Tidsskriftet
DEN NORSKE LEGEFORENING

Internal consistency: from alpha to omega?

MEDICINE AND NUMBERS

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Questionnaires often consist of scales composed of different questions and are intended to measure a given factor, for example anxiety or depression. Internal consistency is a measure of the strength of the relationship between questions in the same scale.

When developing questionnaires and scales, we want them to be as reliable and valid as possible. In other words, the scales must be accurate, and they must measure what they are intended to measure. Internal consistency is a measure of whether questions that are intended to measure the same phenomenon are 'pulling in the same direction', and is often examined when new questionnaires are being developed or collected data are being assessed. A scale should include a sufficient number of questions to measure the underlying factor, but for practical reasons it is desirable to avoid too many questions.

Cronbach's alpha

Cronbach's alpha was first described in an article in 1951 (1) and has since been by far the most frequently used measure of internal consistency of scales. However, Cronbach's alpha builds on the assumption that the responses to individual questions are normally distributed, have equal variance and equally explain the factor. These assumptions are

seldom fully met (2, 3). In fields such as medicine and psychometrics, the response alternatives will often be in steps that range from 'to a small extent' to 'to a very great extent', and the responses will often cluster near one end of the steps. The assumptions will therefore not be met, and alpha will be unsuitable and provide inaccurate or biased estimates of internal consistency. As a result, scales that in fact have a high internal consistency might be rejected or modified, or scales that actually have a low internal consistency might be retained.

McDonald's omega

Several alternatives to Cronbach's alpha have been proposed, for example McDonald's omega, coefficient *h* and the 'greatest lower bound' (2). McDonald's omega is based on a factor analytic approach, in contrast to alpha, which is primarily based on the correlation between the questions. Omega has proven to be more robust than alpha against deviations from the assumptions noted above, and will thus generally be a more suitable measure of internal consistency. The difference between alpha and omega will often be small, but can also be substantial, depending on the extent of the deviations from the assumptions (4). Alpha and omega will have a value between 0 and 1. Internal consistency is usually considered acceptable if the estimate is 0.70 or higher (2). Examples of alpha and omega are shown in Table 1, which is taken from a study that investigated a questionnaire used to measure mental health problems in children (5). In the example, there are only small differences between alpha and omega. The largest difference is for the scale 'somatic complaints', which may indicate that the deviations from the assumptions for alpha were larger in this scale than in the others.

Table 1

Excerpt from Stensen et al. (5) showing Cronbach's alpha and McDonald's omega. Estimate and 95 % confidence interval.

Scale (number of questions)	Cronbach's alpha	McDonald's omega
Emotionally reactive (7)	0.683 (0.656 to 0.701)	0.703 (0.679 to 0.727)
Anxious/depressed (8)	0.690 (0.668 to 0.711)	0.689 (0.664 to 0.713)
Somatic complaints (7)	0.441 (0.400 to 0.484)	0.376 (0.323 to 0.433)
Withdrawn (10)	0.752 (0.734 to 0.769)	0.757 (0.738 to 0.776)
Attention problems (9)	0.874 (0.863 to 0.884)	0.888 (0.879 to 0.897)
Aggressive behaviour (25)	0.921 (0.915 to 0.927)	0.926 (0.921 to 0.932)

It is important that the scales being used have good internal consistency. Since measures of internal consistency exist that have better properties than alpha, the time may be ripe to proceed from alpha to – for example – omega.

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Publisert: 29 August 2022. Tidsskr Nor Legeforen. DOI: 10.4045/tidsskr.22.0112