prosthesis

MDPI

Review

Finite Element in Dentistry: A Review and Bibliometric Analysis

Luca Fiorillo [1,2,*], Javier Flores-Fraile [3], Attilio Caravelli [4], Artak Heboyan [5,6,7], Mario Alberto Alarcón-Sánchez [8,9], Dario Milone [10] and Cosimo Galletti [1]

1 Department of Medicine and Surgery Kore, University of Enna, 94100 Enna, Italy
2 Department of Dental Research Cell, Dr. D. Y. Patil Dental College & Hospital, Dr. D. Y. Patil Vidyapeeth (Deemed to be University), Pune 411018, India
3 Department of Surgery, Faculty of Medicine, University of Salamanca, 37008 Salamanca, Spain
4 Private Practice, 89123 Reggio Calabria, Italy
5 Department of Research Analytics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences, Saveetha University, Chennai 600077, India
6 Department of Prosthodontics, Faculty of Stomatology, Yerevan State Medical University after Mkhitar Heratsi, Str. Koryun 2, Yerevan 0025, Armenia
7 Department of Prosthodontics, School of Dentistry, Tehran University of Medical Sciences, Tehran 1439955591, Iran
8 Molecular Biology in Medicine Program, University Center of Health Sciences, University of Guadalajara (CUCS-UdeG), Guadalajara 44340, Jalisco, Mexico
9 Institute of Research in Dentistry, Department of Integral Dental Clinics, University Center of Health Sciences, University of Guadalajara (CUCS-UdeG), Guadalajara 44340, Jalisco, Mexico
10 Department of Engineering, University of Messina, 98100 Messina, Italy; dmilone@unime.it
* Correspondence: lucafiorillo@live.it

Abstract

Background: Finite element analysis (FEA) has become a cornerstone of dental biomechanics, supporting the simulation of stress, strain, and displacement in biological structures and biomaterials. **Methods**: This combined bibliometric and narrative review examines the development, geographic and disciplinary distribution, and methodological state of FEA-based dental research by analysing 3379 publications indexed in Scopus between 1969 and 2024. **Results:** The dataset shows continued exponential growth in annual output, particularly after 2000, with China, the United States, and India as the leading contributors. Journal articles account for the bulk of the literature, and implant dentistry remains the most prominent focus area. The 100 most-cited works concentrate on implant biomechanics, prosthodontics, and scaffold design, while interdisciplinary contributions linking FEA to regenerative biomaterials, orthodontics, and endodontics are increasing. **Conclusions:** FEA in dentistry is a mature but still rapidly expanding field. Persistent methodological gaps remain, including the routine use of isotropic and linear-elastic bone, idealised osseointegration, static loading, limited patient-specific variability, and scarce in vivo validation. Future work should converge on patient-specific multiscale models, fatigue and contact-aware formulations, standardised validation pipelines, and the integration of artificial intelligence into both pre-processing (mesh generation, parameter identification) and post-processing (surrogate models, outcome prediction). The wider relevance of FEA across orthopaedic, thoracic, and reconstructive biomechanics confirms its role as a unifying computational tool for clinical translation.

Keywords: finite element analysis; biomechanics; bibliometrics; bioengineering; stress distribution; dentistry

Check for updates

Academic Editor: Bruno Chrcanovic

Received: 19 March 2026
Revised: 2 July 2026
Accepted: 6 July 2026
Published: 22 July 2026

Copyright: © 2026 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

1. Introduction

Finite element analysis (FEA) is a numerical method developed to model complex structures and their mechanical behaviour [1]. First formulated in 1956 for engineering problems, FEA was applied to medicine and dentistry only decades later [2]. By discretising biological structures (teeth, bone, implants) into small elements and solving partial differential equations under applied loads, FEA enables the prediction of stress, strain, deformation, and failure modes without invasive experiments [1]. Early dental applications in the 1970s focused on stress analysis of tooth structures; today, FEA is routinely used in implantology, orthodontics, prosthodontics, endodontics, and craniofacial trauma. Trivedi (2014) emphasised the capacity of FEA to study implant components and peri-implant bone mechanics, offering repeatable, ethical, and modifiable virtual experiments [1]. Reviews have repeatedly highlighted its importance in dentistry [3], and recent appraisals confirm that FEA has become a key tool across dental specialities, especially in implant biomechanics [4]. Choi and colleagues (2014) traced its adoption in orthopaedics and dental implant design back to the 1970s [2].

Quantitative bibliometric appraisals of dental FEA have documented an exponential rise in publications over recent decades [5]. Diarra and co-workers (2016) [5] reported that papers involving FEA in dental research increased from 3 in 1990 to 257 in 2010, a 21-fold increase that far outpaced the growth of general dental research. Xie and colleagues (2025) surveyed FEA in dental science and identified about 2800 records in Scopus, together with several emerging trends [6]. The field now sits at the intersection of engineering, materials science, and clinical dentistry. The current study updates and extends these efforts by analysing the literature retrieved from Scopus on FEA in dentistry, summarising publication patterns (year, country, document type, sources, sponsors) and examining the themes of the 100 most-cited papers [5]. Beyond descriptive counts, the present manuscript integrates a narrative synthesis of methodological state of the art, current research gaps, and future directions, with explicit reference to recent calls for multiscale models, fatigue-aware formulations, and standardisation in FEA [7,8].

2. Materials and Methods

2.1. Search Strategy

A systematic search of the Scopus database was conducted on 1 May 2025 to collect publications related to finite element analysis (FEA) in dentistry and oral or craniofacial research, using a combination of FEA and dental terms within title, abstract, and keywords:

> (TITLE-ABS-KEY("finite element analysis" OR "finite element method" OR "finite element modelling" OR "finite element modeling" OR "finite element simulation") AND TITLE-ABS-KEY(dental OR dentistry OR implant* OR orthodontic* OR prosthodontic* OR endodontic* OR periodontic* OR maxillofacial OR oral OR occlusal))

The query captured publications written in English. It combined FEA-related keywords (analysis, method, model, simulation) and dental context keywords (dental, implant, orthodontic, and so on). Specific phrases such as "implant-supported prosthesis" and "implant-supported restoration" were used to refine implant-related retrieval. The search covered all years up to 2024. No restrictions were applied to document type or language at the search stage; non-English items were filtered during analysis. The final dataset comprised 3379 records.

2.2. Data Extraction and Processing

Records were exported from Scopus as CSV and Excel files. Analysis spreadsheets for various dimensions were generated using the "Analyze search results" feature of Scopus. Data tables were cleaned and aggregated using Python (v. 3.13.12 Wilmington, DE, USA) and Microsoft Excel (v. 16.110.3 Microsoft Corporation, Redmond, WA, USA) to summarise counts by year, country, document type, funding sponsor, journal or source title, and Scopus subject area. The Citation Overview tool was used to compute total citations and the h-index of the collection.

During processing, duplicate records were removed, and the consistency of country names and source titles was harmonised. Multi-country collaborations were attributed to each contributing country. Document types ("Article", "Review", "Conference Paper") were tallied. Sponsorship data were aggregated by sponsor name. Variations in journal names (for example, "*Int J Oral Maxillofac Implants*" versus "*International Journal of Oral and Maxillofacial Implants*") were consolidated. Subject categories were assigned according to the Scopus classification, allowing publications to belong to more than one category.

2.3. Flow of Records: PRISMA-Style Diagram

Although a bibliometric review is not a systematic review of clinical evidence, the flow of records was reported using a PRISMA-style diagram (Figure 1) adapted from the PRISMA 2020 statement [9]. This presents the records identified through the Scopus search, intra-Scopus de-duplication, the screening of non-English content and incomplete metadata, the records ultimately included in the bibliometric analysis, and the subset selected for thematic review.

2.4. Thematic Classification of the Top-100 Most-Cited Records

To produce the thematic synthesis of the most-cited literature, the dataset was sorted by Scopus citation count, and the 100 records with the highest "Cited by" values were extracted. Title, year, journal, country of corresponding author, and citation count were recorded for each record. The thematic categorisation was developed in three steps to reduce subjective bias. First, two reviewers (L.F. and C.G.) read the titles and abstracts of the 100 records independently and proposed a preliminary list of themes. Second, the proposed themes were reconciled by consensus into a final six-category scheme (implant biomechanics and design; implant prosthodontics; tissue engineering and regenerative scaffolds; occlusion and orthodontics; dental hard-tissue mechanics; methodological or review contributions), broadly consistent with categories used in earlier bibliometric appraisals of dental FEA [5,6]. Third, each record was assigned independently by the two reviewers; discrepancies were resolved by discussion and, where necessary, by reading the full text. Records that legitimately spanned two themes were assigned to the dominant focus of the abstract; a small minority (n = 4) were dual-coded for descriptive purposes only and counted once in the primary theme. Inter-rater agreement before consensus was substantial (raw agreement 89%, Cohen's kappa = 0.83).

2.5. Analysis Workflow

Quantitative analyses were performed as follows: annual trends were plotted to visualise growth (Figure 2); top contributing countries were identified by author affiliation (Figure 3); the distribution of document types was computed (Figure 4); top funding agencies were ranked by number of funded records (Figure 5); leading journals and conference proceedings were ranked by output (Figure 6); the frequency of publications across Scopus subject areas was tabulated (Figure 7); and total and average citation counts together

with the h-index of the collection (h-index approximately 102 for the citation set of 3376 documents) were retrieved from the Scopus Citation Overview.

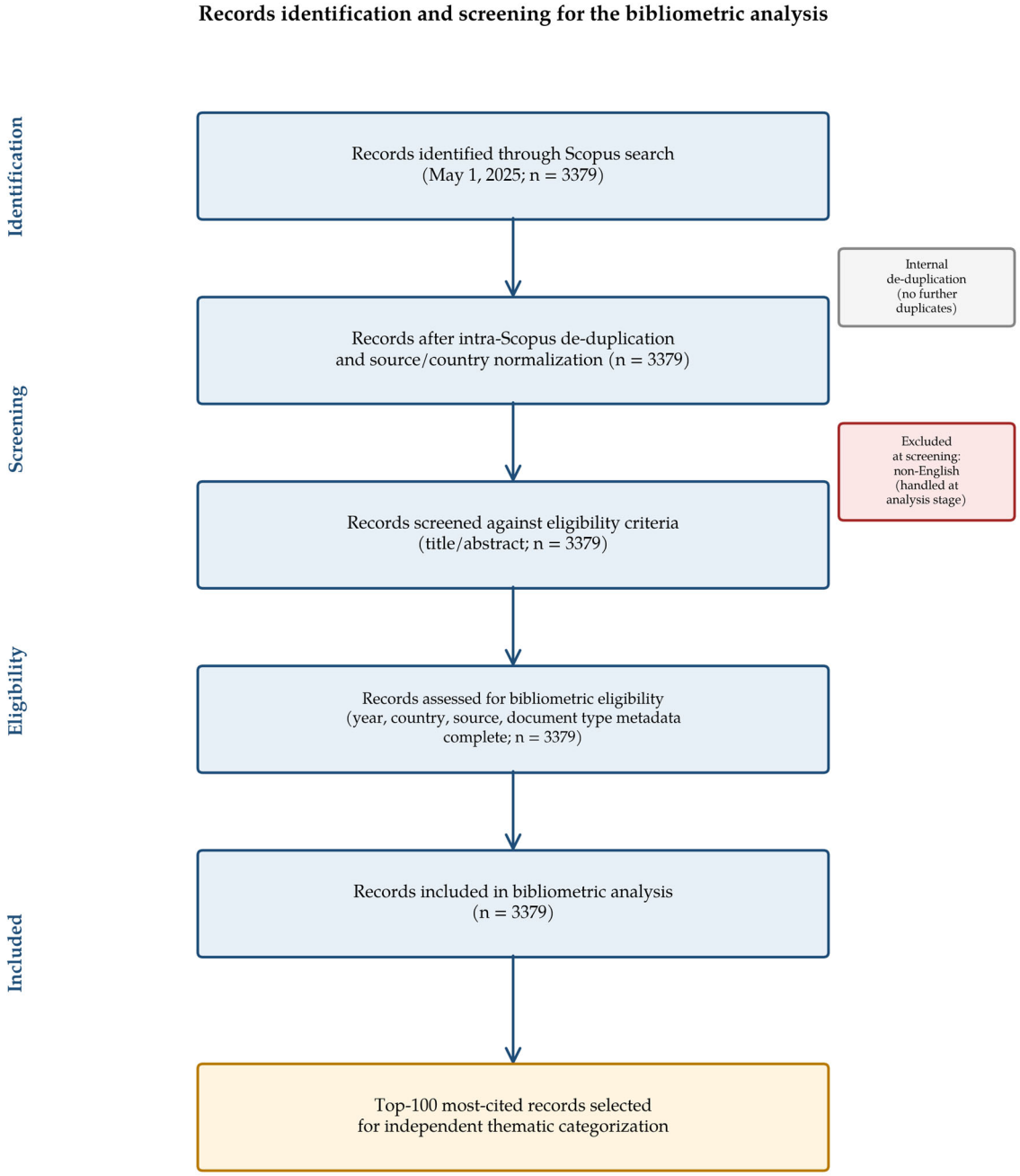


Figure 1. PRISMA-style flow of records for the bibliometric analysis on FEA in dentistry. Adapted from the PRISMA 2020 statement [9].

Beyond descriptive statistics, the manuscript reports an interpretative reading of the collaboration and thematic structure of the field, derived directly from the aggregated Scopus metadata (country of affiliation, source title, subject-area classification, funding sponsor, and publication year). The underlying tabulations were prepared and aggregated in Microsoft Excel (v. 16.110.3, Microsoft Corporation, Redmond, WA, USA), and all figures were generated in Python (v. 3.13, Python Software Foundation, Wilmington, DE, USA) with Matplotlib (v. 3.10, Matplotlib Development Team). Numeric values and percentages reported in the text derive from these aggregated counts. The dataset comprised 3379 records.

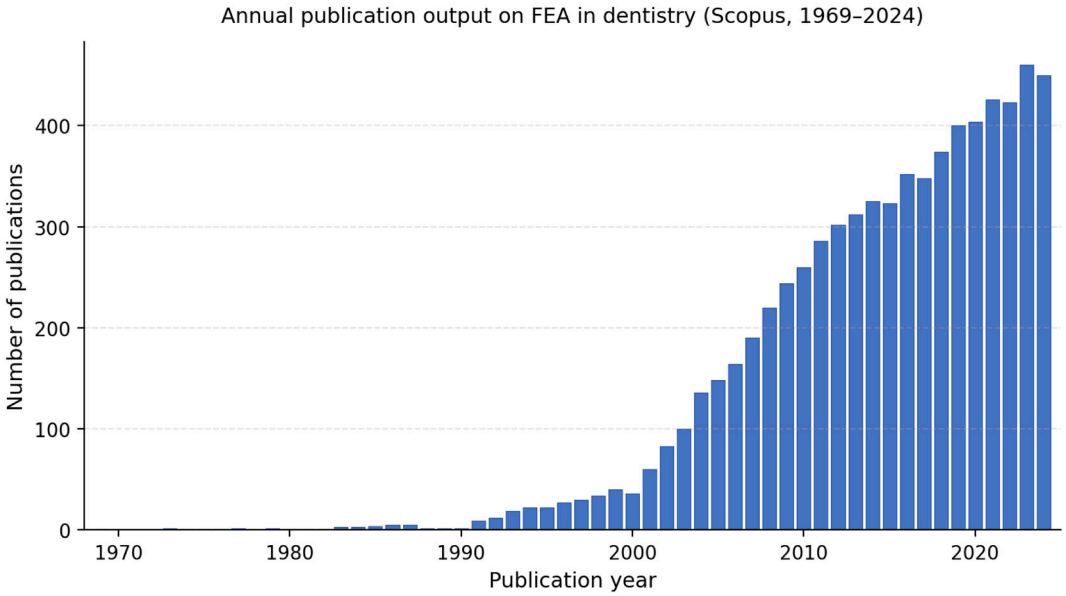


Figure 2. Publication counts by year (1969–2024) for finite element analysis in dentistry (Scopus data). The trend is flat until approximately 2000 and then rises steeply.

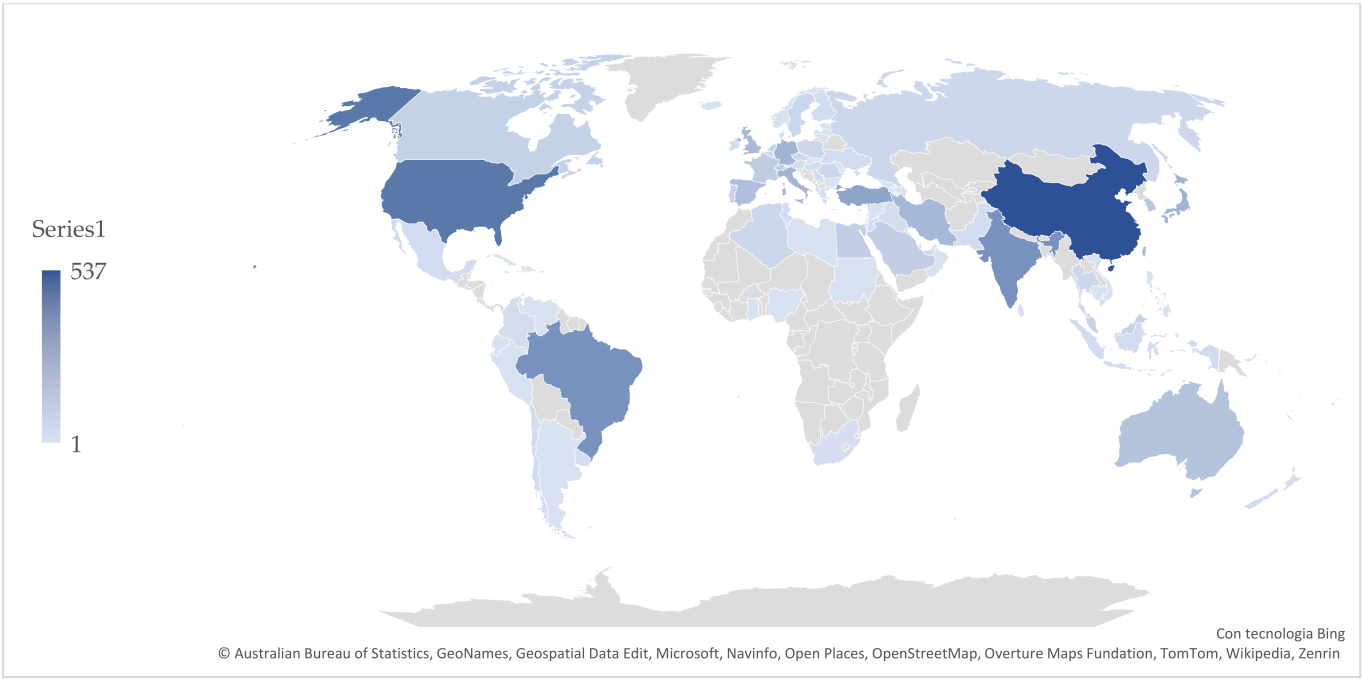


Figure 3. Geographic distribution of dental FEA publications. China leads the count, followed by the United States, India, and Brazil. The colour scale reflects the absolute number of publications per country (1 to 537). Gray color: no data or 0.

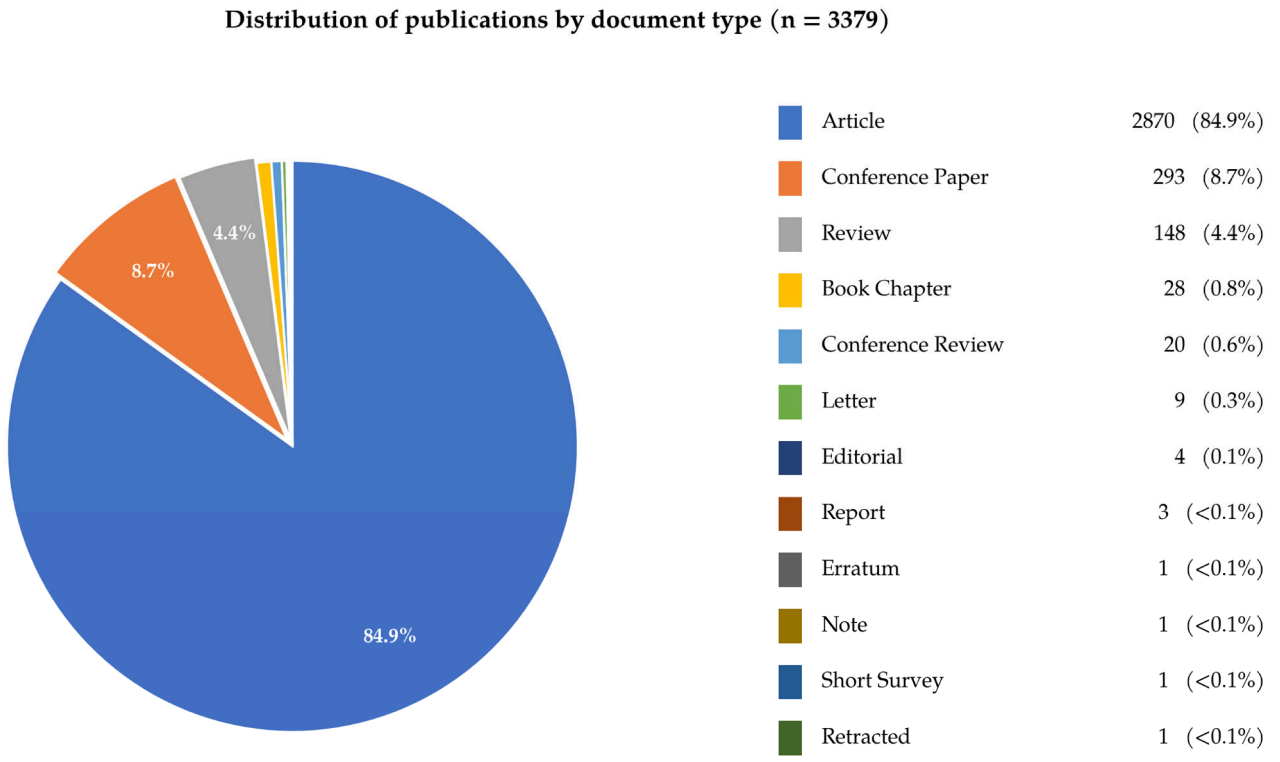


Figure 4. Distribution of publications by document type. Original articles account for 85.0% of the dataset; conference papers and reviews follow.

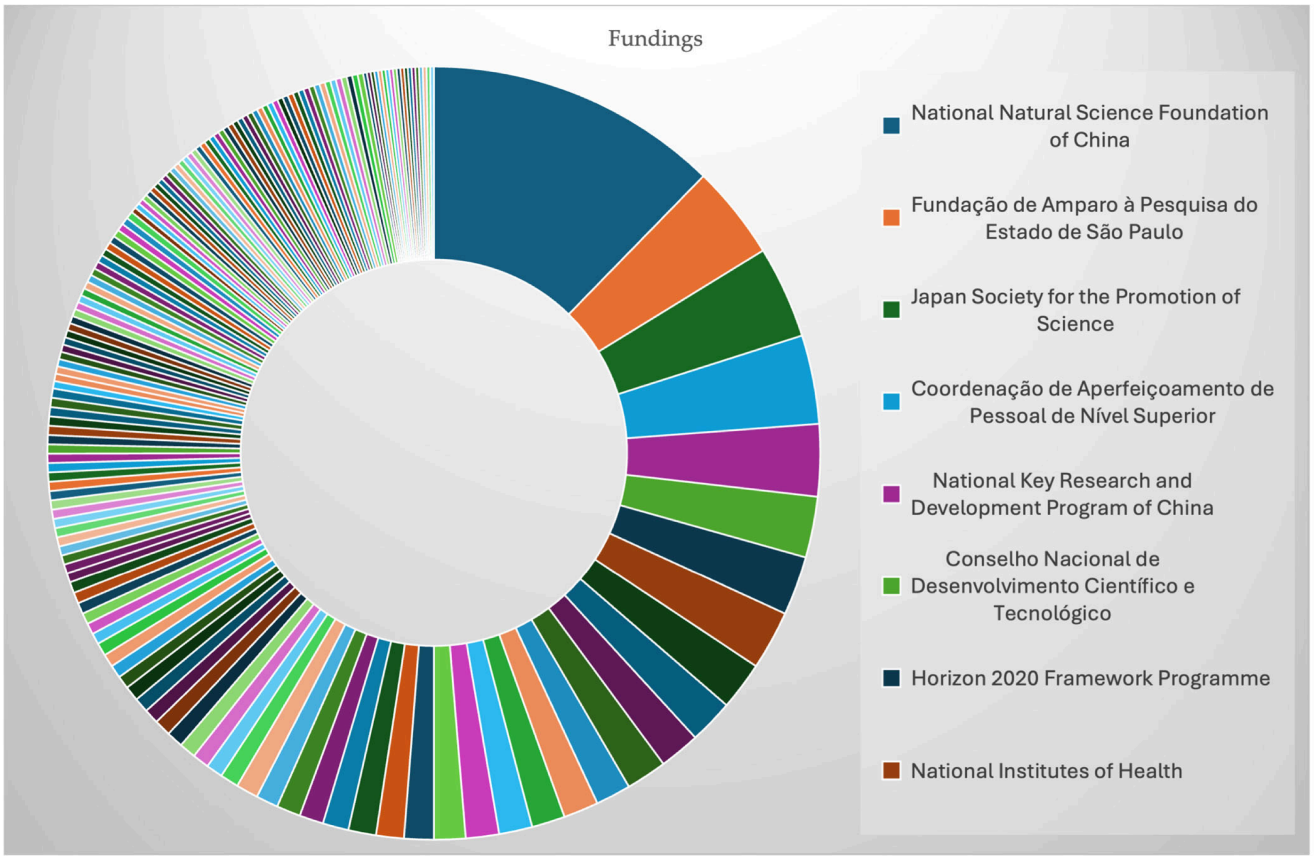


Figure 5. Chart of the top 8 funding sponsors of dental FEA research. Area is proportional to the number of acknowledged publications. The National Natural Science Foundation of China and Brazilian funders dominate. All the other colors correspond to other minor funding sources.

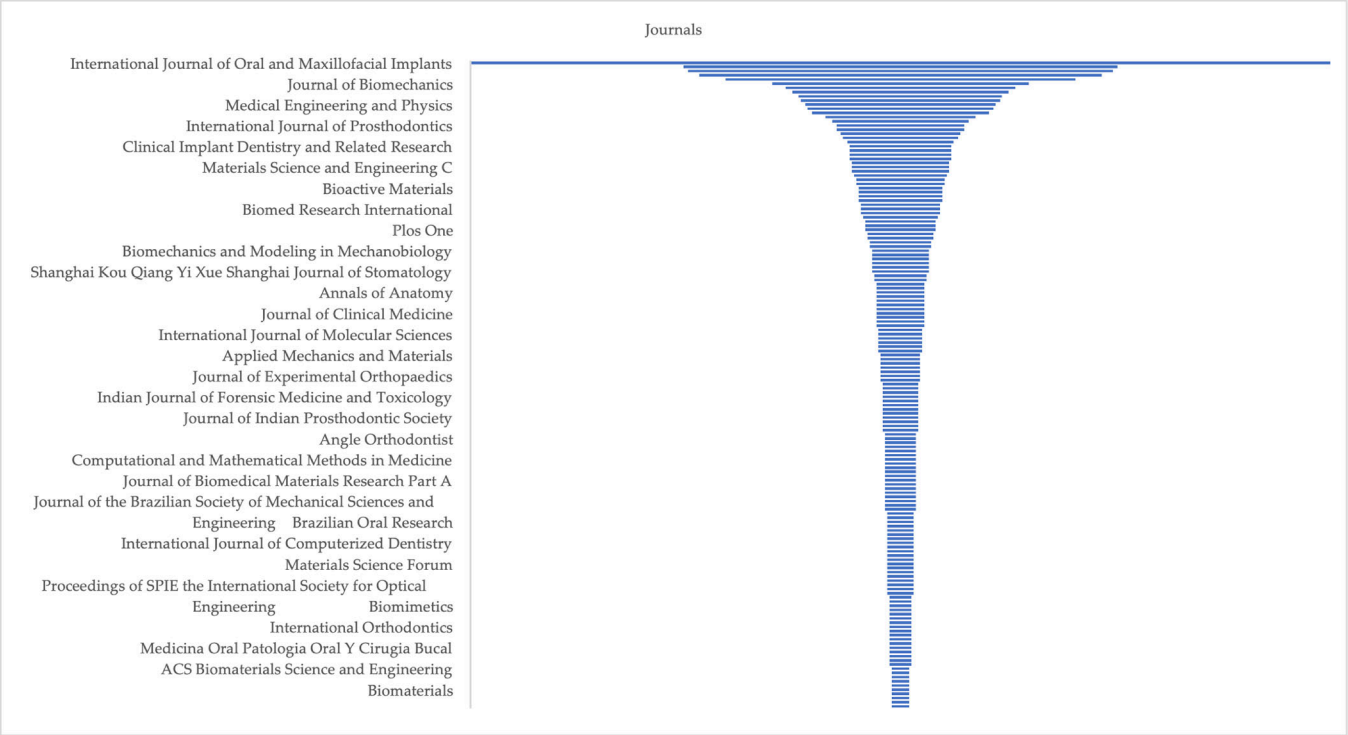


Figure 6. Top journals by publication count in dental FEA. Implantology, prosthodontics, and biomechanics journals dominate.

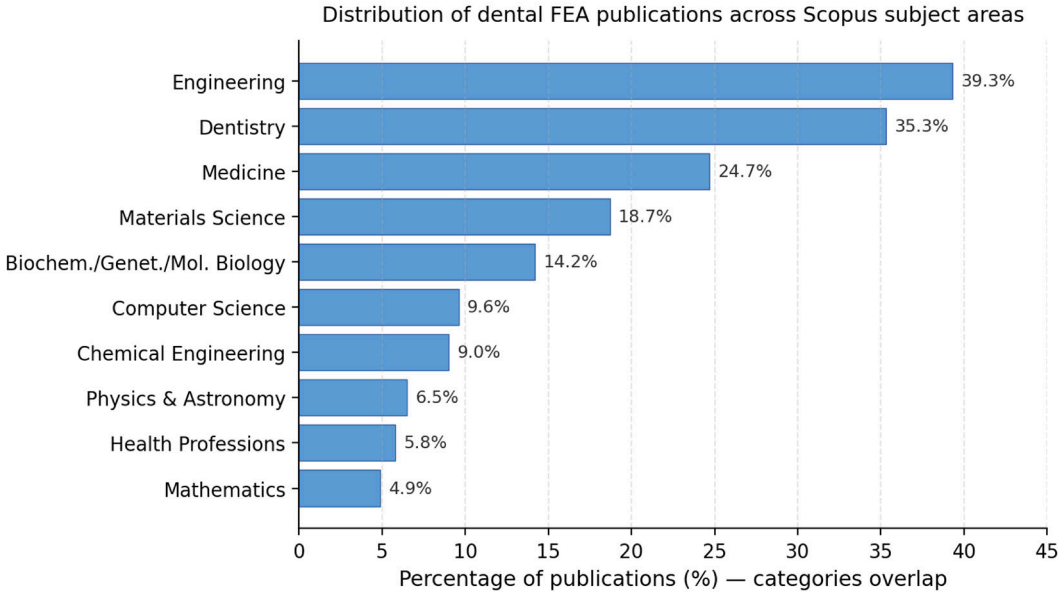


Figure 7. Distribution of dental FEA publications across Scopus subject areas. Engineering and Dentistry lead, followed by Medicine and Materials Science. Categories are non-exclusive.

3. Results

3.1. Overall Output

The search retrieved 3379 publications spanning 1969 to 2024, covering 55 years of literature. The citation overview indicated approximately 67,200 citations, with an h-index of 102 for the collection. On average, papers were cited around 20 times. The earliest dental FEA paper in our set was published in 1969, although the finite element method itself had been formulated as early as the 1940s [8]. Output remained negligible (fewer than

five papers per year) throughout the 1980s. After 1990, growth accelerated. Figure 2 shows the annual trend: virtually no output before 1980, a steady increase in the 1990s, and a clear exponential rise from approximately 2000 onwards, culminating in over 450 papers in 2023 alone. This continuing surge confirms that FEA is now widely embedded in dental research, consistent with Diarra and colleagues' report of exponential growth [5]. By far the most significant jumps occurred in the 2010s, which reflects both rising clinician interest and an increasing number of journals accepting computational studies. For context, Diarra and colleagues reported 257 papers in 2010 [5]; our dataset contains about 260 in the same year, with annual output nearly doubling by 2023.

3.2. Geographic Distribution

Research contributions came from 91 countries. Table 1 lists the top ten, and the corresponding world map is reported in Figure 3. China was the most prolific contributor (537 papers, 15.9%), followed by the United States (399, 11.8%), India (299, 8.8%), Brazil (298, 8.8%), and Turkey (230, 6.8%). Germany (168), Japan (168), Italy (163), Iran (156), and the United Kingdom (146) rounded out the top ten. Together, the United States and China contributed more than one quarter of all publications.

Table 1. Top 10 countries by number of publications on FEA in dentistry.

Country	Publications	% of Total
China	537	15.9%
United States	399	11.8%
India	299	8.8%
Brazil	298	8.8%
Turkey	230	6.8%
Germany	168	5.0%
Japan	168	5.0%
Italy	163	4.8%
Iran	156	4.6%
United Kingdom	146	4.3%

These findings align with previous analyses. Diarra and colleagues noted that in 2009–2010 the United States and China were, respectively, first and second in output [5]. More recently, Xie and colleagues reported the United States with 538 documents and China close behind [6]. In our Scopus-based sample, which extends well past 2010, China narrowly surpasses the United States. Emerging research economies feature prominently, with India, Brazil, Turkey, and Iran in the top ten. This reflects the globalisation of dental research and, as discussed below, the role of nationally coordinated funding programmes. We also note high activity from several European countries (Germany, Italy, the United Kingdom, Sweden).

3.3. Document Types

The majority of publications were standard journal articles (85.0%), followed by conference papers (8.7%) and reviews (4.4%). The remaining categories (book chapters, letters, editorials) together accounted for about 2%. Figure 4 shows the distribution. Articles dominate, which indicates that FEA findings are typically published as full research papers. The share of reviews is comparatively small, suggesting that the field still relies primarily on original studies.

This breakdown is typical for engineering and biomedical fields. The modest share of conference papers (8.7%) suggests that most work is consolidated in journals. Reviews

remain a minority (4.4%), which underscores the value of the present combined review and bibliometric appraisal as a synthesis exercise.

3.4. Funding Sponsors

Analysis of funding acknowledgements identified the most frequent sponsors (Figure 5 and Table 2). The National Natural Science Foundation of China (NSFC) topped the list, associated with 159 papers. Other major sponsors included Brazil's FAPESP (51 papers), the Japan Society for the Promotion of Science (50), Brazil's CAPES (48) and CNPq (33), the Chinese National Key R&D Program (39), the European Horizon 2020 Programme (32), the US National Institutes of Health (32), China's Fundamental Research Funds for Central Universities (26), and the US NIDCR (24).

Table 2. Top 10 funding agencies by number of acknowledged publications.

Sponsor (Country)	Publications
National Natural Science Foundation of China (China)	159
FAPESP, São Paulo Research Foundation (Brazil)	51
Japan Society for the Promotion of Science (Japan)	50
CAPES, Higher Education Personnel Coordination (Brazil)	48
National Key R&D Programme of China (China)	39
CNPq, National Council for Scientific and Technological Development (Brazil)	33
Horizon 2020 (European Union)	32
National Institutes of Health, NIH (United States)	32
Fundamental Research Funds for the Central Universities (China)	26
National Institute of Dental and Craniofacial Research, NIDCR (United States)	24

This pattern reflects the national outputs above. The strong NSFC support explains the lead of China, while the prominent Brazilian funders mirror Brazil's high ranking in the country count. Western funders such as NIH, NIDCR, and Horizon appear lower in the list, consistent with the more limited relative output from North America and Europe. These data underscore the global investment in computational dental science, with notable leadership from Chinese and Brazilian agencies. No single commercial sponsor or industry funder appears among the top ten: governmental and academic research programmes dominate the list.

3.5. Sources (Journals)

A diverse array of journals publishes FEA-based dental research. Table 3 and Figure 6 list the top ten sources by number of articles. The leader is the *International Journal of Oral and Maxillofacial Implants* (194 papers, 5.7%), followed by *Computer Methods in Biomechanics and Biomedical Engineering* (98, 2.9%), the *Journal of Prosthetic Dentistry* (96, 2.8%), the *Journal of the Mechanical Behavior of Biomedical Materials* (91, 2.7%), the *Journal of Oral Implantology* (79, 2.3%), the *Journal of Biomechanics* (58, 1.7%), *Implant Dentistry* (52, 1.5%), the *Journal of Prosthodontics* (49, 1.4%), *Materials* (46, 1.4%), and the *Chinese Journal of Tissue Engineering Research* (45, 1.3%). Together, the top ten accounted for approximately 23% of all publications.

Table 3. Top 10 source titles (journal or conference proceedings) by number of publications.

Journal Title	Publications
International Journal of Oral and Maxillofacial Implants	194
Computer Methods in Biomechanics and Biomedical Engineering	98
Journal of Prosthetic Dentistry	96
Journal of the Mechanical Behavior of Biomedical Materials	91
Journal of Oral Implantology	79

Table 3. *Cont.*

Journal Title	Publications
Journal of Biomechanics	58
Implant Dentistry	52
Journal of Prosthodontics	49
Materials	46
ChineseJournalof Tissue Engineering Research	45

Both speciality and multidisciplinary journals contribute to the dental FEA literature. Several are dentistry-specific (implantology and prosthodontics journals), which reflects sustained clinical interest, while prominent engineering, biomechanics, and materials journals also feature, including *Computer Methods in Biomechanics and Biomedical Engineering* and *Materials*. Xie and colleagues highlighted the relative weight of *Dental Materials* in their bibliometric appraisal [6]; in our Scopus-based sample IJOMI and *Journal of Prosthetic Dentistry* remain the leading clinical outlets, which confirms that implant biomechanics is the most consolidated core of the field [5].

3.6. Subject Areas

According to the Scopus classification, the leading subject categories were Engineering (1330 papers, 39.3%), Dentistry (1196, 35.3%), Medicine (837, 24.7%), Materials Science (634, 18.7%), Biochemistry/Genetics/Molecular Biology (478, 14.2%), Computer Science (324, 9.6%), and Chemical Engineering (303, 9.0%), among others. Records may be classified in more than one category. Figure 7 shows the distribution.

The strong Engineering and Materials Science presence is expected given the computational nature of FEA. The large Dentistry portion underscores its clinical application. Medicine encompasses a range of related biomedical and clinical journals. The pattern indicates that dental FEA sits at the intersection of engineering and clinical sciences. Diarra and colleagues observed that the dental FE literature bridges dentistry and materials journals [5], and our findings of substantial Engineering and Materials representation are consistent with that interpretation. Xie and colleagues similarly identified non-dental engineering journals among the top venues [6]. The take-home message is that while dental journals are key outlets for FEA work, a substantial share of the research output is published in broader engineering and biomedical journals.

3.7. Citation Metrics

The Scopus Citation Overview, which covers the 3376 documents in the dataset with complete citation records (three documents lacked complete citation metadata and are excluded from this tool by Scopus), returned 67,193 citations, corresponding to an average of approximately 19.9 citations per document, and an h-index of 102 for the collection. This indicates a well-cited field; for context, the decade-end data from Diarra and colleagues yielded substantially lower citation volumes [5], reflecting growth in both publication volume and impact. Many publications had moderate citation counts (10 to 50), while a substantial tail reached hundreds (see the Top-100 section below).

3.8. Collaboration and Thematic Structure of the Field

To complement the descriptive counts, we examined how the field is organized by contributing countries, leading sources, and subject areas, using aggregated Scopus metadata. Three observations emerge. First, research output is geographically concentrated: the ten most productive countries (Table 1) account for the large majority of records, led by China (537), the United States (399), India (299), and Brazil (298), with Turkey, Ger-

many, Japan, Italy, Iran, and the United Kingdom completing the group. The coexistence of established research systems (United States, Germany, Japan, Italy, United Kingdom) and rapidly expanding ones (China, India, Brazil, Turkey, Iran) indicates a globally distributed but unevenly resourced field, a pattern consistent with the funding structure reported in Section 3.4. Second, the source distribution (Table 3) shows a dual identity: clinically oriented implant and prosthodontic journals (the International Journal of Oral and Maxillofacial Implants, the Journal of Prosthetic Dentistry, the Journal of Oral Implantology, Implant Dentistry, the Journal of Prosthodontics) sit alongside engineering and biomedical-materials outlets (Computer Methods in Biomechanics and Biomedical Engineering, the Journal of the Mechanical Behavior of Biomedical Materials, the Journal of Biomechanics, Materials). This confirms that dental finite element research is published across, and read by, two partly distinct communities. Third, the subject-area classification (Figure 7) reinforces this interpretation: Engineering (1330 records) and Dentistry (1196) are the two dominant categories, followed by Medicine (837), Materials Science (634), and Biochemistry, Genetics and Molecular Biology (478), with records frequently classified in more than one area. Taken together, these three dimensions describe a field anchored in implant biomechanics and prosthodontics, methodologically rooted in engineering and materials science, and increasingly connected to biomaterials and regenerative applications, in line with the thematic synthesis of the most-cited records presented in Section 3.9.

3.9. Top 100 Most-Cited Papers (Themes)

The 100 most-cited articles in the dataset accumulated approximately 18,062 citations, which represents about 27% of total citations. These papers span the years 1992 to 2020, and the most-cited are generally older, which allows citation accumulation. They were classified into six themes as described in Section 2.4.

3.9.1. Implant Biomechanics and Design

The majority of top-cited works (approximately 80%) involved dental implants. Seminal examples include Geng and colleagues (2001) in the *Journal of Prosthetic Dentistry* on implant load analysis [10], Baggi and colleagues (2008) in the *Journal of Prosthetic Dentistry* on the effects of implant diameter [11], and Petrie and Williams (2005) in *Clinical Oral Implants Research* on implant design variables [12]. These studies use three-dimensional FEA to evaluate stress distribution under various implant geometries, loading conditions, and bone qualities. For example, Baggi and colleagues showed that a larger implant diameter significantly reduces cortical bone stress under load [10,12–17]. Such findings have informed clinical implant selection (diameter, length, taper) to minimise the risk of bone overload. The thematic emphasis is consistent with the appraisal of Falcinelli and colleagues, who identified implant biomechanics as the dominant FEA topic in dentistry and called for more physiologically realistic and standardised models [7].

3.9.2. Implant Prosthodontics

Several top articles examined multi-implant prostheses, including all-on-four and full-arch bridges. A representative example is Baggi and colleagues (2013) on the biomechanics of complete-arch prostheses supported by four implants [13], which evaluated cantilever length, framework rigidity, and bone properties as the main drivers of load transfer. Studies of this kind have typically used FEA to inform prosthesis design and to identify configurations in which cantilever stress remains within physiologically tolerable ranges.

3.9.3. Tissue Engineering and Regenerative Scaffolds

A smaller cluster, approximately 10% of the top-100, addressed biomaterials and bone scaffolds. Highly cited papers include Yang and colleagues (2020) in *Nature Communications* on biodegradable zinc alloys for load-bearing bone implants [18], and Gao and colleagues (2020) in *Nature Communications* on high-entropy alloy nanoparticles for biomedical use [19]. Although not strictly dental, these studies are highly cited in dental FEA because they inform implant material design. Other examples include FEA of 3D-printed scaffolds for bone regeneration and FEA of bioceramic and polymer composites [18–25]. These works show how FEA is used to predict the mechanical response of new biomaterials for both dental and orthopaedic applications.

3.9.4. Occlusion and Orthodontics

Approximately 5% of the top-cited articles focused on orthodontic or masticatory biomechanics, including studies on the force systems of clear aligners, on bracket stress, and on mandibular loading. Xie and colleagues already identified clear aligners and endocrowns as emerging research fronts [6]. The current dataset confirms this trajectory: orthodontic FEA is not yet dominant among the most-cited classics but is rising sharply in recent annual output.

3.9.5. Dental Hard-Tissue Mechanics

A handful of works modelled tooth structures, including FE studies of endodontically treated teeth under load and fracture analyses of teeth. These studies are fewer in the top-100, but they complement implant research and are necessary to interpret restoration biomechanics. Abdelhafeez and colleagues (2024) systematically reviewed FEA in endodontics and confirmed its value in predicting fracture resistance in treated teeth [26–33]. The cluster includes work on dentine and enamel constitutive behaviour, on the propagation of cracks under cyclic load, and on the stress fields produced by intracanal posts of different stiffness.

3.9.6. Methodological or Review Contributions

A subset of review and methodological papers made the top-100. Trivedi (2014) is itself an example of a highly cited review [1], and Geng and colleagues (2001) is a review that became a classic reference on implant FEA [10]. In nearly all top-cited studies, authors assumed linear-elastic and isotropic bone and perfect osseointegration, which are simplifications that have been criticised in the recent literature [7]. Most analyses applied static occlusal or implant loading and did not consider dynamic effects, muscle forces, contact non-linearity, or fatigue. These limitations are revisited in detail in the Discussion. The high citation counts of these implant-focused studies nonetheless reflect their continuing influence on the core knowledge of the field.

In summary, the thematic focus of the leading FEA articles is implant dentistry and biomechanics, followed by biomaterial design for implants, with emerging interest in orthodontic applications. This is consistent with the structure of the field described in Section 3.8 and with the trends reported by Xie and colleagues [6].

4. Discussion

4.1. Position of the Present Findings Within the Bibliometric Literature

The bibliometric results corroborate and extend previous appraisals of FEA in dentistry. Consistent with Diarra and colleagues (2016), we observe exponential growth in publication output, with the 2010–2024 period showing a far more rapid expansion than earlier decades [5]. The number of countries involved has more than tripled since the

late 1980s, and the dataset now encompasses 91 countries. The rise of China and India, both large economies investing heavily in biomedical research, has been sharp. Diarra and colleagues noted a waning of US dominance [5]; our data show China now leading and the United States second, which echoes the findings of Xie and colleagues [6].

Comparisons with Xie and colleagues (2025) [6] are particularly instructive. Their Web of Science search identified 2838 records, whereas our Scopus-based query found 3379, with the differences reflecting database coverage and query syntax. Both analyses ranked top contributors similarly: the same five countries appear in the top five. The journal rankings differ in detail: Xie and colleagues ranked *Dental Materials* first (231 documents) [6], whereas in our data IJOMI and the *Journal of Prosthetic Dentistry* lead, which probably reflects database scope and the relative weight of conference proceedings. Both studies emphasise implantology and prosthodontics. Xie and colleagues identified endocrown and clear aligner as emerging keywords; in our top-100 set, these are absent, which is consistent with the citation lag of recent topics and suggests that these areas are gaining prominence but have not yet produced highly cited classics. The implication is a shift in research fronts towards minimally invasive restorations and orthodontic biomechanics, largely driven by digital dentistry innovations [6].

4.2. Scientific, Economic, and Research-Policy Drivers

The dominance of specific countries, journals, and funding agencies is not random and merits a more interpretative reading than rank tables alone. Three interlocking drivers shape the observed distribution.

The first driver is sustained, nationally coordinated funding. The leadership of China in publication count closely tracks the trajectory of the National Natural Science Foundation of China (NSFC), which has consistently expanded its budget for biomedical engineering and dental biomechanics over the past two decades. A similar argument applies to Brazil, where FAPESP and CNPq have provided continuity of investment in dental and engineering research [34]. By contrast, US and European funders (NIH, NIDCR, Horizon Europe) appear lower in the rankings even though their per-project funding is on average higher: the difference suggests that the European and US ecosystems support a smaller number of larger, longer projects, whereas Chinese and Brazilian agencies fund a higher volume of shorter projects, which translates more directly into publication counts.

The second driver is the global expansion of doctoral training and dental engineering programmes in Asia and South America. The rapid growth of dental implantology curricula in China, India, Turkey, and Brazil has produced cohorts of clinician-researchers with direct access to FEA softwares and computational resources, which in turn lowers the marginal cost of producing each additional FEA study. The third driver is industrial: dental implant and biomaterial manufacturers (often based in Europe and East Asia) increasingly require pre-clinical computational evidence for regulatory submissions and marketing claims, which sustains a steady demand for FEA analyses of new implant geometries and surfaces. None of these drivers appears in isolation, and the observed bibliometric pattern is best understood as the joint result of public investment, training pipelines, and industrial demand [35].

4.3. Subject and Source Distribution

The subject and source distributions show that dentistry is not an insular field. Like Xie and colleagues [6], we find engineering and materials science to be major contributors. Diarra and colleagues observed that specialised dentistry-and-materials journals emerged by 2000 [5]; we similarly see the *Journal of Dental Materials* and *Dental Materials Journal* among many outlets, although neither cracked the top ten. Traditional prosthodontic and

implant journals remain heavily cited, but many authors publish in engineering or biomedical journals with higher impact factors. Diarra and colleagues reported that the impact factors of top dental journals were rising in part because of dental FEA papers [5]; this suggests that FEA research is being cited beyond dentistry by materials and biomechanics audiences. Tracking cross-disciplinary influence will remain useful in future work.

4.4. Research Gaps Identified by the Bibliometric and Thematic Analysis

Beyond descriptive counts, the bibliometric analysis allows three categories of research gaps to be identified, which are particularly relevant for newcomers and for doctoral candidates entering the field.

4.4.1. Geographic and Topical Gap

The geographic distribution shows that Africa, most of South-East Asia outside India, and large parts of Latin America outside Brazil are under-represented. The topical distribution shows that paediatric dentistry, sleep medicine and obstructive sleep apnoea devices, and the biomechanics of mucosal-supported or partially edentulous reconstructions are markedly under-studied compared with implant biomechanics. These under-explored areas correspond to genuine clinical demand and represent an opportunity for new investigators.

4.4.2. Methodological Gap

The thematic analysis of the top-100 confirms the appraisal of Falcinelli and colleagues [7]: even the most-cited dental FEA studies routinely assume isotropic and linear-elastic bone, perfect osseointegration, ideal interface bonding, and static load. Studies that explicitly address anisotropy, non-linear constitutive behaviour, contact non-linearity, frictional sliding, fatigue, or biological adaptation remain a minority. The gap is widest in patient-specific modelling and in the validation of in silico predictions against in vivo or ex vivo measurements.

4.4.3. Integration Gap

Tissue engineering and digital dentistry remain a small share of the subject-area distribution, yet 3D-printing, machine learning, and digital twin approaches are attracting rapidly growing attention in the recent literature. Integration of FEA with artificial intelligence, with intraoral scanning and cone-beam computed tomography (CBCT), and with longitudinal clinical outcome data is still rare in the dental FEA literature. Closing this gap is a precondition for FEA to move from research to routine treatment planning.

4.5. Methodological Limitations of Current Dental FEA Models

The predominant themes (implant design, stress analysis) align with Falcinelli and colleagues' recent review of FE modelling in implant dentistry [7]. Falcinelli and colleagues point out that, despite extensive use, many models make important idealisations: they often consider a portion of bone as isotropic and assume 100% osseointegration, neglect muscle forces, bone remodelling, and anisotropy. These limitations are common in the studies retrieved in the present analysis. The following methodological gaps are particularly important and recurrent in the literature.

4.5.1. Anisotropic and Inhomogeneous Material Behaviour

Cortical and trabecular bone, dentine, enamel, and periodontal ligament are all strongly anisotropic and inhomogeneous, with mechanical properties that vary with mineral density, collagen orientation, hydration, and age. The majority of published dental FE models still rely on a single isotropic Young's modulus for each tissue, which biases the

predicted strain field and the location of peak stress. Patient-specific mapping of bone mineral density from CBCT and the use of orthotropic or transversely isotropic formulations is now feasible but uncommon.

4.5.2. Non-Linear Constitutive Models

Linear elasticity remains the default assumption in dental FEA. Yet many of the tissues and materials involved exhibit substantial non-linearity: the periodontal ligament is viscoelastic and undergoes large deformations; bone shows post-yield softening and damage accumulation under repeated load; polymeric materials used in clear aligners and removable prostheses are viscoelastic and temperature-dependent; and contact between implant threads and bone is non-linear because of friction and progressive engagement. Models that ignore these non-linearities cannot accurately describe long-term load-bearing.

4.5.3. Contact Conditions and Interface Behaviour

Real bone–implant and implant–abutment interfaces are characterised by partial bonding, micro-motion, friction, and gap formation under load. Models that impose perfect bonded contact systematically underestimate stress peaks at the marginal bone crest and at screw joints. Tied-contact assumptions also obscure the mechanism of screw loosening and the role of preload.

4.5.4. Fatigue and Cyclic Loading

Mastication is a cyclic phenomenon, and the clinically relevant failure modes (screw fracture, framework debonding, abutment loosening, peri-implant bone resorption) are fatigue phenomena. Most published dental FEA is single-step static, which cannot predict cycles to failure, crack initiation, or the role of pre-existing micro-damage. Stress–life and strain–life formulations, including the recently proposed FE-enhanced neural-network surrogates [29], remain rare in dental applications.

4.5.5. Patient-Specific Variability

Bone quality, occlusal force, and morphology vary substantially across patients, yet the typical dental FEA model is built on a single anatomy and a single load case. The lack of population-level sampling means that the reported stress and strain ranges are not representative. Stochastic and probabilistic FE approaches, although well-established in biomechanics, remain uncommon in dental publications.

4.5.6. Model Validation and Biological Adaptation

Validation of FE predictions against in vivo strain measurements (digital image correlation, strain-gauge data, micro-CT-based displacement fields) or against well-characterised in vitro experiments is limited. Equally limited is the modelling of biological adaptation, including bone remodelling around implants according to mechanostat-type laws, mucosal healing, and soft-tissue response. Without validation and adaptation, FEA outputs remain qualitative.

4.6. Future Directions and Translation to Clinical Practice

The next decade is likely to be defined by five converging trajectories.

4.6.1. Artificial-Intelligence-Assisted FEA

Machine learning is poised to enhance FEA at every stage of the workflow. Convolutional neural networks can automate segmentation and meshing of CBCT and intraoral scans; graph neural networks and FE-enhanced neural-network surrogates can approximate full FE solutions at a fraction of the computational cost [29]; and reinforce-

ment learning can support inverse design of implant geometry and orthodontic appliances. AI also enables real-time uncertainty quantification, which is necessary for clinically meaningful predictions.

4.6.2. Multiscale Biomechanical Simulations

Coupling organ-level FE models with tissue-level and cell-level mechano-biology is the most promising route to model long-term clinical outcomes such as marginal bone remodelling, osseointegration kinetics, and peri-implant bone loss. Multiscale coupling between FEA and cellular automata or agent-based models of bone turnover has already been demonstrated in orthopaedics; transfer to implant dentistry is a clear research opportunity.

4.6.3. Digital Twin Frameworks

A patient-specific digital twin combines anatomical imaging, occlusal data, sensor data, and a calibrated FE model into a continuously updated representation that can be queried during treatment planning and follow-up. Digital twins are emerging in cardiovascular and orthopaedic medicine and represent a natural target for implant dentistry and orthodontics, where treatment planning is already digital.

4.6.4. Standardised Validation Pipelines

The field needs shared benchmark datasets, agreed metrics for in silico–in vivo comparison, and reporting checklists analogous to those used in clinical research. Without standardised validation, FE predictions will continue to be regarded as qualitative reference points rather than quantitative decision support.

4.6.5. Clinically Integrated Predictive Modelling

The translation of FEA into the clinic depends on integration with the digital workflow already in routine use, including intraoral scanners, CBCT, computer-aided design or manufacturing of crowns and surgical guides, and orthodontic planning software. The end-point of the trajectory is treatment-planning software that, behind a clinician-friendly interface, runs a calibrated and validated FE model on the patient-specific anatomy and returns an interpretable summary of mechanical risk and expected outcome [36–43]. This is consistent with the broader observation that FE modelling is not confined to the dental or maxillofacial field: it has proven essential in the simulation and design of orthopaedic prostheses, hip and knee replacements, thoracic and biomechanical reconstructions aimed at enhancing respiratory mechanics, and even at replicating historical prosthetic systems [37–39], all of which reinforce the reliability of FEA as a transversal computational tool.

4.7. Limitations of the Bibliometric Analysis

Several limitations of the present bibliometric appraisal should be acknowledged. The dataset is restricted to Scopus and would differ in scope and completeness if Web of Science, PubMed, or Dimensions were used. We included all document types and did not filter by dental subject alone, so some interdisciplinary papers (for example pure biomechanics work) may be retained. Citation counts are time-dependent and favour older work, which is a structural feature of citation-based selection; in the present manuscript this limitation is acknowledged: the top-100 necessarily under-represents recent and emerging contributions, and the thematic synthesis should therefore be read alongside the annual output trend reported in Section 3.1, which captures the growth of newer topics. Finally, thematic classification carries an unavoidable subjective component, which we mitigated by independent dual coding and consensus reconciliation (Section 2.4).

5. Conclusions

This combined review and bibliometric appraisal indicates that finite element analysis in dentistry is a mature and rapidly growing research field. Publications have increased dramatically since the 1990s, and both the authorship base and the journal base have widened. Implant dentistry dominates the literature, but applications now extend to biomaterials, orthodontics, restorative dentistry, and endodontics. Leading countries include China, the United States, India, and Brazil, backed by major national science agencies. Our analysis confirms prior findings of rapid expansion in dental FEA and highlights the continuing momentum of the field.

Looking ahead, the field would benefit from concentrating effort on five priorities. The first is the systematic adoption of artificial-intelligence-assisted finite element modelling for mesh generation, parameter identification, and surrogate solutions. The second is the development of multiscale biomechanical simulations that couple organ-level stress with tissue-level and cellular-level adaptation. The third is the construction of patient-specific digital twin frameworks that integrate anatomical imaging, occlusal data, and longitudinal outcomes. The fourth is the establishment of standardised validation pipelines, including shared benchmark datasets and agreed metrics for in silico–in vivo comparison. The fifth is clinically integrated predictive modelling, embedded in the digital workflow that already supports treatment planning. Methodologically, progress will also require routine adoption of anisotropic and non-linear material formulations, realistic contact conditions, fatigue and damage analyses, and explicit modelling of biological adaptation. Bibliometric evidence positions FEA as an indispensable tool for dental biomechanics and as a field that is poised for substantially greater clinical impact in the next decade.

Author Contributions: Conceptualisation, L.F. and C.G.; methodology, L.F. and A.C.; software, L.F.; validation, L.F., A.H. and C.G.; formal analysis, L.F., A.H. and M.A.A.-S.; investigation, L.F. and D.M.; resources, L.F.; data curation, L.F.; writing—original draft preparation, L.F.; writing—review and editing, J.F.-F., C.G., A.C., A.H. and M.A.A.-S.; visualisation, L.F., J.F.-F., A.C., A.H., M.A.A.-S., D.M. and C.G.; supervision, J.F.-F., A.H. and C.G.; project administration, L.F.; funding acquisition, none. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data supporting the findings of this study were retrieved from the Scopus database (Elsevier) and are available from the corresponding author upon reasonable request.

Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

FEA	Finite element analysis
FEM	Finite element method
CBCT	Cone-beam computed tomography
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
AI	Artificial intelligence

References

1. Trivedi, S. Finite element analysis: A boon to dentistry. *J. Oral Biol. Craniofac. Res.* **2014**, *4*, 200–203. [CrossRef] [PubMed]
2. Choi, A.H.; Conway, R.C.; Ben-Nissan, B. Finite-element modelling and analysis in nanomedicine and dentistry. *Nanomedicine* **2014**, *9*, 1681–1695. [CrossRef] [PubMed]

3. Cervino, G.; Fiorillo, L.; Arzukanyan, A.V.; Spagnuolo, G.; Campagna, P.; Cicciù, M. Application of bioengineering devices for stress evaluation in dentistry: The last 10 years FEM parametric analysis of outcomes and current trends. *Minerva Stomatol.* **2020**, *69*, 55–62. [CrossRef] [PubMed]
4. Shivakumar, S.; Kudagi, V.S.; Talwade, P. Applications of Finite Element Analysis in Dentistry: A Review. *J. Int. Oral Health* **2021**, *13*, 415–422. [CrossRef]
5. Diarra, A.; Mushegyan, V.; Naveau, A. Finite Element Analysis Generates an Increasing Interest in Dental Research: A Bibliometric Study. *Open Dent. J.* **2016**, *10*, 35–42. [CrossRef] [PubMed]
6. Xie, B.; Zhang, L.; Wang, Y.; Chu, Y.; Lu, Y. Finite element analysis in the Dental Sciences: A Bibliometric and a Visual Study. *Int. Dent. J.* **2024**, *75*, 855–867. [CrossRef] [PubMed]
7. Falcinelli, C.; Valente, F.; Vasta, M.; Traini, T. Finite element analysis in implant dentistry: State of the art and future directions. *Dent. Mater.* **2023**, *39*, 539–556. [CrossRef] [PubMed]
8. Liu, W.K.; Li, S.; Park, H.S. Eighty Years of the Finite Element Method: Birth, Evolution, and Future. *Arch. Comput. Methods Eng.* **2022**, *29*, 4431–4453. [CrossRef]
9. Page, M.J.; McKenzie, J.E.; Bossuyt, P.M.; Boutron, I.; Hoffmann, T.C.; Mulrow, C.D.; Shamseer, L.; Tetzlaff, J.M.; Akl, E.A.; Brennan, S.E.; et al. The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ* **2021**, *372*, n71. [CrossRef] [PubMed]
10. Geng, J.P.; Tan, K.B.; Liu, G.R. Application of finite element analysis in implant dentistry: A review of the literature. *J. Prosthet. Dent.* **2001**, *85*, 585–598. [CrossRef] [PubMed]
11. Baggi, L.; Cappelloni, I.; Di Girolamo, M.; Maceri, F.; Vairo, G. The influence of implant diameter and length on stress distribution of osseointegrated implants related to crestal bone geometry: A three-dimensional finite element analysis. *J. Prosthet. Dent.* **2008**, *100*, 422–431. [CrossRef] [PubMed]
12. Petrie, C.S.; Williams, J.L. Comparative evaluation of implant designs: Influence of diameter, length, and taper on strains in the alveolar crest. A three-dimensional finite-element analysis. *Clin. Oral Implants Res.* **2005**, *16*, 486–494. [CrossRef]
13. Baggi, L.; Pastore, S.; Di Girolamo, M.; Vairo, G. Implant-bone load transfer mechanisms in complete-arch prostheses supported by four implants: A three-dimensional finite element approach. *J. Prosthet. Dent.* **2013**, *109*, 9–21. [CrossRef] [PubMed]
14. Sayed, A.J.; Mohsin, S.F.; Garg, K.K.; Agwan, M.A.S.; Tareen, S.U.K.; Alruthea, M.S.; Mohan, S. Finite Element Analysis (FEA) for Influence of Variation in Dental Implant Dimensions (Length and Diameter) on Peri-implant Bone Stress/Strain Distribution: A Systematic Review. *Pak. J. Med. Sci.* **2025**, *41*, 318–330. [PubMed]
15. Barbosa, F.T.; Zanatta, L.C.S.; de Souza Rendohl, E.; Gehrke, S.A. Comparative analysis of stress distribution in one-piece and two-piece implants with narrow and extra-narrow diameters: A finite element study. *PLoS ONE* **2021**, *16*, e0245800. [CrossRef] [PubMed]
16. Pai, D.; Prabhu, D.; MA; Soman, A.; Thomas, A.; Koruthu, A. A Comparative Evaluation of Stress Distribution Around Different Widths of Implant and Bony Interface in Function During Axial and Non-axial Loading: A Finite Element Analysis. *Cureus* **2024**, *16*, e62674. [CrossRef] [PubMed]
17. Qiu, P.; Cao, R.; Li, Z.; Fan, Z. A comprehensive biomechanical evaluation of length and diameter of dental implants using finite element analyses: A systematic review. *Heliyon* **2024**, *10*, e26876. [CrossRef] [PubMed]
18. Yang, H.; Jia, B.; Zhang, Z.; Qu, X.; Li, G.; Lin, W.; Zhu, D.; Dai, K.; Zheng, Y. Alloying design of biodegradable zinc as promising bone implants for load-bearing applications. *Nat. Commun.* **2020**, *11*, 401. [CrossRef] [PubMed]
19. Gao, S.; Hao, S.; Huang, Z.; Yuan, Y.; Han, S.; Lei, L.; Zhang, X.; Shahbazian-Yassar, R.; Lu, J. Synthesis of high-entropy alloy nanoparticles on supports by the fast moving bed pyrolysis. *Nat. Commun.* **2020**, *11*, 2016. [CrossRef] [PubMed]
20. Yang, J.; Xiang, H.J. A three-dimensional finite element study on the biomechanical behavior of an FGBM dental implant in surrounding bone. *J. Biomech.* **2007**, *40*, 2377–2385. [CrossRef] [PubMed]
21. Băilă, D.-I.; Păcurar, R.; Savu, T.; Zaharia, C.; Trușcă, R.; Nemeș, O.; Górski, F.; Păcurar, A.; Pleșa, A.; Sabău, E. Mechanical and Wetting Properties of Ta_2O_5 and ZnO Coatings on Alloy Substrate of Cardiovascular Stents Manufactured by Casting and DMLS. *Materials* **2022**, *15*, 5580. [CrossRef] [PubMed]
22. Călinoiu, Ș.G.; Bîcleșanu, C.; Florescu, A.; Stoia, D.I.; Dumitru, C.; Miculescu, M. Comparative Study on Interface Fracture of 4th Generation 3-Steps Adhesive and 7th Generation Universal Adhesive. *Materials* **2023**, *16*, 5834. [CrossRef] [PubMed]
23. Chirca, O.; Biclesanu, C.; Florescu, A.; Stoia, D.I.; Pangica, A.M.; Burcea, A.; Vasilescu, M.; Antoniac, I.V. Adhesive-Ceramic Interface Behavior in Dental Restorations. FEM Study and SEM Investigation. *Materials* **2021**, *14*, 5048. [CrossRef] [PubMed]
24. Chojnacka-Brożek, A.; Liber-Kneć, A.; Łagan, S. Compression Behavior of Dental Flowable Composites: Digital Image Correlation and Numerical Analysis. *Materials* **2024**, *17*, 5853. [CrossRef] [PubMed]
25. Herrero-Climent, M.; Sanchez-Lasheras, F.; Martinez-Lopez, J.; Gil, J.; Brizuela-Velasco, A. Mechanical Behavior of PEEK and PMMA Graphene and Ti6Al4V Implant-Supported Frameworks: In Silico Study. *Materials* **2025**, *18*, 441. [CrossRef] [PubMed]

26. Kofod, T.; Cattaneo, P.M.; Dalstra, M.; Melsen, B. Three-dimensional finite element analysis of the mandible and temporomandibular joint during vertical ramus elongation by distraction osteogenesis. *J. Craniofac. Surg.* **2005**, *16*, 586–593. [CrossRef] [PubMed]
27. Bourauel, C.; Vollmer, D.; Jäger, A. Application of bone remodelling theories in the simulation of orthodontic tooth movements. *J. Orofac. Orthop.* **2000**, *61*, 266–279. [CrossRef] [PubMed]
28. Abdelhafeez, M.M. Applications of Finite Element Analysis in Endodontics: A Systematic Review and Meta-Analysis. *J. Pharm. Bioallied Sci.* **2024**, *16*, S1977–S1980. [CrossRef] [PubMed]
29. Selvaraj, H.; Krithikadatta, J.; Shrivastava, D.; Onazi, M.A.A.; Algarni, H.A.; Munaga, S.; Hamza, M.O.; Saad Al-Fridy, T.; Teja, K.V.; Janani, K.; et al. Fracture resistance of endodontically treated posterior teeth restored with fibre-reinforced composites: A systematic review. *BMC Oral Health* **2023**, *23*, 566. [CrossRef] [PubMed]
30. Magne, P. Efficient 3D finite element analysis of dental restorative procedures using micro-CT data. *Dent. Mater.* **2007**, *23*, 539–548. [CrossRef] [PubMed]
31. Martinez-Mondragon, M.; Urriolagoitia-Sosa, G.; Romero-Ángeles, B.; Maya-Anaya, D.; Martínez-Reyes, J.; Gallegos-Funes, F.J.; Urriolagoitia-Calderón, G.M. Numerical Analysis of Zirconium and Titanium Implants under the Effect of Critical Masticatory Load. *Materials* **2022**, *15*, 7843. [CrossRef] [PubMed]
32. Teodorescu, C.; Preoteasa, E.; Preoteasa, C.T.; Murariu-Măgureanu, C.; Teodorescu, I.M. The Biomechanical Impact of Loss of an Implant in the Treatment with Mandibular Overdentures on Four Nonsplinted Mini Dental Implants: A Finite Element Analysis. *Materials* **2022**, *15*, 8662. [CrossRef] [PubMed]
33. Zieliński, R.; Lipa, S.; Piechaczek, M.; Sowiński, J.; Kołkowska, A.; Simka, W. Finite Element Analysis and Fatigue Test of INTEGRA Dental Implant System. *Materials* **2024**, *17*, 1213. [CrossRef] [PubMed]
34. Oliveira, V.G.B.; Sousa, Á.A.D.; Oliveira, F.E.S.; Martelli, D.R.B.; Araújo, E.; Coletta, R.D.; Martelli Júnior, H. Scientific contribution of the Brazilian CNPq Research Productivity fellows in dentistry. *Braz. Oral Res.* **2024**, *38*, e125. [CrossRef] [PubMed]
35. Bornmann, L.; Mutz, R. Growth rates of modern science: A bibliometric analysis based on the number of publications and cited references. *J. Assoc. Inf. Sci. Technol.* **2014**, *66*, 2215–2222.
36. Ikumapayi, O.M.; Bankole, O.O.; Bayode, A.; Onu, P.; Ting, T.T. Finite Element Analysis and Simulation of 316L Stainless Steel and Titanium Alloy for Orthopedic Hip and Knee Prosthetics. *Prosthesis* **2025**, *7*, 64. [CrossRef]
37. Ramírez, O.; Torres-SanMiguel, C.R.; Ceccarelli, M. Design of a Compliant Sternum Prosthesis for Improving Respiratory Dynamics. *Prosthesis* **2024**, *6*, 561–581. [CrossRef]
38. Schneider, K.-A.; Hazubski, S.; Otte, A. Three-Dimensional Computer-Aided Design Reconstruction and Finite Element Method Analysis of the Complex Inner Mechanics of the Second Iron Hand of Franconian Imperial Knight Götz von Berlichingen. *Prosthesis* **2025**, *7*, 28. [CrossRef]
39. Fiorillo, L.; Meto, A.; Cicciù, M. Bioengineering Applied to Oral Implantology, a New Protocol: "Digital Guided Surgery". *Prosthesis* **2023**, *5*, 234–250. [CrossRef]
40. Galletti, F.; D'Angelo, T.; Fiorillo, L.; Lo Giudice, P.; Irrera, N.; Rizzo, G.; Cervino, G. Micro-CT Structure Analysis on Dental Implants: Preliminary In Vitro Trial. *Prosthesis* **2024**, *6*, 1437–1447. [CrossRef]
41. Kobbe, P.; Laubach, M.; Hutmacher, D.W.; Alabdulrahman, H.; Sellei, R.M.; Hildebrand, F. Convergence of scaffold-guided bone regeneration and RIA bone grafting for the treatment of a critical-sized bone defect of the femoral shaft. *Eur. J. Med. Res.* **2020**, *2*, 70.
42. Michailidis, N.; Karabinas, G.; Tsouknidas, A.; Maliaris, G.; Tsipas, D.; Koidis, P. A FEM based endosteal implant simulation to determine the effect of peri-implant bone resorption on stress induced implant failure. *Biomed. Mater. Eng.* **2013**, *23*, 317–327. [CrossRef] [PubMed]
43. Meethal, R.E.; Kodakkal, A.; Khalil, M.; Ghantasala, A.; Obst, B.; Bletzinger, K.-U.; Wüchner, R. Finite element method-enhanced neural network for forward and inverse problems. *Adv. Model. Simul. Eng. Sci.* **2023**, *10*, 6. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.