

Latin American Forensic Odontology: A Scoping Review of its Current Research and the Objective/Subjective Nature of its Studies

Odontología Forense Latinoamericana: Una Revisión con Búsqueda Sistemática sobre su Investigación Actual y la Naturaleza Objetiva/Subjetiva de sus Estudios

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SUMMARY: The new paradigm in Forensic Sciences initiated by the entry of genetics (the current standard of legal evidence) and accentuated by recognized wrongful convictions derived from experts today in the eye of criticism, has highlighted the potential for bias and error in forensic disciplines when they depend on human interpretation and subjectivity, which has not been avoided by Forensic Odontology (FO). However, a subjective judgment is not necessarily wrong, so the refinement of processes, the development of standards, and robust research can contribute to the validity of interpretation to increase objectivity. Latin America (LATAM) has its own realities and needs, which have conditioned the priorities and objectives of FO research. A scoping review is presented to systematically map the investigation of LATAM researchers and identify the objective or subjective nature of their assessments. LATAM shows interesting productivity and intentions to adhere to international standards, with Brazil leading this research significantly, followed by Chile and Colombia, among others. However, there is a disproportionate approach in certain lines of research (dental age estimation), and needs to address other quantitative studies, and to improve the visibility of the LATAM FO research.

KEY WORDS: Forensic odontology; Research; Qualitative studies; Quantitative studies; Objectivity; Subjectivity; Latin America.

INTRODUCTION

In its pivotal 2009 report, the National Academy of Sciences (NAS) highlighted the potential for bias and error that forensic science disciplines possess when they depend on human interpretation and subjectivity (Committee on Identifying the Needs of the Forensic Sciences Community, 2009). The NAS report, published after two years of work by a committee of experts, academics, and researchers, issued 13 recommendations that insisted on the need to ensure standardization, quality control, and scientific objectivity of evidence to avoid conflicts of interest and potential bias (Committee on Identifying the Needs of the Forensic Sciences Community, 2009). The U.S. Supreme Court in the seminal case *Daubert v. Merrel Dow Pharmaceuticals Inc.* (1993) highlighted that "...the word 'knowledge' con-

notes more than subjective belief or unsupported speculation", which was transferred to forensic identification and according to Page *et al.* (2011a), many tests do not meet evidentiary standards. The entry into the scene of DNA evidence (and fundamentally the exonerations after wrongful convictions that it made possible) raised the question of what evidence is scientifically reliable (Cooper, 2013). The great dependence on subjective evaluations of some disciplines has been harshly criticized in some "popular forensic science disciplines", today recognized as "vulnerable" from a scientific point of view (Cooper, 2013). For some years now, the objectivity of forensic science decision-making represents an inevitable paradigm that has led to research to reexamine and test not only those vulnerable forensic disci-

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plines, but even those considered the gold standard for their objectivity and immunity to subjectivity and bias, such as DNA (Dror & Hampikian, 2011; Kronick, 2021). For some authors, even DNA profiling often involves subjective judgment when its results are ambiguous or subject to multiple interpretations and must be explained by human analysts (Whitman & Koppl, 2010).

For Kruse (2020), forensic objectivity is the necessary issue “to deliver legally secure and useful results despite dealing with inescapable uncertainty”, although this legal security, usefulness, and uncertainty change depending on contexts and time. As it is impossible to achieve absolute certainty, objectivity is a way of producing evidence that can be accepted as reliable and legally secure. Kruse (2020) states that, in analytical terms, “the evaluation makes inescapable uncertainty manageable—quantified uncertainty is still not certainty, but it has been turned into a known quantity”. For this author, quantification and statistics engender trust more than just numbers, and that mechanical objectivity, (the objectivity obtained from the elimination of any human intervention in the observation of nature, that is, from automating scientific procedures or using machines), combats subjective judgments and decisions by standardizing the scientific perspective in an impartial and fair approach. “A decision made by the numbers (or by explicit rules of some other sort) has at least the appearance of being fair and impersonal. Scientific objectivity thus provides an answer to a moral demand for impartiality and fairness. Quantification is a way of making decisions without seeming to decide” highlights Kruse (2020) citing Porter (1995).

Forensic odontology (FO), “the application of the science of dentistry to the field of law” (Committee on Identifying the Needs of the Forensic Sciences Community, 2009), was one of the forensic sciences most impacted by the NAS report, particularly in the area of bite mark comparison (probably the most vulnerable one) (Espinoza-Silva *et al.*, 2023). According to the NAS report, “[a]lthough the majority of forensic odontologists are satisfied that bite marks can demonstrate sufficient detail for positive identification...”, the value and scientific objectivity of this kind of evidence was highly questionable (Committee on Identifying the Needs of the Forensic Sciences Community, 2009). According to Adam (2020), the history of FO (like that of other forensic sciences) has shown that many of its procedures, initially offering a high degree of certainty, were significantly challenged in the subsequent decades. Objectivity was (and still is) the result of a dynamic process that has permanently and continuously sought to change the evidence presented by the FO from “circumstantial” to “scientific” in a context framed by civil, political, and legal circumstances, but undoubtedly based on “all the tacit

knowledge that goes into making a skilled technical and scientific analysis” (Adam, 2020). Although bite mark comparison has been challenged on this basis because of its subjectivity and lack of reliability, many of the methods used by FO have demonstrated scope but also limitations that justify research to ensure reliability, reproducibility, and uniqueness, including molecular methods (Kavitha *et al.*, 2009).

However, it has been stated that a subjective judgment does not necessarily imply that it is incorrect or unreliable, and that even the absence of formal, validated standards does not mean that it lacks all relevant knowledge; it has been suggested that experience can be a legitimate basis for knowledge, and that this knowledge does not necessarily need to be formalized to be considered valid or legitimate; rather, it is important to know how competent the observer is to make that subjective judgment (Mnookin, 2010). At this point, the refinement of methods, the improvement of processes, and the development of validated standards for interpretation to increase objectivity not only responds to this new paradigm, but also “ought to be welcomed, celebrated, and encouraged, and perhaps most importantly, funded” (Mnookin, 2010).

It is well known that local realities and needs trigger appropriate response. Latin America (LATAM) has a history of missing, disasters, and unidentified persons that has led to the development of forensic specializations recognized in some of its countries, but lacking in some sense of sustainability, appropriate research or specific training in all its dimensions and disciplines (Hofmeister & Navarro, 2017; Alcántara-Ayala, 2019; Calmon, 2019). In particular, FO has shown interesting and promising developments, but it is heterogeneous and still far from international standards (Ortiz *et al.*, 2015; Acuña-Méndez *et al.*, 2022; Rodríguez-Niklitschek *et al.*, 2023). Considering that traditional FO analysis may show limitations related to the observer's subjective judgment, and that it is expected that research will progress towards objective assessments through strategies not dependent on morphological, analytical, molecular, automated, and reproducible traits, based on scientific probabilistic studies (Martin-de-Las-Heras *et al.*, 2014; Tejasvi *et al.*, 2021; Bae & Woo, 2022; Mohammad *et al.*, 2022), the following research questions were formulated: What topics did LATAM FO researchers focus on their original research in the last three years? What type of research has been conducted? Which countries, language, collaborations, and publication data characterize these investigations? A scoping review was conducted to systematically map the original research done on FO in LATAM, as well as to identify the objective or subjective nature of its assessments.

METHODS

A scoping review was conducted in accordance with the Preferred Reporting Items for Systematic reviews and Meta-analyses extension for Scoping Reviews (PRISMA ScR) (Tricco *et al.*, 2018). The search was performed in PubMed/Medline, the Scientific Electronic Library Online (SciELO) network, and Literatura Latinoamericana y del Caribe en Ciencias de la Salud (LILACS) databases using the terms “forensic dentistry” OR “forensic odontology” OR “legal dentistry” OR “legal odontology” OR “forensic dental science”, in Spanish and English languages (filter “publication dates”) independently by two of the authors (FQD, GMF). PubMed/Medline was searched because it is considered one of the largest and most accredited online biomedical bibliographic databases in the world and is one of the most important and reliable sources of up-to-date health care evidence (Yoo & Mosa, 2015). Given the nature of the search, SciELO and LILACS were preferred because of the well-recognized impact of both regional databases in LATAM countries (Bojo-Canales & Sanz-Valero, 2019). To increase the power of the search, a manual complementary search was carried out for the same terms, in the journals indexed in PubMed/Medline: The Journal of Forensic Odonto-Stomatology and Journal of Forensic Dental Sciences (both specialized in FO), and Journal of Forensic Sciences, in the latter case, under the Section “Odontology”. To be included in the review, papers needed to have developed some type of original study or case reports that addressed some of the recognized FO topics. Only full-peer-reviewed journal papers were included if they were published between 2020 and 2023, and papers were excluded if they did not fit the conceptual framework of the study; secondary sources, reviews, theses, and letters to the editor were also excluded. Case reports were included because they represent the most explicit way in which objective/subjective assessments are carried out in the field. To increase consistency among the reviewers, both reviewers screened the same 50 publications, discussed the results, and amended the screening and manual data extraction before beginning the screening for this review.

The articles were identified on 08/06/2023 and were categorized and analyzed between 08/07/2023 and 09/13/2023. Categorization and subcategorization of the articles were carried out by both authors following the strategy proposed by Espinoza-Silva *et al.* (2023) using the fourth NAS report’s areas for FO (Committee on Identifying the Needs of the Forensic Sciences Community, 2009), and the category “Not included” for the topics not covered in those focus areas. Given the heterogeneity of the topics and to facilitate categorization, many articles were regrouped according to a logical profile of the addressed

line of research. For example, the “Dental identification” area included not only the traditional topics of comparative or reconstructive dental identification, but also other non-dental topics, logically related to identification (anthropological, facial, rugoscopic, genetic, through QR coding, etc.). The area of “Interpretation of oral injury” also included topics related to incineration, taphonomy, and the conservation of dental materials exposed to aggressive environments. In cases where a researcher had more than one affiliation, all of them were considered, and if those affiliations belonged to international institutions, they were considered as “international collaboration”. Questions about these categorizations and disagreements regarding study selection and data extraction were resolved by consensus and discussion. A data-charting form was jointly developed by the two reviewers to determine which variables to extract. Both reviewers independently charted the data, discussed the results, and continuously updated the data-charting form in an iterative process. The study variables considered were specific topics of research, geography and language of studies, journal data on publications, and type of study (qualitative/quantitative/ qualitative-quantitative). “Qualitative studies” were considered those that only evaluated data supported by the subjectivity, interpretation, or opinion of an observer, beyond the quantification strategies of subjective stages, or the necessary intra- or inter-observer calibrations that could have been carried out on those data. “Quantitative studies” were considered those in which methodologies exclusively supported by objective measurements and administration of quantitative and numerical data, or use of data obtained in an automated manner, without intervention of human evaluations, were used. “Qualitative-quantitative studies” were considered as those that used the two methodological strategies mentioned above.

RESULTS

The literature search identified 1,012 articles, and 29 studies were identified through a manual complementary search. Following the removal of duplicates and screening of abstracts, 107 full articles were assessed for eligibility, and 86 articles were included in the qualitative synthesis. The flow of articles from identification to the final inclusion is shown in Figure 1.

Topic of FO addressed by studies. A preference was observed for the area “Dental Identification” (n = 67 articles), and Dental age estimation (DAE) was the most studied topic (n = 42), representing 48.84 %, 62.69 % and 71.19 % within the global productivity, the “Dental identification” area, and the “Reconstructive ID” subcategory, respectively. “Interpretation of oral injury” was the second preferred area

(n = 12 articles) followed by “Not included” (n = 5). The least addressed areas were “Bite mark comparison” (n = 2) and “Dental Malpractice” (n = 0). Figure 2 shows the distribution of articles according to these categories.

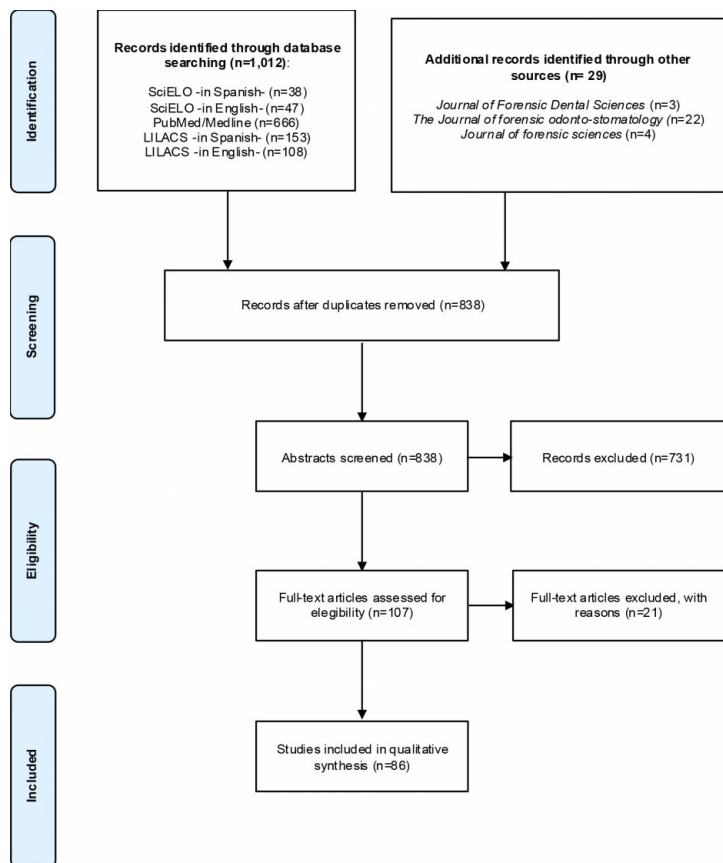


Fig. 1. Flow of selection process for eligible studies for inclusion.

Geography and language of studies. The geographical distribution of FO research (Table I) shows that Brazil was the most productive country (n = 63), followed by Chile (n

Table I. Distribution of the studies according to the LATAM countries involved and their international collaborations.

LATAM Countries	Studies*	International collaborations
Brazil	63	28 (44.44 %)
Chile	11	9 (81.82 %)
Colombia	6	2 (33.335)
Peru	5	3 (60 %)
Argentina	4	2 (50 %)
Venezuela	3	2 (66.67 %)
Dominican Republic	2	2 (100 %)
Mexico	2	1 (50 %)
Costa Rica	1	0 (0 %)
Uruguay	1	0 (0 %)

* The studies were considered one for each of the countries involved, regardless of collaboration.

=11). Other countries with studies in this period were Colombia, Peru, Argentina, Venezuela, Mexico, the Dominican Republic, and Costa Rica. Of the 86 articles identified in this review, 48 (55.81 %) were developed without declared collaboration between countries, 35 of which involved only Brazil. The countries with the highest number of international collaborations were Brazil and Chile (28 and 9, 44.44 % and 81.82 % of their total productivity, respectively), and Peru with three international collaborations (60 % of their productivity). Among the 38 collaborations, only seven exclusively included LATAM countries, and with the exception of Costa Rica and Uruguay, all identified LATAM countries had some type of collaboration. LATAM collaborations with countries from other continents occurred in 34 studies and included European countries (Russia, Italy, Portugal, the UK, Spain, Switzerland, Belgium, Bosnia and Herzegovina, Croatia, Kosovo, Serbia, and Ukraine), Asian countries (Indonesia, Saudi Arabia, India, Japan, Lebanon, Malaysia, Sri Lanka, Turkey), North America (Canada and the USA), and Africans (Egypt and Kenya). The non-LATAM countries with the greatest collaborations were Russia (15 studies), the UK (10 studies), and Italy (8 studies). Two publications involved large multi-ethnic studies to validate the third molar maturity index in European, Asian (Angelakopoulos *et al.*, 2021) and African (Angelakopoulos *et al.*, 2023) countries, including Brazil, Chile, Peru, and the Dominican Republic.

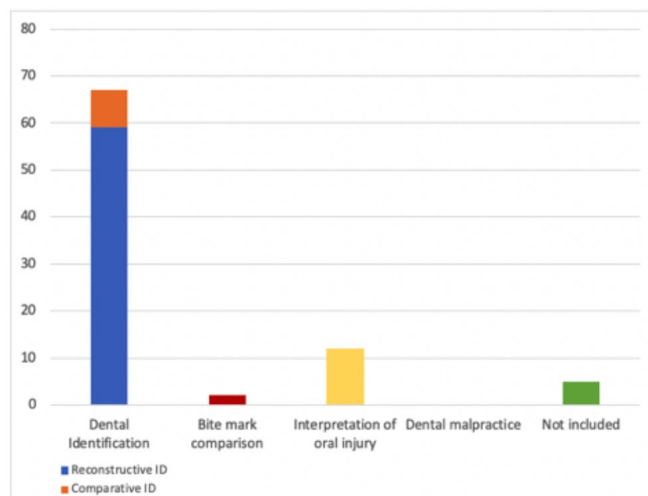


Fig. 2. Distribution of identified studies according to the FO NAS categories (Committee on Identifying the Needs of the Forensic Sciences Community, 2009).

The LATAM researcher with the highest productivity was Prof. Ademir Franco, with declared affiliations to the São Leopoldo Mandic School of Dentistry (Campinas, Brazil), the Department of Imaging and Pathology, Forensic Odontology, KU Leuven (Leuven, Belgium), the Center of Forensic and Legal Medicine and Dentistry, University of Dundee (Scotland, UK), and the Department of Therapeutic Stomatology, Sechenov University (Moscow, Russia). Prof. Franco participated in 16 publications, 15 of which collaborated with Russia, Indonesia, the UK, and Belgium, and none with other LATAM countries. The second most productive LATAM researcher was Prof. Ricardo Henrique Alves da Silva (affiliated with the Department of Stomatology, Public Health and Forensic Odontology, School of Dentistry of Ribeirão Preto, Brazil), who participated in 13 studies, five of which were in collaboration with non-LATAM countries (Saudi Arabia, Italy, the UK, and Russia), but none with other LATAM countries.

It is notable that the non-LATAM researcher with the greatest collaboration was Prof. Roberto Cameriere (declared affiliated with the University of Macerata, Macerata, Italy, and the Department of Forensic Medicine, Sechenov First Moscow State Medical University, Moscow, Russia), who participated in five studies in collaboration with Brazil, Chile, Colombia, Peru, and the Dominican Republic (two of them the multi-ethnic studies mentioned above).

Regarding the language of the studies, 66 were published in English (76.74 %), 11 in Spanish (12.79 %), and nine in Portuguese (10.34 %). Considering the regional language blocks, Brazil, whose native language is Portuguese, published 53 of its 63 articles in English, 9 in Portuguese, and 1 in Spanish (84.13 %, 14.29 %, and 1.59 %, respectively), while the rest of the LATAM countries (whose native language is Spanish) published 16 of their 27 articles in English (including the two multiethnic studies cited above, both including Brazil) and 11 in Spanish (59.26 % and 40.74 %, respectively).

Journal data on publications. Table II lists the journals preferred by LATAM researchers on FO. Of a total of 39 journals, only 10 (25.64 %) were categorized as “Specialized in Legal/Forensics”, two of them recognized as “Specialized in Legal/Forensic Odontology”. Of the total journals, 20 (51.28 %) were included in the Web of Science (WoS) database, 26 (66.67 %) in Scopus database, 19 (48.72 %) were indexed in PubMed/MEDLINE, 10 (25.64 %) in SciELO database, and 15 (38.46 %) in LILACS database. One of the journals (Revista EIA) is currently not indexed in any of the databases searched. Regarding the geographical information of the publisher, 17 (43.59 %) are published in LATAM countries (from highest to lowest: Brazil, Chile,

Argentina, Colombia, Costa Rica, Uruguay, and Peru), 14 (35.90 %) in European countries (from highest to lowest: England, Germany, Ireland, Spain, Croatia, Denmark, and France), 3 (7.69 %) in Asian countries (South Korea, India, Taiwan), 3 (7.69 %) in North American countries (USA), and 1 (2.56 %) in Oceania (Australia).

Significantly, the journals preferred by LATAM researchers was the *Revista Brasileira de Odontologia Legal* (the official journal of the Associação Brasileira de Ética e Odontologia Legal -ABOL-) with 11 of the published studies (12.64 %), followed by the *Journal of Forensic Odonto-Stomatology* (the official journal of the International Organization for Forensic Odontolo-Stomatology -IOFOS-) and the *International Journal of Legal Medicine* (the official journal of the International Academy of Legal Medicine), with 10 publications each (11.49 %), so only those 3 journals accounted for 36.05 % of the productivity.

Of the 86 articles reviewed, 35 (40.70 %) were published in LATAM journals, 20 of which were in Brazilian journals (23.26 % of the total studies, and 57.14 % of the LATAM journals). With the exception of one collaboration between Brazilian and Venezuelan researchers (David *et al.*, 2020), Brazilian journals were preferred only by Brazilian researchers. To deepen the review, we evaluated the editorial preferences of the three most productive LATAM countries. With respect to Brazil, of the 63 published studies, 20 (31.75 %) were published in Brazilian journals, 9 (14.29 %) in the official IOFOS journal (of Australian origin), 7 in German journals (11.11 %), 6 in English journals (9.52 %), and 5 in Irish journals (7.94 %) (other countries with lower preference in their journals for Brazilians were, in descending order, Spain, USA, Croatia, France, South Korea, Costa Rica, Denmark, India and Chile). Chile, had 4 of its 11 studies (36.36 %) published in LATAM journals, 3 of them in Chilean journals (27.27 % of the Chilean productivity, 75 % of the Chilean publications in LATAM journals) (other countries with lower preference in their journals by Chileans were in descending order Germany, England, Argentina and Taiwan). The third most productive LATAM country was Colombia, of which six studies, three (50 %) were published in LATAM journals (two in Colombian journals and one in a Chilean journal), also publishing 1 article in journals from the USA, Ireland, and Germany each.

Types of study. Of the 86 studies identified in this review, 41 (47.67 %) used qualitative methodologies, 34 (39.53 %) used quantitative methodologies, and 11 (12.79 %) addressed both methodologies. Seven case reports were identified: six managed by Brazilian authors (one focused on a qualitative evaluation of injuries (Domingues Conceição *et al.*, 2020), four focused on identification based on qualitative

Table II. List of journals identified. SCIE: Science Citation Index Expanded.

Journal	Country of publication	Indexation	Scopus subject area (exc. where indicated)	Studies
<i>Rev Bras Odontol Leg RBOL*</i>	Brazil	LILACS	Dentistry: Forensic Odontology**	11 (12.64 %)
<i>J Forensic Odontostomatol*</i>	Australia	PubMed, Scopus (CiteScore 1.4)	Medicine: Pathology and Forensic Medicine	10 (11.49 %)
<i>Int J Legal Med</i>	Germany	PubMed, WoS (Q2), Scopus (CiteScore 5.1)	Medicine: Pathology and Forensic Medicine	10 (11.49 %)
<i>Forensic Sci Int</i>	Ireland	PubMed, WoS (Q1), Scopus (CiteScore 4.8)	Medicine: Pathology and Forensic Medicine	4 (4.60 %)
<i>Int J Morphol</i>	Chile	WoS (Q4), Scopus (CiteScore 0.9), SciELO, LILACS	Medicine: Anatomy	4 (4.60 %)
<i>Arch Oral Biol</i>	England	PubMed, WoS (Q2), Scopus (CiteScore 5.1)	Dentistry: General Dentistry; Other	3 (3.45 %)
<i>J Clin Exp Dent</i>	Spain	Scopus (CiteScore 2.9)	Dentistry: General Dentistry	3 (3.45 %)
<i>Acta Stomatol Croat</i>	Croatia	WoS (Q3), Scopus (CiteScore 2.6)	Dentistry: General Dentistry	2 (2.30 %)
<i>Braz Oral Res</i>	Brazil	PubMed, WoS (Q3), Scopus (CiteScore 3.7), SciELO, LILACS	Dentistry: General Dentistry	2 (2.30 %)
<i>Forensic Sci Med Pathol</i>	USA	PubMed, WoS (Q2), Scopus (CiteScore 3.1)	Medicine: General Medicine	2 (2.30 %)
<i>Imaging Sci Dent</i>	South Korea	WoS (Q3), Scopus (CiteScore 3.0)	Dentistry: General Dentistry; Other	2 (2.30 %)
<i>Leg Med (Tokyo)</i>	Ireland	WoS (Q3), Scopus (CiteScore 2.5)	Medicine: Pathology and Forensic Medicine	2 (2.30 %)
<i>Rev Fac de Odon UBA</i>	Argentina	LILACS	Dentistry: General Dentistry**	2 (2.30 %)
<i>RGO Rev Gaucha Odontol</i>	Brazil	SciELO, LILACS	Dentistry: General Dentistry	2 (2.30 %)
<i>Med Leg Costa Rica</i>	Costa Rica	SciELO, LILACS	Medicine: Pathology and Forensic Medicine	2 (2.30 %)
<i>Int J Odontostomat</i>	Chile	SciELO, LILACS	Dentistry: General Dentistry**	2 (2.30 %)
<i>BMC Oral Health</i>	England	PubMed, WoS (Q2), Scopus (CiteScore 4.1)	Dentistry: General Dentistry	1 (1.15 %)
<i>Braz Dent J</i>	Brazil	PubMed, Scopus (CiteScore 2.7), SciELO, LILACS	Medicine: General Medicine	1 (1.15 %)
<i>Braz Dent Sci</i>	Brazil	Scopus (CiteScore 1.5), LILACS	Dentistry: General Dentistry	1 (1.15 %)
<i>Clin Oral Investig</i>	Germany	PubMed, WoS (Q2), Scopus (CiteScore 6.3)	Dentistry: General Dentistry	1 (1.15 %)
<i>Dent Traumatol</i>	Denmark	PubMed, WoS (Q3), Scopus (CiteScore 5.1)	Dentistry: Oral Surgery	1 (1.15 %)
<i>Dentomaxillofac Radiol</i>	England	PubMed, WoS (Q2), Scopus (CiteScore 5.5)	Medicine: General Medicine	1 (1.15 %)
<i>Indian J Dent Res</i>	India	PubMed	Dentistry: General Dentistry	1 (1.15 %)
<i>Int Orthod</i>	France	PubMed, WoS (Q3), Scopus (CiteScore 2.0)	Dentistry: Orthodontics	1 (1.15 %)
<i>J Dent Sci</i>	Taiwan	WoS (Q2), Scopus (CiteScore 3.9)	Dentistry: General Dentistry	1 (1.15 %)
<i>J Forensic Leg Med</i>	England	PubMed, WoS (Q3), Scopus (CiteScore 3.1)	Medicine: Pathology and Forensic Medicine	1 (1.15 %)
<i>J Forensic Sci</i>	USA	PubMed, WoS (Q3), Scopus (CiteScore 3.4)	Medicine: Pathology and Forensic Medicine	1 (1.15 %)
<i>J Health Sci</i>	Brazil	LILACS	Medicine: General Medicine; Other***	1 (1.15 %)
<i>Morphologie</i>	France	PubMed, Scopus (CiteScore 2.1)	Medicine: Anatomy	1 (1.15 %)
<i>Odontostomatologia</i>	Uruguay	SciELO, LILACS	Dentistry: General Dentistry**	1 (1.15 %)
<i>Odontol Sanmarquina</i>	Peru	LILACS	Dentistry: General Dentistry**	1 (1.15 %)
<i>Pesqui Bras Odontopediatria Clin Integr</i>	Brazil	Scopus (CiteScore 1.8), SciELO, LILACS	Dentistry: General Dentistry; Other	1 (1.15 %)
<i>Rev Arg Antrop Biol</i>	Argentina	SciELO	Social Sciences: Anthropology; Other	1 (1.15 %)
<i>R bras ci Saúde</i>	Brazil	LILACS	Dentistry: General Dentistry**	1 (1.15 %)
<i>Rev EIA</i>	Colombia		Engineering***	1 (1.15 %)
<i>Rev Fac Odontol Univ Antioq</i>	Colombia	SciELO, LILACS	Dentistry: General Dentistry**	1 (1.15 %)
<i>Sci Justice</i>	England	PubMed, WoS (Q2), Scopus (CiteScore 3.6)	Medicine: Pathology and Forensic Medicine	1 (1.15 %)
<i>Sci Rep</i>	England	PubMed, WoS (Q2), Scopus (CiteScore 7.5)	Multidisciplinary	1 (1.15 %)
<i>Spec Care Dentist</i>	USA	PubMed, WoS (Q3), Scopus (CiteScore 2.4)	Dentistry: General Dentistry	1 (1.15 %)

ESCI: Emerging Sources Citation Index. * Journals specialized in Legal/Forensic Odontology. ** LILACS subject area. *** Declared by the journal.

comparisons (Lima de Castro-Espicalsky *et al.*, 2020; Correia *et al.*, 2021; Valente-Aguilar *et al.*, 2021; Custodio *et al.*, 2022), and one focused on identification based on qualitative/quantitative comparisons) (Barbosa de Castro *et al.*, 2020), and one managed by Argentinian and Chilean researchers (describing a qualitative anthropological analysis of human remains) (Nasti *et al.*, 2023). Among the 41 exclusively qualitative assessments, 20 (48.78 %) were carried out to enhance reconstructive identification, of which 17 (19.54 % of the total studies) applied methodology for DAE through radiographic evaluations. Among the 34 quantitative studies, 30 (88.24 %) addressed reconstructive identification processes, of which 18 used methodologies for DAE through the measurement of different parameters. Among the automated methods in this type of study, three studies used artificial intelligence strategies, two studies used DNA evidence, and one comparative identification study used QR coding. Of the 11 qualitative/quantitative studies (12.79 %), 6 compared both types of methodologies in DAE strategies (one of them also used supervised machine learning), and 2 used comparative strategies for identification. Among the countries with the highest productivity, Brazil had among its 63 publications, 33 exclusively qualitative, 22 quantitative, and 8 qualitative-quantitative (52.38 %, 34.92 %, and 12.70 % of its total productivity, respectively); Chile 2 qualitative and 9 quantitative (18.18 % and 81.82 % of its total productivity, respectively); and Colombia 2 qualitative, 2 quantitative, and 1 qualitative-quantitative (40 %, 40 %, and 20 % of their total productivity, respectively).

DISCUSSION

It has been mentioned that scoping reviews are a strategy that seeks to synthesize knowledge following a systematic approach to map the evidence on a given topic to identify its main concepts, sources, and gaps in knowledge, and to plan its deepening by establishing possible future lines of research. Unlike systematic reviews and meta-analyses, which seek to answer clearly defined and specific questions, scoping reviews answer much broader questions without evaluating the quality of the documents reviewed (Tricco *et al.*, 2018). This scoping review highlighted the limitations already reported previously, and we must recognize that article categorization strategies can be very discretionary even if they are consensual, a complexity that has already been reported by other authors (Espinoza-Silva *et al.*, 2023) and that can hardly be contrasted with similar studies. Likewise, the lack of data standardization, or particularly the heterogeneity in names or affiliations of the same author, has been identified as an important difficulty when loading databases (Merdiatio Boedi *et al.*, 2023). In our study, although more difficult and time-consuming, we chose to record this information from

the body of the articles themselves, considering that the authors made these records their own when reviewing their galley proofs. However, beyond the obvious limitations of the search for these characteristics, we consider that the information revealed in this scoping review maps a situation not previously visualized, which challenges us to delve into studies of greater complexity and analysis, including a greater chronological extension and evaluation of the quality of research in FO.

This review confirms what was previously anticipated by other authors: Brazil significantly leads LATAM research with almost 50 % of its productivity in international collaborations, although this is almost exclusively carried out in European countries, as reported by Espinoza-Silva *et al.* (2023). The leadership assumed by some Brazilian researchers, their consolidation in prestigious Brazilian universities, their postgraduate training in European countries, and their links with scientific associations, and more specifically with IOFOS, show an enviable openness and recognition of the need for standardization of processes, continuous improvement, and quality assurance in this discipline. Likewise, this review also shows a certain “isolation” of Brazil with respect to the rest of the LATAM countries. Although Brazil shares with the rest of LATAM countries, the possession of a language other than English (“[c]ontrolling science becomes more difficult for the imperial world order under Anglo-Saxon hegemony when science and other knowledge systems function and publish results in languages other than English and use their own research design and interpretive patterns” stated Hamel *et al.* (2016), we speculate that the differences between Portuguese and Spanish (the predominant language in LATAM countries), as well as the already reported reluctance of Spanish-speaking FOs to publish in English (De los Ríos Fernández & Barriga Flores, 2011), may be favoring this phenomenon. This review shows that although there is a notable difference in the preference of Brazilian authors to publish in English (84.13 %) compared to Spanish-speaking authors (60.71 %), in both cases, the use of English was the majority with respect to their native languages. We agree with Espinoza-Silva *et al.* (2023) regarding the fundamental leadership role in international collaborations and standardization carried out by renowned researchers of Italian, British, Belgian, or Croatian affiliation by promoting multicenter studies and supporting research in LATAM. We consider that the consolidation of Brazil and the entry on the scene of Chile, Colombia, Peru, and other countries identified in this review, with increasing productivity if previous reviews are considered (Espinoza-Silva *et al.*, 2023), offers an extremely optimistic outlook in light of the current need for validation of the FO. One point to reaffirm is to strengthen the visibility of LATAM research. Table II shows that although journals

with powerful indexing and indicators are a priority for LATAM researchers, other journals published locally, in native languages, and without the strength of citation and visibility of the previous ones, are also a frequent publication resource. It would be interesting to delve deeper into this aspect and evaluate whether these preferences are a consequence of greater comfort (including language) in initiated researchers (justifiable by the way), or simply a last resort for trained researchers who cannot access large publishers.

It has been mentioned that the conclusions reached by the FO are less important for the admissibility of the evidence than the way in which those conclusions were reached: reproducibility, clear statements of operational definitions, exposition of research methods employed, and “strict limits on the extent of subjectivity in the analysis” are fundamental principles for the acceptance of evidence in court (Deitch, 2009). Bassed (2015) stated that among all identification methods, molecular biology is the only one that can mathematically quantify the degree of certainty of a particular match, while other methods (including odontological ones) are largely dependent on more subjective methodologies and expert opinions, which pose problems in court when laypeople do not have a deep understanding of the situation. However, the author states that there is still a lot of scientific research needed to quantify coincidences in FO, so it is still dependent on a certain degree of expert subjectivity.

True objectivity has been described as a “chimera” in forensic sciences. Given the nature of the interpretation and origin of its samples, there is always the possibility that assessments (particularly in FO) could be influenced by conscious or unconscious observer bias (Whitman & Koppl, 2010; Page *et al.*, 2012). According to Page *et al.* (2012), even DNA analyzes can suffer from subjective interpretation and confirmation bias under specific conditions, a phenomenon that would also occur in FO when the procedures do not eliminate the context and lead to selective and confirmatory hypotheses “akin to painting the target around an arrow”. This phenomenon has been sufficiently reported in bite mark comparisons, and although carefully designed collective and analytical processes and quantitative research on the influence of cognitive bias in FO have been recommended (Page *et al.*, 2012), our review identified only two studies on bite mark evidence (one of them focused on animal bite marks (Toledo-González *et al.*, 2019), the other on bite mark comparisons by using three-dimensional analysis (Dalle Grave *et al.*, 2021)), an insufficiency that has already been reported by Espinoza-Silva *et al.* (2023).

According to Page *et al.* (2011b), in forensic identification, subjective conclusions may be acceptable,

provided that they are derived using objective standards; therefore, the questionability of the evidence arises in the absence of such objective scientific standards or of any formal guidance on how an expert should reach his/her conclusions. These authors assert that many admissibility problems “can be easily avoided by the practitioner maintaining sufficient attention to detail during casework and assignment specific expert witness training”. We agree with them that the application of founded scientific research to daily practice, methodology, and underlying scientific bases in each discipline is an appropriate way to address this problem in forensic identification science evidence.

DAE was the most addressed line of research during the study period, which has already been previously reported (Espinoza-Silva *et al.*, 2023). DAE continues to be of great interest for LATAM FO, although this review demonstrates that the parameters and methodologies of choice remain significantly focused on radiographic and morphological analysis. Undoubtedly, radiographic visualization of the mineralization of developing teeth, the classification into discernible stages from which age can be estimated, is a tool that has demonstrated great usefulness and reliability in both criminal and civil proceedings (Lucas *et al.*, 2016). However, for some authors, this DAE approach fails to resolve some technical or even ethical dilemmas (Lucas *et al.*, 2016; Espinoza-Silva *et al.*, 2023). Pinchi *et al.* (2012) evaluated the potential influence of expert qualifications, training, and cognitive bias on the accuracy of identification by comparing antemortem and postmortem dental radiographs. Although the most experienced forensic odontologists achieved a very high rate of interobserver repeatability, those with formal education in FO but without experience in the field did not guarantee better performance. Odontologists without FO education had low rates of accuracy, with probable cognitive biases that could affect the results and introduce a source of variation among observations (Pinchi *et al.*, 2012). It has been claimed that bite mark comparison is not synonymous with FO (Salazar-Aguilar *et al.*, 2023); the undeniable focus of LATAM FO on DAE and the very little attention paid to other fields of FO in recent years (Espinoza-Silva *et al.*, 2023) (corroborated in this review) can also set a dangerous precedent: FO is not only DAE. For example, the interpretation of oral injury (one of the areas of focus of FO according to the NAS report) (Committee on Identifying the Needs of the Forensic Sciences Community, 2009), was addressed in 12 articles, but the vast majority with a taphonomic/anthropological orientation or related expressions of violence insufficiently approached odontological practice during the medicolegal autopsy. The medicolegal assessment of injuries is highly subjective and operator-dependent and is still a topic with little presence in the literature (Franceschetti *et al.*, 2023). Fonseca (2015)

admits that, having sufficient oral pathological signs in violent deaths that justify the involvement of an odontologist in all the medico-legal autopsies, with very few exceptions, there is no mention of this function or field of knowledge in any formal guideline on FO. This morphological perspective to identify and interpret specific patterns in oral hard and soft tissues during medicolegal autopsy remains unknown, not only to evaluate the subjectivity of the assessments but also to recognize it as an area of focus and responsibility of the FO (Fonseca *et al.*, 2013).

It has been mentioned that DNA typing represents a model to follow in forensic sciences, since “[p]hysical attributes of the objects of interest are measured, data are collected on the variation of these attributes in a reference population, and the probability of a coincidental match is determined and reported. No assumption of uniqueness is necessary and none is employed. Objective data are collected and used to guide judgments about the relative rarity of the questioned and known samples” (Saks, 2010). Saks (2010) stated that it is necessary to advance the development of standards that reduce or eliminate the problematic subjectivity of forensic evaluations, especially forensic identification. Curiously, and although it has been mentioned that FO is incorporating new technology both in the field of biochemical and molecular analyzes (Tejasvi *et al.*, 2021) (according to Adserias-Garriga *et al.* (2018), “new opportunities to perform robust and validated scientific measurements” having “the potential to strongly increase the speed and efficacy of the criminal justice process”), this review only identified two studies focused on DNA typing, both belonging to the same group of Chilean researchers (Carrasco *et al.*, 2020; Inostroza *et al.*, 2020). Returning to DAE, the analysis of aspartic acid racemization (AAR) from teeth, “the most accurate technique among all the new biochemical techniques” (Adserias-Garriga *et al.*, 2018), our review corroborates that it has not been studied in any way by LATAM researchers, which has already been reported by Matteussi *et al.* (2022). These authors mention that AAR, although it produces accurate and potentially reliable results for age estimation, has technical, scientific, logistical and social obstacles to be considered: it requires trained personnel for the great complexity of sample preparation, the method needs standardization, and “[i]n some countries, especially the least developed ones, the use of complex and potentially expensive laboratory techniques is not feasible on a routine basis” (Matteussi *et al.*, 2022). We do not know whether these are the reasons for the lack of development of analytical, molecular, and biochemical FO in LATAM countries, but we agree with these authors that this should not justify advancing research in that direction. In contrast, LATAM has shown signs of aligning with the most cutting-edge FO research. Artificial

intelligence (AI), a major advancement in forensic dental identification owing to the possibility of generating predictive studies and forensic automation (thereby avoiding human evaluations susceptible to subjectivity and error), has been reported to be promising in different areas of FO (Mohammad *et al.*, 2022). In this review, four studies were identified by applying machine learning in different environments, developed by Brazilian and Colombian researchers, to simulate an identification process (Ortiz *et al.*, 2021), distinguish between women and men using dentomaxillofacial features (Franco *et al.*, 2022), and DAE (Becerra-Álvarez & Cortés-Osorio, 2020; Pereira de Sousa *et al.*, 2023).

IOFOS, the well-recognized global association of FO, declares as objects: “a) To provide a liaison between societies of (legal) forensic odontology on a global basis; b) To promote goodwill, advancement and research in forensic odontology” and; c) To publish a newsletter on a regular basis” (www.iofos.eu). In 2003, IOFOS took the initiative drafted recommendations for forensic odontology work addressing different fields of FO: DAE, identification and identification after large disasters, dental injuries, tooth marks, and forensic odontological reports (Solheim, 2018). According to Solheim (2018), it was extremely difficult to reach agreement on techniques and procedures in particular cases, and even though national associations had to establish detailed recommendations on those techniques, there were also great differences in opinions about them. The author highlights that although FO “should have some kind of quality assurance”, there are substantial differences between countries even in defining what a “forensic odontologist” is. According to Solheim (2018), only representatives from European, Asian, and African countries participated in the 2003 meeting. As of the date of this review, the only LATAM societies that are members of IOFOS are ABOL (since 2012) and Sociedad de Odontostomatólogos Forenses Iberoamericanos (SOFIA) (since 2019) (www.iofos.eu). Although Prof. Ricardo Henrique Alves da Silva (from Brazil) is currently the Vice President of IOFOS (2023-2026) and has also been its Secretary General (2017-2023), the rest of LATAM countries has only managed to insert itself in recent years in this search for global standards for research and field practice in FO. In this review, the outstanding leadership of studies carried out by researchers from Brazil (63 of the 86 records, 73.26 % of the total studies) reflects the prominence acquired by that country in LATAM FO, which has already been reported in recent reviews (Espinoza-Silva *et al.*, 2023; Merdietio Boedi *et al.*, 2023; Rodríguez-Niklitschek *et al.*, 2023). Beyond personal initiatives, we believe that Brazil's consolidation as a leader in research and productivity aligns with this global outlook and adoption of standards and quality

assurance. We must also note that the timid but constant entry of the rest of LATAM countries (Chile leading with 11 articles, leadership also reported by Espinoza-Silva *et al.*, 2023) is a declaration of good intentions to this cooperation and understanding of globalization, both of the questions as well as their answers. Whether due to its recognized diversity and population particularities, and its political and social conditions, LATAM is a very attractive opportunity to challenge forensic dental research if it manages to align with global standards (Ortiz *et al.*, 2015; Acuña-Méndez *et al.*, 2022; Rodríguez-Niklitschek *et al.*, 2023).

The assertion by Roux *et al.* (2012) is extremely interesting, when they highlight the lack of a research culture: “researchers see forensics as an opportunity to test generic methods generated for their core discipline using unusual or interesting data sets. This situation creates additional confusion by introducing highly specific and complex methods and technologies that are not specifically devised for forensic science, are sometimes not necessary and whose integration into forensic science practice is far from clear”. To which the authors add: “while the need for more research is obvious, it has become crucial to seriously think about the nature of this research and ask questions about what actually constitutes fundamental forensic science research and who dictates the research agenda. Ultimately, forensic science research outcomes should assist in answering security, policing and justice questions in a tangible manner”.

We agree with Evett (2015) that there is a widespread and erroneous opinion that equates the “subjective” with the “non-scientific”, considering that even when “objective” data is used, the assignment of probabilities to a greater or lesser extent is carried out through a subjective judgment. “There is nothing unscientific about subjective judgement provided it is exercised with discipline within a logical framework” states Evett (2015), and continues: “the scientist’s probabilities must be assigned from: a thorough knowledge of the particular evidence type; a deep understanding of the relevant mechanisms and issues; full awareness of all literature and current developments in the field; sound judgement; and an acute awareness of the boundaries of one’s own knowledge”. These subjective probability assignments must be conditioned not by field experience, but by calibration under controlled conditions. Forensic science aspires objectivity, but subjective interpretation is inevitable in forensic work, even more so if experts are part of the police organization (Whitman & Koppl, 2010).

CONCLUSION

The disciplines of forensic sciences need to develop rigorous protocols based on evidence, and LATAM FO

demonstrates not only a very interesting productivity but also a clear intention to adhere to international standards and collaborations. Brazil is the LATAM leader in research, and countries such as Chile, Colombia, and Peru, among others, are joining the global competitive forensic arena. Although qualitative studies continue to be prioritized by FO research, their standardization and control measures are constantly re-evaluated to improve their performance, which has been promoted by the literature. However, a disproportionate focus is observed in the area of DAE; although quantitative studies are being addressed by LATAM research, there are hardly any outlines of studies in genetics or artificial intelligence, or no development in areas of biochemistry, such as racemization of aspartic acid. However, we consider that the advances prove to be very significant, and the intervention of LATAM and non-LATAM actors, favoring international collaborations, will allow us to establish not only the research priorities but also the necessary quality assurance in the protocols and assessments. It is necessary to delve deeper into critical points regarding the visibility of research (language, selection of journals, etc.).

QUEVEDO-DÍAZ, M. F.; GONZÁLEZ, L. P.; ARROYO-NAVARRETE, M.; GODOY, K. & FONSECA, G. M. Odontología forense latinoamericana: Una revisión con búsqueda sistemática sobre su investigación actual y la naturaleza objetiva/subjetiva de sus estudios. *Int. J. Morphol.*, 42(1):185-196, 2024.

RESUMEN: El nuevo paradigma en ciencias forenses iniciado por la entrada de la genética (el actual estándar de la evidencia jurídica), y acentuado por reconocidas condenas injustas derivadas de pericias hoy en el ojo de la crítica, ha destacado el potencial de sesgo y error que poseen algunas disciplinas forenses cuando dependen de la interpretación humana y la subjetividad, lo cual no ha sido ajeno a la odontología forense (OF). Sin embargo, un juicio subjetivo no necesariamente es erróneo, con lo que el refinamiento de procesos, el desarrollo de estándares y la investigación robusta pueden contribuir a validar esa interpretación para aumentar su objetividad. Latinoamérica (LATAM) posee realidades y necesidades propias que han condicionado las prioridades y objetivos de la investigación en OF. Se presenta una revisión con búsqueda sistemática para mapear sistemáticamente la investigación en OF realizada por investigadores latinoamericanos, así como identificar la naturaleza objetiva o subjetiva de sus evaluaciones. LATAM demuestra una productividad interesante e intenciones de adherirse a estándares internacionales, con Brasil liderando significativamente esta investigación, seguido por Chile y Colombia entre otros. Sin embargo, se observa un enfoque desproporcionado en ciertas líneas de investigación (estimación de edad dental particularmente), y necesidad tanto de abordar otros estudios cuantitativos como de mejorar la visibilidad de la investigación latinoamericana en OF.

PALABRAS CLAVE: Odontología forense; investigación; Estudios cualitativos; Estudios cuantitativos; Objetividad; Subjetividad; Latinoamérica.

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