

AMERICAN STATISTICAL ASSOCIATION RELEASES STATEMENT ON STATISTICAL SIGNIFICANCE AND P-VALUES

*Provides Principles to Improve the Conduct and Interpretation of Quantitative
Science*

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The American Statistical Association (ASA) has released a “Statement on Statistical Significance and P -Values” with six principles underlying the proper use and interpretation of the p -value [<http://amstat.tandfonline.com/doi/abs/10.1080/00031305.2016.1154108#.Vt2XIOaE2MN>]. The ASA releases this guidance on p -values to improve the conduct and interpretation of quantitative science and inform the growing emphasis on reproducibility of science research. The statement also notes that the increased quantification of scientific research and a proliferation of large, complex data sets has expanded the scope for statistics and the importance of appropriately chosen techniques, properly conducted analyses, and correct interpretation.

Good statistical practice is an essential component of good scientific practice, the statement observes, and such practice “emphasizes principles of good study design and conduct, a variety of numerical and graphical summaries of data, understanding of the phenomenon under study, interpretation of results in context, complete reporting and proper logical and quantitative understanding of what data summaries mean.”

“The p -value was never intended to be a substitute for scientific reasoning,” said Ron Wasserstein, the ASA’s executive director. “Well-reasoned statistical arguments contain much more than the value of a single number and whether that number exceeds an arbitrary threshold. The ASA statement is intended to steer research into a ‘post $p < 0.05$ era.’”

“Over time it appears the p -value has become a gatekeeper for whether work is publishable, at least in some fields,” said Jessica Utts, ASA president. “This apparent editorial bias leads to the ‘file-drawer effect,’ in which research with statistically significant outcomes are much more likely to get published, while other work that might well be just as important scientifically is never seen in print. It also leads to practices called by such names as ‘ p -hacking’ and ‘data dredging’ that emphasize the search for small p -values over other statistical and scientific reasoning.”

The statement's six principles, many of which address misconceptions and misuse of the p -value, are the following:

1. *P-values can indicate how incompatible the data are with a specified statistical model.*
2. *P-values do not measure the probability that the studied hypothesis is true, or the probability that the data were produced by random chance alone.*
3. *Scientific conclusions and business or policy decisions should not be based only on whether a p -value passes a specific threshold.*
4. *Proper inference requires full reporting and transparency.*
5. *A p -value, or statistical significance, does not measure the size of an effect or the importance of a result.*
6. *By itself, a p -value does not provide a good measure of evidence regarding a model or hypothesis.*

The statement has short paragraphs elaborating on each principle.

In light of misuses of and misconceptions concerning p -values, the statement notes that statisticians often supplement or even replace p -values with other approaches. These include methods “that emphasize estimation over testing such as confidence, credibility, or prediction intervals; Bayesian methods; alternative measures of evidence such as likelihood ratios or Bayes factors; and other approaches such as decision-theoretic modeling and false discovery rates.”

“The contents of the ASA statement and the reasoning behind it are not new—statisticians and other scientists have been writing on the topic for decades,” Utts said. “But this is the first time that the community of statisticians, as represented by the ASA Board of Directors, has issued a statement to address these issues.”

“The issues involved in statistical inference are difficult because inference itself is challenging,” Wasserstein said. He noted that more than a dozen discussion papers are being published in the ASA journal *The American Statistician* with the statement to provide more perspective on this broad and complex topic. “What we hope will follow is a broad discussion across the scientific community that leads to a more nuanced approach to interpreting, communicating, and using the results of statistical methods in research.”

About the American Statistical Association

The ASA is the world's largest community of statisticians and the oldest continuously operating professional science society in the United States. Its members serve in industry, government and academia in more than 90 countries, advancing research and promoting sound statistical

practice to inform public policy and improve human welfare. For additional information, please visit the ASA website at www.amstat.org.

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