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Review Article

How can Activity Trackers be Useful? A Scoping Literature Review

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Abstract

Aim: Wearables technology plays an important role in supporting patients in self-management. This study aims to identify the functions and purposes of activity trackers that contribute to and assist in addressing the nursing diagnosis of Sedentary Lifestyle in patients with heart failure. **Design**: A scoping review was conducted. Depending on the type of study, critical appraisal took place using PRISMA, CONSORT, STROBE, or SRQR. Methods: A systematic search was performed in CINAHL, MEDLINE/PubMed, and the Cochrane library. Publications from January 2010 through May 2019 were included. The main subjects of the review were the functions and purposes of activity trackers that are used to support heart failure patients who live a sedentary lifestyle. **Results**: Thirteen articles were used for the analysis. The main feature of an activity tracker is the registration of steps, active/sedentary time, and calories burnt during the day. The following functions were mentioned in the articles: data collection, monitoring/self-monitoring, feedback, goal setting, awareness of own behaviour, motivation, and providing social support through the sharing of data.

Keywords: Heart failure; Physical activity; Nursing Diagnosis.

Introduction

Heart failure (HF) is a common health problem in developed countries worldwide [1,2]. HF is considered to be a medical diagnosis, and there are often complications related to this diagnosis in terms of patient health problems that are of concern to nurses, also referred to as 'nursing diagnoses' or 'related health problems'. Patients with heart failure usually experience reduced physical activity tolerance, as well as symptoms such as fatigue and shortness of breath (dyspnoea) that may lead to an excessive amount of physical inactivity and resultant physical deconditioning. Despite the positive effect, physical activity is known to have on the risk factors and symptoms of HF, the majority of HF patients are physically inactive [3]. Consequently, Sedentary Lifestyle and Activity Intolerance are common nursing diagnoses for people with HF [4,5]. They are characterised by a preference for daily activities without physical effort, which in turn results in diminished physical wellbeing and health status [5-10]. The impact of technology on healthcare has been enormous, and new devices are constantly being developed to assist people in measuring their own health. Wearables devices such as activity trackers (ATs) are being used by an increasing number of people, and they appear to contribute to health improvements in patients with a sedentary lifestyle [7].

Background

Park et al. (2018) [6] state in their study that health care providers play an important role in emphasising the importance of physical activity and in insisting that the physical activity of patients be assessed. Health care providers can educate patients with heart failure about the relationship between sedentary behaviour and negative health outcomes. They can also provide practical tools and interventions to promote physical activity (e.g. the use of digital technology) [6,11].

Sedentary Lifestyle is a nursing diagnosis for patients who demonstrate the following characteristics: physical deconditioning, reporting preferences for minimal physical activity, and choosing a daily routine lacking in physical exercise5. There are common related factors such as insufficient knowledge about the benefits that are associated with exercise, insufficient interest, or insufficient motivation. Common expected outcomes are written in a nursing care plan and relate to knowledge, prescribed activity, and physical fitness. The nursing care plan also provides ongoing assessments [5,12]. Nursing objectives are to assist patients to find a way to personalise their own healthy behaviour, and to advise and support patients in the process of increasing their physical activity and self-management skills (i.e. by monitoring their physical activity to ensure it is increased safely)[13,14].

Activity trackers (ATs) are small, user-friendly devices that are typically worn on the wrist. They register the user's physical activity behaviour by measuring the number of steps users take, along with other health measures. Combined with the use of an associated mobile application, this provides the patient with insight into their own health behaviour. Examples of widely used activity trackers are the Fitbit Charge and the Garmin Vivosmart [15].

ATs are able to track and analyse data, enabling patients to monitor their own progress. Additionally, other individuals such as friends and health care providers are able to monitor and support the patient if access is permitted. In this way, the AT can be used as a tool for nurses to encourage patients to develop a healthier lifestyle, as well as to engage them in an effort to understand and improve their chronic disease [7,16,17].

This study focuses on the nursing diagnosis of 'Sedentary Lifestyle in HF Patients', with the aim of examining how the functions and possibilities of activity trackers in this patient category can be beneficial in the nursing process.

All of the aforementioned evidence suggests that ATs may be useful tools in all of the different steps of the nursing process. During the assessment, an AT provides the nurse and the patient with a more complete overview of the situation by providing additional objective data. This information may be useful as an input for diagnosing an inactive lifestyle and could also be helpful for formulating personalised goals when attempting to change activity behaviour. The AT can then be used as a tool both when implementing the goals and when evaluating whether the goals have been met [18].

The primary reason for undertaking this review was to test the hypothesis that the use of an AT is a simple, non-invasive way to obtain essential data about the condition of a person with cardiac disease. It was also judged that the current generation of ATs are sufficiently reliable to be recommended by a nursing professional. However, we had no adequate scientific basis for this assumption. Another central reason for undertaking this study was that if nurses do not incorporate new applications of technology into the nursing process, use of such technology cannot become part of their daily routines, and so cannot be incorporated into the training curriculum. It is precisely the examination both of statements regarding the scientific reliability of the technology involved and of the possibilities of incorporating the use of such technology into the theoretical framework of the nursing process that makes this review of practical value for both everyday nursing practice and nursing education [7,17,18].

Aim

The aim of this scoping review was to identify the functions and purposes of activity trackers that contribute to nurses' recognition and treatment of the diagnosis of Sedentary Lifestyle in patients with heart failure, and to explore how these functions can be used in the nursing process.

The research question was: Which functions and purposes of activity trackers can contribute to the phases of the nursing process for the diagnosis of Sedentary Lifestyle?

Design

To answer the research question, a scoping review was performed using the electronic databases MEDLINE/PubMed, CINAHL, and the Cochrane library. As a theoretical framework, the NANDA classification system was employed to determine the characteristics of the nursing diagnosis of Sedentary Lifestyle [12]. The Nursing Interventions Classification (NIC) and the Nursing Outcomes Classification (NOC) [10,11] were used to describe possible interventions and patient outcomes. The description of the theoretical background of the concepts, published in the aforementioned nursing classification systems, was considered to be potentially helpful for making a sound case for the usability of activity trackers in the nursing process of HF patients.

Method

MEDLINE/PubMed, CINAHL, and the Cochrane library electronic databases were used to search for the functions and possible applications of ATs. Due to the increase in popularity of wearable sensors such as ATs over the past decade, the search period was set to include dates ranging from January 2010 to January 2020. Articles written in either English or Dutch were included. Only studies looking at populations aged 18 years or older were included. The search terms used were: activity tracker(s), activity sensor(s), fitness tracker(s), wearable(s), wearable technology, accelerometer(s), Fitbit(s), Garmin, Jawbone, Misfit, Samsung, Nike, Polar, health behaviour, sedentary lifestyle, inactive lifestyle, physical inactivity, physical activity, physical exercise(s), heart failure, myocardial failure, heart decompensation, congestive heart failure, and cardiac disease(s). Specific brands were used in the search strategy because of several validation studies in which these trackers were involved. Included in this review were studies with a Level of Evidence (LOE) of I–IV according to the Oxford levels of evidence [19]. The main subjects of the review were the potential uses of an AT when it comes to supporting HF patients with a sedentary lifestyle and supporting nurses in the nursing process involved in caring for HF patients with a sedentary lifestyle.

All studies with an LOE from I–IV were used; these included systematic reviews, studies with an experimental design (such as randomized controlled trials and quasi-controlled trials), as well as cohort and validation studies. LOE VI (expert opinions) was excluded.

This study focuses primarily on patients with HF; however, in the inclusion criteria, the term "cardiovascular disease" was also used. Included articles were required to also have specified at least which diagnostics were or could be performed with the ATs, as well as other potential specifications related to the steps in the nursing process.

The articles were assessed according to the inclusion criteria by two researchers working independently. Disagreements were discussed until a consensus was reached.

Search outcome

A total of 876 articles were identified (Figure 1). After removal of duplicates and independent screening of all titles and abstracts by two researchers, 28 studies were retrieved for full text analysis and further screening. When studies were excluded, the reasons for exclusion were noted. The most common reason for exclusion was that no relevant information was provided regarding the functions and purposes of the AT, resulting in the article not being useful for answering the research question. A full article assessment was subsequently performed on 13 studies (Figure 1).

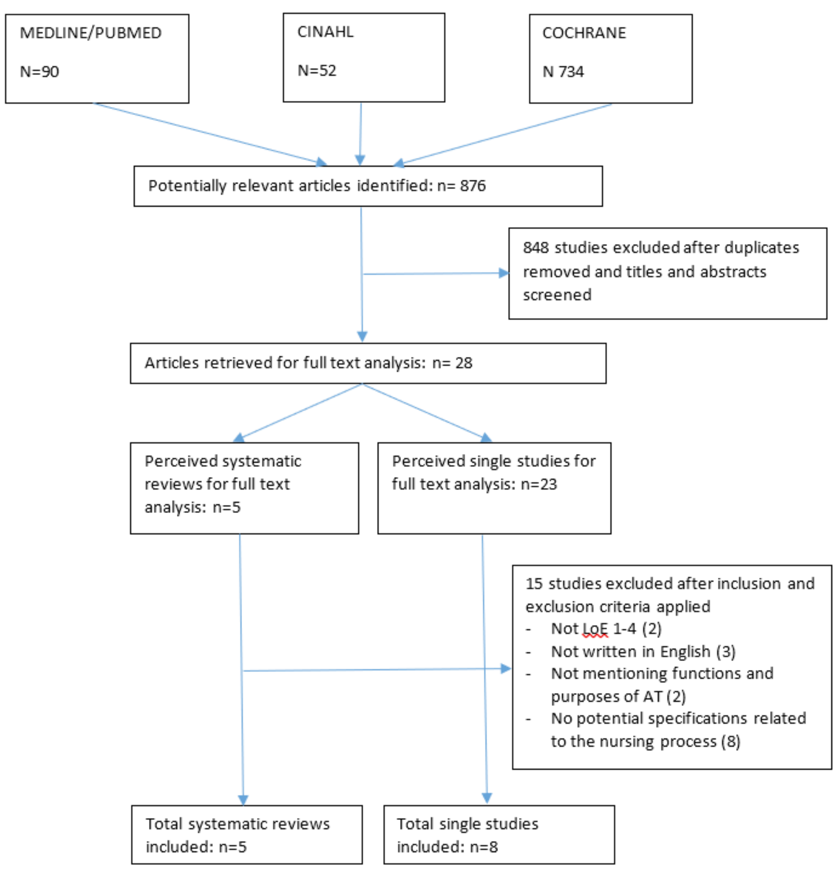

Figure 1: Search strategy and number of articles identified.

Quality appraisal

The included articles were systematically and independently reviewed by two reviewers using the PRISMA review protocol [20]. The reviews focused on the type of study, population and sample size, data analysis, and general findings concerning the functions of the AT related to the nursing diagnosis. Additionally, the reviewers assessed the methodology of each study according to the altered guidelines provided by Cochrane, which depend on the type of study. The EQUATOR resources were used for choosing the critical appraisal instruments (see Supplementary File 1). Systematic reviews were assessed according to the guidelines of the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta Analyses) statement [20]. For single studies, for example, randomized controlled trials were assessed according to the recommendations of the CONSORT (Consolidated Standards of Reporting Trials) statement [21] The STROBE (STrengthening The Reporting of OBservational studies in Epidemiology) statement was used to assess observational and cohort studies [22]. The SRQR (Standards for Reporting Qualitative Research) were used to assess the qualitative studies [23].

Data abstraction and synthesis

Data were extracted by both independent reviewers by assessing the authors' names and the studies' years of publication, study type, patient group and age, sample size, name and type of the AT used, functions and possibilities of the AT used, and other relevant information. The data were used to answer the research questions related to the validity and reliability of ATs, the weaknesses of ATs, and the possibilities presented by ATs when used as part of an intervention.

Data were compared and discussed, and disagreements were resolved by consensus. The data were categorized according to a matrix, the design of which was guided by the several steps of the nursing process. In this way, for each step of the nursing process, the features and possibilities of the AT that were relevant to the nursing diagnosis of Sedentary Lifestyle were shown.

Results

Of the 13 selected articles, five were systematic reviews, three were RCT studies, two were validation studies, two were qualitative studies, and one was a cohort study. The systematic reviews are shown in (Table 1a), while the additional single studies are shown in (Table 1b).

Author	Population	AT type	Assessments	Functions	Specifications / limitations
Allet et al. 2010	Adults with arthrosis, cardiovascular disease, diabetes or COPD	Actigraph GT3X Uniaxial GT1M Yamax Digiwalker StepWatch Caltrac	Steps Heart frequency Active minutes Sedentary time	Data collection (Self) monitoring Feedback	No consumer-based AT. Some of the ATs did not perform well. Methodological limitations in some of the studies (like blinded protocol). AT not reliable in slow speed. Population not only cardiovascular disease.
Gal et al. 2018	Adults with a sedentary lifestyle	Actigraph GT3X	Steps Active minutes Sedentary time	Data collection (Self) monitoring	No consumer-based AT. In three studies, the randomization is not described, risk for selection bias. Population not only cardiovascular disease.

Sanders et al. 2016	Adults with a cardiovascular disease	Fitbit ChargeHR Jawbone Up Garmin Vivovit Nike Fuelband SE Lumoback posture Sensor	Steps Heart frequency Active minutes Sedentary time Calories burnt	Data collection (Self) monitoring Feedback Setting goals	Privacy of personal data is an important topic in using the AT. Participants forgot to wear the AT.
Kirk et al. 2019	Adults with cardiometabolic disease	Fitbit Garmin HR Yamax Digiwalker Actigraph ActivPAL	Steps Heart frequency Active minutes Sitting minutes Sedentary time Calories burnt Saturation Sleep	Data collection (Self) monitoring Feedback Setting goals	Not all of the ATs are consumer based. Participants forgot to wear the AT. Some studies have a risk of a blinding bias. Costs can be a threshold to use an AT. Uncertain if only the AT is enough motivation to be more physically active. Long term effects are unknown. Some studies had small sample sizes.
Tan et al. 2018	Adults with chronic heart failure.	12 different AT Kenz Actigraph Activity monitor (specific device not identified). Accelerometer (specific device not identified).	Steps Active minutes Sedentary time	Data collection (Self) monitoring	Some studies are focused on the environment instead of day-to-day activity patterns. Long term effects are unknown.

Table 1a: Selected systematic reviews on AT and functions (n=5).

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Author	Design, population	AT type	Assessments	Functions	Specifications / limitations
Cupples et al. 2013	RCT Adults with heart failure	Yamax CW-701	Steps Calories burnt	Data collection (Self) monitoring	Selection bias and risk of motivation bias.
Jefferis et al. 2014	Cohort study Adults 70-93 years with chronic diseases	Actigraph GT3X	Steps Active minutes Sedentary time	Data collection (Self) monitoring	No consumer-based AT. Only activities of >10 mins were measured so perhaps an underestimation of physical activity. Population not only cardiovascular disease.
Thorup et al. 2016	RCT Adults with heart failure	Fitbit Zip	Steps Calories burnt	Data collection (Self) monitoring	Participants forgot to wear the AT. AT not reliable in slow speed; can be a problem with this patient group. Population not only cardiovascular disease.
Gualtieri et al. 2016	Qualitative study Adults 39-77 years with chronic diseases (including heart disease)	Withings Pulse	Steps Distance Heart frequency Burnt calories Sedentary time Sleep	Data collection (Self) monitoring Awareness Setting goals Feedback It motivates social support and sharing data	Costs can be a barrier to use an AT. Advice to coach users in the use and interpretation of the AT. Design, size, and discomfort of an AT is sometimes a barrier. Population not only cardiovascular disease.
Mercer et al. 2016	Validation study Adults 50 years and older with a chronic disease (including heart disease)	Fitbit Flex Misfit Shine Withings Pulse Jawbone UP24 Nike Fuelband SE Polar Loop	Steps Active minutes Sedentary time Calories burnt	Data collection (Self) monitoring Awareness Self-regulation Setting goals Feedback It motivates earning points, social support and sharing data	Some AT are no longer very recent. Users need to be motivated to wear the AT. Advice to coach users in the use and interpretation of the AT. Population not only cardiovascular disease.

Alharbi et al. 2016	Validation study Healthy adults and adults with failure	Fitbit Flex Actigraph GT3X	Steps Active minutes Burnt calories Heart frequency Sleep Sedentary time	Data collection (Self) monitoring Feedback Social support, sharing data Earning points	Fitbit slightly overestimates the sum of steps. Participants were very motivated, maybe bias when generalized to other groups.
Vogel et al. 2017	RCT Adults 18 years and older	Polar Loop	Steps Active minutes Burnt calories Distance	Data collection (Self) monitoring Setting goals Feedback	Advice to coach users in the use and interpretation of the AT. It is not advised to use an AT only as a single intervention. No blinding in the design. Population not only cardiovascular disease.
Deka et al. 2019	Qualitative study Adults with heart failure	Fitbit Charge HR Actigraph GT3X	Steps Active time Sedentary time Heart frequency Calories burnt	Data collection (Self) monitoring Awareness Self-regulation Setting goals Feedback and self confidence Social support, sharing data	AT in the sum of steps were overestimating and underestimating but still accurate for self-monitoring. Participants forgot to wear the AT. Small sample size.

Table 1b: Selected single studies on AT and functions (n=8).

Several functions of the ATs are documented in the selected articles. The main function of all ATs is the registration of steps. Most ATs that were mentioned in the articles also measure active and sedentary time and the calories burnt during the day. The more recent ATs are also able to register heart frequency and sleep pattern, just like several types of Fitbit and Garmin.

The following functions of ATs were mentioned: data collection, monitoring/self-monitoring, feedback, assisting in goal setting, improving awareness of own behaviour, improving motivation, and providing social support due to the sharing of data.

The qualitative studies offered information regarding the usefulness of an AT in healthcare settings. An AT can be beneficial as a tool to enhance physical activity; however, it is advised to use the AT in combination with coaching to achieve better results [24-31].

In a few studies, non-consumer-based ATs such as the Actigraph, Caltrac, and ActivPal were used [26-29]. These devices are only used in laboratory or research settings.

The ATs mentioned in (Table 2) demonstrate acceptable validity for laboratory and field settings (ICC of .90 or higher and 96% CI of .83 and higher).

In (Table 2), the functions and purposes of ATs are shown and related to the steps of the nursing process for the nursing diagnosis of Sedentary Lifestyle. The nursing process functions as a systematic guide to client-centered care, with five sequential steps. These are assessment, diagnosis, planning of outcomes, implementation of interventions, and evaluation.

Steps in nursing process	Features of Nursing Diagnosis SL	Functions of AT	Type of AT
Assessment	- Insufficient interest in PA - Insufficient knowledge of benefits of PA - Insufficient motivation - Insufficient resources for PA - Insufficient training for PA	- Objective registration of PA (steps/day), heart frequency, sedentary time, active time - Awareness in PA and active/sedentary time for client and health professional	Fitbit Flex/Charge HR Withings Pulse Jawbone UP24 Polar Loop Garmin Vivofit/HR
Diagnosis	- Physical activity level is lower than recommended: Sedentary lifestyle at less than 300 steps/day - Physical deconditioning - Preference for activity in low level	- Can be used to assess a sedentary lifestyle based on steps/day and sedentary time - Identify client groups at risk - Begin preventive actions to enhance awareness and level of PA	Fitbit Flex/Charge HR Withings Pulse Jawbone UP24 Polar Loop Garmin Vivofit/HR
Outcomes	- Increase awareness or knowledge on importance and benefits of PA - Identify self-monitoring techniques - Engagement in planned exercise programs - Increase gradually in PA - Improve PA, mental, social, and emotional functioning of the body	- Define SMART outcomes based on the individual client, their needs using the AT - AT stimulates the client to meet their goal, enhances motivation - AT provides reminders to meet the individual goals	Fitbit Flex/Charge HR Withings Pulse Jawbone UP24 Polar Loop Garmin Vivofit/HR

Interventions	- Explain the effect of PA on body functioning and well-being to the client - Determine the possible barriers to being physically active - Begin an activity with a warm up and end with a cool down - Check vital signs such as heart rate before starting exercise - Assist the client from the beginning to the last part of the exercise - Recommend keeping a record of activity - Suggest that the client have an exercise buddy - Encourage involvement in active forms of social activities	- Awareness in PA and active/sedentary time for client and health professional - Feedback function to client - Continue monitoring of goals - Enhances self-management and self esteem - Possible positive effect on behavior change - Sharing data with health professional or other AT users, support	Fitbit Flex/Charge HR Withings Pulse Jawbone UP24 Polar Loop Garmin Vivofit/HR
Evaluation	- Evaluating the outcomes	- Awareness in PA and active/sedentary time for client and health professional - Feedback function to client - Continue monitoring of goals - Sharing data with health professional or other AT users, redefine outcomes if needed	Fitbit Flex/Charge HR Withings Pulse Jawbone UP24 Polar Loop Garmin Vivofit/HR

Table 2: Functions of AT related to the nursing diagnosis Sedentary Lifestyle following NANDA-NIC-NOC and the nursing.

Table 2 shows the functions of ATs and in which step of the nursing process they can contribute to the diagnosis and treatment of a sedentary lifestyle. The gathering of objective data can raise clients' awareness regarding their own physical activity patterns [32]. Gualtieri et al. (2016) [27] reported that participants did not expect their physical activity patterns to be as low as they were. For the participants, this realisation provided extra motivation to be more physically active.

When a sedentary lifestyle is diagnosed, an AT can help in setting individual goals. The increased awareness that clients gain from using the AT in combination with motivation or support can help them to achieve their goals [26,33].

All selected articles stated that an AT can play an important role in this context. The client can monitor physical activity levels; they can take initiative to achieve their goals once they see that those goals have not yet been met. Additionally, participants reported that they felt safer being physically active because their heart rates were being measured [32]. Having such data also provides health professionals with feedback about their clients, allowing them to provide better individual coaching on the basis of their assessments [25].

Discussion

Wearable technology is making a move toward tracking physical activity in a more adequate way while providing extra monitoring functions for the user [26].

Although the literature shows accurate counting of steps in activity trackers like Fitbit, Jawbone, Withings, and Garmin with ICC's of .90 and higher in an experimental setting such as in field settings [34], validity and reliability are dependent on walking speed [35]. Step counts were slightly underestimated at slower walking speeds, while free-living circumstances and accuracy improved at higher walking speeds [36,38-40]. Despite apparent underestimations of indicators such as heart rate frequency and energy expenditure compared to laboratory measures, based on the literature we can conclude that measurements can be estimated in a manner that is safe, accurate and useful in the nursing process, helping nurses support patients with heart failure and a sedentary lifestyle.

The implementation of wearables requires nurses' engagement. Therefore, knowledge and skills are needed. Nurses should be educated regarding the circumstances in which wearables can be useful in the nursing process and what they might add for both the patient and the health professional.

Nursing students are already engaging with wearable technology to gain an understanding of patients' conditions[36,37,40]. However, the attitude of manufacturers towards developing wearables for nursing care is also important. It is essential that nurses are involved in the development and testing of wearables so that they will have confidence in the applicability of this new technology and the usefulness of the data that is aggregated [36-41].

Examining the possibilities presented by ATs in the nursing process for the nursing diagnosis of Sedentary Lifestyle, as well as the effects ATs tend to have on activity levels, the use of ATs appears to be a promising nursing intervention and thus should be part of the Nursing Intervention Classification. There is also existing evidence that ATs may contribute to the improved health of other patient groups, so the use of ATs should not only focus on patients with heart failure. Therefore, the usefulness of these devices to other patient groups needs to be explored in more depth.

For ATs to become part of the nursing process, it essential that they become part of evidence-based protocols; guidelines are needed to arrive at efficient and accurate interventions on the basis of accurate assessments.

Another important subject is the need for better compatibility of the data extracted by ATs with other systems, such as electronic patient record systems. Interdisciplinary coordination of care related to lifestyle interventions can lead to better involvement of patients and their family members in shared decision-making processes [37].

Considering the heterogeneous nature of the studies included in this review, the findings must be interpreted with caution. This study included research outcomes based on different levels of evidence. In addition to systematic reviews, RCTs, cohort studies, validation studies, and qualitative studies were also included. Although some of these studies have lower levels of evidence, most of them provide beneficial information about the strengths and weaknesses of the functions of ATs in health care settings and so can be used when considering practical questions regarding where and how to use ATs in the nursing process.

Most studies used consumer-based ATs such as Fitbit and Polar. However, non-consumer-based ATs (ActiGraph) or step counters (Yamax) were also sometimes used. These last two types afford fewer possibilities related to their usefulness in the nursing process. They are more beneficial in experimental settings; furthermore, as a step counter, Yamax lacks functions like monitoring and distance support in comparison to more recently developed activity trackers.

We considered making concrete general recommendations for the choice of certain ATs in nursing practice. A concrete choice may eventually have to be made by the patients themselves in coordination. Based on the data gathered from this review, either Fitbit Charge HR or Polar Loop could be considered in the nurse's advice to the patient. Nevertheless, personal preferences related to wearing comfort or compatibility with other systems can play a role in the final decision and must be taken into consideration as well.

Conclusion

Results show that ATs may be a promising addition to the nursing process. The authors' findings indicate useful functions of ATs in every step in the nursing process for assessing and enhancing the physical activity patterns of heart failure patients. Using ATs, nurses are equipped with a tool to deliver tailored treatment to patients. For ATs to be an effective tool in treating patients and enhancing their capacity for self-management, nurses should be involved in implementing ATs in standard patient care.

Relevance to clinical practice

Science and the publication of articles are always behind the times due to the fast innovation involved in the development of wearables related to healthcare. Therefore, the most recent studies may not be included in the current study. It can be stated that the studies included in this review offer generally acceptable, reliable, and valid data. However, the studies do not always fully describe how their results were obtained. They also frequently examine a "healthy context" (i.e. one in which measurements were made of relatively vital target groups). It is recommended that studies include vulnerable groups along with other, more heterogeneous caloric, conditional backgrounds in this type of reliability study as well, and that studies state more precisely how their sample was selected.

This could lead to adjustments of more defined algorithms based on which the current generation of ATs function. This could usher in a new generation of ATs that are more precisely tailored to users' backgrounds.

It is suggested that further research also include other measurements that can be made by ATs, such as measurements of sleep patterns and heart rate. Furthermore, pilot studies should be conducted in which ATs are used as part of an intervention (i.e., with patients using an AT in their treatment). It is important to investigate the attitude of patients towards the use of ATs in their treatment and daily life. Nurses should be involved from the beginning because they play a key role in supporting patients by providing instructions, support, and interventions.

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