JOURNAL OF GENERAL MANAGEMENT RESEARCH

HEALTH AND FITNESS APPS: A BIBLIOMETRIC ANALYSIS FOCUSING ON THE INCREASED USAGE DURING AND AFTER COVID-19

Naina Sobti*
Dr. Priya Grover*

*Symbiosis Centre for Management Studies, NOIDA, Symbiosis International (Deemed University), Pune India

Abstract

The recent years have seen a rapid change in lifestyles as people have increasingly become sedentary over the last few decades and the Coronavirus pandemic has aggravated the issue. Holistic well-being is a major concern for people due to rising cases of obesity and other lifestyle disorders. Smartphones are seen playing a key role in monitoring health and fitness behavior in recent times. Mobile applications and especially fitness applications are emerging as a keen area of interest and the pandemic has further accelerated their usage with a comprehensive background of publications in leading journals. Present study analyses and identifies the most cited papers in this area in the period of 2010 to 2021. In this study a database of 645 documents were retrieved from Scopus database and bibliometric analysis was done using R studio package. This analysis provides information on trends taking into perspectives both past and present studies. The analysis also reflects important information in areas such as most prominent authors locally and globally most cited countries, most cited documents, growth in sources of production over a period of years which would help in future development of research in this area.

Keywords*: Fitness Applications, Health, Mobile Applications, Activity Tracker, Fitness Trackers, Self-care, Healthy lifestyle*

INTRODUCTION

A dramatic rise has been observed in the number of smartphone users in the last decade**.** Reports from Statista mark the smartphone users at somewhere around three billion in the world where maximum users were in United States, China and India. The number of smartphone users in India in 2020 were around 748 million according to (Statista, 2021). Growth in smartphone users has had a direct impact on mobile application usage according to data analyzed by Buildfire mobile applications would be responsible for revenue amounting to 935 billion dollars by 2023 (BuildFire, 2021). According to Buildfire the Apple Store for mobile applications has 1.96 million applications and around 2.87 million applications are there for download in google play store. The mobile application market is expected to reach a valuation of $407.31 billion by 2026 globally showing a dramatic growth of CAGR 18.4 percent from 2019 to 2026 (Allied Market Research, 2021) The tremendous growth in the fitness app market can be attributed to factors such as greater interest of firms in innovations and technological development. Popularity of ecommerce businesses especially in developing countries and increase in purchasing power of the average consumer. There is a greater interest in health consciousness and more focus on over all wellbeing of consumers as there has been a change in life style over the past decades and people have become sedentary within their daily routines leading to issues such as obesity and many lifestyle-oriented diseases such as blood pressure and cholesterol issues. The problem was aggravated especially during the pandemic where people were not able to move much outside their homes due to social distancing constraints and go to gyms and fitness centers. These reasons were majorly responsible for a greater interest in fitness and health apps and growth in the fitness app market. A lot of people have become more health conscious. Everyone has a different perspective of health consciousness and staying fit. Health orientation is a very important topic that has taken the interest of researchers in recent years. Also it has been observed that health motivation and consciousness encourage preventive health care behavior in people (Jayanti & Burns, 1998). In a research by (Moorman & Matulich, 1993) found that individuals can have different health orientation for some it may be positive for some negative and others may have a neutral outlook towards health orientation. Health conscious individuals have been defined as "wellness -oriented who incorporate health habits into their daily lifestyles by (Jayanti & Burns, 1998). Mobile applications usage for health and fitness are penetrating in our daily routine's due convenience and ease of use. They have an impact on all the parties involved be it the fitness app firms, consumers and health care professionals. These fitness apps have made easier to monitor health and nutrition just with the click of a button on smartphone (Li *et al.,* 2020). The use of mobile applications for health and fitness has increase remarkably during the COVID-19 pandemic due to social distancing regulations (Wang & Tang, 2020). According to WHO "**mobile health**" has been defined as usage of mobile phones, wireless devices and all the peripherals to record patients' data that helps in monitoring of consumers health (Aboelmaged *et al.,* 2021).

The fitness apps can be segregated according to type:

- Lifestyle Monitoring Applications
- Workout Applications
- Diet and Nutrition Regulation applications
- Medication monitoring apps amongst others

Amazfit India, Fitbit, Inc., SAMSUNG, ADIDAS AG, Nike, Inc., LG Electronics., Motorola Solutions, Inc., Fossil Group, Inc., TomTom International BV., Appster, Apple Inc, Fitness keeper Inc., Azumio Inc., MyFitnessPal, Sony Corporation Inc., HTC Corporation, Noom, Inc., Under Armour, Inc. and APPLICO INC are some of the major players in fitness industry. The pandemic has really changed the way how our lives functioned. Going digital took on a new meaning altogether. Earlier it was all about learning and adapting to new technologies but during the pandemic things changed drastically. Going digital was no longer an option but a necessity. Mobile applications which were then used sparingly by people before the pandemic

have now become synonymous with daily life. Regular activities such as buying groceries, medicines, attending online classes and fitness have all become dependent on mobile applications due to social distancing norms and restrictions to move out of confined spaces of one's homes during the lockdown and this dependency on mobile applications is expected to increase in the post-pandemic era. During the period of quarter 1 and quarter 2 of 2020 there was a 46 percent increase in downloads of fitness apps across the world according to MO Engage (World Economic Forum, 2021). The growth has been accelerated due to the coronavirus pandemic and enforcement of nationwide lockdowns leading to shutting of gyms and fitness studios as measures of social distancing. According to Statista, over 593 million smartphone users downloaded health and fitness apps during the first quarter of 2020 and it is predicted that by second quarter the download would increase to 646 million times. In the previous year during the second quarter the apps were downloaded only 446 million times (Statista, 2020) The increase was due to change in lifestyle and exercise habits of people during the pandemic phase. According to a report by Sensor tower mobile application download has doubled in each quarter globally since 2015 which reflects the increase in usage of smartphones and increased dependence on mobile applications (Chan, 2020). It was observed that 38 million apps were downloaded in the first two quarters of 2020 approximately a 32 percent increase since the fourth quarter of 2019 pointing towards a dramatic rise in mobile applications during the coronavirus pandemic period. There has been a spike in the usage of fitness apps especially in the lockdown as gyms and fitness centres were closed and people were restricted to their homes during the lockdown due to which people depended on these apps for their exercise and fitness regimen. These fitness apps keep track of vitals like age weight, BMI, physical activity and calories consumed during a day. Their usage is more popular amongst tech-savvy millennial and Gen Z generations. The youth of current generation is spending considerable time experimenting with mobile apps (Livingstone & Third, 2017). Consumers belonging to younger generation are more comfortable around technology and adapt to technology easily. The younger generation is also more comfortable around innovation and new technology (Bigne *et al.,* 2005).

This study aims to understand the past trends and future projections in the research area of fitness and mobile health applications by doing a bibliometric analysis to address how the pandemic affected their usage. This study aims to achieve this research objective by answering following research questions:

RQ.1 What are the past trends and patterns in this research area of mobile and fitness applications and what shall be the future projections in this research area? (On the basis of bibliometric analysis of data which shall be based on inferences to below answered questions)

RQ1 a. Who are the prominent authors, countries and sources in areas of fitness applications and mobile health applications?

RQ1b. What are the most cited papers, references and sources in fitness applications and mobile health applications?

RQ1c.It reveals important information about annual scientific production, average citation per year.

LITERATURE REVIEW

Over the decades there has been a rise in the sedentary lifestyles of people the advent of mobile health technologies is helping to overcome this situation in recent times (Molina & Myrick, 2021). Smartphones with internet access has made it easier to download and access mobile health applications. The usage of these apps is on a rise and involves constant communication and exchange of information which allows for users to set goals and targets, monitor their overall progress and achieve their goals (LoPresti *et al.,* 2014). The innovation in technology brought rise to the usage of smartphones which also led to the rise of use of mobile health apps for fitness and health maintenance reasons (Edwards *et al.,* 2017). These fitness applications track and monitor the consumers physical activity and give them constant updates on parameters such as number of

steps, weight and calories burned which helps them keep a check on their progress (Korinek *et al.,* 2018).

The pandemic aggravated the risks on health parameters and overall wellness of people today. It helped people remind the importance of staying physically active and incorporating a fitness regimen in their lives. During the pandemic it had been observed that people who exercise are less prone to respiratory and other metabolic illnesses as well. This lead people to become more conscious about physical activity and fitness in everyday life (Mumcu, 2021). During a case study of fitness applications during COVID-19 in turkey (Mumcu, 2021) it was seen that females used fitness and health applications more than males, paid apps were preferred over free ones. The study concluded the fitness applications available on smartphones and other digital devices safeguarded and also helped in increasing physical activity during pandemics and similar situations and also countered the ill effects both physical, and mental that were caused due to inactivity and sedentary lifestyle. Quarantine has affected lifestyle of people in a huge way prolonged periods of inactivity led to poor sleeping and eating habits which in turn impacted psychological and mental wellbeing of people (Hazar Kanık, 2020). Quarantine often affects the mental health adversely brought on by stress and depressive episodes due to lack of physical activity, disrupted sleeping cycles and poor diet. Due to lack of resources movement of people was limited and people were not eating a balanced diet but binging on unhealthy foods to counter stress. Post COVID-19 effort is required on global level and encourage people to return to a healthy lifestyle. As COVID-19 had led to an unhealthy lifestyle for many people they were all more prone to cardiovascular and metabolic disorders. WHO had release guidelines for people in Quarantine who were not expressing symptoms of COVID-19 and other respiratory illnesses to eat a balanced diet rich in fruits and vegetables and indulge home based physical activity (Mattioli *et al.,* 2020).

In today's day and age physical activity is very important for everyone it is said to boost metabolism and helps in controlling weight. WHO had recommended in their report (WHO Report, 2020) that people who are not suffering from COVID or showing any respiratory illness in quarantine period were encouraged to indulge in homebased physical activity using mobile fitness applications and video-supported programs (Khaleghzadeh *et al.,* 2020). These new methods in the form of fitness based mobile applications promote physical activity overall wellbeing and a healthy lifestyle in people. Hence mobile applications are being utilised to improve the physical ,mental and overall health of individuals (Stephens & Allen, 2013). Most fitness based apps can also monitor total calorie intake and nutritional requirement based on BMI hence maintaining weight through eating right and balanced meals (Lau *et al.,* 2011). Mobile based fitness applications which monitor weight gain and physical activity are innovative means to stay healthy (Palička *et al.,* 2016). Smartphones are a great tool with internet connectivity which can be carried along with the individual thus measuring physical activity in terms of number of steps etc., easily thus maintaining healthy behaviours of individual (Intille *et al.,* 2012). Smartphones and other digital devices such as smartwatches provide an ideal platform for mobile health applications as the features such as messaging facilities and running short videos run better on these devices which are crucial for a satisfying user experience leading to greater customer engagement of consumer. Some of the fitness apps allow individuals to create their own customised workouts while encouraging them to do regular workouts. These apps can also regulate meal plans, sleeping cycles and workout times (Liu *et al.,* 2011) There are many apps such as Google Fit, Calm provide consumers with these features.

Market research firm Technavio has forecasted the market cap of fitness application market as 1.68 billion dollars in the period 2020-2024 while market research firm Polaris marked the growth potential of fitness and health application companies at $14.7 billion by the year 2026 (Mumcu, 2021). Many sports-based firms are investing fitness and health applications such as Underarmor, Nike and Asics and Endomondo. It has been observed that fitness applications helped people stay physically active during the lockdown. Specifically, the applications available on smartphones

as they did not require any special hardware and were cost effective as most of them were free apps (Yang & Koenigstorfer, 2020). In recent times use of fitness applications has increased these applications must fit the budget fitness goals and needs of consumers and the social distancing protocols made may users accustomed to these fitness apps and the trend is not going to go anywhere in near future. However, some fitness applications are invasive in nature and this impacts the users negatively (Kirwan *et al.,* 2013). The sports and gamification features of these fitness applications are a great marketing attraction but these apps should also be able to customised according to personal need s and personalities. Fitness app users usually enjoy features that let them indulge in social activity interacting with people and similar groups through social media and provide immediate feedbacks, interaction with fitness trainers and diet experts. It has been observed that messaging service that most fitness applications allow enhances customer satisfaction and hence retention. To develop the fitness apps to full potential developers must focus on the customizability and personalization features of these application (Sun & Zhang, 2006).

Research Gap

On the basis of the above literature review the following research gaps have been highlighted:

a. There is a lack of knowledge on how consumers interact with fitness apps.
b. What are the features that are required to engage consumers over a longer period of time?
c. How did the interaction change especially in pre and post COVID era?

METHODOLOGY

Data

Over 645 documents were extracted from Scopus data base using key words mobile applications, fitness application, COVID-19 in the timespan of 2010-2021. The present study has chosen Scopus as the database because it is one of the largest abstract and citation database which offers a comprehensive source for literature review consisting of research papers, journals etc. In fields of medicine, science and technology, social sciences, management amongst others. Scopus has many tools which helps in identifying the relevant database and analysing it for research (Burnham, 2006).

Research Tool

This study uses Bibliometric analysis and R studio supported by R console has been used to analyse the database. The latest version of Bibliometrix 3.2 which was used for this study is an open resource tool developed in R. It can extract data from databases such as PubMed, Scopus, WoS amongst others and analyse the data in 23 different ways revealing information such as top authors, countries, sources, references average citation score etc. (Pablo *et al.,* 2021). Over the decades researchers have used both qualitative and quantitative methods to review literature. In comparison to other methods, bibliometric is a more organized, systematic, reliable and more objective approach which is based on statistical inferences and is more scientific in nature (Broadus, 1987). There is an overflowing huge pool of information and data available in form of research papers, publications, reports and books this is where bibliometric comes to good use by giving a structure to the data and huge body of information available in databases like Scopus analyse trends over a period of time, understand prominent research scholars and give a direction to future research in that particular area (Aria & Cuccurullo, 2017).

Research Workflow

According to Zupic & Čater (2015), bibliometric analysis follows a particular flow which usually consists of five stages which has also been used for this study as well which are as follows:

1. Research Design
2. Collection of Data
3. Analysis of Data
4. Visualization of Data
5. Interpretation of Data

RESULTS AND DISCUSSION

As can be seen in Table 1, detailed information about the bibliographic data retrieved from Scopus in the

timespan of 2010 to 2020 represents important facts about the data that has been extracted from Scopus for bibliometric Analysis such as Average years from publication, Average citations per documents Average citations per year per doc, document types, documents key words, Authors details such as Authors per Article the Co-Authors per Articles and collaboration index

Table 1: Main Information about Data

Important Facts About Data	
Timespan	2010: 2021
Sources (Journals, Books, etc)	407
Documents	645
Average years from publication	3.6
Average citations per documents	18.7
Average citations per year per doc	3.421
References	23513
Document Types	
Article	324
Book	2
Book chapter	8
Conference paper	223
Conference review	8
Data paper	1
Editorial	3
Letter	2
Note	8
Review	61
Short survey	5
Document Contents	
Keywords Plus (ID)	3851
Author's Keywords (DE)	1592
Author(s)	
Authors	2574
Author Appearances	2907
Authors of single-authored documents	57
Authors of multi-authored documents	2517
Authors Collaboration	
Single-authored documents	65
Documents per Author	0.251
Authors per Document	3.99
Co-Authors per Documents	4.51
Collaboration Index	4.34

Source: Authors Compilation (using R studio)

Annual Scientific Production

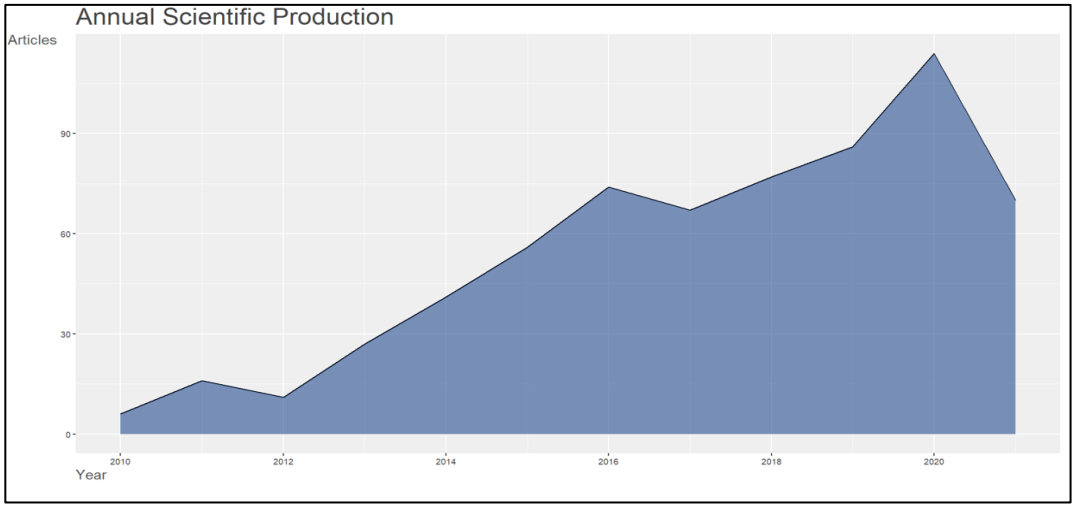
Figure 1 reflects the frequency of publications yearly for the period between 2010-2021. There was an annual growth rate of 25.02 percent in annual scientific production. In the period of (2010-2015) 157 papers were published in this research area. During the next five years in the period of (2015-2020) 474 papers were published showing a remarkable increase in scientific production over next five years. 70 papers were published in the year 2021 itself which reflects an increase in interest in the area of fitness and mobile health applications in recent years.

Table 2: Statistical distribution of articles per year from 2010 to 2021

Year	Articles
2010	6
2011	16
2012	11
2013	27
2014	41
2015	56
2016	74
2017	67
2018	77
2019	86
2020	114
2021	70

Source: Authors Compilation (using R studio)

Figure 1: Visual representation of data of annual scientific production over a period of years 2010-2021



Source: Authors Compilation (using R studio)

Average Citations per Year

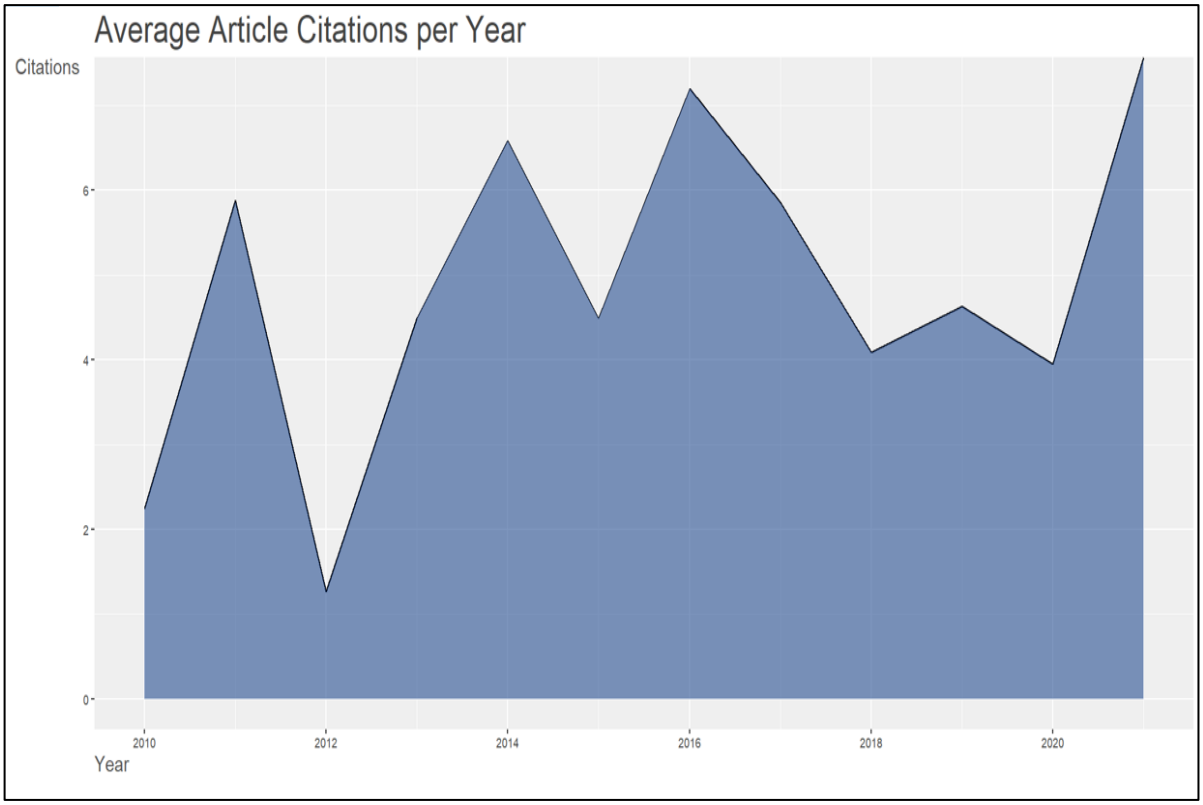
The table 3 depicts the Average Citations per year. According to the table results infer that 2016 was the year with 72.05 citations with highest average percentage of citations per paper in a year.

Table 3: Representing citations average of a research publication per year

Year	N	MeanTCperArt	MeanTCperYear	CitableYears
2010	6	24.667	2.2424	11
2011	16	58.813	5.881	10
2012	11	11.367	1.263	9
2013	27	35.963	4.495	8
2014	41	46.122	6.589	7
2015	56	26.964	4.494	6
2016	74	36.027	7.205	5
2017	67	23.433	5.858	4
2018	77	12.260	4.086	3
2019	86	9.267	4.634	2
2020	114	3.947	3.947	1
2021	70	0.729	-	0

Source: Authors Compilation (using R studio)

Figure 2: Graphical representation of average article citations per year



Source: Authors Compilation (using R studio)

Top Most 10 Relevant Sources

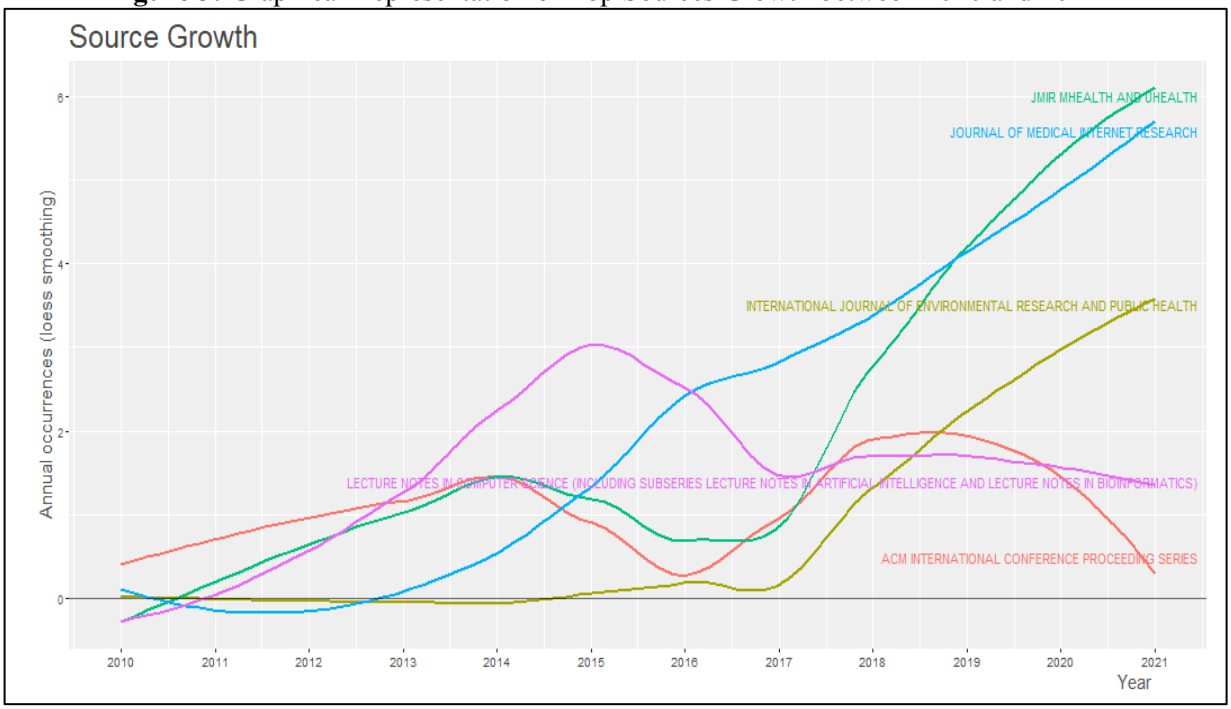
Table 4 represents the Top 10 sources of publications of the data in this bibliometric collection. The topmost contributor being JMIR MHEALTH AND UHEALTH and Journal of Medical Internet Research with 25 articles as well followed by Lecture Notes in computer Science with 17 publications and ACM international conference proceeding series with 13 publications.

Table 4: Representing Top most sources in the selected research field

Sources	Articles
JMIR MHEALTH AND UHEALTH	25
JOURNAL OF MEDICAL INTERNET RESEARCH	25
LECTURE NOTES IN COMPUTER SCIENCE	17
ACM INTERNATIONAL CONFERENCE PROCEEDING SERIES	13
INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH	11
STUDIES IN HEALTH TECHNOLOGY AND INFORMATICS	10
INTERNATIONAL JOURNAL OF BEHAVIORAL NUTRITION AND PHYSICAL ACTIVITY	9
BMC PUBLIC HEALTH	8
TRIALS	8
CONFERENCE ON HUMAN FACTORS IN COMPUTING SYSTEMS– PROCEEDINGS	7

Source: Authors Compilation (using R studio)

Figure 3: Graphical Representation of Top Sources Growth between 2010 and 2021



Source: Authors Compilation (using R studio)

The graph in figure 3, illustrates the statistical distribution of observed frequencies for research publication sources depicting the Top most sources and annual publication of these sources. Between 2010 and 2021 there was tremendous growth in the number of publications in the research area.

Authors and Authors Local Impact

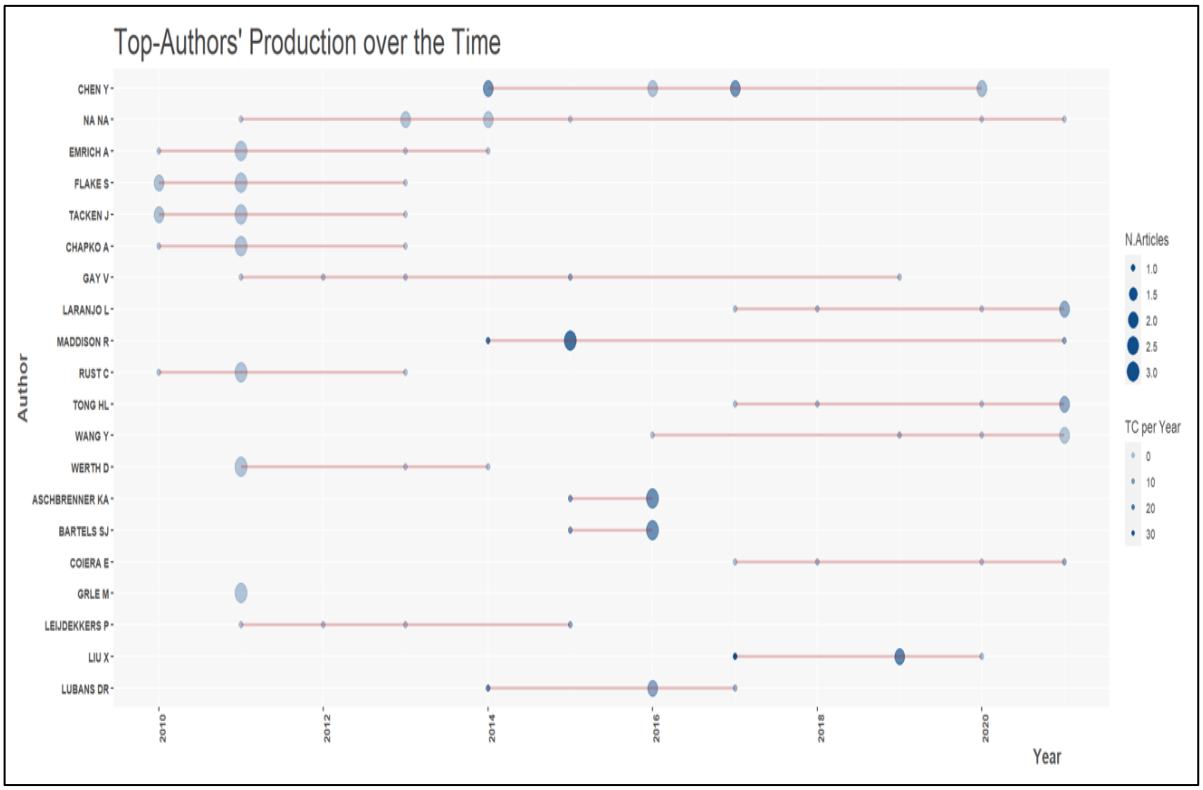
The table 5 shows the Top 10 Most Relevant Authors and their Local Impact. The topmost being CHEN Y with an h-index of 4 followed by EMRICH A

Table 5: Representing Top 10 most relevant authors and their local impact

Author	h_index	g_index	m_index	TC	NP	PY_start
CHEN Y	4	8	0.5	180	8	2014
NA NA	0	0	0	0	8	2011
EMRICH A	2	4	0.167	17	6	2010
FLAKE S	2	4	0.167	16	6	2010
TACKEN J	2	4	0.167	16	6	2010
CHAPKO A	2	3	0.167	12	5	2010
GAY V	5	5	0.455	93	5	2011
LARANJO L	3	5	0.6	25	5	2017
MADDISON R	5	5	0.625	348	5	2014

Source: Authors Compilation (using R studio)

Figure 4: Top 10 Authors' Production Over the Time Data Visualization



Source: Authors Compilation (using R studio)

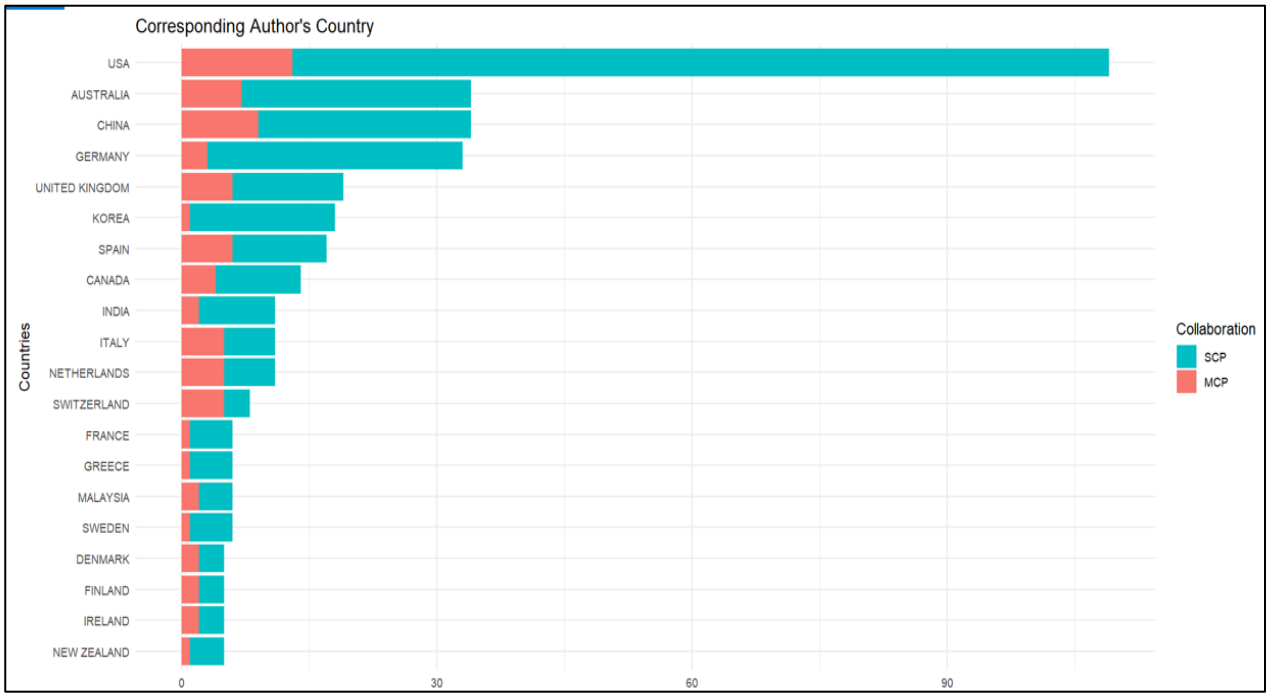
In figure 4, the line is a representation of the author's active years over a timespan. The circle represents the documents published by the respective author. The size of the circle represents the number of documents published in that year and the higher the intensity of the colour that means greater the number of citations for the author in that particular year.

Table 6: Top 10 Corresponding Author's Country.

Country	Articles	Freq	SCP	MCP	MCP_Ratio
USA	109	0.25952	96	13	0.1193
AUSTRALIA	34	0.08095	27	7	0.2059
CHINA	34	0.08095	25	9	0.2647
GERMANY	33	0.07857	30	3	0.0909
UNITED KINGDOM	19	0.04524	13	6	0.3158
KOREA	18	0.04286	17	1	0.0556
SPAIN	17	0.04048	11	6	0.3529
CANADA	14	0.03333	10	4	0.2857
INDIA	11	0.02619	9	2	0.1818
ITALY	11	0.02619	6	5	0.4545
NETHERLANDS	11	0.02619	6	5	0.4545

Source: Authors Compilation (using R studio)

Figure 5: Data visualization of the countries of origin



Source: Authors Compilation (using R studio)

Corresponding Author's Country

Figure 5 is a graphical representation of countries of origin and most relevant corresponding authors who have top-most citations. The blue colour represents single country publications(intra-country) and red colour depicts the MCP i.e., multiple country publication(inter-country). As it can be seen from the figure USA has the highest MCP and SCP authors followed by Australia and China.

Table 7: Top 10 Most Relevant Affiliations

Affiliations	Articles
STANFORD UNIVERSITY	21
UNIVERSITY OF CALIFORNIA	20
UNIVERSITY OF SYDNEY	19
MACQUARIE UNIVERSITY	14
GEISEL SCHOOL OF MEDICINE AT DARTMOUTH	10
KAROLINSKA INSTITUTET	9
UNIVERSITY OF ROSTOCK	9
HANNOVER MEDICAL SCHOOL	8
UNIVERSITY OF GRANADA	8

Source: Authors Compilation (using R studio)

The table 7 represents the top most relevant affiliations in the research area for mobile health and fitness applications. At the first position is Stanford University with 21 articles followed by University of California with 20 articles, University of Sydney with 19, Macquarie University with 14 and at the 5th position is Geisel School of Medicine at Dartmouth with 10 articles.

Country Scientific Production

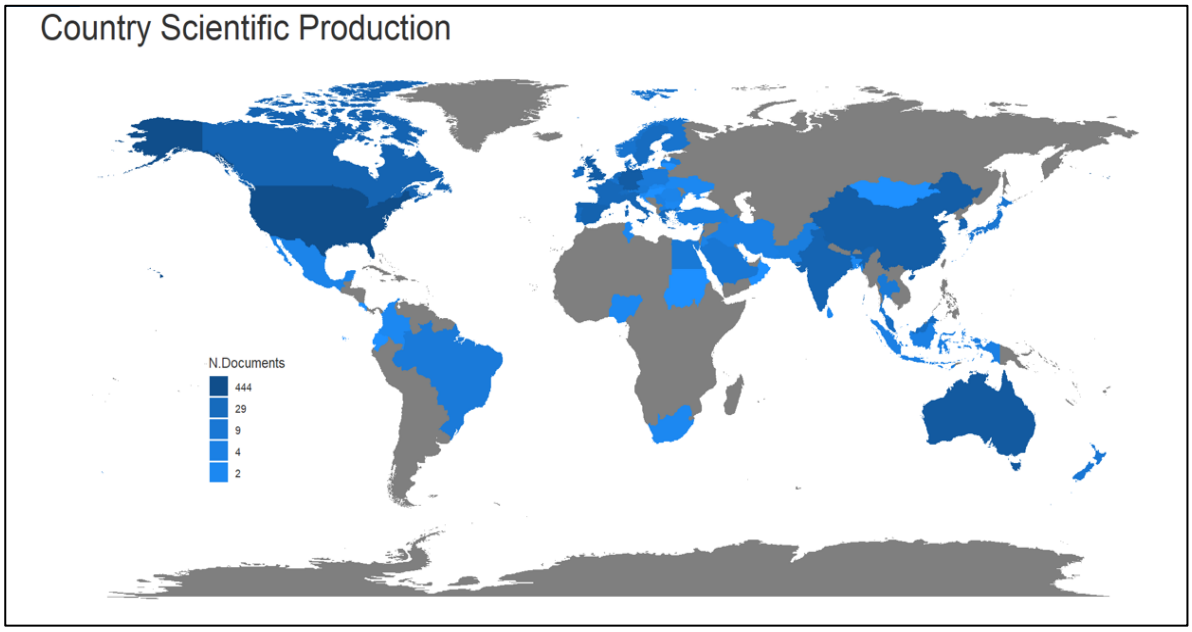
Table 8 reflects frequency distribution of scientific production of respective country according to the results USA was positioned in 1st place in scientific production with a frequency of 444, followed by Australia with a frequency of 142 and Germany at third position with 110 scientific productions. UK with 103 and China with 93.

Table 8: Country Scientific Production

Region	Frequency
USA	444
AUSTRALIA	142
GERMANY	110
UK	103
CHINA	93
SPAIN	62
CANADA	54
SOUTH KOREA	54
INDIA	52

Source: Authors Compilation (using R studio)

Figure 6: Data visualization of country scientific production



Source: Authors Compilation (using R studio)

Figure 6 depicts the scientific production according to country. The intensity of colour blue shows the number of publications as can be seen from the figure USA has the highest publications followed by Australia.

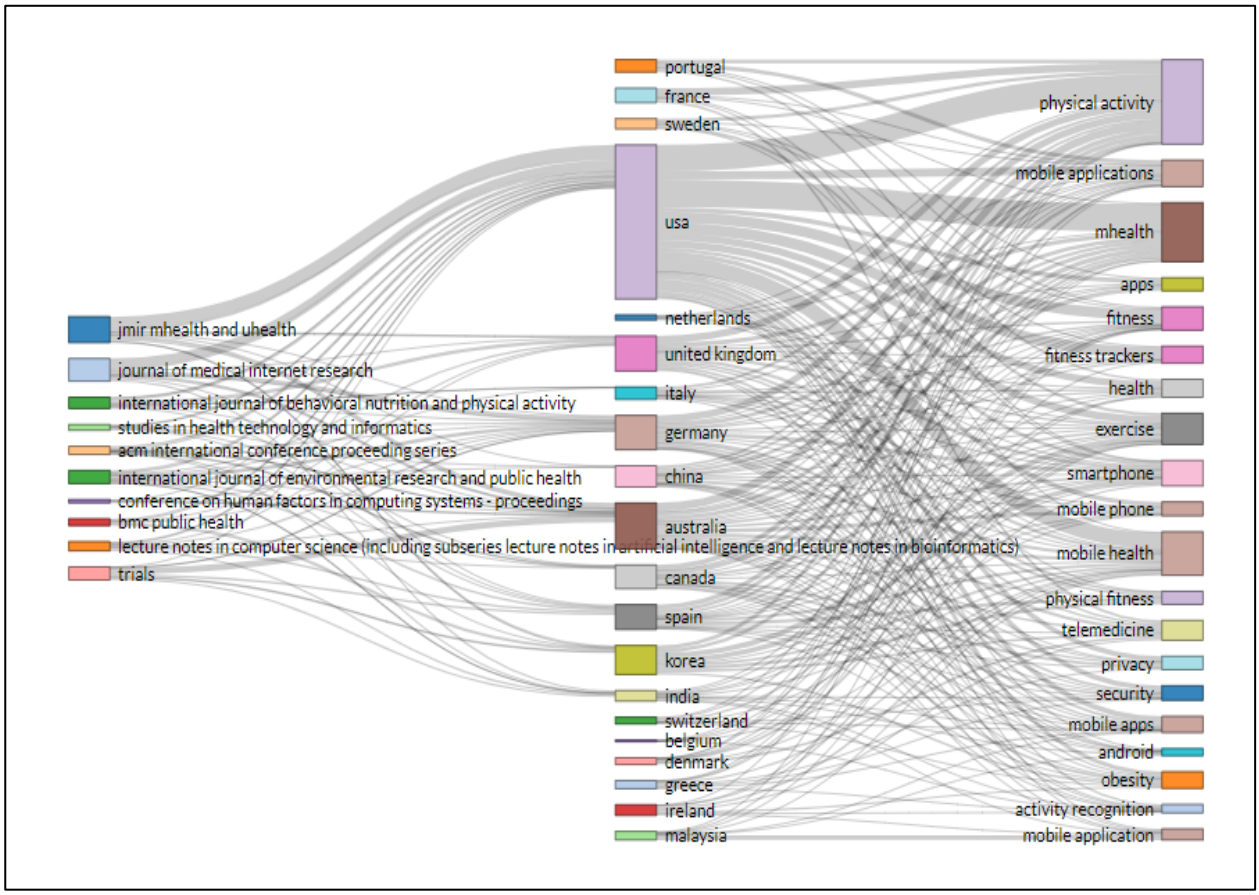
Table 9: Country wise total citations

Country	Total Citations	Average Article Citations
USA	3198	29.339
UNITED KINGDOM	959	50.474
AUSTRALIA	780	22.941
GERMANY	677	20.515
NETHERLANDS	471	42.818
SPAIN	439	25.824
ITALY	327	29.727
KOREA	322	17.889
NEW ZEALAND	314	62.8
CANADA	284	20.286

Source: Authors Compilation (using R studio)

Table 9 represents the countries which have received the maximum total citations. At the top is USA with 3198 citations followed by United Kingdom with 959 citations and Australia with 780 citations respectively.

Figure 7: Three-Fields Plot



Source: Authors Compilation (using R studio)

The figure 7 represents the three fields plot. The right field represents the Keywords, Middle field represents Countries and left field represents sources. While maximum 50 items can be included in the plot only 10 have been included for this purpose. The three fields plot is a pictorial representation of Sankey plot. The arrows and lines depict the flow so thicker the arrows greater is the flow. These lines can divide or combined at every step.

CONCLUSION AND IMPLICATIONS

This research paper has attempted to showcase the progress and development in the area of mobile health and fitness applications over the last ten years. The analysis of bibliometric data has brought to fore the topmost authors, sources, references, affiliations, countries, annual scientific production and most citable documents and publications in the concerned research area and highlighted emerging areas of research and past trends that shall help research scholars in the area of fitness applications and mobile health applications a better understanding and direction to their research work. This study will be a reference point for budding researchers in this area as they shall know the most cited work top authors and countries that are conducting research in this field making it easier for them collaborate with the right people understand current trends. The study also reveals while a lot of work has been done on key features and intentions on usage of mobile applications and behavioural intentions of people who indulge in physical activity there is a need to carry out research in the area to understand what are the factors that engage the customers in the long run as attrition rates are high for fitness applications.

According to Perro (2018), the retention rate of mobile app users is very low and attrition rate is very high in mobile app users. Mobile health technologies are no exception to this case with quoting a statistic of 45% as the attrition rate on an average in mobile health technologies once the initial excitement of using the app diminishes (Becker *et al.,* 2014). The motivations to take up exercise are complex in nature and involve social, psychological and biological motivations (Stuart & Nanette, 2007). However for fitness apps to make visible results it is important that consumers not only download them but use them consistently for longer durations (Chin *et al.,* 2016). Hence it is not only important to observe the download rates of mobile and health apps but very important to improve retention rates (Molina & Sundar, 2020). Hence exploring customer engagement in fitness apps is an important emerging area of research that can be explored.

Managerial Implications

There is an increase in interest in mobile applications and they have become a big point of brand recognition and awareness amongst consumers. In the case of fitness applications, it means an increase in the number of customers who cannot go outside to train at fitness centres and are short of time or prefer fitness applications due to convenience. This gives firms a chance to provide users with the desired features so that they can retain consumers and acquire new ones through word of mouth.

LIMITATIONS OF THE STUDY

The study is based on secondary data further research in this area can be carried out both quantitatively and qualitatively using primary data as well. Since this study utilised bibliographic means to analyse data the analysis is limited to the 645 documents that were used for this purpose there may be more research publications which were not cited much which have been left out. The breadth and depth of analysis was limited to keywords "fitness applications" mobile health applications certain subjects may not have been taken up. These are some of the limitations of this study.

REFRENCES

1. Aboelmaged, M., Ali, I., & Hashem, G. (2021). Mobile apps use for wellness and fitness and university students' subjective wellbeing. Information Development, 2018. https://doi.org/10.1177/02666669211020498

2. Aria, M., & Cuccurullo, C. (2017). bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics, 11(4), 959–975. https://doi.org/10.1016/j.joi.2017.08.007

3. Bigne, E., Ruiz, C., & Sanz, S. (2005). The Impact of Internet User Shopping Patterns and Demographics on Consumer Mobile Buying Behaviour. Journal of Electronic Commerce Research, 6(3), 193.

4. Broadus, R. N. (1987). Toward a definition of "bibliometrics." Scientometrics, 12(5–6), 373–379. https://doi.org/10.1007/BF02016680

5. Burnham, J. F. (2006). Scopus database: A review. Biomedical Digital Libraries, 3, 1–8. https://doi.org/10.1186/1742-5581-3-1

6. Chin, S. O., Keum, C., Woo, J., Park, J., Choi, H. J., Woo, J. T., & Rhee, S. Y. (2016). Successful weight reduction and maintenance by using a smartphone application in those with overweight and obesity. Scientific Reports, 6(November), 1–8. https://doi.org/10.1038/srep34563

7. Chan, S. (2020). Global app revenue reached $50 billion in the first half of 2020, up 23% year-over-year. Sensor Tower Blog. Retrieved October 9, 2021, from https://sensortower.com/blog/app-revenue-and-downloads-1h-2020

8. Edwards, L. C., Bryant, A. S., Keegan, R. J., Morgan, K., & Jones, A. M. (2017). Definitions, Foundations and Associations of Physical Literacy: A Systematic Review. Sports Medicine, 47(1), 113–126. https://doi.org/10.1007/s40279-016-0560-7

9. World Economic Forum (2020), Fitness apps grew by nearly 50% during the first half of 2020, study finds. Retrieved October 9, 2021, from

https://www.weforum.org/agenda/2020/09/fitness-apps-gym-health-downloads/

10. Statista (2020), Global health and fitness app downloads 2020. Retrieved October 9, 2021, from https://www.statista.com/statistics/1127248/health-fitness-apps-downloads-worldwide/

11. Hazar Kanık, Z. (2020). Home-Based Physical Activity in COVID-19 Pandemic. Gazi Sağlık Bilim Derg, Special, 46–51.

12. Intille, S. S., Lester, J., Sallis, J. F., & Duncan, G. (2012). New Horizons in sensor development. Medicine and Science in Sports and Exercise, 44(SUPPL. 1), 1–13. https://doi.org/10.1249/MSS.0b013e3182399c7d

13. Jayanti, R. K., & Burns, A. C. (1998). The antecedents of preventive health care behavior: An empirical study. Journal of the Academy of Marketing Science, 26(1), 6–15. https://doi.org/10.1177/0092070398261002

14. Khaleghzadeh, H., Afzalpour, M. E., Ahmadi, M. M., Nematy, M., & Sardar, M. A. (2020). Effect high-intensity interval training along with Oligopin supplementation on some inflammatory indices and liver enzymes in obese male Wistar rats with non-alcoholic fatty liver disease. Obesity Medicine, 17(December 2019), 100177. https://doi.org/10.1016/j.obmed.2019.100177

15. Kirwan, M., Duncan, M. J., Vandelanotte, C., & Mummery, W. K. (2013). Design, Development, and Formative Evaluation of a Smartphone Application for Recording and Monitoring Physical Activity Levels: The 10,000 Steps "iStepLog." Health Education and Behavior, 40(2), 140–151. https://doi.org/10.1177/1090198112449460

16. Korinek, E. V., Phatak, S. S., Martin, C. A., Freigoun, M. T., Rivera, D. E., Adams, M. A., Klasnja, P., Buman, M. P., & Hekler, E. B. (2018). Adaptive step goals and rewards: a longitudinal growth model of daily steps for a smartphone-based walking intervention. Journal of Behavioral Medicine, 41(1), 74–86. https://doi.org/10.1007/s10865-017-9878-3

17. Lau, P. W. C., Lau, E. Y., Wong, D. P., & Ransdell, L. (2011). A Systematic review of information and communication technology-based interventions for promoting physical activity behavior change in children and adolescents. Journal of Medical Internet Research, 13(3), 1–18. https://doi.org/10.2196/jmir.1533

18. Li, X., Zhao, X., Xu, W. (Ato), & Pu, W. (2020). Measuring ease of use of mobile applications in e-commerce retailing from the perspective of consumer online shopping behaviour patterns. Journal of Retailing and Consumer Services, 55(January), 102093. https://doi.org/10.1016/j.jretconser.2020.102093

19. Liu, C., Zhu, Q., Holroyd, K. A., & Seng, E. K. (2011). Status and trends of mobile-health applications for iOS devices: A developer's perspective. Journal of Systems and Software, 84(11), 2022–2033. https://doi.org/10.1016/j.jss.2011.06.049

20. Livingstone, S., & Third, A. (2017). Children and young people's rights in the digital age: An emerging agenda. New Media and Society, 19(5), 657–670. https://doi.org/10.1177/1461444816686318

21. LoPresti, M., Appelboom, G., Bruyère, O., Reginster, J. Y., Klug, E., & Connolly, E. S. (2014). Patient engagement in clinical research through mobile technology. Clinical Practice, 11(6), 549–551. https://doi.org/10.2217/cpr.14.68

22. Mattioli, A. V, Sciomer, S., Cocchi, C., Maffei, S., & Gallina, S. (2020). Nutrition , Metabolism & Cardiovascular Diseases Quarantine during COVID-19 outbreak : Changes in diet and physical activity increase the risk of cardiovascular disease. Nutrition, Metabolism and Cardiovascular Diseases, 30(9), 1409–1417. https://doi.org/10.1016/j.numecd.2020.05.020

23. BuildFire (2021), Mobile app download statistics & usage statistics (2021). Retrieved on January, 2021. https://buildfire.com/app-statistics/

24. Allied Market Research (2021), Mobile application market size, share & growth| industry analysis, 2026. Retrieved October 9, 2021, from https://www.alliedmarketresearch.com/mobile-application-market

25. Molina, M. D., & Myrick, J. G. (2021). The 'how' and 'why' of fitness app use: investigating user motivations to gain insights into the nexus of technology and fitness. Sport in Society, 24(7),

1233–1248. https://doi.org/10.1080/17430437.2020.1744570

26. Molina, M. D., & Sundar, S. S. (2020). Can Mobile Apps Motivate Fitness Tracking? A Study of Technological Affordances and Workout Behaviors. Health Communication, 35(1), 65–74. https://doi.org/10.1080/10410236.2018.1536961
27. Moorman, C., & Matulich, E. (1993). A Model of Consumers' Preventive Health Behaviors: The Role of Health Motivation and Health Ability. Journal of Consumer Research, 20(2), 208. https://doi.org/10.1086/209344
28. Mumcu, H. E. (2021). Fitness-related on health mobile applications during COVID-19: Case of Turkey. Progress in Nutrition, 23(1). https://doi.org/10.23751/pn.v23iS1.11629
29. Statista (2021), Number of smartphone users in India 2015-2022. Retrieved October 9, 2021, from https://www.statista.com/statistics/467163/forecast-of-smartphone-users-in-india/
30. Pablo, S., Cobo, M. J., Vaccaro, G., Pel, I., & Herrera-viedma, E. (2021). brain sciences Citation Classics in Consumer Neuroscience , Neuromarketing and Neuroaesthetics : Identification and Conceptual Analysis.
31. Palička, P., Jakubec, L., & Zvoníček, J. (2016). Mobile apps that support physical activities and the potential of these applications in physical education at school. Journal of Human Sport and Exercise, 11(Special issue 1), S176–S194. https://doi.org/10.14198/jhse.2016.11.Proc1.08
32. Stephens, J., & Allen, J. (2013). Mobile phone interventions to increase physical activity and reduce weight: A systematic review. Journal of Cardiovascular Nursing, 28(4), 320–329. https://doi.org/10.1097/JCN.0b013e318250a3e7
33. Stuart, J. H. B., & Nanette, M. (2007). Psychology of physical activity: Determinants, well-being and interventions. In Psychology of Physical Activity: Determinants, Well-being and Interventions (Issue June 2014). https://doi.org/10.4324/9780203019320
34. Sun, H., & Zhang, P. (2006). The role of moderating factors in user technology acceptance. International Journal of Human Computer Studies, 64(2), 53–78. https://doi.org/10.1016/j.ijhcs.2005.04.013
35. Wang, Z., & Tang, K. (2020). Combating COVID-19: health equity matters. Nature Medicine, 26(4), 458. https://doi.org/10.1038/s41591-020-0823-6
36. WHO. Guideline Stay physically active during self-quarantine. (2020), Access address: http://www.euro.who.int/en/ health-topics/healthemergencies/coronavirus-COVID-19/ novel-coronavirus-2019-ncovtechnical-guidance/stayphysically-active-during-self-quarantine
37. Yang, Y., & Koenigstorfer, J. (2020). Determinants of physical activity maintenance during the Covid-19 pandemic: A focus on fitness apps. Translational Behavioral Medicine, 10(4), 835–842. https://doi.org/10.1093/tbm/ibaa086
38. Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. Organizational Research Methods, 18(3), 429–472. https://doi.org/10.1177/1094428114562629