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Editorial

CRedit taxonomy: A system for identifying the contribution of each author in a scientific article

La taxonomía CRediT: un sistema para identificar la contribución de cada autor en un artículo científico

The aphorism ‘publish or perish’, introduced in the early 20th century, refers to the constant pressure to publish research papers in the academic and professional world as an essential element of progress and notoriety. The origin of this expression is uncertain, although Eugene Garfield (1925–2017) attributed the first quote to sociologist Logan Wilson (1907–1990) in the book *“The Academic Man: A Study of the Sociology of a Profession”* published in 1942, in a chapter devoted to the prestige and function of research¹. From 1980 onwards, the number of papers published in biomedical journals became one of the criteria linked to the evaluation of scientific productivity² and the claim of authorship as the main source of credit and authority.

The ethics of authorship and the responsibility of authors has been the subject of many debates for half a century, particularly due to the growing number of signatories to scientific articles^{3,4} and fraudulent authorship practices, such as those related to hierarchical positions of power, reciprocity of favours, gift signatures or omission of legitimate authors.^{5,6} While the increasing complexity of scientific research, specialised or superspecialised, and the need for multi-centre studies explain the continuous growth of names in the authors’ section, it is not always possible to eliminate blatant permissiveness based on personal connotations and various circumstances unrelated to the actual power to be or not to be an author.

True authors are those who can take full responsibility for the work carried out because of their active and substantial participation in the execution of the study, as well as in the work of intellectual creativity involved in the writing of the manuscript. The principles governing authorship for biomedical publications were first established by the *International Committee of Medical Journal Editors (ICMJE)* in 1985⁷ and expanded in subsequent editions. During those years, the authoritative opinions of prestigious journals’ editors^{8–11} already repeatedly called for the dissemination of authorship criteria, justifying their importance and warning against irresponsible and unjustified authorship due to its unfairness to the real authors and the secondary damage to the integrity of scientific research.

Journals adhering to the ICMJE recommendations, such as *Medicina Clínica*, include a section on authorship in the authors’ guidelines, in which they clearly list the criteria for authorship, based on substantial participation in: 1) conception and design of

the study, or acquisition of data, or analysis and interpretation of data; 2) drafting of the article or critical review of the intellectual content; 3) approval of the final version submitted to the journal; and 4) agreement among the authors to be responsible for all aspects of the paper, ensuring that any issues relating to the accuracy or completeness of any part of the study have been adequately investigated and resolved prior to submission of the manuscript to the journal.

It should also be noted that the order of authorship is the sole and exclusive responsibility of the authors, that it is permissible to share authorship credit (usually first author) and that changes of authorship (order and/or number of authors) are not possible, nor ethically acceptable, after the initial submission of the paper to the journal. In this respect, changes of authorship have to be justified and carefully explained in order to obtain the editor’s approval. In fact, editors have the right to request any clarification they deem appropriate regarding authorship at any stage of the editorial process. Also, the number of authors may be limited depending on the type of article (in *Medicina Clínica*, for example, a maximum of 6 authors is accepted for short originals and clinical reports, 4 for special articles, 3 for reviews, scientific letters and letters to the editor, and 2 for editorials). For original research articles there are no restrictions, but it is clear that there must be a weighted relationship between the content of the manuscript (complexity of the study, rarity of the disease, number of patients included, number of participating centres, etc.) and the number of authors. Editors may request a reduction in the number of authors if they deem it appropriate.

When corporate authorship is adopted, it is recommended that, in addition to the name of the study group, an acceptable number of individual authors (generally less than 8) should be listed as representing the group. At this point, the ICMJE guidelines insist that group members must continue to meet the authorship criteria, and journals may request authorship forms to be signed by all participants, both those individually named and the members of the group. It is also advisable to include the names of the group members on the first page of the manuscript, so that there is no doubt when considering them fully as authors in bibliometric databases. For single corporate authorships consisting of a large number of researchers, it is advisable to include the specific names of those who have been part of different committees (steering

committee, editorial board and others). In this case, especially in MEDLINE/PubMed, the names of the members of the group appear under the contributors heading.

Authors of studies related to the pharmaceutical industry, government research agencies or sponsored by other bodies that have entered into contractual agreements with these entities must accept full responsibility as authors for having conducted the study, having had access to the data and having exercised control over the decision to publish. Impositions or impediments, direct or indirect, regarding biased reporting of data or biased interpretations of perceived detrimental findings or a negative outcome are unacceptable as they undermine the right of independence and responsibility inherent in authorship.

In order to improve transparency and provide a more comprehensive picture of individual authors' contributions, the proposal of "authorship according to contribution" emerged in the late 1990s, developed and promoted by editors of influential and reputable biomedical journals, especially English-language journals.^{12,13} Authorship according to contribution involves extending the ICMJE's authorship criteria by adding the exact description of the tasks carried out by each contributor (co-author),¹⁴ as well as the creation, among the authors, of the role of a guarantor who (sometimes more than one), in addition to having contributed substantially to meeting the criteria for authorship, would also have made an additional effort to guarantee, endorse and vouch for the scientific integrity of the project as a whole, both before and after publication. In this regard, prior to submission of the manuscript, the authors should discuss and agree on the disclosure of each person's contribution. The type and degree of contribution is also a reasonable justification for agreeing on the order of authors. Journals that have adopted the authorship-according-to-contribution rule publish this information as an integral part of the article, usually at the end of the discussion, in a separate appendix, before the references.

In fact, point 12 of section 5.2 of the evaluation guidelines corresponding to the eighth edition of the procedure for participation in the evaluation of the editorial and scientific quality of Spanish scientific journals, published on 22 December 2022 by the Spanish Foundation for Science and Technology (FECYT)¹⁵ states: "The journal must have a specific and public editorial policy requiring the authors to inform about the criteria chosen to decide the order of signature and about the specific contribution made by each author to the published works".

Although implementing an editorial policy of authorship according to contribution is strongly recommended at a general scientific level, this does not mean that the ambiguities inherent in the terms used to describe individual contributions have been resolved, nor can it bring specificity to the amount and nature of the contribution that would qualify a researcher to sign as an author. Nor is it possible to identify the extent to which responsibilities are shared on the basis of reported contributions. In view of these questions and in line with the growing trend towards transparency in the process and methods of scientific research, in 2015, Brand et al.¹⁶ proposed a new classification to help identify individual authors' responsibilities in scientific papers. In fact, the idea emerged in 2012 from a working meeting led by Harvard University and the *Wellcome Trust*, with input from researchers, the ICMJE and publishers, including Elsevier, represented by the journal *Cell Press*.

It consists of a taxonomy of roles, abbreviated CRediT (abbreviation for Contributors Role Taxonomy) (<https://credit.niso.org>), which includes 14 criteria that provide standardised information on 'who has done what',^{17,18} as a guarantee of compliance with clearly defined standards that justify authorship credit. The categories for each of the roles are evidence-based and were developed from the analysis of authors' self-reported contributions to research articles

in the physical sciences, life sciences and social sciences. The terms and definitions in the CRediT system are as follows:

- 1) Conceptualisation: ideas; formulation or evolution of overarching research goals and aims.
- 2) Methodology: development or design of methodology; creation of models.
- 3) Software: programming, software development; designing computer programs; implementation of the computer code and supporting algorithms; testing of existing code components.
- 4) Validation: verification, whether as a part of the activity or separate, of the overall replication/reproducibility of results/experiments and other research outputs.
- 5) Formal analysis: application of statistical, mathematical, computational, or other formal techniques to analyse or synthesize study data.
- 6) Investigation: conducting a research and investigation process, specifically performing the experiments, or data/evidence collection.
- 7) Resources: provision of study materials, reagents, materials, patients, laboratory samples, animals, instrumentation, computing resources, or other analysis tools.
- 8) Data curation: management activities to annotate (produce metadata), scrub data and maintain research data (including software code, where it is necessary for interpreting the data itself) for initial use and later re-use.
- 9) Writing-original draft: preparation, creation and/or presentation of the published work, specifically writing the initial draft (including substantive translation).
- 10) Writing-review & editing: preparation, creation and/or presentation of the published work by those from the original research group, specifically critical review, commentary or revision — including pre- or post-publication stages.
- 11) Visualisation: preparation, creation and/or presentation of the published work, specifically visualization/data presentation.
- 12) Supervision: oversight and leadership responsibility for the research activity planning and execution, including mentorship external to the core team.
- 13) Project administration: management and coordination responsibility for the research activity planning and execution; and
- 14) Funding acquisition: acquisition of the financial support for the project leading to this publication.

The implementation of role taxonomy has been widely recognised and is now adopted by hundreds of journals published by various publishing groups, such as Nature Publishing Group, Public Library of Science [PLOS], Elsevier, and Multidisciplinary Digital Publishing Institute [MDPI], among many others. In all biomedical journals where the CRediT system has been implemented, investigators interested in publishing need to be able to find the link or a description of the CRediT system in the "author guidelines", as it is very likely that CRediT categories will appear for selection in the electronic manuscript submission platforms, e.g., when using Editorial Manager®.

Finally, if the categories of the CRediT system are combined with the Open Researcher and Contribution ID (ORCID) identifiers, it is possible to link the metadata of a scientific article to trace an author's contributions through his or her publications. The role taxonomy model is a step forward in clarifying the misunderstandings of the meaning of the authors' heading and in ensuring honesty and transparency in the authorship of scientific articles. On the other hand, information on the role played by members of research teams may be of interest to health management and funding agencies in their actions to better understand the ins and outs of the work beyond the research results themselves.¹⁹

Any initiative to clarify such a thorny issue as authorship of scientific articles is praiseworthy and commendable, but in practice, the mandatory nature of new recommendations may be perceived as yet another difficulty in the laborious process of publication. For something not to be difficult, it must be known and understood, hence the importance of disseminating the CRediT model in all academic and institutional environments where scientific research is present. There is one last essential point: isolated participation in some role of the CRediT taxonomy is not synonymous with legitimate authorship, nor are their respective concepts of contribution to a work and being responsible for it synonymous.

Conflict of interest

The author declares no conflict of interest.

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