

Bibliometric Analysis of Trends in Scientific Publication on Culture Chachapoyas

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Abstract

The bibliometric analysis sought to evaluate the scientific production related to the Chachapoyas culture and to provide a systematic and quantitative understanding of the current state of research in this field. Comprehensive searches were conducted in the Scopus database using the defined search criteria limiting the search to scientific articles published in scientific journals until September 2023. The results were exported in a format that allowed subsequent analysis. Relevant bibliographic data were extracted from the search results, including article title, authors, year of publication, abstract and citations. A number of bibliometric metrics were calculated, such as number of publications per year totaling 40, the number of citations per article totaling 354, and the most frequent keyword was Peru with 17 occurrences. The author with the highest number of publications was Toyne J.M. with 9 papers and the journal with the most publications was the International Journal of Osteoarchaeology with 4. The bibliometric analysis shows a constant production in the research of the Chachapoyas Culture, with international collaboration and influential studies. However, there is still much to study and discover about this important pre-Columbian culture.

Keywords: *Articles; Bibliometric analysis; Chachapoyas culture; Peru.*

Introduction

The Chachapoyas culture, also known as the "people of the clouds", developed in parallel to the Inca civilization in northeastern Peru, specifically in the Amazon region, during the period from 800 AD to the 1470s (Friedrich et al., 2010).

In 1997, in the Laguna de los Cóndores, 219 mummies belonging to the Chachapoyas Culture were discovered in a remarkable state of preservation. Computed tomography (CT) studies performed on 12 of these mummies revealed the presence of eight females, three males and one undetermined female, ranging in age from newborn to 40 years old. Dental lesions were observed in seven mummies, while five were in excellent condition. Additionally, pathologies such as occipital osteoma, tuberculous spondylodiscitis and probable tuberculous erosions in tarsal joints and one sacral bone were identified (Friedrich et al., 2010).

An additional study evaluated the presence of tuberculosis (TB) in bone lesions of 13 inhabitants of the Kuelap Fortress, belonging to the Chachapoyas culture, evidencing the existence of the disease before and after the Inca occupation (Toyne, Esplin, & Buikstra, 2020).

Genetic analyses of the Chachapoyas culture indicate that this society was the result of interactions between the Coastal, Andean and Amazonian regions. Although genetic markers do not reveal significant

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substructure in the Chachapoyas sample, they suggest that genetic subdivision does not always correlate with cultural differentiation (Guevara et al., 2020).

A stable isotope study of bones and teeth from graves at Los Pinchudos revealed a mixed plant- and protein-based diet, with moderate proportions of terrestrial animals. In addition, limited variability in oxygen isotopic values was observed among paired tissues, indicating the possible presence of non-local individuals in certain tombs (Toyne, Church, Luis Coronado Tello, & Morales Gamarra, 2017).

The expansion of the Inca Empire and the spread of Quechua, including among the Chachapoyas, has been a topic of interest. Genetic analyses of 119 samples suggest a distinctive indigenous component in the Chachapoyas, challenging the idea of massive relocations by the Incas. Furthermore, Quechua speakers in the region do not share significant genetic similarity with other Quechua speakers, indicating a cultural diffusion of the language rather than migration (Barbieri et al., 2017).

Archaeological and ethnohistoric documents suggest that the Chachapoya region was inhabited by several sociopolitical groups that united against the Incas. Subsequent research focused on internal genetic differentiation and extraregional gene flow during the Late Chachapoya period. Craniometric data from three samples indicate that genetic differentiation varied among populations, with external gene flow higher in Laguna Huayabamba and Laguna de los Cóndores, and lower in Kuelap (Kenneth & Nystrom, 2006).

This article presents a bibliometric analysis of the research conducted on the Chachapoyas culture. Through this bibliometric analysis we explore the scientific production regarding this important Peruvian culture. Our goal is to provide a comprehensive overview of how science is approaching the study of the Chachapoyas culture, and to provide a systematic and quantitative understanding of the current state of research in this field, with the aim of guiding future research and contributing to the advancement of knowledge in the field.

Search Strategy

For this analysis, an electronic search was conducted in October 2023, using Elsevier's Scopus database (<https://www.scopus.com>), due to its wide coverage of scientific journals and the importance of this database in the scientific world. The advanced search subject typed was: (TITLE-ABS-KEY ("Chachapoya* archaeology")) OR TITLE-ABS-KEY ("Chachapoya* culture")

OR TITLE-ABS-KEY ("Chachapoya* civilization") OR TITLE-ABS-KEY ("Chachapoya* archaeological sites") OR TITLE-ABS-KEY ("Chachapoya* history") OR TITLE-ABS-KEY ("Chachapoya* anthropology") OR TITLE-ABS-KEY ("Chachapoya* ethnohistory") OR TITLE-ABS-KEY ("Chachapoya* genetics") OR TITLE-ABS-KEY ("Chachapoya* descendants") OR TITLE-ABS-KEY ("Chachapoya* cultural heritage") OR TITLE-ABS-KEY (chachapoya*) OR TITLE-ABS-KEY (kuelap) OR TITLE-ABS-KEY (karajia) OR TITLE-ABS-KEY (karajia) OR TITLE-ABS-

KEY (leymebamba) OR TITLE-ABS-KEY (leimebamba) OR TITLE-ABS-KEY (revash) OR TITLE-ABS-KEY (quiocta) OR TITLE-ABS-KEY (chilchos)). The authors carefully examined the titles and abstracts of prospective publications related to the Chachapoyas Culture. Of 114 articles retrieved, 40 were selected based on suitability and relationship to the topic (Figure 1). As this research did not involve any human or animal interaction, ethical approval was not obtained for this analysis.

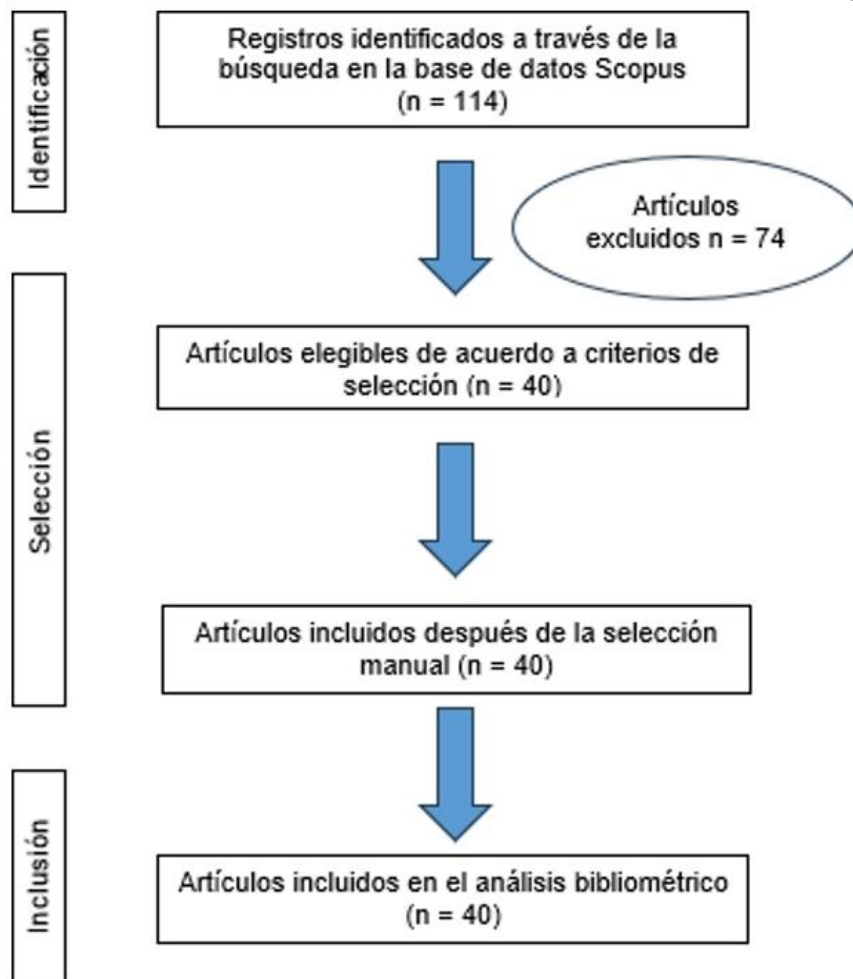


Figure 1. Flow chart of four phases of the data extraction and filtering process of publications related to the Chachapoyas culture.

Inclusion/Exclusion Criteria

The inclusion criteria for this bibliometric analysis included focusing on articles without language restriction. Regarding the type of publication, scientific articles were specified in the search. Research that was not specifically related to the Pre- Columbian Chachapoyas culture was excluded. Throughout the initial screening process by the researchers, articles were further disqualified if the publications were not related to the domain of the Chachapoyas Culture in pre-Columbian times. As the research was conducted in October 2023, all articles from 1961 to 2023, covering research related to this culture, were counted.

Data Analysis

After article selection, data were exported from the Scopus database in BibTeX format. The search results were analyzed using "Microsoft Excel" and VosViewer (<https://www.vosviewer.com/>) which provides the tools to carry out a complete bibliometric analysis, following the Scientific Mapping Workflow.

For the analysis and visualization of the data, we analyzed the evolution of the total number of publications, citation analysis of related articles, the main countries where they were published, as well as the collaboration network between countries, the main journals that have contributed, the main academic institutions, the most frequent keywords in the research and the distribution of articles on Chachapoyas culture by journal.

Results

A study was carried out to know the scientific activity regarding the Pre-Columbian Chachapoyas Culture. Numerical data calculated from the bibliographic characteristics observed in the documents published in the Scopus database were taken.

However, this publication identified in the search does not deal with the Chachapoyas culture, but rather with the work of the Health Service in the construction of the Bagua-Chachapoyas highway (Saavedra, 1961). Thus, the first document identified is from 1988. From the year 2000 onwards, there is a constant publication, with a record of between 1 and 3 publications per year, until the year 2020, when there is a peak with 7 publications, falling back to 4 publications in 2021 and 1 in 2022. However, in the present year, 3 publications related to the Chachapoyas culture have already been found (Table 1). The citations have a different distribution, since the 3 articles published in 2017 have been cited 60 times, being these productions the ones that caused the greatest interest, followed by the 2 publications of 2013, with 53 citations (Table 1).

Table 1. Evolution of publications on the Chachapoyas culture.

Year	Publications	Citations
1988	1	0
2000	1	2
2004	1	20
2005	2	35
2006	1	18
2007	2	27
2009	1	8
2010	2	33
2011	1	13
2013	2	53
2015	3	30
2016	1	15
2017	3	60
2018	2	1
2019	2	1
2020	7	19
2021	4	17
2022	1	2
2023	3	0
Total	40	354

Source: Scopus.

There are 98 different authors in the analysis, of which 19 appear in more than one document registered in Scopus. Of the specialists who have published the greatest number of documents, the Bioarchaeologist of the University of Central Florida, PhD. Marla Toyne stands out with nine articles; followed by Dr. Kenneth Carlyle Nystrom and Dr. Sonia Guillén of the Mallqui Center and Museum of Leymebamba, with 6 publications each (Table 2).

Table 2. Authors with the highest production of documents in Scopus about the Chachapoyas culture.

Author	° of documents
Toyne J.M.	9
Ystrom K.C.	6
Uillén S.E.	6
Hurch W.B.	4
Andoval J.R.	3
Fujita R.	3
Uevara E.K.	3
Palo J.U.	3
Ajantila A.	3
Uengerich A.	3

Antos F.R.	2
Roewer L.	2
Seidler H.	2
Uikstra J.E.	2
King J.L.	2
Buś M.M.	2
Udowle B.	2
Nzellini A.	2
Chjellerup J.	2

Source: Scopus.

Table 3 presents an overview of research activity related to the Chachapoyas culture in various countries. Each row corresponds to a country and includes the number of papers published and citations obtained. It can be seen that the United States

The United States leads in terms of number of papers with a total of 22 publications, followed by Peru with 16 articles, and then Germany and Finland with 4 and 3 papers respectively. Although the United States and Peru have the highest number of citations with 202 and 161 comparatively, it is interesting to note that Brazil, which has only 2 citations, has achieved 50 citations, and Canada, which has only one article, has achieved 13 citations. Figure 3 identifies a network of collaboration between countries that worked together in research related to the Chachapoyas Culture, where the United States is a prominent collaborator in this research network.

Table 3. Production of articles by country on the Chachapoyas culture.

Country	of Articles	Itations
United States	22	202
Peru	16	161
Germany	4	29
Finland	3	29
Brazil	2	50
Austria	2	26
Netherlands	2	6
Canada	1	13
Estonia	1	4
Italy	1	4
Ecuador	1	4
Spain	1	2
Australia	1	2
Tunisia	1	1
Denmark	1	1
France	1	0

Source: Scopus

Figure 2 shows the collaboration between countries for the publication of research documents on the Chachapoyas Culture. The countries with the highest production are between the United States and Peru, with joint collaborations with Germany, Brazil and Estonia. Tunisia, Holland and Italy show individual collaborations with the United States for these publications, while Austria and Spain show individual collaborations with Peru.

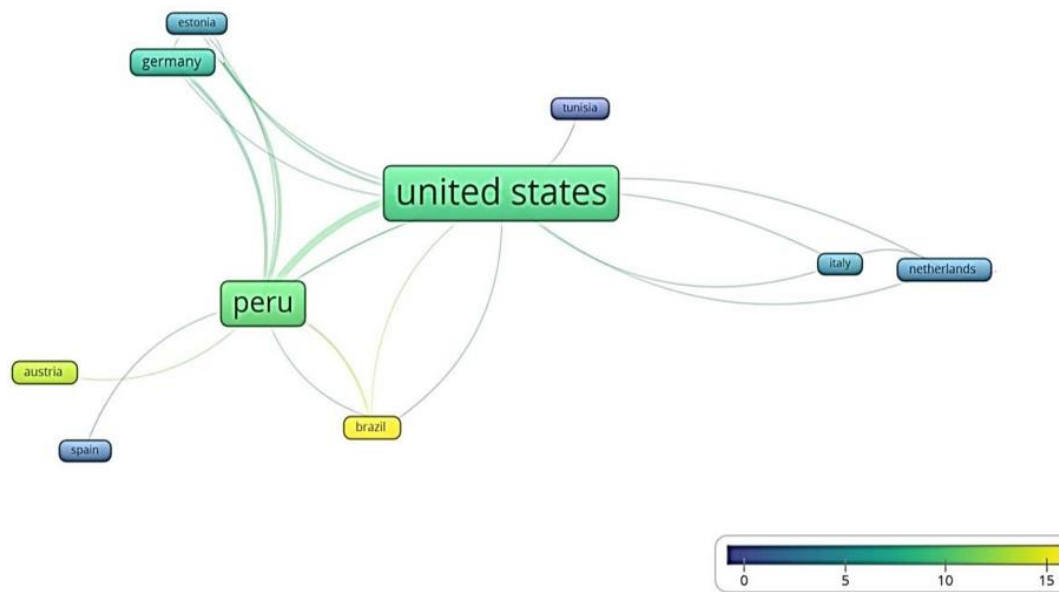


Figure 2. Research network by production and citation on the Chachapoyas Culture among countries.

Source: Scopus

The article published by Sandoval et al. (2013) entitled "Tracing the genomic ancestry of Peruvians reveals a major legacy of pre-Columbian ancestors", is the most cited, with a total of 46 citations. The article by Nystrom, Goff, and Goff (2005) is the second most cited with 22 citations, as is Barbieri et al. (2017) with 22 citations (Table 4).

Table 4. Most cited articles by author on the Chachapoyas culture.

Article	Year	Itations
Andoval et al.	2013	46
Ystrom et al.	2005	22
Barbieri et al. (2017)	2017	22
Toyne et al. (2017)	2017	20
Guillén (2004)	2004	20
Nystrom (2007)	2007	18
Nystrom (2006)	2006	18
Matthews-Bird, Valencia, Church, Peterson, and Bush (2017)	2017	18
Riedrich et al.	2010	17
Ystrom et al.	2010	16
Uevara eta al.	2016	15
Guengerich (2015)	2015	14
Toyne (2011)	2011	13
Urton (2005)	2005	13
Uevara et al.	2016	10
Wild, Guillen, Kutschera, Seidler, and Steier (2007)	2007	9
Toyne (2015a)	2015	9
Nystrom	2009	8
Toyne (2015b)	2015	7
Strom and Toyne	2013	7

Source: Scopus

The most relevant terms or key words found in this research are show that most of the studies refer to the country where the Chachapoyas culture developed, i.e. Peru (n=17). The reference to the names Chachapoya (n=12) and Chachapoyas (n=6), related to the culture studied, stand out in terms of frequency of occurrence. The words Humanos (n=12) and Humano (n=11) also had a high frequency of occurrence in the studies analyzed (Table 5).

Table 5. Most frequent keywords in research on the Chachapoyas culture.

Key words	Urrences
Peru	17
Chachapoya	12
Humans	12
Human	11
Archaeology	10
Article	9
Male	7
Female	6
Chachapoyas	6
South American gods	6
American Indian	5
Andes	5
Genetics	5

Source: Scopus

The key words in the original language in which they appear in the publications are shown in Figure 3. It can be seen that the word that is most closely related to the other terms is "Peru", which is where the Chachapoyas culture developed.

Keywords in the original language of the most frequent publications in research on the Chachapoyas Culture.

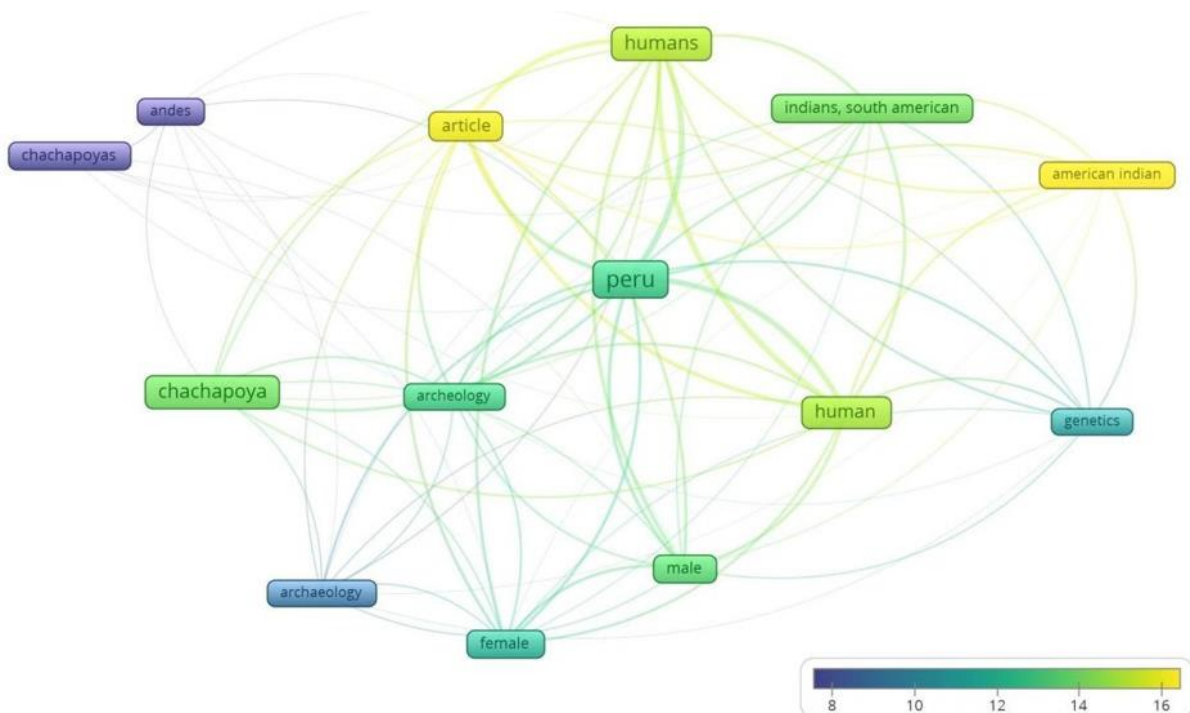


Figure 3.

Source: Scopus

The journals with the greatest interest in publishing research on the Chachapoyas culture are mainly in the United States and the United Kingdom. The journals with the highest number of publications are found within the first quartile in the areas of Archaeology and Anthropology, which shows the relative importance not only of the journals interested in publishing but also the importance of the topic. In addition, these journals have a relatively high H Index, which shows that the probability of citation is also high, as also shown by the number of citations reported for the published papers (Table 6).

Table 6. Journals with the highest number of publications on the Chachapoyas culture.

Magazine	xtures	ations	ce H	artil	aís	ditorial
ational Journal of	4	54	6	1	United	Wiley and
Osteoarchaeology						Sons Ltd
erican Journal of	3	40	30	1	United	y-Liss Inc.
Physical					States	
Anthropology						
atin American	3	27	5	1	United	mbridge
Antiquity					States	University Press
ational Journal of Paleopathology	3	20	2	1	ados United	evier BV
Chungara	3	18	8	2	hile	ersity of Tarapacá

Source: Scopus

Most of the documents registered in Scopus were articles, with a total of 35, and in smaller numbers there were 4 book chapters and only one article. conference document (Table 7).

Table 7. Types of documents published on the Chachapoyas culture.

Documents	Urrences
Articles	35
Book chapter	4
ument of conference	1

Source: Scopus.

Discussion

This is a bibliometric analysis that focuses on research based on the Chachapoyas culture. The amalgam of multidisciplinary studies on the Chachapoyas Culture reveals a complex and multifaceted Andean society, whose understanding has been enriched by approaches ranging from archaeology to linguistics, including genetic studies and interesting medical practices.

Genetic Structure and Diversity:

Genetic research has revealed a predominance of Amerindian ancestry in the Chachapoya populations, with intermediate levels of non-indigenous ancestry, especially of European origin in Chachapoyas, demonstrating that this pattern is consistent with post-Columbian migrations and historical reports suggesting the presence of significant indigenous population during the formation of the present-day country (Sandoval et al., 2013). Craniometric data collected during the Late Chachapoya period suggest internal genetic differentiation between the Laguna Huayabamba, Kuelap and Laguna de los Condores populations, supporting this finding by Relethford-Blangero residuals, which indicate different levels of external gene flow (Nystrom, 2006). Analysis of mitochondrial, Y-chromosomal and autosomal genetic markers in the Chachapoya population highlights a high genetic diversity, despite the dramatic population declines documented during historical events such as the Spanish conquest (Guevara et al., 2020). The study of genetic variation in populations of the northeastern Andes, including Chachapoyas, Huancas, Awajún, Wampís and Cajamarca, using aSTR and iSNP data, provides valuable information for tests of human identity. The observed genetic diversity contributes to the understanding of genetic variability in the region and may be essential for future forensic genetic studies in Peru (Guevara et al., 2021). Genetic analysis between Kañaris populations in Peru and Cañar in Ecuador reveals that, despite not sharing a close genetic relationship, there are some genetic associations between Ecuadorian 'Cañaris' and Peruvian populations such as Cajamarca and Chachapoyas, which point to the complexity of migrations and historical contacts in the region (Sandoval et al., 2020). The absence of a drastic reduction in population size in the past, together with the current high genetic diversity, suggests a not yet fully understood genetic complexity in the region (Guevara, Palo, Guillén, & Sajantila, 2016).

Medical Practices and Trauma:

The medical practices of the Chachapoyas Culture, such as documented cranial trepanations (Toyne, 2015a) highlight the surgical skill and diversity of treatments used by this ancient civilization. The study by Nystrom et al. (2005) offers a unique perspective by employing forensic entomology to examine prehistoric mortuary behavior with the analysis of insect recovered from a Chachapoya mummy package reveals almost immediate colonization after traumatic events, such as blunt blows to the head and trepanations. Nystrom (2007) article provides detailed information on trepanations in the Chachapoya region, highlighting the prevalence of circular trepanations, with evidence of healing in most cases, however, the purpose of these trepanations remains largely unknown. Evidence of medical interventions on skeletal remains suggests an advanced society in terms of medical knowledge.

Impact of diseases:

Toyne, Esplin, et al. (2020) address the presence of tuberculosis in the Chachapoya population, highlighting the importance of identifying extravertebral tuberculosis and noting differences in the manifestation of the disease compared to other coastal sites. Friedrich et al. (2010) employ multidetector computed tomography (MDCT) to study mummies from Laguna de los Cóncores, whose analysis reveals medical conditions, such as osteoarthritis and tuberculosis, allowing a deeper understanding of life and disease in the region. Thomas et al. (2021) conduct a detailed scientific evaluation of a Chachapoya mummy, using modern technologies such as computed tomography to provide unprecedented insight into the anatomy and preservation conditions of this important specimen. These findings expand our understanding of the distribution of infectious diseases in the region prior to European contact.

Estimation of Biological Parameters:

Anzellini and Toyne (2020) contribute height estimation formulas specific to the Andean region, recognizing the need for geographically adapted formulas due to the particularities of human growth at high altitudes. The same authors, Anzellini and Toyne (2019) developed a method for sex estimation from appendicular metrics, demonstrating its applicability in mixed archaeological contexts. This approach provides a valuable alternative in situations where the association of key elements with remains is not possible.

Violence and Cultural Contact:

Toyne (2011) findings of osteological evidence of scalp extirpation raise questions about the nature of interactions and possible conflicts between the Chachapoya Culture and Amazonian lowland tribes. The analysis of skeletal trauma by Nystrom and Toyne (2013) brings a unique perspective to the construction of Chachapoya identity as fierce warriors, by examining trauma marks on the remains, a narrative of violence that contributed to the construction of Chachapoya cultural identity is revealed. The presence of violent practices suggests a complex and dynamic cultural contact.

Khipu Registration Systems:

Urton (2005) study of the khipu highlights the presence of a system of "checks and balances" in the administration of the Inca empire. The identification of matching khipu accounts in Chachapoyas reveals a level of sophistication in the organization of information and the possible existence of khipu archives, thus contributing to the understanding of Inca bureaucracy.

Linguistic Diversity and Toponymy:

Urban (2021) research highlights the linguistic diversity in the Chachapoyas region, challenging the simplified idea of one-to-one correlations between languages and archaeological cultures. Linguistic differences are interpreted as indices of pre-Hispanic social, ethnic or political identities, enriching the reconstruction of cultural complexities. Rojas-Berscia (2020) provides insights into the existence of a pre-Inca language, possibly related to modern Kawapangan languages, through the analysis of toponymy in the region. This suggests an area of intense linguistic contact and highlights the need to further explore linguistic connections in the region. However, Michaela et al.'s (2023) analysis of the linguistic classification of Chachapoya highlights current limitations in research due to the paucity of toponymic and anthroponymic data for future comparative analysis. The linguistic study highlights the spread of Quechua in the Chachapoyas region, suggesting that the language spread primarily by cultural diffusion rather than migration (Barbieri et al., 2017).

Archaeology and Inca Occupation:

The Inca occupation in Chachapoyas, as evidenced in Napán's (2020) study, has been central to archaeological research. Schjellerup (2018) addresses the socioeconomic impact that Inca rule had on the Chachapoya, showing that the complex relationships between the Incas and the Chachapoya rebels, supported by archaeological evidence, ethnohistorical and botanical data, offers a deeper understanding of the social and economic dynamics in this region. The article by Toyne et al. (2017) sheds light on Inca imperial strategies in the Chachapoyas region, known for its resistance to domination, using isotopic analysis of remains at Los Pinchudos provides detailed insight into the dietary patterns and community mobility during Inca rule, which despite the appropriation of Inca material goods, highlights the persistence of local funerary practices, underlining the cultural resilience of the Chachapoyas.

Vernacular Architecture and Urban Management:

Diaz, Ortiz, Moreno, and Ortiz (2023) propose a methodology to assess the vulnerability of vernacular architecture in the historic towns of Leymebamba and Chachapoyas, focusing on the importance of recognizing and preserving these local constructions in the face of the threat of globalized architectural models, highlighting the need for urban management tools. Pratt and Guengerich (2023) present a case study illustrating the value of lithic collections in the Chachapoyas region, highlighting the potential of methods such as use microscopy and raw material analysis to address theoretical questions about sedentary society, providing a unique perspective on subsistence and ceremonial practices. The use of modern technologies, such as LiDAR, in the MEDS BV project (Righetti et al., 2021) has enabled remarkable discoveries at the Kuelap archaeological complex, which have revealed details of the architecture and landscape, providing an updated view of the site's occupation history and functions, as well as the need for conservation.

Climate Change and Land Use Practices:

Matthews-Bird et al. (2017) explore the relationship between climatic changes, land use practices and mortuary activities at Laguna de los Cóncores, showing the transition from a productive to a less productive lake coinciding with an increase in mortuary and settlement activity, concluding an adaptation of the inhabitants to the changing environment, revealing the interconnection between climatic, landscape and ritual factors in the region. Isotopic analysis of human and animal remains in the archaeological center of Kuelap provides information on dietary patterns and subsistence strategies in the region.

different periods. The shift towards more C3 plant resources may reflect adaptations to sociopolitical changes or Inca influences in the region (Toyne, Michell, Denierio, & Vargas, 2020).

Conclusions

The bibliometric analysis of research on the Chachapoyas Culture reveals a steady increase in the production of publications from 2000 to 2020, with a peak in the latter year. However, a decrease in publications is observed in 2021 and 2022, although the present year already shows an increase. Citations, on the other hand, are distributed differently, with the 2017 and 2013 productions standing out as the most cited. Marla Toyne, Kenneth Carlyle Nystrom and Sonia Guillén stand out as the most prolific authors, and international collaboration is evident, with the United States as a prominent contributor. Keywords and terms in the original language reflect a significant focus on the country where the culture developed, Peru. The journals with the highest interest in publishing research on the Chachapoyas Culture are mainly in the United States and the United Kingdom, with a relatively high H-index, indicating a high probability of citation.

There is an intriguing picture of the Chachapoyas Culture as a society rich in diversity, both in terms of cultural practices and interactions with other cultures. The combination of bioarchaeological, linguistic, archaeological studies, forensic sciences and modern technologies provides a more complete and nuanced view of this civilization in the highlands of northeastern Peru. However, many questions remain to be answered, and continued research is required to fully unravel the mysteries of this fascinating pre-Columbian culture.

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