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The Changing Landscape of Science Published by a Cross-Section of 15 Leading Beauty Companies, 2015–2025: A Bibliometric Analysis

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Abstract

Science is central to the beauty business, but how has the peer-reviewed science published by leading companies changed? This bibliometric analysis examined 2571 peer-reviewed papers authored or coauthored by scientists affiliated with a cross-section of 15 leading beauty companies. The study period was divided into 2015–2020 (early) and 2021–2025 (late). Annual publication output rose 16.4%. After a blinded repeat-classification check and full-dataset quality-control review, the later portfolio included more clinical or other human research and less biological, mechanistic, or preclinical research, while the latter remained the largest category; papers linking laboratory and human work also increased. The study additionally assessed whether publications increasingly evaluated products, ingredients, or methods relevant to consumer-facing claims. The estimated share rose from about one-quarter to more than two-fifths, and the increase persisted with narrower claim-oriented definitions. Median field-weighted citation impact (FWCI) declined from 1.15 to 1.02, although later-period papers appeared among the top 10% of comparable publications at about twice the expected rate. The increase in claim-oriented research did not explain the citation decline. Thus, within this 15-company cross-section, peer-reviewed publishing became more abundant and increasingly human- and claim-oriented while mechanistic research remained the largest component; normalized scholarly influence declined from an unusually strong early position but remained above benchmark.

Keywords: beauty companies; corporate science; bibliometrics; clinical research; claim substantiation; citation impact

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1. Introduction

Formulation chemistry remains central, while contemporary cosmetic science also examines bioactive ingredients, biological mechanisms, and clinical evaluation of product performance [1,2].

Given the increasing importance of science to the beauty industry, I asked whether the quantity, type, and scientific impact of peer-reviewed research authored or coauthored by scientists from a cross-section of 15 leading beauty companies changed from 2015 to 2025. I hypothesized that the cohort's publication count and field- and year-normalized citation impact increased, and that a greater proportion of papers combined laboratory and human research. I also examined the categories of science represented, company scientist leadership in those publications, and whether observed changes were broadly distributed across the cohort or driven by a small number of companies. After observing

an increase in clinical or other human research, I additionally conducted an exploratory analysis of whether the published portfolio became more oriented toward substantiating consumer-facing product or ingredient benefits.

Bibliometric analysis can summarize publication output, collaboration patterns, and citation impact across a defined research corpus [3]. Prior bibliometric studies in cosmetics and related fields have generally focused on specific subjects, including cosmetic products, use-related adverse effects, skin aging, and melasma [4–7]. The longitudinal peer-reviewed scientific output involving scientists from major beauty companies has not, however, been systematically characterized by applying the same inclusion rules and impact measures across a defined multi-company cohort.

Peer-reviewed publications provide an independently assessed and accessible record of research conducted by or in collaboration with beauty company scientists. Prior studies have associated corporate engagement with science with access to external scientific networks, enterprise value, and the value of subsequent inventions [8–10]. Publication count alone, however, is not equivalent to scientific impact: citation practices vary substantially by field, publication type and year, and journal-level impact measures cannot establish the influence of an individual paper [11–14]. I therefore assessed publication count, scientific category, company scientist authorship position, field- and year-normalized citation impact, and the combination of laboratory and human research. Together, these analyses addressed not simply whether the selected companies published more science in the later period, but whether the character and influence of that published science changed.

2. Materials and Methods

2.1. Study Design and Company Cohort

I conducted a longitudinal bibliometric analysis of peer-reviewed scientific publications authored or coauthored by scientists affiliated with a cross-section of 15 leading beauty companies during calendar years 2015 through 2025: Amorepacific, Beiersdorf, Coty, e.l.f. Beauty, Estée Lauder, Henkel, Kao, L'Oréal, Natura, ODDITY Tech, Procter & Gamble, POLA ORBIS, Puig, Shiseido, and Unilever. The companies were selected before publication retrieval from companies appearing in the 2025 WWD Beauty Inc. Top 100, an annual ranking of the world's largest beauty manufacturers by beauty sales [15]. The selection was intended to provide a broad cross-section across company size, geography, ownership and business model, and scientific tradition. Publication output or scientific performance was not considered in selecting the companies. The group was intended as a cross-section rather than the 15 largest companies, a statistical sample, or a census of the industry. The 2015 start date defined a contemporary 11-year window ending with the last complete calendar year, 2025, while providing sufficient observations for longitudinal comparison. Publications from subsidiaries and research entities were assigned to the parent company while they were part of that company. When an acquired business retained an active research unit, its qualifying publications were assigned to the acquiring company from the date control was obtained. ISDIN was analyzed separately because Puig owned 50% of the company during the study period; assigning every ISDIN paper to Puig would have overstated the science directly under Puig's control. Additional selection and attribution details are provided in the Supplementary Materials (Table S1).

2.2. Publication Identification

Publications were identified independently of company-supplied bibliographies. Searches were conducted during August 2026 using Crossref [16] and PubMed/Europe PMC [17,18] as the main discovery sources; OpenAlex was used to check completeness, resolve bibliographic details, and obtain citation data [19]. Searches used company names,

historical company names, subsidiaries, and research-center affiliations. No language restriction was applied. Non-English publications were eligible if they otherwise met the study criteria. Available English-language metadata or abstracts were used when present, and AI-assisted translation was used when source-language text required interpretation; final eligibility and classification decisions were made by the author. Company publication lists, when available, were used only after the independently identified set had been assembled, as a check for completeness. The OpenAlex citation data were retrieved on 25 August 2026. The Supplementary Materials provide database-specific search examples (Table S12) and the company-attribution rules (Table S1). Because the searches were iterative and used overlapping databases and company names, I did not retain a single record of every result returned before duplicates were removed. These historical counts cannot now be reconstructed reliably because the databases change over time.

2.3. Eligibility and Attribution

Eligible records were full, peer-reviewed original research articles or substantive reviews published from 1 January 2015 to 31 December 2025, with at least one author whose stated affiliation at the time of the work was an included company or qualifying subsidiary or research entity. Funding, consulting, advisory, or conflict-of-interest disclosures alone did not establish company authorship. This rule measured visible internal R&D and collaborative R&D involving a company scientist; it did not capture every externally performed study a company may have funded. Electronic publication date took precedence when print and electronic years differed. Abstracts and proceedings, preprints, patents, chapters, letters, editorials, news items, corrections, memorials, meeting reports, and protocols without results were excluded. DOI was the preferred deduplication key, with title, year, author, and OpenAlex identifiers used when a DOI was absent.

2.4. Scientific Category

Each publication was assigned to one prespecified category according to its principal scientific question and dominant contribution: (1) formulation, ingredient, or product science; (2) biological, mechanistic, or preclinical research; (3) clinical or other human research; or (4) methods, devices, or data science. Human origin alone did not determine category: isolated human cells, tissues, explants, organoids, and other ex vivo or in vitro models were treated as preclinical unless method development predominated, while research in living human participants or populations was classified as clinical/other human unless the principal contribution was methodological. Nonliving human-derived materials such as excised hair shaft or sebum were classified according to the scientific question. Reviews were classified by their dominant scientific question and evidentiary emphasis rather than the highest translational level of evidence cited. Detailed hierarchy and borderline examples are provided in the Supplementary Materials.

To assess how consistently the four categories could be applied, I reclassified a random sample of 100 papers (25 from each original category) without seeing their original labels. When the title was not sufficient, I reviewed the abstract or paper. The disagreements showed that several recurring situations needed clearer rules, particularly studies using human-derived material, studies centered on a measurement method, and reviews spanning laboratory and clinical evidence. I clarified the rules for these situations and then searched the full dataset for papers likely to present the same problems. Papers flagged by these searches were re-read and changed only when the paper's main scientific contribution clearly supported a different category. All changes were recorded before the category analyses were repeated. Additional details are provided in the Supplementary Materials (Table S10).

2.5. Combining Laboratory and Human Research

Each publication was assessed for whether it combined laboratory and human research. This included translational research, in which experimental or mechanistic findings were carried toward observation or testing in people, and reverse translational research, in which observations in people guided experimental or mechanistic investigation [20,21]. A paper qualified only when an important element linked laboratory and human work in one of these directions. A formulation or product study without that connection did not qualify, and clinical research alone was not sufficient. This deliberately conservative classification described the research reported in the paper; it did not mean that the findings were subsequently translated into a product, claim or commercial outcome. Detailed adjudication rules are provided in Supporting Methods.

2.6. Claim-Oriented Research

Because a company's internal purpose cannot be inferred from a publication, papers were classified as claim-oriented rather than as having been produced for a specific marketing claim. The prespecified rubric required an explicit connection between a finished product, prototype, device, commercially relevant ingredient, formulation technology, or claim-measurement method and a consumer-facing cosmetic benefit such as hydration, wrinkle reduction, firmness, radiance, pigmentation, barrier improvement, hair performance, cleansing, or appearance. Direct product-benefit studies, supporting ingredient or technology studies, and methods developed to quantify claim-relevant performance were included. Safety and tolerability substantiation were coded separately and were not included in the primary claim-oriented endpoint. The rubric was informed by the evidential support principles in Commission Regulation (EU) No 655/2013 [22], industry guidance on cosmetic claim substantiation [23], and published approaches to clinical assessment and support for cosmetic product claims [24,25].

Titles and available abstracts were first screened with a reproducible rule-based text program. All 389 papers that the program flagged for manual review were then classified by the author. To check papers the program had classified automatically, I also reviewed a blinded random sample of 221 papers drawn from the five automated categories. Full text was consulted for two papers that remained unclear from the title and abstract. Because the automated screen missed a substantial number of claim-oriented papers, its labels were not treated as the final classification of the full dataset. Instead, the manually reviewed papers and the random audit sample were combined using sampling weights to estimate the proportion of claim-oriented papers in the full set of 2571. Sensitivity analyses repeated the calculation using progressively narrower definitions of claim-oriented research. The claim-orientation rubric, validation and audit results, prevalence and FWCI estimates, and narrower-endpoint sensitivity analyses are provided in Tables S7–S9 and S11.

2.7. Company Scientist Authorship Position

For each publication, I recorded whether a company-affiliated scientist was a first, last, or corresponding author. A paper with at least one of these positions was classified as company scientist-led. These positions are imperfect but visible indicators of scientific leadership; middle authorship without one of these designations was not classified as leadership.

2.8. Scientific Impact

Scientific impact was assessed at the article level using OpenAlex field-weighted citation impact (FWCI), citation percentile, and indicators that a paper ranked in the top 10% or top 1% of comparable publications. FWCI and percentile are normalized for field and

publication year, reducing but not eliminating differences in citation opportunity [13,14]. DOI was the preferred linkage key; an OpenAlex work identifier was used for papers without a DOI. No impact value was estimated for a paper with missing data. Final impact analysis required complete FWCI and percentile data for at least 98% of papers with a DOI or OpenAlex identifier. Because 2025 papers nevertheless had the least time to mature within the 25 August 2026 snapshot, citation analyses were repeated after excluding 2025.

2.9. Analyses

The study period was divided into 2015–2020 (early period) and 2021–2025 (late period). Publication counts were reported both as totals and as average numbers of papers per year because the periods contained six and five years, respectively. Annual publication rates were compared with a rate test that accounted for the different period lengths. FWCI and citation percentile distributions were compared using two-sided Mann–Whitney tests, and proportions using two-sided Fisher exact tests. Because publication year does not identify when research was performed, a sensitivity analysis omitted both 2020 and 2021 and compared 2015–2019 with 2022–2025. Company-specific p values were adjusted using the Benjamini–Hochberg procedure. Cohort-level analyses counted each scientific work once. Company-level analyses normally credited a shared paper to each participating company; as a sensitivity analysis, I repeated the calculation by dividing credit equally among the companies represented on a shared paper. The claim-oriented estimates accounted for the sampling design described above. A separate descriptive analysis examined whether the change in average FWCI was associated mainly with the changing proportion of claim-oriented papers or with changes in citation impact within the claim-oriented and other groups; this analysis was not interpreted as causal.

As an exploratory descriptive analysis, I identified the three papers with the highest citation percentile in each publication year. Higher FWCI and then citation count were used to resolve any ties. This analysis was intended to show the subjects and companies represented among the cohort's exceptionally influential papers; it was not used to test the primary hypotheses or rank overall company performance.

2.10. Use of Artificial Intelligence-Assisted Tools

I conceived the study, developed and refined the methods, established the eligibility and classification rules, made or reviewed the publication-level decisions, interpreted the results, and wrote and critically revised the manuscript. OpenAI ChatGPT and Codex (GPT-5-series models, accessed during August–September 2026) assisted with developing search queries, building screening and audit workflows, locating relevant evidence in titles and abstracts, writing and checking data-processing and statistical code, preparing tables and figures, and language editing. Routine operations such as deduplication, the rule-based claim screen, sampling calculations, and statistical tests followed defined rules once their inputs were set. The claim screen itself did not use generative AI. AI did not make the final decisions about eligibility, scientific category, interpretation, or conclusions. I reviewed the source evidence and analytic results and take full responsibility for the work. The Supplementary Materials describe the division of work between the author and AI-assisted tools in more detail (Table S14).

2.11. Software

Statistical analyses were performed using Python 3.12.13 with pandas 2.2.3, NumPy 2.3.5, and SciPy 1.17.0. Figures were prepared using Matplotlib 3.10.8, with Microsoft Excel used for tabular review and verification.

3. Results

3.1. Publication Output and Distribution Across Companies

Scientists affiliated with the primary cohort companies authored or coauthored 2571 unique papers during 2015–2025. Ninety-nine papers included qualifying authors from more than one cohort company. Because each such paper was credited to every represented company in company-level analyses, these collaborations accounted for 229 additional company credits and produced 2800 company-paper records. Thirteen companies published at least one eligible paper; e.l.f. Beauty and ODDITY Tech had none under the company authorship rule used here. The early period contained 1305 papers over six years, an average of 217.5 papers per year. The late period contained 1266 papers over five years, an average of 253.2 per year. The annual publication rate therefore increased by 16.4% (p = 0.00012), even though the shorter late period contained fewer papers in total (Table 1; Figure 1). Company-level publication characteristics and the shared-paper sensitivity analysis are provided in Tables S2 and S13, respectively.

Table 1. Peer-reviewed publication output by company, 2015–2025.

Company	Total	2015–2020 *n*	Annual Average	2021–2025 *n*	Annual Average	Change in Annual Rate	Adjusted *p*
Amorepacific	279	175	29.2	104	20.8	−28.7%	0.029
Beiersdorf	196	95	15.8	101	20.2	+27.6%	0.214
Coty	33	26	4.3	7	1.4	−67.7%	0.029
e.l.f. Beauty	0	0	0.0	0	0.0	—	—
Estée Lauder	61	27	4.5	34	6.8	+51.1%	0.228
Henkel	58	33	5.5	25	5.0	−9.1%	0.865
Kao	296	159	26.5	137	27.4	+3.4%	0.865
L'Oréal	583	270	45.0	313	62.6	+39.1%	0.001
Natura	27	10	1.7	17	3.4	+104.0%	0.213
ODDITY Tech	0	0	0.0	0	0.0	—	—
P&G	364	194	32.3	170	34.0	+5.2%	0.827
POLA ORBIS	64	31	5.2	33	6.6	+27.7%	0.549
Puig	34	18	3.0	16	3.2	+6.7%	0.865
Shiseido	329	160	26.7	169	33.8	+26.7%	0.115
Unilever	476	248	41.3	228	45.6	+10.3%	0.471
Primary cohort (unique papers)	2571	1305	217.5	1266	253.2	+16.4%	0.00012 *

Company counts credit a qualifying collaborative paper to every represented cohort company; the primary cohort row counts each scientific work once. Adjusted p values use the Benjamini–Hochberg procedure across the 13 publishing companies. * Unadjusted cohort-level Poisson rate comparison.

The pooled increase was not uniform across companies. When each of the 13 companies with at least one eligible paper was treated as one observation, the change in annual publication rate was not statistically significant (p = 0.110). After correction for testing 13 companies, L'Oréal's annual output increased significantly, while Amorepacific and Coty decreased. Dividing credit for shared papers among the participating companies produced a very similar pattern of company-level changes (Spearman rho = 0.90). Thus, the pooled increase should not be interpreted as a uniform shift of comparable magnitude across companies.

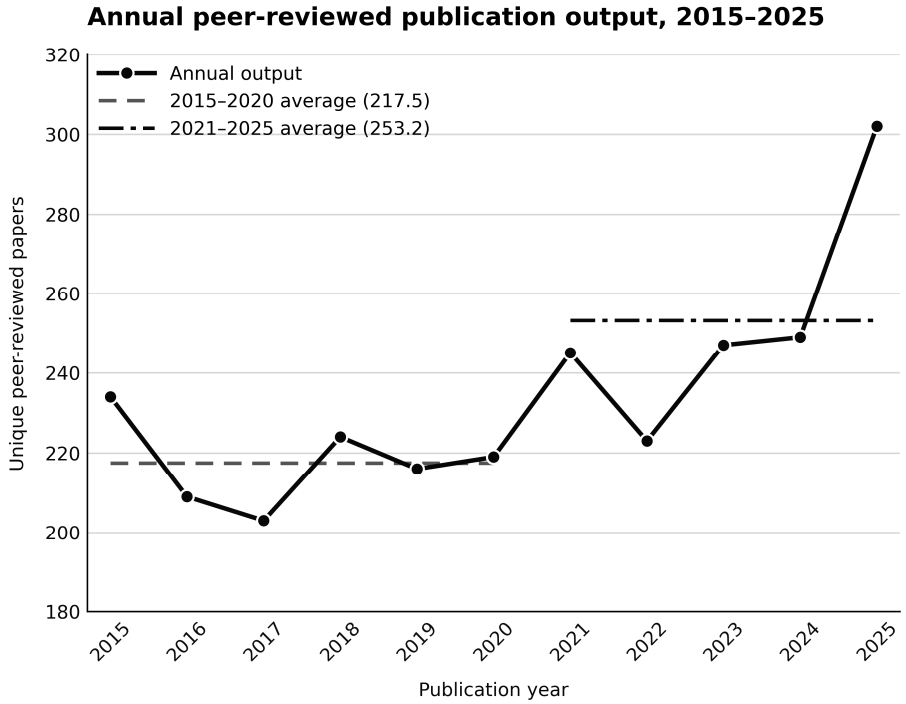


Figure 1. Annual peer-reviewed publication output, 2015–2025. Each scientific work was counted once, including papers coauthored by scientists from more than one cohort company. The primary comparison grouped 2015–2020 as the early period and 2021–2025 as the late period; horizontal reference lines show the average annual publication rates of 217.5 and 253.2 papers, respectively.

3.2. Scientific Categories

In the blinded 100-paper repeat-classification audit, 59% of papers received the same category as before (Cohen's kappa = 0.453), confirming that some category boundaries required judgment. After the rules were clarified, the full dataset was screened for papers likely to present the same boundary problems and those papers were re-read. This quality-control review changed 115 of 2571 category assignments (4.5%). In the corrected dataset, biological, mechanistic, or preclinical research remained the largest category (927 papers; 36.1%), followed by clinical or other human research (718; 27.9%), methods, devices or data science (559; 21.7%), and formulation, ingredient, or product science (367; 14.3%). The overall distribution differed between periods ($p = 0.017$). Biological, mechanistic, or preclinical papers decreased from 38.6% to 33.4%, while clinical or other human papers increased from 25.7% to 30.3% (Benjamini–Hochberg-adjusted $p = 0.0215$ for each). The shares of the other two categories did not change significantly (Figure 2A).

3.3. Combined Laboratory and Human Research and Company Scientist Leadership

Overall, 564 papers (21.9%) combined laboratory and human research. The proportion increased from 18.9% (247/1305) in 2015–2020 to 25.0% (317/1266) in 2021–2025 ($p = 0.00020$; Figure 2B). A test treating each of the 13 companies with at least one eligible paper as one observation was not significant ($p = 0.110$). Thus, the pooled increase did not establish that a shift of comparable size occurred across the cohort.

3.4. Claim-Oriented Research

The rule-based screen was highly specific but missed a substantial number of claim-oriented papers in the blinded 221-paper audit: binary agreement was 79.2%, sensitivity 43.2% (95% CI, 32.6–54.6%), and specificity 97.3% (93.2–98.9%); the confusion matrix was 32 true positives, 4 false positives, 143 true negatives, and 42 false negatives. Automated labels were therefore not treated as the final classifications for all 2571 papers. Combining the

papers reviewed manually with the blinded random audit, the estimated claim-oriented share increased from 26.9% (95% CI, 19.8–34.0%) in 2015–2020 to 41.6% (34.1–49.2%) in 2021–2025 (risk ratio 1.55, 95% CI, 1.08–2.22; $p = 0.018$; Figure 2C). The increase persisted under narrower definitions: direct + supporting claim-oriented research increased from 21.7% to 35.3% (RR 1.63; $p = 0.0166$), and direct-only research from 7.0% to 16.7% (RR 2.37; $p = 0.0073$).

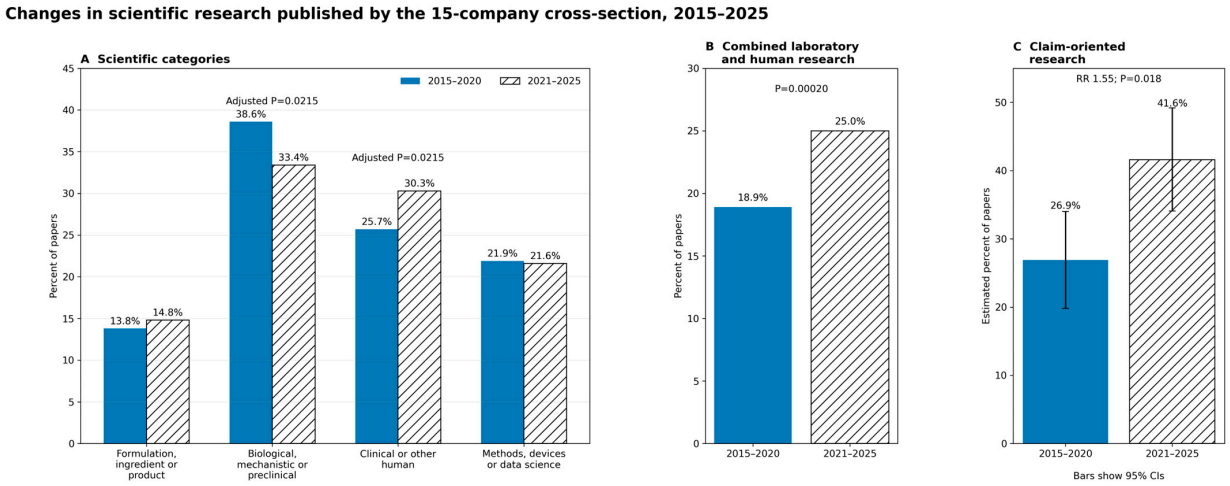


Figure 2. Changes in scientific mix, connection of laboratory and human research, and claim orientation. (**A**) Corrected distribution among four scientific categories after the blinded repeat-classification audit and full-dataset quality-control review. The overall distribution differed between periods ($p = 0.017$); biological, mechanistic, or preclinical research decreased and clinical or other human research increased (Benjamini–Hochberg-adjusted $p = 0.0215$ for each). (**B**) Papers combining laboratory and human research increased from 18.9% to 25.0% ($p = 0.00020$). (**C**) The estimated claim-oriented share increased from 26.9% (95% CI, 19.8–34.0%) to 41.6% (34.1–49.2%; risk ratio 1.55, $p = 0.018$) based on the manual review and blinded random audit.

Among papers classified as clinical or other human research after the category review, the estimated claim-oriented share increased in the same direction, from 27.3% (95% CI, 13.2–41.4%) to 42.6% (29.6–55.5%), but the estimate was less precise and was not statistically significant (risk ratio 1.56, 95% CI, 0.82–2.96; $p = 0.176$). Mean FWCI did not decline within claim-oriented papers overall or within the clinical/human category. Among non-claim clinical/human papers, estimated mean FWCI declined from 2.64 to 1.47 (difference −1.16, 95% CI, −2.17 to −0.16; $p = 0.023$). Thus, the increase in claim-oriented publishing did not explain the decline in impact within the clinical/human portfolio.

A company scientist occupied a first, last, or corresponding author position on 1748 papers (68.0%). The proportion was 66.7% in the early period and 69.3% in the late period ($p = 0.176$). A test treating each active publisher as one observation was nominally significant ($p = 0.027$) but not after correction for the three company distribution comparisons (adjusted $p = 0.080$).

3.5. Article-Level Citation Impact

Of 2564 papers with a DOI or OpenAlex identifier, 2563 (99.96%) had complete FWCI and citation percentile data in the 25 August 2026 snapshot. No values were estimated for missing data. Among papers in the primary comparison, median FWCI declined from 1.15 ($n = 1299$) to 1.02 ($n = 1264$; $p = 0.0030$), and the median citation percentile declined from the 77.3rd to the 75.4th percentile ($p = 0.00086$). The proportion of papers in the top 10% of field- and year-comparable publications declined from 24.1% to 20.3% ($p = 0.023$); the top 1% proportion declined from 2.7% to 1.5% ($p = 0.039$). Despite these declines, the

cohort remained overrepresented among highly cited publications. In the later period, 20.3% of papers ranked in the top 10% of comparable publications—approximately twice the expected proportion—and 1.5% ranked in the top 1%, compared with the 1% expected.

The findings remained materially unchanged when both 2020 and 2021 were omitted. Comparing 2015–2019 with 2022–2025, the annual publication rate increased from 217.2 to 255.3 papers, the proportion combining laboratory and human research increased from 18.8% to 25.2%, median FWCI declined from 1.22 to 1.03, and the top 10% proportion declined from 25.0% to 20.1% (all $p \leq 0.008$); the top 1% proportion declined from 3.0% to 1.5% ($p = 0.026$).

Impact-data coverage and time-window sensitivity analyses are summarized in Table S4. The impact findings were also not attributable solely to the limited citation time of 2025 papers. After 2025 was excluded, FWCI, citation percentile and the top 10% proportion remained significantly lower in the late period; the top 1% difference retained the same direction but was not significant (2.7% versus 1.7%; $p = 0.116$). Among company-led papers, early–late declines were not statistically significant. Among papers combining laboratory and human research, however, median FWCI declined from 1.56 to 1.15 ($p = 0.0030$), median citation percentile from the 82.4th to the 78.7th percentile ($p = 0.0036$), the top 10% proportion from 32.8% to 23.7% ($p = 0.018$), and the top 1% proportion from 4.9% to 1.3% ($p = 0.018$).

3.6. Category- and Company-Level Impact

Within scientific categories, the only impact change that remained significant after correction for multiple comparisons was in methods, devices, or data science: the proportion of papers in the top 10% declined from 27.6% to 16.5% (adjusted $p = 0.0087$). No other category-specific change in FWCI, citation percentile, top 10% representation, or top 1% representation remained significant after correction.

Company-level citation-impact results are provided in Table S3. Company-level impact changes were heterogeneous. After correction for testing each company, Kao and L'Oréal had significant declines in FWCI, citation percentile, and the top 10% proportion. Henkel had a significant decline in citation percentile, while its declines in FWCI and the top 10% proportion did not remain significant after correction. Coty, POLA ORBIS, and Puig had numerical increases in FWCI, but these were not statistically significant and were based on substantially smaller samples.

3.7. Highest-Impact Papers by Year

Identifying the three papers with the highest citation percentile in each year yielded 33 papers, of which 32 ranked within the top 1% of comparable publications (Table 2). Nine cohort companies were represented, alone or through collaborations. Unilever scientists coauthored 14 of the papers; L'Oréal and P&G scientists coauthored 12 each; Beiersdorf scientists coauthored six; Henkel scientists coauthored four; Shiseido and Kao scientists coauthored three each; Coty scientists coauthored two; and Amorepacific scientists coauthored one. Shared papers accounted for many appearances; among papers with only one cohort company, L'Oréal appeared nine times, Unilever six times, and Beiersdorf three times. The 33 papers included 13 biological, mechanistic, or preclinical studies; 12 methods, devices, or data science papers; five clinical or other human studies; and three formulation, ingredient, or product science papers. Earlier years featured exceptionally influential work in exposure assessment, alternative testing, and regulatory toxicology; later selections also included skin aging, oxidative stress, microbiome science, senescent-cell biology, fermentation, personalized care, and alternatives to animal testing. Complete DOI and audit information is provided in Table S6.

Table 2. Three highest-impact papers involving scientists from the 15-company cross-section in each year, 2015–2025.

Year (Rank)	Company Affiliation(s)	Paper Title	Scientific Category	Citation Percentile (%)	FWCI
2015 (1)	P&G; Unilever	Use of an aggregate exposure model to estimate consumer exposure to fragrance ingredients in personal care and cosmetic products	Methods/devices/data	99.97	83.91
2015 (2)	P&G; Unilever	Novel database for exposure to fragrance ingredients in cosmetics and personal care products	Methods/devices/data	99.96	83.91
2015 (3)	Kao; P&G	Bayesian integrated testing strategy (ITS) for skin sensitization potency assessment: a decision support system for quantitative weight of evidence and adaptive testing strategy	Biological/preclinical	99.70	22.75
2016 (1)	L'Oréal	The skin aging exposome	Biological/preclinical	99.90	24.31
2016 (2)	Beiersdorf; Henkel; L'Oréal; P&G	Cosmetics Europe compilation of historical serious eye damage/eye irritation in vivo data analysed by drivers of classification to support the selection of chemicals for development and evaluation of alternative methods/strategies: the Draize eye test Reference Database (DRD)	Methods/devices/data	99.62	16.80
2016 (3)	Unilever	How Adverse Outcome Pathways Can Aid the Development and Use of Computational Prediction Models for Regulatory Toxicology	Methods/devices/data	99.57	22.42
2017 (1)	P&G; Unilever	Application of the expanded Creme RIFM consumer exposure model to fragrance ingredients in cosmetic, personal care and air care products	Methods/devices/data	100.00	156.66
2017 (2)	P&G; Unilever	Integrating habits and practices data for soaps, cosmetics and air care products into an existing aggregate exposure model	Methods/devices/data	99.99	149.01
2017 (3)	Unilever	Perspective: Dissipative particle dynamics	Biological/preclinical	99.78	19.59
2018 (1)	Beiersdorf; Coty; Henkel; Kao; P&G; Shiseido; Unilever	Non-animal methods to predict skin sensitization (II): an assessment of defined approaches	Methods/devices/data	99.63	20.21
2018 (2)	Beiersdorf; Coty; Henkel; Kao; P&G; Shiseido; Unilever	Non-animal methods to predict skin sensitization (I): the Cosmetics Europe database	Methods/devices/data	99.60	19.77
2018 (3)	P&G	Plasticizing Silk Protein for On-Skin Stretchable Electrodes	Clinical/human	99.54	14.45

Table 2. *Cont.*

Year (Rank)	Company Affiliation(s)	Paper Title	Scientific Category	Citation Percentile (%)	FWCI
2019 (1)	L'Oréal	Safety of titanium dioxide nanoparticles in cosmetics	Formulation/product	99.69	20.86
2019 (2)	L'Oréal	Research Techniques Made Simple: Cutaneous Colorimetry: A Reliable Technique for Objective Skin Color Measurement	Methods/devices/data	99.63	18.63
2019 (3)	L'Oréal	Sunscreen photoprotection and vitamin D status	Clinical/human	99.59	17.82
2020 (1)	Unilever	A Next-Generation Risk Assessment Case Study for Coumarin in Cosmetic Products	Clinical/human	99.64	14.45
2020 (2)	P&G; Unilever	Updating exposure assessment for skin sensitization quantitative risk assessment for fragrance materials	Methods/devices/data	99.43	17.63
2020 (3)	L'Oréal	Changes of the human skin microbiota upon chronic exposure to polycyclic aromatic hydrocarbon pollutants	Biological/preclinical	99.40	16.86
2021 (1)	L'Oréal	Oxidative stress in the skin: Impact and related protection	Biological/preclinical	99.83	33.82
2021 (2)	L'Oréal; P&G; Unilever	Paving the way for application of next generation risk assessment to safety decision-making for cosmetic ingredients	Methods/devices/data	99.48	12.64
2021 (3)	Unilever	Explainable AI reveals changes in skin microbiome composition linked to phenotypic differences	Clinical/human	99.18	13.89
2022 (1)	L'Oréal; P&G	The BlueScreen HC assay to predict the genotoxic potential of fragrance materials	Methods/devices/data	99.99	71.18
2022 (2)	L'Oréal	Benefits of topical hyaluronic acid for skin quality and signs of skin aging: From literature review to clinical evidence	Biological/preclinical	99.79	23.28
2022 (3)	L'Oréal	A mechanistic view on the aging human skin through ex vivo layer-by-layer analysis of mechanics and microstructure of facial and mammary dermis	Biological/preclinical	99.39	14.76
2023 (1)	Shiseido	Cytotoxic CD4+ T cells eliminate senescent cells by targeting cytomegalovirus antigen	Biological/preclinical	99.76	25.78
2023 (2)	Unilever	History of Natural Ingredients in Cosmetics	Formulation/product	99.62	16.44
2023 (3)	Beiersdorf	Unlocking the Potential of Fermentation in Cosmetics: A Review	Formulation/product	98.87	10.48

Table 2. *Cont.*

Year (Rank)	Company Affiliation(s)	Paper Title	Scientific Category	Citation Percentile (%)	FWCI
2024 (1)	Henkel	Significance of melanin distribution in the epidermis for the protective effect against UV light	Biological/preclinical	99.63	15.23
2024 (2)	Amorepacific	Ginseng root-derived exosome-like nanoparticles protect skin from UV irradiation and oxidative stress by suppressing activator protein-1 signaling and limiting the generation of reactive oxygen species	Biological/preclinical	99.45	13.65
2024 (3)	Beiersdorf	Identification of dihydromyricetin as a natural DNA methylation inhibitor with rejuvenating activity in human skin	Biological/preclinical	99.40	16.58
2025 (1)	L'Oréal	Unlocking Longevity in Aesthetic Dermatology: Epigenetics, Aging, and Personalized Care	Biological/preclinical	99.80	29.89
2025 (2)	Unilever	EU roadmap for phasing out animal testing for chemical safety assessments: Recommendations from a multi-stakeholder roundtable	Clinical/human	99.15	12.88
2025 (3)	Beiersdorf	Distinct Intraspecies Variation of Cutibacterium acnes and Staphylococcus epidermidis in Acne Vulgaris and Healthy Skin	Biological/preclinical	99.06	14.33

Notes: Papers were ranked within each publication year by OpenAlex citation percentile; higher FWCI and then citation count were used to resolve ties. Citation percentile is normalized for field and publication year and is shown as a percentage; values are rounded to two decimal places. FWCI indicates citations relative to comparable papers, with 1.00 representing the expected level. A collaborative paper lists every cohort company represented among its authors. This exploratory analysis illustrates exceptionally influential work and was not used to rank overall company performance. OpenAlex impact data were retrieved 25 August 2026.

3.8. ISDIN Separate Analysis

Fifty-nine ISDIN papers fell within the 2015–2025 study period and were analyzed separately. Median FWCI increased from 1.20 (n = 24) in 2015–2020 to 2.08 (n = 35) in 2021–2025 (p = 0.027), and median citation percentile increased from the 79.0th to the 87.0th percentile (p = 0.033). The top 10% proportion increased from 12.5% to 42.9% (p = 0.020), whereas the top 1% comparison was not significant (Table S5).

4. Discussion

This study asked whether, from 2015 to 2025, peer-reviewed science published with scientists from a cross-section of 15 leading beauty companies increased not only in quantity but also in scientific impact, and whether more papers combined laboratory and human research. Two parts of the hypothesis were supported: the annual publication rate increased by 16.4%, and the proportion combining laboratory and human research increased from 18.9% to 25.0%. The impact hypothesis was not supported. Median FWCI and citation percentile declined, as did the proportions ranking in the top 10% and top 1% of comparable publications. The cohort therefore published more science per year in the later period, but the additional output was not accompanied by greater normalized citation influence.

That distinction matters. Publication count measures the amount of science made visible through peer-reviewed journals. It does not by itself measure novelty, quality, or influence. Conversely, citation impact does not measure every form of scientific value: a formulation paper can be commercially important without becoming highly cited, and some proprietary work may never be published. The two sets of measures answer different questions. Taken together, they show an expansion of the cohort's visible scientific activity alongside a modest but statistically convincing decline in its influence within the scholarly literature.

The pooled findings also should not be treated as if every company followed the same course. The company-level comparison of annual publication rates was not statistically significant when each shared paper was credited fully to every participating company. Dividing credit for shared papers among the participating companies produced a very similar company pattern. L'Oréal increased significantly, while Amorepacific and Coty decreased. The company-level analysis likewise did not show a consistent increase across companies in the proportion of papers combining laboratory and human research. The pooled results are real, but some were driven more strongly by particular companies than others.

The scientific mix was considerably broader than beauty's traditional association with chemistry and formulation might suggest. Biological, mechanistic, or preclinical research remained the largest category after the classification quality-control review, and clinical or other human research was the second largest. The later period contained a greater proportion of clinical or other human research and a smaller proportion of mechanistic/preclinical work, while mechanistic research still represented one-third of the later portfolio. The finding therefore reflects a relative shift toward human research, not a wholesale retreat from laboratory science. The blinded repeat-classification analysis also showed that some boundaries between these broad categories require judgment, so the categories are best viewed as useful descriptions of the portfolio rather than mechanically objective labels.

The exploratory claim-oriented analysis adds a commercially relevant dimension. The estimated claim-oriented share rose from approximately one-quarter to more than two-fifths of the published portfolio, and the increase persisted when the endpoint was narrowed to direct + supporting or direct-only claim-oriented research. This classification identifies published evidence linking products, ingredients, technologies, or measurement

methods to consumer-facing benefits; it does not establish a company's internal purpose or that any particular advertising claim was made. The finding therefore demonstrates a greater proportion of published papers containing claim-relevant evidence rather than a demonstrated change in corporate intent.

The initial hypothesis that the shift in claim-oriented publishing might explain declining citation impact was not supported. Mean FWCI did not decline within claim-oriented papers, whereas non-claim clinical/human papers showed a significant decline. The decomposition analysis simply separated the observed change in mean FWCI into the part associated with the changing mix of claim-oriented and other papers and the part associated with changes within those groups; it did not test causation. Claim-oriented papers had lower average impact than non-claim papers in the early period, so their growing share could contribute modestly to the overall arithmetic change, but change within the non-claim portfolio was the larger component. Commercial usefulness and scholarly citation influence are distinct outcomes.

The decline in normalized citation impact should be interpreted in context. It represents a decline from an unusually strong early-period position, not a decline to below-average performance. Even in 2021–2025, the cohort produced approximately twice the expected proportion of top 10% papers and 1.5 times the expected proportion of top 1% papers. The cohort's published science therefore remained disproportionately represented among highly influential publications despite the reduction relative to 2015–2020. The decline does not have a single demonstrated cause. Increased output could have added papers of more specialized or incremental interest, lowering the median without implying deterioration of every company's research. Changes in subject matter, collaboration patterns, publication type, or the scientific literature itself could also contribute. The decline among papers combining laboratory and human research is particularly noteworthy because the proportion of such papers increased while their citation impact fell. More frequent combination of laboratory and human work did not automatically produce more influential publications.

The annual highest-impact papers add texture to the quantitative findings. The earlier years were marked by highly influential collaborative work in exposure assessment, alternative testing, and regulatory toxicology. Later years included prominent papers on skin aging, oxidative stress, the microbiome, senescent-cell biology, fermentation, personalized care, and alternatives to animal testing. The pattern therefore suggests not simply a change in citation performance, but a broadening of the scientific questions addressed by researchers in the selected companies.

Exceptionally influential work was also more widely distributed than the cohort's overall publication counts might suggest. Nine companies appeared among the annual top three, either alone or through collaborations, and 32 of the 33 papers ranked within the top 1% of comparable publications. L'Oréal was the most frequent sole-company contributor, but Shiseido had the highest-ranked paper in 2023, Henkel in 2024, and Amorepacific appeared among the 2024 top three. Several of the highest-ranked studies reflected multi-company efforts. The table provides a reminder that a company's total publication volume and its ability to contribute an exceptional paper are related but distinct measures.

These findings also have practical implications for research leaders. Publication volume, scholarly influence, connection of laboratory and human work, and claim orientation measure different properties of a scientific portfolio and should not be treated as interchangeable indicators of R&D performance. A company can increase clinically relevant or product-linked publishing without increasing citation impact, while mechanistic research can remain strategically important even as its proportional share declines. For benchmark-

ing and portfolio review, the dimensions are therefore most informative when considered together rather than reduced to a single publication or citation metric.

Publication lag around the COVID-19 pandemic required particular care. A paper published in 2020 commonly reflects research performed before the pandemic, whereas papers appearing in 2021 or later may reflect work performed or delayed during it. The primary analysis therefore placed 2020 in the early period, producing a six-year early period and a five-year late period; publication output was compared as an annual rate rather than by totals alone. When both 2020 and 2021 were omitted, the direction, size, and statistical interpretation of the principal findings did not materially change. The findings also remained substantially unchanged when 2025 was excluded because those papers had less time to accumulate citations. These analyses cannot eliminate every effect of publication delay, but they make it unlikely that the principal findings were created by the placement of a single year or by the newest papers alone.

This study has several strengths. Publications were identified independently rather than selected from company-supplied lists, and the same authorship and eligibility rules were applied to every company. Cohort analyses counted a shared paper once. In company-level analyses, repeating the analysis after dividing credit for shared papers among participating companies produced a similar pattern. Citation impact was measured at the paper level and normalized for field and year, and impact data were available for virtually every paper with a usable identifier. The additional validation and sensitivity analyses also made the limits of the scientific category and claim-oriented classifications more explicit.

The limitations are equally important. The 15 companies were selected as a broad cross-section from the WWD Beauty Inc Top 100 rather than as the 15 largest companies, a census, or a probability sample of the beauty industry. Because the cross-section was drawn from the 2025 ranking, it is anchored to companies leading at the end of the study period rather than to a year-by-year roster of the largest companies. The authorship rule intentionally excluded studies that a company funded, patented, or licensed when no company scientist was a coauthor. The analysis also excluded meeting abstracts, patents, and scientific outputs outside peer-reviewed original research articles and substantive reviews. Absence of an eligible publication therefore does not establish absence of scientific activity, and companies may rely on external research, acquisitions, proprietary development, or unpublished substantiation. Assigning each paper to one of four scientific categories required judgment. In the blinded repeat-classification, exact agreement was 59% (kappa = 0.453); clarifying the rules and re-examining potentially affected papers led to 115 reclassifications without changing the direction or statistical significance of the main category finding. The corrected labels nevertheless remain single-author judgments. Author position is an imperfect measure of leadership, and citation metrics remain influenced by database coverage and citation maturity despite normalization for field and publication year and the separate analysis excluding 2025. Because the literature searches were iterative across several overlapping sources, raw counts from every search before deduplication were not retained and cannot now be reconstructed reliably. Finally, the findings describe associations and changes over time and do not establish why a company's publication output, mix or impact rose or fell.

ISDIN further illustrates why ownership and attribution rules matter. Its publications were not added to Puig's totals because Puig owns only half of the company. Considered separately, ISDIN showed significant increases in median FWCI, citation percentile, and the proportion of papers in the top 10%, although its sample was small and the top 1% comparison was not significant.

5. Conclusions

From 2015 through 2025, this cross-section of 15 leading beauty companies increased its peer-reviewed publication rate, the share of clinical or other human research, and the proportion of papers combining laboratory and human work. An exploratory analysis also found a substantial increase in claim-oriented research that remained significant when narrower definitions were used, without evidence that this shift was the principal explanation for declining citation impact. Biological, mechanistic, or preclinical research remained the largest component of the portfolio. Thus, the cohort's published science became more abundant and more human- and claim-oriented, while field- and year-normalized scholarly influence declined from an unusually strong early position but remained above benchmark.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/cosmetics13050263/s1. Supporting Methods and Tables S1–S14 provide the cohort and company-attribution framework; company characteristics; citation impact and sensitivity analyses; annual highest-impact-paper audit; claim orientation definitions and validation; scientific category repeatability and quality-control results; the shared-paper sensitivity analysis; search specifications; and details of the human and AI-assisted workflow.

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