Interpreting Epidemiological Studies

To date there have been several studies investigating possible associations between adverse health effects and exposure to radiofrequency (RF) electromagnetic fields emitted by radio sources, including mobile phones and radio broadcast towers. Whilst these studies have received public attention, their interpretation is not straightforward due to methodologic difficulties. Furthermore it should be noted that while epidemiological studies can indicate possible factors influencing health, they cannot be used to unequivocally prove causation.

What is Epidemiology?

Epidemiologists study statistical associations between risk factors and patterns of illness which occur in human populations. Through epidemiology we have been able to learn a great deal about disease incidence and causes of disease. Such studies are important for health risk assessments as they directly study people, however, they must be interpreted with caution.

Conducting an Epidemiological Study

Every study must first begin with a clear and fixed definition of one or more hypothesises regarding what risk factors and illnesses are to be tested. Appropriate study populations are then selected, and their exposure to the agent under consideration is assessed. The five main criteria for establishing a likely association are the s*trength of association* (the relationship must be clear), *consistency* (repeatable in other study populations, t*emporality* (cause must precede the disease), *plausibility* (it must make sense biologically) and *biological gradient* (dose-response relationship). Studies may be *prospective* (following the future developing pattern of exposure and illness) or *retrospective* (examining past exposures and present illness). The most common types of studies are *cohort, case control* and *ecological* studies.

Cohort Studies

These studies follow a group of healthy people with different exposure levels and assess what happens to their health over time. In these studies exposure precedes the disease occurrence which is necessary to establish possible causation. Whilst expensive and time consuming, these studies suffer least from bias as they make fewer assumptions about the study subjects. Cohort studies are most useful for relatively common diseases.

Case Control

Case control studies compare prior exposure of individuals with a particular health condition and those without it to infer why certain subjects (cases) become ill, whilst others (controls) did not. These studies have a higher potential for *bias* (see below), but are cheaper and easier




to execute than cohort studies. An additional advantage is that such studies allow investigation of rare diseases without having to follow very large populations.

Ecological Studies

These studies describe patterns or trends on a geographic level and can be used to explore potential associations between community-level exposures and disease. However, ecological studies are the least informative, as they are unable to reliably estimate individual exposures.

Interpreting Epidemiological Studies

The results of epidemiological studies, whether they show an association or not, will often be affected by limitations of the study design or analysis. Results may be influenced by errors or unidentified bias in the data, the influence of other relevant factors, or by chance variation. Selection bias can be minimised by choosing comparison populations that are similar (e.g. age, sex, socio-economic, etc) except for the exposure under study. In case control studies, bias in exposure assessments may arise in a subject's ability to recall and report past exposures (*recall bias*). Another important issue is *confounding*, whereby a (potentially unrecognised) factor is both a risk factor for the disease and associated with the exposure of interest. *Exposure misclassification* will also affect the strength of the results. A challenge for RF epidemiology is the quality of assessment of RF exposure, ideally this should assess the exposures induced inside the body. These all have to be assessed carefully before the study can be interpreted as showing a strong association, or giving good evidence against such a relationship.

The strength of an association between exposure and disease is most commonly stated as a *relative risk* or an *odds ratio*. The relative risk is defined as the *ratio of the incidence rate of the disease in exposed group to the incidence rate in unexposed group*. The odds ratio is defined differently for cohort and case-control studies but approximates the relative risk when the disease is rare. The risk estimates will also have quoted an estimate of the statistical uncertainty termed the *confidence interval*. Where the lower bound of the confidence interval goes below 1, the finding is stated as not being *statistically significant*. The statistical uncertainty may also be quoted as a *p-value*, by convention when this is <0.05, the result is termed statistically significant.

Where to go for more information

CDC, An Introduction to Epidemiology: http://www.cdc.gov/excite/classroom/intro_epi.htm
Federal Judicial Center, Reference Manual on Scientific Evidence, 2ed: http://www.fjc.gov/