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**Title:** Bibliometric Analysis of Craving in the Field of Drug and Behavioral Addiction during the Last Decade

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## **Abstract**

**Background:** With the growing knowledge of craving and the relevant causal factors that lead to the accumulation of solid theoretical frameworks during the past years and according to the review studies, it seems indispensable to carry out a bibliometric review of this literature.

**Methods:** In this study, by examining the papers published during the last decade in the Scopus database-the largest citation database functional, mapping, and content analysis of citation data- the researchers are trying to clarify the direction of research in the coming years.

**Results:** In the realm of craving research, it has been observed that multi-authored articles, such as, Boswell's (2016) study have garnered the highest number of citations. Notably, the names Boswell (2016) and Wolff May (2016) have emerged as prominent figures in this field. Lee X and the Journal of Addictive Behaviors are leading producers of research in the craving domain, The highest volume of scientific output originates from the Department of Psychiatry, Yale University School of Medicine, with significant contributions from the United States, China, Germany, Italy, and England. The term "craving" exhibits the highest frequency of use. The co-authorship network illustrates that the most significant collaborations occur between the United States and other countries, where the majority of scientific output in this field is concentrated.

**Conclusion:** This analysis leads to the conclusion that studies pertaining to cravings occupy a prominent position in global etiological research and therapeutic interventions for addictive disorders. The enduring popularity of authors and publications addressing these disorders remains noteworthy.

**Keywords:** Addictive behaviors, Bibliography, Craving, Drug addiction

## 1. Introduction

Addiction is a chronic relapsing disorder characterized by compulsive drug seeking, loss of control, and developing a negative emotional state (such as negative affect, anxiety, and irritability) when the substance is unavailable (Gay et al., 2022). Drug addiction and addictive behaviors pose global health challenges, cognitive functions, emotional responses, and cravings (Perrotta & Perri, 2022). Over the past two decades, many problematic or extreme behaviors have increasingly been categorized as addictions due to their resemblance to traditional psychoactive drug addiction (Gomez et al., 2022). During the 18th and 19th centuries, at the onset of the scientific revolution, psychiatrists such as Pinel, Rush, Krippin, Bleuler, and Freud began to presenting clinical observations suggesting that biological factors also contribute to the addiction process (Nathan et al., 2016). Following Second World War, both DSM-I and DSM-II, influenced by psychodynamic theories, emphasized these theories to explain the process of addiction. However, it was with the development of DSM-III that a clear theoretical stance on addiction was explicitly taken. Subsequent editions, such as DSM-IV and DSM-5, have adopted a biological perspective on the addiction process. DSM-5, in particular, references a growing body of empirical research that implicates specific brain mechanisms in addiction and provides a clear framework in this context (Nathan et al., 2016). The most recent iteration, DSM-5, defines "non-substance-related disorders" as addictive disorders that do not involve the use of psychoactive substances (Gay et al., 2022) . It also places substance use disorder (SUD) on a continuum ranging from mild to severe (Perry & Cornish, 2022b). A prominent characteristic of substance use disorder is relapse, often triggered by craving—an intensely subjective experience of the desire to consume (Venniro et al., 2021).

Craving represents a common symptom in individuals with drug use disorders and observed in cases of dependence on substances such as alcohol, nicotine, cannabis, cocaine, and other psychoactive substances (Zheng et al., 2021). In the DSM-5, craving is recognized as a dynamic phenomenon (Venniro et al., 2021), it occupies a central role in both addiction research and treatment. This concept, which has historical mentions dating back to ancient times, possesses a lengthy and somewhat intricate history (Ekendahl & Karlsson, 2022). Over the course of the past four decades, an estimated 10,000 articles have been dedicated to exploring this subject (Sayette et al., 2000). However, akin to other addiction-related concepts craving lacks a singular, universally accepted definition, and the definition of this construct has faced many challenges (Ekendahl & Karlsson, 2022). Furthermore, controversies abound regarding over the definition, measurement, function, neural underpinnings, and practical utility of craving in understanding the processes underlying addiction (Sayette et al., 2000). Notably, craving stands out as a significant risk factor for relapse and represents a crucial target for treatment interventions (Lambert et al., 2022).

Craving is defined as an "intensive desire or "Urge" to consume a substance or engage in a particular behavior In the context of drug addiction,, craving serves as a predictive factor for substance-seeking behavior and relapse following a period of abstinence (Song et al.,

2019). The act of returning to drug consumption, commonly referred to as relapse, represents a substantial obstacle to effective treatment. Relapse is frequently triggered by various factors, including re-exposure to substances, the recurrence of symptoms associated with prior substance use, or exposure to stressors (Perry & Cornish, 2022a).

According to the Elaborated Intrusion Theory of Desire (EIT), craving is characterized as an intense desire for "cognitive events laden with affection, in which a pleasurable or relaxing object or activity becomes the focal point of attention." This model suggests five categories of stimuli that can trigger craving, encompassing external cues (such as advertisement), anticipation of a response (e.g., stress), associated thoughts (for instance, thinking about someone with whom one frequently engages in gambling or drinking), negative affection (including depressed mood) and physiological symptoms (like withdrawal symptoms) (Cornil et al., 2021). In a study by Inge Mike et al. (2017) it was demonstrated that craving exhibits a negative correlation with the duration of the abstinence period. As the length of abstinence increases, the craving induced by gambling symptoms decreases (Limbrick-Oldfield et al., 2017). Recent neuroimaging research has revealed the significant role of the dorsolateral prefrontal cortex (DLPFC), among other brain regions, in craving. The DLPFC is implicated in reward processing, motivation, and decision-making. Its circuits provide the foundation for integrating pertinent cognitive and motivational information and exercising inhibitory control over tempting options that promise immediate reward (Rezvanian et al., 2022). In the field of cognitive neuroscience, the predominant approach to investigating the neural responses related to craving is through the examination of the response pattern to the cues (de Lara & Perales, 2020). The primary advantage the cue-based response approach, in contrast to paradigms for studying addictive behavior is its solid grounding in general behavioral theories, which has been widely studied (Drummond, 2000). The field of craving has witnessed numerous studies exploring existing theories and methodologies, some of which employ systematic review methods, while others utilize alternative review approaches. In a review study 2018 the response to cues and relapse were identified as pivotal constructs that have been integrated into various theoretical models of behavioral addictions. This article offers a comprehensive review of theoretical assumptions and experimental investigations emphasizing the relationship between cue responses and craving at multiple levels, including the cognitive, physiological, environmental, and neurological dimensions, to comprehend and sustain specific behavioral addictions (Wegmann & Brand, 2018).

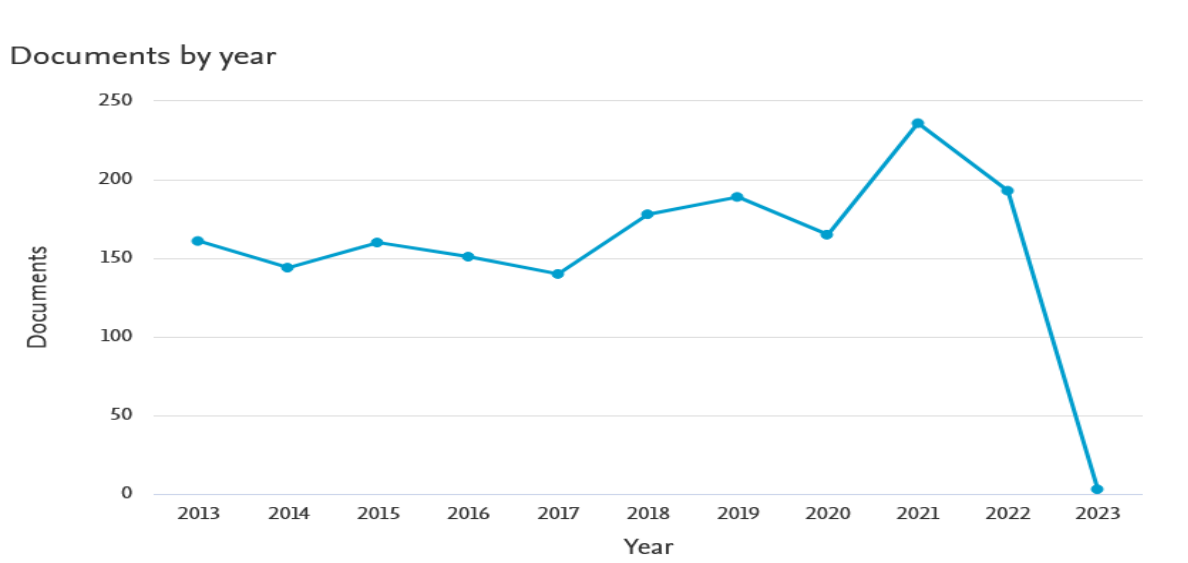
Another review study 2022 underscored the substantial body of literature implicating the influence of negative affect and cravings in the recurrence of addictive disorders. In total, nearly 90% of the studies analyzed in this systematic review demonstrated a positive correlation between negative affections and cravings. This meta-analysis along with the reported studies, underscores the significance of negative affection is a critical component related to craving, albeit with individual variations in response (to craving) (Cyr et al., 2022).

Various review studies have delved into the subject of drug addiction and its impact on individuals with addiction disorders. Classic review studies through their comprehensive examination of the existing literature, have played a crucial role in identifying research gaps and providing comprehensive overview of this field Body of knowledge in this domain continues to expand (Graph, 1), Consequently, one of the essential study types required to keep pace with this growing body of knowledge is bibliometric research. Bibliometrics, though still in its early stages, grapples with functional analysis, document network analysis, content analysis of publications, and scientific documents available within citation databases across various knowledge domains (Moradi, Mohsen., & Miralmasi, 2022). With the burgeoning and widespread of knowledge related to craving across various scientific disciplines (Graph, 2), many traditional review techniques struggle to succinctly summarize literature due to their descriptive nature; As understanding of craving continues to accumulate and knowledge growth in this area remains on an upward trajectory, researchers are increasingly turning to bibliographic reviews to map the landscape of existing studies. They aim to shed light on the factors driving this growth and the areas in which further research is needed. Given the critical role of craving in the processes of relapse and the treatment of addictive disorders, this study seeks to address the following objectives:

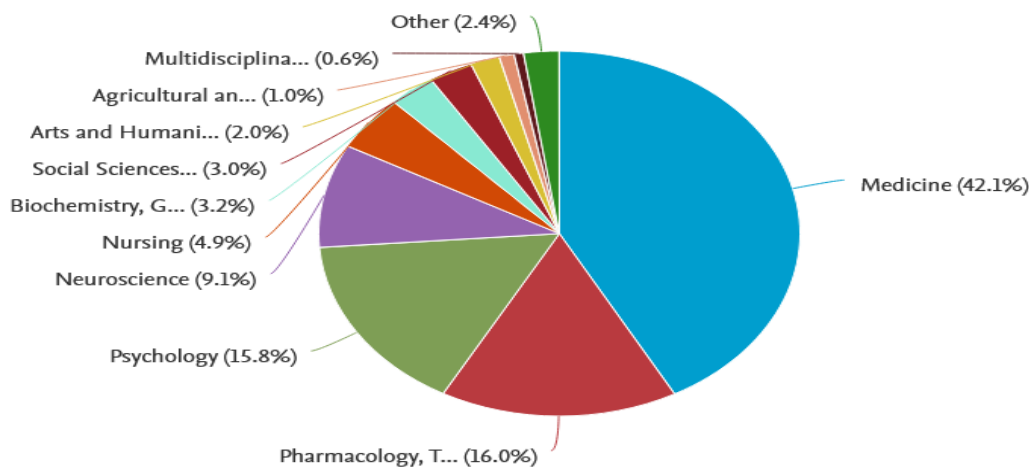
1. Examining and visually represent the structure of keywords prevalent in published articles within this field.
2. Analyzing the co-authorship network of researchers involved in published articles focused on craving.
3. Identifying authors who exert significant influence within the co-authorship network based on citation network analysis indicators.
4. Determination the authors, countries, or institutions that have contributed the most research documents in this field or have had the most substantial impact.

Furthermore, as no comprehensive study specifically centered around this keyword has been conducted to date, and given the significance of scientific indices associated with this keyword, the findings of this research are expected to offer valuable insights for

addiction research, addiction treatment strategies, understanding the factors influencing relapse, and efforts to prevent relapse and reinitiating of substance consumption.



**Graph 1** growth trend of consumption over the last 10 years (Scopus Preview - Scopus, 2022)



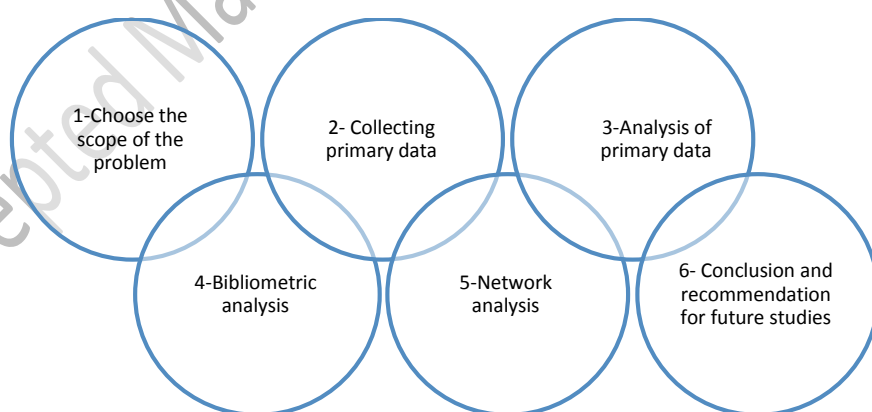
**Graph 2**, different sciences with research in the field of craving of consumption (Scopus Preview - Scopus, 2022)

## 2- Research Methodology

A review is a research methodology designed to systematically and methodically investigate the background of a research topic. Its purpose is to discover, describe, integrate, explain, or critique patterns, relationships, and trends within a body of knowledge that may not be readily discerned through primary studies and first-rate sources (shahsavari & alamohoda, 2019). The increasing accessibility to digital data within scientific inputs and outputs has opened unprecedented opportunities to explore the structure and evolution of science (Uzzi et al., 2018). Scientometrics, situated at the intersection of science and data analysis, offers a systematic approach to unraveling the past, present, and future directions of scientific fields. It has always been central to the

research community because it empowers researchers with a deeper understanding of their specialized fields and their identities. Scientometrics studies play a pivotal role in raising awareness, informing, and educating both internal and external stakeholders about emerging disciplines while suggesting potential corrective actions to steer research in the desired direction (Serenko, 2021). The scientific literature on spans various disciplines, primarily in neuroscience, psychiatry, and addiction journals. Interestingly, relatively few publications account for the majority of citations (Zurián et al., 2021). However, previous research findings have indicated that most publications in the social sciences , including addiction research, tend to appear in the Scopus database after being indexed by the Google Scholar search engine (Martín-Martín et al., 2021). Given the research problem and nature of literature review, it is essential for researchers to employ a common language that resonates with their peers. This common language aligns with the philosophical underpinnings of scientific research and guides how research is conducted(Park et al., 2020). Paradigms, in essence, encapsulate researchers' beliefs and values about the world. Consequently, paradigms have far-reaching implications for every decision made throughout the research process (Kamal, 2019).

In broad terms, paradigms encompass two primary research approaches: quantitative and qualitative. Quantitative research revolves around the measurement of quantity applied to a specific phenomenon and is often employed to test existing theories. In this study, the researcher has adopted a quantitative paradigm consistent with this approach (Park et al., 2020). In line with this paradigm, the researcher must employ specific strategies to conduct the research, commencing with a search strategy that aids in organizing thoughts prior to conducting the search. This search strategy, rooted in the comparative perspective of the quantitative approach, involves formulating a bibliographic research plan or strategy that consists of six core steps (Figure 1).



**Figure 1**, components of the citation data search strategy



**The First Step:** The initial phase involves selecting the scope of the problem and research inquiry. Drawing from the literature covered in Section 1, collected by searching “publish or perish” (Harzing, 2010) It becomes evident that the escalating number of articles in the field of addiction necessitates validation. This validation effort extends to understanding the factors that both fuel and sustain this proliferation, notably the intricate structure of craving. As a result, the researcher embarks on a mission to distill the essence of this knowledge and forecast future trends in research

**The Second Step:** In accordance with Steider (2019) the researcher has devised research objectives that fall into two distinct categories: functional objectives and the creation of a scientific roadmap (Moradi & Miralmasi, 2020).

### **Functional Objectives**

- 1- Identifying the most influential author within the field of craving.
- 2- Identifying the most influential publication within the field of craving.
- 3- Identifying the most influential institute or university contributing to research on craving.
- 4- Identifying the most influential country with a substantial impact on the field of craving.
- 5- Identifying the most influential article within the domain of craving research

### **Objectives of Citation Network Analysis:**

1. Identifying the most impactful co-citation patterns within the realm of craving research.
2. Identifying the most impactful co-authorship patterns evident in craving research.
3. Identifying the most impactful co-lexical patterns within the field of craving.
4. Identifying the most impactful concurrent patterns prevalent in craving research

### **Step 3: Determine the Search Strategy**

This research endeavor aims to access valid citation data pertaining to cravings from top-tier citation databases and search engines. Although various studies have explored the coverage and accuracy of these databases (Martín-Martín et al., 2021), the significance of bibliographic databases has grown substantially in recent times. They serve as primary sources for publication metadata and universally accepted bibliometric indicators used in research evaluation (Pranckutė, 2021).

Scientometric research heavily relies on large-scale citation databases and journal articles (Thelwall & Sud, 2022) . Within the Scopus database, the number of distinct journals has been increasing exponentially, underlining the importance of highly cited articles for both researchers and editors (Yaminfirooz & Ardali, 2018). Taking into consideration the prevalence of humanities studies within the Scopus citation database and the database's precision and accuracy in citation data, the researchers have selected the Scopus reference database for their investigation. To achieve a comprehensive repository of documentary information, a well-defined policy and strategy were established. Management organization tools like Mendeley and its extensions were employed to identify and establish concepts related to this research structure. Subsequently, a systematic search process was carried out, involving the use of synonyms, binary operators, and quotation marks. The data extracted from this search were then inputted into the Mendeley data management software. Following this, a rigorous pre-processing step was conducted, eliminating low-value and extraneous data. Data lacking English abstracts, author names, or other essential citation attributes were excluded from the analysis. Moreover, materials such as books, letters to the editor, web pages, and seminar articles were disregarded. The remaining results were then summarized and subjected to detailed analysis.

**Table 1** search information in the citation database

Items	Description
Scopus	citation database
Keywords	Craving
Search area	Title
Search command	Title (Craving) And (Limit-To (Doctype , "Ar" ) Or Limit-To (Doctype , "Re")) And ( Limit-To ( Pub year , 2023) Or Limit-To ( Pub year , 2022 ) Or Limit-To ( Pub year , 2021) Or Limit-To ( Pub year , 2020 ) Or Limit-To ( Pub year ,2019) Or Limit-To ( Pub year , 2018) Or Limit-To ( Pub year , 2017 ) Or Limit-To (Pub year, 2016) Or Limit-To (Pub year, 2015) Or Limit-To (Pub year, 2014) Or Limit-To (Pub year, 2013))
Document types	journal and review articles
Search period	2013-2023
Language	All languages (English abstract)

#### **The Fourth step: Choosing the Right Software for Bibliometric Data Analysis**

The researcher has selected and acquired proficiency in the following software tools for conducting the specified operations. This decision was influenced by recent technological advancements and the emergence of various websites and software applications that offer diverse approaches to fulfilling descriptive objectives and conducting citation network analysis. It's worth noting that each of these tools has

gained recognition and endorsement from reputable academic organizations and institutions (Table 2).

**Table 2** Information of common bibliometric software(Moral-Muñoz et al., 2020)

Tools	Analyzed version	Year	Developer	Operative System	User interface
<i>Bibexcel</i>	2017	2017	<i>University of Umeå (Sweden)</i>	<i>Win</i>	<i>Desktop</i>
<i>Biblioshiny</i>		2019	<i>University of Naples Federico II (Italy)</i>	<i>Runs in R</i>	<i>Web</i>
<i>BiblioMaps</i>	3.2	2018	<i>University of Lyon (France)</i>	<i>Runs in Python</i>	<i>Web</i>
<i>CiteSpace</i>	5.5.R2	2019	<i>Drexel University (USA)</i>	<i>Win</i>	<i>Desktop</i>
<i>CitNetExplorer</i>	1.0.0	2014	<i>Leiden University (The Netherlands)</i>	<i>Win, OSX, Linux</i>	<i>Desktop</i>
<i>SciMAT</i>	1.1.04	2016	<i>University of Granada (Spain)</i>	<i>Win, OSX, Linux</i>	<i>Desktop</i>
<i>SciP Tool</i>	1.3	2018	<i>Cyberinfrastructure for Network Science Center (USA)</i>	<i>Win, OSX, Linux</i>	<i>Desktop</i>
<i>VOSviewer</i>	1.6.13	2019	<i>Leiden University (The Netherlands)</i>	<i>Win, OSX, Linux</i>	<i>Desktop</i>

**A) Publish or Perish Software:** Professor Harzing created this software in 2008 to gather citation data from search engines. The current version in use is Version 8, compatible with Windows 64-bit (Harzing, 2010).

**B) Mendeley Software:** This software is employed for the organization and management of research resources. The version currently in use is Version 1.98, designed for 64-bit Windows (*Search / Mendeley, n.d.*).

**C) Microsoft Excel:** To adhere to PRISMA protocol criteria, tasks such as identifying duplicate research were performed using Microsoft Excel for data analysis and visualization.

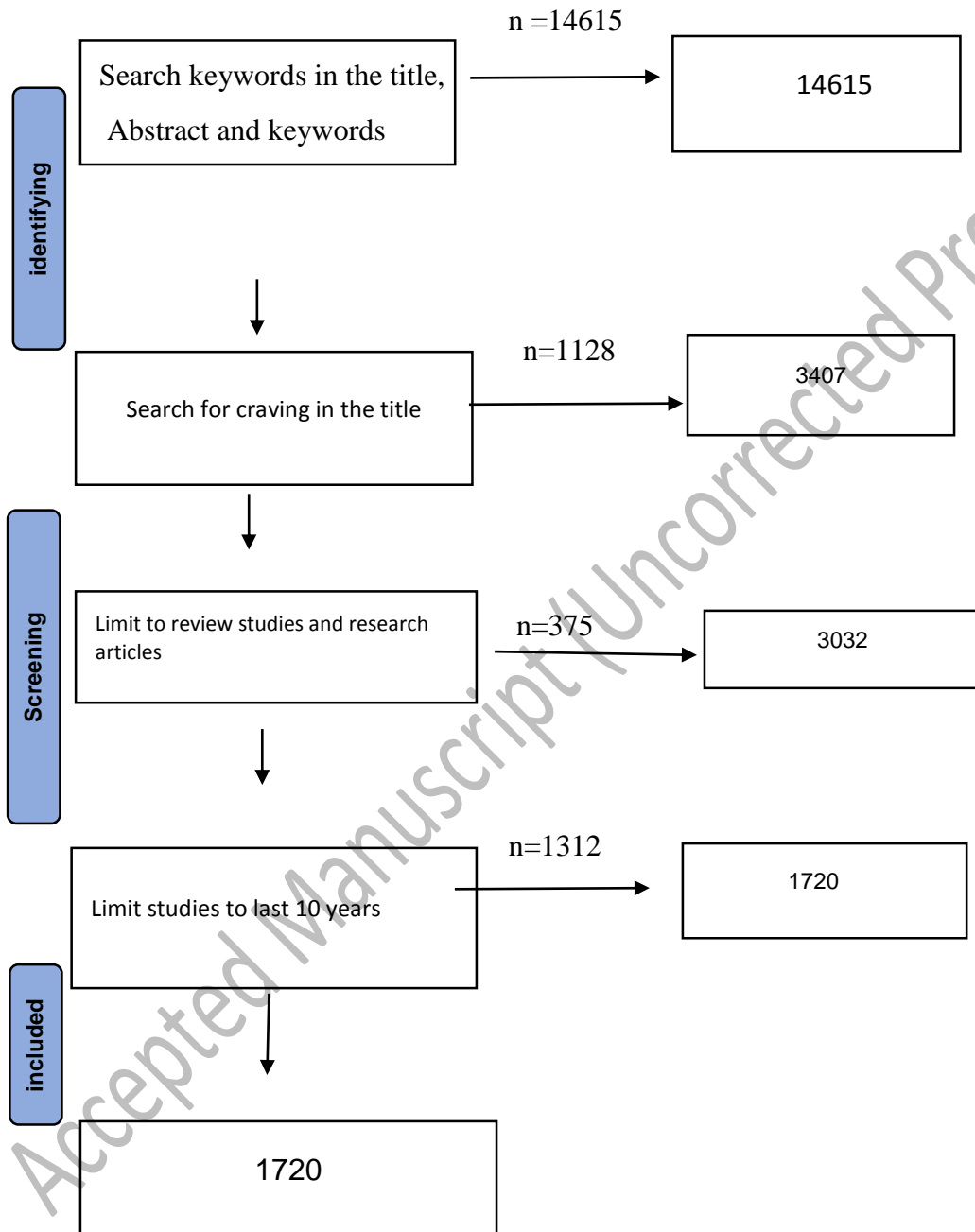
**D) VOSviewer Software:** Developed by Leiden University in the Netherlands, VOSviewer offers researchers network analysis and visualization capabilities of exceptionally high quality. In this research, Version 1.6.18 of the software was utilized on a 64-bit Windows system (Van Eck & Waltman, 2010).

**E) R Software:** In this research, the initial step involved the installation of R Software, Version 4.2. Subsequently, R Studio macros from the free, non-commercial version of 2022 were added to R. Finally, an HTML-based bibliometric software package was installed to facilitate comprehensive functional information and network analysis. This software package was developed by the RStudio Team based in Boston, MA, USA (RStudio & Source, 2022).

**The fifth step: collecting information, screening, and extracting data**

Based on the research, it was found that there were 14,615 documents related to the keyword craving in the Scopus citation database. Due to the high frequency of this phrase in the keywords and abstracts of scientific documents, the researcher limited the review to studies that exclusively included the keyword "craving" in their titles. Consequently, 3407 scientific documents remained for analysis. Two stages of data screening and cleaning were conducted. The first stage occurred in citation databases, where the researcher filtered and removed irrelevant data. In the second stage, involving the remaining 3407 studies from

the previous phase, the researcher re-screened the data using a standard screening protocol such as Prisma (Page et al., 2021) updated in 2020.



**PRISMA, Figure 2 Contract selection of**

### 3- Research Results

In the sixth phase of the research methodology (Moradi & Miralmasi, 2020), the researcher conducted descriptive and network analysis.

**Table 3.** The main bibliometric information

Main Information About Data	
Timespan	2013:2023
Sources (Journals, Books, etc)	522
Documents	1720
Annual Growth Rate %	32/85
Document Average Age	4/17
Average citations per doc	17/14
References	79574
Document Contents	
Keywords Plus (ID)	5634
Author's Keywords (DE)	2766
Authors	
Authors	6019
Authors of single-authored docs	76
Authors Collaboration	
Single-authored docs	83
Co-Authors per Doc	5/37
International co-authorships %	19/77
Document Types	
article	1618
review	102

In this research, 1720 scientific documents, comprising both primary research articles and review articles, were examined. These articles were authored by a total of 6019 authors and published through 522 sources.

#### 3-1 Functional Analysis of Documents and Authors

The definition of authorship in scientific articles and documents is a necessary and intricate procedure, largely reliant on informal arrangements. An author of a scientific document, or a group of co-authors, consists of individuals who have made substantial contributions to the study (Albarracín et al., 2020). Citing an author serves the purpose of alerting researchers to previously published works related to the topic. Nonetheless, research indicates that articles with multiple authors tend to receive more citations compared to single-authored articles (Yaminfirooz & Ardali, 2018).

**Table 4.** Top studies in the field of cravings

AU	TI	Y	TC	PY	NTC
RG Boswell, H Kober	Food cue reactivity and craving predict eating and weight gain: a meta-analytic review	2016	335	47/86	12/78
Wolf Me	Synaptic mechanisms underlying persistent cocaine craving	2016	244	34/86	9/31
Ma Y-Y	Bidirectional modulation of incubation of cocaine craving by silent synapse-based remodeling of the prefrontal cortex to acumben's projections	2014	226	25/11	5/90
Lee Br	Maturation of silent synapses in the amygdala-acumbens projection contributes to the incubation of cocaine craving	2013	213	21/30	4/76
Hormes Jm	Craving Facebook? Behavioral addiction to online social networking and its association with emotion regulation deficits	2014	212	23/56	5/53
Naqvi Nh	The insula: a critical neural substrate for craving and drug seeking under conflict and risk	2014	210	23/33	5/48
Jansen Jm,	Effects of non-invasive neuro-stimulation on craving: a meta-analysis	2013	203	20/30	4/54

As evident in Table 4, Boswell's (2016) meta-analysis study, titled "Predicting Weight Gain Through Response to Food Cues and Food Cravings," has garnered 355 citations (Boswell & Kober, 2016). Another study from 2016, titled "Synaptic Mechanisms Underlying Persistent Cocaine Craving," delves into the challenges faced by individuals with cocaine addiction in achieving abstinence. It emphasizes that the primary issue is not the initial use but the subsequent avoidance of cocaine. This animal study suggests that craving for cocaine during the abstinence period is attributable to neural plasticity in the reward circuitry, which sustains elevated levels of craving. Furthermore, this research highlights the potential of craving studies to identify new therapeutic targets and enhance our comprehension of experience-dependent neural plasticity in the brains of adults under normal conditions and in the context of addiction (Wolf, 2016).

**Figure 3.** The importance of the documents in the analysis basket based on the number of total citations of craving for consumption

The information analysis in VOSviewer software assigns greater weight to authors in the field of craving who have received more citations. Consequently, the names of these highly-cited authors are displayed in a larger font size. Based on this analysis, it is evident that the names "Boswell (2016)" and "Wolff May (2016)" are the most prominent and influential authors in the field of craving, as they have garnered a significant number of citations and recognition within the research community.

**Table 5.** authors with the highest number of scientific productions in the field of craving

Element	PY_start	NP	TC	m_index	g_index	h_index
Li X	2013	40	1501	2	38	20
Sinha R	2013	25	1297	1/9	25	19
Shaham Y	2013	25	1494	1/8	25	18
Meule A	2013	18	572	1/4	18	14
Potenza Mn	2013	19	668	1/4	19	14
Brady Kt	2013	16	841	1/3	16	13
Epstein Dh	2013	20	508	1/3	20	13
Preston Kl	2013	19	517	1/3	19	13
Phillips Ka	2013	17	492	1/2	17	12
Bossert Jm	2013	12	626	1/1	12	11

As Table 5, Lee X stands out as the most prolific contributor in the field of desire, having authored 40 scientific documents in the last ten years. Following Lee X, Sinhar and Shahami Harik rank second with 25 scientific documents each. However, it's noteworthy that none of these authors have produced highly cited or heavily referenced works. This outcome underscores the fact that the quantity of scientific documents produced does not necessarily reflect their quality.

### **2- 3 Functional Analysis of Publications, Organizations**

Effective research policies provide the essential framework for guiding research management within higher education institutions and study programs (De La Cruz Vargas, 2019). These strategies should encompass the promotion of research, enhancement of research infrastructure, financial support for research endeavors, and training of researchers to produce high-quality work. Such knowledge dissemination not only enhances the reputation of institutions through their scientific output but also positions universities as leaders and generators of new knowledge. Consequently, they are recognized as dedicated contributors to research and innovation, ultimately fostering the development of their respective countries (Millones-Gómez et al., 2021). In light of

the information presented in Table 3, which outlines the key bibliometric details, it is evident that 522 publications have contributed to the dissemination of the 1,720 scientific documents in this study.

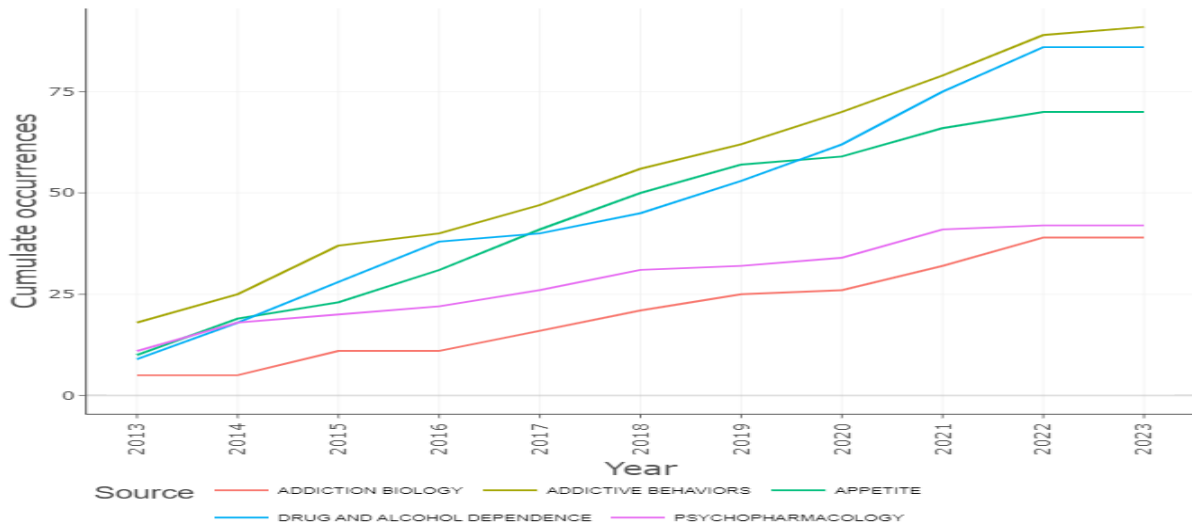
**Table 6**, top 10 publications with the most scientific production in the field of craving

Articles	Sources
91	Addictive Behaviors
86	Drug and Alcohol Dependence
70	Appetite
42	Psychopharmacology
39	Addiction Biology
36	Frontiers In Psychiatry
35	Psychology of Addictive Behaviors
33	Nicotine and Tobacco Research
31	Alcoholism: Clinical and Experimental Research
30	Neuropsychopharmacology

Journals often employ expert reviews to sift through and select the best articles for publication (Candel & Naccache, 2021). Addictive Behaviors is an international journal that boasts a site score of 6.7 and an impressive impact factor of 4.591. Since its inception in 1975, this journal has been dedicated to publishing high-quality human research concerning addictive behaviors and disorders, as well as behavioral addictions, which encompass areas such as gambling and technology. Its primary focus lies in disseminating behavioral and psychosocial research. On the other hand, The Journal of Drug and Alcohol Dependence is an international journal that employs biomedical and psychological approaches. It holds a site score of 1.6 and an impact factor of 4.852. This journal serves as a platform for the publication of original research, scientific reviews, commentaries, and policy analyses, all within the domain of drug, alcohol, and tobacco consumption and addiction (“Drug and



Alcohol Dependence,” 1976).



**Chart 3**, the growth of scientific productions in the field of craving in journals

An analysis of publications from top five journals in field of drug consumption reveals a noticeable increase in number of scientific documents being published in this area.

**Table 7**, top organizations with the most scientific production in the field of craving

Organization	Document
Department of Psychiatry, Yale University School of Medicine, New Haven, Ct, United States	14
Erwin L. Hahn Institute for Magnetic Resonance Imaging, Essen, Germany	14
Department of Psychiatry and Behavioral Sciences, Medical University of South Carolina, Charleston, Sc, United States	11
Department of Psychology, University of Salzburg, Salzburg, Austria	9
Connecticut Council on Problem Gambling, Wethersfield, Ct, United States	8
Connecticut Mental Health Center, New Haven, Ct, United States	8
Department of Psychology, University of Houston, Houston, Tx, United States	8
Department of Psychology, University of Pittsburgh, Pittsburgh, Pa, United States	8
Department of Medical and Clinical Psychology, Uniformed Services University of The Health Sciences, Bethesda, Md, United States	7
Department of Psychiatry and Biobehavioral Sciences, University of California, Los Angeles, Los Angeles, Ca, United States	7



**Figure 4**, top organizations with the most scientific production in the field of craving

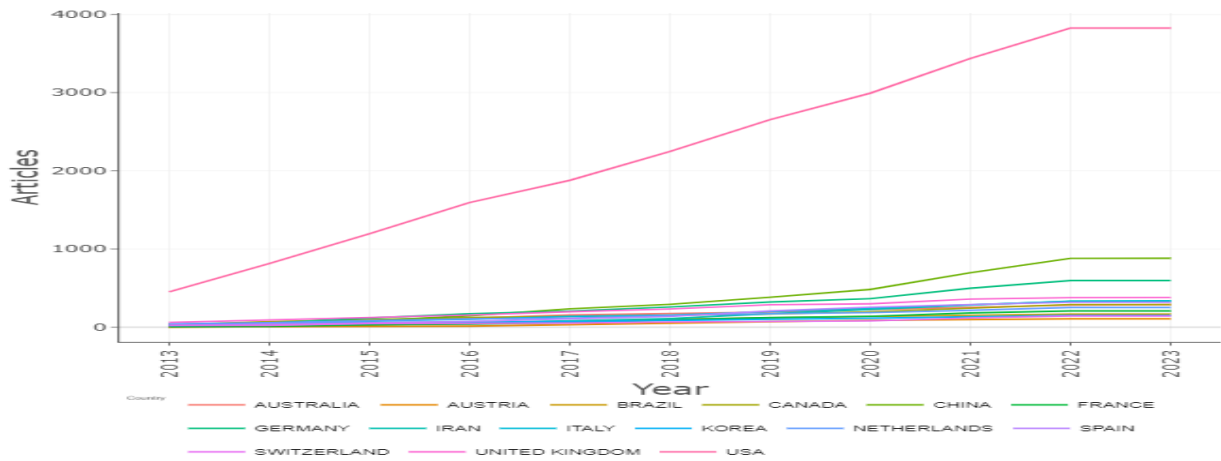
As Table 7 and Figure 4, it is evident that Department of Psychiatry at Yale University School of Medicine in New Haven, CT, USA, has produced the highest number of scientific publications in the field of addiction. Following closely is the Erwin L. Hahn Magnetic Resonance Imaging Institute in Essen, Germany. These two institutions, each having contributed 14 published scientific documents, collectively account for nearly 40% of the world's scientific productions in the field of craving.

### 3-3 Functional Analysis of Countries

Among countries, the United States, China, Germany, Italy, and England emerge as the main contributors to scientific productions in field of craving. The United States significantly outpaces other countries both in terms of quantity of scientific products and the number of references made to these scientific documents.

**Table 8**, Top countries with the most scientific production in the field of craving

Country	frequency	TC	Average Article Citations
USA	3826	15331	23/12
China	882	1726	14/88
Germany	597	1555	25/92
UK	380	1427	20/68
Italy	339	1255	14/26
Iran	332	881	18/35
Spain	318	743	14/57
Canada	290	673	13/73
Australia	288	640	14/88
Netherlands	252	549	7/32



**Chart 4**, Linear trend of the growth of scientific production in the field of craving of countries

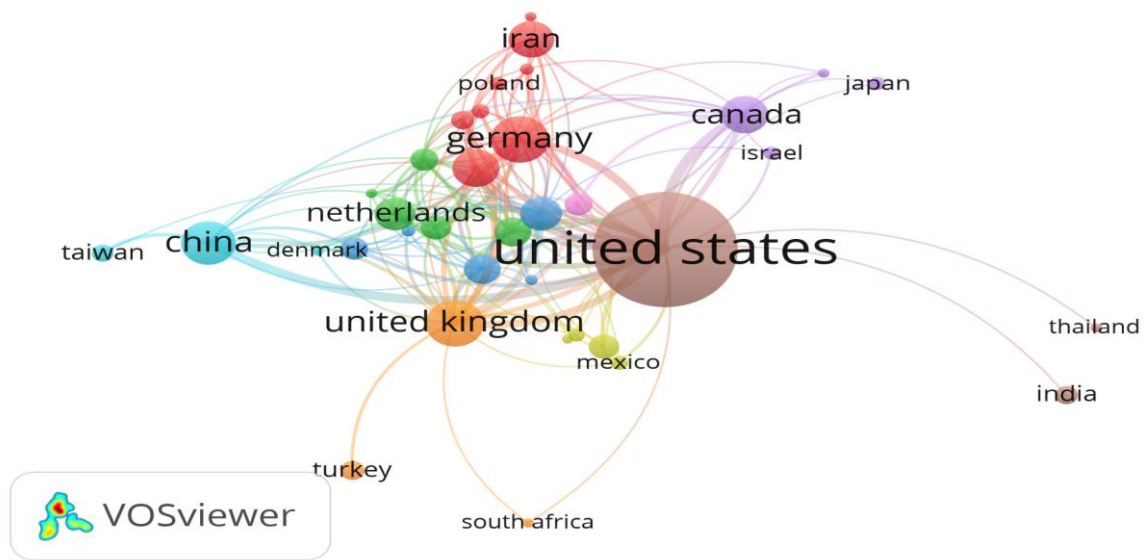
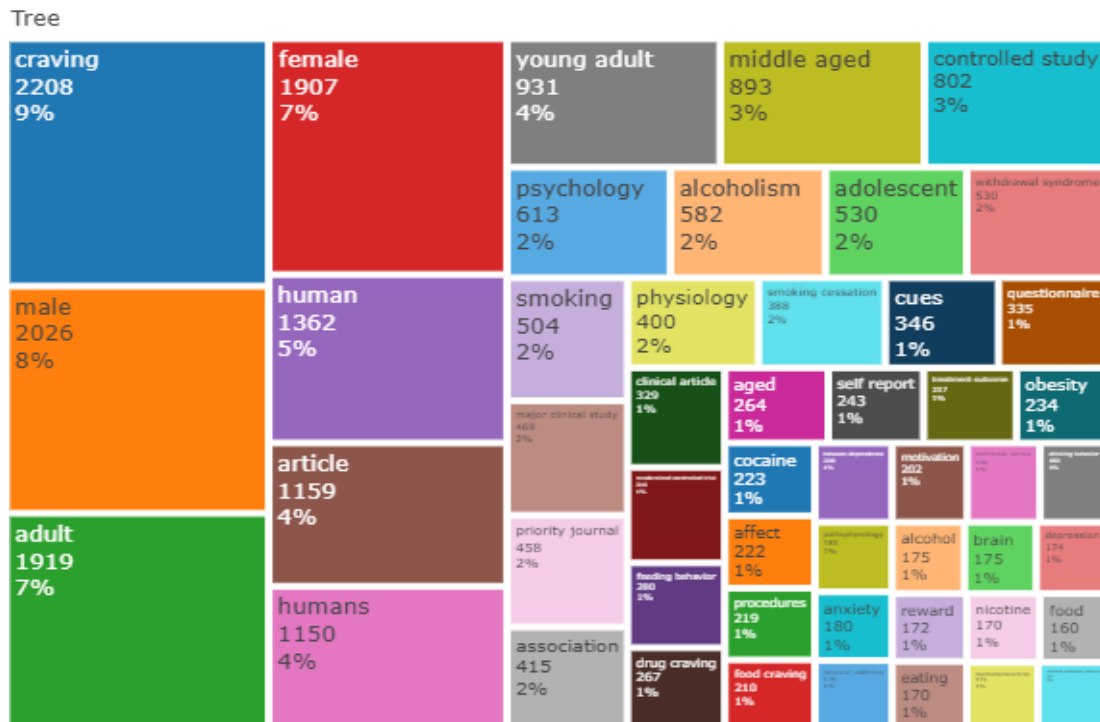


Figure 5, the collaboration of authors from different countries in the field of craving

As Figure 5, it becomes evident that researchers in the United States have engaged in significant collaboration with their counterparts in several countries. Notable collaboration partners for researchers in the United States include China, Germany, the Netherlands, England, Canada, and Iran. This collaborative network highlights the international dimension of research in the field of craving and underscores the global nature of scientific inquiry and cooperation.

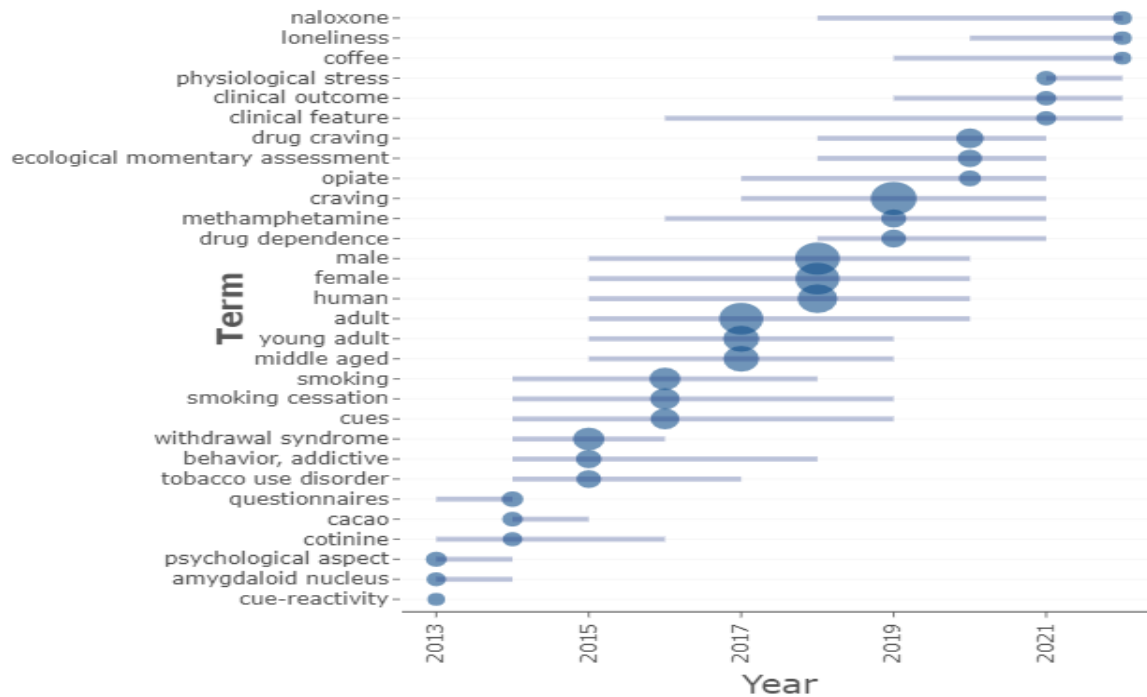
### 3-4 Vocabulary Analysis

In the digital age, effectively harnessing knowledge necessitates information retrieval skills capable of navigating the extensive repository of scientific information available through web technology. Among these skills, proficiently searching the Internet for specific terms is crucial for gaining accurate access to target information. A keyword, also referred to as an index term or descriptor, serves as a term that characterizes the subject matter of document or search query (Babaii & Taase, 2013). Statistical analysis of keywords plays a pivotal role in identifying emerging fields and trends within the realm of science. It serves as foundational tool for gauging the effectiveness of these fields in deepening our understanding and pushing the boundaries of scientific knowledge (Scandura & Williams, 2000).



**Diagram 5**, tree diagram of keywords of researchers (keywords with the highest frequency)

In this diagram, each rectangle represents a keyword, and its size is indicative of its importance and weight within the dataset of 1,720 scientific documents. Notably, the term "desire" stands out with the highest frequency. However, it's interesting to observe that words like "man," "adult," and "women" also hold a high frequency within the dataset, suggesting their significance and prevalence in the context of the research or documents being analyzed. These keywords provide valuable insights into key themes and topics that have been addressed in the corpus of scientific documents.



**Figure 6**, the movement of keywords over time by calculating the weight of topics

The evolution of keywords over the past decade in this field reflects a shift from words like 'reaction to cues,' which are more concerned with theorizing and understanding the etiology of craving or behavior, towards terms such as 'naloxone,' which are directly associated with addiction treatment and rehabilitation interventions and behaviors. This progression in keyword usage mirrors the evolving focus and research interests within the field, with earlier emphasis on understanding the underlying processes and causes of craving, and later emphasis on practical interventions and treatments.

### **3-5 Network Analysis and Bibliometric Scientific Mapping**

Scientific mapping or bibliometric cartography is a method of visually representing the relationships between disciplines, specialties, documents, or authors within a scientific field. It serves as a means of monitoring the development of a scientific field, identifying research boundaries, and revealing the cognitive structure and evolution of that field. Scientometric information mapping is closely linked to the preparation of forecasts for the development of science and improving the quality of existing collaborations, as well as fostering the emergence of new collaborative opportunities. It is a valuable tool for gaining insights into the dynamics and trends within a given area of research (Ashrafioun & Rosenberg, 2012a) .

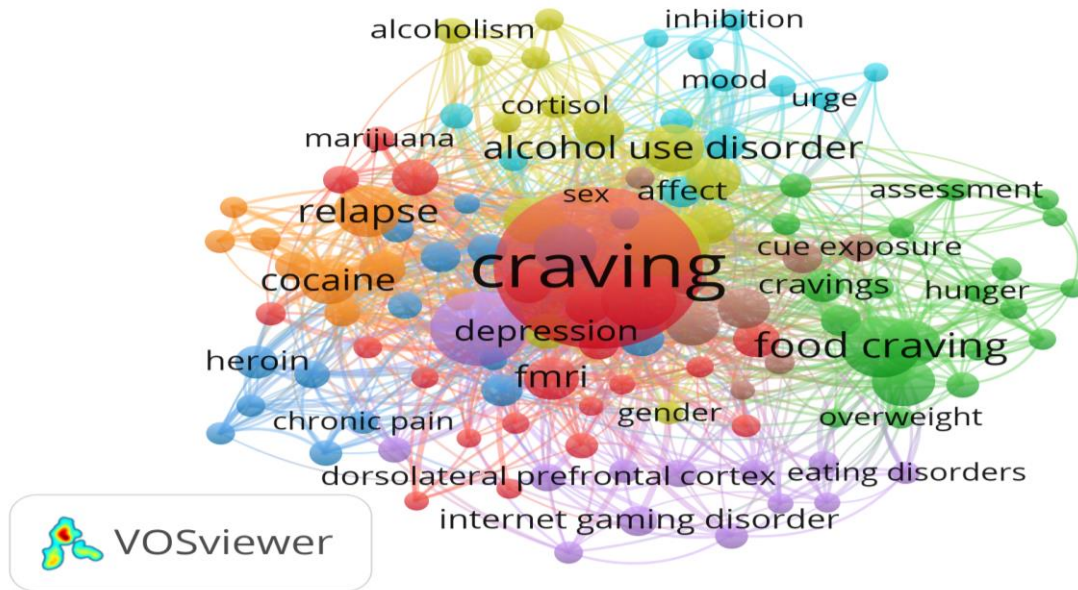


Figure 7, keywords with the highest frequency

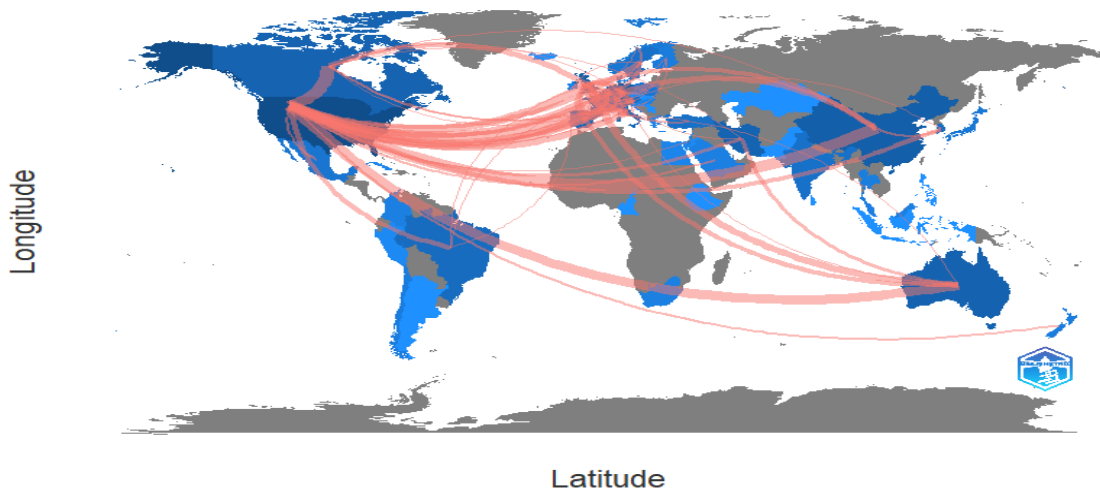


Figure 8, the co-authorship network of the authors of documents in the field of craving

The network of co-authorship or collaboration among authors in the field reveals that the United States has been heavily engaged in collaborative efforts with researchers from other countries. Given the substantial number of scientific products originating from the United States in this field, it is not surprising that it is a key player in international collaborations. This demonstrates the global nature of scientific research and highlights the importance of international cooperation in advancing knowledge and addressing complex issues, such as those related to addiction and craving.

#### 4. Discussion

Visual representation methods in Scientometric can serve as a foundation for formulating initial working hypotheses in the analysis of Scientometric data and for presenting the final results (Smyrnova-Trybulska et al., 2017). In this study, the findings revealed that Boswell's meta-analytic review from 2016, which explored food cue reactivity and its relationship to craving for predicting eating and weight gain (2016), which is a meta-analytic review, about food cue reactivity and craving to predict eating and weight gain (Boswell & Kober, 2016), received the highest number of citations, totaling 607. On the other hand, Li X, who has produced 40 scientific publications in the last decade, emerged as one of the most prolific researchers in the field of craving. One of Li's most cited articles, titled "Volitional reduction of anterior cingulate cortex activity produces decreased cue craving in smoking cessation: a preliminary real-time fMRI study," received 199 citations (Li et al., 2013). This underscores Li X's significant influence in the field of craving.

These results highlight the fact that the quantity of scientific publications by an author does not necessarily indicate the quality of those publications. Based on the outcomes of our analyses, The Journal of Addictive Behaviors, with a site score of 6.7 and an impact factor of 4.591, published the highest number of articles related to craving. This journal, part of Elsevier Publications, has significantly contributed to the field. Moreover, the Department of Psychiatry at Yale University School of Medicine in New Haven, CT, USA, played a pivotal role by producing a substantial number of articles. The United States stands out prominently in comparison to other countries, both in terms of the volume of scientific productions and the number of references to these scientific documents. Most notably, collaborations among researchers were primarily seen among countries such as the United States, China, Germany, the Netherlands, England, Canada, and Iran.

In the pool of these studies, the term "craving" was the most frequently used keyword. However, words like "man," "adult," and "women" also demonstrated high frequency usage. The shifting trends in keywords over the past decade indicate a transition from focusing on terms like "response to cues" to keywords such as "naloxone."



In conclusion, studies related to drug addiction or addictive behaviors continue to be at the forefront of worldwide research on etiology and therapeutic interventions for addictive disorders. The enduring prominence of authors and publications dedicated to these topics remains noteworthy.

An examination of the top authors and publications in the field of craving reveals a shift in research trends from drug craving to cravings associated with behavioral addictions, such as food cravings. Additionally, an assessment of articles authored by leading researchers suggests a paradigm shift from experimental studies to the utilization of functional magnetic resonance imaging (fMRI), including real-time fMRI (rtfMRI), in the study of cravings. The changing patterns in keywords further indicate the evolution from examining and evaluating cravings to addressing the treatment of both drug addiction and behavioral addictions.

The Scientometric approach not only facilitates the analysis of traditional disciplines but also serves as a valuable tool for exploring the interaction and evolution of science across various fields and specialties. This approach, characterized by visualizing and mapping knowledge and information, ultimately constructs a scientific map encompassing a specific specialty, subject area, discipline, or group of disciplines (Ashrafioun & Rosenberg, 2012b).

The methods for visually representing Scientometric information can serve as a foundation for generating initial working hypotheses during the analysis of Scientometric data and for presenting the final results (Smyrnova-Trybulska et al., 2017).

In this research, statistical analyses were employed to identify the most influential authors, publications, institutes, universities, and articles in the field of craving and addictive behaviors. Furthermore, patterns of co-authorship, co-citation, co-word analysis, and coincidences in the realm of drug addiction and addictive behaviors were examined.

To this end, comprehensive searches were conducted in the Scopus reference database. Ultimately, our analysis encompassed 1,720 research and review articles published within the last decade related to craving in the context of drug use or addictive behaviors. As demonstrated by the outcomes of our analyses, Boswell's study in 2016 received the most citations, totaling 355. However, Li X, with a production of 40 scientific documents, ranks among the top contributors in the field of craving over the

past decade. This underscores the principle that the quantity of scientific publications by an author does not necessarily equate to the quality of those publications.

The Journal of Addictive Behaviors, boasting a site score of 6.7 and an impact factor of 4.591, as part of Elsevier Publications, and the Department of Psychiatry at Yale University School of Medicine, New Haven, CT, USA, have emerged as the most prolific sources of articles in this field. Notably, the United States maintains a significantly higher level of scientific production and references to these scientific documents than other countries. Collaboration among researchers is particularly prevalent among the United States, China, Germany, the Netherlands, England, Canada, and Iran.

Among these studies, the term "craving" has been the most frequently used keyword, while words such as "men," "adult," and "women" have been highly prevalent. Notably, evolution of keywords over past decade demonstrates a shift from terms like 'response to cues' to keywords such as 'naloxone.' In conclusion, it can be inferred that research on drug addiction and addictive behaviors remains at forefront of worldwide studies on etiology and therapeutic interventions for addictive disorders. The prominence of authors and publications in this field continues to be remarkable

### **Limitations**

The present study may have potential limitations:

- The search conducted for bibliometric analysis did not allow for the reading and in-depth analysis of the selected articles due to their large number.
- Only one database was utilized, which could potentially result in the omission of relevant information.

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### **Conflict of interest**

The authors declare no conflicts of interest in connection with this research.

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