CAUSE-SPECIFIC MORTALITY AMONG EMPLOYEES OF A NEW ZEALAND-BASED AGRO-SCIENCES MANUFACTURING PLANT: 1969–2004

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Introduction

The former Ivon Watkins-Dow plant (Currently Dow AgroSciences) in New Zealand has been in operation since 1955 making a diverse range of agrochemical products. In the late 1950's and 1960's the plant manufactured phenoxy herbicides including 2,4-dichlorophenoxy acetic acid (2,4-D), 2,4,5-trichlorophenoxy acetic acid (2,4,5-T), and 4-ch1oro 2-methy1phenoxy acetic acid (MCPA). Numerous other herbicides and chemical raw materials were handled in the formulations department of the plant including picloram, atrazine, sinazine, amitrole, and dichloropropionic acid. In 1987, the TCP plant closed and 2,4,5-T production ceased soon after. In 1998, 2,4-D production stopped. The current manufacturing activities include the formulation and packaging of insecticides, herbicides, fungicides and a spraying oil.

Some workers at the plant were included in an international cohort of 18,910 phenoxy herbicide sprayers and production workers designed to evaluate exposure to the contaminant 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD).[1] This study found that soft-tissue sarcomas and non-Hodgkin's lymphoma (NHL) were greater than expected among workers with exposure to 2,4,5-T. The New Plymouth study subgroup included 1,038 men and women who worked at least one month between 1969 and 1984, with vital status follow-up to 1987. In a subsequent study of just the workers at this site found a small excess of all cancers combined and an increase in multiple myeloma but no increase in soft tissue sarcoma nor NHL.[2]

Given these reports about the health risks at the new Plymouth site, the aim of this study was to examine mortality rates for all workers at this site. Thus, we include all employees who worked at the plant between 1969 and 2003, follow these workers to the end of 2004, and determine if the mortality levels were at the site are different than the New Zealand population. This is the first study in a series which will examine the health of these workers.

Materials and Methods

The work history records available were used to identify all the employees who worked at least 1 day at the New Plymouth site between January 1, 1969 and October 1, 2003. Twenty-three individuals who were missing dates of birth were excluded from the analysis. Nine people with missing sex from their records were classified as male in the analysis. The total number of workers in the study was 1,754.

Vital status for each study member was determined from January 1 1969 to December 31, 2003. The search was based on the New Zealand Health Information Service (NZHIS) Mortality Collection, in which deaths registered in New Zealand from 1988 onwards are held in the mortality database, and data from 1970 to 1987 is available on request. Deaths occurring between 1969 and 1987 were matched to work records using an algorithm which required an exact match on date of birth and ranked minor errors in the spelling of surnames and forenames, 9 being a perfect match, with 8 and 7 being minor differences in surname or forename. All matches were examined, and matches of 7-9 proved acceptable. From 1988 onwards, searches were based on the National Health Index (NHI) number on the mortality database, unique to each individual. We then carried out additional searches based on the last known address on the employee database, following name and address changes using the Electoral Roll and Habitation Index; Telephone Book; Companies Office; "Terranet" property information database; and search engines on the internet. Additional deaths up to 1990 were sought from the Registrar-General's Index to Deaths. If a person was not known to be alive at the study end date (i.e. on the electoral roll) an additional search was made through Births Deaths and Marriages. The New Zealand Health Information System (NZHIS) provided the principal and underlying causes of death for all deaths in our study. From the total of 1,754 eligible persons, 247 deaths were observed. Twenty-two percent of the cohort was lost to follow up as

shown in Table 1. This included 392 individuals among which more than a third (156 of 392) were known to have emigrated before the study termination.

The expected numbers of deaths adjusted for age, gender and calendar year were calculated using the OCMAP programme.[3] The New Zealand national mortality rates, obtained from NZHIS, were used as the reference population. Standardized mortality ratios (SMR), and exact 95% confidence intervals (95% CI) were calculated for major causes of death and cancer.

Table 1. Results of Vital Status Follow-up of the 1,754 Workers at the New Plymouth Site from 1969-2003.

Category	Number	%	Person-year Contribution
Alive	1,115	64	31,084
Dead	247*	15	4,579
Lost to follow-up	392	22	2,679
Unknown	236	13	
Emigrated	156**	9	

*Underlying coded cause of death provided New Zealand Health Information Service.
**Three workers died oversees

Table 2. Standardized Mortality Ratios (SMR) and 95% Confidence Intervals (95% CI) by Duration of Employments for Selected Causes of Death.

Cause of Death	Worked less than 90 days	Worked 90+ days
	SMR (95%CI) [# of deaths]	SMR (95%CI) [# of deaths]
All causes	1.2(0.9-1.6)[50]	0.9(0.8-1.1)[197]
All cancer	1.2(0.7-2.0)[14]	1.0(0.8-1.3)[62]
Buccal cavity and pharynx	0.0(0.0-14.5)[0]	2.5(0.5-7.1)[3]
Digestive organs	2.5(1.2-4.8)[9]	1.0(0.6-1.5)[18]
Respiratory system	0.7(0.1-2.6)[2]	1.0(0.6-1.7)[16]
Soft tissue sarcoma	0.0(0.0-49.3)[0]	3.0(0.1-16.9)[1]
Breast (females only)	0.0(0.0-49.3)[0]	0.7(0.1-2.4)[2]
Prostate	0.0(0.0-4.7)[0]	0.6(0.1-1.8)[3]
Kidney	3.5(0.1-19.4)[1]	1.4(0.2-5.0)[2]
All lymphatic & hematopoietic	0.0(0.0-3.3)[0]	1.5(0.6-2.9)[8]
Non-Hodgkin's lymphoma	0.0(0.0-62.0)[0]	1.9(0.5-4.9)[4]
Multiple myeloma	0.0(0.0-19.8)[0]	2.0(0.2-7.1)[2]
Diabetes	1.2(0.0-6.4)[1]	0.9(0.2-2.2)[4]
All heart disease	1.5(0.9-2.4)[18]	0.9(0.7-1.2)[64]
Non-malignant respiratory disease	0.4(0.0-2.0)[1]	0.7(0.4-1.3)[13]
All external causes	1.3(0.6-2.6)[8]	0.7(0.4-1.2)[13]

The rates for those who had worked at the plant for less than 3 months (short term employees) were generally higher than those who worked for three months or more (long term employees). Mortality rates were generally greater in short term employees, with an all causes SMR of 1.2 (95% CI 0.9-1.6). There was a statistically significant excess of all cancers of the digestive system (SMR 2.5, 95% CI 1.2 – 4.8). More deaths than expected were not limited to malignant neoplasm and also occurred from heart disease, and all external causes of death. Conversely, the long term employees exhibited, in general, lower mortality rates with most causes at less than expected rates. These included all causes (SMR 0.9, 95% CI 0.8-1.1), all cancers (SMR 1.0, 95% CI 0.8-1.3), cancers of the digestive system (SMR 0.9, 95% CI 0.6-1.5), and all heart disease (SMR 0.9, 95% CI 0.7-1.2). All 8 lymphohematopoietic cancers in the study group were limited to the long term workers producing an SMR of 1.5(95% CI 0.6-2.9). Four of these lymphohematopoeitic cancers were NHLs (SMR 1.9, 95% CI 0.5-4.9) and 2 were multiple myelomas (SMR 2.0, 95% CI 0.2-7.1). Additional analyses (not shown) by latency, year hired and by sex were unremarkable.

In this study, we found that workers overall have death rates similar to the rest of New Zealand. Employment duration accounted for the greatest differences in observed mortality. Workers who were employed less than 3 months had more deaths than expected for many causes, such as all causes, all cancers, ischemic heart disease, and all accidents. In addition, among these short term workers, cancers of the digestive system were greater than expected especially for rectal cancer, oesophageal cancer and pancreatic cancer. Higher death rates among short term workers have been reported in other studies where they have been attributed to the healthy worker effect lifestyle factors especially alcohol use and tobacco. [4-6] The mortality rates of long term workers and workers with longer latencies are most useful for assessing work related effects. The longer term workers and workers with longer latencies in our study had mortality and cancer rates similar to the New Zealand population. Given the lack of increased death rates among long term and long latency workers, it is unlikely that workplace exposures contributed significantly to the high mortality rates seen in the short term workers.

A potential limitation of this study is the loss to follow up which is 22%. However, our levels of loss are similar to other New Zealand studies. Much of the loss to follow-up is due to the high rate of emigration which occurs in New Zealand. We verified that 9 % of our workers emigrated during the study period and the true emigration rate is likely to have been greater since only validated emigrations were classified as such. Since émigrés do not contribute to the national mortality rates, their withdrawal from follow up does not introduce a bias into risk estimation. The true number lost to follow up, no more than 236, or 13% of the cohort, and in fact likely to be much less, is small enough to have little expected influence on risk estimates.

A previous study at this site examined mortality levels in a subset of the workers in our study who were potentially exposed to dioxins as contaminants of the TCP and 2,4,5-T production. The investigators reported all causes mortality in production workers was not greater than expected. However there were more cancers than expected including a statistically significant increase in deaths from multiple myeloma (3 observed vs 0.5 expected). Our study found all cancers at expected levels and 2 deaths from multiple myeloma versus 1.2 expected. While the tracing methods used and loss to follow up were similar in both studies, the differences in cohort definitions and follow-up methods between the studies could have accounted for the differences in observed deaths. Of the 8 total lymphatic and hematopoietic tissue cancers, 7 occurred among men, 7 occurred among men and women hired before 1976, and all occurred among men and women with 3 or more months of employment at New Plymouth. Further studies are underway to evaluate if this association is related to specific occupational exposure.

In summary, we evaluated the all cause mortality experience of more than 1700 male and female employees of an agricultural chemical manufacturing plant in New Zealand. As a surveillance tool, the principle objective of this analysis was to quantify the potential hazard of employment at that site rather than of any specific chemical exposures. We observed rates for all causes, all malignant neoplasms and many other causes of death to be similar to the population of New Zealand. Higher than expected rates were consistently observed for short term employees. The results of our study indicate mortality rates for employees who worked at the DAS New Plymouth site are unremarkable. The report establishes a basis from which to examine specific exposures at this site.

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