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EDITORIAL
Research Quality

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Along with research integrity, competence in the research process is required to ensure high quality, generalizable, reproducible research that leads to meaningful improvements in health and wellbeing. However, it has been noticed that more and more research studies are being retracted due to poor methodology (so called 'honest' retractions) and that the results of many published studies are not reproducible in subsequent studies [1]. One writer has gone so far as to claim that most published research is false [2]!

With the explosion in the number of research studies, researchers, research articles and journals, the spotlight has been turned on the issue of the 'quality' of the research being conducted. There is a need for objective criteria and tools to identify good quality research. It is also important to identify the causes for poor science and strategies to address them.

Improving the conduct of research

It is likely that the main reason for poor reproducibility of published studies is poor science [3,4]. Due to the pressure to publish frequently, quality is sacrificed for quantity. Adequate time is not spent on perfecting a robuststudy design withdetailedmethodology, standardized processes and appropriate statistical analysis. Validation of definitions, laboratory reagents, kits and tests, questionnaires and other data collection tools, computer models etc. is often not done prior to the study, resulting in non-replicable or even faulty results. Inappropriate or inadequately characterized study populations, sample sizes that do not provide sufficient statistical power, biased study designs, faulty methodology, a lack of positive and negative controls, poor quality instruments, reagents, kits or cell lines, insufficient replicates, incorrect use of statistical tests, insufficiently stringent criteria for statistical significance and faulty interpretation of results contribute to poor quality science. There has been discussion on the development of a checklist or metric that could be used to evaluate the quality of a published study [1]. Such a checklist could be equally useful to researchers during the planning phase of a study and to funding agencies evaluating the merits of a scientific proposal.

Training of scientists in research

Many undergraduate and postgraduate research programmes rely largely on the 'apprenticeship' model, where research is learnt at the feet of a mentor, the research supervisor. While many undergraduate programmes supplement this with a structured course in research methodology, this is not always the case for postgraduate MSc, MPhil and PhD programmes. A basic understanding of the philosophy of science (including epistemology, logic, ethics, and metaphysics), of the development of the scientific method for objective testing of a hypothesis and the use of experiments and triangulation to validate results is fundamental for good scientific practice [5]. In addition, with the increasing complexity of research, it is imperative that researchers acquire specialized competencies in order to avoid errors. Such skills could include competence in experimental design, appropriate use of statistics, good laboratory practices, clinical expertise and experience, bioinformatics, geographic information systems, software design etc. Identification of the particular sets of expertise required to design, conduct and interpret a particular research study and provision of suitable training or inclusion of suitable qualified experts should be an integral part of study design. Continuous education of researchers to update these skills should be part of the mandate for research institutions and universities and a requirement for research funding.

Encouraging publication of 'negative' research findings

The expectation that research should result inclearly positive results can lead to biases during research conduct and publication, with the published results proving to be non-reproducible in subsequent studies [1]. Deliberate or unconscious suppression of negative or inconvenient results, selective publication of results that tally with the hypothesis, manipulation of statistics and biased interpretation may play a role. The availabilityand accessibility of raw data in the public domain (open data) may help to identify these sources of error as the primary data is available for checking by independent researchers [1]. This is now a requirement of many journals and should be more widely practiced. It is also important to encourage publishers to publish research with negative results, so that the pressure on researchers to ensure positive results is reduced and the body of evidence for and against a hypothesis is increased.

Promoting responsible scientific research

All attempts to foster and encourage responsible research will not bear fruit if we do not relieve the pressure on scientists to publish frequently and compete for limited funds and shrinking job opportunities. Fundamental structural reforms to the scientific enterprise including policy, funding, evaluation, tenure, training and publication may have to take place to encourage scientists to emphasise quality over quantity in the conduct of scientific research [5, 6].

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