diagnoses of sarcopenia in clinical settings [6] but in order for this to occur, clinicians require evidence-based guidelines to treat and manage sarcopenia.

Promising sarcopenia drugs including myostatin and activin inhibitors are in development but not yet approved. Supplementation of protein, essential amino acids, β-hydroxy β-methylbutyric acid, omega-3 fatty acids, and vitamin D [1,7,8] may improve muscle composition and function, particularly in older adults with inadequate dietary intakes. Unequivocally however, exercise (particularly progressive resistance training; PRT) is most effective for improving muscle mass, strength and physical performance in older adults [8]. Even in nonagenarians, short-term high-velocity PRT has resulted in increases in muscle strength of > 100%, and significant improvements in mobility [9,10].

Sarcopenia-related functional deficits are a barrier to completing

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activities of daily living (ADLs), and maintaining adequate physical activity and a healthy diet. Interventions which maintain independence and support participation in desirable lifestyle behaviours are clearly required. Assistive technology (AT) is an umbrella term for devices or systems used to maintain or improve functioning and independence, and/or prevent impairments and comorbidities [11]. Examples of AT include mobility aids, communication devices, prostheses, bathroom equipment, and specialised computer software and hardware. The World Health Organisation states that AT is most needed by older adults, and those with disabilities, gradual functional decline and/or chronic conditions.

This review explores the role of AT in overcoming functional declines associated with sarcopenia, through managing components including poor strength and mobility, and/or supporting health behaviours which prevent sarcopenia progression.

2. Methods

We examined both traditional devices as well as emerging technologies that demonstrate promise for sarcopenic patients via a non-systematic search of the MEDLINE and CINAHL databases using search terms including (but not limited to) “sarcopenia”, “muscle weakness”, “muscle wasting”, “functional decline”, “ageing”, “mobility” “disability”, “exercise”, “nutrition”, “assistive”, “technology” “device” and “self-help”, with additional review of personal reference libraries.

No studies specifically addressed use of AT in patients with sarcopenia. While AT may reduce falls risk in older adults [12], falls were considered beyond the scope of this review. Rather, we focused on AT’s role in managing functional decline and improving physical activity and nutrition behaviours.

3. Assistive technologies for functional decline

Commonly prescribed (or sourced) AT for patients with mobility disability include walking aids (eg. walking sticks and frames). A systematic review reported that walking aids can improve mobility and balance in older adults, thus increasing independence [13]. A randomised controlled trial (RCT) examined effects of AT and environmental interventions compared with usual care in 104 frail older adults [14]. Participants in the intervention group were assessed for, provided with, and trained in use of AT addressing motor (including a range of walking aids, bathroom equipment, hygiene aids and kitchen aids), visual and hearing impairments, with follow-up assessments and further provision as needs changed. Change in the Functional Independence Measure (FIM), comprising 18 items assessing severity of disability across motor and cognitive domains, was the primary outcome. After 18 months, the intervention group demonstrated reduced functional decline compared with controls (mean declines of 4% and 11%, respectively; P = .01) [14]. Similarly, a two-year RCT of 91 younger and older adults with disabilities reported that participants randomised to prescribed AT and home modifications (including grab rails, bathroom equipment, hygiene and kitchen aids) experienced functional decline of a smaller magnitude compared to that of controls who received no AT [15]. In 319 community-dwelling older adults who reported difficulty with one or more ADLs, intervention group participants received five occupational therapy contacts involving assessment, task modification and AT prescription (predominately grab rails and bathroom equipment), and one physiotherapy session on balance and strength training, over six months. This intervention resulted in reduced self-reported ADL disability (the greatest benefits were observed for bathing and toileting) compared with a no-treatment control group [16]. However, it is unclear whether the benefits were attributable to AT, education, balance and/or strength training, or their combination.

3.1. Emerging technologies for maintaining independence

Exoskeletons (external orthoses which are often powered robotic devices placed over limbs) can support ambulation including for those with spinal cord injury [17]. Powered orthoses have also been developed to assist older adults in walking, stair climbing and chair rising [18], but their effectiveness for increasing ADL capacity is yet to be established. Robotics are also expanding into the area of personal care and domestic robots to assist people with ADLs [19]. Currently, commercial robots can fetch items such as food or drink, and also aid in feeding and grooming tasks. Robots are also being developed to assist with other ADLs such as showering, cooking, and cleaning [19].

‘Smart homes’ utilise the Internet of Things (IoT), connected devices that can automate the home environment to meet individual needs. Smart home technology is rapidly developing with a focus on medical assistive technology to keep older people safe and healthy within their own home [20]. In-home sensors, cameras and wearable sensors are being used to externally monitor activity, gait, falls and general health of people, providing alerts to carers when abnormal activity patterns or falls occur. Smart home technology also allows operation of numerous household appliances and systems (eg. lights, heating/cooling) through voice activation or touch screens, thereby supporting older adults with functional limitations to maintain independent living. Current limitations of smart home technology include usability by older adults, cost, privacy concerns and limited high-quality evidence of its effectiveness in improving safety, function and health [20].

Thus, evidence is lacking for existing and newer forms of AT in patients with sarcopenia due to the absence of trials in this specific population, and the emerging nature of many forms of AT. Nevertheless, AT may be beneficial in other populations with physical disability and so holds promise for those with sarcopenia. As described in Fig. 1, AT may theoretically prevent accelerated declines in muscle mass and function resulting from cessation of ADLs (e.g. housework, grooming, gardening etc.) in sarcopenic patients by enabling ongoing participation.

4. Assistive technologies for increasing physical activity

PRT is effective for maintaining and improving both muscle mass and function however less than 15% of older adults participate in any form of PRT [21]. Key issues for both clinicians and older adults in prescribing or participating in PRT include lack of access, cost, safety concerns, and also poor self-efficacy and perceptions that PRT is too challenging, particularly for those with injuries or comorbidities [21,22]. These concerns are likely common to sarcopenic patients, and AT may support these individuals to engage in muscle-building exercise.

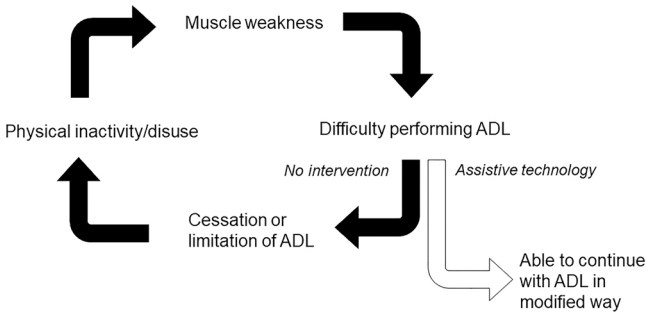

Fig. 1. The potential role of AT in preventing loss of independence due to functional decline.