Information and Communication Technologies for promotion of physical activity

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Abstract

Background: information and communication technologies have produced lifestyle changes, especially in physical activity. Therefore, it is important to promote the use of those resources through innovative processes to improve the quality of life. **Objective:** to analyze the scientific evidence on the information and communication technologies used for the promotion of physical activity. **Method:** a bibliographic search of publications in scientific journals between 2013 and 2019 was carried out. The descriptors technology, physical activity, innovation and their equivalences in English were used. The analyzed elements were title, abstract, publication year, language, country and publication source. From the complete text, the variables technology, population group, activities or strategies and results were analyzed. **Results:** 32 full articles that met the inclusion criteria were analyzed. The most used technologies for the promotion of physical activity in the different groups were PPPs and mobile phones; the evidence concludes that their use generates adherence and contributes to life quality. **Conclusion:** the need for the use of information and communication technologies was evidenced, therefore, innovative physical activity practice in different populations is encouraged. The challenge for professionals who work on the area is to take such technologies and start their implementation.

Key words

Health, Information Technology, Medical Informatics, physical activity, Technology, Health Promotion (*MeSH, NCI*).

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Tecnologías de la Información y la Comunicación para el fomento de la actividad física

Resumen

Antecedentes: las tecnologías de la información y la comunicación han configurado cambios en los estilos de vida de los sujetos, especialmente aquellos relacionados con la actividad física, por ello, es importante que a través de procesos innovadores se promueva la utilización de las mismas, que permitan el aprovechamiento de este recurso para la mejora de la calidad de vida. **Objetivo:** analizar la evidencia científica sobre la utilización de las tecnologías de la información y la comunicación para el fomento de la actividad física. **Método:** se realizó una búsqueda bibliográfica de publicaciones en revistas científicas, entre los años 2013 y 2019. Se utilizaron los descriptores tecnología, actividad física, innovación y sus correspondientes en inglés. Los artículos fueron analizados a partir del título, resumen, año de publicación, idioma, país y fuente de publicación. A partir del texto completo se analizaron las variables tecnología utilizada, grupo poblacional, actividades o estrategias y resultados. **Resultados:** fueron revisados para el análisis 32 artículos en texto completo que cumplieron criterios de inclusión, las tecnologías más utilizadas para el fomento de la actividad física en los diferentes grupos fueron las APP y los teléfonos móviles, la evidencia concluye que su uso genera adherencia y aporta para la calidad de vida. **Conclusión:** se evidenció la necesidad de la utilización de las tecnologías de la información y la comunicación para que de manera innovadora se fomente la práctica de la actividad física en diferentes poblaciones, el reto para los profesionales que trabajan el tema es apropiarlas e iniciar su implementación.

Palabras clave

Salud, tecnología de la información, informática médica, actividad física, tecnología, promoción de la salud (*DeCS, BIREME*).

Tecnologias da Informação e a Comunicação para o fomento da atividade física

Resumo

Antecedentes: as tecnologias da informação e a comunicação tem configurado câmbios nos estilos de vida dos sujeitos, especialmente aqueles relacionados com a atividade física, por isto, é importante que a través de processos inovadores se promove a utilização das mesmas, que permitam o aproveitamento destes recursos para a melhora da qualidade de vida. Objetivo: analisar a evidencia científica sobre a utilização das tecnologias da informação e a comunicação para a promoção da atividade física. **Método:** Realizou-se uma busca bibliográfica de publicações em revistas científicas, entre os anos 2013 e 2019. Utilizaram-se os descritores tecnologia, atividade física, inovação e seus correspondentes em inglês. Os artigos foram analisados a partir do título, resumo, ano de publicação, idioma, país e fonte de publicação. A partir do texto completo se analisaram as variáveis, tecnologia utilizada, grupo populacional, atividades as estratégias e resultados. **Resultados:** foram revisados para a análise 32 artigos em texto completo que cumpriram critérios de inclusão, as tecnologias mais utilizadas para o aumento da atividade física nos diferentes grupos foram as APP e os telefones móveis, a evidencia conclui que seu uso gera aderência e contribui para a qualidade de vida. **Conclusão:** Evidenciou-se a necessidade da utilização das tecnologias da informação e a comunicação para que de maneira inovadora se fomente a prática da atividade física em diferentes povoações, o reto para os profissionais que trabalham o tema é apropria-las e iniciar sua implementação.

Palavras-chave

Saúde, tecnologia da informação, informática médica, atividade física, tecnologia, promoção da saúde (*DeCS, BIREME*).

Introduction

The World Health Organization (WHO) defines physical activity as "a ny bodily movement produced by skeletal muscles that requires energy expenditure. Physical activity refers to all movement including during leisure time, for transport to get to and from places, or as part of a person's work." (1). This organization evidences the importance of physical activity differentiated by life cycle and, accordingly, proposes that for those with ages below 17 it is advisable to practice physical activity at least 60 minutes a day, while for subjects with ages between 18 and 64 or older, at least 150 minutes per week are recommended (1).

In general, the practice of physical activity is a protective factor against diseases and, therefore, helps to improve the quality of life. However, data from the World Health Organization (WHO) show that 1 out of 4 adults do not perform the recommended physical activity. In Latin America and the Caribbean, physical inactivity levels increased from 33% to 39% between 2011 and 2016, especially in adults and older adults, women are less active (32%) than men (23%) (1).

Consequently, the use of Information and Communication Technologies (ICT) such as emails, websites, videos, accelerometers, mobile applications, mobile phones, global positioning systems (GPS), among others, can support counselors and professionals who work on physical activity to promote changes in people's lifestyles. Since they have transformed the way in which things are observed, perceived, captured, interpreted and processed, their proper use can counteract the negative effects of physical inactivity (2,3).

Previously, technology was not as accessible as now in the so-called information society. Technological advances initiated in the twentieth century led to the emergence of this new concept, which includes tools and channels to access information and to build new modes of expression, new models of participation and, ultimately, new forms of cultural recreation (4.5).

The innovation of ICTs favors the creation of increasingly complete, complex and integrated audiovisual and multimedia materials that have gradually been incorporated into the daily life of the individual. Thus, it is common for even the smallest homes to have a technological device (6.7).

Therefore, it is crucial to use the appeal of these technologies and the influence of disciplines such as Physical Education to increase the need to innovate instruction and encouragement in physical activity. This resource may become the new route if it is placed at the service of humanity as an input for quality of life improvement (8–10). The objective of this work is to analyze the scientific evidence on the use of information and communication technologies for the promotion of physical activity.

Method

A bibliographic search of the literature published in scientific journals between 2013 and 2019, registered in search engines and databases such as Google Scholar, SciELO, Redalyc, Virtual Health Library, PubMed, JSTOR and Science Direct, was conducted.

The initial selection of articles was made based on title, abstract, year of publication, language, country and source of publication of the references identified (first filter). The full text version of the articles that passed the first filter was obtained, and the rest of the documents were analyzed based on the inclusion criteria of the variables related to the central topic, *i.e.*, the mediation of ICTs in the promotion of physical activity in different populations.

A matrix analysis document was developed in Excel. The variables analyzed were population group, ICT used, strategy or activity, result, country and year. Finally, a categorization was carried out according to the proposed objective.

The ethical parameters of Resolution 8430 of 1993 (Ministry of Health) (11) and the Declaration of Helsinki(12) were considered for the development of the work. There was not any risk for humans since the work was done with published articles.

DeCs (Descriptors in Health Sciences) and MeSH (Medical Subject Headings) descriptors were used according to the following search strategies (Table 1).

Table 1. Web bibliographic search strategies

GOOGLE SCHOLAR SEARCH STRATEGY
Strategy #1: Non-advanced search: Use of technology to promote physical activity; Interval: 2013-2019 Results: 14,604 Items downloaded: 6
Strategy #2: Non-advanced search: Use of technology to promote physical activity; Interval: 2013-2019 Results: 0
Strategy #3: Exact phrase "Physical activity" "technology"; Interval: 2013-2019 Results: 73 Items downloaded: 4
Strategy #4: Exact phrase "Physical activity and technology" Interval: 2013-2019 Results: 6 Items downloaded: 4
Strategy #5: Exact phrase "Technological strategies to promote physical activity"; Interval: 2013-2019 Results: 0
Strategy #6: Exact phrase "Technology and innovation for physical activity"; Interval: 2013-2019 Results: 0
Strategy #7: All the words "Technology and innovation for physical activity"; Interval: 2013-2019 Results: 9 Items downloaded: 2
Strategy #8: Exact phrase "Technology" "Innovation" "Physical Activity"; Interval: 2013-2019 Results: 1790 Items downloaded: 6
Strategy #9: Exact phrase; allintitle: "Physical Activity" "Technology"; Interval: 2013-2019 Results: 7 Items downloaded: 2
TOTAL DOWNLOADS: 21

SCIELO

Strategy # 1: integrated method; "Use of technology to promote physical activity"; regional. Interval: 2013-2019
Results: 0

Strategy # 2: integrated method; "Use of technology for physical activity"; regional. Interval: 2013-2019
Results: 0

Strategy # 3: integrated method; "Technology and physical activity"; regional. Interval: 2013-2019
Results: 0

Strategy # 4: (Physical activity) AND (technology); all indexes;
Results: 39
Items downloaded: 3

Strategy # 5: (Physical activity) AND (technology); abstract;
Results: 0

Strategy # 6: (Physical activity) AND (technology); Title;
Results: 0

Strategy # 7: (Physical activity) AND (TICS); Title;
Results: 0

Strategy # 8: (Physical activity) AND (TICS); all indexes;
Results: 0

Strategy # 9: (Physical activity) AND (TICS); abstract;
Results: 0

Strategy # 10: (Physical activity) AND (innovation); all indexes;
Results: 0

Strategy # 11: (Physical activity) AND (innovation); abstract;
Results: 0

Strategy # 12: (Physical activity) AND (innovation); Title;
Results: 0

TOTAL DOWNLOADS: 03

VIRTUAL HEALTH LIBRARY

Strategy # 1: (tw: (physical activity)) AND (tw: (technology)) AND (instance: "regional") In: Title, abstract and subject
Results: 64
Items downloaded: 9

Strategy # 2: ti: ((tw: (physical activity)) AND (tw: (technology))) AND (instance: "regional") AND (la :("es") AND year_cluster :("2014" OR "2017 "OR" 2015 "OR" 2016 "))
Results: 21
Items downloaded: 0

Strategy # 3: (tw: (physical activity)) AND (tw: (innovation)) AND (instance: "regional")
Results: 7
Items downloaded: 0

Strategy # 4: ti: ((tw: (physical activity)) AND (tw: (innovation))) AND (instance: "regional") AND (la :("es")
Items downloaded: 0

Strategy # 5: (tw: (tics)) AND (tw: (physical activity)) AND (instance: "regional") AND (la :("es"))
Results: 2
Items downloaded: 1

Strategy # 6: ti: ((tw: (tics)) AND (tw: (physical activity))) AND (instance: "regional") AND (la :("es"))
Results: 0

TOTAL DOWNLOADS: 10

REDALYC

Strategy # 1: "Technology in physical activity". Interval: 2013-2019.
Results: 5
Items downloaded: 1

Strategy # 2: "technology" "physical activity". Interval: 2013-2019.
Results: 0

Strategy # 3: "technology" "physical activity"
Results: 0

Strategy # 4: "TICS" "Physical activity". Interval: 2013-2019.
Results: 0

Strategy # 4: "App" "Physical activity". Interval: 2013-2019.
Results: 109
Items downloaded: 10

TOTAL DOWNLOADS: 8

PUBMED

Strategy # 1: (physical activity) AND technology AND "last 5 years" [PDat]
Results: 27
Items downloaded: 17

Strategy # 2: Search (physical activity) AND technology Sort by: Best Match Filters: published in the last 5 years
Results: 7
Items downloaded: 2

Strategy # 3: (physical activity [Title / Abstract]) AND technology [Title / Abstract] AND "last 5 years" [PDat]
Results: 284
Items downloaded: 18

Strategy # 4: (physical activity [Title / Abstract]) AND TICS [Title / Abstract] AND "last 5 years" [PDat]
Results: 145
Items downloaded: 15

TOTAL DOWNLOADS: 54

JSTOR

Strategy # 1: (physical activity) AND (technology)); 2013-2019; Journals
Results: 21
Items downloaded: 1

Strategy # 2: (ti: (physical activity) OR tb: (physical activity)) AND (ti: technology OR tb: technology)
Results: 0

Strategy # 3: (ab: (physical activity) AND ab: (technology)); 2013-2019
Results: 13
Items downloaded: 0

Strategy # 4: (ab: (physical activity) AND ab: (TICS))
Results: 0

Strategy # 5: (ti: (physical activity) OR tb: (physical activity)) AND (ti: TICS OR tb: TICS)
Results: 0

Strategy # 6: (ab: (physical activity) AND ab: (APP))
Results: 0

TOTAL DOWNLOADS: 1

SCIENCE DIRECT
Strategy # 1: Keywords ("physical activity" "technology") From: 2013 - To: 2019
Results: 66
Items downloaded: 3

Strategy # 2: Keywords ("physical activity" "TICS") from: 2013 - To: 2019
Results: 24
Items downloaded: 2

Strategy # 3: Keywords ("physical activity" "technology") - Article type (REV) from: 2013 - To: 2019
Results: 22
Items downloaded: 5

Strategy # 4: Keywords ("physical activity" "technology") - Article type (REV, FLA) from: 2013 - To: 2019
Results: 0

Strategy # 5: Keywords ("physical activity" "TICS") - Article type (REV, FLA) from: 2013 - To: 2019
Results: 0

Strategy # 6: Keywords ("physical activity" "APP") - Article type (REV, FLA) from: 2013 - To: 2019
Results: 0

TOTAL DOWNLOADS: 10

Source: Compiled by the authors.

Results

A total of 107 articles were identified in the initial search, 63.2% (73) of them were published in English. After discarding duplicates and those without an exact relationship with the subject of study, 100 were included for the final review. Once they were read in full, 32 articles that met the inclusion criteria were selected (Figure 1).

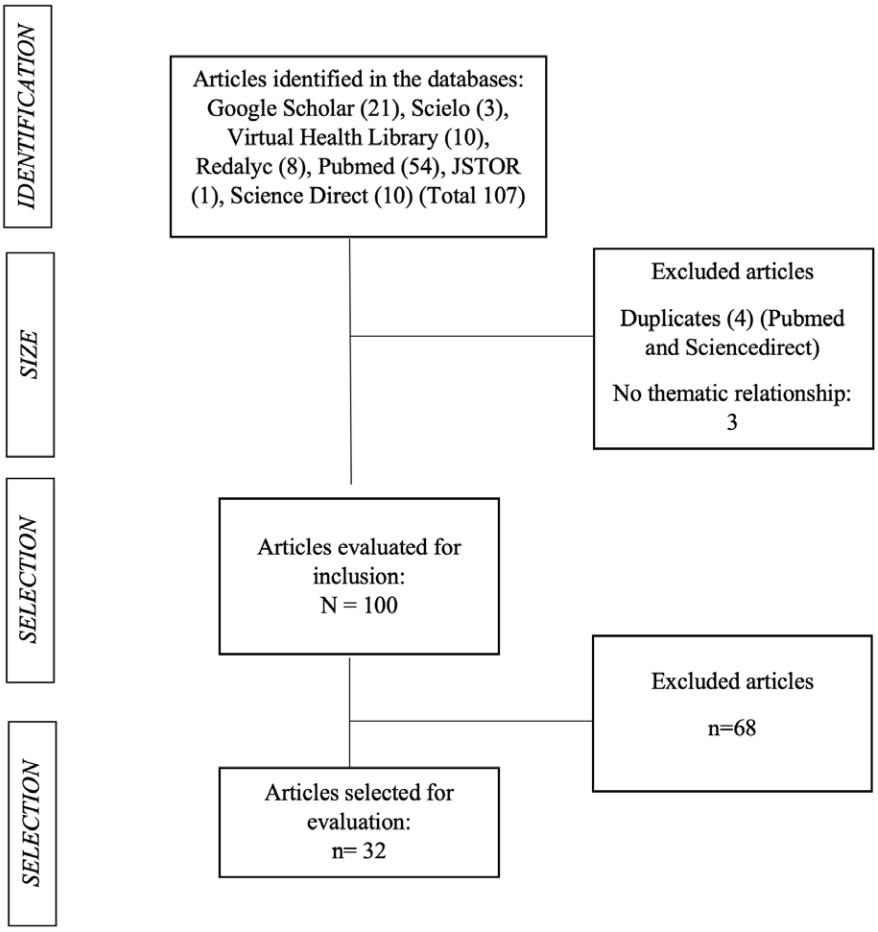

Figure 1. PRISMA diagram.
Source: Compiled by the authors.

Table 2 shows the main results derived from the review, note the way in which both in the different population groups, as some health conditions and in athletes, different information and communication technologies have been used for the promotion of physical activity, stand out as the most used technologies and that have demonstrated the most adherence in all groups are the use of computer applications (App) and mobile phones, some of them used in combination with other technologies. Spain and the United States are the countries where this form of intervention has been implemented the most.

Table 2. Summary of the main findings on the use of ICT for the promotion of physical activity

Group	ICT used	Activity/ Strategy	Results	Country	Quote
CHILDREN	*RutaTIC* (QR codes)	Marking reference points for physical activity	The realization of physical activity supported by ICT contributes to the consolidation of educational processes, grants experiences to students for sensory, intellectual and physical development.	Spain	(13)
	ActiGraph (belt) y GENEActiv accelerometer (watch)	Place devices for 7 days and measure physical activity	It is considered valid to apply the two devices to examine the sedentary behavior of children and to design, from here, strategies for the promotion of physical activity.	England	(14)with ST estimated using the waist mounted ActiGraph 100 count · min−1 threshold. Design: Secondary data analysis. Method: 108 10–11-year-old children (n = 43 boys
	HybridPLAY: Web platform based on wireless sensors	Locate sensors in open physical space and integrate them with mobile devices to record movements	The program promotes the development of play, encourages imagination and creativity for the realization of physical activity in children.	Spain	(15)

ADOLESCENT AND YOUTH	Mobile App	Mobile application that records physical activity time and calorie burning	The use of this technology raises awareness about the importance of healthy lifestyles and the use of Apps for registering physical activity in adolescents.	Spain	(16)
	Web page	Design of website about physical activity education	Satisfaction with the program to achieve adherence to physical activity	Spain	(4)
	Mobile Phone	Focus groups that assessed the use of technology and its relationship to health	Technology Helps adolescents Resolve Questions About Healthy Habits as Physical Activity	Spain	(17)
	Video camera recording with high shutter speed	Camera handling and DUBMOD virtual program handling to calculate jump height and take-off speed	Motivation of teens to use jump calculation strategy and improve physical activity	Spain	(18)
	Mobile informatics	Investigation of digital consumption strategy for the teaching of physical activity	Appropriation of new technologies for the teaching of physical education to young people	Colombia	(19)
	Mobile app and email	Use of FITBIT Plus technology to track physical activity.	Decreased lean body mass in overweight youth	United States	(20)

HEALTHY ADULTS	Exergames	Installation of console for movements Video games to improve postural balance	The use of interactive systems customized from video games increases physical activity and motivation	Colombia Australia	(8) (21)
	Technological Devices and Internet (Man Up)	Evaluation of the use of technological devices for the promotion of physical activity	The use of technology significantly increases the number of days of physical activity practice per week and dietary changes	United States Australia	(22)existe escasa investigación que examine la influencia de los dispositivos tecnológicos en la promoción de la salud y su aplicabilidad en los diferentes niveles de actividad física. Este estudio examinó los niveles actuales de AF de los participantes que usan dispositivos tecnológicos como medio de evaluación de la salud. Método: Una encuesta a 471 adultos en la pequeña Mountain West University, evaluó sus niveles actuales de actividad física. Las variables incluidas fueron: edad de los participantes, peso, altura, uso de dispositivos móviles, tipos específicos (nombre (23)
	Virtual classes and video call	Development of virtual physical activity class through video calls	Virtual targeted activities are a useful and valued strategy for the promotion of physical activity	Spain	(24)the fitness industry is on a growth path. One of the most prominent services in fitness centres is trainer-guided group fitness activities, which have evolved into virtual fitness activities with the inclusion of technology. This research analyses perceived value and customer satisfaction in both activities, exploring the differences between them and the relationship between the two variables. The sample consisted of 572 subjects belonging to a private fitness centre (319 women and 253 men

HEALTHY ADULTS	Ergonomic bike for physical activity and VR3D-S glasses	Physical activity on the bike for 3 minutes and physical recovery with relaxing film with the same duration using the glasses	The use of glasses has a positive direct effect on cardiovascular condition and is motivating for physical activity	Spain	(25)
	Smartphones, Nintendo WII and mobile App	Use of technologies for the promotion of physical activity	These technologies have the potential to motivate physical activity in sedentary adults and are cost-effective	Finland Italy	(26) (27)
	Physical activity monitor and text messages	Use of physical activity monitor to follow steps and text messages to reinforce behavioral strategies around physical activity	Use of strategies increased motivation, frequency and intensity of physical activity	United Stated United Kingdom	(28) (29)and compare e-mail with mobile phone short-message service (SMS
	Jawbone Up24 Monitor and Tablet Electronics	Using ActivPAL monitors to measure physical activity	These technologies produce significant changes in the time of physical activity and decrease sedentary behaviors	United States	(30)
	Email	Sending email promoting physical activity	Use of the Internet for the promotion of physical activity has high reach, low cost and cultural acceptance	United States	(31)
	Physical activity sensors and internet	Use of GPS-based accelerometer belt or sensors to measure physical activity.	The use of this technology is widely accepted to promote physical activity and generate behavioral changes	United States	(32) (33)

HEALTHY ADULTS	Brands of interactive technology	Physical activity program customized by interactive technology guided by videos	The program shows effectiveness and increases the intensity of the practice of physical activity	Amsterdam (Holland)	(34)
	Sensor FiBit & APPA Fit2thrive	Implemented an online gym and Fibit monitoring	Physical activity increased significantly to improve health	United States	(35)
ADULTS WITH PATHOL	Videogames and mobile App	Promotion of physical activity through the use of technological tools such as video games and Skype	The use of technologies that promote physical activity favours rehabilitation in people with physical limitations and systemic diseases and can be used in clinical practice	Australia Finland	(36) (37)
	Smartphone	Phone tracking with coaching sessions and text messages to guide the practice of physical activity	The use of technology is a new model to prevent clinical decline in people with different pathologies, increases physical activity levels and has a cost-benefit balance	Australia United States	(38) (39) (40)

ATHLETES	Mobile App	Monitoring through sensors	The use of APPA allowed to improve sports performance and reduce the possibility of injury and illness	Sweden	(41)often utilizing a pre-defined strategy. To avoid underperformance and/or compromised health, the external load during training should take into account the individual's physiological and perceptual responses. No single variable provides an adequate basis for planning, but continuous monitoring of a combination of several indicators of internal and external load during training, recovery and off-training as well may allow individual responsive adjustments of a training program in an effective manner. From a practical perspective, including that of coaches, monitoring of potential changes in health and performance should ideally be valid, reliable and sensitive, as well as time-efficient, easily applicable, non-fatiguing and as non-invasive as possible. Accordingly, smartphone applications, wearable sensors and point-of-care testing appear to offer a suitable monitoring framework allowing responsive adjustments to exercise prescription. Here, we outline 24-h monitoring of selected parameters by these technologies that (i
	GPS	Use of GPS to synchronize the athlete's performance in real time	GPS technologies can help coaches and athletes in developing physical activity with greater precision	Spain	(42)

Source: Compiled by the authors.

Discussion

The practice of physical activity positively influences the construction of values, skills and improvement of quality of life in the different stages of the life cycle and health conditions. The most relevant results of this work show the use of various technologies in the promotion of physical activity in a differential way, they also emphasize that such technologies should be a starting point as new intervention alternatives incorporated from early childhood and reinforced throughout life (43). The results of the promotion of physical activity in children show how different technologies, ranging from the use of devices and sensors to the consolidation of programs that motivate creativity and imagination, have been used and integrated. These results contain relevant information when compared to the results of Vera, Sánchez and Sánchez (44), who highlight that the promotion of physical activity in recreational spaces increases healthy parameters in school population. They are also consistent with the results of several studies that highlight the need to transform the teaching of physical activity in children by using other technologies and strategies that encourage adherence to making educational centers into promoters of healthy lifestyles through technology (45, 46).

Regarding the practice of physical activity in adolescents and young people, Carrasco et al (47), Gallegos (48) and Martinez and González (49) show that it should be mediated by motivation through different and non-traditional strategies, which allow to enjoy good physical health. Besides, the practice of physical activity influences the improvement of personal image perception, which generates positive changes in relation to sociability, academic performance and citizen competencies. All of the above is combined to increase the frequency of physical activity and to improve the quality of life in this group in this new era of the use of technology. The results of the work carried out are consistent with previous approaches because they highlight how ICT have mediated to achieve adherence to physical activity programs through the use of mobile phones, websites, and APP, among others; the results show motivation, appropriation, satisfaction and impact on body image.

In healthy adults, the use of different technologies for the promotion of physical activity has generated great acceptance and their results have been reflected in adherence to programs, increase of practice frequency and intensity, reduction of sedentary behaviors, and healthy habits development. Similarly, Gómez et al (50), conclude that maintaining the motivation for the promotion of physical activity of all adults in the long term allows to consolidate healthy lifestyle habits. In adults with pathologies the results show how the use of technology for the promotion of physical activity has managed to generate clinical changes and favor rehabilitation processes and its costs. Likewise, Velez et al (51) conclude that physical activity helps to reduce metabolic risk and problems; it also frames a differential pattern on the impact of quality of life and health condition improvement if the use of electronic health is added (52).

To carry out physical activity with greater precision, it is essential to complement training sessions with strategies that allow the athlete to increase physical performance. This research showed that the use of technological tools such as APP and GPS improve sports performance and reduce the possibility of injuries or illnesses. Likewise, Prieto, Giraldo and Salas concluded that another effective strategy is proprioceptive training, considered as an adequate, important and fundamental complement to the physical activity of the athlete. Such strategy increases

the ability to develop simple and complex motor actions and, therefore, to achieve adequate performance in sports performance and to improve coordinative abilities. In this regard, the authors highlight that it is not necessary to promote the development of physical activity in athletes, but to seek strategies that motivate adherence to it (53).

Similarly, the study carried out by Vásquez and López allows to identify the importance for athletes to have spaces and contexts favorable to sports behavior and to the practice of physical activity; it also allows to show that there are several factors that influence motivation in athletes, among them, the methodologies used for practice (54).

Conclusions

There is important evidence on the use of technologies for the promotion of physical activity at different stages of life, which have mostly been cost effective; all of them have shown positive effects that motivate the adherence of participants and guarantee its continuity. The impact of such technologies has been reflected in health conditions and in the quality of life of those who benefit from them. The use of technologies as mediators to carry out activity has become a challenge both for people and for those involved in orientation, recovery or rehabilitation processes.

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