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Spatiotemporal Dynamics, Trends and Emerging Patterns of Hair Straightener and/or Hair Product and Cancer: A Scientometric Study

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Abstract

Aim: The aim of this study was to analyze the published scientific literature on the use of hair straighteners and/or hair care products and cancer. Methodology: This was an observational, cross-sectional, and retrospective study with a scientometric approach. A literature search was performed in the Web of Science database on January 17, 2024. Bibliometric indicators were used to analyze research productivity, research impact, international collaboration, author productivity, and literature dispersion. Data analyses were performed using R Studio 4.3.2 and CiteSpace 6.2 software. A total of 108 relevant manuscripts were retrieved on database search. Results: The number of publications has shown an annual growth rate of 6.37%. The average age of articles was 8.28 years, and these had received an average of 22.19 citations. These articles cited a total of 4,940 previous papers. An additional 506 keywords and 355 keywords provided by the authors were identified, demonstrating the thematic diversity of the papers. The clusters presented diverse nodes, and the most representative were as follows: Kaufman KD (1998); Tobin DJ (2001); Kwon OS (2007); Semalty M (2011), and Dnurat R (2017). The Dual Map Overlay graph allowed the exploration of behavior and trends among scientific disciplines. Conclusion: This study provides valuable insights regarding the scientific literature exploring the relationship between the use of hair straighteners and/or hair care products with cancer. The findings underscore the importance of continued research and collaboration in this field.

Keywords:

Hair Straightener, Bibliometrics, Hair Product, Scientometrics.

INTRODUCTION

Hair care and hair straightening products are widely used across the world and may represent a potential source of exposure to carcinogens and endocrine disruptors. The application of these products varies considerably based on race or ethnicity, with the use of hair straighteners or flat irons being notably more prevalent among black women compared to white women [1, 2]. In recent years, there has been a growing interest in the potential relationship between the use of hair straighteners and the incidence of cancer [3, 4].

The use of hair chemicals may contribute to the high presence of endocrine disrupting compounds in women. Some studies have indicated the potential carcinogenic effect of certain chemicals present in hair straightening products [5, 6]. While it is hypothesized that these cancers may have a hormonal basis, the connection between exposure to these endocrine disruptors and cancer risk is not fully elucidated. Furthermore, studies have substantiated the potential link between personal care products, such as douching, and the use of powders (such as talc) in the genital area, and the presence of endocrine disrupting compounds [7, 8].

However, there has been growing apprehension about the potential link between

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the frequent use of hair straighteners and the onset of cancer [9, 10]. Exposure to high levels of estrogen and an imbalance between estrogen and progesterone are known risk factors for cancer. Formaldehyde, other chemicals present in some hair straighteners that release formaldehyde, and oxidized para-phenylenediamine and 4-aminobiphenyl present in hair dyes may potentially contribute to carcinogenesis [2, 11].

Some straighteners and leave-in conditioners may contain estrogen compounds or endocrine-interfering chemicals which have been linked to breast carcinogenesis [12, 13]. Hair straighteners typically contain sodium hydroxide in formulations that include bleach, and a blend of calcium hydroxide and guanidine carbonate in those that do not. These products may also include phthalates and parabens, substances known for their hormonal effects. Leave-in conditioners may contain placental extracts along with phthalates and parabens. However, there is a paucity of epidemiological studies investigating the link between the use of hair straighteners and the risk of breast cancer. Some studies have indicated that extended exposure to high temperatures may be a risk factor for certain cancers, particularly those affecting the hair and skin [14-19].

Therefore, the aim of this study was to perform a scientometric analysis to examine the spatiotemporal dynamics of the correlation between hair straightener use and cancer.

Material and Methods

Study Design

This was an observational, cross-sectional, retrospective study of the scientific literature published on the topic analyzed using a scientometric approach in the quantitative paradigm.

Literature Search

On January 17, 2024, ae conducted a comprehensive search of the Web of Science (WOS) database. The search strategy was designed to identify as much relevant literature as possible in the field of hair straighteners and/or hair products and cancer. The following search strategy was used: TS=("Hair Straightener" OR "Hair Iron" OR "Flat Iron" OR "Straightening Iron" OR "Hair Straightening Device" OR "Straightening Tool" OR "Hair Smoothing Appliance" OR "Hair Product" OR "Hair Care" OR "Hair Treatment" OR "Haircare Product" OR "Styling Product" OR "Hair Care Item" OR "Hairstyling Product" OR "Hair Enhancement Formula") AND TS=("Uterine Cancer" OR "Endometrial Cancer" OR "Uterine Neoplasms" OR "Womb Cancer" OR "Uterine Carcinoma" OR "Uterine Malignancy" OR "Endometrial Tumor" OR "Womb Neoplasm" OR "Neoplasm" OR "Malignancy" OR "Tumor" OR "Carcinoma" OR "Growth" OR "Lesion" OR "Metastasis" OR "Carcinogenic Condition" OR "Oncological Disease" OR "Carcinosis")

Bibliometric Indicators

Various bibliometric indicators, including publication frequency, annual citations, international collaboration, Lotka's Law, and Bradford's Law were used. These indicators provide valuable insight into aspects such as research productivity, research impact, global cooperation, author productivity, and literature dispersion. In addition, cocitation analysis, cooccurrence analysis, and coauthorship analysis were conducted to illustrate the connections between various disciplines, keywords, and authors.

Bibliometric Analysis

A total of 108 manuscripts were retrieved on database search. The papers selected for analysis included original research articles and literature reviews. Data analyses were performed using R studio 4.3.2 and CiteSpace 6.2 software, which allow detailed bibliometric analysis. Several bibliometric indicators were used to analyze research productivity, research impact, international collaboration, author productivity, and literature dispersion.

Results

The number of publications was found to have increased with an annual growth rate of 6.37%. The publications had an average age of 8.28 years and received an average of 22.19 citations. These publications refer to a total of 4,940 previous works. Regarding the content of the papers, 506 additional keywords and 355 keywords provided by the authors were identified, demonstrating the thematic diversity of the papers. Regarding authorship, 449 different authors contributed to these papers, of which 12 were solo authors. The most common type of articles were original research articles (72) followed by literature reviews (28) (Table 1).

Table 1: Main Data Information.

Description	Results
Timespan	1994:2023
Sources (Journals, Books, etc)	69
Documents	108
Annual Growth Rate %	6.37
Document Average Age	8.28
Average citations per doc	22.19
References	4940
Document Contents	
Keywords Plus (ID)	506
Author's Keywords (DE)	355
Authors	
Authors	449
Authors of single-authored docs	12
AUTHORS COLLABORATION	
Single-authored docs	16
Co-Authors per Doc	4.8
International co-authorships %	18.52
Document Types	
Article	72
Article; early access	3
Article; proceedings paper	3
Editorial material	2
Review	28

The "Timezone Visualization" showing the patterns and trends in the pertinent scientific literature is presented in Figure 1. The clusters presented several nodes and the summary of nodes. The most representative were those of Kaufman KD (1998); Tobin DJ (2001); Kwon OS (2007); Semalty M (2011); and Dnurat R (2017).

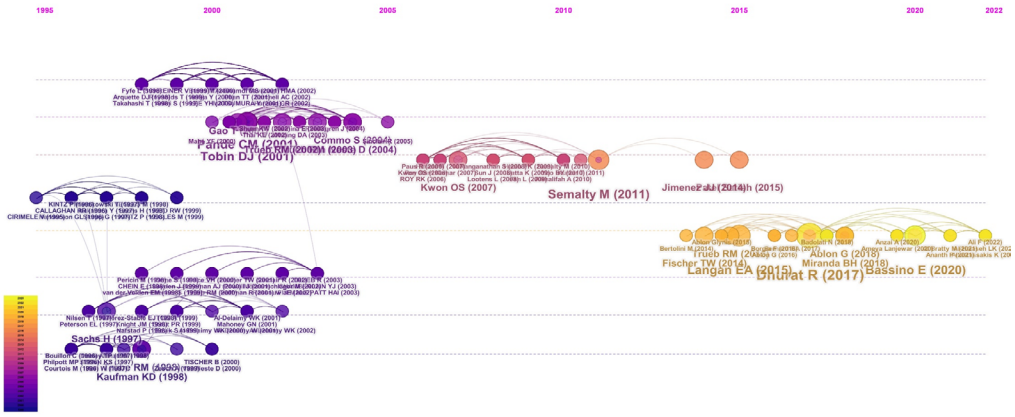

Figure 1: Timeline Visualization.

The Dual Map Overlay graph showing the patterns and trends between citing scientific disciplines (left) and cited scientific disciplines (right) is presented in Figure 2. This visualization shows the top contributing disciplines in this field of study and the evolution of these relationships over time. Publications were mainly condensed in Cluster 4 (Molecular, Biology, Immunology) and Cluster 2 (Medicine, Medical, Clinical) which ended up being predominantly cited by Clusters 2 (Environmental, Toxicology, Nutrition) and Cluster 14 (Dermatology, Dentistry, Surgery).

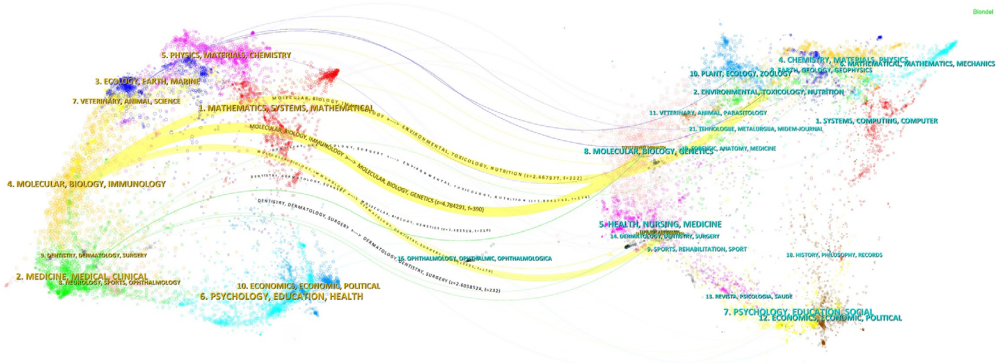

Figure 2: Dual Map Overlay.

Thematic evolution showed that between 1994 and 2013, the focus was on "hair growth." From 2014 onward, the topics diversified toward "hair follicle" and "hair treatment." "Hair treatment" continued to be a relevant topic until 2018, and from 2019, a convergence of "hair treatment" and "hair growth" topics was observed. In this period, an increase in the frequency of occurrence of "hair loss" was also observed. In 2019, "hair care" emerged as a new topic of interest which has maintained its relevance until 2023. In parallel, "hair growth" evolved into "alopecia" and continued to be a topic of interest in 2023 (Figure 3).

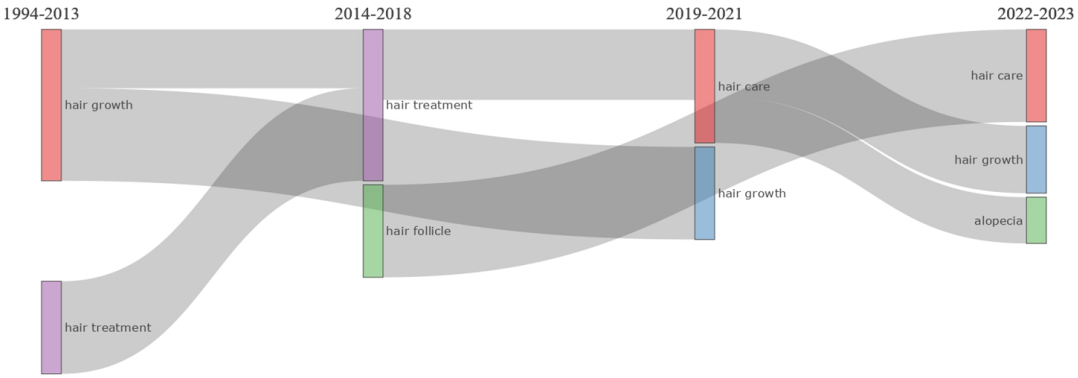

Figure 3: Thematic Evolution.

The analysis of collaboration revealed a diverse international collaboration network. For example, there were a total of three collaborations between France and China. The United States exhibited collaborations with Brazil, Germany, Qatar, and other countries. The diversity of these collaborations suggests a wide dynamicity and focus in research (Figure 4).

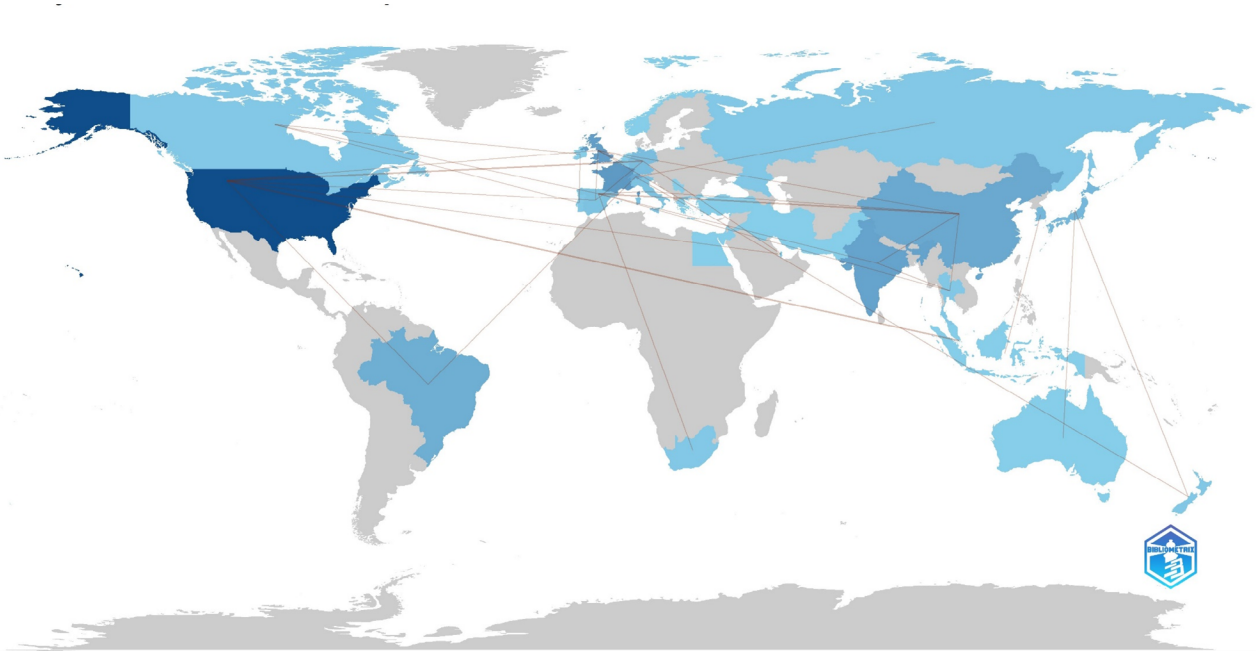

Figure 4: Country Collaboration Map.

Consistent with Lotka's Law, a vast majority of authors (403 89.8%]) were found to have contributed a single paper to the existing literature, while 27 (6%) authors had contributed two papers each. This indicates that as the number of contributions from one author increases, the number of authors making multiple contributions decreases (Figure 5).

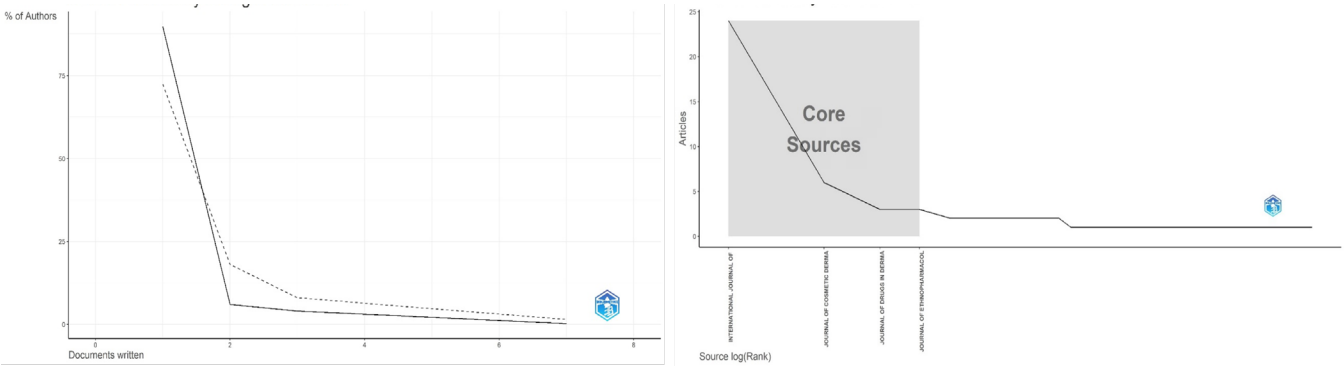

Figure 5: Author Productivity (Lotka´S Law) and Core Sources (Bradford´S Law).

Bradford's Law describes the dispersion of scientific literature. The most productive sources were found in Zone 1: "International Journal of Cosmetic Science" with 24 papers and the "Journal of Cosmetic Dermatology" with 6 papers. Zone 2 included 26 journals, each with 1 or 2 papers each. Some of these journals are "Biomed Research International," "Cosmetics," "Current Traditional Medicine," "Experimental Dermatology," and "Hautarzt" (Figure 5).

From 1994 to 2003, the number of articles published was modest, with a maximum of three articles published annually. This was followed by a phase of low productivity until 2009, with only one or two articles published each year. However, from 2021 to 2023 a significant increase in article production was observed, reaching a maximum of thirteen articles published in a year (Figure 6).

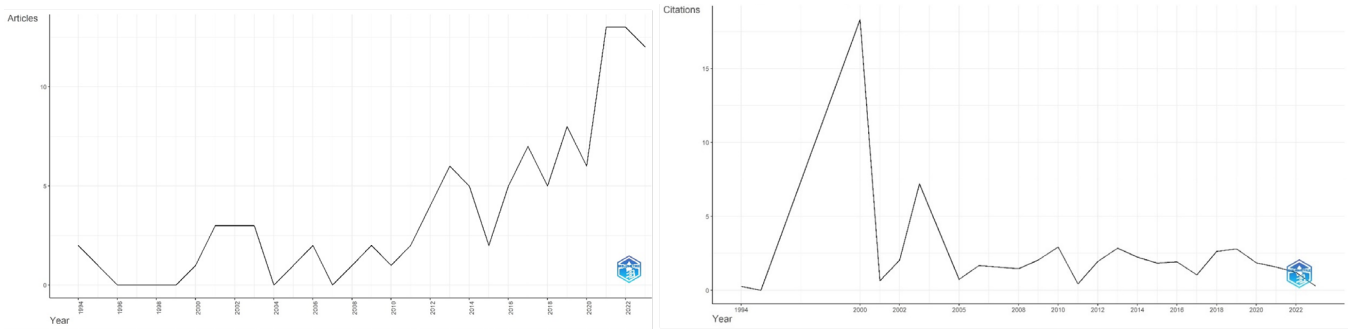

Figure 6: Scientific Production and Citation.

Citation analysis showed that the two articles published in 1994 have accumulated an average of 8.5 citations per article over 31 years, resulting in an average of 0.27 citations per year. However, in 2021 and 2022, despite the high production of 13 articles per year, the average number of citations per article was relatively low (6.31 and 3.62, respectively) (Figure 6).

Discussion

This study identified multiple case studies of uterine cancer in women who have reported regular or occasional use of hair straighteners and related products. The associations found between cancer and other hair treatments like permanent, semipermanent, temporary, bleach, highlights, and perms were minimal [20, 21]. These results are consistent with previous research suggesting the use of straightening irons as a risk factor for hormone-related gynecological cancers [22]. However, previous research has shown that exposure to straightening products is associated with lower levels of sex steroid hormones, which increases the risk of ovarian and breast cancer. This supports the potential role of smoothers in the etiology of hormonal cancer and the occurrence of hormone-sensitive health problems [23, 24].

Exposure to chemicals present in hair products, notably straighteners, may be a more significant concern compared to other personal care products [25]. Chemical absorption through the scalp is higher compared to other parts of the body, such as the skin over the forearm, palm, and abdomen. Hair straightening generally involves the use of chemicals, heat, and other methods that can affect the health of the hair and scalp [26, 27]. Heating processes, such as the use of a flat iron or blow dryer during straightening treatments may release or break down chemicals present in the products, converting them into potentially harmful compounds. This underscores the importance of awareness and caution when using these products [28, 29].

Hair straightening involves the use of hot combs and/or irons which entails the use of less damaging products than chemical straighteners. Therefore, exposure to ironing products may vary over time due to their lower aggressiveness compared to chemical straighteners and irons [30]. In the case of the latter, association estimates may underestimate the true association between their use and uterine cancer. Some studies have suggested an elevated risk of certain types of cancer, such as nasopharyngeal cancer, in people with occupational exposure to high concentrations of formaldehyde, such as hairdressers and stylists. However, these studies have not established a direct relationship with the domestic use of hair straighteners [31].

The available evidence supports the influence of hair straighteners and perms on the risk of premenopausal breast cancer, although no such relationship has been found in postmenopausal women.

Some limitations of this study should be considered. The literature search was confined to the WOS database. Future studies should include information from other databases, such as Embase and PubMed, to obtain a more comprehensive scientometrics analysis. Finally, according to Lotka's Law, there is a productivity bias that indicates that there are few highly productive scientists, but they are the ones who contribute greatly to the advancement of science.

Conclusion

In conclusion, the number of publications in the field of hair care has shown a steady annual growth rate of 6.37%. The papers have received an average of 22.19 citations over a mean period of 8.28 years, and cite 4,940 previous works, demonstrating the interconnectedness and accumulation of knowledge in this field. Notable international collaborations were observed in this field. Our findings underscore the need for continued research and collaboration in the field of hair care. As this field continues to evolve, it is essential to keep up with the latest trends and findings to inform best practices and guide future research.

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Competing Interests
The authors declare that they have no competing interest.

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