# WITHDRAWN: A Systematic Review of the Literature Regarding Physical, Cognitive and Emotional Outcomes in Older Adults Practitioners of Physical Exercise

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## EDITORIAL NOTE:

The full text of this preprint has been withdrawn by the authors while they make corrections to the work. Therefore, the authors do not wish this work to be cited as a reference. Questions should be directed to the corresponding author.

# Abstract

**Background:** This systematic review provides an overview about those papers with a specific physical exercise intervention aimed to improve physical, cognitive and/or emotional outcomes in healthy older people aged 60 or over. Studies with no intervention whose sample were active healthy older adults were also included.

**Methods:** An exhaustive literature search was done through two databases, including studies from January 2000 to July 2020.

**Results:** Of the 2006 identified records, 66 met the inclusion criteria and were selected. Results from the review showed a wide variety of older adults and lengths of the interventions, from five weeks (the shortest one) to five years. Aerobic exercise, either isolated or combined with strength performance, was also the most common type of exercise recognized in this systematic review.

**Conclusions:** Findings also suggest that the number of studies with all, physical, cognitive and emotional outcomes have been increasing during recent years in healthy older adults.


# Background

The number of people aged 65 or over in 2050 will be doubled in comparison to the current one, from 703 million people at the moment to a future figure of 1.5 billion [1]. In fact, life expectancy is also increasing, from 72.6 years in 2019 to a probable figure of 77.1 years in 2050 [2].

According to the American College of Sport Medicine (ACSM) [3], ageing is associated with some physiologic changes that modify physical and mental health among other factors. In addition, becoming older has some effects on individuals, such as an acceleration in the decline of aerobic capacity and strength [4], memory deterioration [5], decline of motivation and increase of negative emotions [6] or an increment on the prevalence of cognitive impairment and dementia [7, 8].

The role of physical activity (PA) is gaining attention in this group of people because of the evidence that shows the positive effects of it on healthy older adults, such as the prevention of some diseases including type 2 diabetes, strokes, hypertension and some types of cancer [9]. Furthermore, there are also beneficial effects of PA on unhealthy elders with dementia [10], depression [11], mild cognitive impairment (MCI) [12, 13], and Alzheimer's [14] or Parkinson's disease [15].

Physiologically, regular physical exercise increases maximal oxygen consumption ($VO_2$max) [16], physical function [17], strength and cardiorespiratory fitness [18]. Because of that, physical performance is improved in healthy elderly practitioners of PA [19].

In order to determine what type of activity and how often it should be done, the ACSM and the American Heart Association (AHA) proposed a guidelines recommendation [20] describing frequency and type of

activities to perform, summarizing them in a minimum of 150 min per week for achieving substantial health benefits and including strength, flexibility and cardiorespiratory capacity exercises.

In relation to some of the components of quality of life (i.e., sensorial functioning, social participation, perceptions of death and dying, or intimacy), there seems to be an improvement in them [21] after getting regular PA. Personal growth and well-being also get better with regular PA [22]. A study with older adults ranging from 65 to 96 years old concluded that a weekly activity, such as PA outside the home, was associated with an improvement in both emotional state and cognitive function [23].

It is necessary to highlight brain health as an important factor related to regular PA [24] due to its effects on cognition, such as an enhancement of executive function and information processing speed [25] or beneficial effect on peripheral blood concentrations of brain-derived neurotrophic factor (BDNF) [13, 42]. Regular PA increases the function of neurotransmitters, such as serotonin, noradrenaline or dopamine; therefore, the motivation, happiness and satisfaction are going to be increased in practitioners [26, 27].

Consequently, there is research focused on the relation between PA and cognitive function, which confirms that PA in healthy older adults enhances existing cognitive function and prevents or delays progression of cognitive diseases, such as Alzheimer's dementia [28], in both older adults with and without cognitive impairment [29]. In fact, combined physical and cognitive interventions have been proven as an effective tool for improving cognition in healthy older adults [30].

Overall, considering how important and useful it is to be updated about different physical exercise interventions in an older adult population, the present systematic review pretends to highlight them, taking the recent literature into consideration.

We have performed a systematic review to summarize those supervised physical exercise interventions aimed to improve physical, emotional and/or cognitive performance in healthy older adults aged 60 or over. Studies without interventions in non-sedentary older adults with an active lifestyle have also been included [31–44].

Broadly, this review is organized following different aspects, including original source of information, sample characteristics, study design, objective, duration and characteristics of the intervention in case it exists, and the main outcomes under investigation.

## Methods

This systematic review has followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [45]. A PRISMA flow diagram (Fig. 1) summarizes the information on the phases of the systematic review process.

# Search Strategies

A systematic search for relevant studies was conducted on two of the most respected databases in the field of social sciences and education, ISI Web of Knowledge and Scopus-Elsevier. From these, we contemplated all peer-reviewed publications from the current century, between January of 2000 and July of 2020. We consider two decades as an appropriate period of time, which includes literature from recent years and allows us to observe the gradual process of change and development in this area. In order to be as accurate as possible, we decided which terms should be taken into account. Consequently, all the publications had to contain at least one of the following terms: ‘older adults’ (older adults, elderly, seniors, elders); ‘cognition’ (cognition, cognitive function, cognitive flexible, memory); ‘physical activity’ (physical activity, physical exercise, exercise); ‘mood’ (mood, state of mood); and ‘emotions’ (depression, sadness, anxiety, happiness, self-esteem, optimism, anger, hostility).

The search included those articles where the terms were found in titles and abstracts.

Apart from that, all the references from the retrieved articles were reviewed looking for possible additional publications related to physical exercise interventions in healthy older adults, as well as those where samples were active older adults.

# Selection Criteria

Studies were included according to the following criteria: (1) complete original study; (2) written in English; (3) involving healthy or active people aged 60 years and over; and (4) related to PA and the physical exercise field.

According to these criteria, healthy people were considered as those who did not suffer any kind of mental (e.g., Alzheimer’s or Parkinson’s disease), emotional (e.g., depression) or physical (e.g., arthritis) diagnosed impairment, while active older adults were those who exercised regularly (e.g., marathon runners) [33, 40].

Studies were excluded if they were (1) not written in English; (2) a review, theoretical or protocol article; (3) book or chapter in a book; (4) related to other areas, such as medicine [46] or genetics [47]; or (5) involving unhealthy older adults 60 years old and over.

Two independent expert reviewers screened the titles and abstracts; secondly, they evaluated full-text articles independently. In case of disagreement, a third reviewer was required to solve it. Those reviewers, who are members of different universities with much experience working with older adults and research in physical exercise in the area of health and sport sciences, followed the considerations previously described.

# Quality Assessment

A total of 25 out of the 66 selected papers in this systematic review were indexed on PEDro, the physiotherapy evidence database (https://www.pedro.org.au/). Their scores are shown in Table 1. From the indexed papers, there were 4 articles with a score lower than four points, whereas the number of

studies with a score equal to or higher than four points was 21. In addition, the criteria from PEDro for 2/10, 8/10, 9/10 and 10/10 were not included in Table 1, because there were not in any study.

There were also 41 selected studies that were not rated by using the criteria from PEDro. The quality of these studies was independently assessed by two reviewers. In case of disagreement, a third reviewer's opinion was taken into account.

## Results

# Study selection

A total of 2006 studies were identified using the databases as described in the Search Strategies section. After the removal of 45 duplicated papers, 1749 papers were also excluded based on titles and abstracts. The remaining 212 articles were screened, and from these, 146 were excluded after a full-text evaluation due to the exclusion criteria previously described, leaving 66 studies that were eligible for this review (Fig. 1). These 66 papers were classified according to different aspects, including original source of information, sample characteristics, study design, objective, duration and characteristics of the intervention in case it exists, and the main outcomes under investigation.

# Frequency of published studies and geographical distribution

As we can see in Fig. 2, the 66 selected articles have been mostly (n = 57; 86%) published during the last 10 years (2011–2020), and from these, 38 (67%) were published 2016–2020, so it seems to be an identified pattern in the number of publications with the course of time. In recent years, 2019 was the most prolific year with 12 papers of the total (18%) contained in this systematic review.

On the other hand, there were 6 years (from 2000 to 2004 and 2008) with no selected publications.

In relation to the geographical distribution of the sample, Brazil (with seven papers (11%)) and the United States (with five papers (8%)) are the countries with the most published articles in this area that have been accepted in our review. On this point, it is necessary to clarify that the geographical distribution of the samples in some studies have not been specified. Specifically, it was not indicated in 16 articles (24%). The remaining papers, including those from Brazil and the United States, have been developed with participants from different countries in Europe (22), where Spain, Greece and Norway are the countries with the most publications, as well as Japan or Thailand in Asia (11), while Brazil and the United States, as previously described, had most of the publications in the Americas (14). From all the included papers, there was an unusual sample of participants from two articles [65, 75] composed of people from different countries and/or continents.

# Participant characteristics

The sample size varied from eight participants [62] to 1193 [34] participants. The ages of the participants ranged from 60, which was the minimum accepted in this paper, to 99 years old [79].

In terms of gender, most of the papers (73%) had mixed samples, although there was a minority with men exclusively (6%) and a bigger percentage of studies (21%) comprised mainly of women. Three papers included in this systematic review [36, 66, 95] did not distinguish between men or women in their samples.

According to a PA profile, we found more articles (32%) with a sample composed of sedentary older adults in comparison with those with an active sample (24%). Those active practitioners took part in different studies doing regular activities, such as yoga [32], athletics [33] and dancing [43].

However, there were also studies (41%) that did not specify the PA profile of their samples, as well as those whose samples were comprised of both active and sedentary people [42, 44].

In those papers in which there was no physical exercise intervention, we only included the physically active sample.

# Type of intervention

One of the peculiarities of this systematic review is the inclusion of those papers in which there was no physical exercise intervention, but the articles were related to physical exercise in older adult practitioners. In this way, there were 14 studies (21%) out of the 66 included where there was not a physical exercise intervention. The rest of studies included physical exercise interventions with differences in the length of those, from five weeks (the shortest one) [61] to five years [65]. In relation to the weekly frequency of physical exercise sessions, most of the interventions had two (29%) or three (52%) sessions per week in comparison to those with four [71] or five [69] weekly sessions. Moreover, we found papers where the number of weekly sessions varied depending on the intervention group [63, 77, 79].

According to the type of physical exercise during the intervention, aerobic training was the most common one whether isolated (44%) or combined with strength training (17%). The combination of different types of activities, such as cognitive and physical training [58]; outdoor leisure activities and callisthenic exercises [64]; or aerobic, strength and balance exercises [88] was also interesting. These types of exercise combinations have been defined in Table 2 of this study as concurrent interventions.

# Research Methodology

In terms of methodology, almost all studies (97%) followed a quantitative methodology, whereas only two [72, 75] used a mixed model. Therefore, none of the articles included in this systematic review followed a qualitative methodology.

However, there was less of a difference between the design of studies. Half of the number of articles (n = 33; 50%) had a quasi-experimental study design in contrast to the other half with a randomized controlled trial study design.

# Main Outcomes Investigated

This systematic review is focused on summarizing different types of studies where the main outcomes investigated are related to physical, cognitive and/or emotional performance. According to this, physical performance included some outcomes such as muscle strength [86], heart rate variability [36], stability [57], $VO_2$peak [81], functional balance [95] or gait speed [87]. The studies on executive function [37], attention [41], memory [48], processing speed [93] or concentration [85] made allusion to cognitive performance, while studies of depression [49], anxiety [71], stress [52], health-related quality of life [80], mood [84] or happiness [96] were related to emotional performance. Those outcomes investigated from studies included in this systematic review that were not related to physical, cognitive and/or emotional performance were not included in Table 2.

# Discussion

This systematic review aimed to summarize those studies of healthy older adults aged 60 and over with or without a physical exercise intervention programme where the main outcomes investigated have been related to physical, cognitive and/or emotional performance. We found 66 suitable studies fitting the pre-established inclusion criteria.

These outcomes were, mainly, related to physical performance [53, 55], although emotional and cognitive outcomes were also studied, isolated [54, 78] or combined [66] with the physical ones. This combination of physical, cognitive and emotional outcomes was observed in 14 (21**%**) out of the 66 chosen studies, where six of those 14 papers were published in 2019 [33, 50, 59, 71, 83, 87]. According to this, it is conceivable that there is a current tendency of studying these combinations of physical, cognitive and emotional outcomes together with older adults. It is also interesting how technology is used for improving those outcomes through exergames [51, 74].

Hogan et al. (2013) [100] suggested important benefits in older adults for both affective and cognitive performance after a single bout of moderate exercise, whereas Tarazona-Santabalbina et al. (2016) [101] published the physical, cognitive, emotional and social effects of a multicomponent exercise intervention in frail older adults. In reference to reviews and meta-analysis publications, there is considerable published research focused on the effects of physical exercise on cognition in healthy (Carvalho et al., 2014 [28]; Gomes-Osman et al., 2018 [29]; Zhu et al., 2016 [30]; Kelly et al., 2014 [102]) and unhealthy (Karssemeijer et al., 2017 [13]; Öhman et al., 2014 [103]) older adults.

Investigating cognitive or emotional outcomes, apart from physical outcomes, during physical exercise interventions may contribute to establish more connections between body, brain and emotions to the benefit of science and particularly to older adults. According to the 52 accepted papers in this systematic review in which there was a physical exercise intervention, in 24 of them (46%), the number of physical exercise min per week was 150 or more. If we compare these results and current guidelines of physical exercise for older adults [3, 20, 24], we could suggest that a considerable number of selected papers did

not contribute to the minimum of weekly min, which these guidelines established to achieve benefits in physical health: 150 min of moderate intensity exercise or 75 min of vigorous exercise. According to this, an intervention that does not follow these recommendations could not be successful for practitioners. Thus, this result may insinuate that, in the future, physical exercise interventions should follow current recommendations for weekly min in order to obtain greater benefits to health. In the overall analysis, the results found in this systematic review may prove that physical exercise interventions in healthy older adults have been increasing during recent years. An update on these interventions could provide useful information, such as the length, type of exercise or the effects produced by itself, to those professionals who are in daily contact with older adults.

We considered it appropriate to focus this systematic review in healthy older adults in order to establish differences with the unhealthy older adults. However, there are also published reviews [104, 105], which include both healthy and unhealthy older adults in the same paper. In that case, data or results from those papers should be carefully observed, taking into account possible differences and conclusions to come to.

The sample of studies included in this systematic review was located in two databases, ISI Web of Knowledge and Scopus-Elsevier. We acknowledge that by limiting the search to a couple of databases, we could not capture all possible information. It would be interesting to expand the search to other databases with the purpose of giving access to more information to interested populations. Moreover, of all the included papers, none followed a qualitative methodology, which could also contribute to providing more information in this area. In relation to the quality of the included studies, a remarkable number of them were not indexed on PEDro's criteria. This result suggests some methodologic limitations.

# Conclusions

The results of the present paper suggest there were a remarkable number of studies about this topic, which has been increasing during recent years. This increment shows how current and important it is to investigate the way physical exercise is being practiced in healthy older adults and the connection it has with cognition and emotions. These studies show a large methodological heterogeneity in intervention characteristics (e.g., number of participants, length of the intervention or type of exercise). The current systematic review illustrates how physical, cognitive and emotional outcomes could be, or not be, simultaneously investigated following a specific physical exercise intervention or under no intervention but being focused on active older adults who regularly exercise. However, the results of these investigations are not included in this paper. Future research should also focus on results in order to provide useful information about the effects of these kinds of studies.

# Abbreviations

ACSM: American College of Sport Medicine; PA: Physical activity; MCI: Mild Cognitive Impairment; $VO_2$max: Maximal oxygen consumption; AHA: American Heart Association; BDNF: Brain-derived

neurotrophic factor; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; MPO: Myeloperoxidase; TEE: Total energy expenditure; AEE: Activity-related energy expenditure; IL-6: Serum interleukin-6; DMT: Dance movement training.

# Declarations

### Ethics approval and consent to participate

Not applicable

### Consent for publication

Not applicable

### Availability of data and materials

The datasets analysed during the current study are available in the ISI-Web of Knowledge (https://www.webofknowledge.com) and Scopus-Elsevier (https://www.scopus.com/home.uri) repositories.

### Competing interests

The authors declare that they have no competing interests

### Funding

Not applicable

### Author's contribution

MAA-M, PJR-M, EVAR and ACA were involved in the conception and design of the systematic review. MAA-M generated and conducted the search. EVAR and PJR-M were involved in the data collection, extraction and synthesis. ACA revised the manuscript critically for important intellectual content. All authors contributed to the writing of the paper, read and approved the final manuscript.

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Not applicable

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# Figures

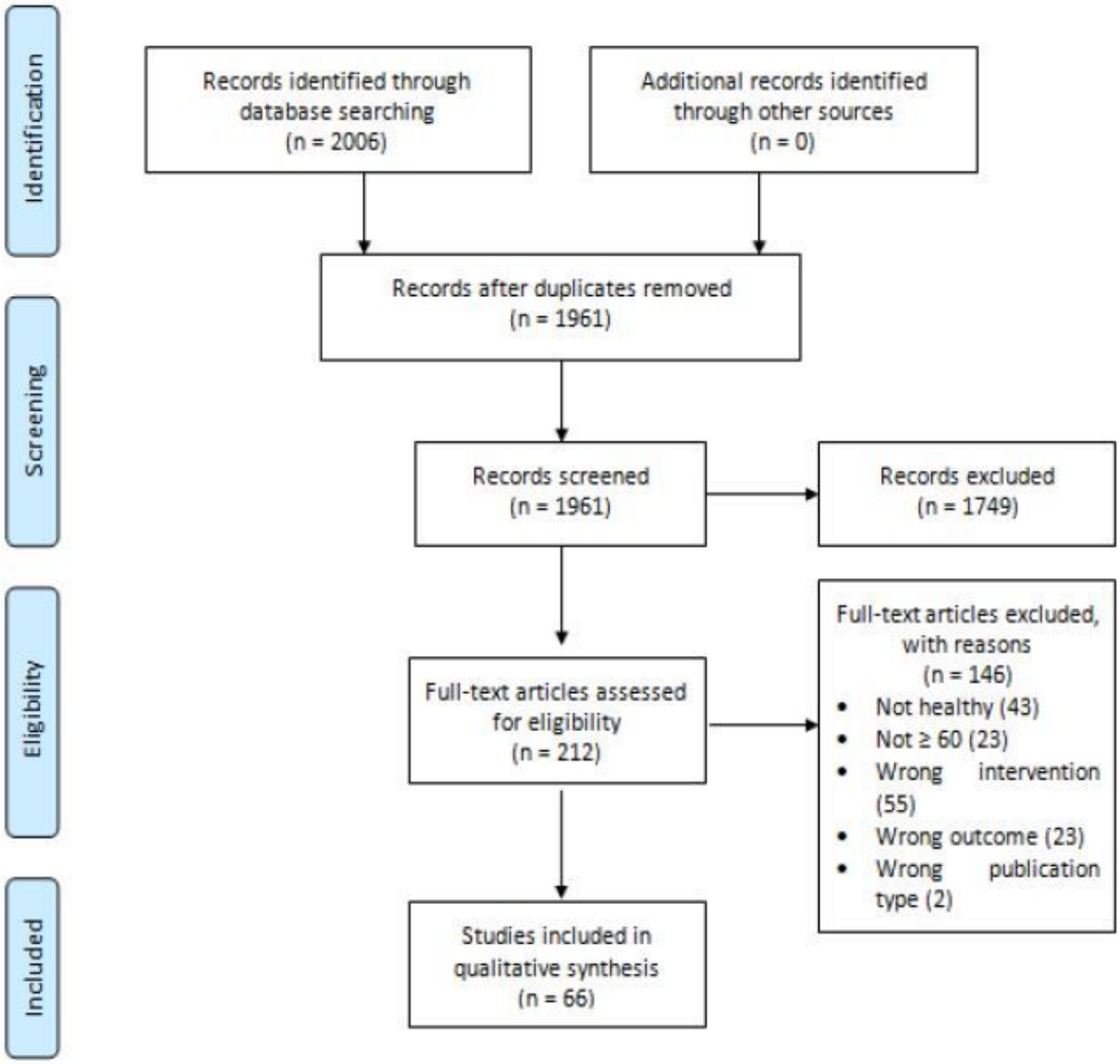


**Fig. 1**

**Figure 1**

Flowchart of the study selection process using the PRISMA framework

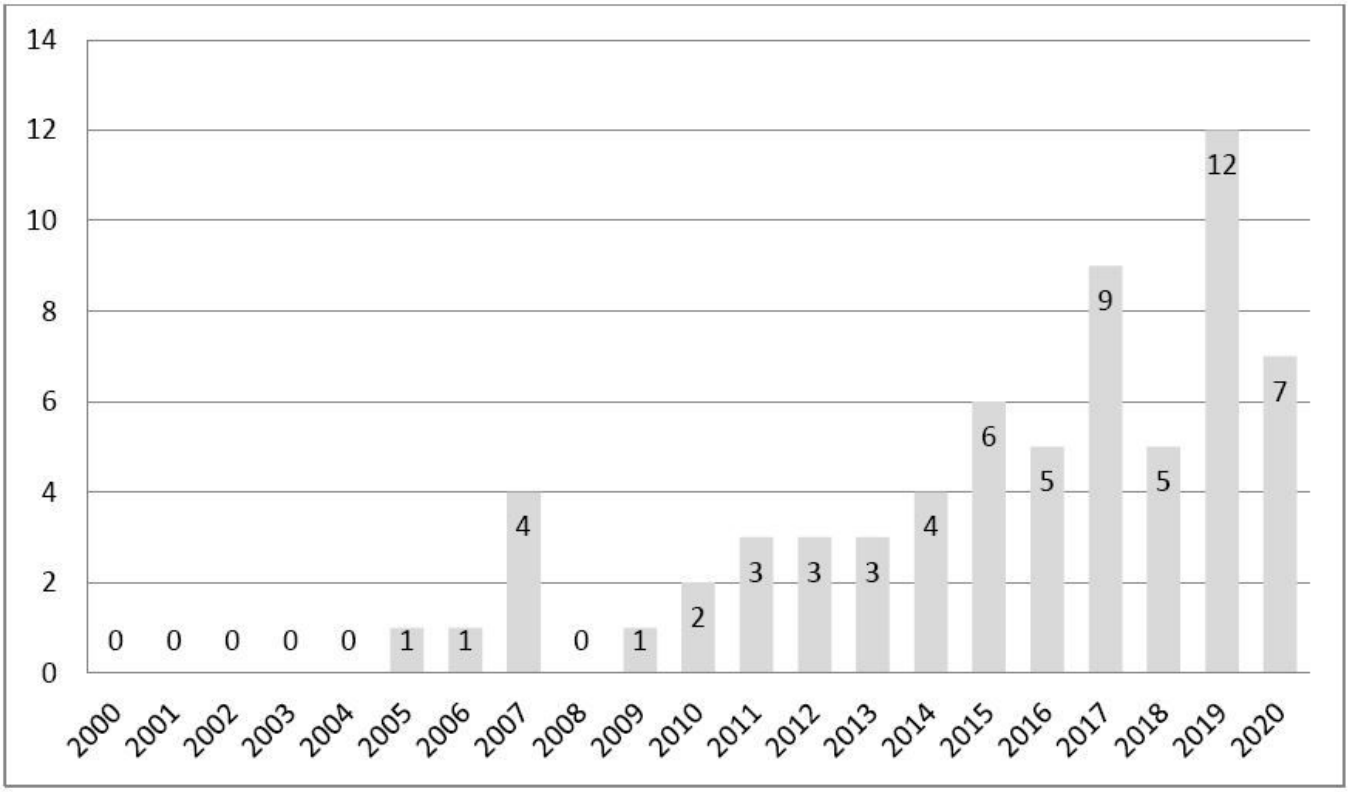


**Fig. 2**

**Figure 2**

Number of articles by year of publication

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