

A Scoping Review of Complexity Science in Dentistry

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Abstract

Introduction: The purpose of this review is to establish how the theory of complexity is understood and instituted in dentistry. **Methods:** The stomatognathic system can be understood as a dynamic, complex, and adaptive system. Each pathological or physiological condition of this system involves physical, chemical, and biological processes in constant, open, and changing interactions with social, emotional, nutritional, political, and economic processes. Against this background, specifically, the following research questions were posed: How do researchers use complexity science in dentistry? How is complexity science described in dentistry articles?. **Results:** A brief literature search was implemented, which identified 11 PubMed articles as well as two from the Literatura Latinoamericana y del Caribe en Ciencias de la Salud (LILACS) database and one from the Cochrane Library for a full text review. Studies on complexity in the dental sciences are mostly presented in the form of critical opinion articles, which corresponded to 50% of the reviewed articles. In dentistry, complexity is understood as less of a theory and more as a line of thinking regarding procedures that can become complex at any given time. **Conclusion:** This article shows that there are great difficulties in integrating complexity and understanding it in dentistry. There are many aspects from complexity science that still need to be understood in oral health.

Keywords: Complexity, complexity science, complexity theory, complexity thinking, dentistry, oral health, public health dentistry

INTRODUCTION

An adaptive complex system, as the world or society can be considered, is defined as a system composed of a large number of entities, showing a high level of interactivity, which is highly nonlinear and contains multiple feedback circuits.^[1-3] A complex system can be self-organizing, which can reflect high susceptibility to abrupt changes and incomprehensibility, which means that any reduction in its understanding will result in a loss of the system's independent aspects.^[4]

There are particular concepts related to complex adaptive systems, among which is the fragility in which some objects or conditions enjoy tranquility, order, and predictability. However, when something is labeled as fragile, it becomes vulnerable, conferring different conditions. A second aspect is robustness and resilience, referring to conditions that withstand shock and endure unchanged. This quality is behind everything that has changed throughout history: revolutions, technological innovation, cultural success, business survival, good recipes, the rise of cities, resistant bacteria, and even our existence as a species.^[5]

Some authors have shown that complex systems have particular characteristics, including having a high number of heterogeneous entities, interaction between various elements, an emerging phenomenon of interactions that differ from individual effects, and effects that persist and adapt over time.^[6] These conditions lead to the idea that health processes are characterized by a high degree of complexity.^[7]

The impact of the digital age (IV scientific revolution),^[8] advances in science and technology, artificial intelligence, changes in population demographics, health status, increased inequalities, treatment needs and modalities, prevention, health care systems, funding, personnel, legislation, and regulations have influenced the practice of public health dentistry,^[9] evoking increasingly complex environments in the exercise of dental treatment. In clinical terms, from

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diagnosis to the choice of therapeutic action, there is a need for a deep knowledge of the stomatognathic system in which the clinician will operate. This is a complex system.^[10]

Some authors have defined complex health care environments by the term “collective bricolage,” defining this as the various people and things that interact in space and time to generate and solve problems in the best way possible.^[11] It is a complex concept of care because of the number of processes that can interact in this activity. These interactions are often not found in clinical care guidelines, or in general care, but it is to be expected that the practice, especially in dentistry, will be complex and paradoxes in complexity are expected.^[12]

There is an increasing need for this theory in the field of oral health. Few health studies have been performed in which researchers reported that this theory was being used. The use of a theory helps us to clarify the application of the research, strengthen the research process, clarify scientific literature and academic process, and provide an environment to give certain to the results.^[13,14]

In the social sciences, efforts have been made to theorize disease/health processes and the probable explanations for various processes. Among them, concepts such as functionalism and social constructivism show that sociology has given us answers beyond the natural and biological sciences, establishing a process that must be dynamic and inherent to the human being. Dentistry must contextualize, theorize, and understand them in order to transform the discipline.^[15]

The stomatognathic system, for example, can be understood as a dynamic, complex, and adaptive system. Each pathological or physiological condition expressed by this system involves physical, chemical, and biological processes in constant, open, and changing interaction with social, emotional, nutritional, political, and economic processes. Therefore, each intervention on one of its components has direct and indirect effects on the others. Occlusion, for example, changes throughout life. It is altered by tiny changes in the dental structure, by anatomical alterations in the musculoskeletal complex, modified by any changes that occur in the temporomandibular joint and it also presents with variations caused by the dentist’s interventions, such as when they introduce a biomaterial to remove decay and restore lost tissue.

Complexity has yet to be clearly defined for research purposes. It is not yet known how complex something must be to be part of complexity science, and any given definition depends on the perspective applied to it.

There are some approximations to definitions of complexity that come close to differential explanations in health processes. It has been specified that complexity can present a great number of meanings, and typically, as it is inherently complex, it brings a plurality of answers. For example, in terms of social science, definitions point to a

“synthesis in which human social systems, natural social systems and artificial systems, do not simply show positive synergy which is actually quite trivial, but, better still, they emerge self-organized.”^[16]

Another possible explanation for the emergence of complexity science is the impossibility of studying a phenomenon or concept without taking into account the context, time, or framework of the universe of the phenomenon and the various types of relationship that traverse an issue. This framework of study seeks to analyze the phenomena characterized by self-organization, emergence, and nonlinearity.^[17]

SCOPING REVIEW

The objective or purpose of a scoping review is to map the body of literature on a thematic area, that is, the most relevant articles in relation to a particular topic. It is also performed to give the authors a critical perspective on the subject. The difference between a scoping review and a systematic review is that the former aims to select the best evidence for each topic and consolidate it.^[18]

Essentially, a scoping review provides a description of the existing material in the literature without critically evaluating individual studies or synthesizing evidence from different studies, but rather by highlighting some aspects of importance and establishing the authors’ critical position.^[19]

A scoping review is used most often when the topic has not been extensively reviewed in the literature or due to its complex or heterogeneous nature^[20] and can be used as the cornerstone or the first stage for a subsequent systematic review.

MATERIALS AND METHODS

Based on a methodology for developing scoping reviews as reported elsewhere, it is proposed that six steps of a methodological framework be integrated: identify the research question, identify relevant studies, select studies, consolidate the results, and collect, summarize and report them.^[19]

The purpose of this review is to establish how complexity is understood and how the theory of complexity in dentistry has been established. With this in mind, the following research questions were posed: How do researchers use complexity science in dentistry? How do dentistry articles describe complexity science?

Search strategy

A search strategy was implemented for databases in Spanish and English. PubMed and the Cochrane Database of Systematic Reviews were searched for literature in English, and Literatura Latinoamericana y del Caribe en Ciencias de la Salud (LILACS) was searched for literature in Spanish. Attempts were made to use the MeSh and Decs databases, but “complexity” as a word is not included in either language as a reference word, and the words included were

chosen from the literature consulted regarding complexity in bibliographic references and previous reviews.

For PubMed, the following search strategy was used: (complexity OR complexity theory OR complexity science OR complexity thinking) AND (dentistry OR public health dentistry OR odontology). In the case of the LILACS database, “complejidad” OR “pensamiento complejo” AND “odontologia” OR “salud oral” OR “boca” were used, and for the final database, the Cochrane database, a search of “complexity” and “dentistry” was performed, with publications from the year 2000 onward selected.

Selection of studies

The studies were selected if they had been published in a scientific journal, and articles in English and Spanish were included. In the manuscripts, the authors reported that they had taken complexity into account in their analysis in some way. As far as possible, we sought out studies that showed that the authors had integrated an understanding of complexity into their analysis.

No particular types of study were excluded. Those in which complexity was not understood as a theory or a framework of analysis, but rather as a major difficulty in a clinical process, were excluded. These articles were not included in this review because what is complicated is different from what is complex.

As this is a scoping review, the methodological quality of each study will not be discussed. The objective is to evaluate the use of complexity science in dentistry and what approximations this health discipline has in the face of this topic. The idea is to give an account of the literature and offer a reflexive critique based on understanding complexity science in the framework of public health.

Data consolidation

A matrix was made in the Excel data consolidation program and individual matrices were consolidated for each database. The data included the title of the article, author, the inclusion as an abstract only or as an abstract and full article, country of

publication, year of publication of the article, study design, purpose, research objective, attributes of complexity used, phenomenon of interest, how the theory of complexity was used in the study, and a detailed description of the complexity involved. For this last variable, this description would allow us to understand the way in which complexity in dentistry is understood and described in the selected articles.

For articles where only the abstract was reviewed, only the basic data (title, year, and the reason for exclusion) were included. The reasons for excluding an abstract from this study were that complexity was viewed solely from the perspective of treatment or a complex clinical diagnosis or because no perspective or analysis of complexity was evident in the abstract.

RESULTS

The consolidation of results in the analysis tables follows the methodology proposed in the literature previously.^[19] This framework generates a good form of approximation, dissemination, and consolidation of knowledge.

The search of the LILACS database yielded 65 results. All identified articles were reviewed using their titles, of which 25 full abstracts were analyzed, two of which were included in the full text review.

In the case of the PubMed search, it yielded 1573 results, of which 600 titles were reviewed. Of those, 25 were chosen for a more extensive review, of which 14 were excluded by their abstract and 11 were included in the full text review.

The same exercise was performed for the Cochrane database. The search yielded 39 articles and 2 were selected for review. One was excluded because of its abstract and one was included in the review. Figure 1 shows the results of the review of the three databases.

None of the articles found in the different databases was duplicated, and so none was excluded for that reason. It should be noted that the main focus of most of the scientific studies described in the articles that emerged

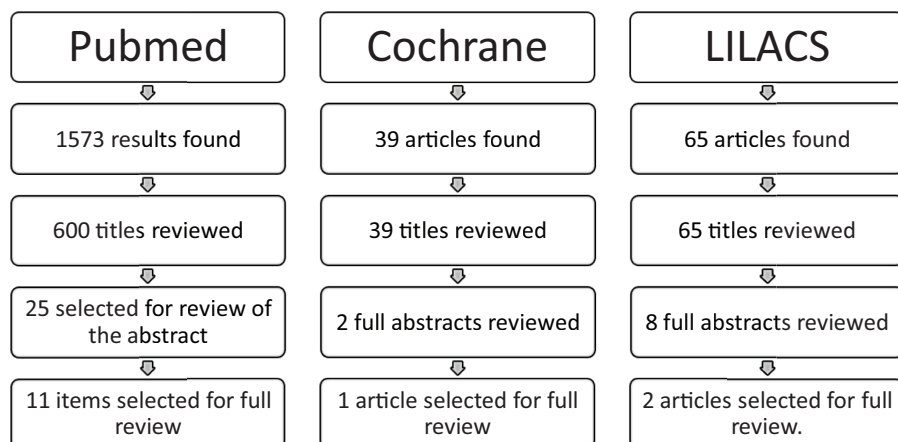


Figure 1: Description of the literature review of the databases

from the search was not complexity, nor was complexity part of the main objectives of the research exercise. However, the implicit or explicit approach to complexity was the focus of interest in this review. Table 1 shows a description of the different articles, presenting the authors involved, the year, the country, and the study design.

The review of the different articles showed different ways of thinking about how to view or perceive complexity depending on the viewpoint from which the study in question was performed. The majority of articles regarding complexity in the dental sciences are in the form of critical opinions, which accounted for more than 50% of the reviewed articles. However, this type of research is not the typical way of approaching this type of subject. Critical opinion studies generally present the authors' opinions regarding a certain subject, and the complexity should emerge from other types of research. We also found some topic reviews (two), journal editorials (one), original articles (two), and supplementary articles (one).

In the literature selected, complexity in the dental sciences was described in different ways. It was generally based on interpretations and the views of an author or a group of authors. This is described in Table 2. The analysis is presented through the qualitative views found in them within it. The literature reviews allow us to elucidate differential analysis frameworks. The left column has no

relation to the thinking of the right; it is simply a matter of answering the question that was asked through representations made or interpreted from the different articles selected.

Fortunately, despite the limited literature that can be found on this subject, there is an agreement that dentistry comes before complexity in history and that it must be understood beyond its own clinical practice. The conditions of a discipline that has been based purely on clinical exercises are generally based on evidence-based medicine. However, a discipline must go further in the development, and in several articles this aspect is criticized.

Much more emphasis must be placed on systems science within the field of dentistry. The scope of the analyses found in the literature search is small, given the range of possibilities available. In addition, a multimethod approach can be used for a better understanding of the research phenomena, which integrates the qualitative sciences and can be of great help in understanding health issues.

DISCUSSION

Until now, dentistry has been a discipline aimed just at understanding disease, but we must now redefine our definition of disease so that we can talk about health. This is not a minor change; it implies the need for rethinking the

Table 1: Description of included articles

Article	Authors	Year	Country	Study design
The Building Blocks of Evidence-Based Dentistry ^[21]	Susan E. Sutherland	2000	USA	Critical opinion
Application of Policy Analysis Models in Oral Health Issues: A Review ^[22]	Mostafa Mozdhehifard, Hamid Ravaghi, and Poursan Raeissi	2019	USA	Systematic review
Practice, Complexity and Evidence-Based Practice ^[12]	Dominic Hurst	2019	United Kingdom	Critical opinion
Embracing Complexity ^[23]	Rebecca Wassall	2019	United Kingdom	Editorial
Evidence-Based Dentistry: Two Decades and Beyond ^[24]	Francesco Chiappelli	2018	USA	Critical opinion
Systems Science and Oral Health: Implications for Dental Public Health ^[25]	Broomhead T and Baker SR	2018	USA	Critical opinion
Use and Misuse Of mixed Methods in Population Oral Health Research: A Scoping Review ^[26]	Gupta A, Keuskamp D.	2018	Australia	Original article
Oral Healthcare Systems for an Ageing Population: Concepts and Challenges ^[27]	Ghezzi EM, Kobayashi K2 Park DY, Srisilapanan P.	2017	USA	Supplementary article
An Approach on Defining Competency in Evidence-Based Dentistry ^[28]	Marshall Ta	2018	USA	Original article
Updated Competencies for the Dental Public Health Specialist: Using The Past and Present to Frame the Future ^[9]	Weintraub JA1, Rozier RG2	2016	USA	Critical opinion
The Complexity of Patient Safety Reporting Systems in UK Dentistry ^[29]	Renton T, Master S.	2016	United Kingdom	Critical opinion
Enhancing Implementation Science by Applying Best Principles of Systems Science ^[30]	Mary E. Northridge and Sara S. Metcalf	2016	USA	Review
Representación Social del Odontólogo ^[31]	Anderson Rocha	2008	Colombia	Critical opinion
El sistema Estomatognatico: Un Sistema Complejo ^[10]	Mario Beszki, Edith Losoviz, Luis Zielinsky	2005	Argentina	Critical opinion

Table 2: Description of the complexity in dental literature selected

How do researchers describe complexity science?	How do researchers use complexity science?
<p>Complexity is described when the author recognizes complexity as the environment in which clinical decisions are made, and the importance of the individual, their circumstances, beliefs, attitudes, and values</p>	<p>A paradigmatic change in the way dentistry is conceived is suggested and it is established that the dental paradigm requires a transversal shift. EBM should not be a codebook that must be followed to the letter</p>
<p>Oral health is a complex interaction that includes factors such as the state of the disease and the physiological and psychosocial properties</p>	<p>Some researchers evaluate it from the stages of formulation and modeling of policies</p>
<p>From an integrated perspective, oral health is a complex interaction that includes factors such as the state of the disease and physiological and psychosocial factors as the central elements</p>	<p>It has been suggested that complexity science be integrated within EBM</p>
<p>Researchers suggest that to see complexity from other perspectives, it must be integrated into narrative and exploratory frameworks that better understand the phenomenon</p>	<p>Complexity that is understood by EBM is criticized as it is not placed on a historical level. In that context, complexity is not sensitive to the state of people, and it does not include the variety of actions in practice within the phenomenon of study</p>
<p>It is described as the aspects or conditions that a clinical case could present and the aspects that should be taken into account</p>	<p>Complexity science could give rise to a new way of thinking, working in, and practicing dentistry. The context in which care occurs and the number of issues that can occur in the attention, taking into account context and processes attached to patient care. It is stated that complexity in dentistry should be studied</p>
<p>The author talks about the transformation of EBM into a meta-complex construct that we do not yet fully understand. This is a construct that has abruptly emerged in the last 20 years and become the new standard in dentistry</p>	<p>Complexity is used to define EBM as a complex construct for the development of processes in oral health. EBM is validated as a construct of complexity</p>
<p>The complexity of health concepts and how they are taught</p>	<p>The best decisions in dentistry must be based on an understanding of both clinical values and beliefs and we must also become lifelong critics and readers</p>
<p>Complexity science is described by the robustness and the statistical complex</p>	<p>Complexity requires a new arsenal of statistical processes to analyze the dynamics of complexity that are nonlinear</p>
<p>Public dental health is described as a system that is much broader and has a more diverse structure that opens up the possibility and the need to understand the complexities associated with oral health. It links complexity to systems science and has defined a way of studying a complex system through the theory of scientific systems.</p>	<p>Simulation methods associated with systems science can be used for capturing models of real-world problems. Knowledge of systems will be the way to generate knowledge regarding the context and complexity of oral public health</p>
<p>Complexity science is described regarding the comorbidities of senior citizens and the complexity of the system of care that treats them</p>	<p>There are five advantages of using systems science in public health: (i) interaction with feedback mechanisms at the individual and system levels, (ii) the inclusion of traditional statistical systems, (iii) relevant policy analysis, (iv) the testing of theoretical frameworks, and (v) methodological advances of the current theory</p>
<p>Public health is complex and requires a lot of effort to understand. It frames collaborative processes as being necessary in public health</p>	<p>A framework of complexity is proposed from the understanding of research problems through different quantitative and qualitative analyses. Health problems are complex</p>
<p>The impossibility or difficulty of recording adverse events and the subsequent costs that this brings</p>	<p>Qualitative methods play an emerging role in addressing the complexity of causes with their capacity for in-depth description</p>
<p>The complexity could be related with the articulation of oral health systems with primary health care due to the number of factors at stake Complexity could be understood by the need to stimulate and conceive new health and social changes</p>	<p>It is important to establish the knowledge and scope of EBM to define its competences. Not everything can be guided by this trend There is evidence of the use of systems science and its process of implementation from the point of view of public health. Researchers understand complexity from the complexity of the world we live in and show that it is a process that will require changes in thinking about the world and in thinking about the problems that the world has in order to attain integrated evidence</p>
<p>Complexity is seen as the experiences, information, knowledge, and models of thought that build the social representation of dentists among the general public. This is also shared by the influence of history, culture, and the interaction of people with the profession</p>	<p>Oral health can be directly influenced by systemic and social processes and behavioral relationships</p>
<p>Complexity has been stigmatized and seen as the enemy of simplicity that comes from scientific knowledge</p>	<p>Complexity is framed in a philosophical and biological understanding, in which reductionism has no place. An exercise is also described that shows how the theory has changed throughout history and how we are progressing in our understanding of it</p>
<p>The stomatognathic system belongs to the field of complex systems and must be approached with complex thinking</p>	

EBM, evidence-based medicine.

theoretical, philosophical, scientific, critical, and logical framework of the field.^[32] The understanding of oral health and its complexity will be seen as a liberating process for the dentistry of the future. In other sciences, the theorization of complexity has already begun, which can already be seen reflected in the practice of such sciences. Ontogenesis has already been explained through epigenetics and artificial intelligence, and, as it is increasingly understood, it increases in value and more and more aspects that are part of the process are understood.^[33]

Considering epigenetics in a little more depth and its relation with complex public health diseases, problems and public health issues should integrate animal models with human clinical, and population-based approaches, paying particular attention to aspects of vulnerability, environmental and nutritional assessment, and cell-type-specific epigenetic patterns.^[34] In the field of health, especially oral health, it is important to focus on understanding this branch of epidemiology, not only from a perspective of purely biological theory, but also from a public health perspective, as the main means of integrating complexity. Epigenetics is also synonymous with chaos, genetic mutations, replacement, evolution, and chance, among others. It is a process that must be immersed in the sciences of various disciplines, and dentistry should understand these processes.^[35]

In the health sector, a new paradigm needs to be established that looks at the sector from a nonlinear and uncertain perspective. The complexity could be a way to incorporate science in a different way into health, although this field is somewhat lagging behind other fields in this regard.^[36]

The results show that there is an idea that gives importance to complexity when the topic is analyzed and interact with the environment, with the interaction of all the fields around the person, and their psychosocial and psychological properties,^[21,22] also an interaction with other fields and analysis in research,^[24,25] this is the key in which complexity could be interacting with dentistry and also with Public Health.

Uncertainty is not an accepted concept in oral health. Clinical dentists and practitioners of evidence-based medicine seek certainty. However, true science develops through indeterminism and is understood by particles and waves of quantum physics. Health processes are not black and white – there are nuances and shades of gray. It is extremely important that we show that so-called black swans have become more prevalent. Black swans are referred to the event whose occurrence cannot be attributed to known reasons, but after it has occurred, the event is rationalized in hindsight, as if it had been expected.^[37,38] Oral health events often get summarized by a notion explained by a Gaussian Bell. It is a process that may require different. Some authors in the review have tried to do it, the complexity and the use of it needs inter- and transdisciplinary work, that is a way in which different points of view and science could

be included in dentistry works, mixed methods research is also a way to understand problems from different perspectives^[26]; also the understanding of health as a complex adaptive system in different modelling quantitative ways.^[25]

In terms of its implications and connections with public health, practice within the field of oral health should adopt a broader perspective in which complexity plays a greater role. This framework not only provides the analysis of population concepts but also analyzes various aspects around oral clinical pathology including social concepts, socio-environmental factors, connection with family and social networks and their relationship with oral health. This could make public health a good gateway for exploring complexity in the dental sciences.

The theory of complexity has provided health professionals with a great capacity to generate new integrated solutions through the historical and social connections of communities, which creates a much broader and holistic knowledge base and builds in a capacity for debate, discussion, adaptation to change, and the ability to develop new goals and strategies.^[39] Already studies have been performed asserting that complexity constitutes a new paradigm in health.^[40] It calls attention to things that even dentistry does not understand.

From the review presented here, in the field of dentistry, complexity has not been understood or it is understood from many very different perspectives. This is not inherently wrong, but it must be seen from clinical and public health perspectives as well as one based on evidence-based medicine, among others. The difficulty is an apparent lack of schools of thought helping to guide the analysis of complexity. Few people talk about the subject and research on it. It has been so diverse that it will be difficult to reach any consensus on it for some time.

Evaluation and improvement should be part of normal practice and include the exploration of the values, meanings, and other phenomena that arise as people and things interact. To some extent, we do this informally through our discussions about cases with colleagues and with the rules that are implicitly developed in different practice spaces. Literature and stories involve plots and, most importantly, meaning, with the narrator trying to make sense of the complexity of events.^[41]

There has often been a tendency to want to see complexity as an obstacle imposed by nature to protect the secret of its laws, which are simple.^[10,42] Thus, in the literature on dentistry, there are few reports based on complexity. The need to keep problems as simple as possible and the continuous growth of evidence-based medicine have meant that most authors who discuss this subject do so in the format of a critical opinion rather than through a broad theoretical or methodological framework that formulates hypotheses and grows throughout the process.

The complex nature of the causal pathways of social determinants in oral diseases requires that their consideration be integrated into all aspects of the specialized practice of public dental health.^[9] Dentistry in its current status requires different analysis topics in all fields of practice. Dental research requires other methodologies such as the use of both literature-derived knowledge and colloquial knowledge, and this must also integrate clinical processes. By understanding issues from different perspectives, we can generate actions that contribute to indicators in public oral health, especially those reported in El Estudio Nacional de Salud Bucal – ENSAB IV.^[43]

In university education, for didactic reasons, the stomatognathic system is broken down into its constituent elements: teeth, periodontium, nervous system, muscles, bones, joints, ligaments, and so on. This approach often leads us to lose the perspective that the interaction of these elements and their connections give “functionality” to this system.^[10]

Complexity science seeks out integration and interaction and emphasizes synthesis rather than separation. Health processes are not understood from this perspective. This can sometimes be seen as a theoretical framework; a process of presenting results and interpretations can assume multiple contexts and can show the great amount of integration of knowledge, sciences, and methodologies that can be part of the subject and problems of research.^[13] It seeks to understand the problem from various perspectives and to find overlapping concepts and explain options without falling into irrefutable determinisms, in contrast to the current status in science.

In order to achieve that, we must include disease and health of the elements: cavities, periodontal disease, edentulism, as well as the rehabilitation needed for these diseases, namely, dental prosthetic devices and restoration, among others. It is not a simple process; the system components themselves are complex and the subject in which they are located is complex. Through restoration of a tooth or a denture, you are modifying a reality.

Reductionism sometimes generates isolation. The clinician requires an understanding of the particularities of a case but never isolates the processes of a functional system, which is also complex. An educational proposal based on cases and problems, in which persons could learn by subjects and environment, has been of great help in understanding the turnaround of the scientific revolution.^[44] This different approach, of avoiding reductionism, does not complicate the problem, but rather puts it in another perspective. From this, we will continue to look “at the tooth” as well as its participation in various functions. Thus, its spatial location will be linked to its participation in the different emergent properties of the system.^[10]

Some articles show the need for a new “evidence-based medicine” that integrates new topics, including tele-dentistry, patient care centers, and individual data from

patients and caregivers.^[24] There is still a lack of discussion of these topics, and the positivist paradigm in the science of dentistry must change and a new approach must emerge. In the 20th century, quantum physics taught us a new way of thinking and it is time to recreate that same kind of mental openness. Our environment is full of complex theories that must be understood for us to generate changes in health sciences that imply indeterminism. The elements of complex systems that generate nonseasonal dynamics in addition to high indeterminism^[45] are necessary in a world where it is necessary to think about health and life, not illness. It is important to recreate concepts of robotic medicine, quantum mechanics, and artificial intelligence.

Another important analysis that should be explored based on what has been found is that dentistry requires multimethod analysis that should be the common denominator of studies within the discipline. In the period between 2017 and 2018, only nine studies with mixed methods in dentistry were reported.^[26] Although there is a clear excess of quantitative literature, the discipline requires the integration of different methods of analysis that allow us to tangentially integrate complexity into our work, including qualitative and scientific systems research.^[25]

One concern within the dental profession is its excessive technification. This alienates it from science and research. Beyond biomaterials and biotechnology, there is life, health, and radical thinking. Beyond the disease, the complementation of the positivist paradigm and the creation of an integral evidence-based medicine must include a process of open-minded that can be applied.

In his book *The Structure of Scientific Revolutions*, Thomas Kuhn writes “No part of the goal of normal science is aimed at bringing about new kinds of phenomena; in fact, the phenomena that do not fit within the limits mentioned are frequently not even seen.”^[46] Many health processes are permeated by the confidence that one has in the established paradigm. If dentistry found a paradigm and began to fully associate with it, what would that mean for our profession?

The value of complexity is not given to simplification, it will never be complete or ended, there will never be closure in the process. It is always necessary to have a deeper level of analysis and depth, where the sealing of a truth condemns us to assume roles and participate in ways that will require even more investigation.

Dentistry needs to begin to break down or deepen its paradigms. A discipline without paradigms often lacks external validity; dentistry finds itself today in a comfortable state, and this way of thinking can prevent the emergence of new trends in the field. Epigenetics, artificial intelligence, and quantum physics, for example, should start to be a part of our research agenda, but this requires open-mindedness to the potential for transformative processes to arise within the discipline.

In Colombia, we have been analyzing what the real role of the dentist is in the construction of public policy. This is a discipline that already suffers from a wide gap with regard to public policy. The authors have already shown the indispensable need for the profession to feel that it is part of the construction of political, economic, and social processes, which implies that they are asking it to strive to develop a more integrated view of the complexity of life and society.^[47] It will be necessary to see beyond the simplism that we see in our environment. We must become a lot more related with the medical, social, and health sciences and invoke transdisciplinary and multidisciplinary studies that help to create different theories within the discipline.

It is important that dentistry widens its knowledge base. Most common serious health problems cannot be addressed or solved by a single discipline despite the expert knowledge of individuals working specifically within these fields. Further progress can sometimes be achieved by adopting a more comprehensive approach, which involves the views and knowledge of other disciplines.^[48]

This does not involve stopping the use of traditional methodologies, but is instead about integrating complexity into an array of analytical possibilities, increasing and extending the conceptual scope and the analytical process of public oral health. One of the best examples of this type of analysis is the modeling that economically verified that different fluoridation processes caused a reduction in tooth decay.^[49]

Within the field of public health, complexity is currently seen from various perspectives. It is most often intended as a referential framework, although it can sometimes be integrated as a means of interpreting results. However, the process of acting on complexity science in the health field has not been made clear and understandable to every health science.

Something that stands out is how the clinical representations of oral cavities are not instituted in quality of life processes. Biological patterns of oral conditions that are considered to be normal or abnormal are not in line with quality of life based on oral health.^[50]

CONCLUSION

This scoping review has shown that there are great difficulties in integrating complexity and its understanding into dentistry. The discussion presented here has shown that there are many aspects that must be widely understood from complexity science regarding oral health, that the challenges are great, and that there is no single truth. This discussion has also shown that the governing paradigm within this field must be reevaluated.

Dentistry has the great task of facing a new scientific revolution, with the great ally that is evidence-based medicine. However, it also faces the challenge of understanding that there is not just a single truth and that life has nuances and is not just black and white.

Interdisciplinary and transdisciplinary studies, qualitative studies, and analysis through systems theory should enable a more holistic understanding of dental health problems.

Dentistry has much to learn from the social sciences. Research requires conceptual and theoretical frameworks that need to be reported in various scientific papers and research papers.

Limitations

Ideally, there is a need for a systematic review that integrates a greater number of databases in order to broaden the spectrum of the search. In addition to this, it is necessary to include papers written in a greater number of languages. It should be noted that many of the interpretations of complexity in this review are based on the authors' own interpretations upon reading the article that was chosen for the scoping review. This does not compromise the particular vision of the authors' of the article.

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REFERENCES

1. Richardson KA, Cilliers P, Lissack M. Complexity Science: A "Gray" Science for the "Stuff in Between", *Emergence: Complexity & Organization* 2001;3:6–18.
2. Richardson K, Cilliers P. What is complexity science? A view from different directions. *Emergence: Complexity and organization* 2001; 3:5–23.
3. Vattay G, Kauffman S, Niiranen S. Quantum biology on the edge of quantum chaos. *PLoS One* 2014;9:e89017.
4. Auyang S. *Foundations of Complex-system Theories in Economics, Evolutionary Biology and Statistical Physics*. USA: Cambridge University Press; 1999.
5. Taleb N. *Antifragil – las cosas que se benefician del desorden*. Paidós; 2013.
6. Luke DA, Stamatakis KA. Systems science methods in public health: dynamics, networks, and agents. *Annu Rev Public Health* 2012;33:357–76.
7. Pagani V, Kivits J, Minary L, Cambon L, Claudot F, Alla F. Complexity: concept and challenges for public health interventions. *Sante Publique* 2017;29:31–9.
8. National Academies of Sciences Eam. *The Fourth Industrial Revolution: Proceedings of a Workshop-in Brief*. Washington (DC): National Academies Press; 2017.
9. Weintraub JA, Rozier RG. Updated competencies for the dental public health specialist: using the past and present to frame the future. *J Public Health Dent* 2016;76(Suppl 1):S4–s10.
10. Beszkin M, Losoviz E, Zielinsky L. *El Sistema Estomatognático: un sistema complejo*. Rev Ateneo Argent Odontol 2005.
11. Hurst D, Greenhalgh T. Knowing in general dental practice: anticipation, constraint, and collective bricolage. *J Eval Clin Pract* 2019;25:921–9.
12. Hurst D. Practice, complexity and evidence-based practice. *Br Dent J* 2019;227:12–4.
13. Thompson DS, Fazio X, Kustra E, Patrick L, Stanley D. Scoping review of complexity theory in health services research. *BMC Health Serv Res* 2016;16:87.

14. Davies P, Walker AE, Grimshaw JM. A systematic review of the use of theory in the design of guideline dissemination and implementation strategies and interpretation of the results of rigorous evaluations. *Implement Sci* 2010;5:14.
15. Lupton D. Theoretical perspectives on medicine and society. *Medicine As Culture*. 2nd ed. London: Sage 1994. p. 5-21.
16. Maldonado CE. Complejidad de los Sistemas Sociales: un reto para las ciencias sociales. *Cinta moebio* 2009;146-57.
17. Maldonado CE. Complejidad: revolucio'n cienti'fica y teori'a. Bogota: Universidad del Rosario- Facultad de Administracion; 2009.
18. Pham MT, Rajic A, Greig JD, Sargeant JM, Papadopoulos A, McEwen SA. A scoping review of scoping reviews: advancing the approach and enhancing the consistency. *Res Synth Methods* 2014;5:371-85.
19. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol* 2005. pp. 19-32. ISSN 1364-5579
20. Mays N, Roberts E, Popay J. Synthesizing research evidence. In Fulop N, Allen P, Clarke A, Black N, editors, *Methods for studying the delivery and organisation of health services*. London: Routledge; 2001.
21. Sutherland SE. The building blocks of evidence-based dentistry. *J Can Dent Assoc* 2000;66:241-4.
22. Mozhdhifard M, Ravaghi H, Raeissi P. Application of policy analysis models in oral health issues: a review. *J Int Soc Prev Community Dent* 2019;9:434-44.
23. Wassall R. Embracing complexity. *Br Dent J* 2019;227:1.
24. Chiappelli F. Evidence-based dentistry: two decades and beyond. *J Evid Based Dent Pract* 2019;19:7-16.
25. Broomhead T, Baker SR. Systems science and oral health: implications for dental public health? *Community Dent Health* 2019;36:55-62.
26. Gupta A, Keuskamp D. Use and misuse of mixed methods in population oral health research: a scoping review. *Community Dent Health* 2018;35:109-18.
27. Ghezzi EM, Kobayashi K, Park DY, Srisilapanan P. Oral healthcare systems for an ageing population: concepts and challenges. *Int Dent J* 2017;67(Suppl 2):26-33.
28. Marshall TA, Straub-Morarend CL, Guzman-Armstrong S, *et al*. An approach on defining competency in evidence-based dentistry. *Eur J Dent Educ* 2018;22:e107-e15.
29. Renton T, Master S. The complexity of patient safety reporting systems in UK dentistry. *Br Dent J* 2016;221:517-24.
30. Northridge ME, Metcalf SS. Enhancing implementation science by applying best principles of systems science. *Health Res Policy Sys* 2016;14:74.
31. Rocha A. Social representation of the dentists. 2008.
32. C M. Complejidad y salud publica. Marcos, problemas, referencias. *Revista Salud Bosque*. 2018;8.
33. Barbieri M. A new theory of development: the generation of complexity in ontogenesis. *Philos Trans A Math Phys Eng Sci* 2016;374.
34. Rozek LS, Dolinoy DC, Sartor MA, Omenn GS. Epigenetics: relevance and implications for public health. *Annu Rev Public Health*. 2014;35:105-22.
35. Tobler CAB, Anny Bonilla JVB, Cardenas H, Galvis S, Gomez LA, Maldonado C, Sandoval J. La ciencia como la tension entre lo visible y lo invisible; Optica, Biologia, Fisiologia, Cultura y Complejidad. Bogota: Universidad el Bosque 2019.
36. Reina GD. La Salud y las Ciencias de la Complejidad. *Revista Movimiento Cientifico*; 2010.
37. Kotsias BA. The black swan image in medicine. *Medicina (B Aires)* 2018;78:301-2.
38. Ale BJM, Hartford DND, Slater DH. Dragons, black swans and decisions. *Environ Res* 2020;183:109127.
39. Betancourt JA, Ramis Andalia RM. Apuntes sobre el enfoque de la complejidad y su aplicación en la salud. *Revista Cubana de Salud Pública* 2010;36:160-5.
40. Hernandez E. Complejidad, nuevo paradigma en la salud. *Innovación y Ciencia*. 2005;XII (1).
41. Tsoukas H, Hatch MJ. Complex thinking, complex practice: the case for a narrative approach to organizational complexity. *Hum Relat* 2001;54.
42. Echegoyen J, Wagensberg, Jorge XX (1985). Ideas sobre la complejidad del mundo. 1986.
43. Minsalud. Estudio Nacional de Salud Bucal – ENSAB IV. 2014.
44. Leon JS, Winkell K, McFarland DA, del Rio C. A case-based, problem-based learning approach to prepare master of public health candidates for the complexities of global health. *Am J Public Health* 2015;105(Suppl 1):S92-6.
45. Escobar JV, Perez Castillo I. Intermittent dynamics in complex systems driven to depletion. *Sci Rep*. 2018;8:4825.
46. Kuhn T. La estructura de las revoluciones científicas 1971.
47. Tovar SM. Asumir un compromiso de liderazgo para el cambio: desafío de una nueva odontología. 2010. Recuperado de: <http://hdl.handle.net/10554/30635>.
48. Metcalf SS, Northridge ME, Widener MJ, Chakraborty B, Marshall SE, Lamster IB. Modeling social dimensions of oral health among older adults in urban environments. *Health Educ Behav* 2013;40(1 Suppl):63S-73S.
49. Splieth CH, Flessa S. Modelling lifelong costs of caries with and without fluoride use. *Eur J Oral Sci* 2008;116:164-9.
50. Locker D, Slade G. Association between clinical and subjective indicators of oral health status in an older adult population. *Gerodontology* 1994;11:108-14.