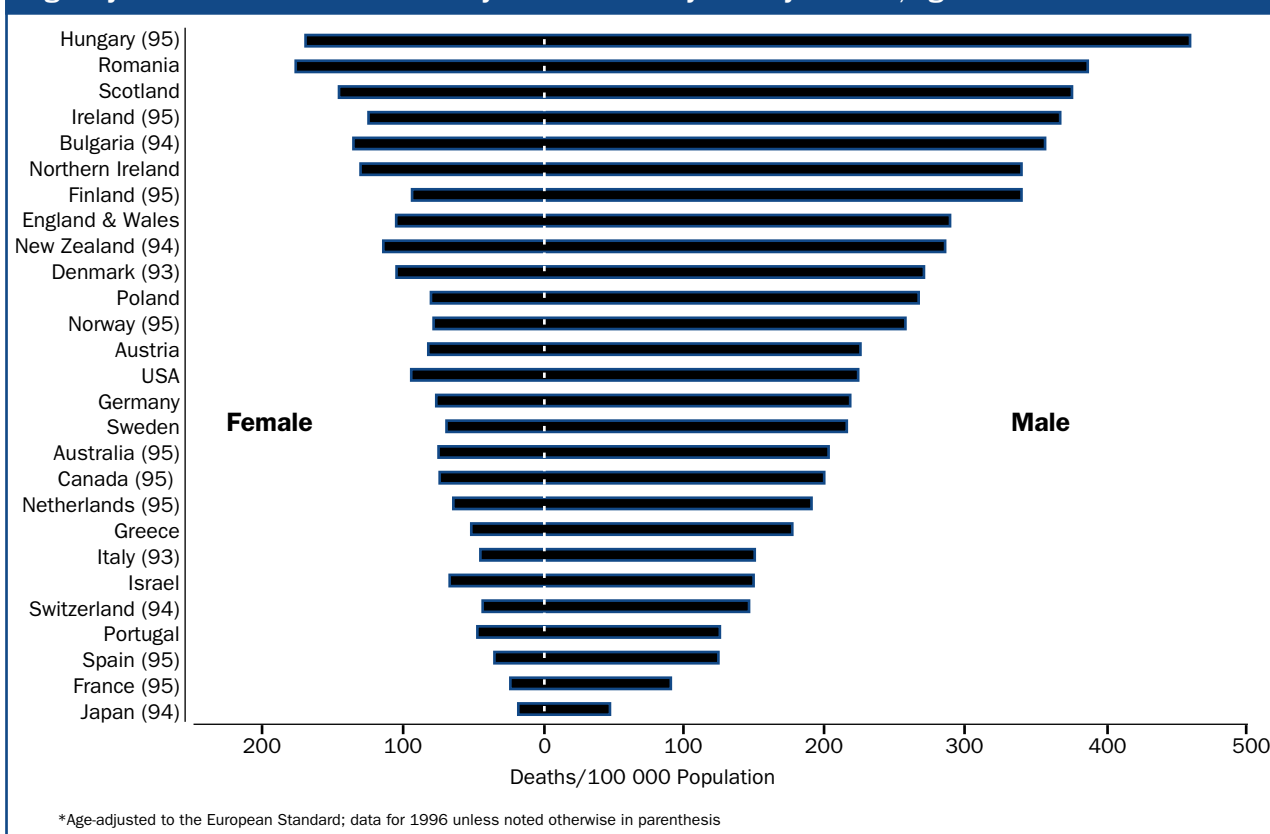


Age-adjusted death rates* for coronary heart disease by country and sex, age 35-74



differences in cardiovascular disease will come from large, longitudinal studies of multi-ethnic cohorts specifically designed to assess the relative contributions of risk factors to subclinical atherosclerosis and incidence of individual cardiovascular-disease outcomes.

Despite many unanswered questions, efforts to control high blood pressure, hypercholesterolaemia, and cigarette smoking must be pursued in all populations because the benefits of risk-factor modification on reducing morbidity and mortality from cardiovascular disease are universal.

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How toxic is DDT?

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In many regions of the world, especially Europe and the USA, people have forgotten what it is like to have endemic malaria. One of the most important reasons why these regions are no longer endemic for malaria is the use of DDT (dichlorodiphenyltrichloroethane) after the 1939-45 war. When DDT was first used in Naples in January, 1944, 1.3 million civilians were dusted, and even in the midst of winter the incidence of typhus fell sharply.¹ Subsequently, many allied troops and refugees were dusted or wore clothes impregnated with DDT to protect against vermin and typhus. Since DDT turned out to be a highly potent contact insecticide, its potential in the control of malaria was soon recognised. The spraying of houses with DDT led to striking reductions in mosquito counts indoors and, subsequently, in cases of malaria. Reports of such findings, with huge economic benefits, came from Europe, Africa, the USA, India, Sri Lanka, and South America.² The start of the decline, by the early 1960s, of the use of DDT in Europe and the USA, was due partly to the introduction of other insecticides but was also hastened by the recognition that DDT and its metabolite DDE (dichlorodiphenyl-

dichloroethylene) persisted in the environment and might harm some species of wildlife.² Much of the environmental concern arose as a result of the general use of DDT for the control of many pests and because DDT was not distinguished from other insecticides, but there has also been concern over its direct effects on human beings.

DDT is prohibited in many industrialised countries, and the United Nations Environmental Programme is starting negotiations for a global ban. In today's *Lancet* D R Roberts and colleagues argue for the continued use of DDT, on grounds of its value for malaria control and its safety.

The early toxicological information on DDT was very reassuring; it seemed that acute risks to health were small. If the huge amounts of DDT used are taken into account, the safety record for human beings is extremely good. In the 1940s many people were deliberately exposed to high concentrations of DDT through dusting programmes or impregnation of clothes, without any apparent ill effect.³ There are probably few other chemicals that have been studied in as much depth as has DDT, experimentally or in human beings.³ It quickly became clear that the dermal toxicity of dry DDT was very low, but even the oral toxicity depended on the composition of the diet. By contrast dieldrin caused poisoning of sprayers in many malaria-control programmes² and is equally toxic by oral and dermal routes, the acute toxicity to rats being more than three times that of DDT.³ Ingestion of DDT, even when repeated, by volunteers or people attempting suicide has indicated low lethality, and large acute exposures can lead to vomiting, with ejection of the chemical. The earliest symptoms are hyperaesthesia of the mouth, followed by paraesthesia of the tongue, dizziness, tremors, and vomiting. Few toxicological effects due to inhalation of DDT have been reported. Some deaths attributed to DDT have been due to mixtures with other chemicals or solvents.³ Dermatitis in workers exposed to DDT was also probably due to solvents. Thus with acute or high-level exposure, DDT is probably safer than many other chemicals.

What concerns most people is chronic exposure to DDT. Evidence for any paraesthesia, headaches or dizziness, or changes in liver-function tests in workers who worked with or used DDT are very rare despite the presence of significantly raised serum concentrations of DDT or DDE.³ Many of those workers investigated have been sprayers in antimalarial programmes. As exemplified by malaria control in Natal,^{4,6} serum DDT has been significantly higher in sprayers and members of sprayed households than in control populations, and the chemical may be passed in the milk to infants, but associated toxicity has not been proven.

Of great concern has been the potential association between cancer incidence and exposure to DDT, especially via an environmental route. Studies of the mutagenicity of DDT and its significance in human beings have not yielded clear results.³ Although DDT acts as a hepatocarcinogen at high doses in some strains of mice, there is no convincing evidence for this effect in human beings.³ A preliminary study of deaths among Sardinian men who had worked with DDT in a malaria-eradication campaign in the 1940s showed a significantly increased risk of liver and biliary-tract cancers among those workers (PMR 2.10, 95% CI 1.17–3.47), but the effect was also found among non-exposed workers (PMR 2.28, 1.43–3.45).⁷ In fact, there is no strong evidence for any associated cancer risk among people exposed to DDT except perhaps among workers who may have been exposed to DDT plus other chemicals, for whom there was an increased risk of pancreatic cancer.⁸ There has been a debate, driven by in-vitro studies, about a

possible link between environmental exposure to DDT and breast cancer in the USA, perhaps due to increased levels of oestrogen receptors, but the overall evidence is weak.⁹ No increased incidence of breast cancer was found among North Vietnamese women who had raised serum DDT concentrations after exposure to antimalarial sprays.¹⁰

Although there is little evidence that chronic low-level exposure to DDT produces serious deleterious effects, the current debate on potential "endocrine disruptors" has brought up the possibility of other potential toxicological effects. DDE has been found to be an antiandrogen¹¹ and, in addition to its proposed link to breast cancer, DDT is commonly cited as having oestrogenic effects. In one study of the most heavily exposed workers in a DDT factory, there seemed to be no effect on their ability to father children.³ In interpreting possible toxic hormonal effects of DDT, it should be noted that in-vitro studies often employ the *o,p*-isomer of DDT, which does have weak oestrogenicity in vivo but has constituted only a tiny percentage of the total DDT used. Nevertheless there has been a proposal that exposure of mice to very low concentrations of DDT in utero or at certain perinatal stages could have subtle developmental influences.¹² This idea or its applicability to human beings would be very difficult to disprove completely.

In summary, DDT can cause many toxicological effects but the effects on human beings at likely exposure levels seem to be very slight. However, the perceived rather than the calculated risks from DDT use are an important consideration in maintaining public confidence. Thus it would seem prudent that if its use was continued for antimalarial campaigns and the benefits of use outweigh the risks, tight control should continue and the effects of spraying DDT should be closely monitored. What has not been discussed here, though, is the environmental issue of any detrimental effect on wildlife.

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