

# Bibliometrics of Scientific Productivity on Physical Activity in Children and Adolescents With Autism Spectrum Disorder and Down Syndrome

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## Abstract

The aim of this study was to compare bibliometric indicators of scientific productivity in physical activity (PA) in children and adolescents with Autism spectrum disorder (ASD) and Down syndrome (DS) in the PubMed database. A bibliometric study was conducted for the last 5 years (2017 to 2021). The data collected for each article were: year of publication, language of publication, country, journal name, and type of paper. The results showed that there was higher scientific productivity in the population with DS (20 studies) relative to their counterparts with ASD (31 studies). The language of publication in both cases was English. There were 10 countries that published on PA in ASD and 14 countries that published on DS. Overall, the greatest interest in publishing on PA in children and adolescents with ASD was in North America (6 studies), followed by Asia (5 studies) and Europe (4 studies). In the DS population it was in Europe (13 studies), North America (9 studies) and South America (4 studies). Nineteen journals were identified that published in the ASD population and 29 journals in DS. Six experimental studies were identified in ASD and 7 in DS. There was a higher scientific productivity with original studies. There was a positive trend of increasing scientific productivity over the years in both populations. We suggest the need to promote research on PA in both populations, regardless of the type of study, as it is an indicator of overall health status.

## Keywords:

Physical Activity, Bibliometrics, ASD, Down Syndrome, Children and Adolescents.

## Introduction

Physical activity (PA) is defined as any bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2020). It is characterized as featuring a range of human movements, from competitive sports and exercise to hobbies or activities related to daily life (Miles, 2007), and even considers modality, frequency, intensity, duration, and context of practice (Caspersen et al, 1985), as its guidelines. Overall, participation in PA plays a crucial role in promoting and maintaining a healthy lifestyle at all ages (Liang et al, 2020).



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Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by deficits in social communication and the presence of restricted interests and repetitive behaviors (APA, 2013). On the other hand, DS is a genetic disorder that occurs due to abnormal division between cells resulting in a complete or partial extra copy of chromosome 21 (Cabeza-Ruiz et al. 2019). This condition causes various physiological, functional and intellectual limitations (Winnick, 2011).

Indeed, the benefits of PA for children and adolescents with ASD and DS are well documented in the literature. For example, in children with ASD, PA is associated with improved academic performance, enhanced communication skills, cooperation, self-control, and improved quality of life (Oriol et al. 2011; Chan et al. 2013; Zhao & Chen, 2018; Toscano et al. 2018). In the case of youth with DS, it improves self-efficacy, motivation, mood, satisfaction, quality of life, (Wilson et al. 2012; Lee & Kim, 2014), increases cardiovascular and muscular endurance, reduces the percentage of total body fat mass (Mendonca et al. 2011) and improves functional fitness for work performance (Terblanche & Boer, 2013).

Therefore, studying the scientific productivity of PA in children and adolescents with ASD and DS should be considered a priority, as it helps prevent obesity, helps maintain physical fitness (Alghamdi et al. 2021), reduces the risk of secondary health problems, and improves quality of life (Brown et al. 2014).

Consequently, to our knowledge, no bibliometric study has compared scientific productivity on PA in children and adolescents with ASD and DS, as this information can help in the development of public policies to boost research in school populations with disabilities and special educational needs.

In fact, bibliometric studies have achieved great importance in scientific and management policy, given the rise of the culture of evaluation and accountability, to the extent that scientific knowledge is seen as a strategic value (Bordons & Zulueta, 1999), so, in recent years it is becoming an important research method to evaluate national and international research productivity, international cooperation, citation analysis, research trends and the development of specific fields (Hu et al. 2020).

Therefore, the aim of this study was to compare bibliometric indicators of scientific productivity in physical activity in children and adolescents with ASD and DS.

## Methodology

### *Type of study*

A documentary (bibliometric) study of scientific productivity on PA in children and adolescents with ASD and DS was conducted. Bibliometric mapping is used to visualize trends in various research and create a descriptive visual environment of terms commonly included in studies on a specific topic or population (van Eck & Waltman, 2010).

The published articles were retrieved from PubMed of the U.S. National Library of Medicine (<https://pubmed.ncbi.nlm.nih.gov/>), which is a database of biomedical and biomedical and life sciences literature containing more than 33 million records (National Library of Medicine, 2022). It was queried from January 15 to January 20, 2022.

### *Search strategy*

The search strategy covered the period from January 1 to December 31, 2021. To achieve relevance with this bibliometric review, search keywords included the following components: (1) physical activity, exercise, exercises, activities, physical, physical exercises, aerobic exercise, exercise training; (2) Down syndrome, chromosomal disorder, trisomy 21, mental retardation; (3) Autism spectrum disorder, dysfunction, autism; (4) Children, adolescents, schoolchildren, youth. Physical inactivity was included as a reverse term for BP.

Initially, keywords and the Boolean operators "OR" and "AND" were used. Subsequently, words were grouped to combine them in pairs or threes, as appropriate, and a new search was performed, for example, physical activity AND down syndrome AND children.

### *Data management and extraction.*

The following were considered as indicators of scientific productivity: language and year of publication, country, continent of publication, name of the journal and type of document published. The technique used for the extraction of indicators was observation.

The terms indicated were reviewed in the title, abstract and keywords of the manuscripts. The inclusion criteria were (i) peer-reviewed articles related to health sciences areas; (ii) articles on PA; (iii) articles in population with DS and ASD; (iv) articles that provided all the required bibliometric indicators listed in the period from 2017 to 2021; and (v) published in English and Spanish, (vi) original research articles and documentary studies (literature reviews, systematic, with or without meta-analysis).

Articles whose topic was not related to physical activity and health, published outside the period from 2017 to 2021, that did not include children and adolescents, and if they involved research on animals or in vitro samples were excluded from the analysis.

The procedure for extracting the bibliometric indicators was carried out by two researchers in this study (PPF and RGC). Each of the observers recorded the information separately on a card. A third observer (MACB) collated the records of the first two observers. This ensures the process of abstraction of the information. In cases where there was no coincidence, this third observer verified each of the indicators and made the pertinent corrections. A general matrix of the studies was then obtained, which made it possible to analyze the bibliometric indicators considered.

The PRISMA guidelines (Moher, Liberati, Tetzla, & Altman, 2009) were used to identify and extract the data for the bibliometric review. Figure 1 illustrates the steps performed.

The search was performed both for articles related to PA and ASD and for PA and DS. In the case of PA and

ASD articles, a total of 78 scientific articles were initially identified, then 39 studies were eliminated because they were not related to the study topic. Next, the titles and abstracts were read and thoroughly evaluated to be certain that they corresponded to the purpose of the research (eliminating 19 articles). Finally, 20 studies were considered for bibliometric analysis. In the case of PA and SD articles, a total of 89 articles were initially identified, of which 36 were eliminated because they were not related to the topic. Subsequently, after reading the titles and abstracts, 22 were eliminated, leaving 31 studies considered for bibliometric analysis.

### Data analysis

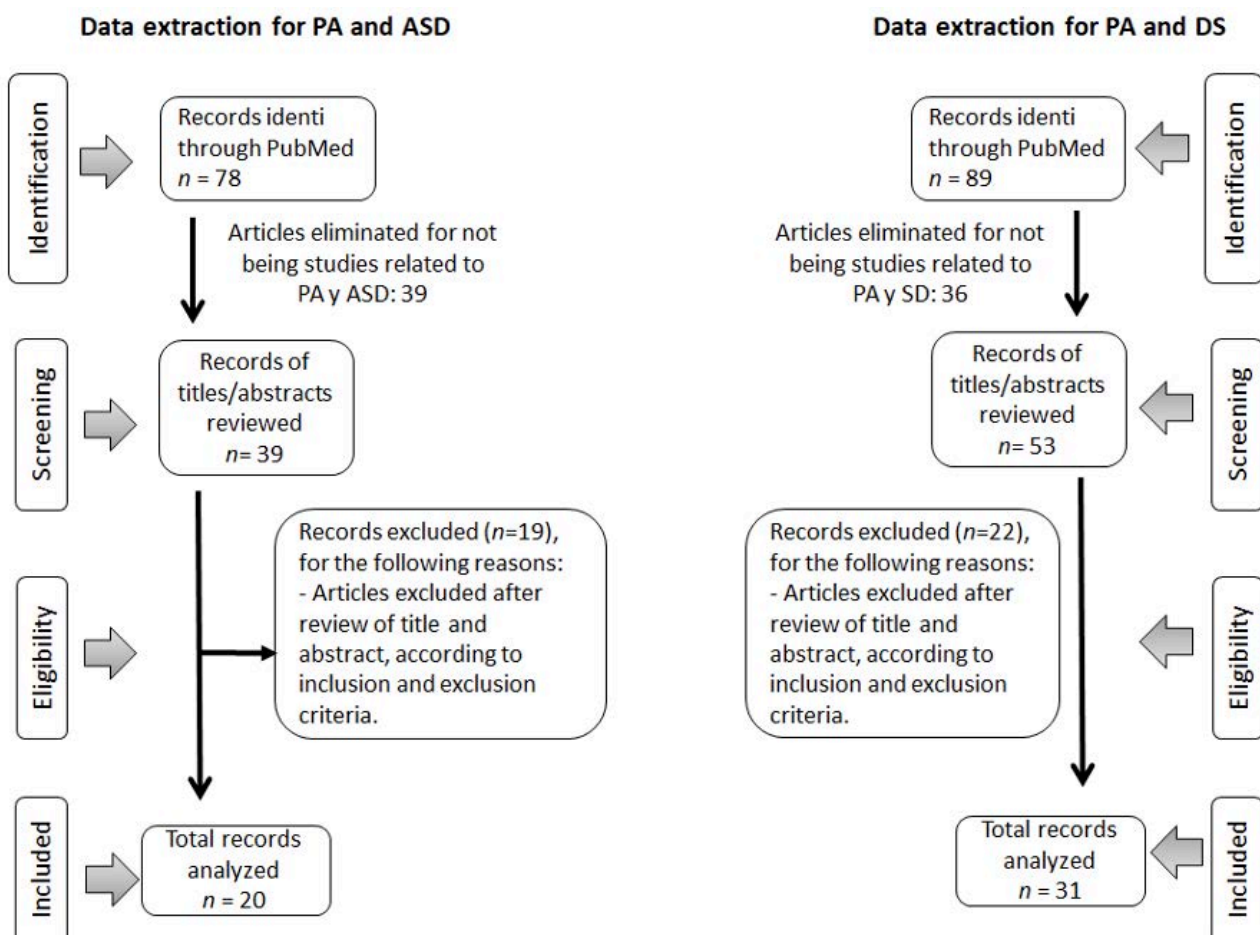
The data extracted from the bibliometric matrix were recorded as spreadsheets in Microsoft Excel (Office 365 suite; Microsoft, Redmond, WA, USA). They were subsequently quantified through descriptive statistical analyses, such as frequency, range and percentage (%).

### Results

The bibliometric indicators that characterize the scientific productivity of the studies conducted in PA

**Figure 1.**

Screening and selection process for the records according to the PRISMA (Preferred Reporting Items for Reviews and Meta-Analyses) flowchart.



in children and adolescents with ASD and DS can be seen in Table 1. In summary, it is highlighted that, in the last 5 years, there was greater scientific productivity in the population with DS (20 studies) in relation to their ASD counterparts (31 studies). It also stands out that the language of publication in both cases was English (19 studies in ASD and 30 in DS). In addition, we can observe that a total of 10 countries published PA topics in ASD (USA, China, Argentina, Brazil, Italy, Belgium, Australia, Iran, Spain and the United Kingdom). However, 14 countries were identified as having published in SD (USA, China, Brazil, Italy, Australia, Spain, Germany, Canada, Egypt, Poland, Portugal, South Africa and Switzerland). Overall, the greatest interest in publishing on BP in ASD children and adolescents was in North America (6 studies), followed by Asia (5 studies) and Europe (4 studies). On the other hand, in the DS population it was in Europe (13 studies), North America (9 studies) and South America (4 studies).

In relation to the number of journals that published topics on BP in children and adolescents with ASD and DS, we were able to identify 42 scientific journals in total. For example, in the ASD population, 19 journals published a total of 20 articles, while in the population with DS, 29 journals published 31 scientific articles. We can also highlight the presence of six journals (International journal of environmental research and public health, Disability and health journal, Disability and rehabilitation, Journal of bodywork and movement therapy, Medicina, and Physical & occupational therapy in pediatrics), which are the ones that published in both ASD and DS populations. In general, it is evident that there is a greater number of PA publications in the DS population and consequently a greater number of journals that promote such content in relation to the ASD population.

Table 3 shows the results related to the types of studies (original and documentary). Six experimental studies were identified in ASD and seven in DS. However, no cross-sectional and longitudinal studies were found in both populations. Regarding documentary studies (e.g., literature reviews, systematic reviews, meta-analyses, systematic review-meta-analyses), in both ASD and DS there was greater scientific productivity in relation to original studies. In fact, we identified 14 studies in ASD and 24 in DS, so that in both populations systematic review studies have been prioritized (6 in ASD and 16 in DS).

Figure 2 shows the trend of scientific productivity in PA in children and adolescents with ASD and with DS in the last 5 years (2017 to 2021). In both populations, a positive trend of increasing scientific productivity is evident (in ASD an  $R^2 = 0.95$  and in DS  $R^2 = 0.92$ ). In young people with DS, a trend of decreasing productivity is observed from 2017 to 2019, but then, in 2020 and 2021, it reaches the productivity of 2017, reflecting a

recovery of scientific productivity. On the other hand, in the ASD population, a similar trend is observed in the first two years (2017 and 2018). However, after 2019 to 2021, there is a greater increase in scientific productivity in relation to the ASD, whose trend is to continue to increase in the coming years.

**Table 1.**  
*Bibliometric indicators used in the study.*

Indicators	PA ASD		PA DS	
	f	%	f	%
Language of publication				
English	19	95	30	96.88
Spanish	1	5	1	3.12
Total	20	100	31	100
Country				
USA	6	30	7	22.6
China	3	15	1	3.2
Argentina	1	5	0	0
Brazil	2	10	4	12.9
Italy	1	5	1	3.2
Belgium	1	5	0	0
Australia	2	10	2	6.5
Iran	2	10	0	0
Spain	1	5	6	19.4
United Kingdom	1	5	0	0
Germany	0	0	1	3.2
Canada	0	0	1	3.2
Egypt	0	0	1	3.2
Poland	0	0	2	6.5
Portugal	0	0	2	6.5
South Africa	0	0	1	3.2
Switzerland	0	0	2	6.5
Total	20	100	31	100
Continent				
Asia	5	25	1	3.2
Europe	4	20	13	41.9
South America	3	15	4	12.9
North America	6	30	9	29
Africa	0	0	2	6.5
Oceania	2	10	2	6.5
Total	20	100	31	100

Legend: f: frequency, %: percentage

**Table 2.**

Number of journals that published scientific articles on physical activity in ASD and Down syndrome children and adolescents.

N°	Journals	PA ASD		PA DS	
		f	%	f	%
1	BMJ open	1	5		
2	Brain sciences	1	5		
3	Disability and health journal		0	1	3.2
4	International journal of environmental research and public health	1	5	2	6.5
5	International journal of medical sciences.		0	1	3.2
6	The Cochrane database of systematic reviews.		0	1	3.2
7	Advances in therapy		0	1	3.2
8	African journal of disability		0	1	3.2
9	Aging cell		0	1	3.2
10	American journal of human biology		0	1	3.2
11	American journal of lifestyle medicine		0	1	3.2
12	BMC cardiovascular disorders		0	1	3.2
13	Clinical practice and epidemiology in mental health	1	5		0
14	Computer methods and programs in biomedicine		0	1	3.2
15	Cureus	1	5		0
16	Current osteoporosis reports		0	1	3.2
17	Developmental medicine and child neurology		0	1	3.2
18	Disability and health journal	1	5	1	3.2
19	Disability and rehabilitation	1	5	2	6.5
20	Disease markers		0	1	3.2
21	Frontiers in pediatrics	1	5		0
22	Gait & posture		0	1	3.2
23	International journal of environmental research and public health		0	1	3.2
24	Journal of autism and developmental disorders	2	10		0
25	Journal of bodywork and movement therapi	1	5	1	3.2
26	Journal of intellectual disability research		0	1	3.2
27	Journal of orthopaedic surgery and research		0	1	3.2
28	Journal of prevention & intervention in the community	1	5		0
29	Journal of science and medicine in sport		0	1	3.2
30	Medicina	1	5	1	3.2
31	Medicina clinica		0	1	3.2
32	Nutritional neuroscience	1	5		0
33	Osteoporosis international		0	1	3.2
34	Pediatric physical therapy		0	1	3.2
35	Physical & occupational therapy in pediatrics.	1	5	1	3.2
36	Physical therapy		0	1	3.2
37	Plos one	1	5		0
38	Preventive medicine reports	1	5		0
39	Research in developmental disabilities.		0	1	3.2
40	Revista de salud pública (Bogotá)	1	5		0
41	Sleep medicine	1	5		0
42	Sports medicine (Nueva Zelanda)	1	5		0
Total		20	100	31	100

Legend: f: frequency, %: percentage, PA: Physical activity

**Table 3.**

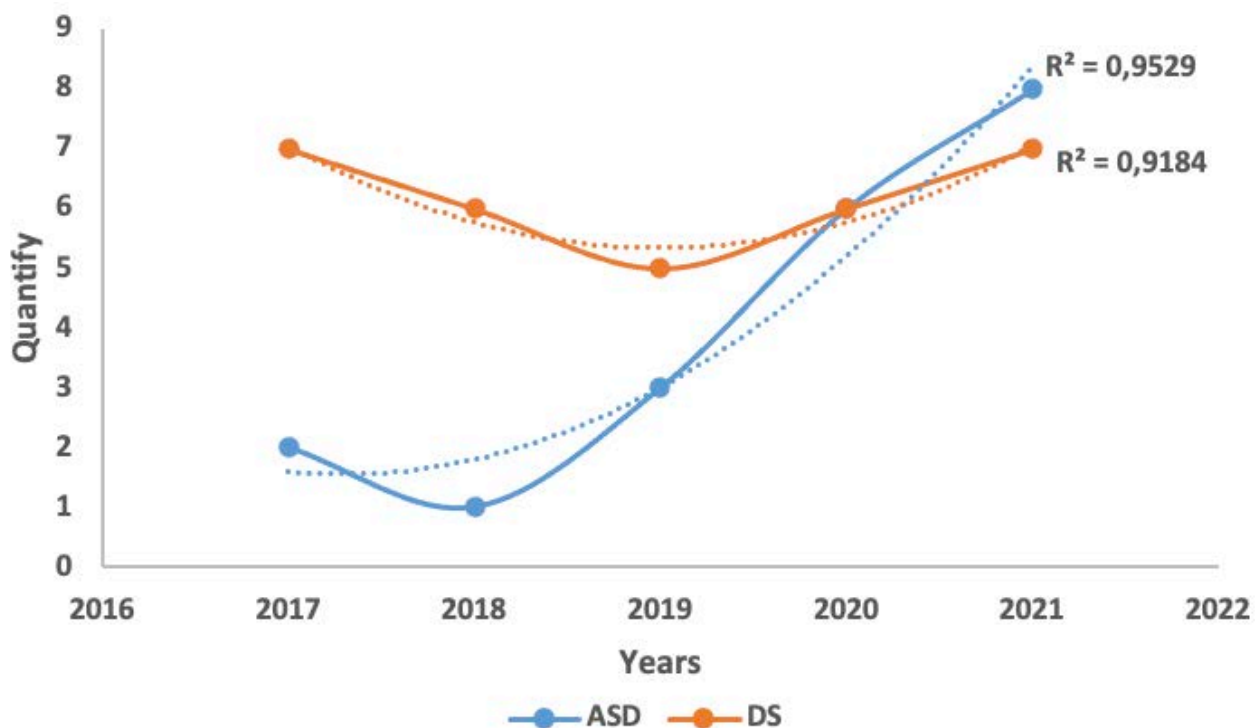
Types of studies that have published topics on physical activity in ASD and Down syndrome children and adolescents.

Type of document	PA ASD		PA DS	
	F	%	f	%
Original articles				
a) Cross-sectional	0	0	0	0
b) Longitudinal	0	0	0	0
c) Experimental	6	100	7	100
Total	6	100	7	100
Review Articles				
a) Review	3	21.4	7	29.2
b) Systematic review	6	42.9	16	66.7
c) Meta-analysis	1	7.1	1	4.2
d) Systematic review and meta-analysis	4	28.6	0	0
Total	14	100	24	100
Total	20	100	31	100

Legend: f: frequency, %: percentage, PA: Physical activity

**Figure 2.**

Trend values of bibliometric studies on PA from 2017 to 2022 in ASD and Down syndrome.





## Discussion

This study aimed to compare bibliometric indicators of scientific productivity in PA in children and adolescents with ASD and DS. These results indicate that during the period 2017 to 2021 there was higher research productivity related to PA in children and adolescents with DS, evidencing a total of 31 studies in relation to their similar with ASD that had a total of 20 studies.

Perhaps one of the reasons for the low productivity in PA in children and adolescents with ASD could be related to deficiencies in social communication, as this could significantly limit direct participation in physical activities and "group" sports and forming relationships with peers (Srinivasan et al. 2014), which consequently, prevents participation in PA programs organized by institutions whose main objective is to study PA patterns in children and adolescents with ASD. However, in the case of youth with DS, adaptive behaviors have evidenced greater capacity for socialization than their peers with ASD (Loveland & Kelley, 1991), which would explain a greater participation in recreational, physical and social activities (MacDonald et al. 2016).

We also verified the presence of five specialized journals (International journal of environmental research and public health, Disability and health journal, Disability and rehabilitation, Journal of bodywork and movement therapy, Medicina, and Physical & occupational therapy in pediatrics), which are the ones that published PA topics in both populations (ASD and DS). For one of the functions of scientific journals in health sciences is to share data and materials generally accepted in the scientific community and is fundamental for scientific development and progress (US, 2003).

In fact, these identified journals can serve not only professionals working in the area, but also students and researchers who deepen research in PA topics, since the use of the bibliometric technique is an important, feasible and systematic means to make judgments about the importance of published works, to examine the productivity and influence of individuals and institutions and to compare different disciplines and scientific journals (Haddad, 2017).

Regarding the types of study, we also verified that the largest number of articles published in both populations were systematic reviews in relation to original studies. This finding is striking, as it seems that researchers' preferences are to publish documentary articles in relation to original studies. Although, both types have their advantages, for example, original outcome-based publications are important for the advancement of science and for professional development (Huston & Choi, 2017). However, documentary studies contribute specifically in articulating clear goals, showing evidence of adequate preparation, selecting

appropriate methods, communicating relevant results, and engaging in reflective critique (Hofmeyer et al. 2007), thus, reviews are relevant for grounding theory and even, for organizing the theoretical basis and conceptual framework, which can help to interpret the types of original studies and their results (Bordage, 2009).

Consequently, regardless of the types of articles published in PA in populations with ASD and DS, it is vital to recognize that both types of publications contribute to the development of scientific knowledge, since we currently live in the era of scientific knowledge production, which is increasingly recognized as a social collaborative activity (Hofmeyer et al. 2007), which should be taken advantage of by health professionals and researchers.

In relation to the trend of publications during the period 2017 to 2021, the results show that scientific productivity in both populations decreases in the first years. Then from 2018 in young people with ASD and from 2019 in young people with DS the research ostensibly increases its productivity until 2021. This pattern, showed a polynomial relationship, reflecting a greater tendency to scientific productivity in PA in the population with ASD with respect to their similar with DS.

These increases in publications in the last 5 years, it is possible that it is due to the establishment of goals in the 2030 agenda for sustainable development (United Nations, 2015), which establishes specific goals for reducing inequalities, promoting the inclusion of persons with disabilities, ensuring equal opportunities and reducing inequality of outcomes. As well as achieving safe, non-violent, inclusive and effective learning for all students with disabilities.

In fact, one of the ways to achieve these goals is through PA, which, helps to decrease negative behaviors and on the contrary promotes positive behaviors in youth with disabilities (Prupas & Reid, 2001). For example, both in ASD, and DS improve motor skills, cognitive skills, general physical fitness, quality of life (Mendonca et al. 2011; Li et al. 2013; Zeng et al. 2017; Sefen et al, 2020) among other aspects.

In essence, this bibliometric study presents some strengths, given that it is a first study comparing bibliometric indicators that have been produced in PA in children and adolescents with ASD and DS. In addition, the information documented in this study can be used to create thesauri (taxonomies) to judge interdisciplinary impact and improve automated searches (Cooper, 2015). So too, they can help identify the most researched journals and types of studies over time. This evidence may be essential for raising awareness and developing public policy priorities in the field of disability and special educational

needs. We should also highlight some limitations, for example, we used only one database (PubMed), and we compared a 5-year period. It is possible that future studies will expand the range of search years and use other databases to complement this study.

### Conclusions

In conclusion, this study verified that the bibliometric indicators of scientific productivity (2017 to 2021) in PA in the school population with DS was higher relative to the population with ASD. In addition, we were able to identify that most journals have published documentary research (systematic reviews) regarding original studies, and the trend of scientific productivity in PA in both populations is increasing in both cases, reflecting a greater tendency to increase scientific productivity in the population with ASD compared to DS. These results suggest the need to promote PA research in both populations.

### Disclosure Statement

The authors reported no potential conflict of interest.

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