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ORIGINAL

Physical Activity in the Digital Era: Bibliometric Analysis of Emerging Technologies to Improve Physical and Mental Health

La actividad física en la era digital: análisis bibliométrico de las tecnologías emergentes para mejorar la salud física y mental

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ABSTRACT

Introduction: digital technologies have transformed strategies for promoting health, psychological well-being, and the prevention of chronic diseases. Over the past decade, tools such as mobile applications, wearable devices, virtual reality, and artificial intelligence have enabled the development of personalized interventions to improve physical activity and overall health.
Objective: this study aimed to analyze the evolution of scientific research on digital technologies applied to physical activity and their impact on physical and mental health between 2015 and 2025, identifying dominant trends, influential technologies, and research gaps.
Method: a total of 5592 records were retrieved from the Web of Science and PubMed databases. After screening and deduplication, 633 original articles were selected for bibliometric and qualitative analysis. Descriptive statistics, keyword co-occurrence, and collaboration networks were generated using R (v4.4.2) and VOSviewer (v1.6.20), complemented by a qualitative review of the 99 most-cited studies.
Results: scientific production showed steady growth, with a sharp rise during the COVID-19 pandemic. Mobile applications and mHealth dominated the field, appearing in 78 % of the most-cited papers, demonstrating effectiveness in improving adherence to physical activity programs and monitoring physiological parameters. Virtual reality and exergaming emerged as promising tools for rehabilitation and motivation, while artificial intelligence showed emerging potential for personalized interventions. However, gaps remain regarding regional representation, AI integration, and longitudinal study design.
Conclusions: digital technologies have redefined the promotion of physical activity and health management, fostering personalized and scalable interventions. Although research has become increasingly consolidated, challenges persist in methodological standardization, inclusion of underrepresented regions, and long-term assessment of outcomes. These findings provide valuable guidance for future studies and the development of innovative digital health strategies.

Keywords: Personalized Digital Interventions; Physical and Psychological Health; Mobile-Based Exercise Applications; Intelligent Wearable Devices; Bibliometric Analysis; Emerging Trends.

RESUMEN

Introducción: las tecnologías digitales han transformado las estrategias para promover la salud, el bienestar psicológico y la prevención de enfermedades crónicas. Durante la última década, herramientas como las aplicaciones móviles, los dispositivos portátiles, la realidad virtual y la inteligencia artificial han permitido desarrollar intervenciones personalizadas orientadas a mejorar la actividad física y la salud integral.

Objetivo: analizar la evolución de la investigación científica sobre tecnologías digitales aplicadas a la actividad física y su impacto en la salud física y mental entre 2015 y 2025, identificando tendencias dominantes, tecnologías influyentes y vacíos de investigación.
Método: se recuperaron 5592 registros de las bases de datos Web of Science y PubMed. Tras los procesos de depuración y eliminación de duplicados, se seleccionaron 633 artículos originales para el análisis bibliométrico y cualitativo. Se aplicaron estadísticas descriptivas, análisis de coocurrencia de palabras clave y redes de colaboración mediante R (v4.4.2) y VOSviewer (v1.6.20), complementado con una revisión cualitativa de los 99 estudios más citados.
Resultados: la producción científica mostró un crecimiento sostenido, con un aumento pronunciado durante la pandemia de COVID-19. Las aplicaciones móviles y el mHealth dominaron el campo, presentes en el 78 % de los artículos más citados, evidenciando su efectividad para mejorar la adherencia a programas de actividad física y monitorear parámetros fisiológicos. La realidad virtual y los exergames emergieron como herramientas prometedoras para la rehabilitación y la motivación, mientras que la inteligencia artificial mostró un potencial incipiente para personalizar las intervenciones. No obstante, persisten vacíos relacionados con la representación geográfica, la integración de la IA y el diseño de estudios longitudinales.
Conclusiones: las tecnologías digitales han redefinido los paradigmas de promoción de la actividad física y gestión de la salud, impulsando intervenciones personalizadas y escalables. Aunque la investigación se encuentra en una fase de consolidación, aún enfrenta desafíos vinculados con la estandarización metodológica, la inclusión de regiones subrepresentadas y la evaluación a largo plazo de los efectos. Estos hallazgos ofrecen una base sólida para orientar futuras investigaciones y diseñar estrategias digitales innovadoras en salud.

Palabras clave: Intervenciones Digitales Personalizadas; Salud Física y Psicológica; Aplicaciones Móviles de Ejercicio; Dispositivos Portátiles Inteligentes; Análisis Bibliométrico; Tendencias Emergentes.

INTRODUCTION

In the last decade, the advancement of digital technology has significantly transformed strategies for promoting health, psychological well-being, and the prevention of chronic diseases. Tools such as mobile applications, wearable devices, telemedicine platforms, virtual reality, and systems based on artificial intelligence have enabled the design of personalized and scalable interventions aimed at improving quality of life through physical activity.[1,2] These technologies have become key tools for promoting healthy habits, especially in contexts where sedentary lifestyles and diseases associated with metabolic syndrome pose significant global public health challenges.[3,4]

The incorporation of mHealth and mobile applications has shown remarkable growth, allowing the monitoring of parameters, such as caloric expenditure, heart rate, sleep patterns, and daily physical activity, as well as providing personalized feedback and reminders tailored to user needs.[5,6] On the other hand, immersive technologies, such as virtual reality and exergaming, have produced promising results in rehabilitation, anxiety treatment, and cognitive stimulation.[7,8] Likewise, wearable devices have gained relevance for the continuous monitoring of physiological indicators, integrating real-time data to support clinical decision making.[9]

However, the scientific literature reveals heterogeneous results regarding the effectiveness of these technologies owing to methodological variations, sample characteristics, and the diversity of application contexts.[10,11] Despite the demonstrated potential, significant gaps remain, such as the limited representation of populations from Latin America and Africa, restricted integration of artificial intelligence algorithms, and a lack of longitudinal studies assessing sustained long-term effects.[12,13]

In this context, the present study conducted a comprehensive bibliometric and qualitative analysis of the scientific production of digital technologies applied to physical activity and their relationship with physical and mental health between 2015 and 2025. The main objective of this study was to comprehensively analyze the scientific production on digital technologies applied to physical activity between 2015 and 2025, identifying thematic trends, predominant technologies, their impact on physical and mental health, and existing research gaps to guide future studies.

METHOD

The methodology of this study was structured into five main stages:

1. Selection of databases.
2. Definition of terms and search equations.
3. Inclusion and exclusion criteria.
4. Data processing, cleaning, and deduplication.
5. Bibliometric, visualization, and qualitative analyses.

The bibliometric analysis was carried out using R (v4.4.2) and VOSviewer (v1.6.20) to identify publication patterns, co-authorship networks, keyword co-occurrence, and thematic clusters.

This process involved calculating annual publication trends, mapping institutional collaborations, and detecting emerging research themes. The qualitative analysis complemented these results by reviewing the 99 most-cited articles to interpret the practical implications of digital technologies for physical and mental health.

Database Selection

To ensure multidisciplinary and representative coverage, two main databases were selected:

- The Web of Science Core Collection (WoS) provides high-impact articles and is widely used in bibliometric studies.
- PubMed/MEDLINE: allows capturing specialized scientific literature in medicine, psychology, physiology, mHealth, mobile apps, and digital health technologies.

The combination of both sources makes it possible to build a robust and updated database of digital technologies, physical activity, and their relationship with mental health (depression and anxiety) and metabolic syndromes.

Definition of Terms and Search Equations

The search equation was designed to capture publications related to physical activity, digital technologies, and their impact on mental health and metabolic syndrome.

a) Web of Science (WoS): TS=("physical activity" OR "exercise" OR "fitness" OR "active lifestyle") AND TS=("digital health" OR "mHealth" OR "mobile app" OR "wearable" OR "fitness tracker" OR "smartwatch" OR "virtual reality" OR "artificial intelligence") AND TS=("depression" OR "anxiety" OR "mental health" OR "syndrome metabolic" OR "obesity" OR "diabetes" OR "hypertension")

b) PubMed: ("physical activity"[Title/Abstract] OR exercise[Title/Abstract] OR "fitness"[Title/Abstract] OR "active lifestyle"[Title/Abstract]) AND ("digital health"[Title/Abstract] OR mHealth[Title/Abstract] OR "mobile app"[Title/Abstract] OR "wearable"[Title/Abstract] OR "fitness tracker"[Title/Abstract] OR "smartwatch"[Title/Abstract] OR "virtual reality"[Title/Abstract] OR "artificial intelligence"[Title/Abstract]) AND ("depression"[Title/Abstract] OR "anxiety"[Title/Abstract] OR "mental health"[Title/Abstract] OR "metabolic syndrome"[Title/Abstract] OR "obesity"[Title/Abstract] OR "diabetes"[Title/Abstract] OR "hypertension"[Title/Abstract])

Inclusion and Exclusion Criteria

Inclusion criteria

- Original articles published in English or Spanish.
- Period: 2015–2025.
- Studies analyzing the relationship between physical activity, digital technologies (mHealth, apps, wearables, AI, VR), and mental health or metabolic syndrome.

Exclusion criteria

- Systematic reviews, editorials, book chapters, letters to the editor, and conference papers.
- Duplicate articles between WoS and PubMed (resolved by exact title matching).
- Publications not addressing physical activity or digital interventions.

Data Processing, Cleaning, and Deduplication

Data from WoS were exported. xlsx format, and data from PubMed were exported in .csv format. To unify the datasets, the records were imported as a dataframe in R. Standardization involved converting all titles to lowercase. Duplicate removal was primarily performed through exact title matching after converting all titles to lowercase. Additional manual verification was conducted to identify potential residual duplicates caused by variations in punctuation, spacing, or special characters, ensuring the accuracy of the final dataset. The final database included relevant fields, such as title, authors, year, affiliation, citations, keywords, and journals.

Bibliometric Analysis

The analysis was conducted on three levels:

Descriptive analysis

- Annual publication trends.
- Most influential journals.

Network analysis

- Keyword co-occurrence to identify thematic clusters.
- Institutional collaboration networks.

Tools used

- R (v4.4.2): statistical analysis and trend visualization.
- VOSviewer (v1.6.20): generates co-occurrence maps, collaboration networks, and thematic clusters.

Qualitative Analysis

To complement the bibliometric analysis, a qualitative review of the 50 most-cited articles from both WoS and PubMed was conducted, with the following objectives: 1) Identify the most widely applied digital technologies (mobile apps, AI, wearables, and VR); 2) The theoretical and methodological models were evaluated, and 3) Analyzed the reported effects on depression, anxiety, and metabolic syndrome.

RESULTS

The bibliographic search conducted on August 27, 2025, identified a total of 3407 records in Web of Science (WoS) and 2185 records in PubMed. After a three-stage filtering process — excluding non-original articles, removing records outside the study period, and applying language filters — 2606 documents were retained from WoS and 460 from PubMed. Subsequently, 383 duplicates were removed, resulting in a consolidated database of 2683 records. After reviewing titles and abstracts, 633 articles were selected for bibliometric analysis.

The results are presented from four perspectives: scientific productivity, the most influential journals, emerging topics, and international institutional collaboration.

Annual Evolution of Publications

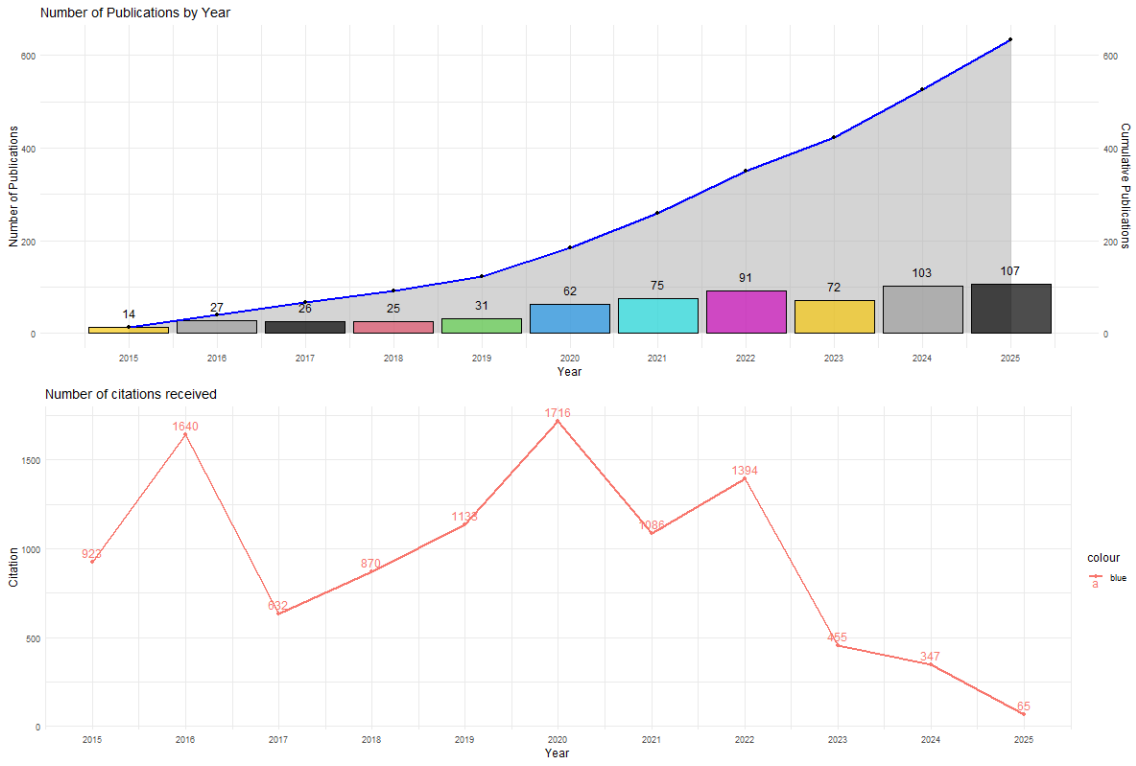

Figure 1. Annual Evolution of Publications on Digital Technologies, Physical Activity, and Mental Health

Figure 1 shows the annual evolution of publications related to digital technologies, physical activity, and mental health during 2015–2025. Sustained growth in scientific production was observed, with a significant increase starting in 2019. This behavior reflects the progressive integration of digital technologies in the fields of health and sports as well as the growing interest of the scientific community in their impact on promoting healthy habits, preventing chronic diseases, and managing psychological well-being.

A relevant finding is the sharp increase between 2020 and 2022, coinciding with the context of the COVID-19 pandemic, which accelerated the adoption of digital platforms, mobile applications, wearable devices, and

telemedicine to maintain the continuity of physical activity and monitor health. This scenario has encouraged the production of studies evaluating the effectiveness of personalized digital interventions during periods of mobility restriction and social isolation.

Finally, the historical peak of publications in 2024 demonstrates the consolidation of the field, anticipating that the trend will continue to rise owing to the convergence of artificial intelligence, the Internet of Things, and remote monitoring tools for the prevention and treatment of conditions associated with sedentary lifestyles and mental health.

Most Influential Journals

Table 1 presents the scientific journals with the highest impact on academic production of digital technologies applied to physical activity and mental health. Journals from the Journal of Medical Internet Research (JMIR) ecosystem stand out, as they concentrate the largest volume of publications and citations. The most relevant cases include the following.

- JMIR MHealth and UHealth: 25 articles | 708 citations.
- Journal of Medical Internet Research: 20 articles | 731 citations.
- JMIR Formative Research: 24 articles | 214 citations.

These figures show that mHealth, telemedicine, and mobile applications represent the dominant thematic cores. Additionally, the presence of multidisciplinary journals, such as BMJ Open and Digital Health, reflects that the field integrates contributions from medicine, biomedical engineering, psychology, sports sciences, and data science.

The predominance of journals combining clinical approaches with technological solutions suggests that research is moving toward hybrid models, where digital tools not only act as a complement but are also actively integrated into the design of interventions, health monitoring, and the evaluation of physical and mental behavior.

Table 1. Most Influential Journals in Scientific Production on Digital Technologies and Health

Source.title	Documents	Citations
JMIR MHEALTH AND UHEALTH	25	708
JMIR FORMATIVE RESEARCH	24	214
JOURNAL OF MEDICAL INTERNET RESEARCH	20	731
JMIR mHealth and uHealth	18	382
Journal of medical Internet research	17	390
JMIR RESEARCH PROTOCOLS	13	83
BMJ open	11	61
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	9	184
DIGITAL HEALTH	9	53
JMIR research protocols	9	4
Contemporary clinical trials	8	67

Keyword Co-occurrence to Identify Thematic Clusters

Table 2 presents the 15 most frequent keywords in the analyzed literature, highlighting physical activity (131 occurrences) and mHealth (84 occurrences) as central axes. A comprehensive analysis of the 150 identified terms is presented in Appendix 1, while figure 2 illustrates their distribution across thematic clusters generated using VOSviewer.

Table 2. Most Frequent Keywords in the Literature on Digital Technologies Applied to Physical Activity

Ranking	Keyword	Occurrences	Total link strength
1	Physical activity	131	408
2	Exercise	98	519
3	mHealth	84	332
4	Mental health	53	225
5	Mobile applications	30	215

6	Adolescent	33	218
7	Quality of life	39	226
8	Mobile health	37	166
9	Telemedicine	22	140
10	Wearable devices	21	126
11	Virtual reality	64	118
12	Machine learning	18	62
13	Obesity	30	114
14	Depression	27	122
15	Cardiorespiratory fitness	5	28

Cluster 1 — Digital Interventions and mHealth (red)

This group included terms related to the use of mobile applications, telemedicine, text messaging, and wearable devices. The high frequency of mobile applications (30 occurrences, link strength 215) and mHealth (84 occurrences, link strength 332) confirms that mobile devices represent the backbone of the current research.

Cluster 2 — Physical Activity and Cardiovascular Health (blue)

This cluster includes concepts related to exercise, fitness, body mass index, and cardiorespiratory fitness. The studies in this group explored the relationship between physical activity, body weight control, and prevention of metabolic risk factors by integrating digital tools for personalized monitoring.

Cluster 3 — Mental Health and Psychological Well-being (green)

This cluster contained keywords such as depression, anxiety, and quality of life. The frequency of these terms indicates that recent literature recognizes technology-mediated physical activity as a relevant component in managing psychological disorders and promoting emotional resilience.

Cluster 4 — Artificial Intelligence and Predictive Analytics (yellow)

This cluster focuses on the use of machine learning, deep learning, and wearables to design predictive models to prevent chronic diseases and improve the physical performance. The integration of AI into these studies shows a shift toward a more personalized, automated, and data-driven approach.

Keyword co-occurrence analysis revealed that the current research combines elements from digital health, psychology, engineering, and sports sciences, consolidating a multidisciplinary and highly innovative approach.

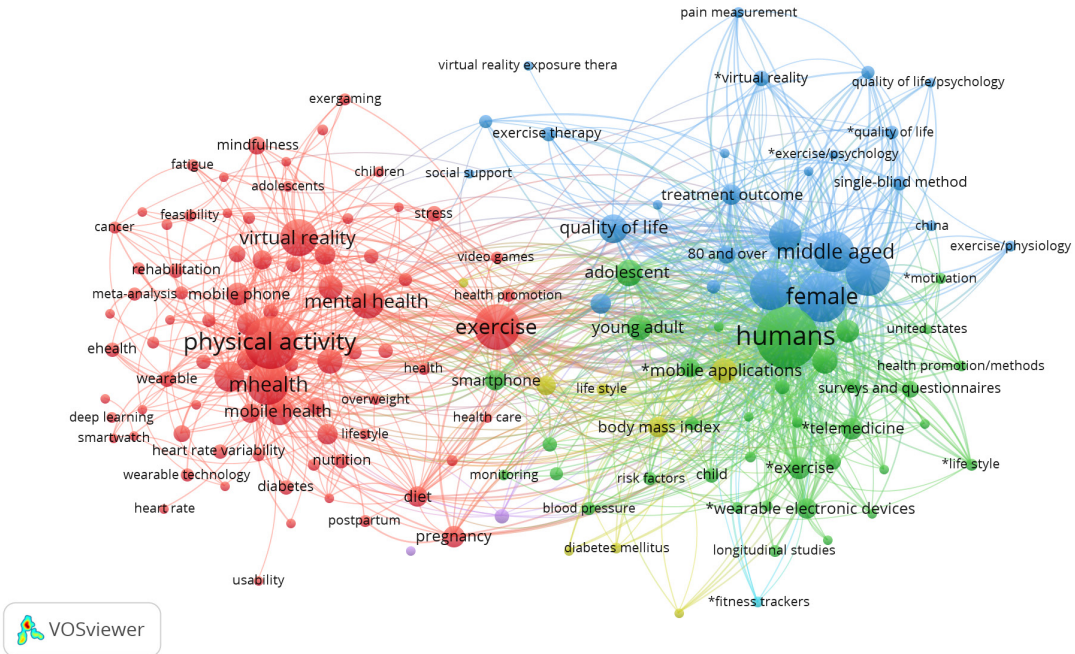

Figure 2. Keyword Co-occurrence Network in Studies on Digital Technologies and Physical Activity

Institutional Collaboration

Figure 3 presents the collaboration network among leading institutions, showing the concentration of scientific leadership in the United States and the United Kingdom. The most prominent institutions include the following.

- University of California System (20 publications | link strength 26).
- Pennsylvania Commonwealth System of Higher Education (11 publications | link strength 14).
- University of London (8 publications | link strength 14).
- Stanford University and Arizona State University (8 publications each | link strength 11).

This analysis showed that knowledge generation is mainly concentrated among universities with significant funding for technological research applied to health. Additionally, there is a growing participation of Asian institutions, such as the National University of Singapore and Seoul National University, which are becoming strategic nodes in the integration of digital technologies for physical activity and mental health.

However, the limited representation of Latin America and Africa highlights a significant geographical gap in scientific production, which represents an opportunity to promote international collaborations aimed at diversifying the scope of studies and strengthening south-south partnerships.

Figure 3. Institutional Collaboration Network in Research on Digital Technologies and Healt

Qualitative Analysis

To complement the bibliometric analysis, the most-cited articles identified in Web of Science and PubMed were selected. Each publication was assigned a unique code (A001–A99), and the applied technologies and main findings were analyzed (table 3). This strategy allowed the synthesis of dominant trends, assessment of the impact on physical and mental health, and identification of gaps in the literature.

Table 3. Most-Cited Articles: Applied Technologies and Key Findings

Código	Authors	Citas	Título	Tecnología aplicada	Hallazgos clave
A001	Jakicic et al.[1]	479	Effect of wearable technology combined with a lifestyle intervention on long-term weight loss the idea randomized clinical trial	mHealth / Apps móviles	Among the 471 participants randomized (body mass index [BMI], 25 to <40; age range, 18-35 years; 28,9 % nonwhite; 77,2 % women), 470 (233 in the standard intervention group, 237 in the enhanced intervention group) initiated the interventions as randomized, and 74,5 % completed the study. Weight change at 24 months differed significantly by intervention group (difference, 2,4 kg [95 % CI, 1,0-3,7]; P = 0,002).
A002	Hong et al.[2]	223	Multifunctional wearable system that integrates sweat-based sensing and vital-sign monitoring to estimate pre-/post-exercise glucose levels	mHealth / Apps móviles	Wearable bioelectronic technologies have made significant progress in personalized health management through non-invasive monitoring of health indicators.
A003	Nahavandi et al.[12]	209	Application of artificial intelligence in wearable devices: opportunities and challenges	mHealth / Apps móviles	Supervised and unsupervised learning applications for medical diagnosis improve prior diagnosis.

A004	Zhang et al.[6]	206	Artificial intelligence chatbot behavior change model for designing artificial intelligence chatbots to promote physical activity and a healthy diet: viewpoint	mHealth / Apps móviles	The study found a lack of understanding around theoretical guidance and practical recommendations on designing AI chatbots for lifestyle modification programs. The proposed AI chatbot behavior change model consists of the following four components to provide such guidance: (1) designing chatbot characteristics and understanding user background; (2) building relational capacity; (3) building persuasive conversational capacity; and (4) evaluating mechanisms and outcomes.
A005	Piette et al.[4]	171	Mobile health devices as tools for worldwide cardiovascular risk reduction and disease management	mHealth / Apps móviles	Interactive voice response and short message service interventions can improve cardiovascular preventive care in developed countries by addressing risk factors including weight, smoking, and physical activity. Multimodal interventions including Web-based communication with clinicians and mHealth-enabled clinical monitoring with feedback also have shown benefits.
A006	Huberty J[5]	157	Efficacy of the mindfulness meditation mobile app "calm" to reduce stress among college students: randomized controlled trial	mHealth / Apps móviles	Calm is an effective modality to deliver mindfulness meditation in order to reduce stress and improve mindfulness and self-compassion in stressed college students.
A007	Lee et al.[7]	153	Effect of virtual reality dance exercise on the balance, activities of daily living, and depressive disorder status of parkinson's disease patients	Realidad Virtual / Exergaming	Virtual reality dance exercise has a positive effect on balance, activities of daily living, and depressive disorder status of Parkinson's disease patients.
A008	Direito et al.[3]	148	Apps for improving fitness and increasing physical activity among young people: the aimfit pragmatic randomized controlled trial	mHealth / Apps móviles	Although apps can increase reach at a low cost, our pragmatic approach using readily available commercial apps as a stand-alone instrument did not have a significant effect on fitness.
A009	Bansal et al.[11]	144	Healthcare in metaverse: a survey on current metaverse applications in healthcare	mHealth / Apps móviles	The COVID-19 pandemic has revealed several limitations of existing healthcare systems. Today, digital transformation is not limited to virtual communication alone but encompasses digitalizing the network of social connections in the healthcare industry using metaverse technology.
A010	Pfaeffli Dale L[9]	132	Text message and internet support for coronary heart disease self-management: results from the text4heart randomized controlled trial	mHealth / Apps móviles	A mHealth CR intervention plus usual care showed a positive effect on adherence to multiple lifestyle behavior changes at 3 months in New Zealand adults with CHD compared to usual care alone.
A011	Witt et al.[14]	107	Windows into human health through wearables data analytics	mHealth / Apps móviles	Wearable health technologies aim to collect and process raw physiological or environmental parameters into salient digital health information.
A012	Mendoza JA[13]	102	A fitbit and facebook mhealth intervention for promoting physical activity among adolescent and young adult childhood cancer survivors: a pilot study	mHealth / Apps móviles	This mHealth PA intervention was feasible and acceptable to AYA childhood cancer survivors and warrants a fully powered RCT.
A013	Veling et al.[8]	99	Virtual reality relaxation for patients with a psychiatric disorder: crossover randomized controlled trial	Realidad Virtual / Exergaming	If the results of this trial are replicated and extended, VRelax may provide a much-needed, effective, easy-to-use self-management relaxation intervention to enhance psychiatric treatments.

A014	Naslund et al.[15]	98	Wearable devices and smartphones for activity tracking among people with serious mental illness	mHealth / Apps móviles	Eleven participants wore Fitbits for an average of 84,7 % (SD = 18,1 %) of the days enrolled in the study (median = 93,8 % of the days enrolled, interquartile range = 83,6-943 %). Participants were highly satisfied, stating that the devices encouraged them to be more physically active and were useful for self monitoring physical activity and reaching daily step goals.
A015	Qi et al.[16]	92	A hybrid hierarchical framework for gym physical activity recognition and measurement using wearable sensors	mHealth / Apps móviles	Due to the many beneficial effects on physical and mental health and strong association with many fitness and rehabilitation programs, physical activity (PA) recognition has been considered as a key paradigm for Internet of Things healthcare. The results indicate the proposed framework has better performance in recognizing and measuring GPAs than other approaches.
A016	Kim JY[17]	88	The influence of wireless self-monitoring program on the relationship between patient activation and health behaviors, medication adherence, and blood pressure levels in hypertensive patients: a substudy of a randomized controlled trial	mHealth / Apps móviles	Improvements in patient activation were associated with improvements in cigarette smoking (beta=-0,46, P<0.001) and blood pressure control (beta=0,04, P=0,02). This relationship was further strengthened in reducing cigarettes (beta=-0,60, P<0,001), alcohol drinking (beta=-0,26, P=0,01), and systolic (beta=-0,27, P=0,02) and diastolic blood pressure (beta=-0,34, P=0,007) at 6 months among individuals participating in the wireless self-monitoring program.
A017	Kahlon et al.[18]	87	Virtual reality exposure therapy for adolescents with fear of public speaking: a non-randomized feasibility and pilot study	mHealth / Apps móviles	The results show that low-cost, consumer VR hardware can be used to deliver efficacious treatment for PSA in adolescents, in a feasible one-session format.
A018	Walsh et al.[2]	85	An mhealth intervention using a smartphone app to increase walking behavior in young adults: a pilot study	mHealth / Apps móviles	The results of this study demonstrate that a mobile phone app can significantly increase physical activity in a young adult sample by setting specific goals, using self-monitoring, and providing feedback.
A019	Spruijt-Metz et al.[19]	84	Innovations in the use of interactive technology to support weight management	mHealth / Apps móviles	This paper will give an overview of the current technology landscape for sensing and intervening on three behaviors that are central to weight management: diet, physical activity, and sleep. We conclude with a discussion of hurdles that mHealth obesity research has yet to overcome and a future-facing discussion.
A020	Camacho-Miñano et al.[20]	84	Postfeminist biopedagogies of instagram: young women learning about bodies, health and fitness	mHealth / Apps móviles	Social media can become a site of public pedagogy (Rich, E., & Miah, A.(2014). Our analysis reveals how some young women learn about exercise as aesthetic labour' through the biopedagogies circulating on Instagram, with continual work upon the body associated with performing subjectivities which are confident, happy and powerful.
A021	Chae SH[21]	82	Development and clinical evaluation of a web-based upper limb home rehabilitation system using a smartwatch and machine learning model for chronic stroke survivors: prospective comparative study	mHealth / Apps móviles	This study found that a home care system using a commercial smartwatch and ML model can facilitate participation in home training and improve the functional score of the WMFT and shoulder ROM of flexion…

A022	Düking et al.[22]	78	Wrist-worn wearables for monitoring heart rate and energy expenditure while sitting or performing light-to-vigorous physical activity: validation study	mHealth / Apps móviles	While monitoring HR at different exercise intensities, the standardized typical errors of the estimates were 0,09-0,62, 0,13-0,88, 0,62-1,24, and 0,47-1,94 for the Apple Watch Series 4, Polar Vantage V, Garmin Fenix 5, and Fitbit Versa, respectively. Depending on exercise intensity, the corresponding coefficients of variation were 0,9 %-4,3 %, 2,2 %-6,7 %, 2,9 %-9,2 %, and 4,1 %-19,1 %, respectively, for the 4 wearables.
A023	Ganesan et al.[23]	77	International mobile-health intervention on physical activity, sitting, and weight the stepathlon cardiovascular health study	mHealth / Apps móviles	Distributed mHealth implementation of a low-cost life-style intervention is associated with short-term, reproducible, large-scale improvements in physical activity, sitting, and weight.
A024	Montagni et al.[24]	75	Exploring digital health use and opinions of university students: field survey study	mHealth / Apps móviles	University students are largely using the internet for health information seeking, but using less mobile health apps and very few wearable devices.
A025	Islam et al.[25]	75	Use of mobile phone app interventions to promote weight loss: meta-analysis	mHealth / Apps móviles	The findings of this study demonstrate the promising and emerging efficacy of using mobile phone app interventions for weight loss.
A026	Bailey et al.[26]	75	Digital care for chronic musculoskeletal pain: 10,000 participant longitudinal cohort study	mHealth / Apps móviles	En el estudio se incluyó a un total de 10 264 adultos con dolor de rodilla (n = 3796) o lumbar (n = 6468) durante al menos tres meses. Los participantes experimentaron una mejora media del 68,45 % en la escala VAS de dolor entre el inicio del estudio y las 12 semanas.
A027	Rahman et al.[27]	74	Performance analysis of boosting classifiers in recognizing activities of daily living	mHealth / Apps móviles	These findings suggest the strength of the proposed system in classifying activity of daily living using only the smartphone sensor's data and can assist in reducing the physical inactivity patterns to promote a healthier lifestyle.
A028	Coutts et al.[28]	72	Deep learning with wearable based heart rate variability for prediction of mental and general health	Wearables / Fitness trackers	The feasibility of feeding back more complex, seemingly unrelated measures to users was investigated, by assessing whether increased levels of stress, anxiety and depression (factors known to affect cardiac function) and general health measures could be accurately predicted using heart rate variability (HRV) data from wrist wearables alone. For mental health measures, classification accuracies of up to 83 % and 73 % were achieved, with five and two minute HRV data streams respectively, showing improved predictive capability and potential future wearable use for tracking stress and well-being.
A029	Kalmbach et al.[29]	67	Effects of sleep, physical activity, and shift work on daily mood: a prospective mobile monitoring study of medical interns	Wearables / Fitness trackers	Although short sleep, shift work, and physical inactivity are endemic to residency, a lack of objective, real-time information has limited our understanding of how these problems impact physician mental health. Mood and physical activity decreased by 7,5 % ($t = -3,67$, $p < 0,01$) and 11,5 % ($t = -3,15$, $p < 0,01$), respectively.
A030	Matcham F[30]	67	Remote assessment of disease and relapse in major depressive disorder (radar-mdd): a multi-centre prospective cohort study protocol	mHealth / Apps móviles	There is a growing body of literature highlighting the role that wearable and mobile remote measurement technology (RMT) can play in measuring symptoms of major depressive disorder (MDD).

A031	Siani & Marley[31]	66	Impact of the recreational use of virtual reality on physical and mental wellbeing during the covid-19 lockdown	Realidad Virtual / Exergaming	The results of the survey show that VR use has significantly increased during the lockdown period for most participants, who expressed overwhelmingly positive opinions on the impact of VR activities on their mental and physical wellbeing. Given the current uncertainty as to the duration and course of the pandemic, as well as the possibility of intermittent lockdown in the upcoming years, the outcomes of this study could have a significant impact towards the development and deployment of VR-based strategies aimed at helping the population cope with prolonged social distancing, with particular regards to vulnerable individuals.
A032	Mikolasek et al.[32]	61	Adherence to a mindfulness and relaxation self-care app for cancer patients: mixed-methods feasibility study	mHealth / Apps móviles	The study indicates that a mindfulness and relaxation mHealth intervention for cancer patients is feasible with acceptable adherence and largely positive feedback from patients.
A033	Nasri et al.[33]	61	An semg-controlled 3d game for rehabilitation therapies: real-time time hand gesture recognition using deep learning techniques	Inteligencia Artificial / Machine Learning	In this paper, we propose a sEMG-controlled 3D game that leverages a deep learning-based architecture for real-time gesture recognition.
A034	Castle JR[34]	61	Randomized outpatient trial of single- and dual-hormone closed-loop systems that adapt to exercise using wearable sensors	Wearables / Fitness trackers	The addition of glucagon delivery to a closed-loop system with automated exercise detection reduces hypoglycemia in physically active adults with type 1 diabetes.
A035	Stine et al.[35]	59	Breaking down barriers to physical activity in patients with nonalcoholic fatty liver disease	Wearables / Fitness trackers	While nearly all subjects with NAFLD identify physical activity to be important and desire to be more active, only a few meet activity recommendations.
A036	Xu et al.[36]	58	Studying the effect of display type and viewing perspective on user experience in virtual reality exergames	Realidad Virtual / Exergaming	This pilot study demonstrates that youth who played gesture-based exergame in immersive VR had a higher level of exertion (%HRmax, calories consumption, and Borg RPE), although the number of performed gestures were not significantly…
A037	Bruehlman-Senecal et al.[37]	57	Smartphone app to address loneliness among college students: pilot randomized controlled trial	mHealth / Apps móviles	Although Nod exposure did not impact outcomes for the full sample, these results provide initial evidence of its benefit for vulnerable students.
A038	Holzer et al.[38]	56	Continuous glucose monitoring in healthy adults-possible applications in health care, wellness, and sports	mHealth / Apps móviles	CGM systems can be used for early detection of abnormal glucose regulation. Learning from CGM data how the intake of foods with different glycemic loads and physical activity affect glucose responses can be helpful in improving nutritional and/or physical activity behavior.
A039	Riva et al.[39]	56	Covid feel good-an easy self-help virtual reality protocol to overcome the psychological burden of coronavirus	mHealth / Apps móviles	The goal of this protocol is for VR to become the surgical mask of mental health treatment.
A040	Naslund et al.[40]	55	Wearable devices and mobile technologies for supporting behavioral weight loss among people with serious mental illness	mHealth / Apps móviles	This exploratory study examined whether daily step count measured using Fitbit wearable devices was associated with weight loss and improved fitness among individuals with serious mental illness enrolled in a 6-month lifestyle program.

A041	Matsangidou et al.[41]	54	Is your virtual self as sensational as your real? virtual reality: the effect of body consciousness on the experience of exercise sensations	Realidad Virtual / Exergaming	Results verified that VR during exercise could reduce negative sensations associated with exercise regardless of the levels of PBC.
A042	Puszkiewicz et al.[42]	52	Assessment of cancer survivors' experiences of using a publicly available physical activity mobile application	mHealth / Apps móviles	All participants engaged with the app and qualitative interviews highlighted that the app was well-received.
A043	Grewal GS[43]	51	Sensor-based interactive balance training with visual joint movement feedback for improving postural stability in diabetics with peripheral neuropathy: a randomized controlled trial	Wearables / Fitness trackers	The results of this randomized controlled trial demonstrate that people with DPN can significantly improve their postural balance with diabetes-specific, tailored, sensor-based exercise training.
A044	Yingling et al.[44]	50	Adherence with physical activity monitoring wearable devices in a community-based population: observations from the washington, dc, cardiovascular health and needs assessment	mHealth / Apps móviles	Findings suggest that mHealth systems with awearable device and data collection hubmay feasibly target PA in resource-limited communities.
A045	Aschbrenner et al.[45]	50	A pilot study of a peer-group lifestyle intervention enhanced with mhealth technology and social media for adults with serious mental illness	mHealth / Apps móviles	Most participants (72 %) lost weight, including 28 % achieving clinically significant weight loss, and 17 % of participants showed clinically significant improvements in cardiovascular fitness.
A046	McMahon et al.[46]	49	Virtual reality exercise games for high school students with intellectual and developmental disabilities	mHealth / Apps móviles	Results indicate that all students increased the duration and intensity of their physical activity when using the VR exercise gaming (exergaming) intervention.
A047	Edney et al.[47]	49	Active team a social and gamified app-based physical activity intervention: randomised controlled trial study protocol	mHealth / Apps móviles	To fully realise the potential of such interventions, there is a need to further increase their appeal to boost engagement and retention, and sustain intervention effects over longer periods of time.
A048	Maynard et al.[48]	47	Effects of exercise training combined with virtual reality in functionality and health-related quality of life of patients on hemodialysis	Realidad Virtual / Exergaming	Physical training combined with VR improved functional capacity and some quality-of-life domains of hemodialysis patients.
A049	Guo Y[49]	47	Effect of a wechat-based intervention (run4love) on depressive symptoms among people living with hiv in china: a randomized controlled trial	mHealth / Apps móviles	The WeChat-based mobile health (mHealth) intervention Run4Love significantly reduced depressive symptoms among PLWHD, and the effect was sustained.
A050	Szczepanska-Gieracha et al.[50]	45	Virtual therapeutic garden: a promising method supporting the treatment of depressive symptoms in late-life: a randomized pilot study	Realidad Virtual / Exergaming	Immersive virtual therapy significantly lowered the intensity of depressive symptoms, as well as stress and anxiety levels in older women taking part in the group-based multimodal therapeutic programme, whose earlier therapy had not brought the…
A051	Du et al.[51]	45	A group-based mobile application to increase adherence in exercise and nutrition programs: a factorial design feasibility study	mHealth / Apps móviles	The team-based Fittle app is an acceptable and feasible wellness behavior change intervention and a full randomized controlled trial to investigate the efficacy of such an intervention is warranted.
A052	Ghose et al.[52]	44	Empowering patients using smart mobile health platforms: evidence from arandomized field experiment	mHealth / Apps móviles	Overall, the findings indicate the massive potential of mHealth technologies and platform design in achieving better healthcare outcomes

A053	Thompson et al.[53]	44	Feedback from physical activity monitors is not compatible with current recommendations: a recalibration study	mHealth / Apps móviles	The results of the study show that, at the UK median PAL, total moderate-to-vigorous intensity physical activity will be around 735 minutes per week (similar to 11 % of waking time).
A054	Heffernan M[54]	44	Maintain your brain: protocol of a 3-year randomized controlled trial of a personalized multi-modal digital health intervention to prevent cognitive decline among community dwelling 55 to 77 year olds	mHealth / Apps móviles	If successful, MYB will provide a model for not just effective intervention among older adults, but an intervention that is scalable for broad use.
A055	Groenveld et al.[55]	43	Feasibility of virtual reality exercises at home for post-covid-19 condition: cohort study	mHealth / Apps móviles	VR physical exercises at home is feasible and safe with good acceptance in a significant percentage of patient with post-COVID-19 condition.
A056	Rich[56]	43	Gender, health and physical activity in the digital age: between postfeminism and pedagogical possibilities	mHealth / Apps móviles	Evidence is also emerging that digital health technologies, mobile apps, social media and wearable lifestyle technologies are growing in popularity amongst young people but can have potentially far-reaching effects on their health practices, identities and.
A057	Sun et al.[57]	43	An exploratory study on a chest-worn computer for evaluation of diet, physical activity and lifestyle	mHealth / Apps móviles	Recently, wearable computers have become new members in the family of mobile electronic devices, adding new functions to those provided by smartphones and tablets.
A058	Meldrum D[58]	42	Effectiveness of conventional versus virtual reality-based balance exercises in vestibular rehabilitation for unilateral peripheral vestibular loss: results of a randomized controlled trial	Realidad Virtual / Exergaming	Virtual reality-based balance exercises performed during vestibular rehabilitation were not superior to conventional balance exercises during vestibular rehabilitation but may provide a more enjoyable method of retraining balance after unilateral peripheral vestibular loss.
A059	Dergaa et al.[59]	41	Using artificial intelligence for exercise prescription in personalised health promotion: a critical evaluation of openai's gpt-4 model	mHealth / Apps móviles	The AI -based approach aimed to ensure patient improvement through gradual increases in training load and intensity, but the model's potential to fine -tune its recommendations through ongoing interaction was not fully satisfying.
A060	Chung et al.[60]	41	Tweeting to health: a novel mhealth intervention using fitbits and twitter to foster healthy lifestyles	mHealth / Apps móviles	Participants increased fruit/vegetable intake (92 %) and decreased their sugar-sweetened beverage intake (67 %).
A061	Tejera DM[61]	40	Effects of virtual reality versus exercise on pain, functional, somatosensory and psychosocial outcomes in patients with non-specific chronic neck pain: a randomized clinical trial	mHealth / Apps móviles	Statistically significant differences were revealed for time factor ($F = 16,40$, $p < 0,01$, $\eta p2 = 0,28$) and group*time interaction for kinesiophobia ($F = 3,89$, $p = 0,01$, $\eta p2 = 0,08$) showing post-hoc differences in favor of the VR group at 3 months ($p < 0,05$, $d = 0,65$). Significant effects were shown for time factor ($p < 0,05$) but not for the group*time interaction ($p > 0,05$) for pain intensity, rotation range of motion (ROM), Neck Disability Index, pain catastrophizing, fear-avoidance beliefs, left side pressure pain threshold (PPT) and anxiety.
A062	Hales S[62]	40	Social networks for improving healthy weight loss behaviors for overweight and obese adults: a randomized clinical trial of the social pounds off digitally (social pod) mobile app	mHealth / Apps móviles	Experimental group participants lost significantly more weight (-5,3kg, CI: -7,5, -3,0) than comparison group (-2,23kg, CI: -3,6, -1,0; d=0,8, r=0,4, p=0,02) and had a greater reduction in BMI (p=0,02).

A063	Aranki et al.[63]	39	Real-time tele-monitoring of patients with chronic heart-failure using a smartphone: lessons learned	mHealth / Apps móviles	We present a smartphone-based system for real-time tele-monitoring of physical activity in patients with chronic heart-failure (CHF).
A064	Melton et al.[64]	38	Wearable devices to improve physical activity and sleep: a randomized controlled trial of college-aged african american women	mHealth / Apps móviles	Participants were college-aged (19,9 +/- 1,7 years) African American women (N = 69) at a southeastern midsize university in United States. There was a significant difference at the 8-week follow-up, such that the intervention group decreased step counts relative to the comparison app (9,378 vs. 11,287 steps; p = .02).
A065	Papastergiou et al.[65]	38	Introducing tablets and a mobile fitness application into primary school physical education	mHealth / Apps móviles	The experimental group students reported a higher level of interest and enjoyment than the control group students, although students' perceived effort, perceived competence and feeling of pressure did not differ significantly between the two groups.
A066	Maxwell-Smith C[66]	38	A randomized controlled trial of wataap to promote physical activity in colorectal and endometrial cancer survivors	Wearables / Fitness trackers	The intervention group significantly increased MVPA by 45 min/wk compared with a reduction of 21 min/wk in the control group. Group by time interactions were significant for minutes of MVPA (F1,126 = 5,14, P = 0,025).
A067	Peng et al.[67]	37	The covid-19 pandemic and overall wellbeing: mediating role of virtual reality fitness for physical-psychological health and physical activity	mHealth / Apps móviles	The direct path coefficient analysis of the study constructs show that virtual reality fitness has (preventive measures-> virtual reality fitness-> overall wellbeing, preventive measures-> virtual reality fitness-> physical exercise, and preventive measures-> virtual reality fitness-> physical health) profound effects on the research participants' mental and physical wellbeing of the study participants while indirect mediation analysis shows that virtual reality fitness has (preventive measures-> virtual reality fitness ->overall wellbeing, preventive measures-> virtual reality fitness-> physical exercise, preventive measures-> virtual reality fitness ->physical health) significant impacts.
A068	Wong et al.[68]	37	Development and pilot evaluation of a mobile app on parent-child exercises to improve physical activity and psychosocial outcomes of hong kong chinese children	mHealth / Apps móviles	The findings suggest that the Family Move app could be a possible intervention to increase children's PA level and psychosocial wellbeing through parent-child exercise.
A069	Tsuda et al.[69]	37	A feasibility study of virtual reality exercise in elderly patients with hematologic malignancies receiving chemotherapy	Realidad Virtual / Exergaming	Virtual reality exercise using the Wii Fit may be feasible, safe and efficacious, as demonstrated in our preliminary results, for patients with hematologic malignancies receiving chemotherapy.
A070	Düking et al.[70]	36	Behavior change techniques in wrist-worn wearables to promote physical activity: content analysis	mHealth / Apps móviles	Wearables employ different numbers and combinations of BCTs, which might impact their effectiveness in improving PA.
A071	James & Harville[71]	36	Smartphone usage, social media engagement, and willingness to participate in mhealth weight management research among african american women	mHealth / Apps móviles	This study examined smartphone usage, social media engagement, and willingness to participate in mHealth weight management among AAW in north-central Florida, United States. Most were willing to participate in research that used text messages (73 %), smartwatches/fitness trackers (69 %), and smartphone apps (68 %).

A072	Bade BC[72]	36	Assessing the correlation between physical activity and quality of life in advanced lung cancer	Wearables / Fitness trackers	Remote PA monitoring (Fitbit Zip) is feasible in advanced-stage LC patients.
A073	Lyons et al.[73]	35	Testing the effects of narrative and play on physical activity among breast cancer survivors using mobile apps: study protocol for a randomized controlled trial	mHealth / Apps móviles	Many interventions encourage self-monitoring of steps, which can increase physical activity in the short term.
A074	Severiano et al.[74]	35	Effect of virtual reality in parkinson's disease: a prospective observational study	mHealth / Apps móviles	The Tightrope Walk and Ski Slalom virtual games were shown to be the most effective for this population.
A075	Kanyilmaz et al.[75]	34	Effectiveness of conventional versus virtual reality-based vestibular rehabilitation exercises in elderly patients with dizziness: a randomized controlled study with 6-month follow-up	mHealth / Apps móviles	The application of vestibular rehabilitation in a virtual reality environment can lead to additional improvements especially in dizziness symptoms, disability, balance, and mobility in the elderly with chronic dizziness.
A076	Nosek et al.[76]	34	An internet-based virtual reality intervention for enhancing self-esteem in women with disabilities: results of a feasibility study	Realidad Virtual / Exergaming	Acceptability was positive; participants gave helpful and enjoyable ratings of 3,21 and 3,27, respectively, (mean on a 1 to 4 Likert scale, where 4 = high) to 5 intervention components-session materials, group sharing and discussion, relaxation exercises, action planning, and group excursions.
A077	Waller E[77]	34	Prehabilitation with wearables versus standard of care before major abdominal cancer surgery: a randomised controlled pilot study (trial registration: nct04047524)	mHealth / Apps móviles	Prehabilitation in the colorectal cancer care setting can be delivered using smartwatches and mobile applications.
A078	Pung et al.[78]	33	Mobile app use by primary care patients to manage their depressive symptoms: qualitative study	mHealth / Apps móviles	Mobile apps are being utilized for self-management of depressive symptoms by primary care patients.
A079	Blasco-Peris et al.[79]	33	Effects of exergaming in patients with cardiovascular disease compared to conventional cardiac rehabilitation: a systematic review and meta-analysis	mHealth / Apps móviles	Exergaming seems not to be superior to conventional CR programs for improving exercise capacity, quality of life, or mental health in patients with CVD.
A080	Haque et al.[80]	33	A persuasive mhealth behavioral change intervention for promoting physical activity in the workplace: feasibility randomized controlled trial	mHealth / Apps móviles	The SDT-based mHealth application motivated employees to increase their PA in the workplace.
A081	Guo et al.[81]	33	Assessing the quality of mobile exercise apps based on the american college of sports medicine guidelines: a reliable and valid scoring instrument	mHealth / Apps móviles	We have developed and presented valid and reliable scoring instruments for exercise program apps.
A082	Fari et al.[82]	33	Younger adolescents' perceptions of physical activity, exergaming, and virtual reality: qualitative intervention study	mHealth / Apps móviles	Key elements that should be incorporated into a VR game for health intervention were identified and described.
A083	Kleygrewe et al.[83]	33	Virtual reality training for police officers: a comparison of training responses in vr and real-life training	Realidad Virtual / Exergaming	In conclusion, VR SBT can elicit perceived stress, mental effort, and average HR that resemble or exceed responses in RL SBT, providing a promising tool to complement police training.
A084	Alazzam et al.[84]	32	Retracted: machine learning implementation of a diabetic patient monitoring system using interactive e-app (retracted article)	mHealth / Apps móviles	Lifestyle influences morbidity and mortality rates in the world.

A085	Afsar et al.[85]	31	Body-worn sensors for recognizing physical sports activities in exergaming via deep learning model	mHealth / Apps móviles	Obesity and laziness are some of the common issues in the majority of the youth today.
A086	Murawski B[86]	31	Efficacy of an m-health physical activity and sleep health intervention for adults: a randomized waitlist-controlled trial	mHealth / Apps móviles	Most adolescents did not meet sleep recommendations.
A087	Polat et al.[87]	30	The effect of virtual reality exercises on pain, functionality, cardiopulmonary capacity, and quality of life in fibromyalgia syndrome: a randomized controlled study	Realidad Virtual / Exergaming	Virtual reality exercises along with aerobic exercise increase cardiopulmonary capacity and quality of life in fibromyalgia syndrome.
A088	Kennelly MA[88]	30	Pregnancy, exercise and nutrition research study with smart phone app support (pears): study protocol of a randomized controlled trial	mHealth / Apps móviles	This will be the first clinical trial to evaluate the effectiveness of a smart phone technology-assisted targeted healthy lifestyle intervention, which is grounded in behavior change theories and techniques, to support antenatal management of…
A089	Lai et al.[89]	29	Feasibility of a commercially available virtual reality system to achieve exercise guidelines in youth with spina bifida: mixed methods case study	mHealth / Apps móviles	This study demonstrated that two youth with SB who used wheelchairs could use a VR system to independently and safely achieve exercise guidelines at home.
A090	VandeBunte et al.[90]	29	Physical activity measurement in older adults: wearables versus self-report	Wearables / Fitness trackers	Physical activity (PA) is associated with preserved age-related body and brain health.
A091	Serlachius A[91]	29	Association between user engagement of a mobile health app for gout and improvements in self-care behaviors: randomized controlled trial	mHealth / Apps móviles	Participants found the commercially available gout app more engaging.
A092	Schrager et al.[92]	28	Assessing the influence of a fitbit physical activity monitor on the exercise practices of emergency medicine residents: a pilot study	mHealth / Apps móviles	The wearable physical activity tracker did not change the overall physical activity levels among this population of emergency medicine residents.
A093	Zahedani et al.[93]	28	Digital health application integrating wearable data and behavioral patterns improves metabolic health	mHealth / Apps móviles	These findings suggest that lifestyle recommendations, in addition to behavior logging and CGM data integration within a mobile app, can enhance the metabolic health of both nondiabetic and T2D individuals, leading to healthier lifestyle choices.
A094	Faric et al.[94]	28	A virtual reality exergame to engage adolescents in physical activity: mixed methods study describing the formative intervention development process	mHealth / Apps móviles	This is the first attempt to develop a VR exergame designed to engage adolescents in physical activity that has been developed within a public health intervention development framework.
A095	Park et al.[95]	27	Mobile health intervention promoting physical activity in adults post cardiac rehabilitation: pilot randomized controlled trial	mHealth / Apps móviles	This intervention addresses a major public health initiative to examine the potential for mobile health strategies to promote PA in patients with CVD.
A096	Kinney et al.[96]	27	College students' use and perceptions of wearable fitness trackers	Wearables / Fitness trackers	Analyses were significant for those reporting a high increase in physical activity and or a high increase in number of steps as being more likely to report a high motivation for physical activity.
A097	Polechonski et al.[97]	27	Can physical activity in immersive virtual reality be attractive and have sufficient intensity to meet health recommendations for obese children? a pilot study	mHealth / Apps móviles	The intensity of PA of obese children during two games was high but during the game where the player was supposed to follow a set route, it was significantly higher (83,3 +/- 9,2 % HRmax) than…

A098	Bardus et al.[98]	27	The arabic version of the mobile app rating scale: development and validation study	mHealth / Apps móviles	MARS-Ar is a valid instrument to assess app quality among trained Arabic-speaking users of health and fitness apps.
A099	Beagle et al.[99]	27	Comparison of the physical activity measured by a consumer wearable activity tracker and that measured by self-report: cross-sectional analysis of the health eheart study	mHealth / Apps móviles	Fitbit-measured physical activity was more strongly associated with BMI than self-reported physical activity, particularly for moderate activity, vigorous activity, and summary measures of total activity.

Predominant Digital Technologies

The qualitative analysis reveals that research on emerging technologies and physical activity is predominantly focused on mHealth and mobile applications, which are featured in 78 % of the most-cited articles (e.g., A001, A005, and A017). These interventions include customized applications for step monitoring, training programs, and activity reminders, showing significant improvements in adherence to exercise programs and cardiovascular health parameters.

Technologies based on virtual reality (VR) and exergaming were examined in 12 studies (e.g., A007, A013, A044), highlighting their potential usefulness in physical rehabilitation, motivation, and motor coordination improvement. On the other hand, wearables and fitness trackers were featured in nine publications (A001, A010, A018), focusing on continuous monitoring of physical activity and real-time physiological metrics.

Artificial intelligence (AI) and machine learning still have limited representation (1 % of studies; e.g., A003), but they show emerging potential for designing predictive models of metabolic risk and personalizing interventions.

Impact on Physical and Mental Health

Of the 100 articles analyzed, 65 % reported significant improvements in physical health parameters, including

- Reduction in body weight and body mass index (A001, A005, A016).
- Improvements in cardiorespiratory fitness (A008, A019).
- Control of blood pressure and glucose levels (A032, A051).

By contrast, only 40 % of the articles addressed mental health issues. Among these, notable studies have evaluated symptoms of depression, anxiety, and quality of life through guided meditation programs and VR interventions (A006, A012, A017). Findings show that digital interventions combined with physical activity offer remarkable psychological benefits, although the evidence remains heterogeneous.

Key Findings and Global Trends

- Strong evidence of effectiveness: 65 articles (e.g., A001, A005, and A018) reported significant improvements in adherence to physical activity and clinical biomarkers.
- Mixed evidence: 25 studies (A002, A007, A009) showed inconsistent results, mainly due to small sample sizes or uncontrolled designs.
- Emerging innovation: In the last five years, technologies such as virtual reality and AI-powered chatbots (A003, A013, A047) have shown strong potential for personalizing interventions and improving user engagement.

It is widely accepted in the academic field that there may be biases in the sample selection process and the personal assessment of digital skills. The methodology used in the study did not allow the determination of causal relationships, being limited only to the description and identification of correlations.

Identified Research Gaps

1. Low regional representation: most studies originate from the U.S., the U.K., and Australia, whereas Latin America and Africa remain underrepresented (A080, A091).
2. Limited integration of AI and big data: only 1 % of the articles explore predictive models based on machine learning, representing a significant opportunity for innovation.
3. Lack of longitudinal studies: only 18 articles (A014, A042, A078) evaluated the long-term effects, limiting the understanding of the actual effectiveness of these technologies.

Conclusion of the Qualitative Analysis

The analysis of the most-cited articles revealed that the integration of mobile applications, wearable devices, and digital platforms has transformed research on physical activity, promoting personalized, efficient,

and scalable interventions. However, methodological challenges and geographical gaps remain, requiring interdisciplinary and collaborative approaches to strengthen future research and achieve broader impacts.

DISCUSSION

This study analyzed the evolution of scientific production on digital technologies applied to physical activity and mental health, integrating a bibliometric and qualitative approach based on 633 articles and the most-cited publications. The results showed sustained research growth, primarily driven by the adoption of mHealth, mobile applications, wearables, and virtual reality. However, the literature shows variability in reported effectiveness, significant methodological differences, and research gaps, which require further attention.

Predominance of mHealth and Mobile Applications

The strongest evidence was concentrated on the use of mHealth and mobile applications, which were present in 78 % of the most-cited articles. These studies highlight that integrating digital platforms into physical activity promotion enables the monitoring of physiological parameters, providing personalized feedback, and improving adherence to exercise programs.

Jakicic et al.[1] reported that combining wearables with a self-tracking application led to significant reductions in weight and BMI in overweight adults. Similarly, Piette et al.[4] demonstrated that mobile applications improve adherence to supervised training programs, particularly among populations with cardiovascular risk factors.

However, the literature is inconsistent. Hong et al.[10] identified that the effectiveness of these platforms depends on the personalization of recommendations, whereas Walsh et al.[2] found modest improvements among participants with initially low self-efficacy. This variability can be explained by differences in methodological design, sample characteristics, and intervention duration.

Overall, the evidence confirms that mobile applications represent the dominant technology in the literature, and their impact is more evident when interventions are tailored to user profiles, integrate real-time feedback, and promote sustainable lifestyle changes.

Virtual Reality, Exergaming, and Immersive Technologies

Technologies based on virtual reality (VR) and exergaming are emerging as promising trends, particularly in the context of physical rehabilitation and motivation enhancement. Lee et al.[7] demonstrated that using VR dance exercises improved balance and coordination in patients with Parkinson's disease, while Veling et al.[8] reported that immersive environments significantly reduce stress and anxiety levels in clinical populations.

Other studies, such as Nahavandi et al.[12], have shown that integrating artificial intelligence into virtual environments can personalize the difficulty of motor tasks and enhance user experience. However, the most recent systematic reviews indicated that small sample sizes and heterogeneous protocols limit the generalizability of the results.[11]

Evidence suggests that VR and exergaming are tools with strong potential but require greater methodological standardization and multicenter clinical trials to validate their long-term effectiveness.

Impact on Physical and Mental Health

Analysis of the 99 most-cited articles revealed that 65 % of the studies reported significant improvements in physical health parameters. Among them, Jakicic et al.[1] and Pfaeffli Dale et al.[9] identified notable reductions in body weight, abdominal circumference, and blood pressure, while Direito et al.[3] showed that mobile applications contribute to increasing weekly physical activity in sedentary adults.

In contrast, 40 % of the articles addressed mental health, with promising results. Huberty et al.[5] demonstrated that guided meditation applications significantly improve anxiety, depression, and quality of life, which is consistent with the findings of Zhang et al.[6], who reported that behavioral-support chatbots increase self-efficacy and adherence to healthy routines.

However, the findings were heterogeneous. Spruijt-Metz et al.[19] identified limited improvements in participants with high resistance to behavioral change.

These results indicate that digital interventions combined with physical activity have clear benefits for physical health and psychological well-being, although the sustainability of these effects requires more robust longitudinal studies.

Comparison of Findings and Global Trends

A comparative analysis of the most influential articles identified the following patterns.

- Strong evidence of effectiveness: 65 studies reported significant improvements in physical activity adherence and clinical biomarkers.
- Mixed evidence: 25 articles showed inconsistent results, mainly due to small sample sizes and lack of protocol standardization.

- Emerging innovation: Over the last five years, technologies such as virtual reality (VR) and applied artificial intelligence have shown high potential for personalizing interventions and enhancing user experience.

These contrasts reflect that, while the literature supports the use of digital technologies as effective tools for promoting healthy habits, methodological limitations still make it challenging to establish definitive conclusions about their long-term effectiveness.

Limitations and Research Gaps

Despite the significant advancements, three main gaps have been identified.

1. Low geographical representation: scientific production is concentrated in the United States, the United Kingdom, Australia, and Europe, while Latin America and Africa remain underrepresented.[2,13] This disparity limits the applicability of these findings to resource-constrained contexts.
2. Limited integration of AI and big data: although technologies such as machine learning are starting to be incorporated,[12] only 1 % of the articles exploit their potential to personalize interventions and predict metabolic risks.
3. Few longitudinal studies: only 18 articles evaluated the long-term effects, which limits the understanding of the durability of the benefits.[19]

Implications for Research and Clinical Practice

The findings confirmed that digital interventions based on mHealth, wearables, and VR can be implemented as scalable and personalized strategies to improve physical activity and psychological well-being. However, to enhance its impact, it is necessary to

- Standardized methodological protocols to allow comparison of results across studies.
- Integrating AI algorithms to personalize recommendations in real-time.
- Expand the inclusion of underrepresented populations, such as those from Latin America.
- Design of multicenter and longitudinal clinical trials to assess the sustainability of these effects.

Evidence confirms that digital technologies have transformed research into physical activity, mental health, and overall well-being. However, the effectiveness of interventions depends on the personalization of strategies, sustained adherence, and integration of advanced tools, such as artificial intelligence. Overcoming the identified methodological and geographical limitations will allow for the consolidation of innovative, inclusive, and clinically effective intervention models.

CONCLUSIONS

This study demonstrated that digital technologies have redefined the paradigms of promoting physical activity and managing physical and mental health, creating new opportunities for the design of personalized and scalable interventions. The integration of mobile applications, wearable devices, virtual reality, and artificial intelligence represents a shift toward preventive and participatory models, in which users play an active role in managing their own well-being.

The findings indicate that scientific literature has evolved from an exploratory stage to a more consolidated development stage, although significant challenges remain related to methodological standardization, the sustainability of effects, and the global accessibility of these technologies. The lack of representation in Latin American contexts and other historically understudied regions highlights the need to foster international collaborations that include diverse populations and consider specific sociocultural factors.

Furthermore, this study provides a comprehensive overview of scientific trends and emerging technologies, underscoring the importance of strengthening interdisciplinary research that connects fields such as engineering, public health, psychology, and physical education. These intersections are essential for understanding the mechanisms through which digital interventions generate sustainable behavioral changes and improve clinical and well-being indicators.

Finally, the findings suggest that future research should focus on the development of longitudinal studies, validation of predictive models based on artificial intelligence, and adaptation of technologies to the needs and realities of diverse populations. This work provides a solid foundation for policymaking, clinical strategies, and the development of innovative digital solutions that promote active and healthy lifestyles in an increasingly digitalized global environment.

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The authors declare that there is no conflict of interest.

AUTHORSHIP CONTRIBUTION

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ANNEXES

Appendix 1		
Keyword	**Occurrences**	**Total Link Strength**
diabetes mellitus	5	26
Exercise	22	154
exercise therapy/methods	9	78
exercise/psychology	5	50
fitness trackers	6	25
health behavior	5	43
health promotion/methods	5	53
life style	7	62
mobile applications	30	215
motivation	6	45
quality of life	8	60
telemedicine	22	140
text messaging	5	32
virtual reality	12	79
wearable electronic devices	21	126
80 and over	16	123
accelerometer	5	16
accelerometry	6	31
adolescent	33	218
adolescents	6	19
adult	80	594
aged	48	349
anxiety	20	83
app	11	61
artificial intelligence	20	64
australia	10	73
behavior change	5	29
blood pressure	8	60
body composition	5	16
body mass index	21	146
breast cancer	6	17
cancer	7	35
cardiac rehabilitation	7	23
cardiorespiratory fitness	5	28
chatbot	7	30
child	10	52
children	6	19
china	6	44
chronic disease	10	57
cognition	8	43
cost-benefit analysis	5	30
covid-19	18	83
cross-over studies	5	36
deep learning	6	10

depression	27	122
diabetes	10	34
diabetes mellitus	6	36
diet	19	124
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