

Retraction rates are on the rise

Scientific enterprise is not just a quest for knowledge and truth; it is also a fairly good reflection of the whole spectrum of human behaviour: from genius, passion and jealousy, to mistakes and misconduct. Although new scientific advances and insights are always exciting, the reaction of many scientists to mistakes and misconduct—and to the accompanying retraction of articles—reflects the collapse of a profound belief in the truth-seeking nature of the ideal scientist: one who is devoid of ordinary human flaws.

Recently, there have been several highly publicized retractions in high-profile journals, which creates a feeling that the integrity of science is in decline. It also raises the question of whether retraction rates for scientific articles are higher than in the past. Here, we show that the latter is indeed the case.

We used the Medline database to calculate both the number of published articles and the number of retractions since 1950: more than 17 million articles have been recorded in Medline and, as of 21 October 2007, 871 of these have been retracted. Not surprisingly, the number of articles published in the biomedical sciences has been constantly increasing (Fig 1; black line). We divided the number of retracted articles by the number of published articles each year to find the percentage of articles retracted (Fig 1; red line). Fig 1 includes the first retractions in the 1970s, which raised awareness of the problem of scientific misconduct and triggered the establishment of the US Office of Research Integrity (ORI; Washington, DC, USA). Nevertheless, we found that the rate at which articles are retracted has increased over time. The low retraction rates in the first few decades of the study period might originate from the fact that Medline did not mark retracted articles at that time. However, even limiting our analysis to the period between 1990 and 2006, we found a significant increase ($r=0.55$, $p=0.02$). It must be noted that this figure underestimates the most recent retraction rates as there has not yet been sufficient time to identify flawed articles

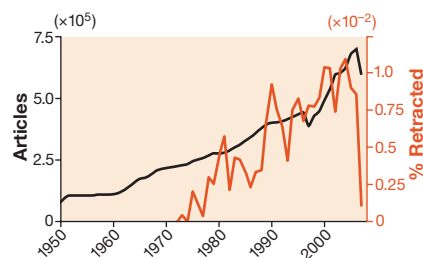


Fig 1 | Number of articles and the percentage of articles retracted since 1950 as recorded in Medline.

that were published recently, which would explain the sharp decline in retraction rates for 2007. Hence, if in the future we were to analyse the retraction rates after all the retractions for the studied time period had been made and recorded, we might expect to see an even sharper increase. From these observations, we conclude that retraction rates are still on the rise.

This conclusion, of course, can have two interpretations, each with very different implications for the state of science. The first interpretation implies that increasing competition in science and the pressure to publish is pushing scientists to produce flawed manuscripts at a higher rate, which means that scientific integrity is indeed in decline. The second interpretation is more positive: it suggests that flawed manuscripts are identified more successfully, which means that the self-correction of science is improving.

We recently showed in a mathematical model that articles published in high-impact and highly visible journals receive significantly greater scrutiny; consequently, there is a greater chance that flawed articles will be identified in these journals (Cokol *et al*, 2007). Our report suggested that science will increasingly improve its own self-correction as the dissemination of information—for example, through the Internet or electronic publishing—further improves and thus increases the visibility of research results. Of course, an increase in the number of flawed manuscripts might still be a cause of the increased retraction rates, but this remains to be proved or disproved by future analysis. However, with scientific knowledge

becoming more visible each day, we might anticipate that flawed manuscripts are more readily identified and dealt with, and that science and scientists are getting better at self-auditing their communities and research.

REFERENCE

Cokol M, Iossifov I, Rodriguez-Esteban R, Rzhetsky A (2007) How many scientific papers should be retracted? *EMBO Rep* **8**: 422–423

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