

A Checklist for statistical Assessment of Medical Papers: The CHAMP Statement

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Despite previous efforts to improve the statistical quality of medical journals, we still witness serious statistical errors or deficiencies in the design, analysis, reporting and interpretation, even in high-ranked journals¹. Flawed statistics and methodology will negatively affect the study results and consequently on public health and patients care². Despite numerous expository papers on biostatistics as well as reporting guidelines including CONSORT, STROBE, STARD, REMARK and TRIPOD (and others at listed in the EQUATOR Network; www.equator-network.org), endorsed by many journals³⁻⁷, the methodological quality of medical publications still remains low⁸⁻⁹. Editors typically do not have expert knowledge of statistics, and worse, often remain unconvinced or appear blasé about the importance of solid methodology in medical research¹⁰ and thus few do or are able to systematically assess the methodological or statistical aspects of a scientific paper.

Although there is some excellent guidance on reporting statistics in medical papers¹¹⁻¹⁴, and guidance available for a small number of journals, a checklist for peer reviewers (and readers) to use to assess general statistical aspects in a research publication is lacking. In this paper, we present CHAMP, Checklist for statistical Assessment of Medical Papers (Figure 1) which contains 30 items on general statistical aspects to assess during peer review of original papers. The checklist includes considerations in following sections: design and conduct (items 1-6), data analysis (items 7-16), reporting and presentation (items 17-23) and interpretation (items 24-30). The items were selected by the first author (MAM) mostly based on his vast experience of reviewing statistics of medical papers published in several journals including *British Journal of Sport Medicine* for which he is a Deputy Editor in Biostatistics, with special attention to a previous *British Medical Journal* checklist¹⁵. All coauthors read the first draft of checklist and suggested revisions.

CHAMP does not cover all topics of medical statistics but focuses on important and common statistical issues that may generally arise. We appreciate that each type of study or statistical model such as randomized trial or prediction model has specific issues which may not be covered in our checklist. We also note that for some items in the checklist there may be no decisive answer, and thus assessment of the methodology of a paper may involve some subjectivity. Moreover, the issues raised in the checklist are not equally important e.g., the serious errors in the design are irremediable regardless of how the data were analyzed, and problems of presentation are less important (as these can be easily fixed) than other statistical problems.

Using CHAMP requires some introductory knowledge of statistics, as it is also often needed for the authors of scientific manuscripts¹⁶. Further guidance on how to use the checklist can be found in the companion Explanation and Elaboration paper^R. We hope CHAMP provides a useful tool in the editorial process for editors and referees for the statistical assessment of medical papers.

Design and conduct				
1.	Clear description of study objectives, study design, and study population	Yes	Unclear	No
2.	Clear description of outcomes, exposures and potential confounders, and their measurement method	Yes	Unclear	No
3.	Validity of study design	Yes	Unclear	No
4.	Clear statement and justification of sample size	Yes	Unclear	No
5.	Clear declaration of design violations and acceptability of the design violations	Yes	Unclear	No
6.	Consistency between the paper and its previously published protocol	Yes	Unclear	No
Data analysis				
7.	Correct and complete description of statistical methods	Yes	Unclear	No
8.	Using valid statistical methods	Yes	Unclear	No
9.	No comparison of P-values or confidence intervals to assess treatment effect or interaction between treatment and another covariate	Yes	Unclear	No
10.	Correct use of correlation and associational statistical testing	Yes	Unclear	No
11.	Adequate modeling of continuous predictors	Yes	Unclear	No
12.	Not quoting confidence intervals that include impossible values	Yes	Unclear	No
13.	Correct comparison of baseline characteristics between the arms in randomized trials	Yes	Unclear	No
14.	Correct assessment and adjustment of confounding	Yes	Unclear	No
15.	On-support inference i.e., no model extrapolation to the region not supported by data	Yes	Unclear	No
16.	Adequate handling of missing data	Yes	Unclear	No
Reporting and presentation				
17.	Adequate and correct description of the data	Yes	Unclear	No
18.	Descriptive results given as occurrence measures with confidence intervals, and analytic results given as association measures and confidence intervals along with P-values	Yes	Unclear	No
19.	Confidence intervals given for the contrast between groups rather than for each group	Yes	Unclear	No
20.	Avoiding selective reporting of analyses and P-hacking	Yes	Unclear	No
21.	Appropriate and consistent numerical precisions for effect sizes, test statistics, and P-values, and reporting the P-values rather their range	Yes	Unclear	No
22.	Giving numerical results that could be included in a subsequent meta-analysis	Yes	Unclear	No
23.	Acceptable presentation of the figures and tables	Yes	Unclear	No
Interpretation				
24.	Interpreting the results based on association measures and 95% confidence intervals along with P-values, and correctly interpreting large P-values as indecisive results, not evidence of absence of an effect	Yes	Unclear	No
25.	Using confidence intervals rather than post-hoc power analysis for interpreting the results of studies	Yes	Unclear	No
26.	Correctly interpreting occurrence or association measures	Yes	Unclear	No
27.	Distinguishing causation from association and correlation	Yes	Unclear	No
28.	Results of pre-specified analyses are distinguished from the results of exploratory analyses in the interpretation	Yes	Unclear	No
29.	Discussion of the study methodological limitations	Yes	Unclear	No
30.	Drawing only conclusions supported by the statistical analysis and no generalization of the results to subjects outside the target population	Yes	Unclear	No

Fig 1. Checklist for statistical Assessment of Medical Papers

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