

ANALYSIS OF SCIENTIFIC PRODUCTION IN STREET SPORTS WITH ACROBATIC COMPONENTS

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Abstract

In recent years, the number of practitioners of disciplines such as parkour, break dance or calisthenics (freestyle or street workout) has increased. These disciplines share common characteristics, such as an unregulated street origin and a focus on acrobatics. This study aimed to analyze the state of scientific publications related to these acrobatic street sports. A bibliometric analysis was conducted, applying traditional bibliometric laws to scientific documentation found in journals indexed in WoS and Scopus. Data processing and visualization were performed using Bibliometrix and Excel. A total of 199 articles published between 1984 and 2024 were identified, indicating exponential growth. Among these, 139 papers were related to parkour, 48 to breakdance, and 12 to street workout. A review of 158 journals revealed that they contained related publications, although their distribution did not conform to Bradford's model, showing only two areas. Among 417 authors identified, 22 were deemed prolific and 12 prominent. France emerged as the most prolific country, followed by the USA. The 553 author keywords were categorized into three groups, each associated with one of the sports. The 26 most cited papers were selected as relevant, demonstrating a correlation between the increase in publications and the popularization of these sports, largely due to television exposure. The "International Journal of Sport Policy and Politics" emerged as the most prolific journal. The most relevant authors identified in each sport were Signey Grosprêtre (parkour); Max Daniel Kauther and Christian Wedemeyer (breakdance); and Javier Sanchez-Martinez (street workout).

Keywords: *Acrobatics; sports; physical activity; parkour; break dance; street workout.*

INTRODUCTION

Any acrobatic movement involves inversions and rotations of the body in space. The quintessential basic skill involves a 360-degree compound turn around the transverse

axis while maintaining continuous contact with the apparatus or surface. The term "rolls" refers to this group of very basic acrobatic skills practiced in certain sports

disciplines. By extension, it is also used to describe a set of motor activities of indeterminate acrobatic character practiced in different contexts, which serve as the foundation for learning more advanced elements (Cartoni & Putzu, 1990).

In recent years, there has been a trend towards the practice of sports as a recreational opportunity of an urban nature, developed outdoors (Salazar, 2020). These activities are far from institutionalized, regulated, and organized "sports" (Salazar, 2020). Instead, they are more alternative cultural manifestations of a motor nature, rather than exercises or movements aimed at comparison or competition (Salazar, 2020). Promoted by concerns or expressive and alternative currents, break dance, parkour, and calisthenics are names that identify a series of motor practices of eminently urban origin and development, which are very current and constantly gaining followers (Mollenhauer, 2021; Pagnon, Faity, Maldonado, Daout, & Grospretre, 2022; Yang, Bai, & Wei, 2022).

The different definitions and conceptualizations of the term "acrobatics" fluctuate between art, motor skills, sport, and even ritual. The dictionary of the Royal Academy of the Spanish Language (Real Academia Española, 2022) refers to it with three meanings that are not very clear:

1. f. Profession or activity of the acrobat. U. t. in sent. fig.,
2. f. Each of the exercises performed by an acrobat. U. t. in sent. fig.,
3. f. Each of the spectacular evolutions performed by an aviator in the air.

In deeper definitions more specific to the sports field, acrobatic activities refer to movements of the body or in conjunction with some device, involving rotations, inversions, jumps, and aerial trajectories, always endowed with a certain degree of

spectacularity and/or risk (Pozzo & Studeny, 1987). Definitions also link these activities to the displacement and trajectories of the performer, referring to "control of the body" and "control of the body in space" (Rico & Brasileiro, 2002).

While neither parkour nor break dance originally intended to include acrobatic skills as an objective, the expressive possibilities offered by movements in which the body holds an inverted position or passes through it when performing a turn or flip have made their presence constant in the practice at a certain level of performance.

In recent years, there has been a significant rise in sports practices initiated by individual interests rather than governmental or institutional efforts, achieving substantial social impact among young people, primarily due to the influence and reach of social networks (Herrera, 2012).

Some of these motor practices have a high acrobatic component, characterized by spectacularity and risk, making them particularly well-suited for success on social networks, which has fueled their rapid popularity growth (García & Aguado, 2009).

Parkour, break dance, and calisthenics (recently known in many places as street workout) are examples of acrobatic sports practices that have proliferated on social networks. Originating from the streets, these activities were initiated by groups of enthusiasts who developed ways of moving or exercising the body that are ideal for dissemination and audiovisual enjoyment (Paolillo, Ghule, & Harper, 2019).

Parkour is a motor activity generated from the natural method developed by Georges Hébert at the beginning of the 20th century. It consists of moving fluidly from one point to another and emerged in the early 1990s in France (Pagnon et al., 2022),

emphasizing the efficiency of displacement. Derived from parkour, freerunning embodies freedom of movement and includes many acrobatic maneuvers. It maintains the essence of displacement but incorporates other practices during the course, and its mentality is very different.

According to Yang et al. (2022), break dance is a form of street dance that emerged in the neighborhoods of New York in the 1960s, although it had its greatest boom and expansion to Europe in the 1980s. It was born as part of the hip-hop culture and has been growing and expanding its competitive capacity, being incorporated for the first time in the upcoming Olympic Games in Paris 2024 (Wei et al., 2022).

Calisthenics is a form of traditional functional work in which the weight of one's own body is used as a workload (Mollenhauer, 2021). In recent years, public facilities and groups of practitioners have proliferated alongside the advancement of social networks. Simultaneously, the practice has been "sportified" by organizing movements and techniques around competition rules that allow for comparison between executions (Morozova, Zinchuk, Dorontsev, & Kashirsky, 2019).

This discipline, which began as strength training, has been incorporating dynamic movements with a greater acrobatic component, and its health benefits have been sought in diverse and disparate populations. Calisthenics has been structured into different modalities, the most related to acrobatics being the freestyle modality, also known as "street workout" ('Entrenamiento callejero', 2022).

Figures provide a quick idea of the popular reach of these sport disciplines. A simple search in common Internet search engines reveals millions of references when entering the names of these three sports.

There are more than twenty-seven million references for "calisthenics," fifty-six million for "parkour," and more than two hundred and sixty million for "break dance."

These sports modalities appear as an evolution, simplification, or concretization of other similar, more extensive, traditional, or complex activities. For example, calisthenics includes many movements found in the scoring Artistic Gymnastics code of points (FIG - Fédération Internationale de Gymnastique, 2020b, 2020a). A similar situation occurs with the other sports disciplines, where the intention and/or form differ notably, at least initially, from the competitive concerns of gymnastic-acrobatic sports disciplines. However, in recent years, they have entered the competitive world, establishing scoring and comparison systems that enhance performance and development, albeit at the cost of losing part of their initial essence or purpose.

Considered as a competitive sport discipline or as a street motor expression, there is no doubt that interest in these activities and the number of practitioners have been growing in recent years. Therefore, it is necessary to understand the scope these emerging modalities present to researchers. In recent years, bibliometric analysis has become popular as a method for determining the current state of research in a specific field of study. This type of analysis can be found in other topics, such as mountain tourism (Ng, 2022).

The first approach was to determine which acrobatic disciplines have a fully street origin and do not depend on an implement. After an extensive process of review and inquiry, parkour, freerunning, breakdancing, and calisthenics were selected. Disciplines such as skateboarding, which depend on specific equipment like a

skateboard, were discarded. Some of these disciplines dependent on an implement are categorized as Sliz sports (León, 2002) and were not included in the review for the aforementioned reasons.

Given the growing public interest in these disciplines, it is considered appropriate to perform a bibliometric analysis. The aim is to determine whether there is also a growing interest in street acrobatic disciplines within the scientific community, identify current research trends, and discover which authors and journals are the most prolific and influential. Additionally, the analysis seeks to reveal the most relevant keywords, the most prolific countries and affiliations, and the most cited documents.

METHODS

In this section, we will explain the various stages followed to perform the bibliometric analysis. A bibliographic search of publications related to the subject matter was carried out in journals indexed in the Web of Science (WoS) of Clarivate Analytics and Scopus databases. These databases are among the most widely used sources by researchers (Cascajares, Alcayde, Salmerón-Manzano, & Manzano-Agugliaro, 2021; Díaz, Teixidó, Gil, Cabeza, & Aras, 2021) when performing bibliometric analyses due to the large number of journals indexed in them and the extensive information offered on journals, authors, and articles (Archambault, Campbell, Gingras, & Larivière, 2009; Jamali, Md Zain, Samsudin, & Ale Ebrahim, 2015).

The following search vector was used in the WoS database: *TI=("break dance") OR TI=(breakdance) OR TI=(break-dance) OR TI=(parkour) OR TI=(freerun*) OR AK=("break dance") OR AK=(breakdance) OR AK=(break-dance) OR AK=(parkour)*

OR AK=(freerun) OR TI=(gymnast*) OR TI=(acrobat*) OR AB=(gymnast*) OR AB=(acrobat*) OR AK=(gymnast*) OR AK=(acrobat*)) AND (TI=(calisthenic*) OR AB=(calisthenic*) OR AK=(calisthenic*)) OR TI=("street workout") OR AK=("street workout")* as a means of obtaining the largest possible number of publications on the subject. The tags "TI", "AB" and "AK" were used, locating the searched terms only in title, abstract and author keywords. The search was limited to articles and reviews within the Core Collection Database of WoS, and 196 documents were obtained.

In the Scopus database, the search was also limited to articles and reviews, and the "TITLE" tag was used to locate the search terms in the titles of the publications. The search vector used was: *TITLE("break dance") OR TITLE(breakdance) OR TITLE(break-dance) OR TITLE(parkour) OR TITLE(freerun*) OR ((TITLE-ABS(gymnast*) OR TITLE-ABS(acrobat*)) AND TITLE(calisthenic*)) OR TITLE("street workout")*, resulting in 182 articles. Keywords were not included in this search because it does not allow limiting to author keywords. By including indexed keywords, many of the resulting articles are not related to the subject matter.

Both searches were carried out on December 20, 2023. The results were exported in their respective formats: WoS formats as ".xlsx" and plain text ".txt", and Scopus as ".csv". The exported searches were processed using Microsoft® Excel® for Microsoft Office Professional Plus 2019, RStudio 2022.7.2.576 (RStudio Team, 2020), and the Bibliometrix data package (Aria & Cuccurullo, 2017). Scripts were used to automatically detect 92 duplicates, resulting in a total of 268 documents from both databases. The remaining publications

underwent manual review by two researchers, KLG and YRR. Twenty-five documents were discarded due to duplicates, and 62 documents were excluded based on title or abstract not being related to the selected topic. Disagreements between the

two researchers were resolved through discussion. The total number of documents considered for the bibliometric analysis was 199 publications. This entire process is represented in Figure 1.

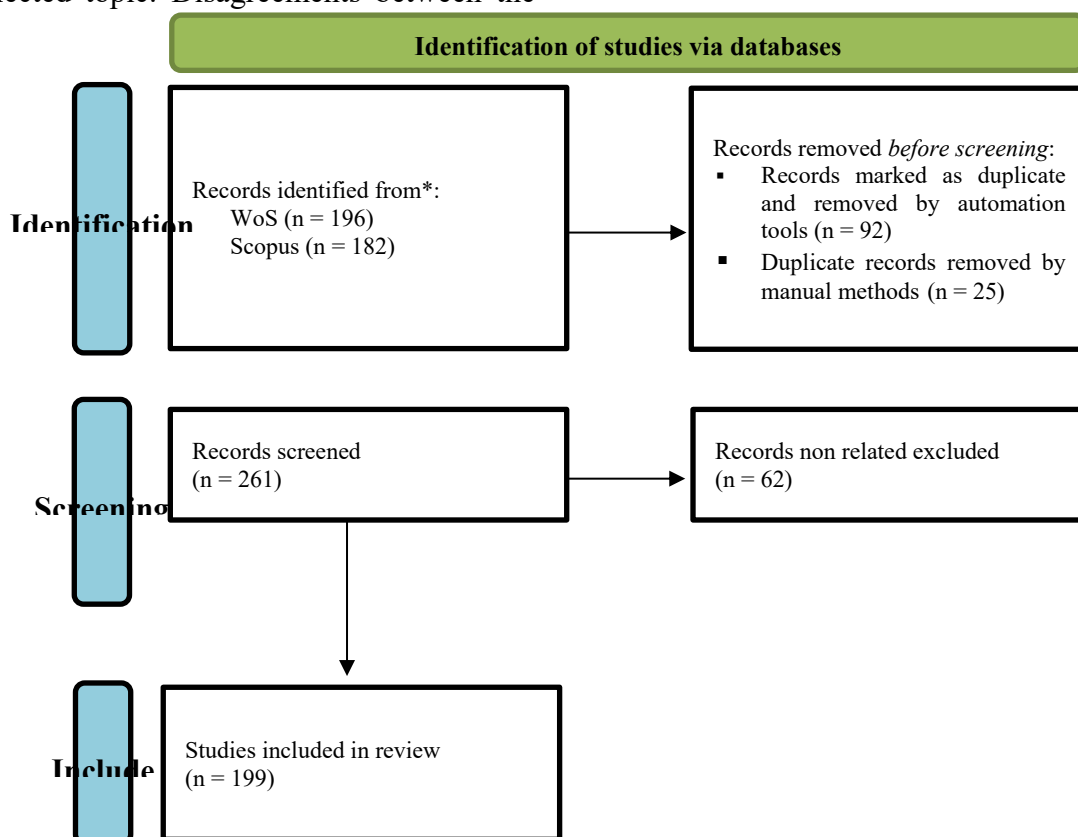


Figure 1. Flowchart of the document selection process (Page et al., 2021)

A descriptive bibliometric analysis was conducted. To determine whether the annual publications followed an exponential growth phase, according to DeSolla Price's law of exponential growth of science (Dobrov, Randolph, & Rauch, 1979; Price, 1976), the coefficient of determination (R^2) adjusted to an exponential growth ratio was calculated to interpret this trend. The WoS Analyse Reports tool was utilized to descriptively analyze thematic categories with the most related publications, as well as the publishers and journals with the most papers in each category. Bradford's law of concentration of science (DeShazo, LaVallie, & Wolf, 2009; Goffman & Warren, 1969; Nash-Stewart,

Kruesi, & Del Mar, 2012) was applied to highlight the most prolific journals and those with the highest number of citations. Lotka's law (Kushairi & Ahmi, 2021) was employed to identify authors with the highest number of publications, and the Hirsch index (h-index) was applied to these authors to determine those with the highest number of citations within the selected set of publications (Hirsch, 2005; Yie et al., 2021). To ascertain the most relevant articles, the Hirsch index (h-index) was used again, considering the h articles with h or more citations (Hirsch, 2005; Rodrigues-Santana et al., 2022). Finally, to determine the most relevant author keywords, Zipf's law was

applied to the set of author keywords from the publications analyzed (Zipf, 2013). The Biblioshiny tool from the Bibliometrix data package (Aria & Cuccurullo, 2017) was employed to generate visualization graphs of relationships between co-authors, keywords, countries, and articles, as well as to produce the world productivity map and productivity graphs of journals and institutions.

RESULTS

Annual publications trends

After applying the exclusion criteria, we obtained a total of 199 documents published between 1984 and 2024, which included 15 reviews, 180 articles, and 4 early access articles. There is no continuity in annual publications until 2006, the year in which we found at least one annual publication on the subject up to the present.

Between 1984 and 2003, there is no annual continuity, with a total of 12 publications in that period. A preliminary filtering of our database with the search terms in titles and keywords allowed us to determine that 139 documents were related to parkour or freerunning, 48 to breakdance, and 12 to calisthenics or street workout.

We analyzed the trend followed by the annual publications between 2006 and 2022, inclusive, excluding the years in which there was no annual continuity and 2023, as the analysis has not concluded at the time of writing. As a result, we found that publications in this period follow an exponential growth trend with an adjusted percentage of 74.7% (R^2) (Figure 2). At the time of the analysis, in 2023 and 2024, there are 18 publications related to the subject.

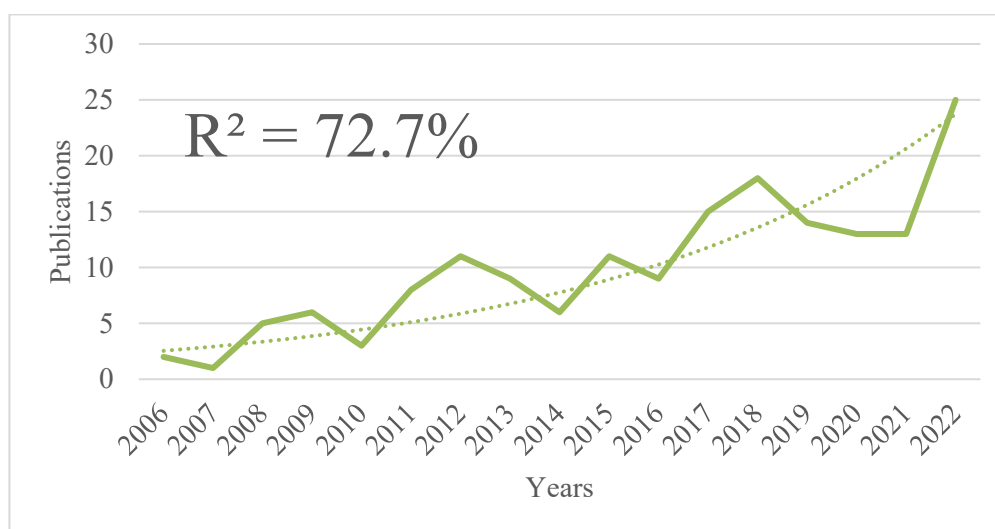


Figure 2. Annual publications trend on street-based acrobatic disciplines

Publications titles

We identified a total of 158 journals in which the documents were published, ranging from 1 to 6 publications each. The most prominent journals were determined using Bradford's law; however, due to the distribution of publications, only the core and Zone I could be identified. The core

comprises 33.67% of the total number of documents and consists of 26 journals that have published between 5 and 2 documents each. The most prolific journal is the "International Journal of Sport Policy and Politics," published by Routledge Journals, Taylor & Francis LTD. It is located in the second quartile (Q2) of the category

"Hospitality, Leisure, Sport & Tourism - ESCI" and has a total of 6 documents. The next most prolific journals include the "European Journal of Sport Science" (Routledge Journals, Taylor & Francis LTD) and the "Journal of Physical Education and Sport," both with 4 publications. Additionally, there are 7 journals with 3 publications and 16 journals

with 2 publications. Bradford's Zone I includes the remaining 132 journals, each with only one publication, accounting for 66.33% of the total number of publications. Table 1 presents the 8 journals included in the core with 3 or more publications and provides details such as publisher, impact factor, quartile, and open access percentage.

Table 1.
Journals with 3 or more publications

	Journals (Publishers)	Doc.	% Doc.	Cit.	JIF	Q.	% O.A.
Journals with 3 or more publications	International Journal of Sport Policy and Politics (Routledge Journals, Taylor & Francis LTD)	5	3.02%	183	*0.60	*Q2	25.76%
	European Journal of Sport Science (Taylor and Francis LTD)	4	2.01%	48	3.2	Q2	14.12%
	Journal of Physical Education and Sport	4	2.01%	8	n/a	n/a	n/a
	Qualitative Research In Sport, Exercise And Health (Routledge Journals, Taylor & Francis LTD)	3	1.51%	93	4.9	Q2	21.05%
	Theatre, Dance and Performance Training (Routledge Journals, Taylor & Francis LTD)	3	1.51%	35	3.2	Q2	14.12%
	Modern Italy (Cambridge Univ Press)	3	1.51%	28	0.5	Q3	52.78%
	Frontiers in Psychology (Frontiers Media SA)	3	1.51%	17	3.8	Q1	99.39%
	Sport in Society (Routledge Journals, Taylor & Francis LTD)	3	1.51%	15	1.4	Q3	14.59%
	International Journal of Morphology (Soc. Chilena Anatomía)	3	1.51%	5	0.5	Q4	3.72%
	Retos: Nuevas Tendencias en Educación Física Deporte y Recreación (FEADEF)	3	1.51%	0	1.3	Q3	24.78%

Doc. (Number of documents); Cit. (Number of citations); % Doc. (Percentage of documents); JIF (Journal impact factor); % O.A. (Percentage of open access); Q. (JIF Quartile); n.a. (not application). JIF or Q. with "*" are JCI (Journal Citation Indicator) and JCI Quartile.

Most prolific and influential co-authors

We identified a total of 417 researchers within the set of publications analyzed. Among them, 84.65% had only one paper (353 researchers), 10.07% had two publications (42 researchers), and 5.28% had 3 or more papers, with the maximum being 8 publications by one author. Applying Lotka's law, we determined that the most prolific authors would be the first 20 ($\sqrt[4]{417}$), selecting 22 co-authors with 3 or more publications. The most prolific co-author was Signey Grosprêtre, with 8 papers, affiliated with Univ Bourgogne Franche Comte (France). This was followed by Nicola de Martini Ugolotti

(Bournemouth University, England), Joseph Antony Stone, and Ben William Strafford (both from Sheffield Hallam University, England), each with 6 papers.

Figure 3 illustrates the 22 prolific co-authors and their interactions within the set of analyzed documents. The node size represents the level of interaction, while the thickness of the lines indicates the level of interconnection. Each color represents an author or group of collaborating authors. We identified 4 co-author groupings, with the largest being led by Signey Grosprêtre (highlighted in red). Another significant group (highlighted in orange) includes J. A. Stone, B. W. Strafford, K. Davids, and J. S.

North from Sheffield Hallam University, England, predominantly publishing papers related to parkour. Additionally, a group (highlighted in purple) comprising Y. Bai, Z. Yang, and M. T. Wei from the University of Melbourne (Australia) and Changshu Institute of Technology (China) focuses on breakdancing. Lastly, there is a pair of authors (highlighted in blue), M. D. Kauther and C. Wedemeyer from the University of Duisburg Essen (Germany), also contributing to breakdance-related papers.

To highlight which authors, within the 22 most prolific, are the most prominent, we checked which of these authors had a publication in the set of most cited documents (these are obtained by applying the h-index). We found that only 12 of the prolific authors meet this condition. This group is again headed by the authors mentioned in the most prolific section. Table 2 shows the 12 prominent authors, as well as their affiliations, location, number of papers and total citations.

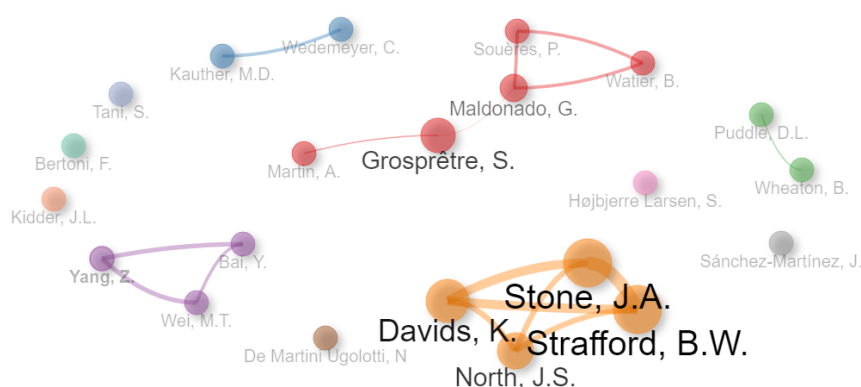


Figure 3. Chart with the prolific co-authors and their relationships. Bibliometrix: Analysis: Collaboration Network. Field: Authors. Network Layout: Kamada & Kawai. Clustering Algorithm: Walktrap. Normalization: Association. Number of nodes: 22. Repulsion force: 0.1. Remove isolated nodes: No. Min. number of edges: 1.

Table 2.

Most prominent co-authors

Co-authors	Affiliation / Countries-Regions	Documents	Citations
Grosprêtre, Signey	Univ Bourgogne Franche Comte / France	8	61
De Martini Ugolotti, Nicola	Bournemouth University / England	6	76
Stone, Joseph Antony	Sheffield Hallam University / England	6	53
Strafford, Ben William	Sheffield Hallam University / England	6	53
Davids, Keith	Sheffield Hallam University / England	5	52
Wheaton, Belinda	University of Waikato / New Zeland	4	163
Højbjerg Larsen, Signe	University of Southern Denmark / Denmark	4	63
Kidder, Jeffrey L.	Northern Illinois University / USA	3	128
Tani, Sirpa	University of Helsinki / Finland	3	70
Kauther, Max Daniel	University of Duisburg Essen / Germany	3	64
Wedemeyer, Christian	University of Duisburg Essen / Germany	3	64
Puddle, Damien L.	University of Waikato / New Zeland	3	56

Countries/Regions

We found a total of 41 countries/regions to which the co-authors of

all the documents in the analysis belong. According to the number of documents, we can highlight France (27 documents) as the most productive country, followed by the USA (26 documents), Germany (22 documents), the United Kingdom (21 documents), and China (13 documents). According to the number of citations, the United Kingdom stands out in first place with 522 total citations, the USA again in second place (345 citations), followed by France (158 citations), Germany (81 citations), and, in fifth place, Finland, with 5 documents and 73 citations.

Figure 4 represents the collaboration network between countries/regions,

showing the interactions between them. The size of the node represents the level of collaboration, and the thickness of the connections indicates the amount of interactions. We can highlight China as the most collaborative country, which is grouped with Thailand, Australia, Singapore, and Canada (highlighted in red). The USA presents connections with Finland and Chile (highlighted in blue). Finally, we find connections between Poland and Russia (highlighted in green). Figure 5 shows a map of the world in which the volume of publications is highlighted in shades of blue; the darker the shade of blue, the greater the number of publications.

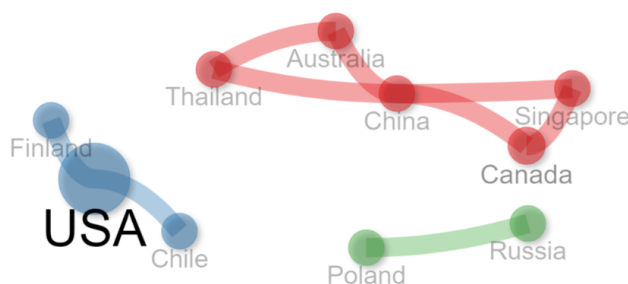


Figure 4. Collaboration network between countries/regions. Bibliometrix: Analysis: Collaboration Network. Field: Countries. Network Layout: Automatic layout. Clustering Algorithm: Walktrap. Normalization: Association. Number of nodes: 41. Repulsion force: 0.1. Remove isolated nodes: Yes. Min. number of edges: 1.

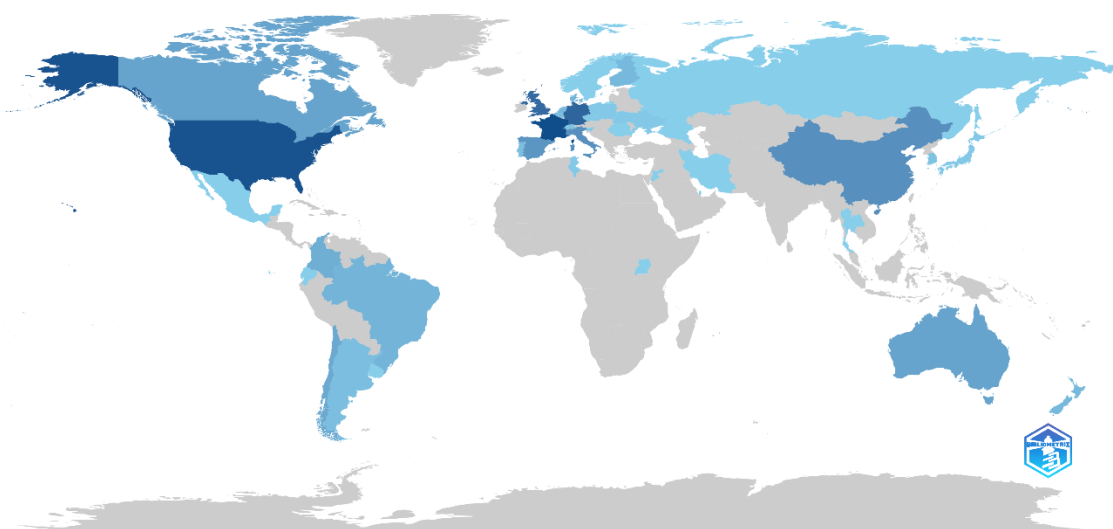


Figure 5. Country scientific production

The total number of keywords used by the authors in the documents selected for our analysis is 553. Applying Zipf's law, it

Author keywords

was determined that the most relevant ones should have a frequency of 23 or fewer. We found 20 words with 5 or more occurrences and 28 words with 4 or more occurrences. The first 20 were selected as the most relevant keywords for the authors. The author keywords were reviewed and corrected or collected in thesauri of synonyms. Two of the three sport modalities that were searched, "parkour" (73 occurrences) and "breakdancing" (24 occurrences), stand out in first place; the terms "free running" (8 occurrences) and "street workout" (5 occurrences), despite having been used in the search vector, are not at the top of the list. The five words with the highest number of occurrences that are not part of the search vector are "injury" (12 occurrences), "hip hop" (11 occurrences), and "lifestyle sports" (11 occurrences).

Figure 6 shows the most relevant keywords and their connections. The size of

each node represents the number of occurrences, the thickness of the line indicates the frequency with which they appear together, and the proximity of one node to another represents the relationship between them. We can distinguish three groupings, each related to one of the sports modalities of the analysis. Highlighted in blue is the cluster headed by the term "parkour" along with nine other keywords. Highlighted in red is the cluster headed by the term "breakdance," together with seven directly related terms. Highlighted in green is the term "street workout," which appears more isolated. Figure 7 represents the cumulative frequency of appearance of the 10 most relevant keywords over time, showing that in 2007 the term "parkour" began to be used as a keyword. The term "breakdance" began to be used in 2008, a year after parkour, and it shows much less pronounced growth compared to parkour.

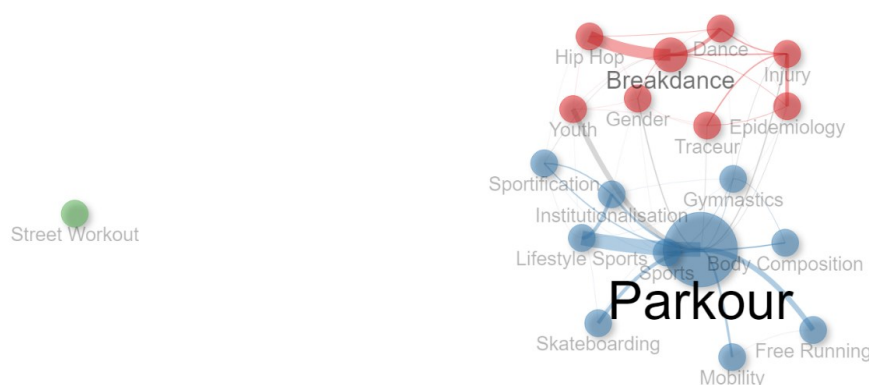


Figure 6. Most important author keywords and their connections. Bibliometrix: Analysis: Co-Occurrence Network. Field: Author's Keyword. Network Layout: Automatic layout. Clustering Algorithm: Walktrap. Normalization: Association. Number of nodes: 20. Repulsion force: 0.1. Remove isolated nodes: No. Min. number of edges: 1

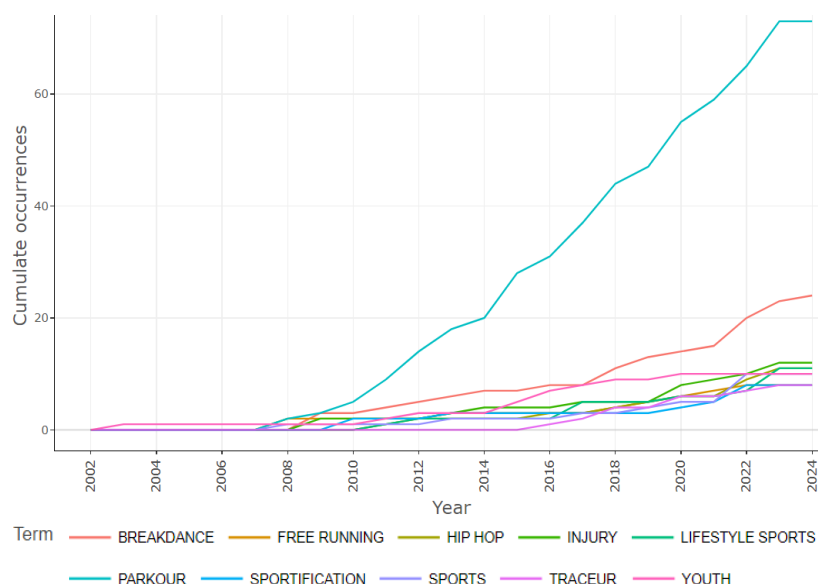


Figure 7. Most prominent author keywords and their cumulative frequency over time. Bibliometrix: Analysis: Word Dynamics. Field: Author's Keyword. Occurrences: Cumulate. Number of words: 10.

Documents

We can highlight as the most relevant articles in our subject matter the first 26 publications with at least 27 citations (Table 3), applying the h-index. The most cited article is "Playing With Fear: Parkour And The Mobility Of Emotion" by Saville (2008), with a total of 156 citations, published in "Social And Cultural Geography." This paper explores the emotions involved in parkour, highlighting the playfulness and fear that practitioners experience in engaging with different places.

The next article with the most citations is entitled "Parkour, Anarcho-

Environmentalism, and Poiesis" published by Atkinson (2009) in the journal "Journal Of Sport And Social Issues," with a total of 129 citations. This article seeks to analyze how parkour can be seen as a form of resistance against technology and urban structure and how it can be used to rediscover the city in a different way. The breakdance-related article with the highest number of citations is "Breakdance Injuries And Overuse Syndromes In Amateurs And Professionals" by Kauther et al. (2009), with 36 citations, dealing with breakdance injuries at different levels. Figure 8 represents the most cited articles and their interrelationships.

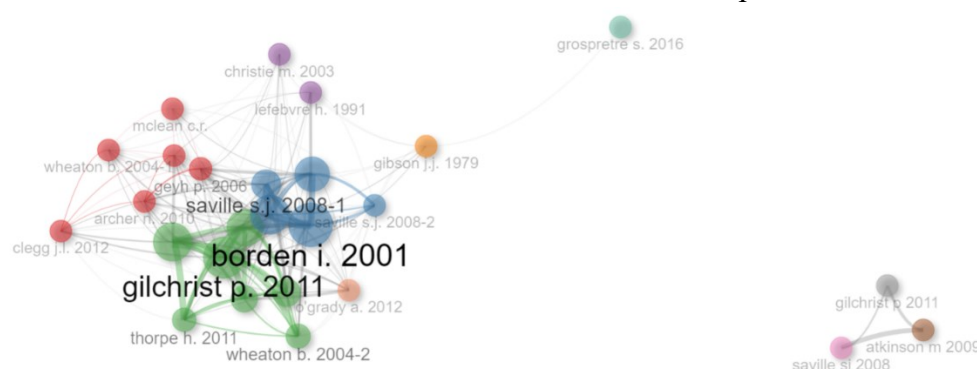


Figure 8. Graph with the most cited articles and their interrelationships. Bibliometrix: Analysis: Co-citation Network. Field: Papers. Network Layout: Kamada & Kawai. Clustering Algorithm: Walktrap. Number of nodes: 26. Repulsion force: 0. Remove isolated nodes: Yes. Min. number of edges: 2.

Table 3.
Documents

Title. Main author (Year of publication)	Journal ISO Abbreviation	Cites
Playing with Fear: Parkour and the Mobility of Emotion. Saville (2008)	Soc. Cult. Geogr.	156
Parkour, Anarcho-Environmentalism, and Poiesis. Atkinson (2009)	J. Sports Soc. Issues	129
Lifestyle Sport, Public Policy and Youth Engagement: Examining the Emergence of Parkour. Gilchrist & Weaton (2011)	Int. J. Sport Policy	124
Parkour The City the Event. Mould (2009)	Environ. Plann. D Soc. Space	78
Parkour The Affective Appropriation of Urban Space and the Realvirtual Dialectic. Kidder (2012)	City Commun.	68
Breakdance Injuries and Overuse Syndromes in Amateurs and Professionals. Kauther et al. (2009)	Am. J. Sports Med.	57
When Walls are No Longer Barriers Perception of Wall Height in Parkour. Taylor et al. (201)	Perception	52
Youth Action Sports and Political Agency in the Middle East Lessons from a Grassroots Parkour Group in Gaza. Thorpe & Ahmad (2015)	Int. Rev. Sociol. Sport	52
Terrain Runner Control Parameterization Composition and Planning for Highly Dynamic Motions. Liu et al. (2012)	Acm Trans. Graph.	50
Parkour Creating Loose Spaces. Ameel & Tani (2012)	Geogr. Ann. Ser. B Hum. Geogr.	48
An Existential Phenomenological Examination of Parkour and Freerunning. Clegg & Butryn (2012)	Qual. Res. Sport Exerc. Health	44
Ground Reaction Forces and Loading Rates Associated with Parkour and Traditional Drop Landing Techniques. Puddle & Maulder (2013)	J. Sports Sci. Med.	41
Climbing Walls Making Bridges Children of Immigrants Identity Negotiations Through Capoeira and Parkour in Turin. De Martini Ugolotti (2015)	Leis. Stud.	39
Parkour as Acrobatics An Existential Phenomenological Study of Movement in Parkour. Aggerholm & Højbjerg (2017)	Qual. Res. Sport Exerc. Health	37
Injury Incidence in Hip Hop Dance. Ojofeitimi et al. (2012)	Scand. J. Med. Sci. Sports	35
Personality Self-efficacy and Risk-taking in Parkour Freerunning. Merritt & Tharp (2013)	Psychol. Sport Exerc.	33
From Break Dancing to Heavy Metal Navajo Youth Resistance and Identity. Deyhle (1998)	Youth Soc.	33
Parkour Masculinity and the City. Kidder (2013)	Sociol. Sport J.	32
Break Dancing and Breaking out Anglos Utes and Navajos in a Border Reservation Highschool. Deyhle (1986)	Anthropol. Educ. Q.	29
Performance Characteristics of Parkour Practitioners Who Are the Traceurs. Grosprêtre & Lepers (2016)	Eur. J. Sport Sci.	28
Break Dance Significantly Increases Static Balance in 9 Year-Old Soccer Players. Ricotti & Ravaschio (2011)	Gait Posture	28
Parkour A New Extreme Sport and A Case Study. Miller & Demoiny (2008)	J. Foot Ankle Surg.	28
Parkour Adventure Risk and Safety in the Urban Environment. Kidder (2013)	Qual. Sociol.	28
Musculoskeletal Injuries in Breakdancers. Cho et al. (2009)	Injury-Int. J. Care Inj.	28
Parkour as a Donor Sport for Athletic Development in Youth Team Sports Insights Through an Ecological Dynamics Lens. Strafford et al. (2018)	Sports Med. - Open	27
The Aesthetics of Urban Movement Habits Mobility and Resistance. Sharpe (2013)	Geogr. Res.	27

DISCUSSION

Regarding acrobatic sports with street origins, this research is pioneering, as no similar studies were found. A total of 199 documents published between 1984 and 2024 were analyzed. Although no annual continuity was found in the publications until 2006, the trend from then onwards shows exponential growth, demonstrating scientific community interest in these types of sports. This study identifies the temporal evolution of publications related to the subject, the most prolific and cited journals, the most productive and prominent authors, the most relevant articles, and the keywords most used by researchers, all following traditional laws of bibliometrics (Goffman & Warren, 1969; Kushairi & Ahmi, 2021; Nash-Stewart et al., 2012; Price, 1976; Zipf, 2013)..

The oldest paper is entitled "Injuries from Break Dancing" (Norman & Grodin, 1984), focusing, as its title indicates, on breakdancing injuries. Reviewing the oldest papers, we find that the first 12 are related to breakdancing. Breakdancing originated in the Bronx (New York) in the 1970s (International Olympic Committee, n.d.), but its popularity increased significantly in 1983-1984 due to its portrayal in movies such as Flashdance (1983), Breakin' (1984), and Breakin' 2: Electric Boogaloo (1985) ('Break dance', 2023). The rise in popularity during these years coincides with the first related research, suggesting a possible connection between the two. Breakdancing is set to be included in the 2024 Olympic Games (International Olympic Committee, n.d.), which may again lead to an increase in related publications.

The first paper related to parkour dates from 2006, entitled "Paediatric Fractures Sustained in Parkour (Free Running)"

(McLean, Houshian, & Pike, 2006). The article analyzes two cases of pediatric fractures in untrained individuals practicing parkour without protective equipment, highlighting the risk of upper extremity injuries in children due to falls, with the distal radius being the most frequently fractured part of the immature skeleton. From this date onwards, there are more publications related to parkour than to breakdancing. Parkour originated in France in the late 1980s but did not gain widespread popularity until the late 1990s and early 2000s, spurred by movies like Yamakasi (2001) and District 13 (2004). David Belle, a member of the first parkour group, further increased the sport's visibility by sharing his skills on YouTube (LW, 2023). The timing of parkour's television exposure aligns with the burgeoning scientific interest, indicating a potential relationship.

The first document related to freestyle calisthenics or street workout is from 2017, with two documents published that year: "Morphological Characteristics of Street Workout Practitioners" (Sanchez-Martinez, Plaza, Araneda, Sanchez, & Almagia, 2017) and "Assessment of Physical Fitness Indicators in Students Practicing Powerlifting and Street Workout" (Kharisov, Nenasheva, Aminov, Cieslicka, & Mushketa, 2017). Both papers focus on the morphological profile and physical fitness of practitioners. This sport has a more diffuse origin, heavily influenced by social networks, and has gradually incorporated new elements from artistic gymnastics and parkour into traditional calisthenics ('Entrenamiento callejero', 2022). The Spanish Federation of Street Workout and Calisthenics was founded in February 2015, the same year the first official competition took place ('Entrenamiento callejero', 2022). From this point, the competition

modalities became more clearly structured, with freestyle calisthenics being referred to as street workout or freestyle modality ('Entrenamiento callejero', 2022). Given its recent creation, it is logical that the first studies on this sport appeared in 2017.

The analysis of the most productive journals did not conform to Bradford's theoretical model, revealing only the core and zone 1. The core was composed of 26 journals with a total number of publications ranging between 6 and 2. This large core indicates that there are no specific journals exclusively focused on the analyzed subject matter, with publications being distributed primarily in journals related to physical activity and sport. It may also suggest that analyzing three different sports has resulted in a mixed distribution of journals, showing a more confusing structure.

The most prolific journal was "International Journal of Sport Policy and Politics" from Routledge Journals, Taylor & Francis LTD, with 6 publications. This journal aims to publish papers addressing all aspects of general politics and sport policy. Notable from this journal is the article "Lifestyle Sport, Public Policy and Youth Engagement: Examining the Emergence of Parkour" (Gilchrist & Wheaton, 2011), which has 124 citations. The other five papers published in this journal also relate to aspects of institutionalization or the parkour lifestyle.

The next journals with the highest number of publications are "European Journal of Sport Science" (Taylor and Francis LTD) and "Journal of Physical Education and Sport", each with 4 papers, almost all related to parkour. The only paper not covering parkour published in the "Journal of Physical Education and Sport" is entitled "Street Workout Is the New Gymnastics - Strength Development in a

Very Short School-Based Program" (Schlegel, Sedláková, & Křehký, 2022), which relates to street workout.

Of the prolific journals, the only ones presenting papers related to sports other than parkour are "Frontiers in Psychology" (Frontiers Media SA) and "Retos" (FEADEF), which have papers related to breakdancing; "Sport in Society" (Routledge Journals, Taylor & Francis LTD), which has a paper related to street workout; and "International Journal of Morphology" (Soc. Chilena Anatomía), which has a paper related to breakdancing and two related to street workout.

Regarding the scientific production of the authors, S. Grosprêtre stands out with 8 articles. Although he does not belong to a specific research group, he collaborates with other authors, such as A. Martin and the research group of G. Maldonado. His publications are related to parkour, with his most cited article being "Performance Characteristics Of Parkour Practitioners Who Are The Traceurs" (Grosprêtre & Lepers, 2016), which is included among the set of relevant articles.

The next most prolific authors, each with 6 papers, are N. de Martini Ugolotti and B. W. Strafford, along with J. A. Stone. N. de Martini Ugolotti generally approaches the subject from a social perspective. B. W. Strafford and J. A. Stone, who work together with K. Davids and J. S. North, focus on parkour from a sporting perspective. All these authors are part of the set of prominent authors.

The prominent authors with the highest number of citations are B. Wheaton, with 4 papers and 163 citations, and J. L. Kidder, with 128 citations and 3 papers. Belinda Wheaton collaborates with D. L. Puddle, who is also a prominent author with 3 papers and 56 citations. Both authors have co-

authored two papers related to parkour (Puddle & Wheaton, 2023; Puddle, Wheaton, & Thorpe, 2019). B. Wheaton's most cited paper is "Lifestyle Sport Public Policy and Youth Engagement: Examining the Emergence of Parkour" (Gilchrist & Wheaton, 2011), published in the "International Journal of Sport Policy". J. L. Kidder's three articles, all related to parkour, are highlighted as relevant (Kidder, 2012, 2013a, 2013b).

The featured authors with the highest number of citations and who also publish on breakdancing are M. D. Kauther and C. Wedemeyer, with 3 articles and 64 citations. All three articles focus on injuries in the discipline of breakdancing, and they are co-authored with less prominent authors. Their most relevant article is "Breakdance Injuries and Overuse Syndromes in Amateurs and Professionals" (Kauther et al., 2009), with 57 citations.

The author with the most papers related to street workout is Javier Sanchez-Martinez, with 4 papers and 9 citations, although he is not included in the set of prominent authors. His most cited paper is "Morphological Characteristics of Street Workout Practitioners" (Sanchez-Martinez et al., 2017). However, the most cited paper related to street workout is "The Comparative Analysis of Morphological and Functional Indicators of Arm Wrestling and Street Workout Athletes" (Podrihalo et al., 2021), which compares the physical condition of arm wrestlers with that of street workout practitioners.

The most cited paper related to parkour is the one at the top of Table 3, entitled "Playing With Fear: Parkour and the Mobility of Emotion" (Saville, 2008). As for breakdancing, the most cited paper is in sixth place and is entitled "Breakdance Injuries

and Overuse Syndromes in Amateurs and Professionals" (Kauther et al., 2009).

Regarding the number of publications presented by each country, it is interesting to note that France ranks first with 27 documents and 158 citations, the country of origin of parkour. In second place is the USA, with 26 documents and 345 citations, the country of origin of breakdancing. In bibliometric analyses, the USA usually accumulates the greatest number of documents, so it is worth noting the influence that parkour has had on the scientific production of its country of origin.

Looking at the distribution of the author keywords (Figure 7), we observe three groups, each related to one of the sports analyzed. The group related to street workout presents a single keyword, namely the term "street workout". This can be justified due to the low number of publications related to the sport, all these publications share this term but the rest of the related keywords do not accumulate 5 or more appearances, so they do not appear in the graph.

The term "breakdance" appears accompanied by several terms that describe various aspects of this sport, such as "hip hop" and "dance"; and by other terms that are related to the population that is usually practicing or perspectives that have been interesting or controversial, such as "youth" or "epidemiology". The term "traceur" also appears within this grouping, this is due to the fact that although it is not directly related to the term "breakdance", it is directly related to the terms "gender" and "injury". Many articles on parkour, as well as on breakdance, address the issue of injuries or the use of these sports to combat or vindicate inequality.

The term "parkour", on the other hand, is accompanied by terms that refer to the

attempt to turn it into a regulated sport, such as "sportification" and "institutionalisation"; there are also terms that refer to its acrobatic nature and its fundamental idea, which is mobility, such as "gymnastics" and "mobility". Parkour for its practitioners is usually more than a sport, it is a lifestyle, which is reflected in the term "lifestyle sports".

Finally, it is worth mentioning that there are two sports that tend to be closely linked to this discipline, these are "skateboarding" and "free running", the latter being a modality derived from parkour.

This study serves as a valuable tool for authors, research groups, and publishers to understand the current trends in scientific production within the field of street acrobatics. By analyzing the three main disciplines collectively and occasionally individually, it provides insight into the temporal evolution and various branches of research within each discipline. This enables individuals interested in these sports to gain a comprehensive understanding of their development and research directions.

Identifying key authors in the field can facilitate the formation of productive research groups, while leveraging the information presented in this study can enhance the development of research projects with strong connections to seminal works. The increasing trend in this thematic area suggests that future research, if approached correctly, has the potential to yield publications with significant readership and impact.

However, it's important to acknowledge some limitations in this study. We recognize the possibility of publication bias as we only analyzed articles from WoS Core and Scopus databases, which, although comprehensive and prestigious, may not cover all relevant publications. Some articles

related to the subject may have been published in sources of lower impact or not indexed in these databases. Future research could address these limitations by conducting individual analyses for each discipline and expanding the scope to include additional databases.

Annual publications related to street acrobatics, specifically parkour, breakdance, and calisthenics, have exhibited an exponential growth trend over the past 18 years. Parkour leads with the highest number of related articles (139 papers), followed by breakdance (48 papers), and finally, freestyle calisthenics or street workout (12 papers). Despite breakdancing having an older origin than parkour, the latter surpasses breakdancing in the number of publications. The emergence of parkour and breakdancing in movies and television significantly influenced the popularization of these sports and consequently, the development of related scientific production. There appears to be a temporal relationship between their introduction to television and the commencement of scientific publications. Street workout, being a recently established sport, does not yet exhibit a similar evolution to other sports, although its popularity has also been greatly influenced by social networks.

The most prolific journal on the subject is the "International Journal of Sport Policy and Politics" from "Routledge Journals, Taylor & Francis LTD", featuring predominantly parkour publications, like the majority within the core. Other journals such as "Frontiers in Psychology", "Retos", and "International Journal of Morphology" present publications related to breakdancing, while "Journal of Physical Education and Sport", "Sport in Society", and again, "International Journal of Morphology"

feature publications related to street workout.

The most relevant papers in each sport are "The Comparative Analysis of Morphological and Functional Indicators of Arm Wrestling and Street Workout Athletes" (Podrihalo et al., 2021) in street workout; "Playing with Fear: Parkour and the Mobility of Emotion" (Saville, 2008) in parkour; and "Breakdance Injuries and Overuse Syndromes in Amateurs and Professionals" (Kauther et al., 2009) in breakdance.

The most prominent author in the field of parkour is Signey Grosprêtre, with 8 papers; the most prominent authors presenting papers related to breakdance are Max Daniel Kauther and Christian Wedemeyer, with 3 papers each; and finally, the most prolific author publishing on street workout is Javier Sanchez-Martinez, with 4 papers.

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