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(REVIEW ARTICLE)

The relationship between tea consumption and sleep quality: A bibliometric analysis

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Abstract

This study aims to analyzes the development of studies related to the relationship between tea consumption and sleep quality using a bibliometric approach based on 173 Scopus indexed documents from 2018 to 2024. Key keywords include "Sleep Quality", "Tea", "Herbal Tea", "Green Tea", and "Chamomile Tea". A bibliometric analysis with VOSviewer revealed the highest upward trend in publications in 2023 (32 documents), with the main contributions coming from the United States (13 publications, 522 citations), China (33 publications, 296 citations), and Japan (13 publications, 458 citations). Leading institutions include Ministry of Education of the People's Republic of China (5 publications) and University of Shizuoka (4 publications). Variations in research methodology were identified through the use of measurement tools such as the Pittsburgh Sleep Quality Index (PSQI), electroencephalography (EEG), and analysis of bioactive compounds (L-theanine and caffeine). The differences in that research were influenced by the type of tea (e.g. green tea vs. magnolia), the dose of consumption, and the characteristics of the participants (age, caffeine sensitivity). The results of this study suggest that tea has the potential to promote relaxation and reduce stress through neurochemical mechanisms, although the effects of caffeine need to be anticipated. The design implications of future research include the development of low-caffeine tea variants, the integration of psychometric methods (e.g., Stanford Sleepiness Scale), and a longitudinal approach to evaluating long-term impacts.

Keywords: Bibliometric Analysis; Tea Consumption; Sleep Quality; VOSViewer

1. Introduction

Sleep is one of the most important biological processes for humans. In addition to providing rest time for the body, sleep also plays a role in maintaining physical and mental stability, as well as maintaining overall health [1]. Sleep problems can include a variety of aspects, ranging from difficulty starting to sleep, difficulty maintaining sustainable sleep, poor sleep quality, to the habit of waking up too early [2]. This sleep disorder is a serious problem that continues to increase. For example, in the United States, the prevalence of sleep problems among working adults showed a significant increase, from 30.9% in 2010 to 35.6% in 2018 [3]. This condition shows that sleep disorders are not only an individual problem but also a public health issue. Although certain medications have been shown to be effective in treating severe cases of insomnia, many individuals are still looking for safe, effective, and easily accessible alternative solutions to improve their sleep quality [4].

One potential solution that is increasingly attracting attention is the use of functional foods. These foods contain bioactive compounds that can provide additional health benefits, including helping to improve sleep quality [4], [5]. Several types of functional foods have been proposed as potential sleep aids. One of the most popular is tea. Drinking tea is a very common habit, especially in Asian countries [6]. Tea derived from the leaves of the Camellia sinensis plant contains a variety of active biomolecules, such as flavonoids and antioxidants, which are known to have biological properties, including warding off free radicals and providing protection against oxidative stress [7]. Based on the

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processing method, tea can be categorized into three main types: black tea, green tea, and oolong tea. Of the total tea produced globally, as much as 78% is black tea, which is widely consumed in Western countries, 20% is green tea, which is popular in Asian countries, and only about 2% is oolong tea, which is produced by partial fermentation, especially in the South China region [8], [9], [10]. Each type of tea has different characteristics and bioactive content, so its effects on health, including sleep quality, can also vary.

Although research on the relationship between tea consumption and sleep quality continues to grow, the available results still show uncertainty due to differences in methodology, type of tea consumed, participant characteristics, and intervention approaches used. Some studies suggest that tea may exert positive effects on sleep through neurochemical mechanisms, such as L-theanine's role in promoting relaxation, while inhibitory factors such as caffeine content are still a challenge. To further understand the impact of tea consumption on sleep quality, this study combines a bibliometric analysis based on VOSviewer and a systematic literature review (SLR) of 173 Scopus indexed documents from 2018 to 2024 which will be used as some of the research questions: 1. Analyze the relationship between keyword occurrence and citation patterns using VOSviewer? 2. Map the development of research related to tea consumption and sleep quality based on publication trends, country/institution contributions, and author collaboration? 3. Evaluate the impact of tea consumption on sleep quality by considering the variables of tea type, dosage, and participant profile? and 4. Identify research gaps, such as the need for longitudinal studies and the development of low-caffeine tea variants, to support innovation of non-pharmacological interventions

2. Methods

2.1. Search Strategy

The data search strategy for this study was carried out by utilizing the Scopus search engine. In this study, literature related to tea consumption and sleep quality was obtained through a search in Scopus using the following keywords: "Sleep quality" AND "tea" OR "herbal tea" OR "green tea" OR "chamomile tea" OR "magnolia tea." The search period is set from January 2014 to December 2024, with additional criteria in the form of an English-only article language. The type of literature selected is limited to scientific articles and reviews. In addition, articles that explicitly discuss the link between caffeine and sleep quality are also manually filtered to ensure only studies relevant to the research topic are included-search details in figure 1.

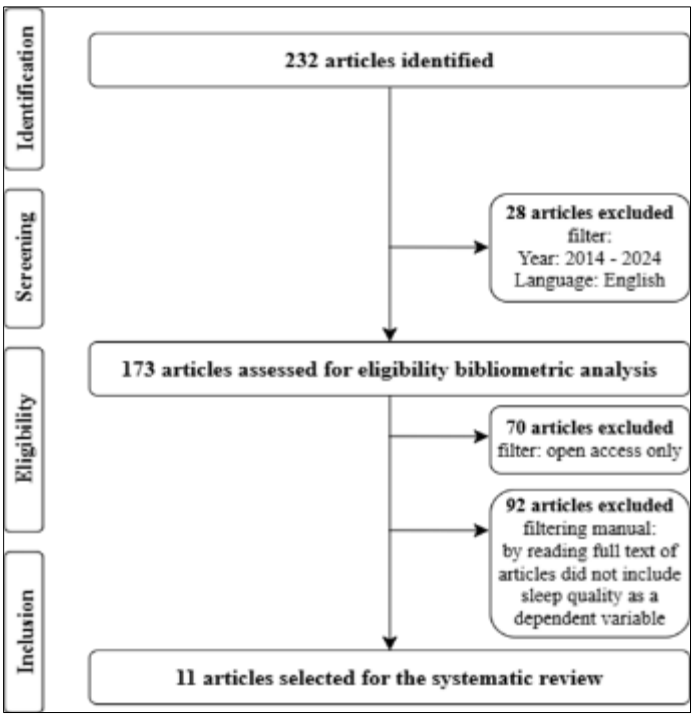

Figure 1 Article Selection Process Diagram

2.2. Data Collection

After the literature is obtained through a search in Scopus, the documents are exported in CSV format with the recording content settings including full record and cited references. This process allows for a comprehensive bibliometric analysis of the collected literature. The data obtained were then summarized based on various parameters such as authors, institutions, countries, journals, and citation frequency to identify patterns and trends in research related to tea consumption and sleep quality.

To support bibliometric analysis, VOSviewer software is used. VOSviewer is a bibliometric analysis tool designed to visualize and analyze scientific literature networks. The software automatically processes bibliographic data, identifies relevant keywords, calculates the frequency of keyword occurrences, and performs co-occurrence or co-occurrence analysis of keywords. Based on the relationships between keywords, the algorithm in VOSviewer generates clustering that allows researchers to explore patterns, relationships, and key insights in the literature network.

In addition to bibliometric analysis, systematic reviews are also conducted. Researchers manually excluded duplicate articles based on title and abstract. Then, studies that meet the criteria are selected and analyzed in depth. The data obtained from the selected study is recorded in a table using Microsoft Excel. The extracted information includes the author's name, year of publication, country of origin of the study, characteristics of participants (such as number and age), study design, type of tea used, measurements as well as results.

2.3. Data Extraction

From each of selected studies, the following information was extracted in detail:

- Research objectives
- Country of origin of the study
- Participant characteristics, including sample size and age
- The study design used
- Sleep quality measurement method
- The main results obtained

All data is recorded and organized using Microsoft Excel to ensure accuracy and ease of access during analysis. This approach allows researchers to evaluate patterns, trends, as well as relevant relationships between tea consumption and sleep quality in a systematic and structured manner.

3. Results and discussion

This section provides a comprehensive presentation of the results of bibliometric analysis. The main purpose of this analysis is to present a summary of the research on the relationship between tea consumption and sleep quality

3.1. Publication by Year

As seen in Figure 2, research on the relationship between tea consumption and sleep quality has improved significantly in the last decade, specifically from 2014 to 2024. The initial number of publications was relatively low, with only a few articles published between 2014 and 2016. In 2017, there were nine publications, and this number began to increase gradually. In 2020, there was a significant surge with 21 publications, which lasted until 2021. This trend further strengthened in 2022 with 28 publications, followed by rapid growth in 2023 (33 publications) and peaked in 2024 with 38 publications.

Overall, publications in the last three years (2022-2024) accounted for about 57% of the total research analyzed. This increase in the number of studies indicates a growing academic interest in the topic of tea consumption and sleep quality, which is likely driven by increasing awareness of the importance of sleep health as well as the exploration of non-pharmacological interventions to improve sleep quality. These figures clearly reflect the growing research trends in this area and confirm the relevance and urgency of further study in this domain.

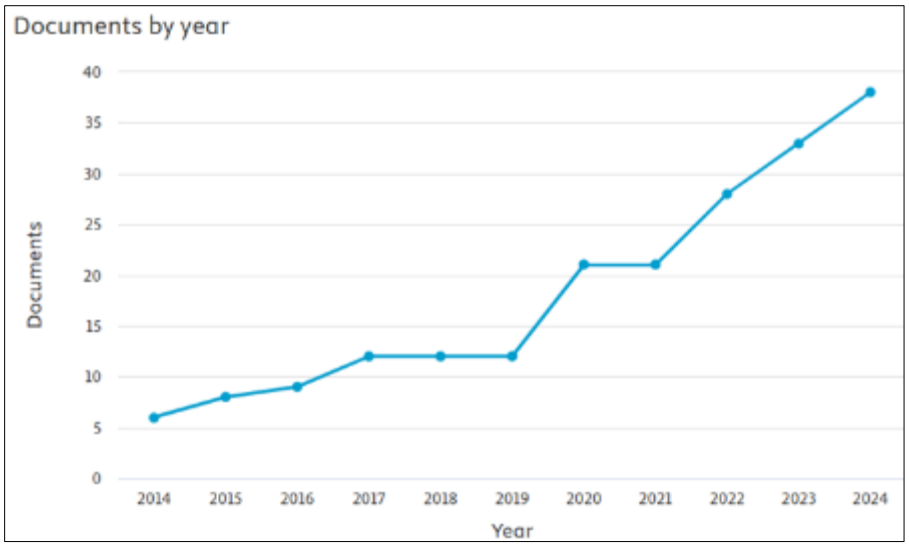

Figure 2 Research Trends Publication from 2014 to 2024

3.2. Publications by Author

A total of 160 authors has contributed to this field. Table 1 presents the top 10 most prolific authors, each with 2–4 publications. The authors with the highest contributions are Iguchi, K; Morita, A; Nakamura, Y; Unno, K; and Yamada, H., each with a total of 4 publications. The co-authorship analysis shown in Figure 3 shows that there is a wide network of collaboration among the authors. The network reflects cross-disciplinary and institutional collaborations that allow for the exchange of ideas as well as the development of new approaches in research. This strong collaboration is important in answering the complexities of problems related to sleep quality and tea consumption, as well as promoting innovation in this area.

Table 1 Top authors by number of publications

Author	Publication
Iguchi, K.	4
Morita, A.	4
Nakamura, Y.	4
Unno, K.	4
Yamada, H.	4
Ao, L.	2
Baba, Y.	2
Cao, J.	2
Chen, Q.	2
Dualé, C.	2

Source: Scopus, 2024

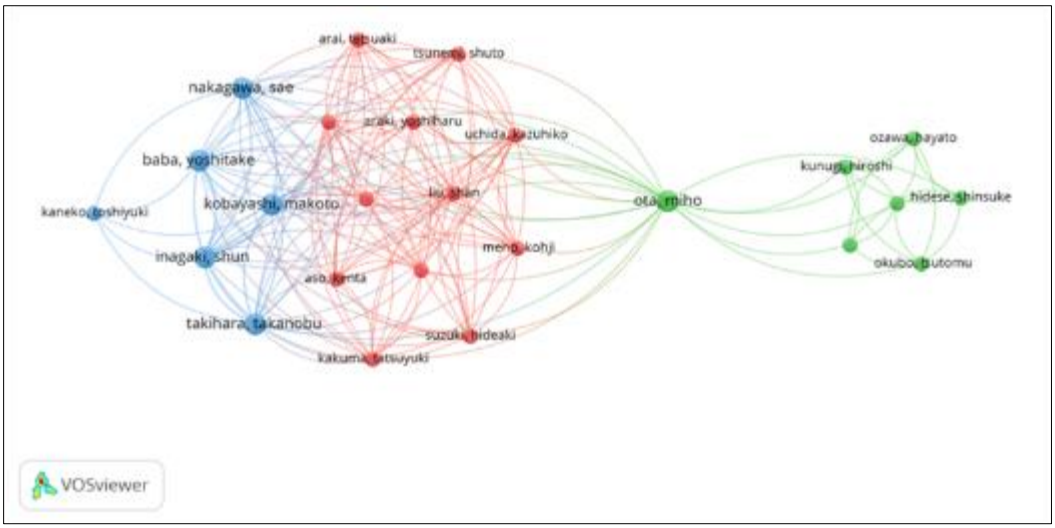

Figure 3 Analysis of Co-authorship of authors

3.3. Publications by Institution

A total of 158 institutions has published literature related to tea consumption and sleep quality. Ministry of Education of the People's Republic of China became the institution with the most publications, namely 5 publications, followed by the University of Shizuoka with 4 publications. Table 2 presents a list of the top 10 institutions by number of publications. The institutional dominance of China and Japan reflects the great attention of Asian countries to the potential benefits of tea in improving health, including sleep quality. The large number of institutions contributing shows that this topic is relevant in various research contexts and has global appeal.

Table 2 Top 10 institutions by number of publications

Institutions	Publication
Ministry of education of the people's republic of China	5
University of Shizuoka	4
Inserm	3
Nanjing University of Chinese Medicine	3
Chengdu University of Traditional Chinese Medicine	2
Jilin University	2
Universidade de Sao Paulo	2
China Medical University Shenyang	2
Sanofi S.A	2
Pukyong National University	2

Source: Scopus, 2024

3.4. Publications by Country

The analysis by country shows that China has the highest number of publications, at 33 publications with 296 citations, followed by the United States (13 publications, 522 citations) and Japan (13 publications, 458 citations). Table 3 summarizes the 10 countries with the highest publications. Figure 4 shows a visualization map of co-authorship by country, showing the close relationship between researchers from different countries. China's dominance in the number of publications shows the country's important position in tea-related research, which is also supported by a strong tradition of tea consumption in its society.

Table 3 Top 10 Countries by number of publications

Country	Publication	Citation	Total link strength
China	33	296	6
Japan	13	458	3
United States	13	522	13
South Korea	9	216	2
United Kingdom	7	283	11
Brazil	6	119	10
Iran	5	47	4
Italy	5	231	0
France	4	347	2
India	4	65	1

Source: Scopus, 2024

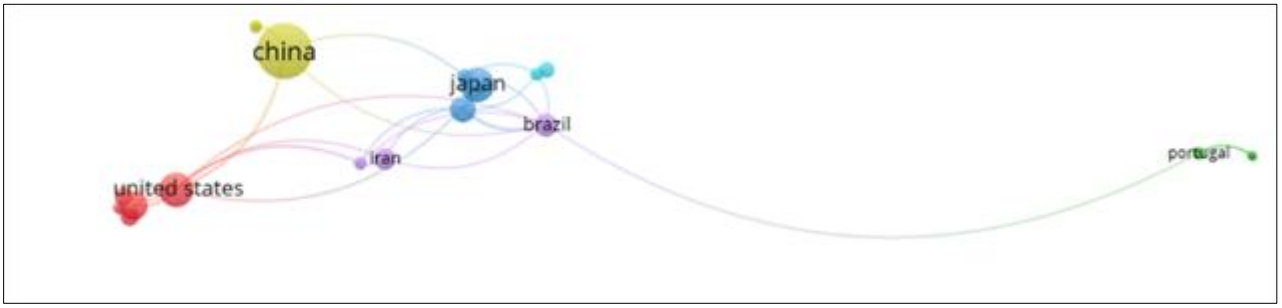

Figure 4 Co-authorship Analysis by Country

3.5. Publication Based on Journal Publishing

The documents included in this study come from 75 journals. The journal Nutrients was the most prolific with 13 publications and 494 citations, followed by Frontiers in Nutrition and Heliyon, with 4 publications each. Table 4 presents a list of the 10 journals with the highest number of publications. Nutrients' dominance as a top journal demonstrates the high relevance of this topic to the field of nutrition, which highlights the potential of tea as a health-supporting functional food.

Table 4 Top 10 Journal by number of publications

Journal	Publication	Citations	Total link strength
Nutrients	13	494	3
Frontiers In Nutrition	4	31	0
Heliyon	4	24	1
Frontiers In Medicine	2	31	1
International Journal of Molecular Sciences	2	16	0
Journal of Medicinal Food	2	30	1
Journal of Nutrition Health and Aging	2	16	0
Journal of Sleep Research	2	22	0

Nutritional Neuroscience	2	31	0
Plos One	2	13	0

Source: Scopus, 2024

3.6. Publication Based on Number of Citations

List of the 10 most frequently cited publications. The most frequently cited article is published in Frontiers in Psychiatry with a total of 325 citations by Temple et al. In this review article provides an overview of caffeine consumption, which is the most widely consumed psychoactive drug in the world. This article covers a wide range of topics related to caffeine, including natural and synthetic sources of caffeine, consumption patterns in different populations, as well as the health effects of caffeine consumption on healthy individuals and vulnerable groups such as pregnant women, children, and people with certain health conditions. This article highlights some of the challenges faced in research on caffeine, including the lack of consensus regarding safe doses for different population groups and the need to better understand the long-term effects of caffeine consumption, especially in more vulnerable groups. Additionally, this article emphasizes the need for further research to understand the mechanism of action of caffeine, genetic variation in caffeine metabolism, as well as its impact on mental and physical health. Additional research is also needed to explore how factors such as age, gender, and health conditions affect the effects of caffeine. Table 5. The following is a list of the 10 most cited journal publications.

Table 5 Top 10 Publications with the highest number of citations

Title	Journal	Citation	Year
The Safety of Ingested Caffeine: A Comprehensive Review	Frontiers in Psychiatry	325	2017
Nutrition, physical activity, and other lifestyle factors in the prevention of cognitive decline and dementia	Nutrients	175	2021
Effects of Oral Gamma-Aminobutyric Acid (GABA) Administration on Stress and Sleep in Humans: A Systematic Review	Frontiers in Neuroscience	152	2020
GABA and L-theanine mixture decreases sleep latency and improves NREM sleep	Pharmaceutical Biology	106	2019
Effects of an intervention with drinking camomile tea on sleep quality and depression in sleep disturbed postnatal women: A randomized controlled trial	Journal of Advanced Nursing	76	2016
Effect of caffeine consumption on the risk for neurological and psychiatric disorders	nutrients	66	2020
Stress-reducing function of matcha green tea in animal experiments and clinical trials	Nutrients	62	2018
Effects of chronic L-theanine administration in patients with major depressive disorder	Acta Neuropsychiatrica	62	2017
Pain-relieving agents for infantile colic	Cochrane Database of Systematic Reviews	51	2016
Dietary polyphenols targeting arterial stiffness: Interplay of contributing mechanisms and gut microbiome-related metabolism	Nutrients	46	2019

Source: Scopus, 2024

3.7. Analysis Co-Occurrence Based on Keywords

A network visualization map of all keywords is illustrated in Figure 5. Different colors represent different directions of research focus. The dot size reflects the frequency with which keywords appear. All the keywords form 5 groups such as:

- Red Clusters are sleep, sleep, sleep time, sleep latency, sleep efficiency, sleep pattern, sleep disorders, sleep deprivation, rem sleep, drug effect, caffeine, stress, and green tea.
- Yellow Clusters are female, male, middle age, aging, risk factor, demography, health status, hypertension, and diabetes melitus.
- Green Clusters are Human, sleep quality, tea, insomnia, anxiety, depression, sleep wake disorders, melatonin, fatigur, antioxidant, and aromatheraphy.
- Blue Clusters are adult, young adult, coffee, body mass, exercise, physical activity, drinking behavior, energy drink, soft drink, alcohol, beverage, milk, fruit and vegetable.
- Purple Clusters are Pittsburgh Sleep Quality Index, tea consumption, coffee consumption, smooking, age, gender, and marriage.

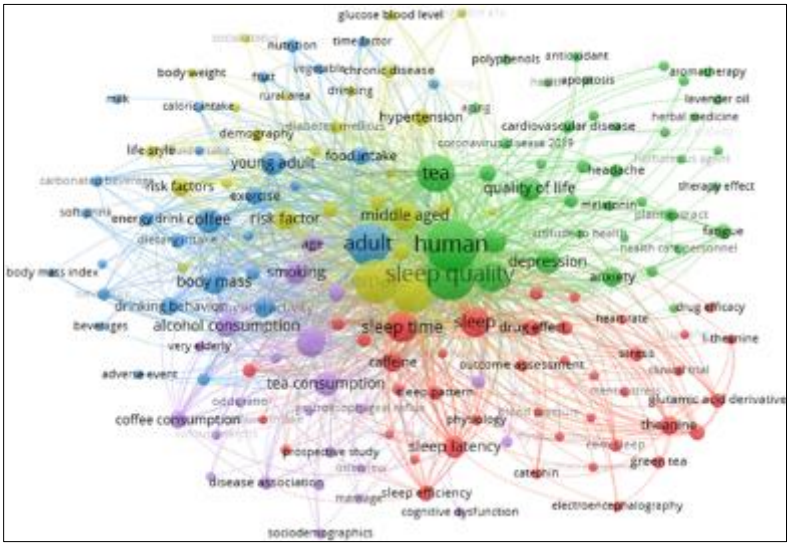

Figure 5 Visualization of co-occurrence analysis by keywords

3.8. Literature Review

As a result of the systematic review analysis, as many as 11 journals relevant to this research topic were included in the final evaluation. The journals were selected based on strict selection criteria and included important information such as research objectives, geographical location, participant characteristics, study design, measurement methods, and research results (Table 6). A thorough analysis of these journals aimed to deeply understand the relationship between tea consumption and sleep quality and how various factors affect these outcomes.

This study was conducted to summarize the methodology and results of previous studies to determine a clear relationship between tea consumption and sleep quality. The eleven selected studies showed variations in terms of geographical location (e.g., China, Japan, Korea, France), the type of tea used (such as green tea, magnolia tea, and herbal tea containing Hibiscus syriacus L or L-theanine), the design of the study (including randomized controlled trials), and the characteristics of participants (adolescents, adults, to the elderly). Various positive results found include a decrease in stress levels, depression, pain, and fatigue that contribute to improved sleep quality. However, it is important to remember that the interpretation of these results requires caution, given the variation in age, health conditions, and research methodology across the studies analyzed. Some studies show that the consumption of tea at night has a significant positive effect on sleep quality due to the specific bioactive content, such as L-theanine in green tea, which has natural relaxing properties. In addition, randomized controlled studies (RCS) involving herbal tea products containing Hibiscus syriacus L, magnolia tea, and green tea showed that tea can help improve sleep efficiency, reduce insomnia, and improve the overall sleep experience

Table 6 Top 10 Publications with the highest number of citations

Ref	Objective	Country	Participants	Measurement	Result
[11]	The relationship between tea habits and quality of life and the mediating effect of sleep quality	China	300.000 permanents residents ≥ 18 years old (adults)	HRQoL was measured using a 12-item Short-Form Health Survey.	Maintaining the habit of drinking tea (6-7 days per week), in small amounts (<10 g of tea per day) is conducive to increasing the HRQoL of Chinese adults by improving sleep quality.
[12]	Effect of matcha green tea on cognitive function and sleep quality	Japan	124 participants aged 60-85 years (Older adults)	Montreal Cognitive Assessment, Alzheimer's Disease Cooperative Study Activity, PSQI.	The study showed regular consumption of matcha may improve emotional perception and sleep quality in older adults with mild cognitive decline.
[13]	Effect of Tea Consumption on Cognitive Function and Examining Possible Psychosocial Mechanisms with Sleep Quality	China	11,910 participants aged ≥ 60 years (Older adults)	Propensity Score Matching (PSM)	Frequent consumption of tea was found to have a beneficial effect on cognitive function, especially in older people with green tea intake. Sleep quality and depression levels partly mediate the relationship between frequent tea consumption and cognitive function among older Chinese adults.
[14]	Effect of Hibiscus syriacus L. flower extract (used for tea) on sleep quality	Korea	80 participants aged 19 to 65 years old (Adults)	PSQI, Insomnia Severity Index (ISI), Epworth Sleep Scale (ESS), sleep diary, and polysomnography (PSG)	The potential of HSF extract as a functional food that improves sleep quality in humans will be evaluated, and the trial findings will be submitted to the Korean Ministry of Food and Drug Safety for consideration as a new functional ingredient that can help improve sleep quality.
[15]	Effect of the combination of magnesium, vitamins B6, B9, B12, rhodiola and green tea/L-theanine (Mg-Teadiola) on stress-related quality of life parameters (sleep and pain perception).	France	123 participants aged 18 to 65 years (Adults)	PSQI, Depression Anxiety Stress Scale (DASS)	Mg-Teadiola was effective in relieving stress on Days 14 and 28 in chronically stressed but healthy individuals. These findings, in addition to the observation that Mg-Teadiola can reduce pain perception, underscore its potential benefits for patients suffering from pain, where comorbidities such as stress and sleep disturbances are common.
Ref	**Objective**	**Country**	**Participants**	**Measurement**	**Result**
[16]	Three components of herbal tea reduce prolonged fatigue and improve sleep quality	Korea	40 participants aged 35 to 44 years (adults)	Chalder Fatigue Scale	In this study, herbal tea treatment improved sleep quality, in a pattern similar to that observed for fatigue improvement. These results highlight the potential usefulness of herbal teas for treating sleep disorders that accompany fatigue.

[17]	Consumption of green tea with lower caffeine improves sleep quality through stress suppression	Japan	10 participants with an average age of 89 years (elderly)	Salivary α-amylase activity (sAA) was measured using a testing strip and a colorimetric system. EEG monitoring is achieved using single-channel EEG.	The effects of caffeine on sleep can be suppressed by theanine (green tea), which has been concluded to improve sleep quality under normal circumstances. On the other hand, poor sleep quality has been reported to increase oxidative stress on the central nervous system.
[18]	Reduced Stress and Improved Sleep Quality Caused by Green Tea Associated with Reduced Caffeine Content	Japan	20 participants with an average age of 51 years (middle-aged)	The sAA was measured using a testing strip and a colorimetric system. EEG monitoring is achieved using single-channel EEG.	These results suggest that LCGT intake may reduce stress in middle-aged individuals and improve their sleep quality. Caffeine reduction is suggested to be a valid reason to increase the anti-stress effects of green tea
[19]	The effectiveness of magnolia tea in alleviating depression and improving sleep quality	China	143 Postpartum women (adults)	Postpartum Sleep Quality Scale (PSQS), Edinburgh Postnatal Depression Scale (EPDS), and Postpartum Fatigue Scale (PFS)	The results of our experiment showed that drinking single-ingredient magnolia tea for 3 weeks had a positive effect on postpartum women. Magnolia tea is recommended as an additional approach to improve the sleep quality of postpartum women, while relieving their symptoms of depression
[20]	Effect of caffeine consumption on sleep quality	Pakistan	83 students aged 18 to 23 (young adults)	Caffeine Consumption Questionnaire (CCQ) and PSQI	Increased caffeine consumption reduces sleep quality, implying that caffeine consumption and sleep quality are inversely proportional to each other.
[21]	Determining the relationship between caffeine consumption and sleep quality	Australia	80 participants with an average age of 38 years (adults)	Caffeine Food Frequency Questionnaire (C-FFQ) and PSQI	Current studies show that total caffeine consumption has a small negative correlation with time spent in bed

4. Conclusion

This bibliometric analysis provides a comprehensive overview of the current status and emerging trends in research on the relationship between tea consumption and sleep quality. Of the 173 publications analyzed, there has been a significant increase in the amount of related literature from 2018 to 2023, reflecting growing academic interest in the role of tea as a non-pharmacological intervention to improve sleep quality. The analysis shows that this research is not limited to a single geographical region but has global appeal, with significant contributions from countries such as China, Japan, and the United States. In addition, collaboration between authors and institutions demonstrates a multidisciplinary approach to understanding the benefits of tea for human health.

Through a systematic review, this study successfully identified 11 relevant journals that met the selection criteria. Most of the studies analyzed concluded that tea consumption, especially green tea and magnolia tea, has a positive effect on sleep quality. Green tea, which is rich in L-theanine, is known to have natural relaxing properties that help reduce stress levels, improve sleep patterns, and reduce insomnia symptoms. On the other hand, magnolia tea has been proven effective in improving sleep quality while alleviating symptoms of depression, especially in women postpartum. These findings indicate that tea can be a promising natural alternative for addressing sleep disorders with broad impacts across various age groups, from adolescents to the elderly.

This study also revealed that tea has mechanisms that can support sleep quality, such as reducing oxidative stress through its antioxidant content and its ability to counteract the negative effects of caffeine through compounds such as theanine. However, the effects of tea on sleep quality are also influenced by other factors, such as dosage, time of consumption, type of tea, and individual health conditions. For example, consuming low-caffeine green tea before bedtime has been found to have a significant positive impact on normal sleep patterns.

In addition to identifying the potential benefits of tea on sleep quality, these findings also underscore the important role of caffeine content in determining the effects of tea on sleep. Based on previous research, high caffeine consumption, including that contained in tea, has a negative correlation with sleep quality, such as a decrease in effective sleep duration and shorter sleep time [20], [21]. This shows that although tea has the potential to improve sleep quality through bioactive compounds such as L-theanine, the negative effects of caffeine content also need to be taken into consideration.

Future research needs to further explore types of tea with low caffeine content and their benefits in improving sleep quality, especially in individuals who are highly sensitive to caffeine. Additionally, developing tea products with controlled caffeine content could serve as a strategic solution to maximize the benefits of tea for sleep quality while minimizing the risk of caffeine-induced sleep disturbances. Thus, tea consumption can be optimized as a safe, effective, and science-based natural intervention to improve sleep quality across various age groups and health backgrounds.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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