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Research during Radiology residency: training need, professional responsibility and institutional obligation.

Investigar durante la residencia de Radiología: necesidad formativa, responsabilidad profesional y obligación institucional.

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Abstract: Research training during radiology residency is often perceived as a secondary activity, separate from clinical practice and even incompatible with it. This opinion piece challenges this dichotomy and argues that research simultaneously constitutes a training need for residents, a professional responsibility for radiologists, and an institutional obligation for the department. Drawing on various sources, including data from the Spanish-speaking world, it analyzes how the current system expects research results without providing infrastructure, mentorship, or recognition, and how the most significant barriers are cultural rather than logistical. The position of authors who propose limiting research to residents with "genuine passion" is discussed, acknowledging the partial validity of their premises but rejecting their conclusion: the problem is not that residents conduct research, but that they do so without structure or supervision. As an alternative, a tiered model with three levels is proposed, and it is argued that, in the context of a specialty increasingly dependent on artificial intelligence, imaging biomarkers, and precision medicine, training radiologists with research skills is not an academic luxury but a condition for professional survival.

Keywords: research training, radiology residency, research culture, scientific literacy, applied research, mentoring, quality of care, scientific leadership.

Resumen: La formación investigadora durante la residencia de radiología se percibe con frecuencia como una actividad secundaria, separada de la práctica asistencial e incluso incompatible con ella. Este artículo de opinión cuestiona esa dicotomía y argumenta que la investigación constituye simultáneamente una necesidad formativa del residente, una responsabilidad profesional del radiólogo y una obligación institucional del servicio. A partir de diversas fuentes, incluyendo datos del contexto hispanohablante, se analiza cómo el sistema actual espera resultados investigadores sin proporcionar infraestructura, mentoría, ni reconocimiento, y cómo las barreras más determinantes son culturales antes que logísticas. Se discute la posición de autores que proponen limitar la investigación a residentes con «pasión genuina», reconociendo la validez parcial de sus premisas, pero rechazando su conclusión: el problema no es que los residentes investiguen, sino que lo hagan sin estructura ni supervisión. Como alternativa, se propone un modelo escalonado en tres niveles y se sostiene que, en el contexto de una especialidad cada vez más dependiente de la inteligencia artificial, los biomarcadores de imagen y la medicina de precisión, formar radiólogos con competencias investigadoras no es un lujo académico sino una condición de supervivencia profesional.

Palabras clave: formación en investigación, residencia de radiología, cultura investigadora, alfabetización científica, investigación aplicada, mentoría, calidad asistencial, liderazgo científico.

1. Introduction

There is an implicit premise in the training of resident physicians that is rarely questioned: clinical practice and research are separate, even antagonistic, activities. "Learn to report first, you can do research later." This statement, repeated with good intentions by tutors and attending physicians, contains a serious conceptual error that should be analyzed from at least three angles: the resident's training needs, the radiologist's professional responsibility, and the department's institutional obligation. The artificial separation between "clinical practice" and "research" not only impoverishes the training of future specialists but also perpetuates a reactive and uncritical model of professional practice, incapable of responding to the challenges that radiology and modern medicine will face (if they haven't already) in the coming decades.

The debate is not new. A 1993 editorial in The Lancet already raised the question of whether research makes better doctors, and three decades later we still lack a consensus answer (1). The urgency of addressing this question intensifies as radiology, among other specialties, becomes increasingly dependent on technological innovation, methodological validation, and the integration of artificial intelligence tools, the critical evaluation of which requires skills that are not acquired simply by reporting on studies. The question is no longer whether residents should conduct research, but how we integrate research into their training in a structured, realistic, and beneficial way for both them and the patients they will treat.

Recently, Halligan and Taylor (2) have revived this discussion with a provocative position: not all residents should "do research." They propose concentrating scarce resources on those who demonstrate "genuine passion" and limiting the training of the rest to critical literature appraisal. Their argument, which Martí-Bonmatí (3) has robustly refuted from the perspective of scientific leadership in the specialty, deserves a more developed response than the letter-to-the-editor format allows. This article aims to contribute to that debate from the perspective of someone who has experienced both the shortcomings of the current system and the possibilities of structured research training, and who considers the dichotomy posed (to research or not to research) to be, in itself, part of the problem.

2. The structural problem: expectation without infrastructure

The ESR Radiology Trainee Forum survey (4) offers data that should concern us: almost half of European residents (47.8%) have never published an indexed manuscript; 79% did not receive statistical training during their residency; 34.6% never received guidance on how to critically appraise an article; and 36.5% were never encouraged to participate in research. These figures alone describe a system that expects results without providing the necessary resources. But perhaps the most revealing statistic is another: 78% of residents carry out their research activities in their free time, outside of working hours, and 83.6% do so without any financial compensation.

These data are not unique to the European context. In Spain, Ríos Zambudio et al. (5) documented that 68% of residents were dissatisfied with their research training and that 49% had not published any scientific work. More recently, Porcel et al. (6) found that only 44.5% of five-year medical residents had published at least one article. In Latin America, the situation may be even more unfavorable: Herrera-Añazco et al. (7) found in a Peruvian national survey that only 11.1% of 1062 residents had published during their residency, while a survey in 18 Latin American countries revealed that 61.6% of Internal Medicine residents did not have facilities to develop research and 78% had not contributed to scientific publications (8). The interpretation of this data, both European and Spanish-speaking, is clear: the system operates with a tacit expectation ("research if you can, when you can, however you can") rather than with an explicit training design ("research because it is a core competency and you are given the opportunity to do so"). Research is treated as an optional add-on, a curricular merit for the ambitious, not as an integral part of the training of a competent specialist. This

is not a problem exclusive to radiology or to Europe. It reflects a structural tension present in medical training worldwide, where increasing clinical demands compete with evolving educational objectives.

This model has a direct victim: the resident with a passion for research. Those who arrive with scientific curiosity, who ask questions and seek answers beyond the routine report, encounter a system that effectively tells them their interest is a personal hobby to be pursued in their free time. Without structured mentorship, without access to statistical support, without institutional recognition, their vocation erodes. It is not uncommon for these residents to abandon research upon completing their specialization, convinced that "it wasn't for them" when in reality the system never gave them a real opportunity. The loss of research talent is not due to a lack of interest, but rather to exhaustion in the face of obstacles that the system itself could (and should) eliminate.

But the indirect victim is equally important: the resident who never considered research because no one showed them it was possible, that it could be rewarding, that it was part of what it means to be a good doctor. This resident, who probably represents the majority, finishes their training convinced that research is for others—for academics, for those who "have time," for large university hospitals—and perpetuates, as an attending physician, the same culture that shaped them. The cycle repeats itself generation after generation, and the gap between departments that conduct research and those that don't grows ever wider.

3. What really predicts research participation

Contrary to what might be expected, the available evidence suggests that the commonly cited barriers (lack of time, absence of statistical support, shortage of mentors) are not the main predictors of research participation during residency. Chan et al. (9) demonstrated that what distinguishes those who conduct research from those who do not is, above all, the belief in the intrinsic value of scientific activity. Residents who considered that "research is an end in itself" were significantly more likely to participate actively, regardless of the logistical barriers they faced.

The implications of this evidence are difficult to ignore. The problem is not only structural; it is, above all, cultural. A resident who arrives convinced that research is an essential part of being a doctor will find a way to do it even with limited resources. One who perceives it as a curricular obstacle (something to overcome to gain points in the competitive exam) will abandon it as soon as they obtain a permanent position, regardless of how many methodology courses are offered. Culture cannot be changed with infrastructure, although infrastructure without culture also fails.

Structural barriers are not irrelevant, therefore. Addressing them without changing the culture is necessary, yes, but insufficient. Offering protected time is of little use if the resident perceives that their supervisors consider research a distraction from "what's important." Facilitating access to databases is of little use if no one teaches them what questions are worth asking. Organizing statistics courses is of little use if the department neither values nor recognizes research activity. Infrastructure is a necessary, but not sufficient, condition; culture is the foundation upon which any structural intervention may or may not succeed.

The finding by Chan et al. (9) suggests that the most effective interventions may not be those that eliminate logistical barriers, but rather those that transform the perception of research. Exposing residents early on to well-designed projects, showing them the clinical impact of the evidence they generate, and involving them in solving real problems in their department—all of this builds the conviction that research has value, that it is not an academic luxury but a professional responsibility. And that conviction, once established, is surprisingly resilient to logistical difficulties.

4. The clinical rationale: measure to improve

There is an argument that transcends the curriculum and is often forgotten in this debate: variability. In radiology departments, procedures that are rarely measured are assumed to be correct. We act without knowing how our work correlates with reference standards and take it for granted that things are being done well without verification (10). What is our actual sensitivity for detecting subcentimeter pulmonary nodules? What is the interobserver agreement in our department's BI-RADS classification? How many prostate MRI reports correlate with the histopathological findings? What proportion of follow-up recommendations are actually met? Most departments cannot answer these questions because they have never even asked them.

Radiology does not progress by accumulating reports. It progresses through technical innovation, methodological validation, and evaluation of results (11). Every clinical decision we make rests on evidence generated by someone who, at some point, stopped simply "providing care" and questioned whether what they were doing made sense. The protocols we follow, the diagnostic criteria we apply, the intervention thresholds we recommend—all of these are products of research. Assuming that it is possible to benefit from the research of others without contributing can be considered, in the author's opinion, a form of scientific parasitism or, in the worst case, a sign of professional irresponsibility.

Applied research (quality audits, diagnostic performance evaluations, concordance analyses, impact studies of new protocols) is the mechanism for transforming intuition into local evidence and evidence into organizational change. This research does not require external funding or complex designs; it requires a willingness to measure, analyze, and act upon the results. And its benefits are immediate and tangible: when a service discovers that its sensitivity in detecting vertebral fractures is lower than expected, it can implement specific training and verify the improvement. When it identifies excessive variability in measurement instruments, it can establish consensus sessions and double-reading protocols. Research, understood in this way, is not an academic luxury; it is quality control with a method.

Participation in research directly benefits patients, not just the researcher's curriculum vitae. Bhuiya and Makaryus (12) recently reviewed the evidence on the impact of research on medical training, concluding that residents involved in research activities develop better clinical reasoning skills, data interpretation, and a commitment to lifelong learning. The goal is not to train professional researchers; it is to train scientifically minded clinicians capable of questioning established practices, evaluating evidence, and adapting their practice to new knowledge. Research, even if it does not produce publications, makes better doctors.

A service that conducts research is a service that questions, measures, and improves. A service that doesn't conduct research perpetuates practices out of inertia, assuming that what has always been done is correct. Separating clinical practice from research can be considered, at best, a didactic simplification; at worst, an institutional excuse for not investing in what truly matters. This dichotomy doesn't exist in clinical practice: every report we issue should be informed by the best available evidence, and generate new evidence when existing evidence is insufficient.

5. From collaborators to leaders: the necessary change

There is a crucial distinction that is often overlooked in this debate: the difference between collaborating on other people's projects and leading one's own research. Historically, some radiology professionals have played a secondary role in biomedical research, contributing their imaging

expertise to projects led by other specialists, acting as technical consultants for research designed by oncologists, neurologists, and surgeons. This position, while valuable, relegates the specialty to a service role that does not reflect its potential or the competencies that should be developed.

If we want radiology to remain relevant in the era of artificial intelligence, imaging biomarkers, and precision medicine, we need radiologists who lead multidisciplinary projects, not just support them (3). We need radiologists who define research questions, design studies, interpret results, and translate findings into changes in clinical practice. Scientific leadership is not a privilege of the few; it is a strategic necessity for the survival of the specialty. This leadership is not improvised upon completing residency; it is cultivated throughout. And it requires mentors who transmit not only diagnostic technique but also a scientific attitude: the ability to identify relevant problems, the discipline to address them with methodological rigor, the humility to recognize the limitations of one's own findings, and the courage to defend them before the scientific community.

Artificial intelligence makes this change even more urgent. Algorithms that detect findings, classify lesions, and predict prognoses will become increasingly ubiquitous in radiology departments. Who will validate them? Who will identify their biases, limitations, and failures? Who will decide when to use them and when not to? If radiologists don't assume this leadership, others—engineers, computer scientists, technology companies—will, lacking the clinical expertise.

6. The necessary counterpoint: Halligan and Taylor's objection

Halligan and Taylor (2) have raised an objection that deserves consideration: forcing all residents to produce research without adequate infrastructure leads to low-quality publications. The proliferation of poorly designed and methodologically flawed studies is a real problem that pollutes the scientific literature and hinders the practice of evidence-based medicine. Radiomics, as they point out, is a paradigmatic example of a field where the number of publications has grown exponentially without a corresponding increase in quality: thousands of studies with small sample sizes, lacking validation, and with dubious reproducibility contribute more noise than signal to the collective knowledge. Their proposal to concentrate resources on those who demonstrate "genuine passion" has an apparent logic: if resources are scarce, it is better to invest them in those most likely to benefit from them. Identifying residents with a research vocation early on and providing them with intensive mentorship, protected time, and access to infrastructure seems more efficient than dispersing limited resources among everyone. His recommendation that training focus on critically evaluating the literature, given that "many more radiologists will be reading articles than writing them," seems pragmatic and realistic.

But their argument, while valid in its premises, doesn't invalidate research during residencies; it refines it. The problem isn't that residents conduct research, but that they do so without structure, supervision, and clear objectives. The solution isn't to abandon training researchers, but to abandon the quantitative approach (the "publish for the sake of publishing" *mentality*) and replace it with a model where scientific literacy is universal and research output is reserved for programs with real resources. It's not about requiring all residents to publish; it's about ensuring that everyone understands what research entails and that some have the opportunity to do it well.

The alternative they propose—focusing solely on critically evaluating the literature—is insufficient for one fundamental reason: passive learning does not replace the direct experience of designing, executing, and communicating a project. Halligan and Taylor's argument assumes that "genuine passion" is a stable trait that can be identified early on. But research, like any vocation, is discovered through doing. Many successful researchers did not arrive at their residency with a special predisposition; they developed it by finding a problem that mattered to them, a mentor who

inspired them. Reserving research only for those who already demonstrate passion excludes all those who could develop it if given the opportunity.

7. A realistic model: three levels of research training

As a central element of this article, a tiered approach is proposed that acknowledges both resource limitations and the importance of universal research training, and aims to provide a framework applicable to radiology departments with varying levels of resources. This model distinguishes three levels of rigor, each with different objectives and resources, allowing all residents to acquire basic competencies while concentrating additional resources on those who can benefit most from them.

At the first level, every resident must learn research. This means formulating structured clinical questions using frameworks like PICO, understanding the main study designs and their limitations, identifying the most frequent biases and their impact on the validity of the results, interpreting confidence intervals and p-values without falling into common errors such as confusing statistical significance with clinical relevance, recognizing the signs of bad science (p-hacking, HARKing, selective publication, overfitting, salami slicing), and critically appraising the literature that will guide their daily practice. This training is not an academic luxury; it is patient safety. A radiologist who cannot distinguish a robust study from a flawed one will make clinical decisions based on poor-quality evidence, with direct consequences for the patients they treat. This foundational level should be explicitly integrated into the training program: seminars on critical appraisal, article evaluation exercises, participation in structured *journal clubs,* and exposure to systematic reviews and meta-analyses. It does not require significant additional protected time; it requires an intentional effort to take advantage of existing training opportunities. A service that critically reviews the articles it applies, questions the guidelines it follows, and debates controversial recommendations is unknowingly training researchers.

At the second level, some residents are required to produce original research, but only those with genuine interest and, crucially, with structured support. This support includes dedicated research time, active mentorship, access to methodology and statistics resources, and institutional recognition of their work. For these residents, producing original work during their residency (regardless of its ultimate impact) should be an explicit educational objective. Experiences with structured research rotations, such as the one described by Kanna et al. (13), demonstrate that this model works: they increase resident satisfaction, participation in academic activities, and measurable outcomes (publications, presentations, fellowship acceptances), without sacrificing clinical training. These rotations, which vary in duration depending on the program, allow residents to temporarily immerse themselves in a project under intensive supervision, learning not only specific techniques but the entire craft of research: from formulating a research question to defending the conclusions.

At the third level, the service must integrate research into patient care improvement. This involves systematic audits of diagnostic variability, performance evaluation of new techniques before widespread implementation, analysis of the impact of protocol changes, and correlation with reference standards when available. This applied research, which does not require external funding or complex designs, transforms the care-research dichotomy into a false one: research and care are not separable activities when the goal is to improve the quality of service.

8. Implementation obstacles and strategies

The immediate objection to any proposal to increase research in residency is predictable: there isn't enough time. Services may be overwhelmed, on-call shifts exhausting, and clinical pressure

relentless. How can research be added to an already overloaded schedule? The objection is legitimate, but it stems from a false premise: that research is an additional activity that competes with clinical care for the same hours of the day. Some research doesn't require additional time; it requires doing the same things differently. Critically discussing articles in clinical sessions instead of accepting them uncritically doesn't take more time. Systematically recording doubtful cases for later review doesn't slow down reporting. Participating in a concordance audit is part of the quality control that every service should implement. The key isn't adding hours, but making better use of the ones that already exist.

For original research, which does require dedicated time, the solution cannot be individual but must be institutional. If we consider research training important (and this article argues that it is), we must explicitly allocate resources to it. This may mean formal research rotations, such as those already included in some programs; it may mean reducing clinical workloads during defined periods; it may mean reorganizing on-call schedules to free up protected time. None of these solutions is impossible; they all require institutions to decide that research deserves investment.

There is also the objection of a lack of mentors. Attending physicians can be just as overworked as residents; who has time to supervise research projects? Here the answer is similar: if research mentoring is important, it must be recognized as a valuable activity and allocated time. An attending physician whose research dedication is recognized in their professional evaluation will have more incentive to mentor residents than one evaluated using other metrics. The problem is not a lack of capable mentors; it is an incentive system that does not value research.

The objection of methodological training remains: radiologists, among other medical specialists, are not statisticians, they are not epidemiologists, they lack the necessary skills. This objection confuses the desirable with the necessary. It is not necessary for every radiologist to be an expert methodologist; rather, they need access to them when needed. Methodological support units in university hospitals, collaborations with biostatistics departments, continuing education courses—all of these exist and are underutilized. The humility to acknowledge what one does not know is, in itself, an essential research skill.

9. Publishing: a natural consequence, not an end in itself

It is worth pausing for a moment to consider what publishing truly means. Publishing is, above all, an act of transfer: sharing knowledge with the scientific community, increasing the transparency of medical practice, and contributing to the technical advancement of the specialty (11). Reducing it to mere curricular merit completely distorts its function and contributes precisely to the proliferation of low-quality research. If we aspire for residents to publish rigorously, it is necessary to teach them the rules of the publishing ecosystem: what constitutes legitimate authorship and what is gifted or ghost authorship, how peer review works and what its known limitations are, what ethical obligations are assumed by those who sign an article, how to identify predatory journals, what the impact factor really means and why it should not be the only, or even the main, criterion of quality (14). Training in manuscript evaluation, both as an author and as a reviewer, is not a curricular embellishment; it is an integral part of the scientific method.

This leads us to an uncomfortable reflection: part of the problem of poor research that concerns Halligan and Taylor stems from a perverse incentive system that rewards quantity over quality, impact factor over clinical relevance, and multiple authorship over genuine contribution. As long as professionals continue to be evaluated by the number of publications without regard for their quality, the machine for producing irrelevant articles will continue to be fueled. However, the solution is not for residents to stop doing research; it is to change the criteria by which we evaluate research activity.

The alternative to poor research is no research at all; it is better research, and that requires better training, better incentives, and better supervision. Publishing should be the natural consequence of having done work that deserves to be shared, not an end in itself that justifies any means.

10. Conclusions

- Clinical care and research are not opposites, but complementary dimensions of a complete radiological practice; separating them impoverishes both training and professional practice.
- Research is key to the survival of the specialty, especially in the face of artificial intelligence and precision medicine, which demand critical thinking, validation, and the generation of one's own evidence.
- To lead innovation, structural changes are needed: residents trained in research, tutors with a scientific culture, services that evaluate their results, and institutions that integrate research into training.
- Maintaining the dichotomy between care and research is detrimental to professionals and patients; the solution is not to demand production without support or to downplay the importance of research, but to collectively assume the responsibility of making it viable.

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