
Significance of Relationships

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Deceptive, dishonest, and misleading. These are the relationships that are often described by correlation coefficients. What makes a correlation coefficient deceiving? On one hand, the coefficient can show a “statistically significant” relationship between two clinical measures. On the other hand, the *same* coefficient can indicate a weak association between the measures of interest. The contradiction of correlation is that statistical significance and weak association can occur simultaneously.

The key to understanding the contradiction of correlation is realizing that the statistical significance of the coefficient has absolutely nothing to do with the magnitude of association between two measurements. It has everything to do, however, with the number of observations that are made. The truth is that if you test enough subjects, almost any correlation coefficient will reach statistical significance.

A Pearson Product Moment correlation coefficient measuring the strength of a relationship between quadriceps power and jump height (for example, $r = 0.23$) will not be significant when 16 patients are evaluated. This correlation coefficient will reach statistical significance, however, if 52 patients are assessed. Just add subjects and voila! A near-zero coefficient becomes a “significant” coefficient.

A statistically significant association at $r = 0.23$? When authors report a relationship between two variables that have a correlation this small, the claim is deceiving. Statistical significance in this case simply means that the coefficient was tested against a reference point of $r = 0$. If a correlation is statistically significant, it means that the magnitude of association was probably different from 0. It does *not* mean that the statistic shows a strong association between the variables in question.

The literature is replete with examples where authors have succumbed to the temptation to report the “significance” of an association between clinical measures when the size of the coefficient actually reflected a weak relationship. Sometimes we fall back on testing the statistical significance of the relationship when we find that the correlation between variables in our research is weak. We hope that assigning that magical P value ($P < 0.05$) will inflate the worth of our findings.

The real value of a correlation coefficient is the information that it conveys about the magnitude of association between two variables. It is more important to know how often two variables change together than to know about the statistical significance of the coefficient. Multiplying the correlation coefficient by itself will help you sort this out. When you square the correlation coefficient, you arrive at a number that tells you the percentage of shared variance. By squaring $r = 0.23$ we see that two variables change together only 5% of the time. It should become obvious, particularly if you apply this test to other examples in the literature, that a statistically significant correlation coefficient can be reported for two variables that are not related!

The deceit in describing relationships does not end with bivariate measures of association like the Pearson Product Moment or the Spearman Rank Order correlation coefficients. The chi-square statistic (χ^2) is, by design, a vague representation of association and authors rarely take steps to clarify the meaning of this statistic in the context of their studies. It might be reported that there is a significant association between two variables in a contingency table, but we are rarely told precisely what that association is. At least with Pearson and Spearman, the sign of the coefficient (positive or negative) will indicate the direction of association. With χ^2 , there is no sign that will indicate a direct or inverse relationship.

The chi-square statistic is commonly used to analyze the distribution of the tallies of patients in specific categories. When we want to know the relationship between pain and posture, for example, we can tally the patients who have good and poor posture and then see how many patients in each group have inter-scapular pain. If χ^2 is significant, we then conclude that there is an overall association between posture and pain. This overall association, however, does not tell us precisely how postural abnormalities are related to pain. A relationship exists, but what is it?

Most physical therapists would assume that significant χ^2 reflects a clinically expected relationship—that pain is associated with postural deficits in the example presented above. This assumption follows our clinical intuition, but because χ^2 is not a “precise” measure of association, our guess about the meaning of significant χ^2 and the relationship between pain and posture may not be true. It is possible that subjects with *no pain* had the highest count of postural abnormalities. Without looking deeper into the data, we would miss the real reason that χ^2 reached statistical significance.

In order to tell the whole story about relationships, authors who use χ^2 should calculate residuals that will guide the reader to the exact nature of the association between the variables of interest. Calculating residuals is a simple procedure that is illustrated nicely by Portney and Watkins² and in a recent paper published in the *Journal*.¹

We can end the deceit in measuring the strength of relationships by becoming informed. Statistics of association lie only to those who do not understand them.

REFERENCES

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