

EPIDEMIOLOGICAL DATA BASE FOR A HEALTH EFFECTS STUDY AT A COAL GASIFICATION PLANT

S. C. Morris¹, H. Ukmata², M. Begeraca², B. Canhasi²
and M. A. Haxhiu³

The Biomedical and Environmental Assessment Division, Brookhaven National Laboratory, Upton, NY, USA¹, Department of Occupational Health Electro-Economy of Kosovo, Priština, Yugoslavia² and The Medical Faculty, University of Kosovo, Priština, Yugoslavia³

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An occupational population is characterized as a basis for epidemiological study. Parameters include age, smoking history, years of work, job title, all medical diagnoses by 3-digit ICD code, and selected laboratory test results. By example analyses differences are examined in the incidence of chronic bronchitis and circulatory system disease by smoking history and job title. The data base includes coal gasification plant workers and surface lignite miners in Kosovo, Yugoslavia. Because of the national system of socialized medicine, similar data are available for all worker organizations in Yugoslavia.

This paper characterizes morbidity in an occupational population as a basis for epidemiological study. While it focuses on a specific occupational group, i.e. workers at the Kosovo coal gasification plant and a comparison group of lignite surface miners, similar information is available for all worker organizations in Yugoslavia.

The coal gasification plant is located in Obilić, in the Autonomous Province of Kosovo, Yugoslavia. It supplies up to 480 million Nm³ gas annually with a heating value of about 16.7 MJ/Nm³. The plant is operated by Electro-economy of Kosovo (EEK) which also operates surface lignite mines and two coal-fired electric power plants. EEK employs about 15,000 people in total. The EEK Medical Clinic, with a staff of 20 physicians, provides primary medical care for all workers and maintains their medical records using a medical records system standard throughout Yugoslavia.

The gasification plant has been in commercial operation since 1971, sufficient time for many potentially occupation-related health effects to develop in the workforce. The workforce was relatively stable with limited shifting of jobs within the plant. The gasification plant and lignite mine were designated as work areas having potential respiratory hazards and workers are screened for respiratory disease in pre-employment medical examinations.

SUBJECTS AND METHODS

Population Description. All current and former workers at the gasification plant ($n = 757$) were characterized by date of birth, sex, smoking habit in 1980 (and, for smokers, number of cigarettes smoked per day and number of years smoked), years of work, job title and location. Information was drawn from EEK personnel and medical records. Each worker was assigned a number for purposes of this study. Duplicate computer files, identified by worker number, were kept at the EEK Medical Clinic in Yugoslavia and at Brookhaven National Laboratory. Listings of workers' names and pension numbers (equivalent to a social security number in USA) associated with each number were kept only in Yugoslavia.

Each worker entered the cohort at the date of his or her assignment to the plant. While the plant began commercial operation in 1971, some workers were assigned before that time for training and start-up testing. While different from those during commercial operation, pre-1971 exposures were of the same general nature. Records were incorporated in the study through 1980 or the year the worker left (if before 1980). Because of the small number of women in the workforce, particularly when broken down into subgroups by job category and length of service, only males were included in the analysis.

Records of 500 lignite miners were selected as a comparison population. These were characterized in the same way as the gasification plant workers, with the study period extending from the date of their first assignment to the mine and continuing until 1980 (or the year the miner left the mine if earlier than 1980). The mine began operation in the 1920s and originally included underground operations. All miners with underground experience were identified and excluded from the study (28 out of the 500).

Basic demographic statistics from the gasification workers and the lignite miner sample were compared to detect differences between the groups (Table 1). The number of workers at the gasification plant and the lignite mine for each year during the period 1971-1980 is given in Table 2.

Job titles (profession) and principal work location in the gasification plant were identified from personnel records for each gasification plant worker (1). Twenty-two job titles were identified in all (Table 3). Individual assignments to these categories were reviewed on site with current workers. Workers generally stay in the same profession throughout their career. Lignite miners were not classified by job category for this study.

Medical Data. Workers at both the gas plant and lignite mine receive all primary medical care at the EPK medical clinic which has a staff of 20 physicians. Medical records are maintained using a standard medical records system which exists throughout Yugoslavia. Two separate records are kept on each worker. The first records results of routine, periodic medical examinations; the second is an encounter file recording results of examinations, treatment, and follow-up from a worker reporting in sick. The latter file also includes hospitalization and referral records; these are believed to be complete for all hospitalization ordered from the clinic or other hospitalization in Kosovo, but may not include records from medical care outside of Kosovo (e.g.,

emergency hospitalization or other medical care occurring outside Kosovo while the worker is on vacation). Both files were used to develop the data for this study.

Physicians in Yugoslavia are trained to encode all diagnoses by 3-digit code of the International Classification of Diseases referred to here as ICD. These are encoded at the time of diagnosis using the ICD version in effect at the time. In addition, the written diagnosis is entered in the medical record in Latin with supporting comments in the local language. The three-digit ICD codes were abstracted from the medical records of the 757 gas plant workers and the 500 lignite miners for all diagnoses from first assignment through 1980 and encoded on microcomputer diskette (KAYPRO II) by year of diagnosis.

Although ICD code books were changed from the 8th edition to the 9th edition on 1 January 1979 at the EEK medical clinic, a check of reported ICD codes against the written diagnosis for a small sample of cases indicated that some codes entered in 1979 were from the 8th edition. Since at least entries for 1979 were thus suspect for diseases with ICD codes which changed between the 8th and the 9th editions, and since there were insufficient resources available to check each diagnosis for 1979 and 1980, it was decided to exclude 1979 and 1980 data from analyses in which misclassification would affect the results.

Chronic bronchitis (ICD 490-491) was diagnosed at the EEK medical clinic using the standard Medical Research Council questionnaire. This questionnaire has been well tested in the region (2, 3).

In addition to disease diagnoses, results of pulmonary function tests and some laboratory blood tests conducted as part of routine physical exams were also encoded (sedimentation, leukocytes, and erythrocytes). Additional laboratory analyses were available for some workers but were not encoded. Pulmonary function results (FEV₁ and vital capacity) were available for over 90% of smokers and 50% of non-smokers.

Methods to follow-up workers who left the plant were established, but this report only includes disease data from the EEK medical clinic records and thus only morbidity occurring while a worker was employed by EEK. If a worker moved to another EEK facility, e.g., a power plant, his records would still be maintained in the EEK Department of Medicine and were included in the follow-up.

ANALYSIS

Analyses were carried out to investigate potential health impacts as part of the Kosovo Coal Gasification Plant Health Effects Study (4). Example analyses of general interest are reported here. These are incidence of chronic bronchitis and circulatory system diseases for the combined population by smoking history and for gasification plant workers by job title. Chronic bronchitis included ICD 490-491 and circulatory system diseases included ICD 390-459 (with the exception of 455, hemorrhoids). Changes between the 8th and 9th revisions of the International Classification of Diseases do not affect these analyses.

Incidence of disease was determined by age group and length of service in the gasification plant or lignite mine by calculating the number of persons

diagnosed in an age and length of service category divided by the number of person-years at risk in that category. Age and length of service categories were selected a priori. Age categories selected were: < 25, 25-34, 35-44, 45-54, 55+. Length of service categories selected were: 1 year, 2-4, 5-9, 10+. Only the first diagnosis was included in the analysis. For circulatory system diseases, only the first diagnosis within the category was included. Person-years at risk included only pre-diagnosis exposure. The year of diagnosis was considered as 0.5 person-year at risk. Age- and length of service-adjusted morbidity rates were then calculated by the direct method using the combined populations as the base.

For analysis by smoking habits, three exposure categories were defined: (1) non-smokers, (2) smokers with a lifetime consumption of fewer than 146,000 cigarettes (equivalent to 20 cigarettes per day for 20 years), and (3) smokers with a lifetime consumption of more than 146,000 cigarettes.

Disease incidence was considered by job title separately for smokers and non-smokers. Job titles were aggregated into six job title groups: (1) maintenance workers, who might be expected to have high exposures and generally had a high school education; (2) engineers and foreman, who generally had technical school (post high school) or college educations; (3) laborers, who generally had less than a high school education; (4) office and laboratory workers; (5) miscellaneous titles which individually had few people; and (6) unknown. Only the first three groups contained sufficient cases to consider. Results from the other remaining groups were lumped for comparison.

RESULTS

Characteristics of the Study Population. The selected study cohort consisted of 757 coal gasification workers. One hundred-thirty-five were excluded from analysis: 88 (11.6%) females and 47 (7.0%) with incomplete data. The remaining 622 workers accumulated 6620 person-years of exposure during the study period, an average of 10.6 years per worker. Among the initial sample of 500 miners, 58 were excluded: 21 (4.2%) females, 28 (6.0%) with previous underground mining experience and 9 (1.9%) with incomplete data. The remaining 442 miners accumulated 5053 person-years of exposure during the study period, an average of 12.0 years per miner. Summary demographic data on both groups are included in Table 1. The gasification plant workers and lignite miners are similar in average age. Gasification plant workers on average have 10% less time on the job than miners.

Effects by Smoking Habits. Overall, 29% of the population were smokers. Incidence rates of chronic bronchitis and circulatory system diseases were compared among workers with different lifetime smoking histories: non-smokers, moderate smokers (lifetime consumption of fewer than 146,000 cigarettes), and heavy smokers (Table 4). Moderate smokers had a lower chronic bronchitis incidence rate than non-smokers, although the difference was not statistically significant. Heavy smokers had a significantly higher chronic bronchitis incidence than either non-smokers or moderate smokers ($p < 0.05$). Circulatory system disease incidence rates were essentially the same for the three categories.

Table 1.
 Summary information on population

	Gas Plant	Lignite Mine
Statistics on Total Population		
Total number	757	500
Women	88 (11.6%)	21 (4.2%)
Incomplete data	47 (6.2%)	9 (1.8%)
Underground mining experience	0	28 (5.6%)
Statistics on Those Included in Analysis		
Number included	662	442
Person-year exposure	6615	5053
Average years experience in 1980	10.0	11.4
Average age in 1980	34.2	35.5
Percent smokers	28	
Average cigarettes per day among smokers	23.3	24.3
Average years smoked among smokers	14.2	15.0
Left job before 1980	156 (25.1%)	

Table 2.
 Number of workers in coal gasification plant and lignite surface mine during the period 1971-1980.

Year	Coal Gasification Plant	Lignite Mine
1971	526	1134
1972	545	1239
1973	547	1338
1974	558	1471
1975	579	1538
1976	584	1425
1977	569	1424
1978	570	1440
1979	535	1440
1980	531	1526
10 year mean:	554	1398

Table 3.
Coal gasification plant job assignments

Code	Education Requirement	Job Title
00	—	Unknown
01	Tech School	Plant engineer
02	High School	Maintenance mechanic
03	None	House cleaner
04	None-	Laborer
05	High School	Maintenance electrician
06	Tech School	Foreman
07	High School	Administrative officer
08	College	Graduate engineer
09	High School	Chemical technician
10	High School	Technician
11	High School	Welder
12	High School	Bookkeeper
13	High School	Metal smith
14	None-	House man
15	High School	Plumber
16	None-	»Puts signs up«
17	None-	Warehouse man
18	High School	Mechanical technician
19	None-	Driver
20	High School	Insulator
21	High School	Painter

Locational Assignment

- 0 Unknown
- 1 Generator
- 2 Air separator
- 3 Phenol plant
- 4 Rectisol plant
- 5 Laboratory
- 6 Process control maintenance
- 7 Mechanical and electric maintenance
- 8 Administrative

Table 4.
Incidence of chronic bronchitis and circulatory system disease by smoking history

Smoking Category	Chronic Bronchitis	Circulatory Disease
Non-smokers	15.3 ^a (112) ^b	15.1 (109)
Moderate Smokers ^c	12.1 (24)	15.0 (31)
Heavy Smokers ^d	19.3 (31)	15.3 (25)

^aAge and length of service adjusted incidence rate: number of cases at first diagnosis per 1000 person-year at risk.

^bNumber of cases, first diagnosis.

^cModerate smokers: lifetime consumption of fewer than 146 000 cigarettes (equivalent to 20 cigarettes per day for 20 years).

^dHeavy smokers: lifetime consumption of equal to or more than 146 000 cigarettes.

Table 5.
Incidence of chronic bronchitis CB and circulatory system disease (Circul) by job title

Title	Non-smokers		Smokers	
	C B	Circul.	C B	Circul.
Engineers and foremen	11 ^a (7) ^b	12 (8)	11 (5)	16 (6)
Maintenance	12 (30)	17 (43)	12 (19)	13 (18)
Laborers	15 (6)	11 (5)	13 (2)	16 (2)
Others	19 (9)	8.4 (4)	24 (2)	38 (2)

^aAge and length of service adjusted incidence rate: number of cases at first diagnosis per 1000 person-year at risk.

^bNumber of cases, first diagnosis.

Effects by Job Title. Incidence of chronic bronchitis increased in the following order for both smokers and non-smokers (Table 5): engineers and supervisors: maintenance workers: laborers: others. There was no consistent pattern for circulatory system diseases. For non-smokers, circulatory system disease incidence increased in the following order: laborers: engineers and foreman: maintenance workers. For smokers, the opposite order occurred. None of the differences in circulatory system disease incidence rates for the various job titles, however, were statistically significant.

DISCUSSION

The low percentage of smokers in the population (Table 1) probably reflects economic conditions in the area. The same may be true of the generally high

rates of chronic bronchitis, particularly for a population which was selected in pre-employment examinations for respiratory health. Available data indicate that over 90% of the diagnoses were simple chronic bronchitis without impairment of pulmonary function (4).

A comparison of chronic bronchitis rates in non-smokers vs. smokers indicated no difference between the two. Only when smoking history was further subdivided did an (unexplained) low chronic bronchitis rate in moderate smokers and an elevated incidence in heavy smokers appear.

The pattern of increase in chronic bronchitis incidence seen in Table 5 (from engineers and foreman to maintenance workers to laborers) corresponds to decreasing educational level and may be more related to socio-economic differences represented by education than to differences in occupational exposure. Associations between chronic bronchitis and education income have been suggested previously (5).

The category »other« (Table 5) includes a wide variety of jobs. One of these is administrative and laboratory workers. Although only males were included in the analysis, the majority of laboratory workers were women. Since laboratory workers range through the plant to take samples for analysis, their exposures might be high. Closer examination of this largely female population is warranted.

Lack of any significant differences among job titles for circulatory system disease incidence is similar to findings of *Van Peenen and co-workers* for medical insurance claims in petrochemical workers (6).

The strength of the data base is its completeness and its ability to generate accurate disease incidence rates. It draws data from individual medical records in the company medical clinic which provides primary medical care and maintains complete medical records for all workers. Because of the national system of socialized medicine, similar information is available for all worker organizations in Yugoslavia.

CONCLUSION

Increased incidence of chronic bronchitis among heavy smokers and a trend in chronic bronchitis incidence by job title associated with educational level were found. No parallel effects were found in circulatory system disease incidence. The study showed that retrospective encoding of individual medical records of workers in Yugoslav industrial and mining facilities can provide an economical and comprehensive data base for epidemiological analysis of disease incidence.

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Sažetak

IZVORI ZA EPIDEMIOLOŠKO PROUČAVANJE ZDRAVSTVENIH EFEKATA GASIFIKACIJE UGLJA

Analiza zaposlenih radnika služila je kao osnova epidemiološkog proučavanja. Praćeni parametri obuhvatili su dob, naviku pušenja, radno mesto i sve lekarske dijagnoze prema trocifrenoj internacionalnoj kodifikaciji bolesti, kao i određene laboratorijske rezultate. Dat je primer proučavanja razlika incidence hroničnog bronhita i bolesti cirkulatornog sistema prema navici pušenja i radnom mestu. Podaci se odnose na radnike gasifikacije uglja i rudnika površinskog kopa u Kosovskom bazenu. S obzirom na zdravstvenu zaštitu i unificirani sistem, slične informacije se mogu dobiti za sve radne organizacije u Jugoslaviji.

Odjel za biomedicinu i procjenu okoline
Brookhaven National Laboratory, Upton,
SAD¹, Elektroprivreda Kosovo, RO Dispanzer
za medicinu rada, Priština, Jugoslavija², Medicinski
fakultet Sveučilišta Kosovo, Priština, Jugoslavija³

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