

## The 50 most-cited review papers on physical activity and depression: A bibliometric analysis

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### ABSTRACT

**Abstract:** A growing body of literature has demonstrated the preventive role of physical activity in depression, and relevant research is rapidly on the rise. The aim of this study was to conduct a bibliometric analysis of the 50 most-cited review papers on physical activity and depression, thus identifying important research topics and future research directions.

**Methods:** The 50 most-cited review articles were identified and extracted from the Web of Science Core Collection database (on 31<sup>st</sup> October 2022), and a bibliometric citation analysis was performed using the Microsoft Excel and VOSviewer software (Version 1.6.18). Information on the country, authors of publications, publishing journals, citations (i.e., total or annual), keywords, and other meaningful data was analysed comprehensively.

**Results:** The 50 most-cited review articles received, on average, 247.5 citations per article. Most review articles were from England, with contributions from some highly cited researchers and research teams. Western countries/regions, such as England, Australia, and the USA were the most influential in publishing review articles on physical activity and depression. The *Journal of Affective Disorders* and *Cochrane Database of Systematic Reviews* were the journals that published the most highly cited review articles on physical activity and depression. Important research topics on the literature on physical activity and depression focused on (1) different types of physical activity and depression; (2) intervention studies related to physical activity and depression; (3) fitness and physical activity levels in people with depression; (4) methodological analyses in physical activity and depression studies; and (5) the impact of physical activity on depression in different populations.

**Conclusion:** This study reveals that review studies on physical activity and depression have great potential to develop further knowledge. This study also highlights some future research directions, which can serve to effectively advance the knowledge base.

### 1. Introduction

An individual with depression may experience symptoms such as mood issues, loss of interest or pleasure, a lack of energy, feelings of guilt or low self-esteem, disturbed sleep or appetite, and difficulty concentrating [1]. There is a higher risk of disease associated with depression, which adversely affects human health and well-being [1]. It has been well-documented that depressive symptoms have a detrimental impact on psychological and physical health from infancy through to old age [2, 3]. For example, depression in childhood has a long lasting negative effect on mental health later in life [4], and can lead to neurological abnormalities in the aging population [3]. Specifically, the detrimental health outcomes of high levels of depression include diabetes [5],

cardiovascular disease [6], cancer [7], and other health problems [8]. Furthermore, depression is an important predictor of cardiac mortality and morbidity, such as cardiac functioning and coronary heart disease [9]. Depression also affects biological factors and, consequently, contributes to physical disability [10].

The high prevalence of depression has been established in the existing evidence. According to the World Health Organisation, the prevalence of depression is increasing globally, and 4.4% of the world's population was predicted to suffer from depression in 2015 [11]. A systematic review synthesised 14,866 non-duplicate articles, and an estimated 19.1% pooled prevalence of depression was observed in children, adolescents, and young adults [12]. Further, the weighted mean prevalence of depression was 30.6% in university students [13],

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while the prevalence ranged from 0.9% to 49% in the aging population [14]. Notably, evidence from a scoping review has shown that 20% of the participants suffered from depression during the COVID-19 pandemic [15]. The potential factors leading to the increasing prevalence of depression are mainly due to the environmental changes, including high prevalence of obesity, unhealthy diet, insufficient physical activity, and inappropriate light and lack of sleep [16]. To reverse the situation on the large number of patients suffering from depression or a group of people at the risk of developing depression, clinical practice or evidence-based recommendations strongly suggest that doing more physical activity (PA) can provide a feasible and effective approach against depression [17–21]. There has been a great amount of literature examining the relationship between PA and depression [17, 18, 22, 23], especially review studies [24–26]. This is because review studies can not only summarise in-depth research knowledge, but also allow for the determination of future research directions. This type of study design has, thus, become increasingly popular, and more researchers have studied PA and depression using reviews [27–31]. Additionally, considering some unknown research issues in the context of PA and depression, more research in this field is required. The use of the bibliometric analyses serves as a useful analytical approach to comprehensively summarise the current state of review studies on PA and depression is [32].

Bibliometric analysis is centred on the citations of publications [32]; referring to the number of research articles that cite a given published article [33,34]. The total number of citations not only establishes the academic impact of a specific article in the field, but also serves as a basis for determining a journal's impact factor, which can then be used as an indicator for assessing its quality [33,35,36]. Across the vast majority of research fields, a research article with more than 100 citations can be considered a high-quality paper [37,38]. On the basis of citation analyses, many studies have attempted to conduct bibliometric analyses to better understand recent scientific progress and research trends in a particular subject area [32,39,40].

Given that the publications concerning PA and depression in the literature are evolving rapidly, the relevant research scope and characteristics are worth studying. Therefore, the main objective of this study was to identify the 50 most-cited review articles focusing on PA and depression, using a citation analysis. The second aim of this study was to visualise the most active countries/nations, author groups, and most frequent keywords using the VOSviewer software. This kind of analysis can help to deepen our understanding of the current state of research on PA and depression and is expected to offer novel insights into future research.

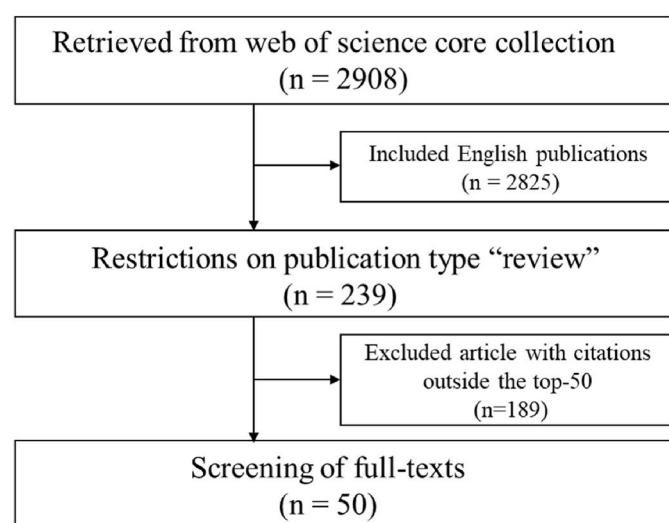
## 2. Methods

### 2.1. Search strategy

The Web of Science Core Collection database was selected as our literature search source, as this database consists of more than 20,000 peer-reviewed, high-quality journals, due to which it has been widely utilized for bibliometric analyses. The Web of Science Core Collection database provides information on author(s), countries, and keyword on each publication, which served as the foundation for current bibliometric analysis. This kind of literature search approach has been recommended by other similar studies. The search strategy was as follows: “physical activity” OR “sport” OR “exercise” AND (depressi\*). The data extracted from the database were exported as a “Tab-delimited” file. Language limitation and publication type were specified as English and review, respectively. The flow chart of the study selection process is displayed in Fig. 1.

### 2.2. Publication selection and data extraction

All the publications (n = 2310) retrieved from literature search were



**Fig. 1.** Flow chart of study selection.

screened for study selection. First, the document type was restricted to “article” from the 2310 publications initially retrieved, and then the titles and abstracts of each article were independently reviewed by two authors, in order to ensure that they were relevant to physical activity. Then, the 50 most-cited articles were selected for bibliometric analysis, based on the citation number, sorting with 50 as the cut-off value. The 50 most-cited review articles were analysed by extracting the following information systematically: (1) publication author(s); (2) publication year; (3) journal; (4) total citations per review article; and (5) journal impact factor.

### 2.3. Visualization

The Microsoft Excel and VOSviewer (version 1.6.15) software were used to analyze the information from the included review articles. General information processing was performed using Microsoft Excel. A unimodal network with a focus on the visualization of academic knowledge was constructed using VOSviewer — a software specifically designed for performing bibliometric analyses on data imported from bibliographic databases. Author and country collaborations were visualized through co-authorship analysis, while detecting research hotspots required analyzing co-occurrence of keywords.

### 2.4. Statistical analysis

All the statistical procedures for this study were performed using the Microsoft Excel, and descriptive results were presented as mean or range.

## 3. Results

**Table 1** lists the information on the review articles included in the bibliometric analysis. As for the citations of included review articles, the range was from 89 to 756 (until the date of literature search). The publication year ranged between 1989 and 2019. The mean number of citations for all the included review articles was 247.5 citations per paper. More details are provided in **Table 1**.

**Fig. 2** depicts the network map for research collaborations between the countries/regions that published the 50 most-cited review articles, of which five clusters of countries/regions can be found. The figure indicates that some western countries/regions, such as the USA, England, and Australia were predominant over other countries. England, Australia, and Brazil were the top three countries/regions that published top-cited review articles in the research field of PA and depression. In

**Table 1**

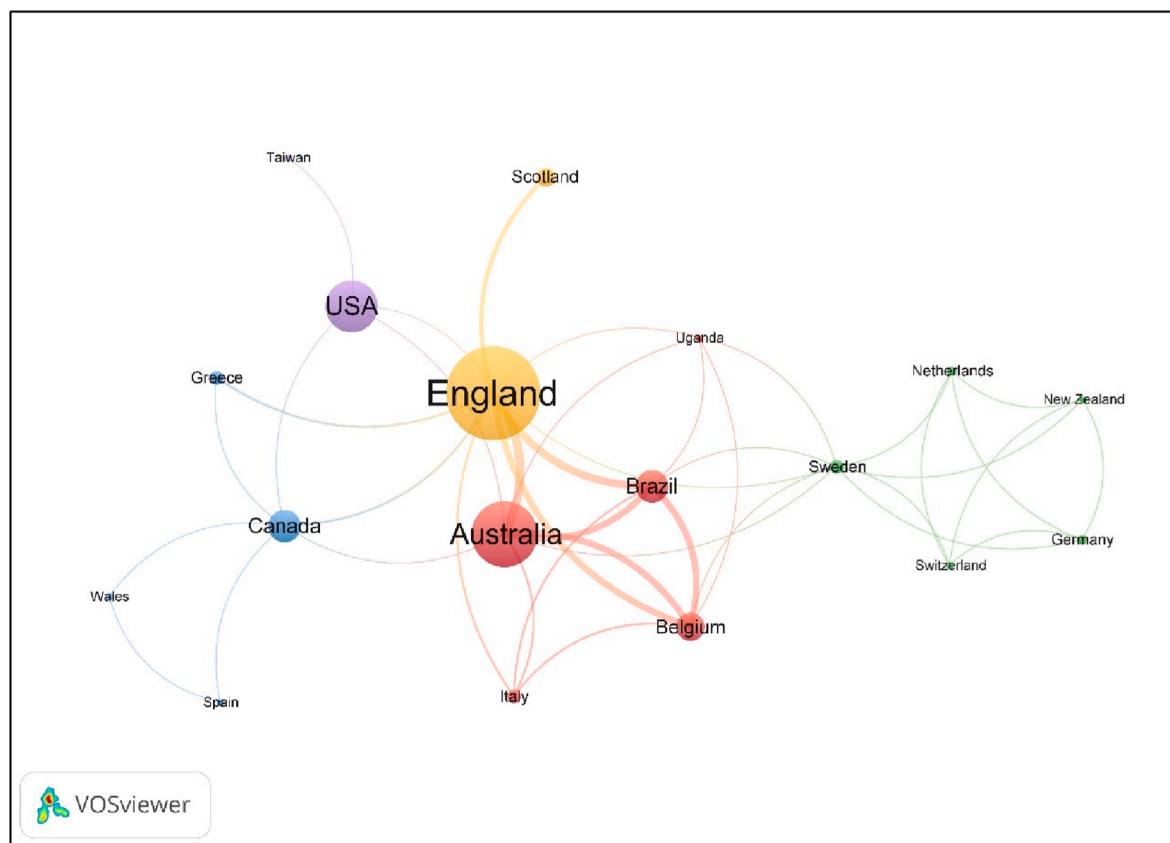
List of the top-50 cited review articles in this bibliometric analysis.

Authors	Article Title	Total Citations	Journal	Publication Year
Salmon [44]	Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory	756	CLINICAL PSYCHOLOGY REVIEW	2001
Strohle [45]	Physical activity, exercise, depression and anxiety disorders	685	JOURNAL OF NEURAL TRANSMISSION	2009
Cooney et al. [46].	Exercise for depression	675	COCHRANE DATABASE OF SYSTEMATIC REVIEWS	2013
GIANROSSI et al. [47].	EXERCISE-INDUCED ST DEPRESSION IN THE DIAGNOSIS OF CORONARY-ARTERY DISEASE - A META-ANALYSIS	609	CIRCULATION	1989
Mammen et al. [48].	Physical Activity and the Prevention of Depression A Systematic Review of Prospective Studies	601	AMERICAN JOURNAL OF PREVENTIVE MEDICINE	2013
Lawlor et al. [49].	The effectiveness of exercise as an intervention in the management of depression: systematic review and meta-regression analysis of randomized controlled trials	518	BMJ-BRITISH MEDICAL JOURNAL	2001
Teychenne et al. [50].	Physical activity and likelihood of depression in adults: A review	426	PREVENTIVE MEDICINE	2008
Vancampfort et al. [51].	Sedentary behavior and physical activity levels in people with schizophrenia, bipolar disorder and major depressive disorder: a global systematic review and meta-analysis	371	WORLD PSYCHIATRY	2017
Kvam et al. [52].	Exercise as a treatment for depression: A meta-analysis	356	JOURNAL OF AFFECTIVE DISORDERS	2016
Lucassen et al. [53].	Regulation of adult neurogenesis by stress, sleep disruption, exercise and inflammation: Implications for depression and antidepressant action	336	EUROPEAN NEUROPSYCHOPHARMACOLOGY	2010
Lopresti et al. [54].	A review of lifestyle factors that contribute to important pathways associated with major depression: Diet, sleep and exercise	335	JOURNAL OF AFFECTIVE DISORDERS	2013
Erickson et al. [55].	The Aging Hippocampus: Interactions between Exercise, Depression, and BDNF	306	NEUROSCIENTIST	2012
BYRNE et al. [56].	THE EFFECT OF EXERCISE ON DEPRESSION, ANXIETY AND OTHER MOOD STATES - A REVIEW	305	JOURNAL OF PSYCHOSOMATIC RESEARCH	1993
Brosse et al. [57].	Exercise and the treatment of clinical depression in adults - Recent findings and future directions	297	SPORTS MEDICINE	2002
Mead et al. [58].	Exercise for depression	289	COCHRANE DATABASE OF SYSTEMATIC REVIEWS	2009
Schuch et al. [59].	Physical activity and sedentary behavior in people with major depressive disorder: A systematic review and meta-analysis	287	JOURNAL OF AFFECTIVE DISORDERS	2017
Josefsson et al. [60].	Physical exercise intervention in depressive disorders: Meta- analysis and systematic review	264	SCANDINAVIAN JOURNAL OF MEDICINE & SCIENCE IN SPORTS	2014
Rimer et al. [61].	Exercise for depression	249	COCHRANE DATABASE OF SYSTEMATIC REVIEWS	2012
Bridle et al. [62].	Effect of exercise on depression severity in older people systematic review and meta-analysis of randomized controlled trials	231	BRITISH JOURNAL OF PSYCHIATRY	2012
Stanton et al. [63].	Exercise and the treatment of depression: A review of the exercise program variables	226	JOURNAL OF SCIENCE AND MEDICINE IN SPORT	2014
Kandola et al. [64].	Physical activity and depression: Towards understanding the antidepressant mechanisms of physical activity	221	NEUROSCIENCE AND BIOBEHAVIORAL REVIEWS	2019
Mead et al. [65].	Exercise for depression	221	COCHRANE DATABASE OF SYSTEMATIC REVIEWS	2008
Larun et al. [66].	Exercise in prevention and treatment of anxiety and depression among children and young people	212	COCHRANE DATABASE OF SYSTEMATIC REVIEWS	2006
Herring et al. [67].	Effect of Exercise Training on Depressive Symptoms Among Patients with a Chronic Illness A Systematic Review and Meta-analysis of Randomized Controlled Trials	208	ARCHIVES OF INTERNAL MEDICINE	2012
Blake et al. [68].	How effective are physical activity interventions for alleviating depressive symptoms in older people? A systematic review	198	CLINICAL REHABILITATION	2009
Phillips [69].	Brain-Derived Neurotrophic Factor, Depression, and Physical Activity: Making the Neuroplastic Connection	193	NEURAL PLASTICITY	2017
Dauwan et al. [70].	Exercise Improves Clinical Symptoms, Quality of Life, Global Functioning, and Depression in Schizophrenia: A Systematic Review and Meta-analysis	192	SCHIZOPHRENIA BULLETIN	2016
Brown et al. [71].	Physical Activity Interventions and Depression in Children and Adolescents A Systematic Review and Meta-Analysis	187	SPORTS MEDICINE	2013
Dinas et al. [72].	Effects of exercise and physical activity on depression	185	IRISH JOURNAL OF MEDICAL SCIENCE	2011
Sjosten et al. [73].	The effects of physical exercise on depressive symptoms among the aged: a systematic review	160	INTERNATIONAL JOURNAL OF GERIATRIC PSYCHIATRY	2006
Craft et al. [74].	Exercise Effects on Depressive Symptoms in Cancer Survivors: A Systematic Review and Meta-analysis	152	CANCER EPIDEMIOLOGY BIOMARKERS & PREVENTION	2012
Schuch et al. [75].	Neurobiological effects of exercise on major depressive disorder: A systematic review	144	NEUROSCIENCE AND BIOBEHAVIORAL REVIEWS	2016
Stubbs et al. [76].	Dropout from exercise randomized controlled trials among people with depression: A meta-analysis and meta regression	144	JOURNAL OF AFFECTIVE DISORDERS	2016
Bailey et al. [77].	Treating depression with physical activity in adolescents and young adults: a systematic review and meta-analysis of randomized controlled trials	137	PSYCHOLOGICAL MEDICINE	2018
Micheli et al. [78].	Depression and adult neurogenesis: Positive effects of the antidepressant fluoxetine and of physical exercise	127	BRAIN RESEARCH BULLETIN	2018
Potter et al. [79].	A systematic review of the effects of physical activity on physical functioning, quality of life and depression in older people with dementia	127	INTERNATIONAL JOURNAL OF GERIATRIC PSYCHIATRY	2011

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**Table 1 (continued)**

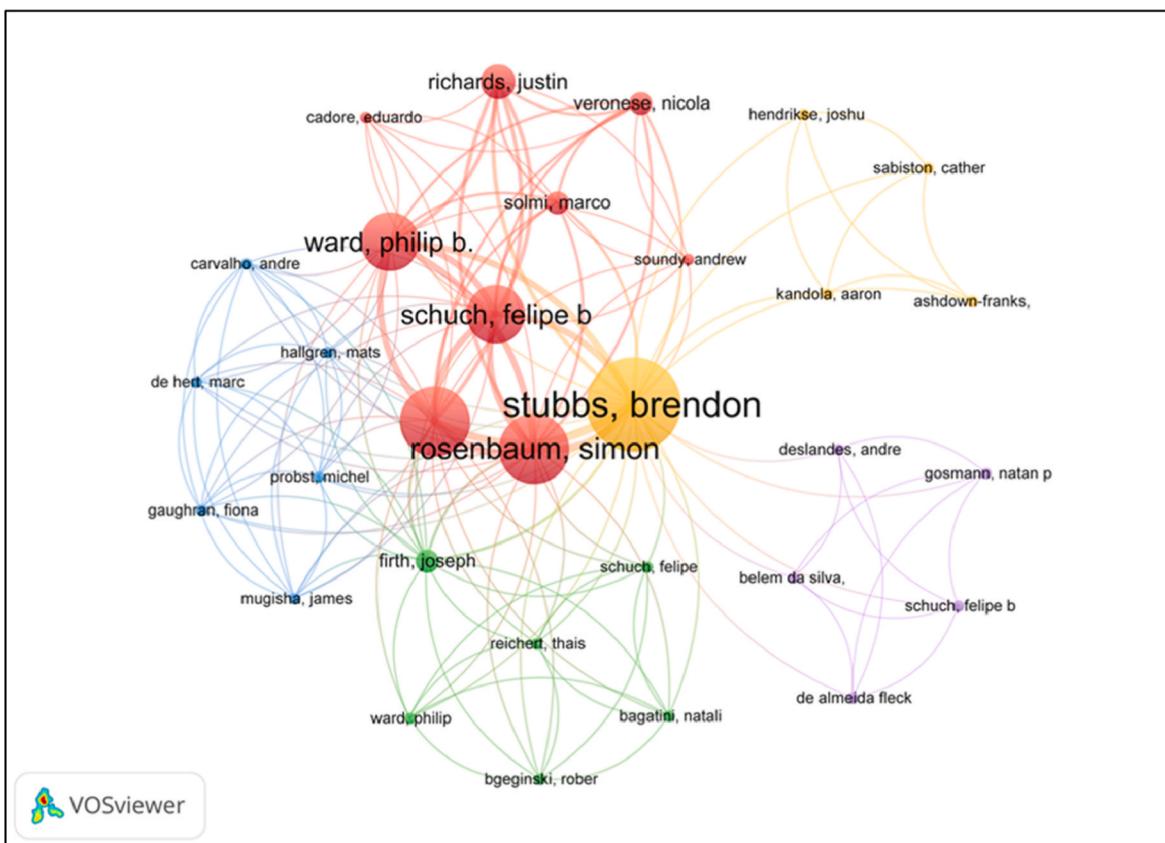
Authors	Article Title	Total Citations	Journal	Publication Year
Barbour et al. [80].	Exercise as a treatment for depression and other psychiatric disorders	114	JOURNAL OF CARDIOPULMONARY REHABILITATION AND PREVENTION	2007
Schuch et al. [81].	Exercise for depression in older adults: a meta-analysis of randomized controlled trials adjusting for publication bias	113	REVISTA BRASILEIRA DE PSIQUIATRIA	2016
Eyre et al. [82].	Neuroimmunological effects of physical exercise in depression	112	BRAIN BEHAVIOR AND IMMUNITY	2012
Davenport et al. [83].	Impact of prenatal exercise on both prenatal and postnatal anxiety and depressive symptoms: a systematic review and meta-analysis	108	BRITISH JOURNAL OF SPORTS MEDICINE	2018
MARTINSEN et al. [84].	BENEFITS OF EXERCISE FOR THE TREATMENT OF DEPRESSION	106	SPORTS MEDICINE	1990
Gujral et al. [85].	Exercise effects on depression: Possible neural mechanisms	105	GENERAL HOSPITAL PSYCHIATRY	2017
Stubbs et al. [86].	Exercise improves cardiorespiratory fitness in people with depression: A meta-analysis of randomized control trials	105	JOURNAL OF AFFECTIVE DISORDERS	2016
Morres et al. [87].	Aerobic exercise for adult patients with major depressive disorder in mental health services: A systematic review and meta-analysis	104	DEPRESSION AND ANXIETY	2019
Korczak et al. [88].	Children's Physical Activity and Depression: A Meta-analysis	101	PEDIATRICS	2017
Carter et al. [89].	The Effect of Exercise on Depressive Symptoms in Adolescents: A Systematic Review and Meta-Analysis	100	JOURNAL OF THE AMERICAN ACADEMY OF CHILD AND ADOLESCENT PSYCHIATRY	2016
Dale et al. [90].	Physical activity and depression, anxiety, and self-esteem in children and youth: An umbrella systematic review	99	MENTAL HEALTH AND PHYSICAL ACTIVITY	2019
Wu et al. [91].	Effectiveness of physical activity on patients with depression and Parkinson's disease: A systematic review	96	PLOS ONE	2017
Zeng et al. [92].	Virtual Reality Exercise for Anxiety and Depression: A Preliminary Review of Current Research in an Emerging Field	91	JOURNAL OF CLINICAL MEDICINE	2018
Schuch et al. [93].	Exercise improves physical and psychological quality of life in people with depression: A meta-analysis including the evaluation of control group response	89	PSYCHIATRY RESEARCH	2016

**Fig. 2.** Countries/regions collaboration networking map.

In addition, two close collaboration groups i.e., Australia and Brazil, and Sweden and Germany were observed. Meanwhile, other collaborations that were not as close and strong existed, such as that between the USA and Chinese Taiwan.

In terms of author collaboration, the visualization analysis

demonstrated that the authors of the included review articles could be divided into three clusters, marking a group of certain research investigators and their collaborating researchers (see Fig. 3), such as Brendon Stubbs and Simon Rosenbaum. A strong and close collaboration was found among various authors, including those of Simon Rosenbaum,

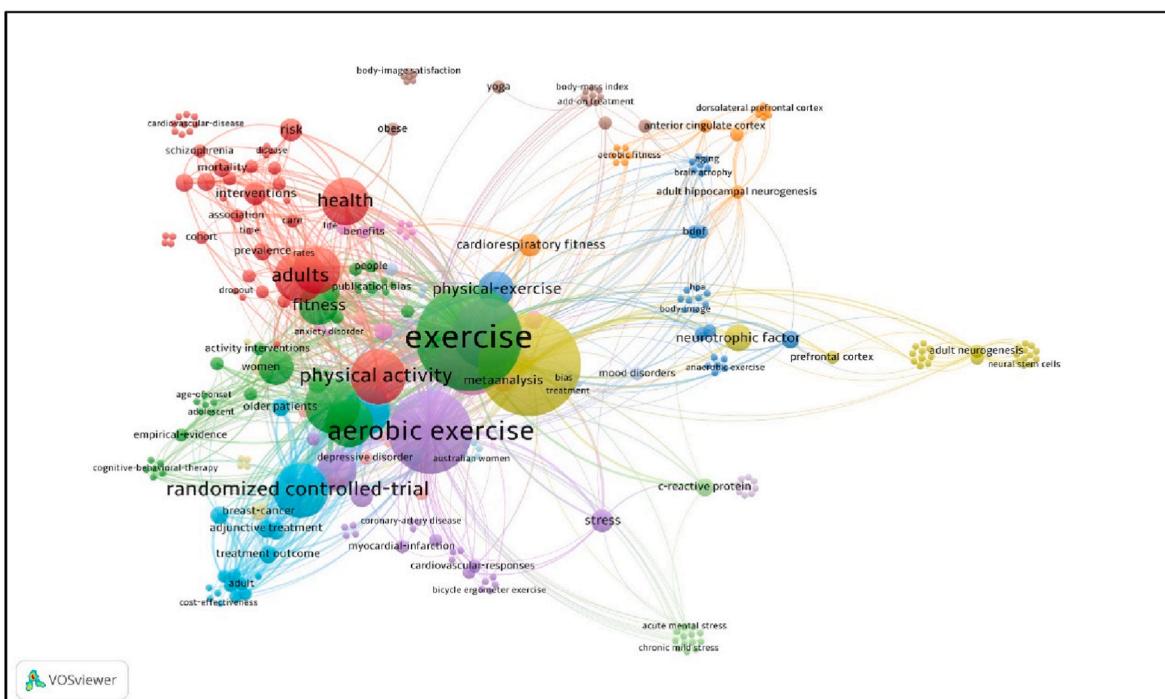


**Fig. 3.** Co-authors collaboration networking map.

Felipe B Schuch, and Philip Ward. Other author clusters, unlike the author clusters led by those mentioned above, were weaker in terms of research collaboration.

When looking at the keyword co-occurrence analysis for the review

articles included in this study (see Fig. 4), it was observed that, in the research on PA and depression, important research areas include the types of PA (e.g., overall physical activity, exercise, aerobic physical activity), health outcomes (e.g., fitness), study design (e.g., randomized



**Fig. 4.** Keyword cooccurrence analysis for the included review articles.

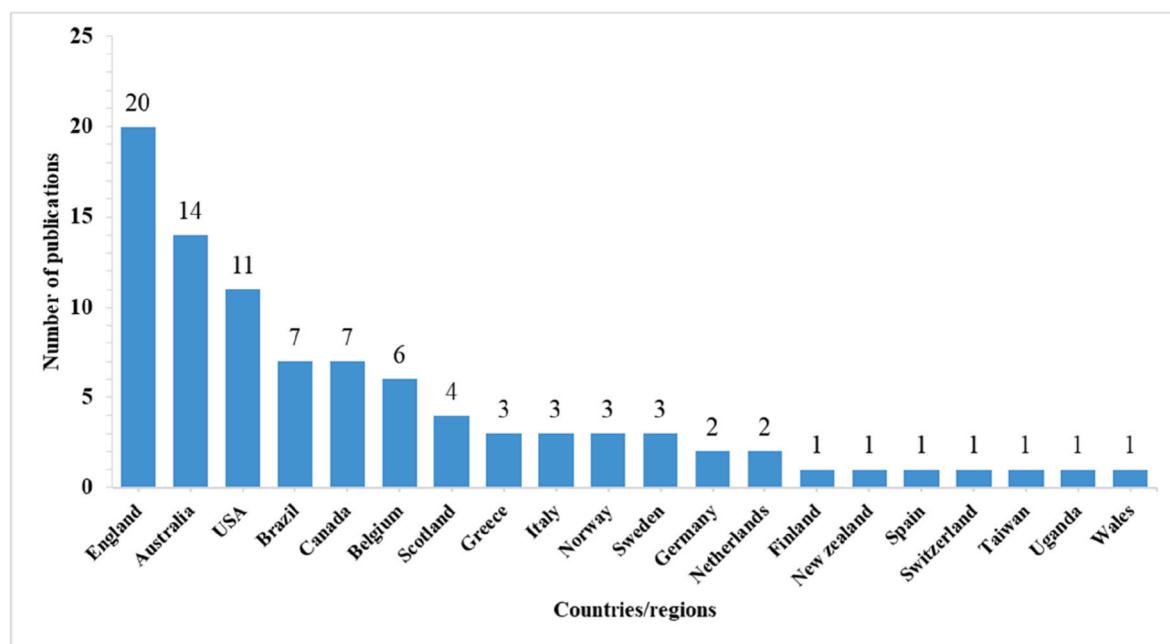


Fig. 5. Number of publications by countries/regions.

controlled trial), and target population (e.g., adults) (see Fig. 5). The most active journal publishing reviews on PA and depression were *Journal of Affective Disorders*, and *Cochrane Database of Systematic Reviews* (see Fig. 6).

#### 4. Discussion

The increasing prevalence of depression at the population level poses a significant public health challenge. Advocating PA for the alleviation

of depression has been encouraged as an effective public health approach [17,19,21,41], as reflected in the relevant literature. Thus, we aimed to comprehensively perform a bibliometric analysis on the 50 most-cited review articles concerning physical activity and depression. By analysing the information on authors, countries/regions, keywords, and some general characteristics of these articles, some interesting findings were obtained. First, the citation number of the most-cited review articles was not very high, compared with other studies concerning PA and health. Second, western countries/regions, such as England,

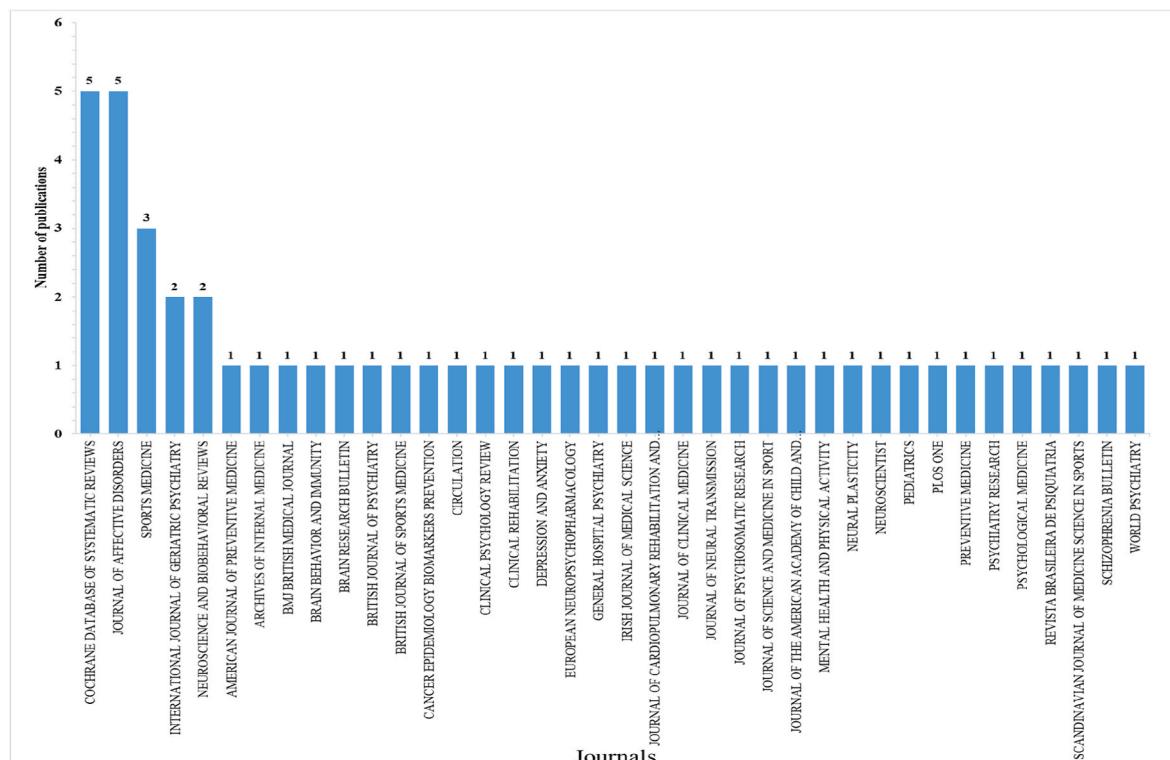


Fig. 6. Number of publications by journals.

were dominant in publishing the top-cited review articles, while research collaboration across different countries/regions was not as strong as expected. Third, some important research topics were identified as future research directions, including the type of PA (e.g., aerobic exercise), study design (e.g., randomized controlled trial), and target population (e.g., adult).

The citation number of the review articles regarding PA and depression was relatively low, compared to those on PA and physical health outcomes or PA guideline reviews. There may be several possible reasons suggesting this. First, research on PA and physical health has a much longer history than that on PA and mental health, resulting in the lower total of citations received by review articles on PA and depression. Second, research on PA and physical health has been extensively studied and has received more attention than that on PA and mental health. This suggests that more research synthesizing evidence on PA and depression is needed, as such an evidence base will be helpful in designing and implementing PA-based treatments for depression. The most-cited review article in our study was “*Effects of physical exercise on anxiety, depression, and sensitivity to stress: A unifying theory*”, with a total of 756 citations. This finding may be because this article was published over 20 years ago, and it explains the mechanism underlying the link between exercise and depression using a theoretical framework, thus existing as a foundation for subsequent publications. Conversely, the publication with the lowest number of citations ( $n = 89$ ) titled “*Exercise improves physical and psychological quality of life in people with depression: A meta-analysis including the evaluation of control group response*” was published in 2016, which might be attributable to the relatively few years since the article was published.

In terms of the country/region analysis, England was the strongest country/region, which published the most review articles ( $n = 20$ ). This finding highlights the position of England in studying PA and depression, which also directs future research collaboration for researchers from other countries with research teams based in England. We also found that Australia was the second highest country to publish top-cited articles. The potential explanation for this is that, in addition to the strong capability of Australian researchers, these researchers have close collaboration with researchers from England (as shown in Fig. 2). Moreover, we found that western countries were predominant in publishing top-cited review articles, while other countries, such as low- and middle-income countries or Asian counties, were very scarce. In this regard, it is suggested that stronger international research collaborations including more countries should be constructed, which is expected to allow the science to move forward.

An analysis of the author collaboration network showed that key authors contributing to the review articles on PA and depression included Brendon Stubbs and Simon Rosenbaum. This may be because Brendon Stubbs and colleagues have specifically focused on the effects of exercise in patients with depression [42,43]. This has been a popular research topic in the field, as focusing on such a population segment is beneficial to reduce PA inequality across different sub-populations. Their research provides, for future researchers, some implications for conducting more meaningful or potentially highly cited research.

We found that most top-cited review articles were published in high-impact journals, such as *Sports Medicine*, *Journal of Affective Disorders*, and *Cochrane Database of Systematic Reviews*. This finding further supports that high-impact journals are more likely to publish high-quality studies, as they impose high requirements on researchers. When further examining the journals, it was found that most journals were of a multi-disciplinary nature, including sport medicine (e.g., *Sports Medicine*), general medicine (e.g., *The British Medicine Journal*, *Circulation*), health psychology (e.g., *Clinical Psychology Review*, *Depression and Anxiety*), and general science (e.g., *PLOS One*). This meaningful finding suggests that the most-cited current literature on PA and depression is likely to encourage multi-disciplinary research. In this regard, future researchers should take a comprehensively integrative approach based on the knowledge in different subjects for research on PA and

depression.

The findings of the keyword co-occurrence analysis suggested common keywords in the most-cited review articles included in this study. The network mapping of keywords clearly exhibited that the research focus in the field of PA and depression included (1) different types of physical activity and their associations, effect, and/or treatment effects on depression; (2) intervention studies using randomized controlled trials to examine the effects of PA on the prevention and treatment of depression; (3) fitness and PA levels in people with depression; (4) methodological analyses of PA and depression studies; and (5) the role of PA in depression in different populations, especially in adults due to the high prevalence of depression in this population. The listed research topics should receive more research attention and interest, in order to further accumulate the evidence and improve the understanding on PA and depression, thus providing a well-constructed foundation for clinical practice.

## 5. Study strengths and limitations

The greatest strength of this study was the analysis of current research focus and trends in the association between physical activity and depression based on the 50 most-cited review articles in this field. However, it should also be noted that there were several limitations to the current analysis. First, the literature search was limited to the Web of Science Core collection, and a more comprehensive literature search will be helpful in better understanding the current research trends in this field. Second, presence of an article in the list of most-cited review articles is affected by the publication year, so the earlier the article is published, the higher the number of citations in general. As the core of the bibliometric analyses is the citation number of publications, the research trends may lag behind the actual situation. It is, therefore, important to consider timeliness and lags when interpreting research trends.

## 6. Conclusion

In this study, we summarised the current research focus and research trends in the field related to the relationship between physical activity and depression by analysing the 50 most-cited research papers. Primarily, this bibliometric analysis found that in the relevant research field, the main contributing authors were from English-speaking countries and aerobic exercise. In particular, we call for a need for future research focused on the areas of physical activity (e.g., aerobic exercise), study design (e.g., randomized controlled trial), and target populations (e.g., adult).

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## Declaration of competing interest

None.

## Acknowledgement

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