

Chapter 1 — Introduction

History

In recent years, few environmental issues have aroused the concern of the public as much as pesticides, especially in relation to the health of children. In spite of the many published studies on the subject of pesticides and human health, there remains deep controversy surrounding this issue. This report will try to elucidate the results of the many studies of pesticides and health, and draw conclusions as to the true health effects of pesticides.

To understand this controversial issue it is helpful to look at the history of pesticide use. Prior to World War II, the pesticides that we use now did not yet exist. Some pesticides currently in use were in fact developed during the World War II for use in warfare. The organophosphate insecticides were developed as nerve gases, and the phenoxy herbicides, including 2,4-D (the most commonly used herbicide in Canada), were created to eradicate the Japanese rice crop, and later used as a component of Agent Orange to defoliate large areas in jungle warfare. After World War II, these chemicals began to be used as pesticides in agricultural production, for environmental spraying of neighbourhoods for mosquito eradication, and for individual home and garden use.

During the 1960s and 1970s, epidemiologists in the USA noted a rise in the incidence of non-Hodgkin's lymphoma (NHL). When plotted on a map of the USA these cases were clearly clustered in agricultural areas. This increase in NHL incidence paralleled the rise in pesticide use, prompting some epidemiologists to theorize that there was a causal link. Rachel Carson's revolutionary book, *Silent Spring* (1), first published in 1962, started the slow process of raising political and public awareness of the hazards posed to wildlife, humans, and the ecosystem by the use of pesticides. This process continued with *Our Stolen Future* (2), described by then Vice-President Al Gore as the sequel to *Silent Spring*, which documented the health effects of endocrine-disrupting chemicals. Since then there have been hundreds of scientific studies done on all continents to determine if there is a relationship between pesticide use and human health problems.

Laws in Canada

Since 1990, when the municipality of Hudson, Quebec passed a by-law restricting the use of cosmetic pesticides on public and private property, pesticides have received considerable media attention in Canada. In 1991, two lawn-care companies challenged the Hudson by-law on the grounds that pesticide use was not within municipal jurisdiction. The court affirmed that municipalities do indeed have the power to pass by-laws regarding pesticide use, so the lawn-care companies appealed the ruling. In 2001, the Supreme Court of Canada upheld the municipality's right to pass the by-law. Interestingly, although the health effects of pesticides were not argued during the Supreme Court challenge, the judgement implied that this had been an important factor in the Court's decision (3). Since then, many municipalities across Canada, including Toronto and Halifax, have passed by-laws restricting the cosmetic use of pesticides. Cosmetic use of pesticides remains a complicated issue involving arguments about the rights of lawn-care and pesticide companies, property owners' rights, and increasingly, the health effects of pesticides.

Issues in Design of Pesticide Studies

So why, with so many studies available, is there still such controversy surrounding the issue of the health effects of pesticides? For ethical reasons, randomized controlled trials, which are the most conclusive studies of cause and effect, are not done with potentially harmful chemicals, so we rely on other types of studies that have marked limitations. Most of the studies done examine farmers, pesticide applicators, gardeners, and other occupational groups with higher exposures to pesticides than those of the general population. The subjects are mostly adult males, subject to multiple exposures to various pesticides and other toxins and carcinogens such as diesel fumes, animal viruses, and cadmium. If evaluated at all, the exposure history is often indirect and may be determined by a surrogate measure such as type of crop grown, annual expenditure on pesticides, or job description, rather than by direct evaluation of the exposed persons. Confounding factors and covariates are often incompletely assessed, and information such as cause of death from death certificates may be inaccurate or incomplete. In addition, the harmful health effects of the so-called inert substances used in pesticide products to potentiate the active ingredients can be difficult to separate from those of the active pesticide ingredients.

Some studies use case-control designs, which do provide good exposure histories, but are marred by the problems of recall bias, low participation rates, and loss to follow-up. The other main study type is ecological, which neither considers exposure at the individual level nor measures pesticide exposure directly. For example, an ecological study may use as an exposure measure the number of tons of pesticide applied annually in a particular county.

Finally, because all humans have some degree of background environmental pesticide exposure (4), there is never a true control group for any study design.

Routes of Exposure

There are many sources of exposure to pesticides. The three routes of exposure for pesticides are oral ingestion, dermal absorption, and inhalation. Lawn and garden pesticides are used in homes and gardens, on golf courses, along highways and hydro rights-of-way, and in public parks, exposing people by all three routes. Pesticides can be tracked into homes, or brought home from work on clothing and in vehicles, exposing family members as well. Pesticides are used in pet flea collars, in treatments for scabies and lice, and for home infestations of wasps, cockroaches, and ants. Agricultural pesticides are used on farms, greenhouses, and orchards, and consumers eating produce and other food products ingest them. Pesticides used domestically or in agriculture run off into ground and surface water, exposing entire populations.

Prevalence of Use

According to a 1997 inventory performed by the Quebec government described in *Lawn and Garden Pesticides: A Review of Human Exposure and Health Effects Research* (5), over 80% of pesticides sold in Quebec are for agricultural purposes, 8.5% are for domestic use (indoor and outdoor), and 3.0% for ornamental horticulture. Although herbicides are the most commonly used pesticide for lawn and garden care, homeowners purchase 3.7 times the amount of insecticides recorded for use in ornamental horticulture. According to a survey done by Toronto Public Health, “approximately 45% of Toronto homeowners with lawns had treated their yards with pesticides in the past two years. This figure reflects both homeowner application and those performed by a professional lawn care company” (5).

Children are particularly vulnerable to the effects of pesticides. Children eat and drink more per kilogram of body weight than adults. Their skin is more permeable and their livers do not excrete as efficiently as adults'. Their hand-to-mouth behaviour increases the chance of ingestion and their dermal contact is increased because of a proportionally larger skin surface, and because they play on the ground outdoors and on the floor indoors. Parents track pesticides indoors on their shoes, inadvertently exposing their children (6). Some pesticides that degrade outdoors in sunlight are more persistent once they are present indoors.

Rationale for Study

Acute effects of pesticides are well documented in the literature, especially with respect to organophosphate poisoning. However, the *chronic* effects of pesticide exposure are much more difficult to assess. Hundreds of studies done in the past few decades have attempted to establish whether chronic exposure to pesticides has adverse effects.

This systematic review of pesticide health effects was initiated in response to a complaint to the Ontario College of Family Physicians by a pesticide lobby group about the College's pesticide education brochure. This information pamphlet, produced in 1998, was designed to educate health professionals. The lobby group claimed that information describing harmful effects of pesticides was inaccurate. This complaint is typical of the confrontations between health advocates and pesticide lobby groups about the true health effects of pesticides, reflecting the difficulties we have in interpreting the studies available, and the dearth of systematic literature reviews on the subject. It may also reflect the fundamentally different interests and perspectives of the two groups.

Description of Study

This project is a systematic review of studies done since 1992, and was conducted with financial support from the Laidlaw Foundation. Chapter 2 details the methods used in the study, and Chapters 3–9 describe the findings of the review regarding major health effects, including nine types of solid tumours, non-Hodgkins lymphoma, leukemia, genotoxic effects, skin diseases, neurological diseases, and reproductive effects. The report also discusses findings specific to children (Chapter 10), and concludes with a chapter on implications for practising family physicians. We hope the report will contribute to a better understanding of this controversial topic, inform those who produce professional and patient educational materials, and aid various levels of government to direct policy on this important health issue.

Chapter 1 — Introduction

References

1. Carson R. *Silent Spring*. 40th anniversary ed. New York: Houghton Mifflin; 2002.
2. Colborn T, Dumanoski D, and Myers JP. *Our Stolen Future*. Toronto: Dutton; 1996.
3. Supreme Court of Canada. Decision regarding 114957 Canada Ltée (Spraytech, Société d'arrosage) v. Hudson (Town). Montreal: University of Montreal, Faculty of Law; 2001 [cited 29 March 2004]. Available from: http://www.lexum.umontreal.ca/csc-scc/en/pub/2001/vol2/html/2001scr2_0241.html
4. Hill RH, Head SL, Baker S, Gregg M, Shealy DB, Bailey SL, et al. Pesticide residues in urine of adults living in the United States: reference range concentrations. *Environ Res* 1995;71(2):99–108.
5. *Lawn and Garden Pesticides: A review of human exposure and health effects research*. Toronto: Toronto Public Health; April 2002.
6. Bradman MA Harnly ME Draper W Seidel S Teran S Wakeham D Neutra R. Pesticide exposures to children from California's Central Valley: results of a pilot study. *J Exp Anal Env Epi* 1997;7(2):217–34.