# On the definition of a confounder…

In 2011 VanderWeele and Shpitser published an article titled "A new criterion for confounder selection",[1] which I criticized harshly.[2] My critique included the following text:

"The title of VanderWeele and Shpitser's article – 'A new criterion for *confounder selection*' [italics added] – implies that they are redefining the word confounder as follows: a confounder is a pretreatment cause of *E*, *D* or both that belongs to a set of measured variables – *if that set contains a subset that is sufficient to remove confounding bias without adding colliding bias*. The new definition is not needed. The variables selected by their method are simply covariates, not confounders in the traditional sense, so the title should have read 'A new criterion for covariate selection for conditioning'."

I don't know if VanderWeele and Shpitser have read my critique,[2] but recently they proposed yet another definition of a confounder.[3]

"We thus proposed that a pre-exposure covariate *C* be considered a confounder for the effect of *A* on *Y* if there exists a set of covariates *X* such that the effect of the exposure on the outcome is unconfounded conditional on *(X,C)* but for no proper subset of *(X,C)* is the effect of the exposure on the outcome unconfounded given the subset. Equivalently, a confounder is a 'member of a minimally sufficient adjustment set'."[1]

Of course, authors can define whatever they want and however they want, but it is helpful to recall the essence and purpose of a definition. Elsewhere, we offered a reminder:[4]

"Consider a long, commonly used phrase, such as 'the formation of a blood clot inside a blood vessel that obstructs the flow of blood'. Since it would be cumbersome to continually repeat the phrase, the shorthand 'thrombosis' may substitute for the entire phrase. To define something is to do just that: to replace a phrase whose meaning is already clear (called definiens) with another, shorter phrase or word (called definiendum). The whole sentence '[definiendum] denotes [definiens]' is called a definition. Placebo, for example, is a definiendum (whose definition is yet to be discussed).

Before a phrase becomes a definiendum, it is a meaningless collection of letters (or it already has a meaning and is being redefined). After becoming a definiendum, the phrase is no more than an alternative name for its definiens. Definienda, just like acronyms, do not serve any deep purpose, but they help to quicken communication. Without them, communication would be as exhilarating as reading the dictionary. A definiens serves even less of a role: it is merely a meaningful phrase, just given an alternative name."

So, what is the purpose of defining "confounder"?

As far as I can tell, VanderWeele and Shpitser don't have a sharp answer. They ask whether a formal definition of a confounder can be given, assuming that a formal definition of confounding is already available. But why should we care about giving an abbreviated name for a "member of a minimally sufficient adjustment set"? Does it help to speed up communication? Does it clarify anything? Hardly so. If researchers already understand what confounding bias means, they only need to write once: "To remove confounding bias we considered the following minimally sufficient adjustment set". The shorthand "confounder" serves no purpose. After all, the key issue is confounding bias, not confounders.

In my view, VanderWeele and Shpitser are conceptually and pedagogically wrong. The term confounder is a helpful abbreviation for "a common (shared) cause of *A* and *Y*" (to use their notation)—and you can find that definition in the literature. The order of the reasoning is as follows:

Using causal diagrams, we first recognize several types of paths (sequences of variables and arrows) between *A* and *Y*, one of which is the open path $A \leftarrow C \rightarrow Y$. This path makes an undesired contribution to the association between *A* and *Y*, and therefore "confounds" the attempt to learn about causation from association. Since *C* is the culprit for the open path, "confounder" would be an appropriate name (definiendum) for "a common (shared) cause of *A* and *Y*" (definiens). Next, "confounding path" denotes "a path that contains a confounder", and "confounding bias" denotes "the bias arising from a confounding path".

Here is how we told the story elsewhere,[6] with no need to bring up "counterfactuals":

[1] Notice an intriguing result from this definition: If there are two or more minimally sufficient adjustment sets, the set of all confounders is *not* a minimally sufficient adjustment set.

"A natural path between two variables is any sequence of causal arrows – regardless of their directionality – that connects the two, and does not pass more than once through each variable. In Figure 1, for example, $E$ and $D$ are connected by three natural paths: $E \rightarrow D$; $E \leftarrow C \rightarrow D$ and $E \leftarrow C \rightarrow S \leftarrow D$. A common cause of $E$ and $D$ is called a confounder (eg, $C$ in Figure 1). If two arrows on a path point at one variable, that variable is called a collider on the path (because the arrowheads collide there). For instance, $S$ is a collider on the path $E \leftarrow C \rightarrow S \leftarrow D$ (Figure 1). By definition, a collider is a common effect of two variables (eg, $C$ and $D$) – the colliding variables.

We distinguish among three types of natural paths between $E$ and $D$: causal paths, confounding paths, and colliding paths. A causal path, as its name implies, is any path by which $E$ affects $D$. For example, $E \rightarrow D$ (Figure 1); and $E \rightarrow X \rightarrow Y \rightarrow D$. A confounding path is any path in which $E$ and $D$ share a common cause (a confounder). For example, $E \leftarrow C \rightarrow D$ (Figure 1); and $E \leftarrow X \leftarrow Y \rightarrow Z \rightarrow D$. A colliding path is any path that contains at least one pair of colliding variables and their collider, for example, $E \leftarrow C \rightarrow S \leftarrow D$ (Figure 1) and $E \rightarrow X \rightarrow Y \leftarrow Z \rightarrow D$.

The theorems of causal diagrams build a solid bridge between a causal structure and expected associations. Both causal paths and confounding paths contribute to the marginal (crude) association between two variables; they are, therefore, called "open" paths. In contrast, colliding paths are "blocked"; they do not add anything to the association between the variables they connect."

"If we estimate the magnitude of the effect of $E$ on $D$ by their marginal association, the estimator contains confounding bias – the unwanted contribution of the confounding path... To get an unbiased estimator of the effect of $E$ on $D$, the confounding path must be blocked."

I think that VanderWeele and Shpitser's definition is motivated by the idea that a confounder must play a role in deconfounding ("adjustment"). Why should we impose this restriction? A confounder is responsible for confounding bias, but that does not imply that we have to adjust for a confounder to remove the bias it will cause! As we all know, there are all kinds of trouble makers in life besides confounders, and we often find indirect ways to control them. For instance, we prevent burglary by securing our homes, not by holding down every burglar. Closer to the topic: The bias that arises by conditioning on a collider (colliding bias) is removed by conditioning on another variable along the induced path.[5]

Now, let the reader be the judge. Shall we start with "confounding bias" and forget about confounders, or shall we start with "confounder" and move to "confounding bias"? Which is a better method to teach confounding bias to epidemiologists and statisticians?

**References**

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