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REVIEW ARTICLE

Bridging gaps, wearable tech, apps and physical activity in older adults: A systematic review

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ABSTRACT

The rapid advancement of wearable trackers and smart phone apps has introduced new avenues for promoting physical activity (PA) among older adults. This review examines efficacy, advantages and gaps associated with the adoption of and sustained utilization of these technologies in enhancing physical activity engagement. Findings showed that wearable trackers and smart phone apps proved significant advantages, such as real-time tracking of health indicators, motivation and early detection of health risks. However, gaps including technical literacy, data accuracy concerns, privacy issues, long-term adherence limit their full potential. This systematic review emphasizes the importance of customized training, intuitive interfaces, and health care integration to enhance adoption rates among older adults. The PrEAP model is proposed as a framework for enhancing preparation and readiness in the utilization of wearable technologies. Further studies ought to investigate tailored strategies and theories to bridge the gaps in technologies adoption among aging population.

Keywords: Wearable trackers, Smart phone apps, Technology adoption, Healthcare, Aging, PrEAP model.

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INTRODUCTION

The incorporation of technology in health management has generated a plenty of attention in this increasingly digital environment, especially when it comes to older adults' physical activity (PA) levels. Wearable trackers and smart phone apps have emerged as promising tools to encourage participants, providing real-time data on healthcare evaluations and promote healthy lifestyles. However, despite their immense potential, an array of challenges and gaps prevent older adults from adopting and utilizing these technologies consistently. Bridging these gaps is essential for enhancing physical activity levels as well as boosting the populations general health and wellbeing.

Chronic diseases listed by World Health Organization (WHO) including cardiovascular diseases, cancers, chronic respiratory diseases, diabetes mellitus, osteoarthritis and neurodegenerative disorders represent a major global health problem (Müller et al., 2019; Gao & Lee, 2019; Ravalli et al., 2022). Year 2019 in December SARS COV-2 virus were first reported in China then by March 2020 the World Health Organization declared COVID-19 a global pandemic (Cucinotta et al., 2020) and presented as a serious challenge facing all societies (Ammar et al., 2021). Furthermore, the rapid spread of the virus affected physical inactivity and obesity (Štajer et al., 2022) that became low and decrease in health. Physical activity is well established as a major contributor to health and well-being. Yet physical inactivity is well recognized globally, a risk factor for several chronic diseases and a major health concern, contributing to 6-10% of the society (Troiano et al., 2020; Kapoor et al., 2022; Ammar et al., 2021). Moreover, older adults with Parkinsons Disease (PD) are common of their physical inactivity or sedentary lifestyle due to axial motor dysfunctions. This may cause deconditioned postural reflexes and declines in muscular strength and increase in motor deterioration (Müller et al., 2019).

Over the past 50 years, there have been a significant shift in terms of food intake, quantities of food (processed foods and ultra processed foods) and the amount or level of physical activity (PA) of older adults (Dobbie et al., 2021). Globally, the population of 64 years old is expanding more than all other ages. According to the 2019 assessment of the global population projection, older adults will expect to 16% of the global population by 2050 (Teixeira et al., 2021). Therefore, with this data it is expecting that older adults are prone to more diseases and low level of physical activity. To prevent this and to provide quality of lifestyle wearable trackers and smart phone apps techniques were introduced. Physical activity is the key component in treating chronic diseases (Dunn et al., 2021) also with the help of wearable and smart phone apps.

Wearable trackers and smart phone apps for monitoring health and wellness behaviour in this generation is rapidly expanding and in the practice of medicine (Leroux et al., 2021; Natalucci et al., 2023). Devices can track many aspects including physical activity like walking, running and hiking, weight, diet (e.g. calorie count), pulse, blood pressure and sleep. Data can be acquired by self-report through real-time feedback in the app and through integrated sensors (e.g. accelerometers) or by integrating with other devices like digital scales and blood pressure cuffs (Hicks et al., 2019; Trumpf, et al., 2020; Štajer et al., 2022; Kapoor et al., 2022; Vijayan et al., 2021; Ng et al., 2021; Ravalli et al., 2022; Low, 2020; 2021; Gregório et al., 2024). Wearable trackers include wristbands, smartwatches, smart phones and smart textiles. They are able to calculate energy consumption, heart rate sleep patterns, aging, mental health and physical activity using integrated pedometers and accelerometers (Pottebaum et al., 2021; Leroux et al.). Wearable devices are typically placed either directly on the wearer's body, within clothing, or semi-rigid structures, such as gloves, insoles, headwear and smartwatches (Vijayan et al., 2021). As technology advances, these devices took the top three spots in the American College of Sports Medicine (ACSM) list in different years 2016, 2027, 2019, 2020, 2021 and 2022 along with nutrition devices also growing with popularity over the past three years

(Štajer et al., 2022; Natalucci et al., 2023). Wearable trackers have already been successfully employed in a number of epidemiological studies (Karas et al., 2019). In a study, it appears appropriate that applying digital technology (wearable trackers, smart phones) in a metal health dimension may help prevent the psychosocial strain and related risk factors of older adults (Ammar et al., 2021). Clinical study also shows that wearable trackers can assess people's lifestyle concerns, obesity, and disease symptoms (Vijayan et al., 2021). Smart technology has a dual purpose in health and social situation, serving as both a means of prevention to assess lifestyle-related health indicators and a continuous monitoring tool for individualized exercise prescription and nutritional intake (Natalucci et al., 2023).

Physical activity is defined as any movement produced by the muscles that expend energy, but it can also include movements during leisure activities or recreational activities (Ravalli et al., 2022), it is encouraging to develop person specific exercise interventions for a positive health and overall wellbeing (Kapoor et al., 2022). Other researchers explained that PA is a complex set of behaviours with possible measurements made of its frequency, intensity, time and activity type (Troiano et al., 2020). PA provides a broad spectrum of health benefits, including decreased risk of early death, coronary heart disease, stroke, hypertension, type 2 diabetes, cancer, weight gain, risk of dangerous falls, anxiety and cognitive decline. Furthermore, substantial scientific data suggests that exercise increases functional ability in older adults, improves sleep quality and reduces the risk of hip rupture and osteoporosis (Štajer et al., 2022). Previous researchers established that regular physical activity benefits older adults' physical activity and mental health, but only 20-25% meet WHO's 15- minutes weekly exercise recommendation, reducing functional and cognitive decline risk (Schmidt et al., 2022).

Monitoring technology such as wearable trackers and smart phone apps approach to older adults has a potential intervention approach to their physical activity levels and awareness. However other researchers discussed that older adults needs to consult first to a healthcare practitioners for consultation and people with knowledgeable in advanced technology. Moreover, another researcher (Wilde et al., 2022) mentioned that healthcare practitioners also need to brief and inform in future healthcare practice and policy in utilizing technology to support long-term use and a positive health care behaviour. Therefore, this review aims to qualitatively study the gaps in older adults' physical activity with the intervention of wearable trackers, smart phone apps and other advanced technology trackers.

To explore the integration of wearable trackers, smart phone apps and other advanced technology trackers ton encourage physical activity in older adults: What are the gaps influencing the adoption and sustained use of wearable trackers, smart phone apps and other advanced technology trackers to enhance physical activity engagement among older adults? The purpose of this review is to identify the challenges and factors influencing older adults use of advanced technologies to encourage physical activity.

METHODS

Search strategy

This systematic review was carried out according to the criteria of the Preferred Reporting Items for Systematic Review and Meta -Analyses (PRISMA) guidelines (Page et al., 2021). The studies were identified from searching in different electronic databases: Google Scholar, SPORTDiscus (EBSCO), BioMed Central and National Library of Medicine (NLM). A time search parameter was established between the year 2019 and January 2025. To ensure methodological reliability in the search, the following Boolean search were used: "*wearable technology*" and "*physical activity levels*" and "*older adults*". Terms will be searched in the titles, abstracts and subjects. The study's search approach was adapted to each databases' unique search engine.

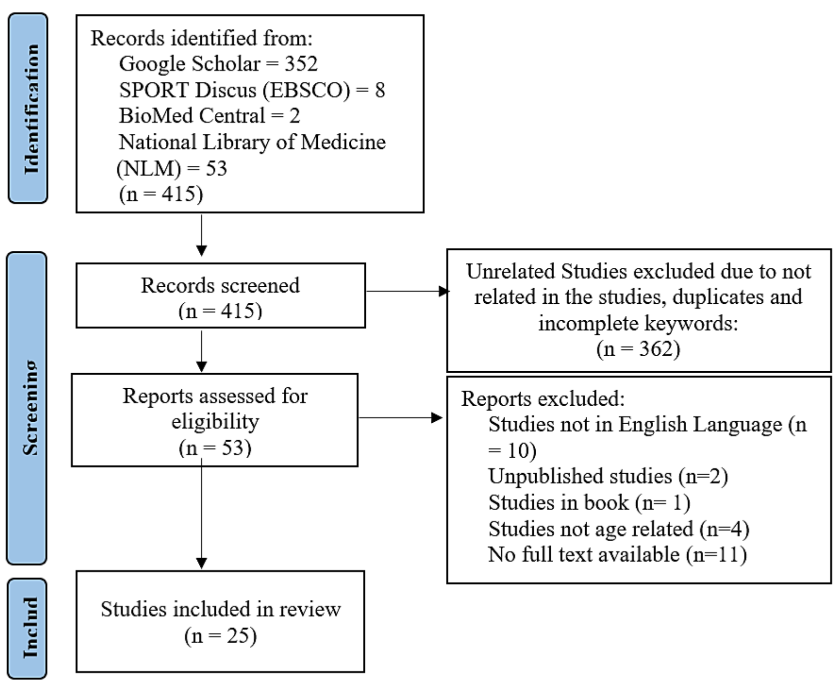
Study selection
The following inclusion and exclusion criteria in this review were considered.

Inclusion
The subjects should be older adults which age ranging to 60 years old and above. Subjects are either physically active or inactive. The subjects were either healthy or have a different disease. The studies had to measure the PA level of older adults with the intervention of wearable trackers, smart phones or other advanced technology. Articles should have benefits and challenges in using wearable trackers or smart phone apps in doing PA.

Exclusion
Unrelated studies excluded due to not correlated in the review, duplicates in other search engines, and incomplete keywords. Case reports, conferences, systematic, narrative report can include or exclude meta-analysis. Studies in non-English language are excluded. Studies do not age related, books and unpublished and inaccessible.

RESULTS

The PRISMA 2020 flow diagram (Figure 1) illustrates the study procedure. Primarily, 415 records were identified through a variety of sources such as, Google Scholar (n = 352), SPORT Discus (EBSCO) (n = 8), BioMed Central (n = 2), and National Library of Medicine (NLM) (n = „53). 362 studies were eliminated during the screening process due to contained insignificant, duplicate, or insufficient keywords. Further eligibility assessment was carried out on the remaining 53 studies, and 28 more were excluded for reasons such as being a non-English language (10), unpublished (2), book-based (1), non-age related (4), or lacking full-text availability (11). Ultimately, 25 studies met the eligibility criteria and were included in the final review.



Source: Page M.J., et al. BMJ 2021;372:n71.

Figure 1. PRISMA 2020 flow diagram.

DISCUSSION

Wearable trackers had a positive impact on physical activity and were predicted to be used to further in three of the 25 studies that involved cancer patients (mean age 60s). Adherence to tracker adopt was notably strong, applicable in both inpatient and outpatient environments, despite overall poor physical activity findings comparable to similar cancer trials. In particular, no correlation was found between patients' perceptions of the trackers and actual physical activity, hinting at potential bias reduction. Outpatients reported a significantly higher perceived usefulness of the trackers (84%) compared to inpatients (66%) (p = .04), and outpatients also found them more beneficial for increasing activity. Both groups found the trackers comfortable (92%), and they provided useful feedback to 60% of inpatients and 86% of outpatients. Challenges in tracker utilization include technology adaptation, data management, device selection, and privacy concerns (Ng et al., 2021; Low, 2020; Pottebaum et al., 2021).

In a survey of exercise in obesity (Dobbie et al., 2021), 48 older adults aged 65-79 years revealed that a 5-month weight loss intervention of a hypocaloric diet, aerobic exercise, enhance with real-time feedback from accelerometers, yielded in greater weight loss and less weight regain than the control group. While wearable trackers and smart phone apps can boost PA and promote weight loss in older adults their long-term benefit is insufficient and remain unclear, with limited evidence beyond 12 months. Additional methods such as exergaming, Social Networking Sites (SNS) programs, and Short Message Services (SMS) have been shown potential for weight reduction. However, there is a lack of long-term evidence to determine if this is due to food changes or restrictions or physical activity modification. Based on this research, limitations were found such as long-term effectiveness, data integration challenges, accuracy concerns, behaviour change, cost and accessibility.

Ravalli et al., (2022) found that using wearable trackers, such as pedometers and fitness trackers, can increase physical activity levels in patients with Osteoarthritis (OA). Patients increased their daily steps by an average of 1,520 steps and completed 10 minutes of moderate to vigorous PA. Wearable trackers help identify discomfort triggers and encourage patients to maintain and promote exercise. Štajer et al. (2022) also found significant benefits for OA patients, including monitoring and controlling OA, enhancing PA monitoring, and increasing adherence to PA programs. However, the also noted a high rate of operator error and data loss, as patients with OA may have low acceptance rates due to technology gaps.

The Developmental Epidemiologic Cohort Study (DECOS) in Pittsburgh, Pennsylvania, examine the impact of accelerometry wear location on PA and sedentary behaviour among 49 healthy older adults. This study found that accelerometry data significantly improved PA levels and their relationships with health challenges. The study emphasizes the potential of using precise activity in health research to design interventions, monitoring health problems, and increase public health knowledge for better life (Karas et al., 2019). Similar findings were discussed by the researcher (Tudor-Locke & Aguiar, 2019), a step-based metrics using wearable trackers and smart phone apps increased PA levels however the scientific community should provide a specific guidance such as standardized protocols and evidence-based error tolerance limits to provide feedback. Further, patients with diabetes positively responded the significant effect of PA utilizing smart trackers and sensors. This sensor enables the measurement of anaerobic threshold, maximizing exercise intensity, and exercise training programs for cardiac rehabilitation, overcoming limitations of activity tests mixed with respiratory gas analysis (Gregório et al., 2024). These studies highlight the need for proper guidance in using wearable trackers or sensors for older adults.

Additionally, based on (Vinciguerra & Vinciguerra, 2019) a German clinical trial compared the two web-based therapies for establishing and maintaining regular physical activity in individuals aged 65-75 years versus a delayed intervention group. Participants were randomly assigned to three study arms: a) a web-based intervention for 10 weeks, tracking weekly physical activity (subjective self-monitoring); b) participants receive access to the web-based intervention for 10 weeks and will track their physical activity using Fitbit® (objective self-monitoring); c) participants receive access to the intervention implemented in the Using a combined approach (including community meetings and psychological Assessment). The study aimed to provide information on the effectiveness of web-based interventions in supporting regular PA in people aged 65 to 75. A pilot study in the UK AND Italy found that the DOREMI bracelet enhanced PA, hemodynamics, caloric intake, and balance in individuals aged 65-80. After three years of testing, the DOREMI system reported an overall spike in physical activity as well as significant improvements in hemodynamics and nutritional habits. The same gaps mentioned above were also mentioned in this study such as technological literacy, physical limitations, motivation and engagement, privacy concerns, system integration and cognitive decline.

In a study with Parkinson's Disease, wearable technology that incorporates low-cost IMU sensors can give precise readings for monitoring and managing Parkinson's disease symptoms. These sensors can give severity rankings for motor complaints, enabling for the detection of disease characteristics that may be overlooked in clinical settings. They can also monitor activity to detect falls and Freeze of Gait (FoG) episodes, which is important for fall prevention methods. Laboratory studies suggest that IMUs can accurately detect gait and balance parameters in PD. However, successful smartphone-based fall or FoG recognition technology is still in its early stages which limits to data interpretation and standardization, battery life and maintenance, user comfort, accuracy and sensitivity issues (Müller et al., 2019).

Chronic diseases identified in these reviews include older adults aged 60 and above acknowledge the effects and its importance of wearable trackers to PA through steps or walking (Tudor-Locke & Aguiar, 2019), offer the potential to improve PA levels by reducing self-bias and enabling more precise data gathering over the course of time (Troiano et al., 2020). Researchers Ammar Et al. (2021) used digital smart tools to provide multi-dimensional health recommendations, encouraging adherence to an Active and Health Confinement Lifestyle (AHCL) and promoting rapid recovery from psychosocial disorders. Trumpf et al. (2020) used another assessment using wrist worn, hybrid motion sensors and Functional Comorbidity Index (FCMI) to older adults aged 65 and above with chronic diseases brought out to identify physical inactivity and sedentary behaviour trends. This study emphasizes the importance of specific methods rather than one- size fits all strategy. Natalucci et al., 2023 used different brands of smart watches to track PA of older adults which findings were the same with other researchers. Another researcher, Schmidt et al. (2022) found that wearable motion sensors particularly FitBit Charge HR, positively impacted PA levels among older adults. Participants boost PA levels, improved psychosocial well-being, and better disease management. Additionally, researcher Dunn et al. (2021), examined how wearable trackers can track and promote PA in liver disease patients among older adults. The aforesaid findings are likewise supported in this study such as gaps like accuracy and reliability, user comfort, data privacy and security concerns, battery life and maintenance.

A study by Kapoor et al. (2022), older adults PA levels utilizing wearable trackers or smart phone apps identified such as motion sensors provided a more precise method of measuring PA and sedentary behaviour that self-reported data, eliminating recall bias and mistakes, standard actigraphy (wrist-worn sensors) underestimated activity levels, but hybrid motion sensors (lower-back sensors) offered more information about sitting, standing, and walking patters. Also, based on the study of Vijayan et al. (2021); Straiton et al. (2023) and Teixeira et al. (2021), claimed the same outcome that wearable sensor-based had accurate data collection while doing PA which encourages older adults to engage in activities like walking, movement speed and posture. The integration of these wearable trackers helps detect heart rate fluctuations, arrythmias, and blood pressure changes, enabling for early detection of heart disease risk (Williams et al., 2023). Thus, challenges in this study were the same as above studies mentioned such as limited evidence for long-term health effect, behavioural and psychological factors, limited integration with healthcare, accuracy and reliability issues, comfortability, and limited digital literacy of older adults.

Findings

In the above discussion highlighted the significant influence that wearable trackers and smart phone apps on managing various diseases prevalent among older adults. Significant health issues that might benefit through greater physical activity made possible by these technologies including cardiovascular diseases, diabetes, osteoarthritis, cancer, and obesity. Research indicates that among older adults with chronic diseases such as Parkinson's diseases frequently leads sedentary lifestyle as an outcome of their motor dysfunctions which exacerbate their health issues. To fully exploit the potential of these technologies in promoting active lifestyles and efficiently address chronic diseases, however, the discussion also highlights the gaps that older adults experience such as technical literacy, as a lot of struggle to comprehend the functionalities without adequate training. Concerns about data security and privacy further hinder consumers from utilizing these tools to their full potential. Another concern is long-term adherence to wearable trackers and smart phone apps; as the novelty wears off, users may experience discomfort, exhaustion or a loss of drive. Data accuracy and integration are also concern, questions about reliability and validity of data collected and how it is incorporated into healthcare systems. Customized training and supports systems are needed to enhance the use of these technologies among older adults.

CONCLUSIONS

Wearable trackers and smartphone apps are high- powered device for health and physical activity (PA) specially among older adults. Despite their positive benefits, these devices have limits, particularly when it comes to validity and reliability of the measures they assess. The swift development of technologies and sensors nowadays may lead to misunderstanding due to mentioned challenges while in use of the wearable trackers and smart phone apps. This review had limitations highlighted challenges for older adults:

1. *Technology Adoption and Usability*. Numerous older adults struggle to use wearable trackers and smartphone apps and need support and training. Some patients struggled to properly interact with wearables due to their unfamiliarity with smart devices.
2. *Data Accuracy and Reliability*. Various wearables underestimated and overestimated step counts leading to inconsistent data gathering. Motion sensors were less accurate in patients with weak or unpredictable movement, which is prevalent in older adults with different diseases.
3. *Privacy Concerns*. Some participants were hesitant to disclose their activity data, claiming worries about data security which could influence adoption rates.
4. *Long – term Compliance and Wearability*. Whereas initial engagement was high, many patients eventually stopped using the devices lowering to its effectiveness. Wearables were not used to consistently due to fatigue, discomfort and medical issues.

To conclude, wearable trackers and smart phone apps provide substantial advantages for tracking physical activity and health. Their effectiveness, is however, constrained by gaps such as usability, data accuracy issues, privacy risk, and decreasing long-term adherence. Reliability is negatively affected by inaccurate step counts and activity tracking, also many older adults have difficulty in embracing new technologies. Concerns in data privacy can affect user confidence, and discomfort or fatigue leads to long-term use. These devices need to improve in terms of use, accuracy, security, and integration with daily life and health care in order to reach their full capabilities.

Future recommendations

To address the reliability and validity of the use of wearable trackers and smart phone apps among older adults, the researcher suggested various preparation strategies. In this review, the researcher discussed a model termed, PrEAP, which stands for preparation and readiness in utilizing new technologies specially among older adults.

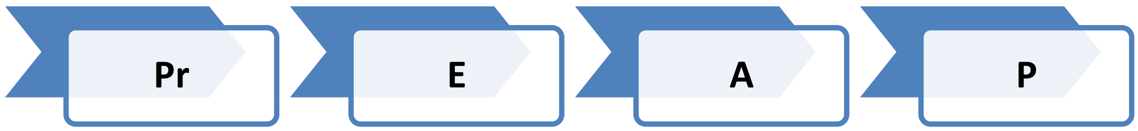


Figure 2. PrEAP model.

According to Confucius, a Chinese philosopher and educator emphasized the critical role in achieving success like what we want in this review to be successful in utilizing wearable trackers and smart phone apps. Based to his beliefs, in order to achieve successful and long lasting while adopting new tolls or technology thorough preparation is needed. This perspective emphasizes how crucial it is to be prepared in embracing new innovations. Moreover, in a study of (Khan et al., 2022), the ease of using mobile health technology is an essential factor affecting older adults' adoption, strengthening the notion that perceived ease can improve readiness for technology adoption. In line with this, the researcher adopts its idea of preparation and readiness and created a PrEAP model.

First, **Pr**ovide comprehensive education and support. Conduct Personalized Training: Conduct hands-on training sessions to older adults for familiarity with device functionalities addressing individuals learning needs. Provide Support Systems: To aid troubleshooting and promote continuous use, provide support systems such as accessible and friendly customer services. Second, **E**nsure Data Accuracy and Reliability, to ensure accuracy and reliability of data, avoid relying solely on wearable trackers and smart phone apps, rather seek advice from a physician whose findings have been verified by medical researchers. Third, **A**ddress Privacy and Security Concern. Provide Control Data Sharing: Allow users to alter privacy concerns, allowing them to decide what data is shared and with whom. Lastly, **P**romote Long-Term Engagement. Highlight long-term benefits: to foster motivation, educate users on the sustained health advantages of regular and consistent use. Further, engage users to collaborate and use these devices with groups to motivate them more.

By these model recommendations, wearable trackers and smart phone apps can become more accessible and beneficial among older adults, promoting physical activity and over all wellbeing. This review recommends future studies to conduct specially gaps in other locations and how older adults' usability. Other age populations, especially the middle aged and young populations can be investigated in the future. Other aspects that could influence older adults' intention to embrace wearable trackers and smart phone apps. Similarly, wearable trackers and smart phone apps can further explore using greater acceptance models and theories in other areas.

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