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THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY, ELDERLY AND TECHNOLOGIES: A LITERATURE REVIEW

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INTRODUCTION

The aging of the population is one of the most important phenomenon of the twenty-first century and one of the largest economic and social challenge for society. The relevance of this process and its consequences at global level are now clear: the study of demographic indicators, the data on living conditions and on population health, are important sources from which have a clear vision of the phenomenon and its trends. In 2015, on the occasion of the International Day for the elderly, the WHO presented the “World Report on aging and health” [WHO, 2015]. According to current estimates, the absolute number of elderly people in the World population has increased dramatically and continues to do so at an ever-increasing pace. Nowadays, in fact, the majority of people, globally, reaches and exceeds 60 years; this percentage is expected to increase significantly by 2050. In the same vein, Europe records a significant increase of the percentage of the population over 60. According to the Aging Index of the European countries, in 2007, Germany (146.4%)¹, Italy (142.8%) and Greece (130.6%) were the oldest countries in Europe [ISTAT, 2008], while in 2013, Germany (158.4%) and Italy (151.4%) were again the oldest countries in Europe, showing a significant increase of the percentages [ISTAT, 2014]. This rapid aging of the population has made the old age a dynamic and variable process that requires individual to age in good health, thanks especially to the increasing improvement of living conditions and medical advances. Quite the reverse, it can be witnessed an increase of the neurodegenerative and chronic-degenerative diseases, which are the main cause of the frailty and disability. Additionally, other aspects are inevitably correlated with health status and with the quality of life of the older people. We are talking about emotional, social and relational conditions bringing the elderly to consider himself incompetent, useless, excluded from a society that considers them as a burden, nurturing in such a way conditions like loneliness, isolation and depression. With the aim to promote aging in good health, it's important to put in place policies and strategies based not only on the needs of the person, that involving all the components of elderly's everyday life, i.e. health care, active lifestyle, community participation, social inclusion, lifelong learning, active participation, etc. The focus, therefore, should be on human rights and on the possibility of its participation in community life: only in this way the actions will be in favour of an “Active Aging” [WHO, 2002].

Physical activity is undoubtedly one of the factors that can positively influence the health and wellbeing. Bodily movements lead to an energy expenditure, including the actions and activities that characterize daily life, such as climbing stairs, walking or carrying the shopping bags. The positive impact and the benefits of physical activity on the aging process are evident.

¹ The percentages refer to the number of over65 every 100 young people belonging to the age group 0-14 years

Numerous scientific evidences show that even a moderate amounts of physical activity may exert a protective effect on health, confirming that the movement and an active lifestyle, are decisive factors for the purpose of a successful aging [Chodzko-Zajko et al., 2009]. The research on this topic and the enhancement of the knowledge about its social and personal implication, led to an increasing interest towards the creation of recommendations, guidelines, protocols, policies and networks implemented in favour of the welfare of people of all ages².

Even the *ICT (Information and Communication Technology)* is increasingly present in the area of the individual wellbeing. Recently, there has been an evolution of the developed technologies and, at the same time, an evolution of the users. We moved from the concept of traditional medicine to telehealth (or eHealth), from home assistance to telecare and to remote rescue, to new areas of use for technological systems such as Exergame, wearable devices, activity tracker. Similarly, we have witnessed a shifting from technologies reserved for a few users, to technologies for all age groups. As well as being in favour of the care and wellbeing of people, today ICTs are more and more age-friendly, thanks mainly to an increase in the percentage of elderly people able to use technological devices.

In this light, the purpose of this study is to investigate the relationship between ICT, physical activity and elderly, and understand the current state of research about these issues.

METHODOLOGY

In order to fulfil the purpose of the study, a literature review was conducted about topics related to technology for physical activity, health and the promotion of active lifestyles in elderly people. Particular attention was given to the study of the actions taken by the national and local authorities to develop programs that promote a healthy and active aging through the use of technological devices. By taking a systematic approach, the review process began with the definition of a working protocol and with a specific identification of the study variables:

Elderly: Although most countries of the world have accepted the chronological age of 65 years to define an elderly person, the United Nations decided that 60+ years can be generally referred to as the age of reference for the elderly population [WHO].

ICT: “Information and Communication Technology”, are the set of methods and technologies that realize the systems of transmission, reception and processing of information. In particular, the research refers to portable devices.

Physical Activity: Any bodily movement produced by skeletal muscle contraction, automatic or deliberate nature that has the effect of energy consumption. It may be part of the free time and configured in organized activities (sports) or unorganized (walking, dancing), part of the working time (heavy manual work) or domestic (gardening, cleaning, movement games) or of the daily transport (using the bike, walking, taking the stairs) [Edwards & Tsouros, 2008; Pietrantoni & Prati, 2012].

The process of identification and selection of the studies was conducted through a previous definition of the *selection criteria* that were used as filters to include/exclude resources. The

² HEPA Europe - European network for the promotion of health-enhancing physical activity -; Active city Network; EUNAAPA -European Network for Action on Ageing and Physical Activity-, to give some examples

study was conducted through queries on electronic databases (PubMed, Google Scholar) and in grey literature, by the use of different keywords as “elderly”, “older”, “aged”, and “senior” to define the target group of the study. We also used terms such as “physical activity”, “movement”, “lifestyle” and “walking” to capture article that addressed physical activity; while the terms “ICT”, “technologies”; “smartphone” and “App”, have been used to identify studies that addressed the topic of the technological devices defined ICT. We also searched for terms like “behaviour”, “motivation”, “social inclusion”, “barriers” and “participation in life community”, to identify articles addressing the issue of motivation to physical activity. Moreover, we used terms such as “sustainable mobility”, “smart city”, “slow mobility”, but also “municipality”, “city”, “policy”, “guideline”, and “action plan” to find articles dedicated to the actions and experiences put in place by municipalities.

Scientific papers, conference proceedings, project and reports, published between years 2000 - a period in history that is commonly to associate the true evolution of smartphones-, and year 2015 were selected. Finally, we selected studies published in English and Italian language, taking into account subjects aged 60 years or above, of both sexes.

The process of inclusion, based on the mentioned selection criteria, was implemented in two phases, (see fig. 1). In the first phase, articles have been identified through research on electronic databases and grey literature. *Texts research* led to the identification of 193 articles. The review excluded studies that have involved people under the age of 60 (including studies involving multiple age groups, i.e. 18-70 years, and those who considered “elderly” people over 55) and studies not addressing the topic of physical activity and / or ICT technologies. Finally, the reference to wearable devices and robotic systems represented further exclusion criteria. At the end of this first phase, 33 articles have been considered relevant, and further analysed. Considering the exclusion criteria that characterized the first phase, they were also excluded from the review studies based on the concepts of Healthcare, Telecare and Telehealth. Furthermore, studies targeting groups affected by diseases and/or in rehabilitation treatments, have represented a further exclusion criteria. Finally, duplicate records were excluded from the review. Thus, the analysis of full-text has allowed the inclusion of 19 articles.

The search for experiences, actions, programs and project activities, instead, pointed its attention on the European context. Our keywords included in this review all studies within Google Scholar and PubMed databases conducted between 2000 and 2015. The process of inclusion, represented in figure 2, based on the selection criteria indicated, excluded studies that didn't take into account the elderly, physical activity and technologies. Moreover, the reference to wearable devices, robotic systems, concepts of Healthcare, Telecare and Telehealth and the presence of disease states or rehabilitation treatments have represented a further exclusion criterion.

RESULTS

The deepening of the selected studies showed an increase, year by year, of the studies that refer to the investigated topic: just to consider that in this review have been incorporated one article published in 2006 and nine in 2014.

Texts analysis has certainly revealed a strong interaction between physical activity, elderly and ICT systems. In particular, the study conducted by Blazun et al. [2], shows how technology can be an important tool for promoting physical and social activity among the elders. Specifically, they report an association between computer use, levels of physical activities and social inclusion before and after the interaction with ICT devices.

Text analysis, therefore, showed the presence of *different types of approaches and applicative orientations*. Several studies focus their attention on the so-called “Home-based systems”, solutions represented by web platforms for PC, TV or tablet, used in the home environment (private homes, nursing homes / rest, community centres, etc.). Albaina et al. [1], for example, suggest a virtual trainer that encourages older people to be more active. This technology based on persuasion, interaction metaphors and the principle of awareness, allows people to monitor their activities and be aware of their progress. Ghiani et al. [8], instead, describes the structure of a web-based platform, which aims to encourage the elderly to be physically active. It consists of a set of logical modules supporting user-oriented services: (1) Monitoring and Behaviour Analysis, (2) The Context Manager, (3) The Adaptation Module, (4) Social Features, (5) Persuasion Services. In the same way, the goal of the study proposed by Wijsman et al. [24] was to assess whether a web-based intervention able to increase physical activity and improve metabolic health in inactive older adults. To this aim, the study proposes a commercially available web-based physical activity program directed at increasing the amount of daily movement. The results of this intervention were exposed by Vroege et al. [23], which showed that 42% of the sample reached the expected level of daily physical activity, demonstrating the large potential of web-based interventions for improving health. Fan, Forlizzi, & Dey [6], instead, focus on the barriers to physical activity. With the help of the target group, the researcher have tried to understand which are the needs that technology can help to tackle and which are the characteristics that it must have in order to support the elderly towards the adoption of active lifestyles. The studies conducted by Silveira et al. suggests that the physical decline, typical of the old age, determines disorders, accidents (such as gait disorders that can lead to falls and their consequences) that limit the independence and autonomy of the person in performing daily activities. For this reason, it has been developed an application for tablet aimed to motivate people to move proposing customized plans of physical activity to be carried out autonomously in their own homes. In the first part of the study, Silveira et al. [18] have exposed the requirements and the principles through which develop their own application named “Active Lifestyle App”. According to them, the points behind the design must include: (1) Design an interactive and friendly user interface to be easily understood; (2) Offer support for balance and strength training plans; (3) Collect, process, store and report information to allow healthcare experts to remotely monitor the users’ performance; (4) Allow remote communication between elders and healthcare experts; (5) Support motivation. The aim of the second phase of the study, Silveira et al. [19], was to run a pilot study to investigate the feasibility of the app, the adherence of the participants and the effectiveness of a motivation tool. The pilot study involved 13 elderly people who, for two weeks, followed the workout plan proposed by the app. The outcome showed that without the app the participants didn’t feel motivated to perform exercises; while with the support of the app they felt more motivated. The third part of the study, Silveira et al. [20], had three main objectives: (1) investigate which

IT-mediated motivation strategies increase adherence to physical exercise training plans in older people, (2) assess the impact of the app on physical activity behaviour change, and (3) demonstrate the effectiveness of the ActiveLifestyle training to improve gait speed. The last phase, van het Reve et al. [21], seek to compare 3 different home-based training programs with respect to their effect on measures of gait quality and physical performance, through planned comparisons between (1) tablet-based and brochure-based interventions, (2) individual and social motivation strategies, and (3) active and inactive participants. The tablet groups showed significant improvements in single and dual task walking, whereas there was no significant changes observable in the brochure group. Therefore, a tablet-based strength-balance training program allows monitoring and assisting autonomous-living older adults. Moreover, social or individual motivation strategies were equally.

Hong et al. [9] present iCanFit, a web application dedicated to the promotion of physical activity in older people. The app focuses on the functions that motivate seniors to exercise regularly, through setting goals, monitoring activities, and providing feedback about the activities, progress and achievements. Finally, the objective of Romero et al. [17] was to design technological solutions able to motivate older people to move more and to maintain or increase their social activity. Romero describes the development of compelling playful solutions that help older people to be aware and proactive in maintaining an adequate level of physical and social activity.

Several studies, instead, focus on technologies for mobile devices, designed to be used even outdoor. Rodriguez et al. [16] describe the system CAMMInA (Calm Application for Motivating elders to Move by Interacting with their Age group), an application for mobile phones that aims to motivate the elderly to move more through the use of factors having a positive impact. The created system, in fact, follows a user-centered approach and supports four persuasive strategies (abstraction, historical information and reflection, trigger the physical activity and positive and playful reinforcement), through which encourages people to adopt healthy lifestyles and more suitable behaviours. It is worth noting that the system provides sound and text notifications to remind the elderly to take a walk; once started the activity, the user sees a copper coin that turns to gold when he reach the goal. Finally, a report of the activities carried out during the last recent weeks and the achievements, make the elderly aware and satisfied with his own progress and workout. Recio-Rodriguez et al. [15], focus their interest on the psychological theories of behavioural change and propose an app for smartphones to promote healthy lifestyles. Through the principle of awareness, the user leads an assessment of life habits, both in terms of physical activity and eating behaviour. Finally, also Vankipuram, McMahan, & Fleury, [22] present an app for Iphone, which allows the user to set his own goals and to monitor the level of activity. To achieve this, the app provides a motivational feedback based on the concepts of Wellness Motivation Theory, which “promotes the emergence of positive health patterns by conceptualizing motivation as a complex and dynamic process of individual growth based on personal values and resources” (p.1).

The contents analysis showed, moreover, the presence of *different types of intervention*. Some of these are represented by exercise programs or plans of physical activity that require the execution of physical exercises (Hong et al. 2014, Recio-Rodriguez et al. 2014, Wijnsman et al. 2013, Vroege et al. 2014) addressed to training, for example, specific motor skills (Silveira

et al. 2012, Silveira et al. 2013, van het Reve et al. 2014) or aimed at the achievement of specific objectives (Albaina et al. 2009, Rodriguez et al. 2012). Another type of intervention is represented by a game setting: the persuasiveness action of the technology, as a means to support the adoption of healthy and active lifestyles, in fact, is achieved also through a playful approach. The “Exergames”, virtual games for older users, have been the subject of numerous reviews. In their articles Gerling, & Mandryk; Larsen; and Brox & Hernandez have faced a literature review about these games, trying to explain their connection with elderly users. Gerling, & Mandryk [7] provide an overview of active virtual games for older people, by classifying the case studies addressing the issue of Exergames for the elderly, paying particular attention to evaluation routines and their implications regarding the deployment of such games in the daily lives of older adults. Larsen et al. [12], have tried to explain how the Exergames may represent an effective and innovative approach to increase the levels of physical activity in the elderly. Brox & Hernandez [3], instead, in dealing a description of persuasive games developed in order to encourage physical activity in older people, stresses the importance, for the achievement of this objective, of the playful, motivational, social and relational components. Finally, Planic, Nake, & Kampel [14] suggests guidelines for designing Exergames able to enhancing physical and social activities for the elderly.

The analysis of the experience gave way to understand how the national and local authorities are activated to develop programs to promote a healthy and active aging through the use of technological devices. The study conducted during this review analysed 26 case studies of cities, but it has not detected programs and initiatives specifically aimed at supporting physical activity and active aging through the use of ICT.

The initiatives and programs put in place by municipalities consist of interventions, aimed in the first place, to sustainable urban mobility, and to the reduction of CO₂ emissions. Indeed, the addressed issues relate to the concepts of smart city, smart mobility, green city, etc., without directly taking into account the issues related to physical activity, inclusion and social participation, autonomy and overcoming barriers, for the elderly. Certainly, these issues have been largely addressed, through initiatives and interventions implemented by the municipalities, but nevertheless, the actions based on the joint use of technology in favour of the active lifestyle and independent mobility of the elderly in urban context, are still limited. These issues were, however, deepened by other institutions (universities, companies, research groups), through the participation in national and / or European projects.

Among the identified project activities, two categories of projects were taken into account. In the first case, the analysis of European project: Smart Move, Street Life, SuperHub, My Way, Move Us, allowed the identification of work plans aimed at the design, implementation, evaluation and dissemination of a series of new ICT tools for smart mobility in the urban context. These studies, propose solutions aimed primarily at sustainable urban mobility and reducing of CO₂ emissions, not taking, however, directly and exclusively into account the issues related to physical activity, inclusion, social participation and autonomy in favour of the elderly. The above projects, in fact, relate to the citizen in general, with the aim of encouraging behavioural and habits changes, directing people towards more sustainable urban mobility choices. For this purpose, the developed technology is represented, in all the cases, by an open-source web platform and an application for portable devices that combines, in real-time, the available

options of mobility and the possibility to plan personalized routes. The topics addressed, relate mainly to the concepts of smart city, smart mobility, “zero” emissions and sustainable mobility.

In the second case, however, a number of projects of the European Programme “Active and Assisted Living Programme” (AAL) was identified. The analysis of project initiatives enabled the analysis of some projects, selected on the basis of the key study variables and the selection criteria of the items defined above, whose themes are related to those we reviewed. The project proposals are characterized by different approaches and applications: in correspondence to the findings of the analysis of texts, also in this case we can recognize different types of technologies developed. Some projects, in fact, offer fixed solutions for use at home according to the concepts of “home-based system” -Motion, Safe Move, Pampap, Gameup, Elf@home, Is Active, Ageing in balance -; while others suggest solutions for the mobile devices – Com’on, Dossy, Happy walker, Mobecs, Virgilius, Wayfis, Trinutri -. Consequently, also the types of intervention are different: some of these projects, in fact, are based on the monitoring of the person, the promotion of physical exercise and the use of virtual games; others are focused on the outdoor environment, referring in particular to the issues of independent mobility, active mobility, safe movement in the environment or through transport. However, what we want to emphasize is that these projects take into consideration the various areas and objectives, in particular in regard to the issues of social inclusion, autonomy, social participation and how to overcome barriers to physical activity.

To conclude, both *text and experiences analysis* has allowed to show the constant presence of a number of common variables (see Tab. 1) that characterize and unite the technology and the proposed interventions, through which is possible to expand the knowledge of concepts and notions that represent the theoretical basis through which to develop this type of technology.

Study Variables	
1. Awareness	Awareness of performed activities Awareness of the progress Awareness of their own limits
2. Pervasive technology	Accessibility Fun Interaction Behaviour
3. Motivation	Motivational messages Intrinsic motivation (Comparison, competition, cooperation)
4. Social connection	Social connections Community Interaction
5. Self monitoring	Monitoring of their current behaviour progress.
6. Positive reinforcement	Rewarding strategies delivered to seniors when they perform the desired behaviour.
7. Goal Setting	Encourage behaviour change

Table 1: Common variables

DISCUSSION

The literature review examined the use of ICT as a tool to support the elderly in adopting active lifestyles and positive behaviours for their own health. Studies were conducted with particular attention to the characteristics that a technology needs in order to motivate the elderly to move more. Motivation, the characteristics of project as well as the design (such as ease of use, colour, notifications) represent the basis through which develop this type of technology. By referring to the type of intervention proposed, what is clear, however, is the near absence of actions that go beyond the concepts of programmed plan of physical activity or Exergame. In fact, despite the technology represents an increasing presence in elderly's everyday life, the studies based on the development of devices motivating the adoption of an active lifestyle are still limited. Moreover, studies aiming at investigating the achievements in the fields of social inclusion, autonomy, and social participation, are uncommon in the scientific literature.

CONCLUSION AND FUTURE WORKS

The study gave the opportunity to investigate the relationship between ICT, the elderly and physical activity and understand the current state of research about these issues. The information obtained represent the theoretical basis of a larger study, which aims to elaborate guidelines through which develop a prototype of app able to motivate and support the elderly toward the acquisition of healthy and active lifestyle. To this aim, we think that only technologies developed together with the elderly can be really effective for achieving the expected objectives. As demonstrated by several studies, only the direct involvement of the elderly is regarded to generate awareness, feeling of participation and learning and therefore only tools projected in this way will be really useful in supporting their everyday physical activity. So, in talking about professionals involved in the development of strategies in favour of the elderly it is important to take into account the point of view of the elderly, which in this case, are in the same way competent and professional.

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