Iran J Public Health, Vol. 50, No.12, Dec 2021, pp.2397-2410

Review Article

Bibliometric Analysis of HIV and Exercise Literature Based on Scientific Studies from 1990-2020

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(Received 09 Mar 2021; accepted 15 May 2021)

Abstract

Background: Exercise is believed to play an important role in maintaining functionality in patients with HIV and it is thought that researchers are increasingly interested in this field. We aimed to shed light on the historical development of research on HIV and exercise by utilizing visual mapping method.

Methods: Overall, 1051 articles retrieved from Web of Science (WoS) core database were analyzed according to the publication year and language, number of issues, citation, country collaborations, co-citation networks and concept–topic trends by using CiteSpace software.

Results: The United States played a key role in country collaborations, and had the highest citation burst. The most cited studies were meta-analysis studies. The studies gathered mainly around the clusters named "physical activity" and "metabolic abnormalities" meanwhile, the recent topics of research were heart failure, metabolism, comorbidity, Ethiopia, muscle, cardiovascular event and drug user.

Conclusion: The reason why USA was found to be one of the key actors in the network is supposed to be the financial resources it can allocate for the studies conducted. It appears that the majority of the studies in the field dwell upon the impact of exercise on the physical parameters in HIV patients, whereas there are only a limited number of studies focusing on the impact of exercise on HIV-induced psychological and cognitive problems. Recent studies on neurocognitive impairment, on the other hand, are predictive of possible future popularity of such topics among researchers.

Keywords: Bibliometric; Social network analysis; Exercise

Introduction

After the increase detected in cases coursing with pulmonary infection in Los Angeles, New York, San Francisco in 1981, Acquired-immunodeficiency syndrome (AIDS) which had been progressing in opportunistic infections was defined as a chronical disease emerging with the suppression of the immune system by Human Immunodeficiency Virus (HIV) (1). Before the

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use of antiretroviral treatment (ART) in the late 1990s, HIV infection almost resulted in AIDS, with frequent opportunistic infections leading to death. ART has changed HIV infection into a chronic disease (2,3). Patients began to live healthier and longer. It was shown that the lifetime of HIV-positive individuals was nearly the same with HIV-negative ones. So the population living with HIV has started ageing–(4). With the effective ART treatment and the increasing lifetime of people living with HIV (PLWH), the incidence of age-related chronical health problems, aging syndromes (dementia and frailty), and side effects of ART treatment–increased (5-8). Also, HIV-associated chronic inflammation and immune activation persisted, leading to downstream consequences including hypertension (HT), metabolic syndrome, diabetes mellitus (DM), type 2 diabetes mellitus and cardiovascular diseases (9,10).

On the other hand, it is known that weight gain is one of the reasons for the increase in the prevalence of comorbid diseases, therefore for these individuals, lifestyle changes are the backbone of treatment and reducing body weight is incredibly important (11,12).

Increasing age-related polypharmacy has been reported widely among PLWH due to increased comorbidities (13). Therefore, non-pharmaceutical management of comorbidities was critical for PLWH, which may experience a higher comorbidity burden. Routine participation in health-promoting behaviors, including physical activity, can be helpful in preventing and managing comorbid health problems and aging syndromes. (14). Besides, exercise was observed to enhance immune system particularly the number of CD4+T cells which were affected negatively by HIV (15). Exercise is a very important way to enhance or maintain physical fitness and overall health and wellness. It is known that exercise helped preventing and managing chronic diseases such as cardiovascular disease, stroke, DM, HT and several cancers. Moreover, exercise is an excellent form of approach which is used to ameliorate immune and health outcomes in the elderly and the obese, as well as patients living with cancer and chronic viral infections such as HIV (16). Therefore, at the second edition of Physical Activity Guidelines published by U.S. Department of Health and Human Services, adults even with chronical diseases and disabilities were recommended to make at least 150-300 minutes of weekly exercise with moderate intensity or 75-150 minutes of weekly aerobic exercise with high intensity and two times a week or more muscle strengthening activities (17). In order to decrease the risk of falling, elderly individuals were advised to make balance exercises as a part of their weekly physical activity (17,18). Within the scope of the information acquired, it could be commented that exercise is a key to bring the permanence of physical health and functionality to the highest level. This circumstance increased the interest of HIV researchers in the subject.

In this study; the aim was to conceptualize studies on HIV and exercise, in order to present the scope of the literature, map of the global research activity and global research cooperation and provide a macro perspective for researchers in this field. Therefore, this study is expected to reveal developmental attributes and trends, epochal studies and clues concerning the mainstream topics. Based on this motivation these research questions were tried to be answered: a) How is the distribution of studies on HIV and exercise according to years; b) Which are the most productive authors, institutions and countries?; c) Which are the most contributing studies to the field?; d) What are the trends in topics in the area; e) What are the new trends in the area?

In order to put forward the areas emerging as interdisciplinary and showing rapid change, map analytics was utilized. Even though Bibliometric analysis is a basic analysis, it is an efficient method used by different studies in order to present the historical development of the concerned area. By the help of various techniques such as reference, author co-citation, co-citation, co-word analysis, Bibliometric analysis shows a holistic view to researchers working in the field.

Methods

Research Model

Bibliometric analysis is a method using mathematical and statistical tools screening scientific books, articles, journals for some characteristics (19); presenting the structure and dynamics of the field by evaluating the performances of institutions, countries and authors (20).

Bibliometric analysis is defined as a method using mathematical and statistical tools for analyzing certain features in books, journals, articles and presenting hints concerning the area, discipline, and study topic (21-23). Through bibliometric analysis researchers can detect the accumulation between certain years. By this means, guiding information is presented to other researchers in the field so that they can reach the knowledge quicker and more accurate (24). In order to perform bibliometric analysis, Citespace II software was utilized. Citespace software consists of tools that are helpful for visualizing scientific data. Also, for calculating author productivity and collaborations Excel programme was used.

Unit of Analysis

Criterion sampling method, one of the purposive sampling methods was used during the determination of the research sample. WoS Core Collection data base was searched by the terms "Exercise" and "HIV" and a total of 1379 publications were retrieved from SCI-Expanded, SSCI, AHCI and ESCI collections. However, only 1051 articles included in this study.

The earliest dated study retrieved was in 1990. In 2021 there were only 3 studies at that time so the year 2021 was not included in the study. The unit of analysis was limited with publication during years 1990-2020.

Data Analysis

The thickness of lines between actors in the map obtained by Citespace II software showed clue about the density of the network. Network density represents the intensity of the relationship between nodes and collaboration frequency (19). Network density displays the level of utilization of the potential connections in the network (25). "Q Modularity" was used for evaluating the network density which changes between 0-1 and displayed information about the relationship between clusters and connections (26). Q modularity value is a statistical measure indicating if a network is divided into independent blocks. If Q value is 0.6 or higher, this suggests that the network is divided into clusters with significant clear borders (24). If this value is close to 1, this is an indicator of the density of clustering and the relationship between clusters. Another metric used in bibliometric analysis was the "Mean silhouette" score which changes between -1 and +1. A mean silhouette value close to 1 indicates a consistent and similar relationship among the actors of a network (27). Meanwhile this measure was used for determining the optimal number of clusters and if its value exceeds 0.7, this reflects a strong clustering in the network (28). Another metric presented in the bibliometric analysis was citation burst which provided evidence that a particular reference source received a sharp increase of citations during a certain period of time. According to Zhang et al. (29), a concept or reference with a high burst value had a close relationship with research trends during this period. The centrality score states the position and importance of the nodes (country, institution, researchers etc.) in the network. In other words, the level of centrality emphasizes potential key points and is represented by the thickness of the purple circle. Finally, in order to identify topic trends, log likelihood ratio (LLR) and Term frequency by inversed document frequency (TFIDF) were utilized.

Results

In Table 1 the publications are shown in 5-year periods except the last period which includes 6 years with the addition of the year 2020.

Table 1: Distribution of publications on "Exercise" and "HIV" according to years

Years	*(n)*	*Percent (%)*
1990-1994	37	3.5
1995-1999	92	8.7
2000-2004	133	12.6
2005-2009	167	15.8
2010-2014	187	17.7
2015-2020	435	41.3
Total	1051	100

According to Table 1, a systematic increase in the number of publications on "Exercise" and "HIV" was detected. 3.5% of the 1051 studies were published during 1990-1994, meanwhile this percentage increased up to 41.3% after 2015.

Citation Analysis

From 1990 on, the 1051 publications on "Exercise" and "HIV" were cited 27252 times by studies indexed in WoS. The number of citations increased systematically since 1990 and the most cited year was 2019 with 2993 citations (10.9%). This number was followed with 2845 citations (10.4%) in 2020. 114 studies of 1051 publications were not cited yet meanwhile 4 studies received more than 300 citations. It can be stated that the studies having more than 300 citations attracted considerable attention from researchers and contributed more to the body of literature. When these publications were examined, the most cited study was a systematic analysis study with 633 authors (30) with n=2708. The second most citied study is a meta-analysis study (31) with n=914. The next publications were as follows: DiClemente et al. (32) with n=361, Jewkes and Morrell (33) with n=360.

Table 2: Author collaborations and productivity

Co-Authorship	*Collaborations Frequency (n)*	*Percent (%)*	*Publication Number*	*Productivity Frequency (n)*	*Percent (%)*
1	91	8.6	1	4533	84.9
2	102	9.7	2	534	10.0
3	117	11.1	3	139	2.6
4	135	12.8	4	59	1.1
5	117	11.1	5	36	0.6
6-10	392	37.2	6	9	0.1
11-20	88	8.3	7	10	0.1
21-30	7	0.6	8-9	9	0.1
31+	2	0.1	10+	8	0.1
Total	1051	100	Total	5337	100

In Table 2, author collaborations and productivity were given in details. The first column on the left displayed the number of authors and collaborations of authors. 37.2% of 1051 publications were with 6-10 authors. 0.1% of the studies had more than 31 authors. At the 4th column the numbers of studies of the authors contributing to the topic were given. According to the results 4533 (84.9%) researchers contributed to the topic by only one study meanwhile 534 researchers contributed with two publications (10%). The rate of the researchers contributing to the field

with 10 or more than 10 publications was 0.1%. These authors were Allison R. Webel (n=17), Todd T. Brown (n=13) and Kelly K. O'Brien (n=12) respectively.

Institution and Country Collaboration

In this section the nodes in the network demonstrated institutions and countries meanwhile the connections between nodes gave insight about the collaborations. The colors in the network represented the collaborations and the density of collaborations between nodes in parallel with the time scale shown at the upper side of the Fig. 1. The size and thickness of the circle around the nodes exhibited the centrality level of the actor in the network.



Fig. 1: Institution and country collaboration

According to Fig. 1, the country network consisted of 118 nodes and 446 connections. It was divided into 12 clusters. The network density was 0.06 and the modularity was Q=0.235, Mean Silhouette was calculated as 0.78. The institution network consisted of 665 nodes, 1107 connections. The network intensity was 0.005 and the network was divided into 212 clusters; Modularity was Q=0.329 and Mean Silhouette was calculated as 0.91. During the examination of country and institution collaborations, the countries and institutions were counted once in the case of publications with the authors from the same country or institutions. While the country with highest citation burst frequency is USA, the institution with highest citation burst frequency is Harvard University (Table 3).

Co-citation Network Analysis

When common citation network was examined it was observed that the network was divided into 288 clusters. The number of nodes in the network was 1163 meanwhile the number of connections was 3030. Network density was calculated as 0.004. The modularity value of the network was Q= 0.37 and mean silhouette score was 0.9 (Fig. 2).

Table 3: Citation bursts of countries/institutions

Countries/Institutes	*Burst*	*Beginning*	*End*	*1990 - 2020*
Countries				
USA	8.11	2003	2004	
France	3.85	2000	2009	
South Africa	3.55	2018	2020	
Institutes				
Harvard Univ.	5.27	2003	2006	
Case West. Reserve	4.09	2015	2020	
Univ. Cape Town	4.02	2016	2020	

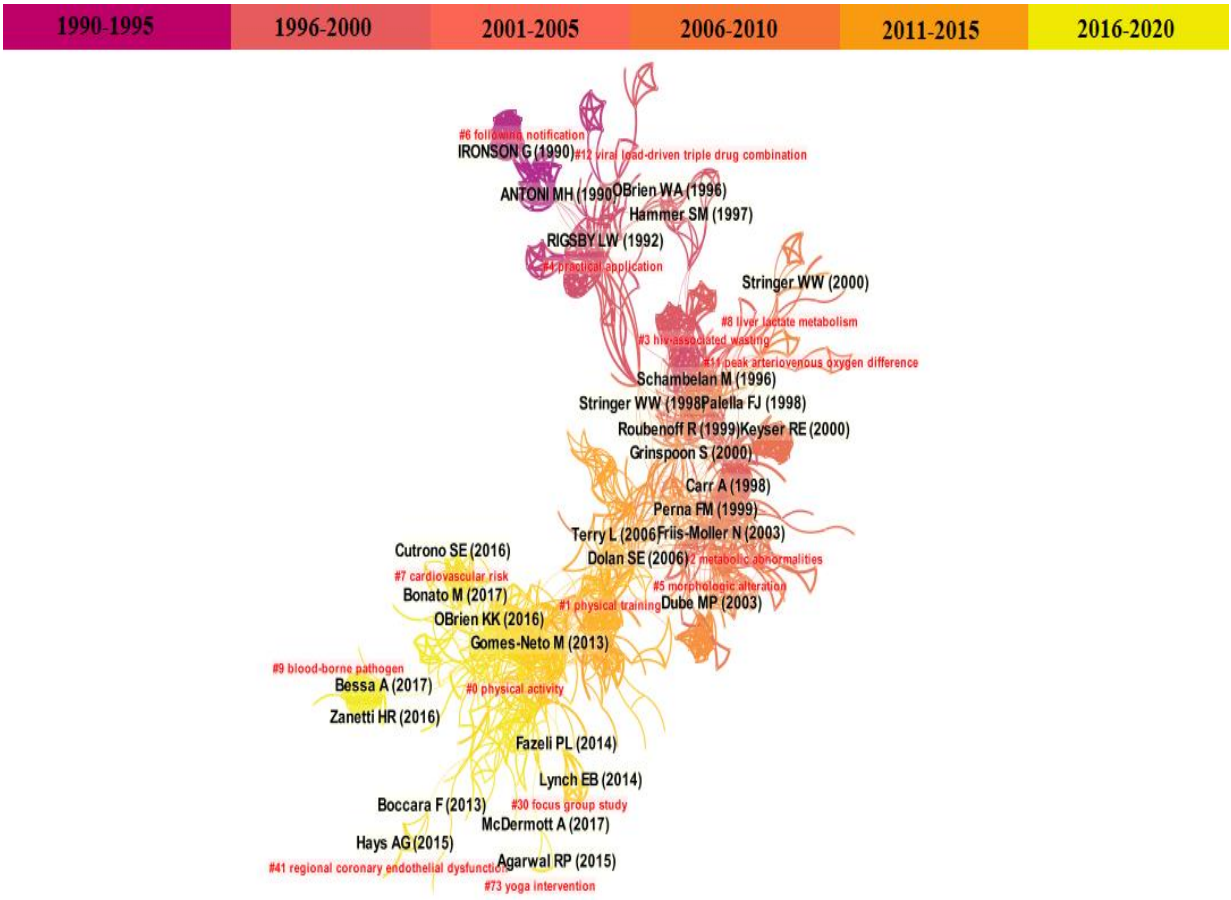


Fig. 2: Clustering of topics

Table 4 shows the most citied documents and their frequency values by the studies published on HIV/AIDS (34-38).

The clustering of topics of the publications cited by the studies, showed the topic trends. The topic trends of the cited publications indicated that there were a total of 15 clusters. But only 6 clusters with the highest size were reported in the Table 5.

Table 4: Frequency values of cited documents

Sources	*Frequency*	*Year*	*Cluster#*
O'Brien KK, Tynan AM, Nixon SA, et al. Effectiveness of aerobic exercise for adults living with HIV: Systematic review and meta-analysis using the Cochrane Collaboration protocol.	41	2016	2
Carr A, Samaras K, Burton S, et al. Syndrome of peripheral lipodystrophy, hyperlipidaemia and insulin resistance in patients receiving HIV protease inhibitors.	29	1998	4
Gomes-Neto M., Conceição CS, Carvalho VO, et al. Systematic review of the effects of different types of therapeutic exercise on physiologic and functional measurements in patients with HIV/AIDS.	25	2013	4
O'Brien K, Nixon S, Tynan AM, et al. Aerobic exercise interventions for adults living with HIV/AIDS.	24	2010	5
Rigsby LW, Dishman RK, Jackson AW, et al. Effects of exercise training on men seropositive for the human immunodeficiency virus-1.	26	1992	5

Table 5: Topic clusters according to cited documents

Cluster	*Size*	*Mean Silhouette*	*Label (TFIDF)*	*Label (LLR) p-value*	*Average Citation Year*
0	135	0.908	people	physical activity (183.45, 1.0E-4)	2013
1	93	0.914	effects	physical training (151.04, 1.0E-4)	2007
2	80	0.892	HIV-infected patients	metabolic abnormalities (163.1, 1.0E-4)	2000
3	67	0.978	HIV infection	HIV-associated wasting (86.28, 1.0E-4)	1996
4	55	0.954	exercise	practical application (165.7, 1.0E-4)	1992
5	35	0.978	exercise - training	morphologic alteration (72, 1.0E-4)	2002

Co-word network analysis

Co-word network analysis displayed the most frequently used concepts in keywords and abstracts among the 1051 publications retrieved in order to give clues about the most attractive topics and the change in these topics during years. By the help of this analysis, researchers can get hints about today's existing tendencies. Co-word network analysis is an effective way for explaining the structure of the scientific knowledge, bringing out the current research topics and discovering research trends (Fig. 3).

The network regarding to keywords was divided into 50 clusters, the number of nodes in the network was 723 and the number of connections was 3462 meanwhile the network density was 0.01. Modularity value was Q=0.16 and mean silhouette score was 0.75.

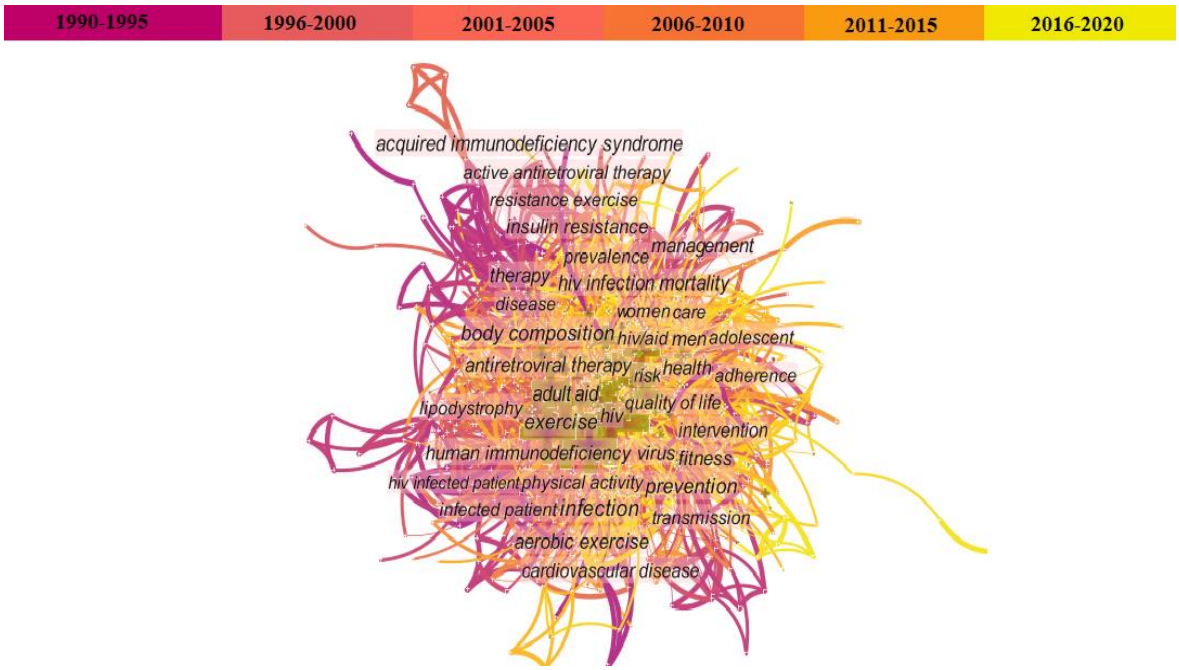


Fig. 3. Keywords analysis

Table 6: Co-word frequencies and betweenness centrality

Years	*Words*	*Frequency*	*Centrality*
1991	HIV	691	0.00
1993	Exercise	364	0.00
1995	Health	80	0.00
1997	Prevalence	124	0.00
1999	Women	73	0.00
2001	Weight loss	27	0.00
2003	Dyslipidemia	16	0.00
2005	Mortality	30	0.00
2007	South Africa	22	0.00
2009	Cardiorespiratory fitness	10	0.00
2011	Medication adherence	4	0.00
2013	Older adult	25	0.00
2015	Impact	18	0.00
2017	Intensity	7	0.00
2019	Heart failure	5	0.00
2019	Comorbidity	5	0.00
2019	Metabolism	4	0.00
2019	Neurocognitive impairment	3	0.00
2019	Cardiorespiratory fitness	2	0.00
2019	COPD	2	0.00
2020	Ethiopia	4	0.00
2020	Muscle	3	0.00
2020	Cardiovascular event	2	0.00
2020	Drug user	2	0.00
2020	Alcohol use	2	0.00
2020	Opioid	2	0.00
2020	Hepatitis B/C	2	0.00

Table 6, presents the distribution of the most cited concepts according to years in studies concerning HIV and Exercise. The researchers are expected to get an idea of the change in the topics attracting interest according to years.

According to the co-word analysis, the most frequently used words were HIV (n=541) and exercise (n=252). The calculation of centrality of the words was not possible. When trend topics in recent years related with HIV and exercises were examined; heart failure, metabolism, comorbidity, neurocognitive impairment, muscle concepts were prominent and the studies were conducted predominantly in Ethiopia.

Discussion

The development of studies in the area of HIV and Exercise

Besides its results for the individual, HIV/AIDS is one of the global public health problems as it can transmit from person to person and can be widely disseminated and also due to its high socioeconomic load. HIV infection is not only a health problem but also a social problem concerning the society and every individual living in that society. At the end of 2019, there were an estimated 38 million people living with HIV. The 2030 vision of the action plan regarding HIV infection is "Elimination of HIV infections, HIV related deaths and HIV related discriminations by creating a World where HIV infected individuals live longer and healthier" (39).

The 90-90-90 targets which aim to eliminate HIV epidemic until 2030 declared by United Nations and approved by all countries could be influential in this increase. During the last years, healthy living was determined as the fourth objective and this could be interpreted as the increase in the awareness of the importance of exercise. Due to the initiatives realized in order to reach these targets, an increase in the number of individuals that are living with HIV and individuals that are diagnosed, lifelong therapy treated and provided with viral suppression (40). Epidemiologic studies reported that the load created by comorbid diseases due to aging was higher in HIV infected individuals than HIV negative individuals (10,41). The multimorbidity load can be decreased in HIV infected individuals by aggressive management of risk factors of comorbidities and usage of less toxic antiretroviral medicine. The primary objective in the basic management of risk factors associated with comorbid disease is changing the life style by introducing diet and exercise in the routine life, and so the disease could be controlled without medicine. Parallel to the increase in the comorbid diseases, the increase in the number of medications utilized disrupts the compliance to treatment and quality life of the patients. Exercise has an important role in preventing the development of chronic diseases and also in keeping them under control. If there is an occurrence of a chronic disease, the toxic effects of the medication used for these patients can be palliated by regular exercise. Exercise is emphasized to improve the life standard of PLWH. Moradi et al. (42) researched the health needs of PLWH from the perspectives of health managers, doctors, consultants, PLWH and their families, and concluded that physical activity should be supported as one of the rehabilitation needs of PLWH. The rise of the awareness to the importance of exercise was thought to be one the reasons of the augmentation of studies on exercise in PLWH.

According to the findings of the studies, the number of publications on the topic "exercise in individuals with HIV" increased systematically since 1990. When compared with the period of first five years the number of studies increased 10 times. From 2014, the increase was observed to be more significant.

The development of HIV and exercise literature during years caused researchers to turn towards different research topics. During the period before 2005, antiretroviral treatments (ART) were not potent and had many side effects so HIV was expected to be a malignant disease. Therefore, is the early 2000s, undesired results related with HIV such as the loss of weight, dyslipidaemia, mortality were prominent. Meanwhile during the 2010s, with the inurement of new medicine, the

acceleration gained in antiretroviral treatment, drug compliance parallel to longer lifespan, medicine effect, elderly ages were prominent. By 2019, the extension of the lifespan in PLWH the heart failure, cardiovascular, cardiorespiratory fitness, chronic obstructive pulmonary disease (COPD), comorbidity, cognitive impairment and gait speed concepts related with elderly ages were current issues. In 2020 different topics were observed to be on the agenda. The research on cardiovascular event was still going on, meanwhile related with the continuation habit of PLWH, studies on alcohol use, illegal substance use(opioid) and other viral infections transmitted sexually or by blood (such as hepatitis B virus, hepatitis C virus) came forward.

Findings presented an important clue for the researchers. The co-word analysis and the topic clusters of the cited sources revealed that the studies examining the effect of exercise on physical health condition (Cardiorespitatory fitness, metabolism, muscle) in individuals with HIV were predominant. However, the studies handling psychological health conditions of individuals with HIV stated that mental illnesses were rather common among individuals with HIV and the studies inquiring the effect of exercise on the mental health in this group attracted less interest from researchers. Depression was the most frequent psychiatric diagnosis (36%) among HIV patients accompanied by comorbid anxiety (16%) (43). Due to depression in HIV patients, low levels of self-efficacy, self-esteem and self-compassion were also encountered. There is also evidence that HIV patients had neurocognitive deficiencies (44).

Although this study showed that the researchers in HIV area showed an interest in neurocognitive studies in 2019 (n=3) this interest seemed to be brand new. When the positive effects of exercise on mental (45,46) and cognitive (47,48) parameters are taken into consideration, studies examining the positive impact of exercise on psychological and cognitive problems developing in relation with HIV are expected to gain importance among researchers.

Yield

The research findings displayed that a total of 5337 researchers contributed to HIV and exercise literature. But some of these authors contributed to the field more than the others with the studies they conducted.

The authors contributing to the field with more than 10 studies (0.1%) were Allison R. Webel (n=17), Todd T. Brown (n=13) and Kelly K. O'Brien (n=12) respectively. These three authors published a total of 42 studies concerning exercise in PLWH and becoming the most productive researchers in this topic. Allison R. Webel is a nurse from US, particularly investigating the social and behavioral determinants of comorbid disease. Meanwhile, Todd T. Brown working on HIV is an expert of diabetes, endocrine and metabolism from US. Another significant point is that the citations to the retrieved 1051 publications increased over the years. These publications received only several citations in 1990 but the number of citations increased to 2993 (10.9%) in 2019 and 2845 (10.4%) in 2020 making a total of 27.252. The number of citations and the number of studies on this topic showed parallelism. When author collaborations are considered, the results indicate that the majority of studies on exercise in PLWH were with 6-10 authors (37.2%) and 4 authors (12.8%).

When the most cited studies examined, Vos at al. takes the first place with a multinational and extensive study participated by researchers from many different fields and supported by strong firms. Another reason that this study attracted so much attention might be due to the fact that this was a systematic review study that included 310 diseases. Because systematic review and meta-analysis studies present clues to researchers by providing synthesis and summaries of various studies on a certain topic.

However, as this study was published in Lancet journal with an impact factor of 60.39, this situation could be one of the reasons of high attention of academics.

Collaboration network analysis

In this study, the findings about the country and institution of the author contributing most in the topic of exercise in individuals with HIV were presented. According to the results, researchers from USA (n=517) and University of California in San Francisco (n=34) were observed to be the most contributing researchers in the field. When network analysis was evaluated, it was observed that USA and England showed high centrality values and had a strategical importance in connecting the studies made in other countries. The results concerning country and institution analysis were as follows: Modularity Q=0.23 and mean silhouette=.78 for countries, modularity Q=0.32 and mean silhouette = .91 for institutions. Modularity Q value was in [-1,1] range but as silhouette scores were higher than 0.7, this was accepted as a dissociation of the units in the cluster (28,49), and it could be concluded that the general dissociation rate was low for the clusters but the units inside the clusters dissociated from each other. One reason that USA was an important actor might result from the sufficient financial resources for research. However why South Africa was also a significant actor in the network might be explained by the increases in the number of HIV infected individuals (50).

When Citation burst rates of countries and institutes were evaluated USA was the country with the highest citation burst value. Meanwhile South Africa had been getting a high level of citations until today although not as many as USA. France was the country with the longest duration of citations burst during 2000-2009. Harvard University was the institution with the highest citations burst value. Meanwhile Case Western Reserve University in USA and Cape Town University in South Africa continued to get a high level of citations during last years.

Another finding of the study was concerning the most cited publications by the retrieved 1051 studies. The most cited publication was a meta-analysis study of 24 publications by O'Brien et al. (34) with the title "Effectiveness of aerobic exercise for adults living with HIV: systematic review and meta-analysis using the Cochrane Collaboration protocol". This study was classified under the topic cluster of "metabolic abnormalities". The most frequently studied topic clusters were "physical activity", physical training and "metabolic abnormalities" respectively.

Conclusion

The aim of this study was to present a macro perspective to researchers in the field of HIV and exercise about the developmental attributes, important reference sources, existing topic trends and gaps in the area. The results indicated that, studies on HIV and exercise gained importance, researchers focused to a large extent on effects of exercise on physical parameters in individuals with HIV, USA was at the highest rank in efficiency. The studies mentioning effects of exercise on the cognitive and psychological problems that developed in relation with HIV were found to be limited in number and expected to have potential for future research. This study was limited with WOS database and consequently representativeness of the results was also restricted. It is recommended to use different databases in order to enhance the profoundness and scope of the research.

Ethical considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

No financial support was received for this study.

Conflict of interest

The authors declare that there is no conflict of interests.

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