

# Pesticides and Reproductive Health

SMARTtrain Chemical Notes 6

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This background note is intended for trainers delivering to groups which include women. It attempts to summarise what we know about the risk pesticides pose to reproductive health and to identify the issues associated with managing those risks in the workplace.

## What's reproductive health and what's it got to do with me?

Disorders of human reproduction include:

- birth defects
- developmental disorders
- spontaneous abortions
- low birth weights
- premature births
- reduced fertility
- impotence
- menstrual disorders.

Chemical exposure can contribute to these disorders.

Historically, most people exposed occupationally to chemicals have been men. Males have dominated the workforce in industries that either manufacture or use chemicals. Industries where chemicals are known to affect women's reproductive health, such as lead refining, have managed the risk by excluding women of child bearing age from employment. In a time when women didn't want to work in these industries, or it was not considered socially acceptable for them to work in these industries, exclusion from employment on the basis of gender was an effective risk control. This approach raises equity issues and is not as acceptable as it once was.

As more occupations have become open to women, chemical exposures that were not of concern in an all male workforce have gained prominence. While many chemicals that affect reproductive health adversely affect both men and women, men's reproductive health has not received the same attention as women's.

Historically, agriculture has been male dominated. However, in recent years, women have entered more and more occupations in agriculture. Some of these involve exposure to pesticides. While men tend not to worry about exposures that may affect their reproductive health, women in general tend not to be quite so indifferent.



Women are increasingly exposed to pesticides in agriculture. Source: Mark Scott

## Can pesticides affect human reproduction?

Some pesticides are suspected of being fetotoxic (fatal to foetuses) and teratogenic (causing birth defects) on the basis of laboratory studies involving animals. (Over 1000 chemicals, mostly industrial, have caused adverse reproductive effects in laboratory animals but few have been studied in humans.) The animal studies are mostly carried out on rats and mice but occasionally rabbits and dogs are also exposed. To determine if pesticides affect reproduction, animals are usually dosed orally but sometimes they are injected or subjected to inhalation of vapours.

Contrary to popular opinion, there are naturally high background rates of miscarriage (from one in five to one in six – with an estimated additional 15-40% of embryos dying before pregnancy is confirmed), birth defects (3% of live births) and developmental disabilities (17%). One in twelve US couples fail to conceive after a year of unprotected sex. Because of these high background rates, it is usually difficult to determine the exact contribution of specific factors such as chemical exposure, although some industrial exposures such as lead and ionising radiation have been positively identified.

There is better information on male than female reproductive health, as factories where chemicals are manufactured tend to employ males. In a manufacturing plant, exposures are a lot higher than in agriculture because the workers are exposed to the concentrate throughout their shift. Pesticides such as carbaryl and 2,4-D affect sperm quality, which can lead to fertility problems for males. A male contract weed sprayer who was using 2,4-D regularly would be wise to minimise exposure in the interests of maintaining fertility.

Common reproductive hazards include alcohol, tobacco, recreational drugs, infectious disease (e.g. German measles, mumps), prescription medications (e.g. thalidomide), and radiation (e.g. X rays). Hereditary (i.e. genetics) and age are also factors. Even so, known factors only account for about a third of all cases. The other two thirds are of unknown origin.

Most pesticides given at high oral doses to rodents will result in one or more of the following:

- death of foetuses
- miscarriages and spontaneous abortions
- reduced birth rates of litters
- birth defects in survivors
- impaired behaviour of survivors
- reduced male and/or female fertility
- adverse effects on the health of pregnant females.

This is not surprising as, irrespective of toxicity, if the dose of a substance is increased beyond the body's ability to biotransform and excrete it, adverse health effects are virtually inevitable. The weakness of high dose animal testing is that it fails to discriminate. If most dose regimes result in the same outcome, the testing is not much of a guide to which chemicals are harmful and which aren't.

Animal testing is based on the assumption that testing animals genetically similar to humans is a good guide to what will happen to humans. However, where several species are tested, e.g. rabbits and dogs in addition to rats and mice, more likely than not the test results will vary. What species predicts what will happen with humans in the case of varying results: rats, mice, rabbits, dogs?

Recent genetic mapping of species has revealed it is not the common genetic material that is critical but the small amounts of genetic material that are different. This research supports the criticism of high dose oral testing of rodents for regulatory purposes made by Bruce Ames and others. (Bruce Ames developed the Ames test, which is the standard laboratory test for mutagenicity or whether a chemical can cause mutations.)

The high oral doses given to animals are not an accurate guide to human occupational exposure for the application of agricultural chemicals. What we want to know in respect of humans is what happens in the case of low dose exposures. For ethical reasons, we can't subject humans to the same experiments we carry out on animals.

In the case of humans, we are limited to statistical studies known as occupational epidemiology. We compare a group of people exposed to pesticides to a group of similar people who are not exposed. We look for a statistically significant association between the pesticide exposure and a health outcome that shows the exposed group has worse health outcomes than the unexposed group. In the case of women's reproductive health, e.g., we might look for an association between exposure to pesticides and an increased rate of miscarriages or birth defects compared to the similar group of women who were not exposed.

Few studies have been done on reproductive health in agriculture. Such studies tend to be inconclusive for the following reasons:

- small numbers of people studied, which makes it difficult to identify and measure causal factors even if they are present;
- poor, non-existent or estimated chemical exposures, which makes it difficult to detect a statistically significant association between a suspected causal agent and an adverse health effect;

- confounding factors, i.e. aspects of agricultural work that could cause problems with human fertility other than pesticides - heavy physical work, zoonotic diseases (transmitted by animals), organic substances, e.g. dusts and moulds, non-pesticide workplace chemicals, e.g. solvents, fertilisers, welding fumes.

Without confirmatory human evidence, the results of high dose animal studies provide little guidance as to what will happen to humans, especially in low exposure occupational settings.

## What is the occupational risk?

While there are no specific standards designed to protect people from pesticide exposures that will cause toxic reproductive effects, adhering to general occupational exposure standards will usually also protect against reproductive toxicity. The problem in relation to pesticides is that virtually all exposure standards relate to inhalation, which is not a significant exposure pathway for pesticide application (except for fumigants).

Most occupational exposures relating to the application of agricultural chemicals are dermal or through the skin. Dermal exposures have to be much higher than oral to achieve the same health effects. High dermal exposures are rare in the workplace.

The highest occupational exposures to agricultural chemicals occur in manufacturing plants, where workers are continually exposed to the concentrate and its constituents. In some cases, e.g. chlordimeform and carbaryl, high human exposures produce the same results as experimental animal studies.

Just because a pesticide affects rodent fertility, it does not mean it will also affect human fertility. Conversely, because it does not affect rodents, it does not mean it won't affect humans. At best, animal data are a rough guide.

For the majority of people working with pesticides, the exposures are too low to cause any adverse health effects. This absence of high exposures is what protects people, not the regulatory system which tests and classifies pesticides in terms of their toxicity. While the population risk is low, the individual risk is unknown. You can't extrapolate from population risk to individual risk. You have to assess individual risk in terms of known risk factors. When it comes to pesticides and reproductive health, there are too many unknowns.

## How does the regulatory system respond?

As a precaution, if rodent data reveal an effect on female fertility we assume a similar effect on humans, e.g.

- Bromoxynil (a commonly used herbicide in field crops and pastures) is a developmental toxin or teratogen, so we apply a large uncertainty or safety factor – we divide the dose that effects rats by 1000 to calculate the ADI (acceptable daily intake or the amount of pesticide a person can consume each day over a lifetime without harming their health) and the ARfD (acute reference dose or the amount of pesticide a person can consume over a short period of time such as in a single meal or over a day without harming their health). These safeguard the diet by making residues miniscule. Controlling potentially harmful residues in the diet is a public health risk. To achieve very low ADIs and ARfDs, the MRL (maximum residue limit) is correspondingly low. In turn, to achieve this, extended WHPs (withholding periods) are mandated on label to extend the time elapsed between pesticide application and harvest to allow the residues to decline.

- Procymidone (a fungicide use to control diseases in a range of fruit, vegetable and field crops) is similarly toxic, so the APVMA has applied a label warning – 'causes birth defects in laboratory animals. Women of child bearing age should avoid contact with procymidone.' Such warnings are applied if the animal data are highly suggestive, pending finalisation of a human exposure assessment. Procymidone is currently under review and the label warning is precautionary. When the review is finalised, there may be new label instructions, especially in respect of PPE, to reduce the risk. If wearing more PPE doesn't reduce the risk sufficiently, some use patterns could be deleted, e.g. application by hand held equipment, where the risk of exposure is greater than using a boom spray.

Sometimes, manufacturers withdraw products from the market without regulatory intervention. The fungicide benomyl was suspected of causing human birth defects (on the basis of animal studies) and was the subject of a number of highly publicised damages cases. A review was begun in Australia but was abandoned when the registrant voluntarily withdrew the product. The adverse publicity generated by the court cases in the US killed the market for the product. In addition, there was the likelihood that anyone whose child was born with birth defects and could prove an exposure to benomyl would seek damages from the manufacturer. Just because a court awards damages, or a manufacturer settles out of court, doesn't prove a causal effect. There are still no human epidemiological studies that prove benomyl could have caused the birth defects claimed.

## How should the workplace respond?

The Australian College of Occupational Medicine recommends that women who are pregnant or likely to become pregnant should protect themselves against chemical exposures that may have adverse reproductive effects. What constitutes 'protection' is not defined. Other agencies such as the ILO (International Labour Organisation), NIOSH (National Institute for Occupational Health – US) and the European Agency for Safety and Health at Work make similar recommendations and are similarly vague about specific agents and specific protective measures.

At an individual level, for advice on pregnancy, fertility and occupational exposure to chemicals, talk to a medical practitioner who specialises in occupational health. These doctors will know what screening tests are available to monitor pesticide exposure (see below).

In a family farming situation, work can generally be rearranged so that the women involved are not likely to be exposed to pesticides.

How to deal with women's exposure in an employer-employee situation, e.g. women weed spraying for councils or working in green houses and packing sheds, can be complex. It may not be practical to job rotate or to exclude women who are or who are likely to become pregnant from pesticide exposure without excluding them from the workplace altogether. There is an equity issue in balancing protection of health with equal employment opportunity.

In these workplaces, gender should be taken into account in doing risk assessments and deciding upon control measures:

1. When identifying hazards, include health as well as safety; ask women to identify occupational health issues of concern in the workplace; encourage women to report health and safety hazards that may affect them.
2. When assessing risks, ensure women are involved.
3. When implementing control measures, eliminate risks at source to protect both genders (see below); select PPE that fits women (much PPE, e.g. respirators, is made to fit males); involve women in deciding upon control measures.
4. When monitoring and reviewing control measures, ensure women are involved; and consider gender specific health surveillance (see below).

The best way to balance equity with protection of health is to move to a pest management strategy that does not include broad spectrum pesticides that harm both pests and people, e.g. IPM (integrated pest management) and biological insecticides such as Bt (a naturally occurring soil bacterium poisonous to insects) and NPV (a naturally occurring insect virus that kills insect larvae if they eat it). This is an example of a control measure that eliminates risk at the source to protect both genders equally. Elimination of broad spectrum pesticides that are toxic to human health is more achievable with insect pests.



Women in greenhouses can be exposed to pesticides that persist on plants. *Source: NSW I&I Image Library*



PPE designed for males doesn't always fit women: this half-face respirator is too big for someone with a small nose and flat cheekbones, failing to provide a perfect seal to keep fumes out. Source: Mark Scott

Minimising pesticide exposure for those involved in environmental weed spraying is more difficult. While there are complementary controls to pesticide application by adopting an integrated weed management approach, there are few stand-alone biological controls. Manual removal or weed chipping is not a viable alternative for pregnant women as excessive physical effort is a pregnancy risk in itself. While many herbicides are reproductive toxins at high doses, these are not likely to occur in a typical occupational setting.

For women involved in environmental weed spraying, monitoring of exposure might be warranted. There are screening tests available for common herbicides: 2,4-D, bromoxynil, clopyralid, dicamba, picloram, triclopyr, glyphosate and MCPA. Urine samples are taken and analysed. All employees involved in weed spraying should be screened, both men and women. The pathology does not measure health effect. If metabolites or traces of the herbicides show up in the screening of the urine samples, it means no more than that the person has been exposed to the herbicide. High levels mean higher exposure, low levels mean lower exposure. The screening should be carried out in conjunction with auditing of work practices. Ideally, women should have no or low exposures. If, however, they have high exposures, changes should be made to their work practices to reduce the exposures.

## How do I manage occupational exposure?

The key decision for the individual is whether or not to accept low exposure or no exposure. Good work practices will result in low exposures that are not likely to pose a threat to reproductive health. No matter how careful a person is, it is virtually impossible to handle pesticides without some level of exposure. Low exposure means low risk, not an absence of risk. If the individual is unwilling to accept any level of risk, then the only option is to avoid exposure altogether. This should be kept in mind when deciding upon what employment to accept.

In a workplace where women are employees, women should be directly involved in risk management (see above). The aim should be to reduce the exposure to the lowest level practicable. Individual women who are pregnant should be allowed to choose between accepting low exposure or no exposure. For those pregnant women who opt for no exposure, they should not be discriminated against but allocated other duties.

To avoid exposure altogether in respect of pesticides, DO NOT

- mix and load
- apply (including post-harvest dips and biocides for ornamentals)
- clean up
- re-enter sprayed crops (including activities like picking, pruning, bug checking etc).

Sources:

Australian College of Occupational Medicine, 1989, *Pregnancy and Occupation*

NIOSH, 1999, *The Effects of Workplace Hazards on Female Reproductive Health*

NIOSH, 1997, *The Effects of Workplace Hazards on Male Reproductive Health*

European Agency for Safety and Health at Work, 2003, *Including gender issues in risk assessment*

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ALWAYS READ THE LABEL

Users of agricultural (or veterinary) chemical products must always read the label and any Permit before using the product, and strictly comply with the directions on the label and the conditions of any Permit. Users are not absolved from compliance with the directions on the label or the conditions of the permit by reason of any statement made or not made in this publication. Job number 9661