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Introducing the Numbers Needed for Change (NNC): A practical measure of effect size for intervention research

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**Introduction**

The evaluation of health interventions is often done using randomized controlled trials, where a sample exposed to a intervention is compared to a control sample drawn from the same population. Effectiveness of an intervention is usually quantified in terms of changes in determinants of health behavior, determinants which are often couched in sociocognitive theories of behavior. Results of such evaluation studies test experimental-control group differences on statistical significance of an intervention effect, but usually also involve standardized estimates of effect size - such as Cohen’s *d*. Intervention implementers can use Cohen’s *d* to compare different interventions with each other, and can get some insight into how substantial the effect of an intervention is.

The usefulness of such indices of effect size are, however, limited to relative conclusions of effectiveness, and are not appropriate to guide decisions about whether it is worth to put an intervention to practice. Although a shift towards measures such as Cohen’s *d* – and corresponding confidence intervals - to evaluate intervention effectiveness is a clear improvement to null-hypothesis significance testing (NHST), such measures of effect still have limited practical value. What does it mean to observe that the effectiveness of an intervention corresponds to *d* = .7? Is it necessarily better than an alternative program, the effectiveness of which is estimated at Cohen’s *d* = .6 ? The answer is obviously no, and there are at least two immediate reasons why Cohen’s *d* values are by themselves practically uninformative about behavior change.

First, intervention effects are often examined on the level of determinants of behavior. It is difficult to relate a change in determinants (say, an increase from 3.5 to 4.2 for control versus experimental group on a 7 point Likert scale) to a conclusion about whether we can expect behavior change. Second, since the effectiveness of an intervention has to be related to the investments (i.e. time, money and other resources) required for successful implementation, even huge intervention effects can be practically meaningless – if the costs of the investment outweigh the benefits of the program. We think that intervention developers can benefit from a quantification of effect size that is able to provide some additional, practical information about an intervention effect. One that allows for more intuitive and accessible information about 1) what we can expect from an intervention, and 2) the resources needed to attain program goals.

Here, we promote the use of the Numbers Needed to Treat statistic (NNT). For use in the context of behavior change, we have amended the terminology to one more appropriate: numbers needed for change (NNC). We define NNC, briefly, as the number of people that need to partake in an intervention in order to change the behavior of *one* individual towards a good health outcome (formal definitions will be discussed in a later section). The addition of the NNC moves intervention effect analyses from *statistical significance* conclusions (using NHST), and conclusions about *substantial significance* (Cohen’s *d*), to a novel level: *practical significance*. We suggest that intervention effect evaluations should be given along these three axis of significance, as to strengthen the link between research and practice.

The remainder of this paper is organized as follows: first, we discuss the meaning of NNC and how it be calculated based on Cohen’s *d* values. Second, we discuss how intervention effects on the level of determinants can be translated to conclusions about change in actual behavior outcomes. An example of this application, using an existing health promotion program, is given as well. Finally, we describe a statistical package for *R* software that can be used to 1) calculate the NNC based on Cohen’s *d* estimates and pre-defined response criteria, and 2) translate intervention effects on the determinants level (input in terms of Cohen’s *d)* to a prediction of actual behavior change in terms of NNC.

**Numbers needed for Change: A definition**

The NNT index was developed in the context of medical statistics. Here, medical professionals had a growing need for intuitive effect measures, able to easily inform clinical practitioners about optimal treatment choices. The NNT provides a more intuitive index relative to Cohen’s *d* - in its ability to express how much one treatment is preferred over another, both for clinicians and patients.

In medical statistics, for treatments that aim to increase an event rate (ER), NNT is defined as:



Where EER is the experimental group event rate, and CER is the control group event rate. For example, ….

Alternatively, treatments aiming to decrease a certain event rate can use the inverse to estimate NNT:

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From Cohens *d*, given Furakawa’s method,

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Where, 

**From NNT to NNC**

**Determining response criteria**

**For research purposes use Cohen’s *d***