8

Puzzles of Attributability

Summary

Measures of attributability are not mathematically complicated, but they are conceptually tricky. This chapter examines them with a view to achieving a clear and rigorous conceptualisation of attributable fractions. Two common errors in causally interpreting excess fractions are explored: the Exclusive Cause Fallacy, which supposes that the exposure causes all and only the cases represented by the excess fraction; and the Counterfactual Fallacy, according to which the excess fraction tells us how much the risk would drop by, absent the exposure. Instead we settle on an interpretation of “attributable to” as “explained by”, in line with the model of causal interpretation set out in Chapter 3.

Two common errors in understanding attributable fraction

If it appears that an exposure causes a health outcome in a population, it is natural to want to know how much of the outcome is due to the exposure and how much is not due to the exposure. Given the basic measures described in Chapter 2, the question is most naturally framed by asking what proportion of the risk is caused by the exposure. This is a quantitative question, and the family of measures offering an answer can be grouped under the heading of measures of attributability (a subkind of measure of association, as discussed in Chapter 2).

The measures in this family go by a bewildering variety of names, including attributable risk, excess risk, attributable fraction, excess fraction, and all of the aforementioned prefaced by “population”. Notwithstanding this variety, there are essentially two measures of attributability, the difference being marked usually (but not always) by
the presence or absence of the prefix “population”. We met these measures in Chapter 3. \textit{Excess fraction} (\(EF\)) is defined as follows:

\[
EF = \frac{R_E - R_U}{R_E} - 1 - \frac{1}{RR}
\]

where \(R_E\) is exposed risk, \(R_U\) is unexposed risk, and \(RR\) is risk ratio. \textit{Population excess fraction} (\(PEF\)) is defined as follows:

\[
PEF = \frac{R_T - R_U}{R_T}
\]

where \(R_T\) is total risk. Note that \(EF\) is often called \textit{attributable risk} and \(PEF\) is often called \textit{population attributable risk}. But since questions of attributability are at stake, it is useful for us to start with the more neutral term “excess” (following Rothman, Greenland, and Lash 2008, 63–4). This is a departure from some uses, in which “excess” is used causally, to mean the excess risk that is \textit{caused} by the exposure. But we have to start somewhere: let us stipulate that “excess” is not to have causal connotations, at least in this chapter, while “attributable” is reserved for indicating causality.

\(EF\) can be calculated as a function of relative risk alone, while \(PEF\) can only be calculated either using information about total risk in the population (as above) or else from relative risk, along with the prevalence of the exposure in the population (as it was for the example in Chapter 3). Despite this difference, \(EF\) and \(PEF\) clearly have something important in common, in that they express the difference between two risks as a proportion of one of them. They are also open to the same conceptual confusions, as we will see. The discussion to follow will emphasise their common features. The two measures become identical when the unexposed population is replaced by an “expected” or “background” risk, since then \(R_E = R_T\), which is just the risk in the group under study, all of which is subject to the exposure. Thus \(EF\) approaches \(PEF\) as prevalence of exposure increases (Szklo and Nieto 2007, 86–7).

The variation in terminology between “risk” and “fraction” is relatively unimportant, but “fraction” is slightly more accurate, since the measure is not itself an \textit{actual} risk but a fraction of an actual risk. The other variation, between “excess” and “attributable”, is more important. “Excess” is often thought preferable, since it does not carry the causal implications of “attributable” and thus can be calculated without having to worry about whether a causal inference is warranted. However, sidestepping the causal implications of “attributable” is a