

QUANTITATIVE ISSUES IN BIOMEDICAL RESEARCH

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The following considerations should describe the quantitative components of a (biomedical) research program, proposal or report.

1. Identification of the language, approach, framework (e.g., cell-biology, genetics, epidemiology);
2. Identification of research questions and hypotheses (are they native to the language?);
3. Identifications of predictions associated with proposed hypotheses (new knowledge);
4. Identification of the unit of analysis (e.g., eyes vs subjects);
5. Identification of random variables $X, Y...$ (outcomes). Note that this implies the identification of the sources of randomness or variation (e.g., measurement, treatment, systematic);
6. Identification of time-dependence structures, $X(t), Y(t), dY/dt, ...$;
7. Determination of the corresponding scales, ranges and measurement units;
8. The notion of representation of a natural phenomena ω by a numerical construct $X(\omega)$. For example, in vision research ω may indicate the subject's visual acuity whereas $X(\omega)$ may indicate the subject's visual acuity measured by the logarithm of the minimum angle of resolution (say, $X=0.301$). In that case, do the algebraic properties of real numbers provide a fair representation of the biological construct? (data analysis vs biological explanation);
9. Proximity between the methodology (e.g., statistical testing of a parametric hypothesis) and the original research question (translation, editing, adaptation, distortion).
10. Cause-effect, symmetry principle, structural models;
11. The notion of scale (variance) vs location (mean). Is there relevant information in changes in variation due to treatment (in addition to eventual changes in location)? How to interpret?;
12. Symmetry, changes in symmetry, symmetry studies;
13. Prediction of observable quantities (e.g., statements about the next vector of observations, X_{n+1}) vs parametric comparatives (e.g., testing the equality $\mu_1 = \mu_2$ of two model means);
14. Questionnaires and instruments in general, validity and reliability issues;
15. Generalizability of results. Generalizability of reasoning (arguments);
16. (Hypothesis-free) modeling studies (e.g., compartmental models, clearance rate determinations);
17. Comparative studies, randomization issues, other sampling designs;
18. How are clinical interventions (if any) incorporated in the formulation of the hypotheses (study design)?
19. Correlational studies aimed at prediction (time-line, anticipation, window of intervention);
20. Sources of dependence (univariate, multivariate considerations, time-dependency);
21. Primary and secondary usage of data, meta-analytic arguments;
22. Small-sample considerations;
23. Selective use of inferential statements;
24. Statistics, Statisticians and the Belmont Report;

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1. THE CLASSICAL INFERENCE/DEDUCTION PARADIGM

