ABSTRACT

Introduction Sarcopenia is a highly prevalent muscle dysfunction among older adults and is associated with adverse events. The periodic monitoring enables an early screening of patients at risk and control of the progression of muscle impairment. Wearable devices have been used as clinical support for sarcopenia detection. Therefore, this review aims to identify how wearable devices have been used to screen sarcopenia.

Methods and analyses Searches will be conducted from August 2023 on PubMed, CINHAL, Embase, Web of Science and SciELO databases. We will include cross-sectional and/or baseline data from prospective studies reporting the use of wearable devices to investigate sarcopenia. Studies that discuss only the development of algorithms or applications for the assessment of sarcopenia or unavailable full texts will be excluded. The main reviewer will conduct the initial search and exclusion of duplicates, while two independent reviewers will select studies, extract data and assess the methodological quality using the Appraisal tool for Cross-sectional Studies.

Ethics and dissemination No previous ethical approval is required for this review. The findings of this review will be submitted to a scientific journal and disclosed at international scientific conferences.

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INTRODUCTION

Sarcopenia is a progressive muscle disorder characterised by loss of muscle mass and function that slowly starts between 40 and 50 years and accelerates after 60 years. This condition is associated with risk of adverse events, such as physical disability, frailty, cognitive impairment, falls, poor quality of life, and death.1–3

Currently, different consensus definitions have been proposed by groups of specialists around the world, with the aim of standardising the conceptual approach to sarcopenia.4–6 The most cited definition nowadays was proposed by the European Working Group on Sarcopenia in Older People (EWGSOP),4 and its updated version (EWGSOP2) proposes that a person with low strength and muscle mass will be diagnosed with sarcopenia.7

In addition, the International Working Group on Sarcopenia (IWGS) proposes, in addition to low skeletal muscle mass, low physical performance as a diagnostic criterion for sarcopenia.8 As for the EWGSOP2, the measurement of physical performance, such as low gait speed, is recommended to determine the severity of the condition, allowing predicting outcomes and determining the intensity of interventions.7,9

Traditionally, measures of physical performance are assessed through subjective or objective measures, which include assessment of mobility, balance and strength, and are commonly measured with single tests, such as gait speed test.10,11 Although these tests are economical and simple to develop, they have limitations such as changes in behaviour due to being observed or may not represent the individual’s actual performance in their daily context.12

Technological advances have made it possible to monitor and record information about physical performance in real time, through the capture of information about physiological patterns, physical activity and mobility of the individual, from
wearable devices. These sensors are characterised by being attached to the individual’s body and allowing the continuous monitoring of measures such as linear and angular body speeds and cardiac activity, preserving the user’s autonomy and independence.\textsuperscript{14–16}

Considering that individuals diagnosed with sarcopenia can present several deteriorations in terms of physical performance,\textsuperscript{17} it is important to understand how objective parameters obtained through wearable monitoring sensors are related to sarcopenia, so that it is possible to identify individuals at risk of severity and that therapeutic strategies can be elaborated in an assertive way. The aim of the present study is to examine the literature to identify how wearable devices are being used for sarcopenia monitoring. Likewise, it aims to define which parameters obtained by sensors have been most used and how they are associated with the diagnostic criteria for sarcopenia.

METHODS AND ANALYSIS

Registry

This protocol was elaborated according to the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols\textsuperscript{18} and registered in the International Prospective Registry of Systematic Reviews (PROSPERO) in September 2022.

Eligibility criteria

Types of study

Cross-sectional and/or baseline data from prospective studies will be included. Studies with full text unavailable and studies that discuss only the development of algorithms or applications for the investigation of sarcopenia will be excluded.

Types of participants

Participants must be subjects of both sexes aged 40 years or older, considering that the decline in muscle mass begins at this age.\textsuperscript{4} Furthermore, when observing, preliminarily, the studies that are carried out on the subject, it was observed that the included population had an average age of 40 years or more, which is the justification for using this age as a reference. The participants must be clinically diagnosed with sarcopenia based on the following consensus: (a) EWGSOP\textsuperscript{4}; (b) EWGSOP\textsuperscript{27}; (c) IWGS.\textsuperscript{8}

Exposition

Studies assessing the use of wearable devices to investigate sarcopenia will be considered. A wearable device is a mobile electronic device composed of electronic sensors, wireless communication modules and processing units. These sensors can be integrated into textile fibres, clothing, elastic bands or directly attached to the human body to continuously and autonomously transmit data.\textsuperscript{12,19}

The most commonly used sensors are wireless inertial sensors, which can be identified in the form of accelerometers, gyroscopes and pedometers, which provide information on the intensity and duration of physical activity. Accelerometers are wearable devices that measure the acceleration of the body segment to which the sensor is connected.\textsuperscript{20} Gyroscopes measure changes in orientation, either rotational or angular velocity, acceleration or displacement.\textsuperscript{21} Pedometers measure the number of steps and are considered the simplest sensors.\textsuperscript{22} Currently, smartphones, smartbands and smartwatches incorporate a large set of sensors that can be used to generate health information.\textsuperscript{23} For the development of this study, wearable devices capable of providing quantitative measurements on mobility and/or physical activity and/or physiological measures, which allow the monitoring of physical performance, will be considered.

Types of outcome measures

Primary outcomes

1. Measurements or parameters of wearable devices that may be used to assist or assess sarcopenia.
2. Describe which parameters, found in the sensors, are associated with the diagnosis of sarcopenia in comparison with operational definition criteria.

Secondary outcomes

1. Gait speed (distance in metres and time in seconds).
2. Number of steps per day.
3. Physical activity (time involved in an activity that increases the heart rate above the resting level; or time at different levels of intensity: light, moderate and vigorous; or energy expenditure).
4. 4. Types of wearable sensors used to assess sarcopenia.
5. 5. Location or positioning of sensors in the body.

Search

Search strategy

Searches will be conducted in PubMed, CINHAL, Embase, Web of Science and SciELO databases. We will select full-text studies without language or publication date restriction. A customised search strategy will be designed for each database. The search headings used will be ‘sarcopenia’ and ‘wearable electronic devices’, with the search terms relating to each of these headings. The search strategy and search terms used for this research are detailed in online supplemental file. A manual search will be performed by consulting the list of bibliographic references of the included studies. Studies will be included after reading titles, abstracts and full texts.

Study selection

After identifying the studies, all files will be transferred to the Mendeley reference manager (https://www.mendeley.com) to identify duplicates. Subsequently, the reference list will be transferred to the Rayyan QCRI systematic reviews web application (https://rayyan.qcri.org) for title and abstract selection by the main reviewer (MMP). Two other reviewers (WHBdS and SGGF), blindly, one in relation to the other, will independently read the titles and abstracts, and the selection of these reviewers will be paired with the selection of the main reviewer. In case of disagreement, a discussion will be held to reach a consensus among reviewers considering
the pre-established eligibility criteria. Eligible articles will be obtained in full text. A fourth reviewer (EKRS) will be included to analyse the studies when necessary. The detailed search selection process will be recorded to elaborate a Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram.

**Data extraction**
The following data will be extracted by one reviewer using a standardised form and verified by the second reviewer:
1. Participants (age, sex, health conditions).
2. Methods (study design, sample size, country, and year).
3. Sensors used and location in the human body.
4. Assessment tools (strategy to diagnose sarcopenia).
5. Findings (primary and secondary outcomes).
6. Limitations of the study.

**Quality assessment**
The Appraisal tool for Cross-sectional Studies (AXIS) will be applied by two independent reviewers (MMP and WHBdS) to assess the methodological quality of the selected studies. The AXIS was developed to assess cross-sectional studies, help assess the suitability of the study to answer the hypothesis, identify possible biases and assess the relevance of the study. The 20 items of the tool can be answered using ‘yes’, ‘no’ or ‘I do not know’. The results of each item will be tabulated according to the identification of authors. To assess the methodological quality of this review, the AMSTAR2 instrument will be used, which is a critical evaluation tool for systematic reviews, which include randomised and non-randomised studies. AMSTAR2 includes a list of 16 check items. A review is considered well conducted when it addresses all items on the list.

**Analysis**
The results of each study will be summarised in tables for the elaboration of a quantitative synthesis of the study.

**Study timeline**
This review will be conducted for 8–12 months.

**Patient or public involvement**
No patient involved.

**Ethics and disclosure**
No previous ethical approval is required for this review. The findings of this review will be submitted to a scientific journal, disclosed at international scientific events and shared in social media using accessible language.

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**Contributors**
MMP conceptualised and designed the review and drafted the manuscript. WHBdS, EKRS, SGSF, PdC, PESSA, ATdNSSF contributed to the design of the review and edited and approved the manuscript. ACCM conceptualised and designed the review, authored or reviewed drafts of the paper, and approved the final draft.

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**Competing interests**
None declared.

**Patient and public involvement**
Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication**
Not applicable.

**Provenance and peer review**
Not commissioned; externally peer reviewed.

**Supplemental material**
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