

Original Article

Lymphohematopoietic Cancer Mortality and Morbidity of Workers in a Refinery/Petrochemical Complex in Korea

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Objectives: The purpose of this retrospective cohort study was to investigate the relationship between exposure of Korean workers to petrochemicals in the refinery/petrochemical industry and lymphohematopoietic cancers.

Methods: The cohort consisted of 8,866 male workers who had worked from the 1960s to 2007 at one refinery and six petrochemical companies located in a refinery/petrochemical complex in Korea that produce benzene or use benzene as a raw material. Standardized mortality ratios (SMRs) and standardized incidence ratios (SIRs) were calculated for 1992-2007 and 1997-2005 based on the death rate and cancer incidence rate of the Korean male population according to job title (production, maintenance, laboratory, and office workers).

Results: The overall mortality and most cause-specific mortalities were lower among these workers than those of the general Korean population. Increased SMRs were observed for leukemia (4/1.45; SMR 2.77, 95% CI: 0.75-7.09) and lymphohematopoietic cancers (5/2.51; SMR 2, 95% CI: 0.65-4.66) in production workers, and increased SIRs were also observed in leukemia (3/1.34; SIR 2.24, 95% CI: 0.46-6.54) and lymphohematopoietic cancers (5/3.39; SIR 1.47, 95% CI: 0.48-3.44) in production workers, but the results were not statistically significant.

Conclusion: The results showed a potential relationship between leukemia and lymphohematopoietic cancers and exposure to benzene in refinery/petrochemical complex workers. This study yielded limited results due to a short observational period; therefore, a follow-up study must be performed to elucidate the relationship between petrochemical exposure and cancer rates.

Key Words: Petrochemical, Leukemia, Refinery, Non-Hodgkin's lymphoma, Multiple myeloma, Cancer

Introduction

The refinery/petrochemical industry is indispensable because it produces fuels, plastic resins, rubber, and various chemicals including agricultural chemicals. However, employees working

in the refinery/petrochemical industry are exposed to many hazardous chemicals. Among them, benzene, 1,3-butadiene, and ethylene oxide are representative carcinogens.

Many studies have been conducted to determine the relationship between exposure in the refinery/petrochemical industry and the increasing risk of cancer [1-9]. But no published report has been conducted on the cancer risk of Korean workers working in the refinery/petrochemical industry.

The refining industry began in the 1960s, and the full-scale petrochemical industry started in the 1970s in Korea. The refinery/petrochemical industry began first in Ulsan city, and other complexes were built in Yosu and Daesan. This retrospective

Received: July 22, 2010, **Accepted:** October 16, 2010

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cohort comprised 8,866 male workers who worked at a refinery/petrochemical complex where benzene was manufactured or used as a raw material.

We investigated the relationship between benzene exposure and lymphohematopoietic cancer mortality and morbidity in refinery/petrochemical industry workers.

Materials and Methods

Study population

The study population consisted of male workers in a refinery and petrochemical complex composed of one refinery and six large petrochemical factories. Among these, four factories and the refinery produce benzene, three factories had naphtha cracking centers, and two factories used benzene as a raw material to make other chemical products. Employee data for the seven factories, including resident registration numbers (a unique Korean identification number), date of employment and retirement, and departments were collected from the date of business initiation (the early 1960s) to Dec 31, 2007. Female workers were excluded from the study population. In total, 8,866 male workers with a work history of one or more days in the refinery/petrochemical complex were included in this study.

The most recent departments of the employees were used to categorize the workers into four groups: production, maintenance, laboratory, or office workers. The employees were also divided into manufacturing and office worker groups. The manufacturing workers included those employed in the processing operation (production), maintenance, and laboratory departments. The office workers included those in the sales department and the general office.

Cancer mortality and morbidity data

Mortality data are readily accessible in Korea, given the resident registration numbers, and the data were attained from the Korea National Statistical Office (KNSO). Data on mortality and causes of death were obtained for 16 years from Jan 1, 1992 to Dec 31, 2007. Causes of death were coded using the 10th Revision of the International Classification of Diseases. The cancer classification was in accordance with the KNSO classification (Korea Classification of Diseases and Causes of Death, 4th edition).

Cancer incidence was identified using the Central Registry of Cancer in Korea. Morbidity of the subjects was observed retrospectively for a 9-year period from Jan 1, 1997 to Dec 31, 2005.

Data analysis

The observation period for cancer mortality of the subjects was 16 years from Jan 1, 1992 to Dec 31, 2007. The 16-year observation period was divided into four calendar periods; 1992-1996, 1997-2001, 2002-2006, and 2007. National population data for 1994, 1999, 2005, and 2007 with 5-year age group intervals of those aged 20-80 years were used as the reference population.

For workers who were employed before Jan.1, 1992, and who died during the observation period, the number of person years was calculated from Jan 1, 1992 to the date of death. Subjects who survived throughout the study period were observed until the final date of this study, Dec 31, 2007. If workers were hired during the observational period, their person years were considered from the date of hire to the date of death or Dec 31, 2007. Workers who retired before the beginning of the observation period, Jan 1, 1992, were excluded from the study, as their mortality before 1992 could not be determined.

Standardized mortality ratios (SMRs) of all-cause mortality, overall cancer mortality, lymphohematopoietic cancer mortality, and other cancer mortalities were calculated after dividing the subjects into production, maintenance, laboratory

Table 1. General characteristics of study subjects

Variable		No.	%
Age of employment	20-24	1,247	14.06
	25-29	3,941	44.45
	30-34	1,568	17.69
	35-39	937	10.57
	40-44	643	7.25
	45-49	293	3.30
	50-54	174	1.96
	55-59	52	0.59
	60-64	6	0.07
	65-69	4	0.05
Job	70-74	1	0.01
	Product	4,194	47.30
	Maintenance	1,451	16.37
	Laboratory	1,099	12.40
	Office	2,122	23.93
Total		8,866	100

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