What can it mean if X is correlated (associated) with Y in a sample?

1) $X \Rightarrow Y$ i.e. $\Delta\uparrow X \Rightarrow \uparrow E(Y)$

2) $Y \Rightarrow X$

3) $Z \Rightarrow X$, $Z \Rightarrow Y$ — Confounding factor(s)

Maybe

a) Directly $X \Rightarrow Y$

b) Through mediating factor(s)

$X \Rightarrow M_1 \Rightarrow Y$

$X \Rightarrow M_2 \Rightarrow Y$

a) Z known + measurable

b) Z " but hard to measure

c) Z unknown

d) There are clusters in which Z is constant

4) Chance

5) Selection

- To conclude that $X \Rightarrow Y$ we need to be willing to reject the other possibilities.
- Ordinary statistical analysis only helps with #4 via p-value.

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OBSERVATIONAL DATA

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