

VIETNAMESE DIOXIN BLOOD AND MILK LEVELS 1970-1999 AND IMPLICATIONS FOR FUTURE EPIDEMIOLOGY STUDIES

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Introduction

The largest known dioxin contamination is believed to have occurred in Vietnam between 1962 and 1971 from spraying of Agent Orange. Approximately 12,000,000 gallons of Agent Orange, half 2,4-D and half 2,4,5-T phenoxy herbicides, was sprayed heavily over discrete areas in the south of Vietnam for purposes of defoliation and crop destruction. Most, 85 %, was sprayed by fixed wing aircraft, with the remainder from back pack, helicopter or naval spraying. Several hundred pounds of 2,3,7,8-TCDD, the most toxic of the dioxins, contaminated the Agent Orange¹⁻³.

Dioxins are currently believed to lead to serious human health consequences including cancer mortality, ischemic cardiovascular disease mortality, immune system alteration, reproductive and developmental pathology, endocrine disruption in children and adults, nervous system damage, liver pathology, transient elevation of blood lipids, skin rashes, rarely including chloracne (rarely), and death⁴⁻⁶.

Vietnam provides a living laboratory for studying the health effects of dioxin contamination and of Agent Orange with its dioxin contaminant. We have previously documented marked elevation in dioxin levels from Agent Orange exposure in the breast milk of nursing Vietnamese mothers, in blood, and in fat tissue. Human milk collected in 1970 in two villages in the South that had been sprayed with Agent Orange had 2,3,7,8-TCDD levels as high as 1,850 ppt (lipid)⁷. Most Vietnamese, however, do not have elevated dioxin from Agent Orange.

We review our previous data after converting them to the new WHO dioxin toxic equivalency values and present new blood dioxin measurements from 1999 samples. We conclude that it is relatively easy to find large populations in Vietnam with elevated dioxin levels from Agent Orange (and sometimes from other sources), as well as a large population with low dioxin body burden, and that Vietnam offers a unique opportunity to learn about the consequences of dioxins in humans. Men, women and children have been exposed to dioxin for a number of decades in Vietnam and several generations can be studied.

Materials and Methods

Whole blood samples from Vietnam were collected in the early 1990s at nine sites in southern Vietnam, four sites in the central region, and two sites in Hanoi, in the North. Blood of 30 to 50 donors at each site was sometimes pooled⁷. During 1999, a single pooled sample from Ho Chi Minh City and eight individual samples from individuals thought by Vietnam Red Cross to have been exposed to Agent Orange were collected. All samples were collected in chemically

Epidemiology: Recent Results and Research Paths P415

cleaned glass jars, frozen at -20° C, and shipped to the dioxin laboratories. Analysis was performed using high resolution gas chromatography-mass spectrometry. The methods have been described previously and will not be repeated here⁸.

Results and Discussion

Results of dioxin analyses of pooled blood samples collected in Vietnam in 1991-92 are graphically presented in Figure 1, along with results of analyses of blood from the general population of the United States and Germany collected in 1996^{9,10}. Measured levels have been converted to dioxin toxic equivalents (TEQ) using the 1998 WHO toxic equivalency factors (TEFs)¹¹. These results have been reported previously using the older I-TEFs^{12,13}. Total TEQ for 3 regions of Vietnam, the United States, and Germany is presented using both sets of TEFs. Total TEQs using 1998 WHO TEFs are increased by 10-20% in comparison with the previous I-TEF results.

The increased mean level of 2,3,7,8-TCDD in pooled and individual samples of blood from Central and Southern Vietnam versus Northern Vietnam corresponds to the areas where Agent Orange was most heavily sprayed.

Epidemiologic studies have examined the association between dioxin exposure and the incidence of cancer, endometriosis, endocrine disorders, cognitive impairment, spontaneous abortion, congenital malformations, and immune deficiency in several populations, and have consistently reported a positive association between dioxin exposure and total cancer mortality, soft tissue sarcoma and non-Hodgkin's lymphoma³⁻⁶. However, only a few epidemiologic studies have examined the risk of health effects from dioxin exposure in exposed Vietnamese populations^{2, 14-16}. Inadequate individual measures of exposure and outcomes, and inadequate control of confounders can be noted in some of these studies. In one case-control study aimed at examining the association between Agent Orange exposure and the risk of gestational trophoblastic disease in Ho Chi Minh City, controls were matched to cases on residence, yet residence was also the method of measuring the exposure, thus diluting the estimated measure of effect¹⁴. Future high quality epidemiologic studies of individuals in Southern and Central Vietnam are needed to assess the long-term health effects of dioxin exposure, especially when the dioxin is a component of the phenoxy herbicide mixture found in Agent Orange. Due to the high cost of dioxin analyses and incomplete medical records in Vietnam, case control studies with appropriate control selection are the most feasible design to evaluate potential associations between elevated dioxin level and adverse health outcomes.

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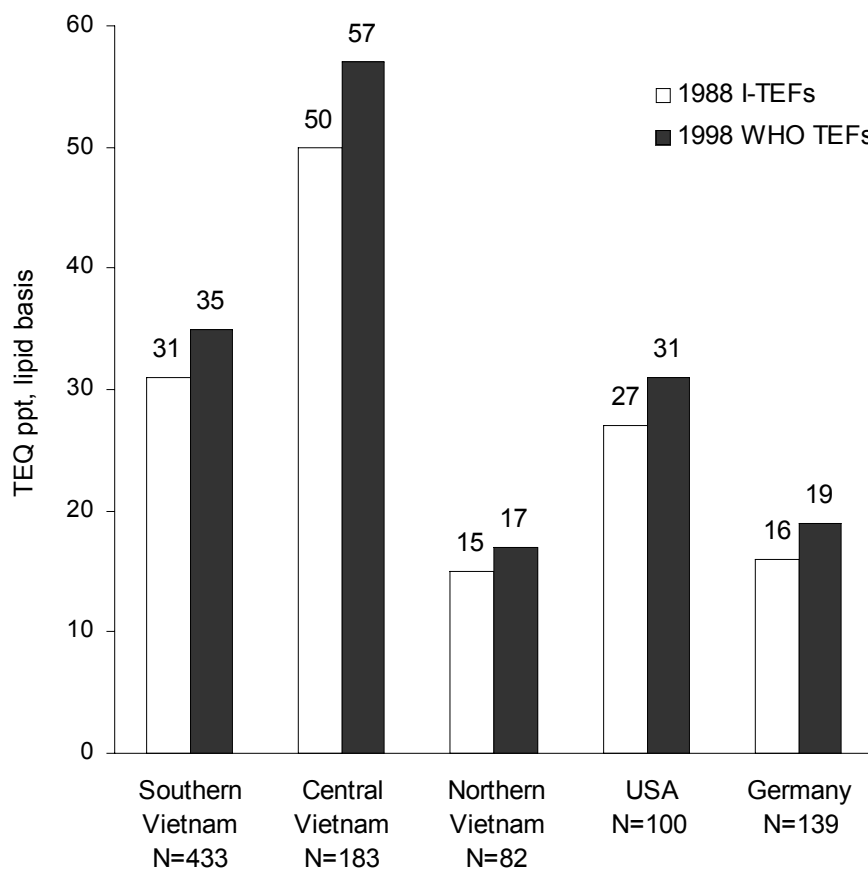
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Epidemiology: Recent Results and Research Paths P415

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Figure 1. Blood TEQ for dioxins and dibenzofurans in three regions of Vietnam, 1991-92, and in the USA and Germany, 1996



Totals calculated with 1988 I-TEFs^{12,13} and with WHO 1998 TEFs¹¹
 pg/g (ppt) lipid basis non-detects=1/2 limit of detection