Editorial

The Replication Crisis: A Persistent Challenge in Biomedical Research

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Keywords

Replication, Reproducibility, Reliability, Replication crisis, Reproducibility crisis, Biomedical Research, Psychology.

The "replication crisis" emerged in the early 2010s as a significant concern in scientific research, highlighting the difficulty in reliably reproducing key findings across various fields, particularly psychology [1-3]. As of 2024, the replication crisis remains a pressing issue, with recent statistics revealing slower-than-desired progress in improving replicability despite growing awareness. A study by Begley and Ellis [4] found that only 11% of preclinical cancer studies could be reproduced. Prinz et al. [5] reported a 20-25% reproducibility rate for preclinical studies.

Baker's [6] survey also revealed that over 70% of researchers failed to reproduce other scientists' experiments. Errington et al. [7] found that only 46% of experiments from high-impact cancer papers could be successfully reproduced. These figures highlight the need for more rigorous standards across biomedical sciences. The editorial reinforces the importance of maintaining the issue at the forefront of scientific discourse by revisiting this topic.

Several factors contribute to this crisis. The pressure to publish novel and positive results leads to unethical practices like p-hacking, HARKing, and selective reporting [8]. Other contributing issues include insufficient statistical power, poor study design, lack of standardization, publication bias, the context-dependent nature of many psychological phenomena [9], and misinterpreting findings [10]. According to Stroebe and Strack [11], the replication crisis in psychology might stem from prioritizing the replication of phenomena over understanding underlying mechanisms.

The consequences of the replication crisis are multifaceted. It reduces the credibility of published studies, eroding trust in scientific research both within the scientific community and among the public. There's also a substantial waste of time and resources as researchers attempt to reproduce irreproducible findings. Irreproducible studies might lead to misguided clinical trials and potentially harmful treatment recommendations. Moreover, the economic impact is considerable, with Freedman et al. [12] estimating that US$28 billion per year is spent on irreproducible preclinical research in the United States alone.

In response, the scientific community has implemented various initiatives. Preregistration of studies, which involves researchers publicly

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DOI: https://doi.org/10.3329/bjms.v23i4.76503

declaring their hypotheses, methods, and analyses before conducting experiments, has significantly reduced questionable research practices and increased the credibility of findings [13]. Adherence to stringent reporting guidelines, such as the CONSORT statement for clinical trials, has improved the quality and transparency of published research in a dental specialty journal [14]. However, an overemphasis on certain methodological practices can distort the true objective of scientific inquiry, an issue captured by Campbell's Law [15]. Kidwell *et al.*, [16] found that open data badges increased data sharing rates significantly in Psychological Science.

Additionally, the rise of preprint servers like bioRxiv and medRxiv has changed the publication landscape, allowing for more rapid dissemination of research findings and earlier detection of replication issues [17]. Collaborative efforts like the Reproducibility Project: Psychology have highlighted the scale of the problem while offering insights into improving research practices [18]. Statistical reforms have been promoted, including a shift from p-value thresholds to effect sizes and confidence intervals. However, their adoption has been slow and inconsistent, as Trafimow and Marks [19] noted. Technological solutions are also being explored. Artificial intelligence and machine learning are being developed to detect flaws in study designs and statistical analyses and flag improbable data patterns that might indicate

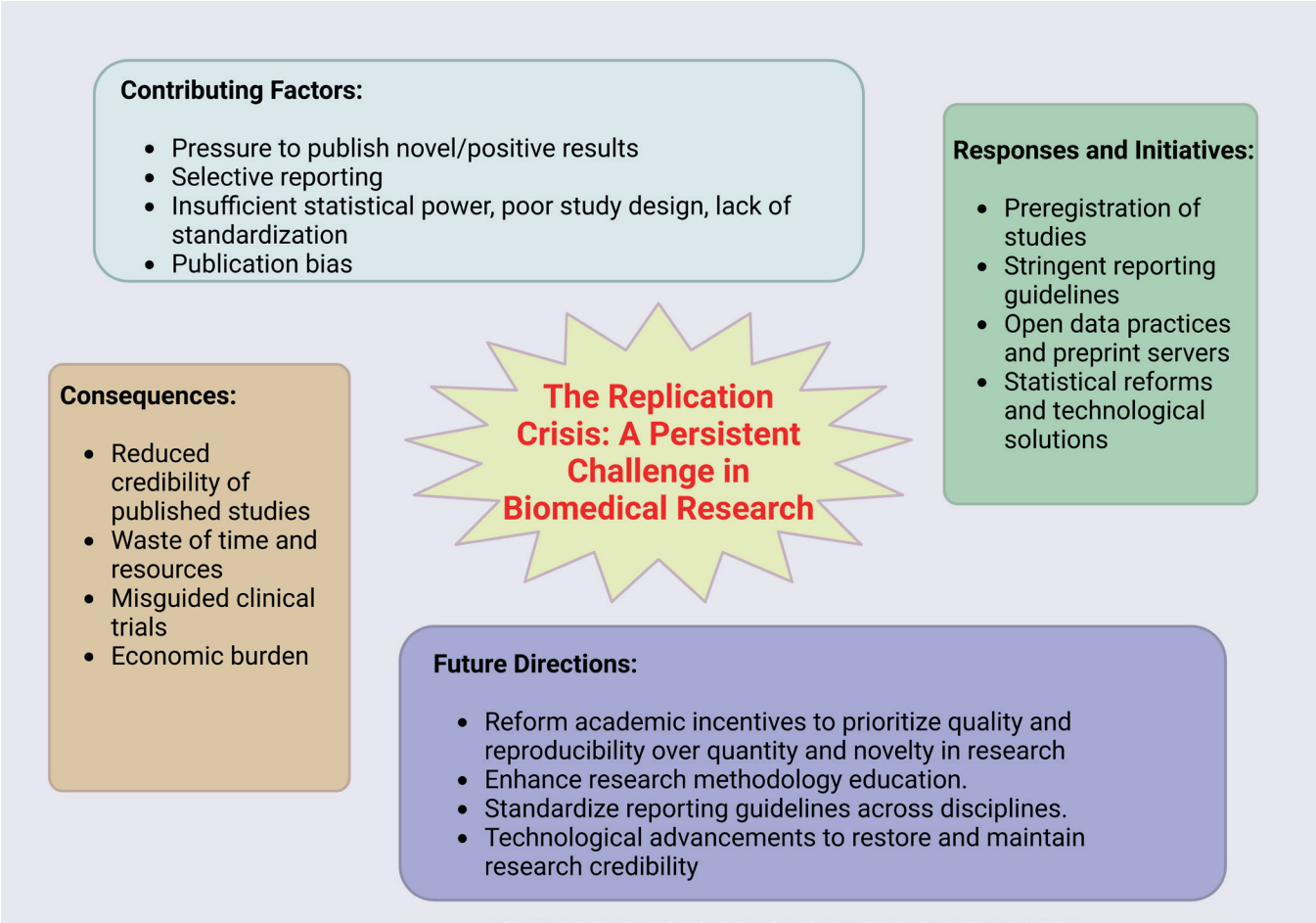

Figure 1: The principal findings of this paper.

Notes: This figure has been drawn using the premium version of BioRender 26 [(https://biorender.com/) Accessed on August 14th, 2024) with the agreement license number VP276JGC7V.
Image Credit: Namrata Dagli.

fabrication or manipulation. Meta-research, the study of research itself, has become increasingly important in understanding and addressing the replication crisis [20]. Meta-research employs various methods, including systematic reviews, meta-analyses, and bibliometric analyses, to evaluate research practices and outcomes across disciplines. Fanelli [21] argues that while progress has been made, sustained effort is needed to address the replication crisis fully. However, we should also consider that reported replication failure rates in scientific studies can be substantially biased and highly variable due to statistical uncertainty in determining whether individual studies replicated, meaning that extreme failure rates could arise by chance [22].

Looking to the future, more comprehensive solutions and systematic reforms [23] are needed to address the replication crisis effectively. Replicability should be considered a matter of degree, existing on a continuum rather than binary concepts [24]. One crucial step is reforming academic incentives to reward robust, reproducible research rather than prioritizing novel findings. Additionally, enhancing research methodology education with a strong emphasis on reproducibility and open science practices is particularly vital for early-career researchers [13,25]. While many journals have implemented stricter reporting methods and results guidelines, there is still room for more standardized approaches across disciplines to ensure consistency and transparency in scientific publishing [25,26]. Blockchain technology offers another promising avenue by ensuring data integrity and the immutability of research protocols [27].

In conclusion, the replication crisis remains a significant challenge in scientific research, highlighting the need for more awareness, rigorous methodologies, transparent reporting, critical research evaluation, and technological advancements. By collectively addressing these issues, we can work towards restoring and maintaining the credibility of published research. The key findings of this editorial are depicted in Figure 1.

CONSENT FOR PUBLICATION

The author reviewed and approved the final version and has agreed to be accountable for all aspects of the work, including any accuracy or integrity issues.

DISCLOSURE

The author declares that they do not have any financial involvement or affiliations with any organization, association, or entity directly or indirectly related to the subject matter or materials presented in this editorial. This includes honoraria, expert testimony, employment, ownership of stocks or options, patents, or grants received or pending royalties.

DATA AVAILABILITY

Information is taken from freely available sources for this editorial.

AUTHORSHIP CONTRIBUTION

All authors contributed significantly to the work, whether in the conception, design, utilization, collection, analysis, and interpretation of data or all these areas. They also participated in the paper's drafting, revision, or critical review, gave their final approval for the version that would be published, decided on the journal to which the article would be submitted, and made the responsible decision to be held accountable for all aspects of the work.

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