

Assessment of factors influencing the citation level of scientific publications in the field of sport and physical activity

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Abstract

Background and Study Aim The citation level of scientific publications is a key indicator of their scientific impact and significance. With the increasing number of publications in the field of sport and physical activity, it is crucial to identify the factors influencing citation levels. The aim of this study is to analyze the relationship between the number of cited references and the citation level of publications. Additionally, the study examines the impact of access mode (open or closed) and publication type on citation metrics.

Material and Methods The study is based on the analysis of bibliographic data from the Web of Science database covering the period from 2015 to 2024. The dataset includes 10,000 publications related to sport and physical activity. Metrics such as Cited Reference Count (NR), Times Cited (TC), and Total Times Cited (Z9) were used to evaluate the relationship between the number of cited references and the citation level of publications. The study also analyzed the impact of access mode (open or closed) and publication type (Article, Review, Other) on citation metrics. Data processing involved descriptive statistical methods and nonparametric tests, including Spearman's correlation and the Kruskal-Wallis test.

Results The analysis of bibliographic data revealed the following patterns. The citation level of publications is associated with the number of cited references (NR); however, the correlation remains weak (Spearman's coefficients: 0.1329 for TC and 0.1342 for Z9). The average number of cited references for highly cited articles is 69.56, with a maximum value of 766. Open-access publications exhibit significantly higher citation levels. Among them, the «Green Accepted» (7.19%) and «Green Published, hybrid» (4.45%) formats make a substantial contribution. However, the majority of publications (60.14%) fall into the «Unknown» category, limiting the assessment of their accessibility. An analysis of publication types showed that Review and Article formats have the greatest impact. These account for 21.81% and 75.29% of highly cited works, respectively. In the high-citation category, most publications fall into the «Moderate» citation subcategory (52.5%), followed by «Low High» (46.21%), while only 1.29% are in the «High» and «Very High» subcategories. A temporal analysis demonstrated that the highest number of highly cited publications was from 2015 (1,890 publications), followed by a decline in subsequent years. The lowest citation levels were observed for 2024 publications (only 18 articles), likely due to insufficient time for citation accumulation. These results confirm the influence of factors such as accessibility, publication type, and temporal characteristics on the citation metrics of publications in the field of sport and physical activity.

Conclusions The study highlights the importance of a comprehensive approach to analyzing factors influencing the citation levels of scientific publications. Considering contextual characteristics such as publication accessibility, type, and temporal aspects is key to understanding the mechanisms underlying citation dynamics. The findings provide a foundation for developing strategies to enhance the scientific significance of publications, including optimizing article structure, selecting appropriate access models, and accounting for disciplinary specificity. Further research in this area will deepen the understanding of the relationships between various factors and citation levels, contributing to improved quality and visibility of scientific work.

Keywords: Web of Science, Sport Sciences, citation, analysis, sources

Introduction

In the context of the rapidly growing volume of scientific publications, ensuring their visibility and recognition within the academic community has become a critical task. In this regard, the role and

significance of citation metrics are increasing, as they have become one of the key indicators for evaluating publications and journals overall. Therefore, the search for strategies to enhance the scientific impact and accessibility of publications will contribute to advancing knowledge across various fields.

In this context, citation approaches become particularly important, as emphasized in

recommendations from well-known methodological guides [1], Guidelines for authors [2, 3, 4]. and confirmed by research [5, 6, 7, 8, 9, 10].

All these recommendations focus on the need to refer to reliable, primary sources with the most up-to-date information.

Jawaid et al. [11] and other researchers [12] emphasize the importance of being informed about developments in the last 5-10 years. The authors call for researchers to optimally and balanced inclusion of high-quality and current references in their work. This is confirmed by the scientific consensus, which recognizes the importance of citing works no older than 2-5 years [13, 14, 15, 16, 17]. The authors assert that older references may indicate an incomplete literature review [18].

Other studies [19, 20] draw attention to the need for careful verification and relevance of references. The authors highlight potential errors that can arise, for example, when using artificial intelligence like ChatGPT to compile a bibliography.

The authors highlight the potential errors that may arise when using artificial intelligence tools, such as ChatGPT, to generate reference lists. This concern is supported by research that identifies cases of spontaneous fabrication of false citations. For instance, McGowan et al. [21] note that ChatGPT and similar tools, like Bard, are capable of creating fictitious references when conducting literature searches in psychiatry. Additionally, Walters and Wilder [22] emphasize that errors in bibliographic references generated by ChatGPT stem from both data fabrication and the misrepresentation of existing sources. The studies by Hueber and Kleyer [23] focus on the quality of data in rheumatology, revealing instances of fabricated references, which underscores the need for a critical approach to using such technologies. Citing non-existent sources not only misleads readers and violates academic ethics but also undermines trust in scientific publications. This issue is particularly significant given the increasing use of artificial intelligence in academia.

Comeau et al. [24] analyse a multimillion array of references. The authors demonstrate a tendency to cite literature published in the last 5-10 years. This approach reflects the scientific community's aspiration for the timeliness of research.

Hui et al. [16] limited the search depth for the last 5 years (2013-2018) and for the last 10 years. In another study [9], the authors assert that citation indicators alone cannot provide sufficiently detailed or reliable measurements of quality.

An integral part of a manuscript is the number of cited publications. Recommendations in this context vary widely. For instance, it is suggested to limit the number of references to 50 in an original research article, 40 in a preliminary communication, 30 in a scientific note, and 100-150 in a mini-review and review, respectively [25]. Preferably,

the references should include recent international publications, unless they provide an overview of the field. They should reflect the manuscript's topic and demonstrate relevance to the journal.

Other studies highlight limitations on the number of references for certain types of articles [26], such as no more than 40 references [27]. These citation metrics draw the attention of researchers [28].

In general, recommendations regarding the number of references in an article and the depth of coverage in years are provided in journals. These guidelines depend on the journal's thematic focus and the type of article. The number of references can range from 30-150 [25], up to 40 [5], or even be unlimited [6]. Reviewer guidelines often recommend checking for references to recent publications and the most relevant prior research [7].

Other author guidelines impose reference limits for specific types of articles, starting from as few as five references [5]. The validity of such approaches is emphasized in the study by Liang et al. [28], where the authors highlight the importance of addressing citation quality issues.

Among other studies, publications based on bibliometric analysis stand out, particularly those utilizing tools like VoSviewer [29, 30, 31].

This analysis involves extracting bibliographic data from documents, including indicators such as the number of citations, the number of references in the References section, the year of publication, and others. However, this approach has limitations due to the specifics of the algorithm used to process the information retrieved from databases.

Modern research emphasizes the importance of the impact factor as a key indicator of scientific journal quality, linking it to citation counts and publication accuracy [32, 33, 34]. Various aspects are analyzed, including the relationship between alternative metrics and the impact factor [33], citation trends and reference accuracy [35], and broader bibliometric approaches to evaluating academic journals [36]. Some studies highlight prospects for improving publication quality [34] and examine factors influencing the impact factor in specific fields [37], including sports and physical activity [38].

These studies contribute to a trend toward more comprehensive journal evaluations that incorporate both traditional and innovative measures of scholarly impact. Notably, the study by Ariza-Guerrero [39] points to a continuous and substantial increase in citations per article, limited only when journals impose restrictions on the maximum number of pages per article. In some cases, the number of citing documents reaches 400-500 [40, 41, 42] in journals with impact factors of 6.0, 10.9, and 4.5, respectively.

Overall, research highlights the need for a comprehensive approach to evaluating level scientific

journals (articles), incorporating alternative metrics, bibliometric analysis, and citation accuracy control.

Web of Science (WoS) and Scopus are widely recognized as global benchmarks for assessing the scientific quality of journals and articles. Citation indicators derived from these databases play a pivotal role in evaluating the scientific contribution of journals and classifying them into quartiles, which act as a measure of journal quality [43, 44]. These databases are extensively consulted and often utilized in research assessments, though recent studies indicate that systematic differences between them are minimal or non-existent [45, 46]. These findings showed that journals with high citation rates often achieve top quartile rankings, reinforcing the role of citations as an indicator of quality. Furthermore, studies suggest that Web of Science and Scopus databases provide robust metrics for evaluating the impact of individual articles, departments, and institutions [44].

Despite numerous studies analyzing the citation dynamics of scientific publications, there remains a need for a deeper exploration of the factors influencing citation patterns, particularly in the field of sport and physical activity. Existing guidelines for authors and journal editors often prove insufficient in addressing issues related to the quality and relevance of references, as well as the impact of various metrics on citation levels.

In the context of increased use of artificial intelligence and the growing volume of publications, there is a pressing need to develop more effective approaches that enhance the quality of scientific works, minimize errors in bibliographic data, and ensure their significance within the academic community.

Based on the conducted analysis, several hypotheses are proposed, the confirmation or refutation of which could provide new insights into addressing issues related to the citation factors of scientific publications:

1. *Number of Cited References and Citation Level.* The number of references cited in an article may serve as an indicator of the depth of topic coverage and overall publication quality, thereby contributing to increased citation levels. *Hypothesis:* There is a positive relationship between the number of cited references in an article and its citation level.
2. *Access Mode and Citation Level.* Open access enhances the visibility and accessibility of articles, which may positively affect their citation levels. However, the number of cited references is likely independent of the article's access status. *Hypothesis:* Open-access articles exhibit higher citation levels compared to closed-access articles, but access status does not influence the number of cited references.
3. *Impact of Publication Year.* The year of publication

determines the opportunities for accumulating citations and may also reflect variations in the amount of available literature over time.

Hypothesis: The publication year influences both the citation level of an article and the volume and structure of its reference list.

The aim of this study is to analyze the relationship between the number of cited references and the citation level of publications. Additionally, the study examines the impact of access mode (open or closed) and publication type on citation metrics.

Material and Methods

An initial pilot search and analysis were conducted to assess the feasibility of extracting references from the References sections on the scientific journals' web resources. In fact the journals present the References section with some distinctive features. This significantly complicates the data extraction process that would take these differences into account.

Therefore, the need for a unified methodology for extracting references determined the direction of the search – the Web of Science database [47]. In this context, Web of Science provides the ability to extract document data using the same settings for all journals. Similar extractions have already been performed by us in our previous studies [5, 6].

Selection of Search Categories in the WoS Database

The selection of search categories was based on the mandatory inclusion of publications related to the topics of «sport, physical activity» in the context of education, training, recreation, and physical rehabilitation. This choice was guided by the understanding that these topics significantly contribute to promoting a healthy lifestyle, which is a key criterion for the quality of life in the population. Three categories met this criterion: 'Sport Sciences,' 'Hospitality, Leisure, Sport & Tourism,' and 'Education & Educational Research.'

Other categories might also include similar topics but are often supplemented by specific focuses—such as medical, technical, or economic perspectives. Another criterion for selecting a category is the ability to extract all cited documents or the maximum possible number of them for analysis. Therefore, only these three categories were selected.

Justification for Information Search Periods

The selection of information search periods was based on the formula for calculating the impact factor in WoS (2024):

$$\text{Impact Factor} = \frac{A}{B}$$

Where, A - Citations in 2023 to items published in 2021 and 2022; B - Number of citable items in 2021 and 2022.

The formula for calculating the CiteScore 2023 metric (Scopus):

$$\text{CiteScore} = \frac{C}{D}$$

Where, C - Citations from 2020 to 2023; D - Documents published from 2020 to 2023.

Both metrics are based on a 3-year or 4-year period, respectively. Additionally, WoS provides the option to filter searches for the past 5 years or specify a custom time range. A 5-year period from the current year was selected for the study.

Justification for the Depth of Information Search

The selection of the search depth considered recommendations from previous studies [48, 49, 50]. The authors highlight that both the depth and breadth of research coverage can influence citations.

A 2 × 5-year periodization was chosen:

- 2020–2024: For contemporary data.
- 2015–2019: For comparison and assessment of changes.

The starting date of the period was clarified as the last complete year (2024). It was noted that publications from the last year may include future dates due to «EARLY ACCESS» articles, which can have publication dates set in the future. Such publications were considered as part of the last year's data.

Justification for the Number of Bibliographic Records Extracted

An equally important factor is the number of bibliographic records extracted for analysis. A review of studies indicates that authors select varying numbers of highly cited articles for analysis: TOP-50 [51]; TOP-96 [52]; TOP-100 [53]; TOP-2000 [54]. In some cases, authors analyzed fewer articles, including for citation analysis [55]. Different criteria were applied to justify the selection of articles for analysis.

A search in the Web of Science Categories 'Sport Sciences; Hospitality, Leisure, Sport & Tourism; Education & Educational Research' yielded 795089 documents.

Sample Size

Steps for determining the minimum sample size from N=795089 bibliographic records:

Formula for Sample Size Calculation (when the total number of documents is known). The calculation is based on a commonly accepted formula for determining sample size, which considers:

- Confidence level: 95% (Z=1.96)
- Margin of error (e): 2% (e=0.02)
- Estimated proportion of success (p): 50% (p=0.5), which ensures maximum variability.

Formula:

$$n = \frac{Z^2 \cdot p \cdot (1 - p)}{e^2}$$

Adjustment for finite dataset size:

$$n_{adj} = \frac{n}{1 + \frac{n-1}{N}}$$

Sample size without considering N: 4148
Sample size adjusted for N=795,089: 4126

An analysis of N bibliographic records directly on the WoS search page revealed that citation counts decrease sharply after the first 10000 records. For example, at 10000 records, the minimum citation count is 72. For the subsequent 100 and 650 records, the citation counts drop to 23 and 0, respectively. Therefore, it was decided to limit the extraction to 10000 bibliographic records. This decision aligns with the calculated values. In fact, 5% of the documents that were cited were not considered.

Search Strategy

The search strategy was based on extracting data from the Web of Science (WoS) database. The process of identifying and extracting the required publications followed this sequence:

1. The first 1,000 bibliographic records were selected (due to WoS limitations).
2. The 'Export' field was configured for accurate data extraction.
3. The data was saved to a text file.

Export Configuration:

- Select 'Plain text files.'
- In the new window titled 'Export Records to Plain Text File,' choose 'Edit' and select all 29 fields.
- Save the selections using 'Save selections,' which will remain valid for the session.

The first 1,000 records were extracted and saved. Subsequently, the next 1,000 records were selected and saved to another file.

Inclusion and exclusion criteria

Documents in the fields of 'Sport Sciences; Hospitality, Leisure, Sport & Tourism; Education & Educational Research' published between 2015 and 2024 were identified. The criteria for extraction were selected from the 'Web of Science Core Collection Field Tags':

NR - Cited Reference Count;

TC - Web of Science Core Collection Times Cited Count;

Z9 - Total Times Cited Count (Web of Science Core Collection, Arabic Citation Index, BIOSIS Citation Index, Chinese Science Citation Database, Data Citation Index, Russian Science Citation Index, SciELO Citation Index);

U1 - Usage Count (Last 180 Days);

U2 - Usage Count (Since 2015);

PY - Year;

UT - Accession Number;
DT - Document Type;
WC - WoS Categories;
OA - Open Access.

During the processing of the extracted data, documents without a References section were excluded from the analysis. Subsequently, documents lacking the «tag» for either the number of citations or the number of cited sources were also excluded. A total of 95% of the extracted documents were used for analysis, while 5% were excluded.

Statistical Analysis

Descriptive statistical methods and distribution analysis were applied for data processing. Key indicators such as mean, median, standard deviation, minimum, and maximum values were calculated for metrics related to the number of cited references (NR) and citation levels (TC, Z9). The data were processed using the Python programming environment with libraries such as pandas, numpy, and matplotlib for visualization. Distribution diagrams and tables highlighting the key characteristics of the data were employed to enhance result interpretation.

Results

General Characteristics of the Extracted Records

The overall characteristics of the extracted records are presented in Figure 1. The data in Figure 1 illustrate the distribution of publications by year and their respective proportions within the dataset. The highest proportion of records corresponds to publications from 2015, accounting for 19.99% of

the total. This is followed by 2016 and 2017, with 17.61% and 16.33%, respectively. The number of records gradually decreases over subsequent years, with notable drops in 2022 (2.12%) and 2023 (1.04%). Publications from 2024 constitute only 0.18% of the dataset, which is expected given the partial availability of publications for this year.

For further analysis, the dataset is divided into two periods:

2020–2024: Representing the most recent data, with a total of 1,999 records (19.99% of the total).

2015–2019: Representing the earlier years, with a total of 8,001 records (80.01% of the total).

Based on the analysis of the extracted records, article characteristics were identified. Table 1 presents the top 10 documents with the highest number of citations in the References section.

The top 10 articles (Table 1) are characterized by high citation counts (TC) and a significant number of cited references (NR). The most cited article (UT: WOS:000474219100010) has TC=7027 and NR=41, indicating its importance within the scientific community. The article with the highest number of references (NR=159, UT: WOS:000464864400007) has relatively lower citation counts (TC=2852), which may reflect its use in a specific context. The publication years span from 2016 to 2021, with the majority of articles published between 2018 and 2020.

Table 2 presents the distribution of documents by categories. The majority of articles (over 98%) demonstrated a strong correlation between the number of cited references (NR) and citation

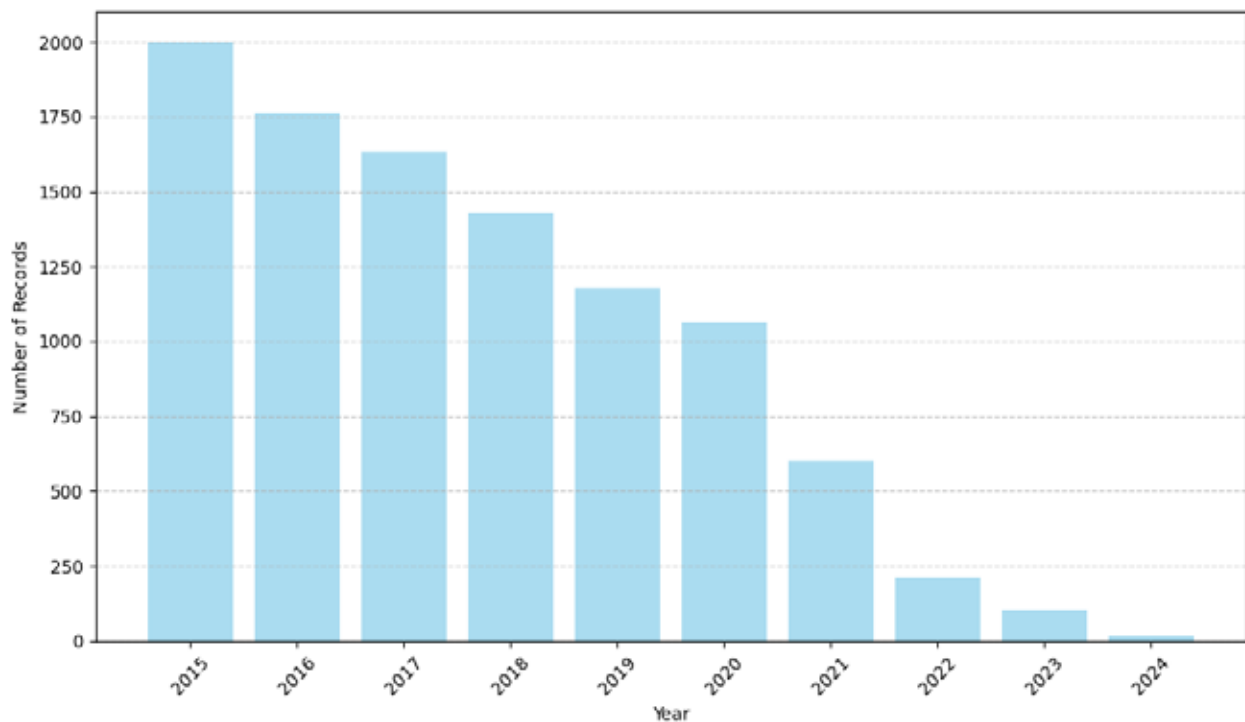


Figure 1. General Characteristics of Extracted Records

metrics (TC and Z9), supporting the hypothesis that an increase in the number of references in an article contributes to its citation count. Medium and low correlations are extremely rare (<2%), which may indicate specific thematic or structural characteristics of these publications. These findings confirm a consistent pattern between the number of references and article citation levels

Table 3 presents the statistical description of the NR, TC, and Z9 metrics. The data in Table 3 demonstrate key statistical indicators for the High category, including mean values, medians, minimum and maximum values, as well as standard deviations for the NR, TC, and Z9 metrics. The presented data indicate significant variation in citation levels and the number of cited references, confirming the diversity of publications within this category.

Figure 2 presents the distribution of publications with a high level of citations by year. The analysis of highly cited publications (High) shows that in 2024, only 18 documents reached this level, 88 in 2023, and 195 in 2022. The highest number of highly cited

documents was observed in 2015 (1890).

Table 4 presents the distribution of document types in the high-citation category. The data in Table 4 demonstrate the diversity of publication types within this category. The majority are articles and reviews, highlighting their significant impact in the scientific domain. The category also includes less common document types, such as book chapters, conference materials, and monographs.

Table 5 presents the distribution of high-category documents by citation subcategories. The data in Table 5 shows the division of high-category documents into subcategories based on the number of citations. Most documents fall into the “Moderate” and “Low High” subcategories, indicating a broad range of citation levels. The “High” and “Very High” subcategories contain fewer documents, highlighting their exceptional citation impact.

The results related to open access (OA) data constitute a specific portion of the extracted records. Table 6 presents the distribution of publications by open access types (OA):

Table 1. Top-10 documents with the highest number of citations in the references section

UT	NR	TC	Z9	U1	U2	PY
WOS:000474219100010	41	7027	7874	98	522	2019
WOS:000454273400010	37	4671	5677	49	288	2018
WOS:000605879000004	30	3990	4003	114	819	2020
WOS:000456831900004	31	3306	3467	10	99	2018
WOS:000464864400007	159	2852	2909	2	19	2017
WOS:000573273700003	74	2677	3178	6	16	2016
WOS:000402416500003	46	2547	2848	24	218	2017
WOS:000504687300001	57	2031	2468	51	247	2021
WOS:000532557100001	118	1934	2084	58	161	2021
WOS:000431310400001	46	1539	1564	15	141	2018

Note. UT - Accession Number; NR - Cited Reference Count; TC - Web of Science Core Collection Times Cited Count; Z9 - Total Times Cited Count (all indexes); U1 - Usage Count (Last 180 Days); U2 - Usage Count (Since 2013); PY - year.

Table 2. Distribution of Documents by Categories

Category	Count_TC	Count_Z9
High	9417	9457
Medium	120	82
Low	17	15

Table 3. Statistical Description of Metrics NR, TC, Z9

Metric	NR	TC	Z9
count	9414.0	9414.0	9414.0
mean	69.56	136.97	157.28
std	39.38	147.97	169.44
min	21.0	73.0	73.0
25 %	43.0	84.0	95.0
50 %	62.0	104.0	119.0
75 %	87.0	145.0	168.0
max	766.0	7060.0	7908.0

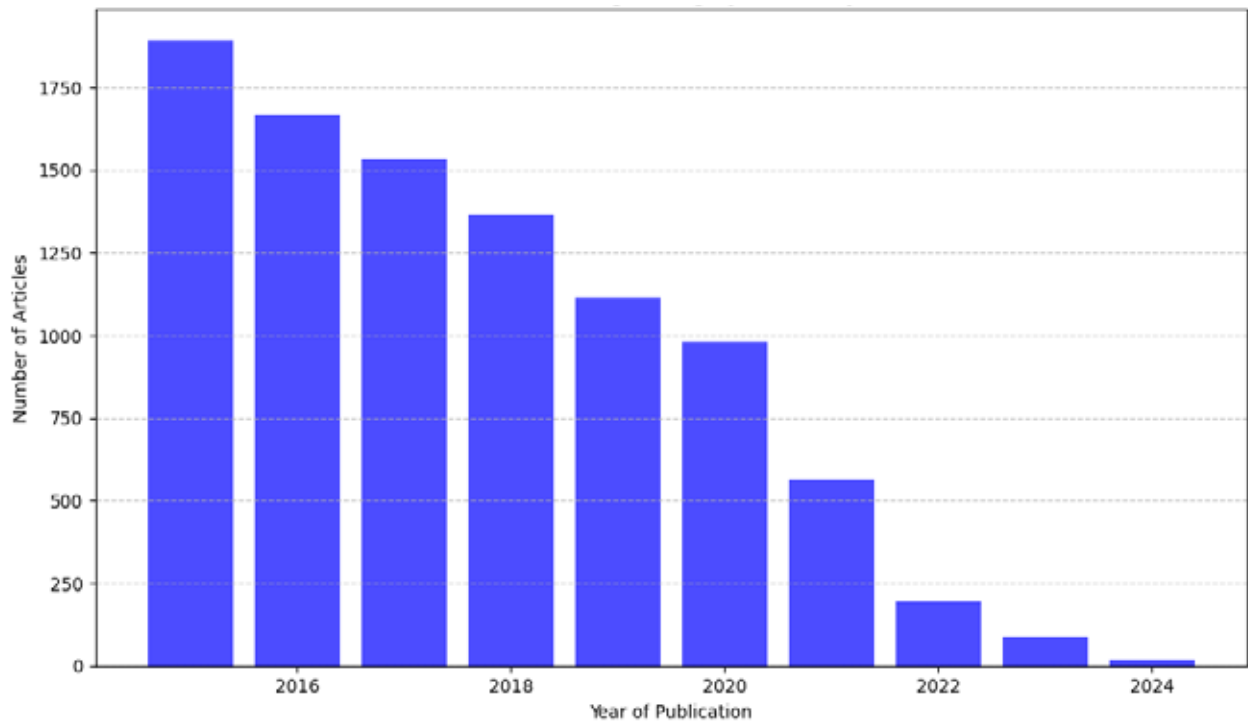


Figure 2. Distribution of Publications with High Citation Levels by Year

Table 4. Distribution of Document Types in the High Citation Category

Document Type	Percentage
Article	75.29
Review	21.81
Chapter	1.04
Material	0.87
Paper	0.8
Book	0.12
Access	0.03
Publication	0.03
Letter	0.01

Table 5. Distribution of High-Category Documents by Citation Count Subcategories

TC_Subcategory	Percentage
Moderate	52.5
Low High	46.21
High	1.06
Very High	0.23

- The largest number of publications falls under the “Unknown” category (5,745 records), indicating a lack of open access information for these records.
- Among publications with known access types, the most common are:
 - Green Accepted (687 records),
 - Green Published, hybrid (425 records),
 - Green Submitted (411 records),
 - Green Published (358 records).
- Combined categories, such as “Green Published, hybrid” and “Green Accepted, Green Published, hybrid,” are less frequent but provide valuable

insights for analyzing publication accessibility.

Before testing the hypotheses, an assessment of the normality of key metrics was conducted using the Shapiro-Wilk and Kolmogorov-Smirnov tests. The results of both tests indicated a significant deviation from a normal distribution ($p < 0.05$), justifying the use of nonparametric methods, such as Spearman’s correlation and the Kruskal-Wallis test.

Hypothesis 1, regarding the relationship between the number of cited references and the citation level of articles, was tested using Spearman’s correlation. The analysis revealed a weak but statistically significant correlation between the number of

Table 6. Distribution of Publications by Open Access Types

OA_Sorted	Count	Percentage
Unknown	5745	60.14
Green Accepted	687	7.19
Green Published, hybrid	425	4.45
Green Submitted	411	4.3
Green Published	358	3.75
Green Published, gold	307	3.21
Bronze	305	3.19
hybrid	223	2.33
gold	171	1.79
Green Accepted, Green Submitted	129	1.35
Bronze, Green Published	120	1.26
Green Accepted, Green Published	85	0.89
Green Submitted, gold	78	0.82
Green Accepted, Green Published, hybrid	71	0.74
Bronze, Green Accepted	62	0.65
Green Published, Green Submitted, gold	54	0.57
Bronze, Green Submitted	46	0.48
Green Published, Green Submitted	42	0.44
Green Accepted, hybrid	37	0.39
Green Published, Green Submitted, hybrid	36	0.38
Green Accepted, Green Published, gold	24	0.25
Green Accepted, Green Published, Green Submitted	21	0.22
Bronze, Green Accepted, Green Submitted	19	0.2
Bronze, Green Published, Green Submitted	17	0.18
Green Submitted, hybrid	16	0.17
Green Accepted, Green Published, Green Submitted, hybrid	13	0.14
Bronze, Green Accepted, Green Published, Green Submitted	11	0.12
Bronze, Green Accepted, Green Published	11	0.12
Green Accepted, Green Published, Green Submitted, gold	9	0.09
Green Accepted, gold	9	0.09
Green Accepted, Green Submitted, gold	7	0.07
Green Accepted, Green Submitted, hybrid	3	0.03

cited references and citation levels (coefficients of 0.1329 for TC and 0.1342 for Z9, $p < 0.05$). These results confirm that the number of cited references is associated with an article's citation level, but the relationship is weak, likely influenced by other factors such as the publication year or journal prestige.

Hypothesis 2 regarding differences in citation levels between open-access articles (OA) and articles with closed-access (Non-OA) was tested using the Kruskal-Wallis test. The analysis revealed statistically significant differences for TC (Kruskal-Stat = 34.7722, $p < 0.05$) and Z9 (Kruskal-Stat = 19.6908, $p < 0.05$), but not for the number of cited references (Kruskal-Stat = 0.6218, $p > 0.05$). A detailed breakdown by publication type showed that open access significantly influences the citation levels of Article and Review formats. For the Other category, no significant differences were observed, likely due to the small sample size.

Hypothesis 3 concerning differences in citation metrics across publication years was confirmed. The Kruskal-Wallis test indicated significant differences for all metrics: TC (Kruskal-Stat = 41.0379), Z9 (Kruskal-Stat = 176.6505), and NR (Kruskal-Stat = 324.5172), all with $p < 0.05$. Additional Dunn post-hoc tests for TC demonstrated that the largest differences were observed between 2021 and the years 2022, 2016, and 2015. These differences highlight the temporal influence on citation level distribution.

The analysis results indicated that the number of cited references has a weak but statistically significant impact on the citation level of articles, as evidenced by Spearman's correlation coefficients. However, this relationship is limited and likely influenced by additional factors such as the publication year or journal prestige.

Open access shows a statistically significant impact on the citation levels of publications,

particularly for articles and reviews, underscoring the importance of accessibility in enhancing the scientific impact of research. However, no differences in the number of cited references were identified between articles with different access statuses.

The publication year was found to be a significant factor influencing citation metrics and the structure of references. This highlights the need to account for temporal aspects when evaluating scientific outputs.

Thus, the study's findings confirm the importance of a comprehensive approach to analyzing citation dynamics, taking into account factors such as the number of cited references, publication accessibility, and temporal characteristics.

Discussion

The aim of the study is to evaluate the relationship between the number of cited references and the citation level of scientific publications in the field of sport and physical activity. Additionally, the study seeks to analyze the impact of access mode (open or closed) and publication type on citation metrics.

Our results revealed that the number of cited references has a statistically significant but weak impact on citation levels, indicating the presence of other factors influencing citations. Open access was identified as a significant factor that increases citation levels, particularly for articles and reviews. Additionally, the publication year was found to have a substantial effect on citation metrics, with the most notable differences observed for recent publications.

Our results confirm the presence of a weak but statistically significant correlation between the number of cited references (NR) and article citation levels, as reflected by the TC and Z9 metrics (Spearman's coefficients of 0.1329 and 0.1342, respectively). This indicates that while the number of references influences citation levels, its role is not definitive.

Numerical data from our study indicate that the average value of the NR metric in categories with high citation levels is 69.56, ranging from 21 to 766 (Table 3). At the same time, the highest number of citations (TC = 7027) is observed in an article with 41 references, highlighting that a high citation level is achievable even with a moderate number of cited references.

Comparison with data from other studies confirms the ambiguous impact of the number of references on citation levels. For example, Aksnes et al. [15] and Dougherty et al. [56] suggest that citation metrics are more indicative of an article's scientific impact than its structural characteristics, such as the number of references. Nieminen et al. [57] further note that citation levels depend on factors such as journal prestige, indexing in databases, and article visibility.

Unlike other fields, our data, focused on the topic of sport and physical activity, emphasize the importance of the applied aspect of research, which may increase interest in publications regardless of the number of references. For instance, an analysis of highly cited publications revealed that such articles are most frequently published as original research or reviews, accounting for 75.29% and 21.81%, respectively (Table 4).

Moreover, temporal aspects have a significant impact on citation levels: articles from earlier years, such as 2015, have had more opportunities to accumulate citations (Figure 2), further diminishing the relevance of the number of cited references. Thus, our findings confirm that factors such as article accessibility, journal prestige, and research topic play a more substantial role in shaping citation metrics than the number of references.

Our results confirm that the access mode of an article significantly influences its citation level. Statistically significant differences for the TC and Z9 metrics were identified between open-access (OA) and closed-access (Non-OA) articles, whereas the number of cited references (NR) remains independent of the access mode. This suggests that article accessibility primarily affects its visibility and popularity rather than its structural characteristics.

The share of closed-access publications is 60.14% (Table 6), which limits the scope of analysis for this group. Among the known forms of open access, the most common are "Green Accepted" (7.19%) and "Green Published" (4.45%), which, as shown by our data, contribute to greater visibility of publications.

Comparison with literature data confirms the advantages of open access. For instance, Dorta-González et al. [58] note that hybrid journals (Hybrid Gold OA) exhibit higher citation levels compared to closed-access publications. Yun [59] emphasizes that the citation levels of articles in the Hybrid Gold OA model can double, especially when external funding is available. At the same time, Castillo [60] points out that not all OA models are equally effective in increasing citation levels, as this depends on contextual and thematic factors. This is further supported by the findings of Momeni et al. [61].

Our data align with these findings, showing that hybrid and green forms of open access significantly enhance the visibility of publications. For example, hybrid access ("Green Published, hybrid") accounts for 4.45% of all publications with a known access status, while "Green Submitted" represents 4.3% (Table 6). At the same time, the share of publications with Gold OA remains small (1.79%) and shows mixed results in terms of citation levels.

Thus, our results highlight the importance of open access as a factor increasing citation levels, particularly for articles of the Article and Review types. However, the specific impact of various access models remains complex and requires further

investigation to fully understand their effects.

The data analysis confirmed that different publication types (Article, Review, Other) exhibit significant differences in citation levels. Our results showed that publications in the “Review” format have the highest citation levels, followed by “Article,” while publications in the “Other” category do not show significant differences. Articles account for 75.29% of highly cited publications, while reviews represent 21.81% (Table 4). These findings confirm that review articles and original research form the foundation of scientific literature in the field of sport and physical activity.

Most highly cited publications fall into the “Moderate” (52.5%) and “Low High” (46.21%) categories, indicating a wide range of scientific impact among articles (Table 5). This aligns with findings from other studies, such as Weale et al. [62], which emphasize the importance of reviews published in high-impact-factor journals. Due to their systematic approach and in-depth analysis of topics, such articles often serve as key references for subsequent research.

The findings of Kousha and Thelwall [63] confirm that additional factors, such as article length, number of authors, and international collaboration, positively influence citation levels. This is particularly relevant for publications in the Article and Review formats, aligning with our observations.

In the context of sport and physical activity disciplines, unique features emerge due to the applied nature of research. Review articles play a crucial role in knowledge systematization, while original articles in the Article format reflect empirical findings significant for practical applications. Publications in the Other category, which includes less formal or specialized document types, remain minimal (2.9%), limiting their influence within the scientific community.

Thus, our findings emphasize that publication type is a key determinant of citation levels. Review articles play a leading role in shaping scientific discourse, while Article-format publications contribute an applied perspective, advancing science and its practical application. This underscores the need to consider publication types when assessing their scientific impact, particularly in sport and physical activity disciplines.

A comparison of our data with findings from studies such as Abramo et al. [64], Dougherty et al. [56], and Nieminen et al. [57] confirmed that the number of cited references can influence subsequent citation levels. However, unlike these studies, our results demonstrate a weak correlation between these metrics (Spearman’s coefficients: 0.1329 for TC and 0.1342 for Z9), suggesting the influence of additional factors such as journal prestige, article accessibility, and publication year.

An analysis of citation dynamics over the years

showed that articles published between 2015 and 2020 exhibit the highest citation levels. For instance, in the high-citation category, the maximum number of documents (1,890) corresponds to 2015, while the share of publications decreases significantly in later years (e.g., 564 articles in 2021 and 88 in 2023) (Figure 2). This aligns with the findings of Teplitzkiy et al. [65], who emphasize that older publications have more time to accumulate citations.

Our results expand on these observations, clarifying that not only temporal factors but also disciplinary characteristics play a significant role in citation dynamics. For example, in the field of sport and physical activity, the applied nature of research increases interest in articles, which may impact their citation levels regardless of the publication year.

Thus, our findings add specificity to existing data, illustrating how temporal frameworks and disciplinary specificity interact to influence citation metrics. This highlights the necessity of accounting for temporal factors in citation analyses, particularly in rapidly evolving disciplines.

Our results confirm the key findings of previous studies, such as Aksnes et al. [15], Thelwall et al. [66], Lafia et al. [67], and Nightingale et al. [68], which suggest that citation levels reflect the scientific value and impact of an article but are not a universal indicator of its quality. At the same time, our study provides more detailed data that deepen the understanding of the relationships between an article’s structural characteristics, accessibility, and citation levels.

One of the key advantages of our findings is the comprehensive approach, which includes analyzing the impact of access mode (OA and Non-OA) and publication types (Article, Review, Other) on citation metrics. For example, our data showed that open-access articles account for 39.86% of all analyzed publications, with the highest citation levels observed for Review articles (21.81%) and Articles (75.29%) (Table 4). This complements the findings of Dardas et al. [69] and Torres [17], demonstrating that the accessibility of publications plays a crucial role, particularly in the Article and Review categories.

Moreover, our study refined the temporal aspects of citation dynamics. The highest citation levels were observed for publications from 2015–2020, consistent with the findings of Teplitzkiy et al. [65]. However, our data provide additional insights into the quantitative distribution of publications by year: for instance, articles from 2015 account for 19.99% of the sample and exhibit the highest accumulated citation levels (Figure 2).

Our analysis also considers the disciplinary specifics of sport and physical activity. These characteristics, including the applied nature of research, emphasize the importance of factors such as visibility and accessibility of publications. Unlike

the general conclusions of Abramo et al. [64] and Dougherty et al. [56], our findings highlight that thematic specificity significantly impacts citation metrics.

Thus, our study not only confirms existing findings but also provides new, more detailed data. These insights can be used to further explore the relationship between the structural characteristics of publications, their accessibility, and citation levels, as well as to develop strategies for enhancing the scientific impact of research.

Our study confirmed that the citation levels of scientific publications are influenced by multiple factors, including the number of cited references, access mode, and publication type. Despite the weak correlation between the number of cited references and article citation levels, significant effects were observed for open access (particularly hybrid and green formats) and publication types (Article and Review) on citation metrics. These findings underscore the importance of considering context and disciplinary specificity when analyzing scientific publications.

Our study confirmed that the citation levels of scientific publications are shaped by multiple factors, including the number of cited references, access mode, and publication type. Despite the weak correlation between the number of cited references and citation levels, significant impacts were observed for open access (particularly hybrid and green formats) and publication types (Article and Review) on citation metrics. These findings highlight the importance of considering context and disciplinary specificity when analyzing scientific publications.

However, the study has several limitations. First, the dataset covers publications from 2015 to 2024, which may not fully capture long-term citation trends, particularly for recent publications (e.g., articles from 2023–2024 account for less than 2% of the sample). Second, the study is limited to the discipline of sport and physical activity, restricting the generalizability of the results to other scientific fields. Additionally, the applied nature of research in this discipline may reduce the influence of traditional factors, such as the number of cited references, compared to other fields.

For future research, the following recommendations are proposed:

1. Expand the time frame of analysis to include publications with a longer citation history.
2. Conduct comparative analyses across other disciplines to better understand the impact of disciplinary specificity on citation levels.
3. Incorporate additional metrics, such as audience engagement indices and alternative citation indicators (altmetrics), for a more comprehensive analysis.

These steps will deepen the understanding of citation formation mechanisms and enable

the development of more precise approaches to evaluating citations, accounting for interdisciplinary differences and temporal aspects.

Conclusions

The study results confirmed that the citation levels of scientific publications depend on several factors, including the number of cited references, access mode, and publication type. The main findings can be summarized as follows:

1. Despite the weak correlation between the number of cited references and citation levels, this metric holds auxiliary importance and may influence citation levels in combination with other factors, such as journal prestige and publication year.
2. Open access, particularly in hybrid and green forms, has a significant impact on citation levels. This highlights the importance of accessibility in increasing the visibility and influence of scientific articles.
3. Publications in Review and Article formats demonstrate the highest citation levels, underscoring their pivotal role in shaping scientific discourse and advancing research in sport and physical activity.
4. High citation levels are characteristic of publications from 2015–2020, confirming the influence of time on citation accumulation. However, a trend of declining citation levels is observed for articles published in more recent years.
5. In the field of sport and physical activity, the applied nature of research enhances the importance of factors such as publication accessibility and visibility while reducing the influence of structural characteristics, such as the number of references.

The study revealed significant patterns that can be used to develop recommendations for authors and journal editors aimed at enhancing the scientific impact of publications. At the same time, the findings highlight the need for further research that considers temporal and disciplinary aspects and employs a broader set of metrics for analysis.

Conflict of Interest

One of the authors (Sergii Iermakov) serves as the Editor-in-Chief and Publisher of this journal. To ensure an objective review process, the manuscript was handled by an independent editorial board member, and the peer review was conducted by external reviewers who had no affiliations with the authors. The Editor-in-Chief did not participate in the review or editorial decision-making process regarding this manuscript. The other co-author (Georgiy Korobeynikov) declare no conflict of interest related to this publication.

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