Reasons for Association in a Study

Chance, Bias and Confounding (vs. Causation)

In studies we are searching for significant associations of predictor variables with outcomes. If a study shows that taking Vitamin C is positively associated with development of lung cancer, we should consider the options for interpretation.

There may be a true causal relationship, but other explanations must be ruled out. RCTs are the only type of study in which a well-conducted investigation can reasonably lead to a determination of causation. In observational studies (cohort, case control, cross-sectional), and even in RCTs that are not well done, there could be other reasons for the significant association.

Chance is simply the possibility of making a Type 1 error (finding an association that really doesn't exist). This is exactly the p value of the study finding. The lower this p value, theoretically the less likely the finding is due to chance.

Bias is any systematic error in the design, conduct or analysis of a study which results in a mistaken estimate of a predictor's effect on an outcome. Bias can occur in the design of a study, for example, if patients in one group (more than in the other group) have a feature that might affect the results (selection bias). Measurement bias might arise during the conduct of a study if, for example, a rater determining an outcome knows to which group a patient belongs. There are many other types of bias. Some ways to limit bias include randomization (to make groups similar) and blinding.

Confounding occurs when a third variable "confounds" or distorts the relationship between a predictor and an outcome. For example, smoking might be a confounder in the apparent relationship between caffeine consumption and lung cancer. Those with higher levels of caffeine consumption might be more likely to be smoke. Confounding can be controlled by randomization and by statistical methods (stratification and multiple regression).