A short introduction to epidemiology

Chapter 7: Effect Modification

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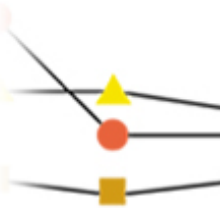
Chapter 8

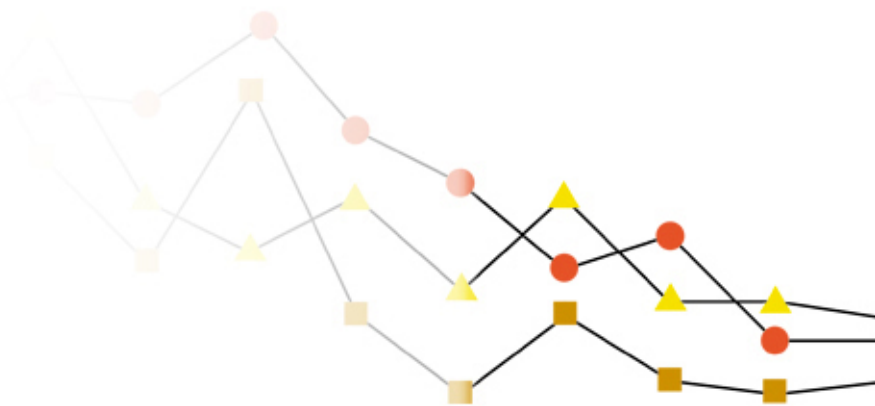
Effect modification

- Concepts of interaction
- Multiplicative and additive models



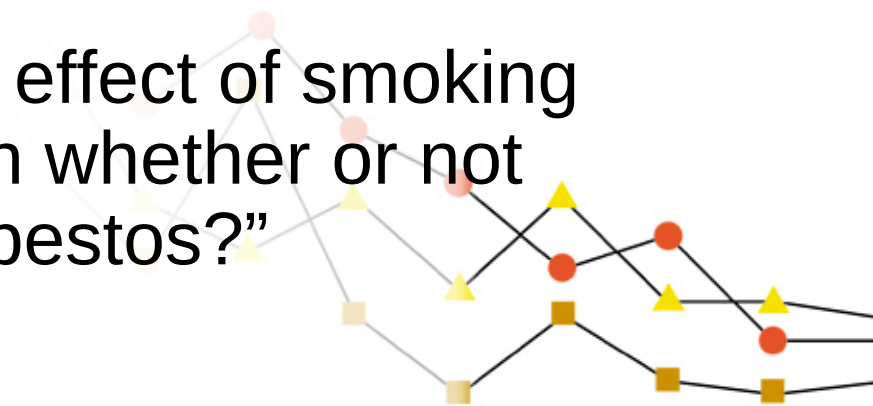
Effect Modification

- Occurs when the effect measure depends on the level of another factor
- Also known as statistical interaction



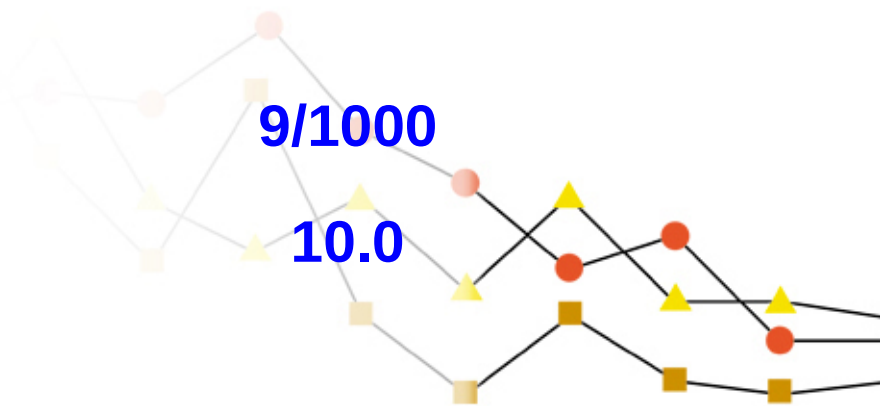
Interaction (Effect Modification)

- Suppose we wish to study whether a particular factor (e.g. smoking) can cause a particular disease (e.g. lung cancer)
- Suppose there is another factor (e.g. asbestos exposure) which may also cause the disease and/or modify the effect of the main exposure of interest (i.e. smoking)
- We ask the question “Does the effect of smoking (on lung cancer risk) depend on whether or not there has been exposure to asbestos?”



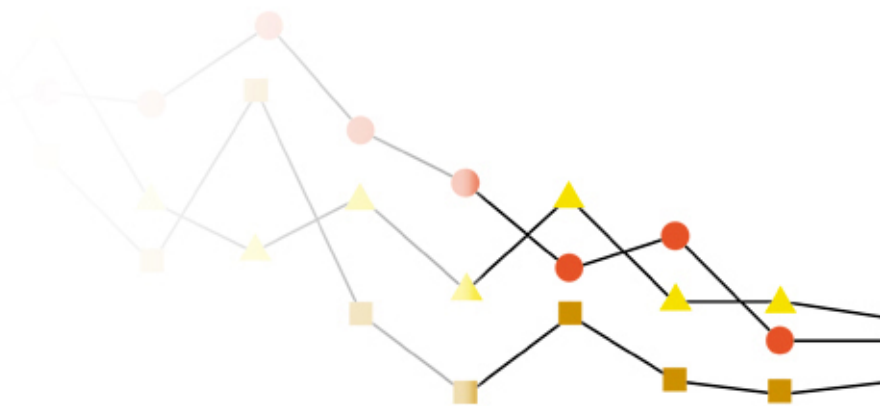
Asbestos Exposure, Smoking and Lung Cancer Risk

	Exposed to asbestos	Not exposed to asbestos
Smokers	**35/1000**	**10/1000**
Non-smokers	**5/1000**	**1/1000**
Rate difference	**30/1000**	**9/1000**
Rate ratio	**7.0**	**10.0**



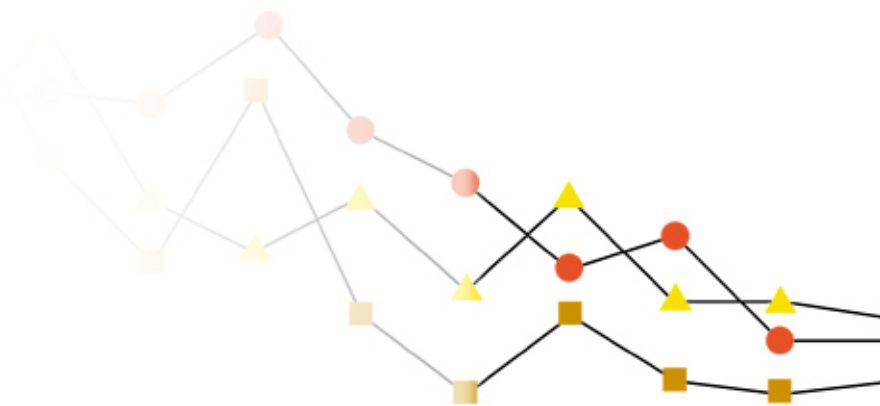
Biostatistician 1

- The relative risk (for smoking as a cause of lung cancer) is 10.0 in the general population, but only 7.0 in asbestos workers
- There is a negative effect modification in that the effect of smoking (on lung cancer) is lower in asbestos workers



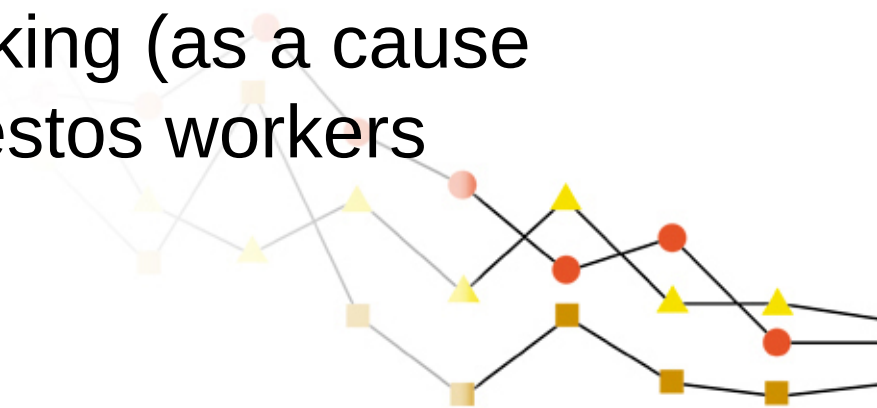
Biostatistician 2

- The risk difference (for smoking as a cause of lung cancer) is 9/1000 in the general population, but is 30/1000 in asbestos workers
- There is a positive effect modification in that the effect of smoking (on lung cancer) is higher in asbestos workers



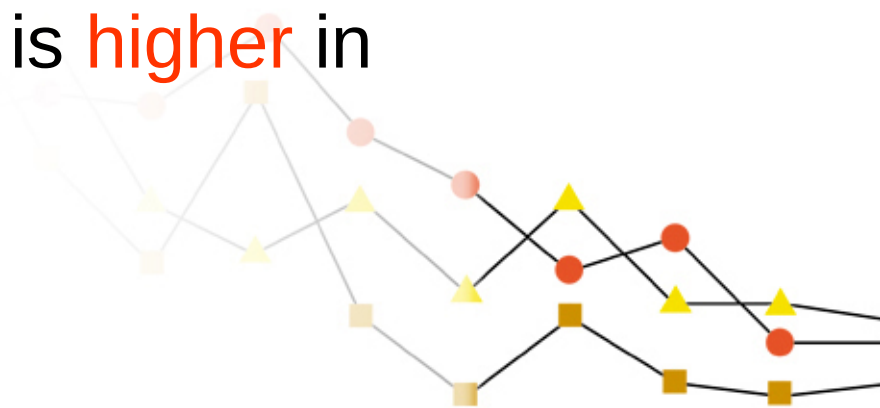
A lawyer

- The probability of causation (of smoking as a cause of lung cancer in a client who is suing the tobacco companies) is 9/10 (90%) in the general population, but is 30/35 (86%) in asbestos workers
- There is a negative effect modification in that the probability of causation of smoking (as a cause of lung cancer) is lower in asbestos workers



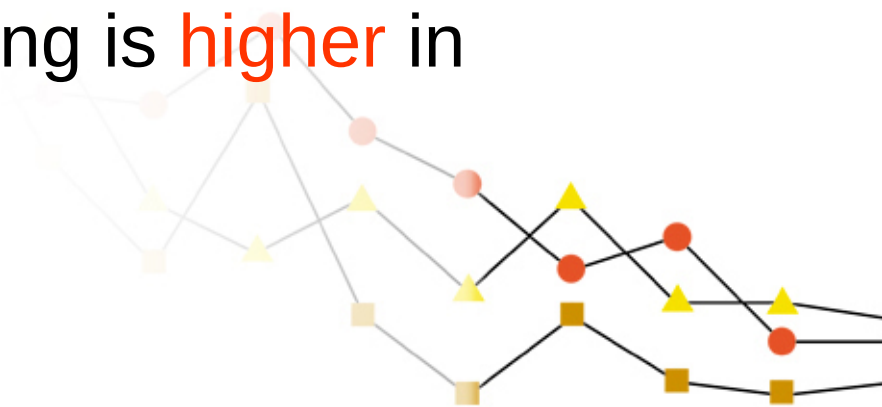
A clinician

- The reduction in individual risk (of lung cancer) that could be achieved by a patient stopping smoking is 9/1000 in the general population, but is 30/1000 in asbestos workers
- There is a positive effect modification in that the individual risk from smoking (as a cause of lung cancer in an individual patient) is higher in asbestos workers



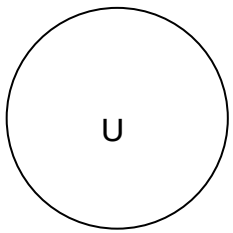
A public health worker

- The number of deaths (from lung cancer) that could be prevented by preventing smoking is 9 per 1000 in the general population, but is 30 per 1000 in asbestos workers
- There is a positive effect modification in that the potential number of deaths (from lung cancer) prevented by preventing smoking is higher in asbestos workers

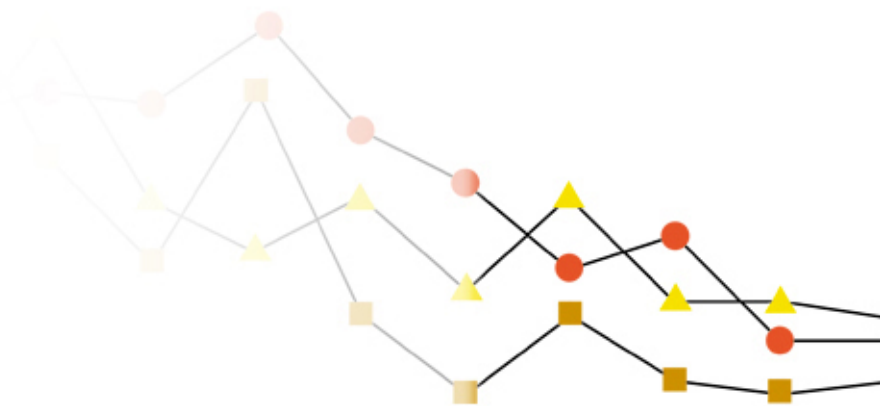


An epidemiologist

Background

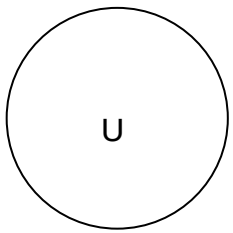


1/1000



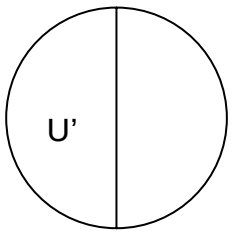
An epidemiologist

Background

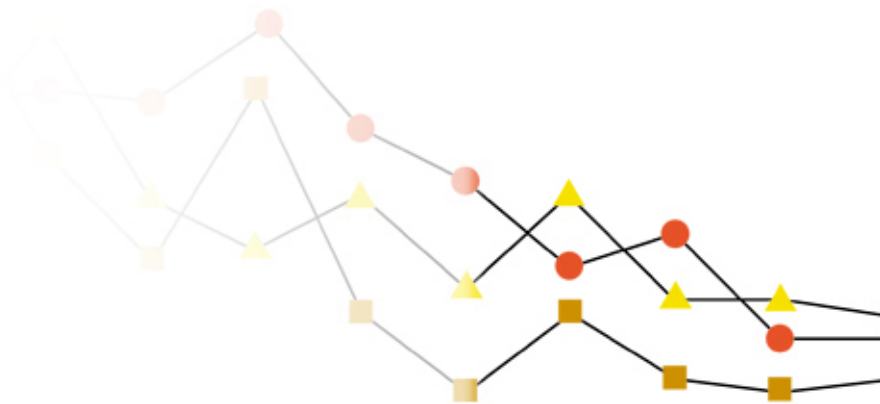


1/1000

Asbestos only

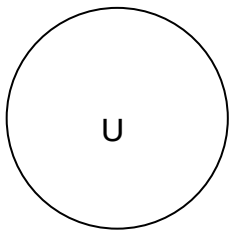


4/1000



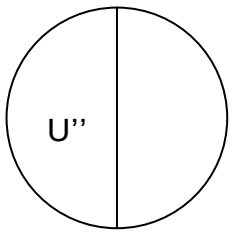
An epidemiologist

Background

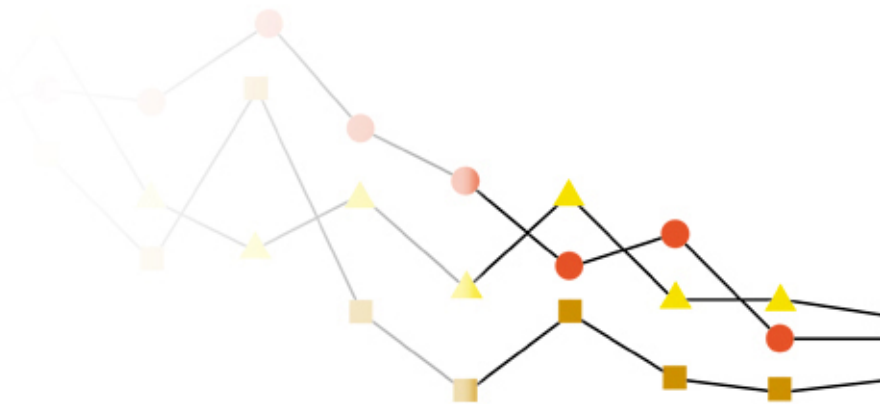


1/1000

Smoking
only

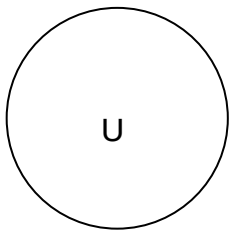


9/1000



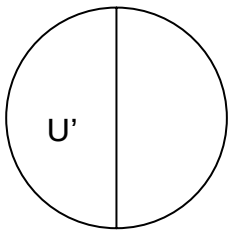
An epidemiologist

Background



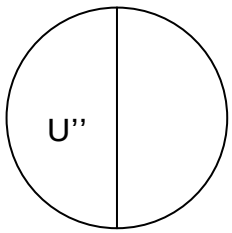
1/000
1/35 (3%)

Asbestos only



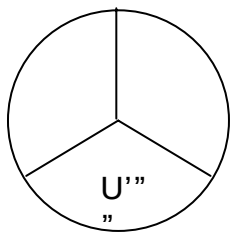
4/1000
4/35 (11%)

Smoking only



9/1000
9/35 (26%)

Both

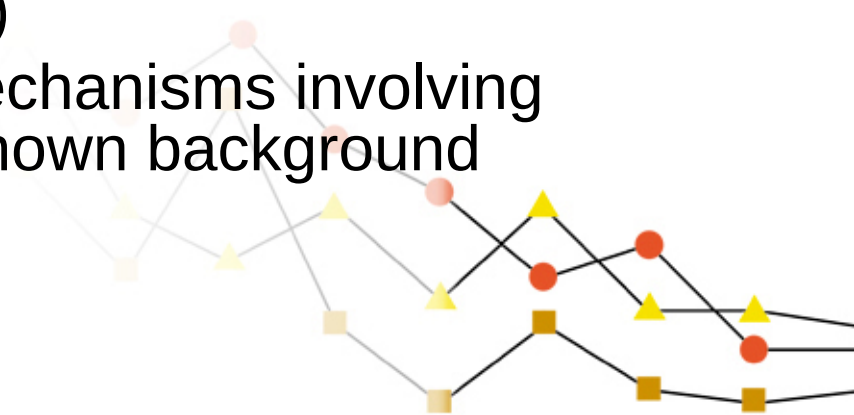


21/1000
21/35 (60%)

An epidemiologist

In the group exposed to both factors:

- 1 case (3%) occurred through unknown “background” exposures (U)
- 4 cases (11%) through mechanisms involving asbestos exposure (A) alone (and not smoking) together with unknown background exposures (U’)
- 9 cases (26%) occurred through mechanisms involving smoking (S) alone (and not asbestos) together with unknown background exposures (U’’)
- 21 cases (60%) occurred through mechanisms involving both factors (A+S) together with unknown background exposures (U’’’)



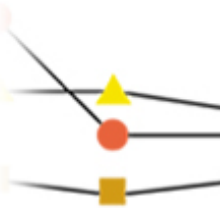
Interaction (Effect Modification)

- Do factor S and factor A *interact*?
- Does the *effect* of S (in causing disease Y) depend on whether or not A is present?
- The answer to the latter question depends on what we mean by the word effect
- This word has different meanings for biostatisticians, public health workers, physicians, biologists and epidemiologists

Chapter 8

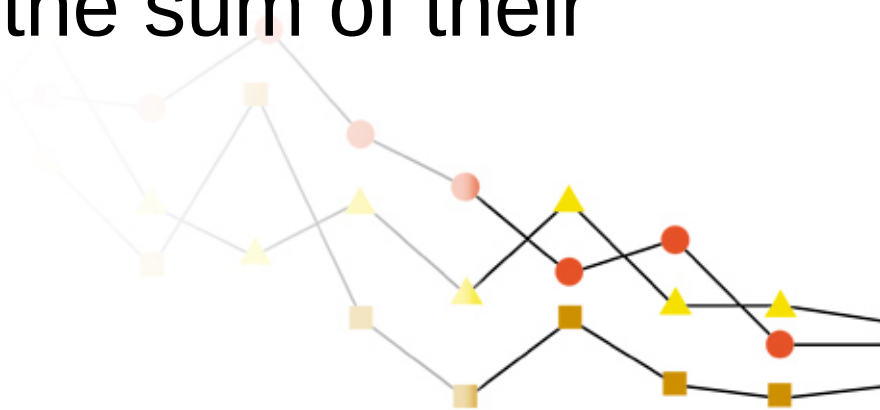
Effect modification

- Concepts of interaction
- Multiplicative and additive models



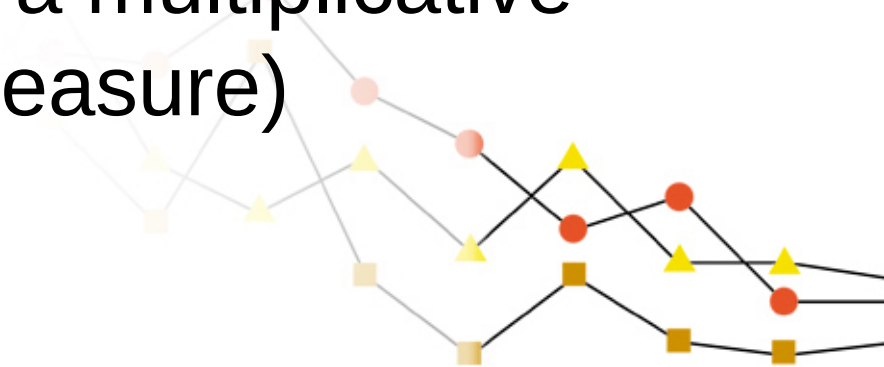
Interaction (Effect Modification)

- In most perspectives (and particularly from the viewpoint of epidemiology and public health), two factors (A and B) are considered to be *independent* if their effects are additive, and they are considered to *interact* if their *joint effect* is different from the sum of their *independent effects*.



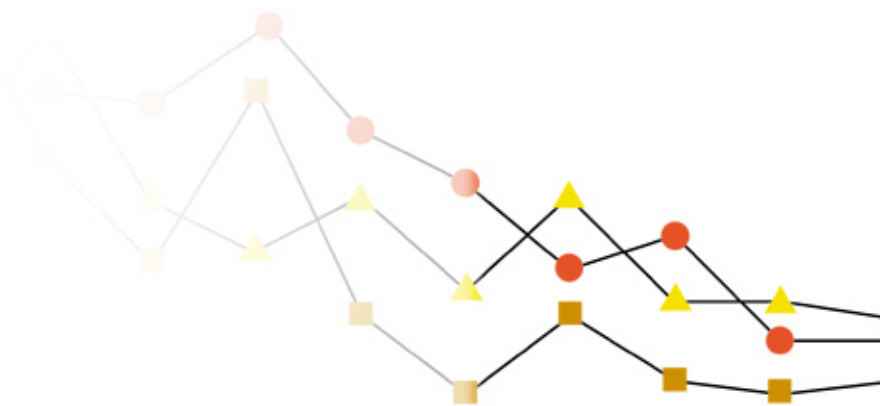
Interaction (Effect Modification)

- Interaction should be assessed in terms of a departure from additive effects (this requires an additive model, i.e. a *risk difference* measure)
- There are several reasons why it is generally preferable to use a multiplicative model (i.e. a *relative risk* measure)



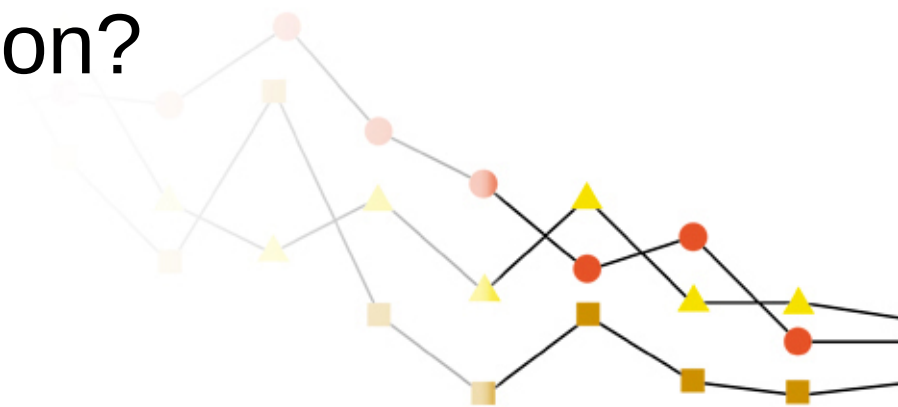
Interaction (Effect Modification)

- When studying the interaction of factors A and B, we can use a relative risk model (adjusting for all other potential confounders), but present the *independent* and *joint* effects of factors A and B



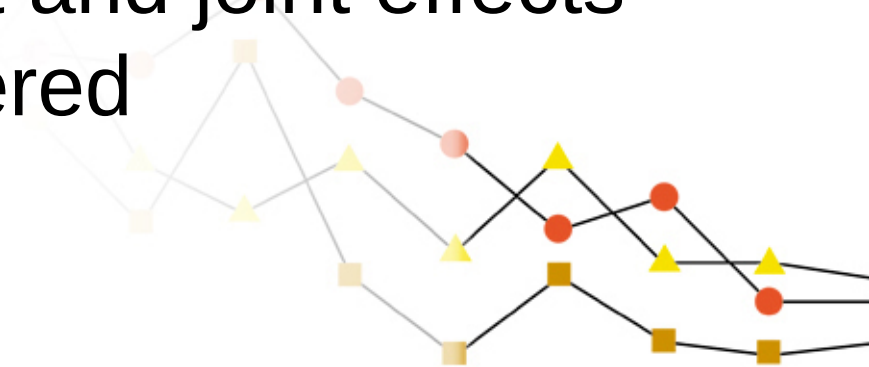
Issues in Interaction

- Additive and multiplicative models are not the only options
- Under most biological models, factors which are part of the same causal process have joint effects which are more than additive
- Should we test for interaction?



Issues in Interaction

- Most studies are consistent with both additive and multiplicative models and tests for interaction have low statistical power
- Whatever pattern the data follows, we can get all the information we need simply by calculating the independent and joint effects of the factors being considered



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