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Review Article

The Effectiveness of New Digital Technologies in Increasing Physical Activity Levels and Promoting Active and Healthy Ageing: A Narrative Review

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Active healthy ageing (AHA) is a goal that several world organisations promote and is essential for modern societies where the average age is increasing. Physical activity (PA), including exercise, is a central aspect of achieving this goal, even though a high percentage of the population has high levels of sedentariness and low levels of PA. Therefore, this narrative review aimed to summarise and critically evaluate the existing literature that investigates technology-induced changes in PA levels and the possibility that these may produce active lifestyles, promoting AHA; this is unclear in the apparently healthy older adult population. Training protocols delivered via a website, similar to mobile applications, seem capable of increasing not only physical fitness but also PA levels, at least in the short term. Wearable active tracker devices (WATs), alone or together with websites, can lead to an increase in step count and average daily moderate PA in outdoor environments, as well as in specifically designed applications. Technology that can offer virtual physical games is an effective strategy to promote PA by overcoming certain barriers that may limit its practice in apparently healthy older adults. Currently, information and communication technologies (ICTs), and more generally new digital technologies, show great potential in increasing PA levels and reducing sedentary levels, at least in the short term. The heterogeneity of the proposed interventions and the frequent lack of follow-ups do not allow us to evaluate the effectiveness in the long term, which is crucial for the AHA process.

1. Introduction

The statistical forecasts speak for themselves: the average age of the population, in Italy and worldwide, is constantly increasing, and the process of population ageing seems to be certain and intense [1, 2]. Between 2015 and 2050, the percentage of the world's population over 60 will roughly double from 12% to 22% [3]. Therefore, the need for intervention aimed at prevention as well as at maintaining the independence of movement to limit the negative biological and also psychological effects induced by advancing age and thus ensure what is called active and healthy ageing (AHA) is becoming predominant. Although there is still no homogeneous definition, generally this process tends towards the improvement of the overall quality of life during the ageing process by improving areas such as health and long-term care, participation in work and society, and physical security. It also contributes to the long-term sustainability of health and care systems by promoting innovative and cost-effective technologies, services, and policies to meet the needs of an ageing population [4, 5].

Unfortunately, the quantitative increase in the average age does not translate into a qualitative increase in the health status of this population. Physical activity (PA), including exercise, is among the main factors that can prevent and mitigate a person's physical [6–8] and cognitive decline [9, 10]. Nevertheless, at present, the percentage of people who consistently engage in any kind of PA remains very low, approximately 31% of the world's population engages in insufficient PA. Although the World Health Organisation's (WHO) goal is to reduce physical inactivity by 15% by 2030 [11], likewise, the United Nations (UN), starting in 2020, has initiated the so-called decade of healthy aging, a global plan to ensure that older people can live longer but, above all, healthier lives [12], to date this appears difficult to achieve.

The insufficient practice of PA is accompanied by the even more dangerous phenomenon of sedentariness, in Europe and the United Kingdom, it is estimated that the population spends 40% of their free time watching TV, while in America the population spends about 55% of their waking time sedentary [13]. It is now generally recognised that certain risk factors, including the lack of PA, can even reduce telomere length, from a biological perspective, accelerating the ageing process [14]. Many strategies and interventions have been put in place over the years trying to reverse this trend, which does not seem to be slowing down, especially in recent years, following the exponential development and accessibility of various forms of technology and exacerbated by the most recent pandemic situation [15]. Paradoxically, a possible intervention strategy would seem to be offered by technology itself; in fact, the digital advancement underlying information and communication technologies (ICTs) could represent a useful tool for the development of health-promoting lifestyle behaviour programs [16, 17], offering new opportunities to promote PA in adult populations [18]. Some studies report an increase in PA levels after the delivery of an intervention delivered via electronic devices (smartphone/tablet) [19, 20], while others point out that web-based PA delivery interventions may be suitable and effective for older adults by increasing the minutes and the total number of PA sessions [21], and that the use of mobile applications alone or in combination with websites may lead to increased engagement and commitment [22].

The overall improvement in the quality of life pursued through the AHA is further promoted by the presence of urban environments designed and structured to facilitate and encourage the practice of PA in contexts that can offer safety and sociability, fundamental conditions, especially for older people. The presence of these spaces, therefore, offers the opportunity to promote health in elderly subjects, but not only through PA developed in outdoor contexts, capable of providing additional health benefits [23–25]. Even in the design of these urban environments, the use of ICTs can represent a strategy to stimulate the AHA process, realising what is called playable or smart cities [26, 27].

While new technological tools have been shown to be effective, either alone [28] or in combination with classical protocols [29], in improving the physiological and cognitive aspects that allow the maintenance of a healthy state over time (e.g., by improving postural control and preventing falls), the effectiveness of these technologies in promoting PA, especially in older populations, is still unclear.

Therefore, this review aimed to assess the current evidence regarding the possibility of ICTs, both private and public, and more broadly digital technologies to facilitate the AHA process by promoting increased PA, in apparently healthy older adults. It thus helped to identify aspects that need to be deepened or more systematically investigated through future research, systematic reviews, and/or meta-analyses.

2. Materials & Methods

2.1. Search Strategy. This narrative review was carried out following the narrative review checklist [30]. Comprehensive research of MEDLINE In-Process and other nonindexed citations was conducted in May 2022, using MEDLINE (PubMed), Web of Science, and Google Scholar to retrieve relevant articles. The literature search was made using medical subject headings (MeSH) and Boolean syntax. Controlled terms were used to search for studies ("Information and Communication Technologies" OR "ICT" OR "ITCs" OR "mobile" OR "device" OR "virtual" OR "e-health" OR "technology") AND ("training" OR "physical activity" OR "physical exercise" OR "exercise" OR "sport" OR "resistance training" OR "walking" OR "circuit-based training" OR "strength training" OR "weight-bearing exercise" OR "aerobic training" OR "cardiorespiratory training" OR "fitness" OR "endurance training" OR "exercise prescription" OR "muscle strength") AND ("active aging" OR "healthy aging" OR "AHA") AND ("adult" OR "adults" OR "elderly") AND ("outdoor" OR "urban space" OR "urban area" OR "public"). The following filters were used: full text and English language. After candidate articles were collected, further identification was conducted based on the inclusion and exclusion criteria.

2.2. Studies Selection. The inclusion criteria were only English language original peer-reviewed articles, randomised and nonrandomised studies, and observational and pilot studies published from January 2010 to May 2022. Excluded records were review articles, meta-analyses, practical guidelines, unpublished studies, editorials, letters to the editor, and essays, although they were used as an added measure to ensure search comprehensiveness and were used as references.

Although AHA is a lifelong process, there is statistically a greater decline in PA levels among older adults than among younger ones. Furthermore, maintaining positive health behaviours is especially important for older adults who are otherwise subject to a decline in physical fitness. Since there is no universal definition of older adults, we chose a low cut-off, selecting studies that included healthy older adults (≥45 years old) where technologies (with no restriction) are utilised to promote and increase PA levels. Works presenting only the design of future studies or subjects with pre-existing chronic medical conditions were excluded. The search was not restricted to the frequency, intensity, type, or time parameters of exercise, gender, comparators, setting, sample size, or length of follow-up.

Since studies analysing the effects of technology to promote AHA through PA, especially in urban contexts, are evolving, we did not use restrictive criteria for selecting the papers for this narrative review.

Two team authors independently extracted relevant information from included studies: author, year of publication, study design, number and age of participants, type of PA carried out, protocol and type of technology used, duration of intervention, and main outcomes. Any disagreements were resolved by consensus.

3. Results

3.1. Identification of Studies. At the end of the selection process, 4.671 articles were extracted, of which $n = 898$ were from Web of Science, $n = 2.020$ from PubMed, and $n = 1.759$ were from Google Scholar. Each title and abstract were screened for relevance, removing review articles, unpublished studies, meta-analyses, practical guidelines, editorials, letters to the editor, and essays ($n = 2.346$). Thereafter, the search strategy was based on the assessment of the full text of the remaining 89 articles to verify their eligibility. Lastly, 21 research articles specifically focused on technologies for promoting and increasing PA levels in healthy older adults were included (Figure 1).

3.2. Studies Characteristics. Thus, this narrative review provided an evaluation of 21 studies [19, 21, 22, 31–48] enquiring about the technologies-induced changes in PA levels and the possibility that these may produce active lifestyles, underpinning the AHA. Most of them ($n = 7$) [21, 22, 31, 34–36, 38] used websites to provide customised exercise protocols and/or advice aiming to promote PA, of which some ($n = 2$) [31, 35] in synergy with pedometers or accelerometers, while others works ($n = 4$) [19, 37, 47, 48] focused on the effects induced by applications for mobile devices; a few studies ($n = 2$) [32, 33] focused on the changes induced by mHealth tools, and others ($n = 3$) [44–46] by wearable tracker devices. Lastly, further works ($n = 5$) [39–43] investigated the effects produced on PA levels following the use of virtual gaming technology, of which some ($n = 3$) [39–41] used the Nintendo Wii gaming console or its accessories and others ($n = 2$) [42, 43] used the Xbox 360 gaming console or specifically designed proprietary software.

4. Discussion

4.1. Web-Based Interventions. Amman et al. [21], divided the sample into the following three groups: younger workers (19–44 years old), older workers (45–59 years old), and retired (60–89 years old) attempted to evaluate the effectiveness of a personalised PA intervention provided via a website in older people. The intervention, which is based on previous studies [49–52], is characterised by useful tips for increasing PA levels and how to put them into practice, which participants can access by logging onto a specific website, received immediately after completing a short questionnaire on PA levels (Active Australia Survey). Although in all three groups there was an overall increase in PA levels, the older group showed a greater increase and showed more interest in continuing to use the website, suggesting that increasing PA levels through digital platforms may be effective for older individuals, contrary to previous reports [53, 54]. The short duration of the intervention (4 weeks) and the absence of a control group are the main limitations of the study, not allowing a focus on its translatability into a long-term lifestyle. Although the work demonstrates that the use of digital platforms is not necessarily a barrier for older people, the high drop-out rate, the data on self-reported PA levels, which were often unintentionally overestimated, and the sample recruited from subjects who already manifested an intention to increase PA levels limit this study.

King et al. [19] investigated the possibility of increasing moderate to vigorous PA, as well as reducing sedentary levels, using three different smartphone applications, in 80 subjects (≥45 years old) with previously insufficient PA (less than 60’ of moderate to vigorous PA per week) and generally spending 10 hours per day in a sedentary manner, new to this technology. The applications, designed by an interdisciplinary team of experts, are based on three different motivational frames: analytical, providing personalised goals, feedback, and advice for behavioural changes; social, involving support and social interaction with other like-minded individuals aimed at behavioural changes, as well as the intergroup competition; and effective, based on positive reinforcement through the use of an avatar providing real-time feedback on one’s progress. PA levels were assessed using the CHAMPS physical activity questionnaire [55], while sedentary levels were assessed using the Australian sedentary behaviour questionnaire [56]. Thus, during the 8-week trial, the apps were shown to increase minutes per week of PA, in line with another study [31], and reduce sedentary levels. Although this is one of the first work to use smartphone applications specifically designed based on behavioural scientific evidence, the small sample and especially the absence, again, of a control group, as well as the lack of follow-up limit the work.

Knight et al. [32], in a randomised controlled trial, tried to understand whether the use of remote monitoring technologies (mHealth) coupled with personalised PA prescriptions can improve and modify psychological and behavioural aspects related to lifestyles involving health risk factors. Thus, 45 older adults (55–75 years old) are divided into 4 groups: no prescription (control), increase high-intensity activity (EX), decrease low-intensity activity (SB), or both (CC). All subjects were given a mHealth technology kit, consisting of a smartphone, a blood pressure monitor, a glucometer, and a pedometer. Based on their previous work on diabetic subjects [57, 58], the researchers extended the intervention protocol over a 12-week period administered to healthy subjects. All the measurement equipment provided was connected via an app to a smartphone that transmitted data in real time to the researchers and allowed participants to visualise their data and progress, in particular, PA was monitored daily through step counts. In all three groups, changes in PA levels were similar, but the EX and CC groups appeared to walk more kilometres per

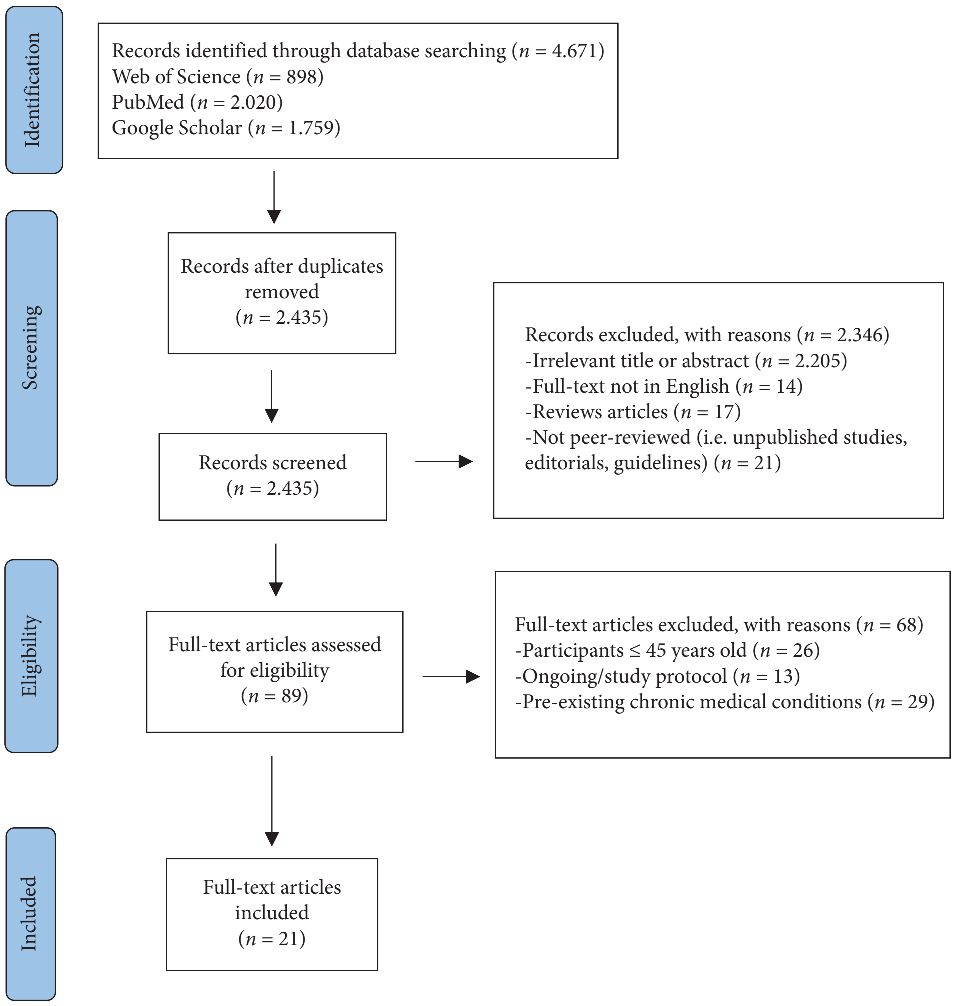

Figure 1: Study selection and eligibility screening flow diagram.

day than the SB group, demonstrating that the prescription of PA associated with mHealth technology could be effective in inducing changes in lifestyles considered to be health risk factors [59–62]. Significant changes in aerobic capacity, a reduction in body mass index (BMI), and improvements in cardio-metabolic and cardiovascular risk markers were also recorded. As previously pointed out [58], mHealth technology induces an increase in users' responsibility for health; although some works [63] suggest weakness and inconsistency in the effectiveness of telemedicine, these only refer to the use of text messages and not to the use of more advanced, user-friendly technologies such as smartphones. The small sample and the participants' pre-existing interest in using mHealth technology may have limited the significance of the results obtained.

This study was followed up by a new [33] longitudinal follow-up study at 6 months, aimed at assessing the maintenance of the improvements in aerobic fitness obtained during the intervention phase, during which participants from the previous study were re-contacted to perform the submaximal self-paced functional aerobic capacity test via the step test and exercise prescription (STEP) [64]. Although there is a tendency to return to baseline levels after the administration of an intervention [65], the researchers noted that the improvements achieved during the intervention phase were maintained at 6 months, demonstrating long-term maintenance of behaviour, similar to others randomised controlled studies [34–36]. However, the results are not easy to interpret, as of the participants in the previous study, who were not informed of future follow-up, and only one-third responded to follow-up.

As web-based interventions appear to suffer from low engagement [66] and a high drop-out rate [67], Guertler et al. [22] structured a study with the objective of assessing the level of engagement in a free PA enhancement programme (10,000 Steps Australian program) [68], using digital platforms, smartphone applications, and how these could increase engagement or both. Within a real-life context and not a controlled environment, the programme encourages users to monitor PA using a pedometer by recording and displaying all data on a dedicated website or smartphone application. Users also have the possibility to set personalised challenges and goals or team-based challenges between colleagues in a work environment. The large sample ($n = 16{,}948$) is divided based on the platform used: web only (WEB), application only (APP), or both (BOTH), over a period of 297 days. The work showed how the use of an application alone or in combination with a website can increase engagement and that programmable challenges can prolong the use of such programmes over time. Despite the large sample considered, the lack of alternative measurements to the inclusion of daily steps for PA levels, the lack of evaluation of PA levels prior to programme participation, and the presence of the application only for iOS operating systems, greatly limit the interpretation of the results obtained.

Within certain elderly populations in need of care (home care service users), there is a gender difference, to the disadvantage of women compared to men, about reduced quality of life and the need for greater assistance in daily activities, also due to impediments caused by a lack of strength [69, 70]. Little evidence currently exists concerning the long-term effects of using ITCs for the promotion of exercise in these populations. Based on these assumptions, Jungreitmayr et al. [37] investigated whether a non-traditional, unsupervised workout provided via a tablet app can improve strength and balance in elderly women (average age 75 years old) over the course of 8 months. The protocol administered to the experimental group (TG), involved mobility, coordination, balance, and strength exercises alternated in daily sessions lasting an average of 10 minutes, and to reduce monotony the exercises changed daily. Of the 124 subjects enrolled, only 43 of the TG group completed all tests, at baseline ($t0$), at 6 months ($t1$), and at 8 months ($t2$), and 36 in the control group (CG), 29 were selected to ensure adequate statistical power. Since the minimum dose to record improvements in strength and balance was 2 sessions per week [71, 72], the TG group was further classified into regular users (rTG, $n = 26$), who used the application at least 8 times per month, and irregular users (iTG, $n = 17$), who used the application less than 2 times per week. Thus, by means of the grip strength test, to indirectly estimate general strength, the authors detected a tendency for improvement in the rTG group, compared to the other groups, only at $t1$, probably due to the short sessions and the greater focus on strength exercises for the lower limbs; the latter were assessed by means of the 30 s chair raise test, and improvements were only noted in the rTG group, providing initial evidence that an increase in lower limb strength, in this specific population, is also possible by means of a training programme using digital instrumentation. Finally, by means of the Uni-Pedal Stance (UPS) test, to assess static balance, a significant improvement at $t1$ was noted in the rTG group followed by a return almost to the baseline compared to the other groups. This suggests that even a protocol involving short, unsupervised training sessions delivered via ITCs can maintain or improve strength and balance levels in the population of elderly women requiring home care. Despite the promising results, the work was limited by the small sample size and the assessment of the frequency of use of the application only through access to it, which does not ensure that exercise is actually performed and does not allow a qualitative assessment of it.

The inactivity and sedentariness that often characterises the ageing process and limits the possibility of an AHA have been further boosted by the pandemic situation generated by COVID-19 [73–78]. To evaluate the acceptability and adherence to remotely delivered exercise protocols via web services in elderly subjects during isolation situations, Buckinx et al. [38] prepared an exercise protocol consisting of a 5 minutes warm-up, 50 minutes of free-body strength, balance, and aerobic exercises followed by 5 minutes of cool-down, to be administered via an online streaming platform (Zoom©) (WebEx, $n = 11$) or via phone-supervised booklet-based (BG, $n = 33$), in elderly subjects (≥65 years old), for a total of 12 weeks (3 times per week). The researchers noted a protocol adherence rate of over 80% in both groups, probably also due to the high degree of satisfaction found, which may be a key factor for continued participation [79]. The perceived level of difficulty in both groups was low to moderate. Whereas the BG group found the flexibility of the training program motivating, the WebEx group drew motivation from the group training and the predetermined program. Both groups found the kinesiologists' support and follow-up, as well as the novelty of the intervention as a new experience, important for continued participation. Contrary to the findings of Knight et al. [32] and Jungreitmayr et al. [37], the different types of technologies used as well as the older persons' not easy understanding of the use of these new technologies, as well as the difficulty in providing support and receiving feedback remotely, are mentioned as limiting factors. Again, the sample size limited the generalization of the results, as well as the self-reported data and online assessments had a non-negligible margin of error.

4.2. Effects of Virtual Game-Based Intervention. In recent years, technology in the form of games has been increasingly used to engage older individuals in exercising, modes of intervention that have been grouped under the name of exergames or exergaming [80]. At the same time, various digital platforms have been developed to promote the AHA. Combining these two aspects, Konstantinidis et al. [39] designed a digital platform called FitForAll (FFA) capable of providing exergaming interventions, with the aim of assessing whether such a system, designed specifically for the elderly, can be user-friendly and sufficiently effective to ensure good adherence to the PA protocol resulting in improved quality of life (QoL). The FFA is characterised by games designed for the maintenance or improvement of the well-being and physical health of elderly subjects, exploits two tools (controller and balance board) of a gaming console (Nintendo Wii), and being connected to a home assistance system, via web services, operators can remotely modify the game/training sessions. Aerobic, strength, balance, and flexibility exergames sessions were planned. Following the recommendations of the American College of Sport Medicine (ACSM) and the American Heart Association [81], the authors organise the training sessions for the experimental group (EXP) as 20 minutes of aerobic activity, 8–10 resistance exercises, 10 minutes of flexibility and some balance exercises; the intensity of the exercises gradually increased, starting from a light level with the goal of reaching 50–60% of the maximum heart rate (HRmax) up to a difficult level where the goal was to reach 80–90% of HRmax. In contrast, the control group (CTRL) was given cognitive training. Of the 415 participants (≥60 years old), only 116 successfully completed the intervention period of 5 recommended weekly sessions, and a minimum of 2, lasting 60 minutes each, for 8 weeks. Thus, the Fullerton fitness test showed improvements in all domains (upper and lower body strength, upper and lower body flexibility, agility/dynamic balance, and aerobic output) in the EXP group compared to the CTRL group, which reported only a slight improvement in lower limb strength, contrary to other studies [40, 82, 83] where improvements were only shown in balance. This supports the idea that the FFA platform is capable of high exercise adherence. Using the WHOQoL-BREF, a statistically significant improvement was observed in the first three domains (physical health, psychological health, and social relationships) compared to the CTRL group, while both groups improved the fourth domain (environmental health). The results, therefore, suggest that the integration of structured physical exercises within electronic play platforms can improve not only the physical fitness of elderly subjects but also the adherence to a protocol that can translate into a real lifestyle. The use of a control group consisting of inactive subjects performing simple cognitive training, together with the lack of follow-up represented the main limitations of this work.

Maillot et al. [41] investigated the ability of exergames to promote cognitive function, along with physical function, in such a way as to be an effective PA modality in motivating lifestyle modification in older adults. To this end, they developed a training programme based on the technology of a game console (Nintendo Wii) and some related PA simulators (Wii Sports, Wii Fit, Mario & Sonic Olympic games). Thus, 30 healthy older adults (65–78 years) were divided into two groups, a control group (CON) that did not practice any activity, either physical or video games, and an experimental group (EXP) that completed 2 weekly sessions of exergames, lasting 1 hour, for 12 weeks. Each session was supervised, and each participant played the session in pairs with another participant. The results showed a significant improvement in physical (i.e., balance, aerobic endurance) and cognitive (i.e., executive control, processing speed task) performance, similar to what has recently been observed in other studies [42, 84], supporting the idea that exergames have the potential to provide health benefits in this population. Furthermore, the high protocol adherence rate (97.50%) suggests high accessibility and attractiveness for older adults. Again, the lack of follow-up and the use of a control group that did not practice any type of PA limited what was found.

Finally, Adcock et al. [43] developed a hardware and software (Active@Home) capable of proposing an exergame experience to support the AHA. This technology, represented by an inertial measurement unit (IMUs) capable of connecting via Bluetooth to the TV via HDMI support, allows for the visualisation of a story concerning trips to different European cities (representing different levels of difficulty) where different types of exergames (i.e., Tai-Chi, dance steps, strength and balance training) are proposed. By means of visual feedback, the 15 actual participants (≥65 years old) of this pilot study received information about the activity performed in real time. The 8-week protocol comprised 3 weekly sessions lasting 40 minutes and was carried out in a home-like living lab for 4 weeks (supervised) and at home for the remaining 4 (contacted by telephone weekly). At the end of the intervention, the researchers noted a high rate of adherence (91.1%), with no differences between the supervised and home-like periods, and an acceptable degree of usability, assessed via the System Usability Scale (SUS score) [85], as well as a positive gaming experience, assessed via Game Experience Questionnaire (GEQ score), although some difficulties in using the technology occasionally arose. Furthermore, improvements in gait parameters and dynamic balance are observed, as well as improvements in cognitive abilities, as previously observed by Maillot et al. [41]. The high rate of adherence together with the general high feasibility and usability of the Active@ Home exergame, both in the laboratory and in the home, suggests that the supervision of a specialist is not essential to motivate PA practice through exergames, supporting the idea that the use of this technology can foster and increase PA levels and consequently foster AHA. The nature of a pilot study, and thus the small sample size, together with the lack of a control group, suggest caution in the interpretation of these preliminary data.

4.3. Digital Technology in the Outdoor Context. Increasing evidence shows that the practice of PA in outdoor settings is positively correlated with health benefits in terms of psychology [23, 86], physical well-being, and quality of life [87, 88]. New technologies can contribute to the promotion of PA carried out outdoors, through the use of so-called wearable activity trackers (WATs), tools that can be worn on the body (i.e., smartwatch), and that thanks to an accelerometer and pedometer, can measure the number of steps, energy expenditure, and sedentary time [89], which can be used in synergy with mobile devices (i.e., smartphones or tablets).

Suboc et al. [44], in a 12-week randomised controlled trial, provided WATs, alone or integrated with a website promoting increased PA, to 114 older adults (≥50 years) with the goal of increasing their PA (walking outside) by 10% each week until they reached 10,000 steps/day. Thus, they found that the use of WATs led to a significant increase in step count and average daily moderate PA with no significant differences between groups, similar to what was subsequently observed in other studies [45, 46]. The main limitation of this work was the lack of follow-up after the intervention period, which makes it difficult to establish whether the effect found can be maintained over time.

Boj et al. [47] investigated the possibility of using an application (HybridPLAY) for mobile devices (iOS and Android) for the purpose of promoting PA in the elderly populations, in outdoor contexts. The HybridPLAY technology was designed to offer a new type of game suitable for urban contexts where PA and social interactions can be developed. It is associated with a sensor inside a clamp that allows it to be mounted on objects in public playgrounds, transforming them into physical interfaces through which to control video games on the mobile device. This technology, therefore, combines physical and digital interactions to offer outdoor play activities. Initially conceived for children (4 to 12 years old), Boj et al. [47] observed active participation by adults and older adults and therefore developed a series of mini-games adaptable to those facilities defined as outdoor fitness equipment (OFE), present in urban public spaces (i.e., parks). Thus, 8 older adults (51 to 71 years old) tested the system by playing the minigames twice and subsequently filled out two questionnaires, one concerning the usability of the system (SUS) and one concerning individual satisfaction to measure several parameters, including how HybridPLAY can influence the desire to play the PA. The results observed by the researchers suggest the use of HybridPLAY technology as a possible means to foster PA and cognitive training in outdoor contexts, even in elderly subjects. Apart from the small sample used, this work represents a cognitive work on the usability of this technology by elderly subjects, but the lack of an actual experimental intervention with a specific training protocol followed over time does not allow reliable conclusions to be drawn.

Ek et al. [48], building on their previous protocol called the smart city mobile phone intervention (SCAMPI) [90], attempted to determine the effectiveness of a behaviour change programme, similar to King et al. [19], lasting 12 weeks with follow-up at 6 months, delivered via an application (TravelVu Plus) for mobile devices to promote active transport (walking, cycling, etc.), with the aim of increasing moderate to vigorous PA (MVPA). Secondly, time spent in active transport was assessed, via the basic version of the application (TravelVu), and how this was perceived via the transport and physical activity questionnaire (TPAQ) [91] as well as health-related quality of life via the RAND-36 [92]. In this first of its kind randomised controlled trial, 250 adult subjects were divided equally into an experimental group (INT) and a control group (CON). During the week prior to the intervention, as well as at 3 and 6 months, both groups used the TravelVu application and an accelerometer to assess travel behaviour, an application that uses GPS to passively collect location and travel speed information in real time. During the intervention, only the INT group used the TravelVu Plus application, which included a 12-week behaviour change programme aimed at increasing PA levels through active transport. This programme, as previously noted in the work of King et al. [19], based on social cognitive theory [93] and social-ecological principles [94], offered the opportunity to set goals and receive feedback on PA carried out weekly. At the end of the intervention period, the INT group had access only to the TravelVu application to continue (12-week follow-up) monitoring their active transport, as did the CON group. It is noted that the use of the TravelVu Plus application did not lead to significant differences in MPVA at 3 months, but only at 6 months, this is probably because the INT group may have needed more time to implement effective strategies for increasing PA levels through active transport, in a systematic manner that would have produced a real behavioural change. At the same time, the use of the basic version of the application (TravelVu) by the CON group may have prompted them to increase the PA levels, as already reported [95]. No effects were observed on the other covariates considered (i.e., health-related quality of life). The use of an accelerometer that did not detect cycling activities and the generation of automatic, nonpersonalised feedback combined with the high battery consumption of the mobile device may have limited the work. Considering also that the location where the intervention took place (Stockholm) due to its characteristics favoured active transport in contrast to other areas, the generalisation of the results obtained must be cautious.

4.4. Limitations and Future Directions. Despite the promising effects of using ITC with the aim of promoting AHA through increased levels of PA, the current evidence appears to be limited mainly by the use of small samples, not only in pilot studies, and by the frequent lack of follow-up, which does not allow an assessment of whether the improvements observed can be transformed into actual behavioural changes and thus lifestyles, which is crucial for promoting AHA. There is also a profound lack of experimentation regarding the integration of ITC in the context of what is called smart cities, where only recommendations, guidelines, or designs for future work currently exist. The heterogeneity of the protocols used and their parameters (frequency, intensity, time, and type), together with the different technologies proposed, makes it difficult to generalise results and observations. Furthermore, in the outdoor ITC context, aspects such as walkability and more generally the urban structure that may or may not favour the practice of outdoor PA are often not considered. Future work should try to focus more on the use and implementation of technologies to ensure high-functioning residential, as well as their use (portable and structural) within the urban context, integrating increasing levels of PA into the landscape of modern smart cities. Using large samples, and follow-up periods of at least 6 months. Samples with a narrower age range should be considered; otherwise, the results obtained may not be representative of the entire population. Lastly, a comparison with groups practicing PA through traditional modalities (without the use of ITC) would be worthwhile to assess the actual usefulness of the proposed technologies in promoting PA and its continuation over time.

This work presents several strengths, including having investigated studies in which a wide range of technologies was used, from the most "primitive" to the most recent, as well as those capable of promoting the PA in outdoor settings. However, some limitations of this narrative review should be noted. The research was limited to studies published in English; furthermore, the use of a cut-off for the age of the participants, although relatively low, may have caused some bias as the younger segment of the population, and generally more confident in using new technologies such as smartphones and apps, was excluded.

5. Conclusions

The results suggest that the use of technology to promote PA, via web-based platforms, may be effective to increase PA levels and reducing sedentariness in the apparently healthy older adult populations, at least in the short term, and indicate a possible behavioural change. Similarly, specifically designated technologies (i.e., WATs or applications) showed the possibility of increases in PA levels practiced in outdoor settings. Some barriers that might limit compliance in exercise practice appear to be overcome using exergames, increasing motivation and adherence, or otherwise may represent a complementary choice to conventional practice. Although the results are encouraging and suggest changes in lifestyles, which are fundamental to the AHA process, the lack of follow-up does not allow reliable conclusions to be drawn. Further studies with rigorous research designs are needed.

Data Availability

No data were available in this study.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

G.G. and L.P. conceptualised and designed the study; G.G., L.P., and F.F. carried out the methodology; G.G., L.P., and S.C. prepared the software; G.G. and L.P. wrote and prepared the original draft; F.M.C., F.F., and S.C. reviewed and edited the manuscript; F.F. and S.C. supervised the study; G.G., F.F., and S.C administered the project. All authors have read and agreed to the published version of the manuscript.

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