Prospective morbidity surveillance of Shell refinery and petrochemical employees

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Abstract

Results for a prospective morbidity study of 14 170 refinery and chemical workers from 1981 through 1988 are presented. Illness/absence data for this study were extracted from the morbidity section of the Shell Health Surveillance System which includes records of all illness/absences in excess of five days. Age adjusted annual morbidity frequency rates and annual durations of absence are presented by age, sex, job, and work status. Generally, rates and durations of absence were highest for older age groups, women, and production workers. Increased risk was associated with the presence of known disease risk factors. Overall, 48% of the employees had at least one illness/absence in excess of five days during the eight year period. Twelve per cent of the employees had four or more absences, which accounted for 54% of the total number of absences and 52% of the total work days lost. Among men, the five most common conditions accounted for 72% of all illness/absences. In descending order they were injuries (25%), respiratory illnesses (17%), musculoskeletal disorders (14%), digestive illnesses (9%), and heart disease (7%). Similar patterns were noted among women. These findings may be useful in setting priorities and directing efforts such as health education programmes and other strategies for the prevention of disease.

Morbidity data are routinely collected as a part of industrial health surveillance programmes in the United States to detect potential adverse health effects due to environment hazards or personal risk factors.[1] General morbidity patterns among workers, however, have rarely been reported.[2] This is partly because of the frequent lack of reliable diagnoses. Many programmes also suffer from inconsistent administration and incomplete reporting.

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The Shell Health Surveillance System (HSS) was established in 1979.[3] One purpose of the HSS is to provide both occupational and non-occupational illness/absence information that can be used to assess overall effectiveness of medical programmes, to formulate preventive strategies, and to reduce corporate health care costs. The present paper reports findings from a prospective morbidity surveillance evaluation of 14 170 Shell refinery and petrochemical employees from 1981 through 1988. The study examined the morbidity patterns for employees by sex, work status, and job group utilising data from the HSS. Also, selected disease risk factors (for example, high blood pressure, hypercholesterolaemia, and obesity) were examined for those who had an illness/absence(s) and for those who had not.

Methods

STUDY POPULATION

The study population consisted of all regular employees who worked at any of 14 Shell manufacturing locations during the period 1 January 1981 through 31 December 1988. These employees were identified from the Shell payroll and personnel computer system. The demographic information included, but was not limited to, name, date of birth, race, sex, date of hire, date of retirement or last separation, date of death, job title, and pay status. Each employee was classified as either production or staff and placed into one of four job groups (operator, maintenance, office, or others) that were used as broad classifications of occupations.

The term production operator refers to employees with such job titles as operators, process technicians, compounders, loaders/unloaders, and pumper gaugers. Staff operators, on the other hand, are the foremen and supervisors of the operations. Maintenance includes those who work as craftsmen. Examples are boilermakers, pipefitters, machinists, and electricians who are considered production employees, and the related foremen and supervisors who are considered staff. Everyone else was included in either the production "others" category or the staff office category. The "others" category was

typically made up of testers, laboratory assistants, truck drivers, and equipment operators.

Included in the office category were clerks, engineers, laboratory technicians, and superintendents and managers. The job categories represent varying levels of occupational exposure. An employee's inclusion into one of the job groups was based on his or her last job title.

MORBIDITY DATA

Morbidity data for this study were extracted from the morbidity section of the HSS which includes all illness/absence events in excess of five work days. Since records of absences originate from personnel and payroll systems, the absence reporting is virtually complete. Ninety four per cent of the morbidity reports had statements from physicians identifying the reason for the absence. The causes of morbidity were coded according to the International Classification of Diseases ninth revision clinical modification (ICD 9-CM).[4] Only the primary cause was used in the analysis. Pregnancy and childbirth related absences were excluded.

SELECTED DISEASE RISK FACTORS

The data for risk factors were derived from the HSS, which contains all employee preplacement and periodic examinations done since 1 January 1978. Data from the most current examination were used; three quarters of these were done in the period 1984–8.

The smoking history was used to determine whether an employee was a current cigarette smoker. Raised cholesterol was defined as a value equal to or greater than 200 mg/dl. Raised blood pressures were those diastolic blood pressure readings equal to or greater than 90 mm Hg or systolic blood pressure readings equal to or greater than 140 mm Hg. Obesity was defined as body mass index (BMI = weight (kg)/height^2 (m))greater than or equal to 27·2 for men and 26·9 for women. This value represents 20% more than the ideal body weight based on the National Institutes of Health Consensus Development Panel recommendations.[5]

ANALYTICAL METHODS

Person-years at risk were accumulated for each worker beginning 1 January 1981 or the date of employment (whichever was later) and ending at the closing date of study (31 December 1988), the date of retirement, the date of death, or the date of termination (whichever was earlier). The number of years contributed by each worker was classified by age (<30, 30–39, 40–49, 50–59, and $\geqslant 60$), by work status (production and staff), and by sex.

Directly age adjusted frequency rates for morbidity by sex and work status and by diagnostic category for the three job groups and the combined group were computed with the age specific person-year distribution of the combined group as the standard set of weights. The same standardisation method was used to calculate age adjusted prevalence rates for selected disease risk factors. Age adjusted rates were compared by a two sided test of significance.[6]

Table 2 Number of workers according to work status, sex, and number of absences

No of absences	Women		Men	
	Production No* (%)	Staff No* (%)	Production No (%)	Staff No (%)
0	148 (30·7)	812 (50·9)	2534 (37·7)	3502 (65·2)
1	71 (14·7)	410 (25·7)	1400 (20·8)	1066 (19·9)
2	61 (12·7)	183 (11·5)	896 (13·3)	442 (8·2)
3	46 (9·5)	105 (6·6)	614 (9·2)	176 (3·3)
4	37 (7·7)	40 (2·5)	380 (5·7)	86 (1·6)
5	25 (5·2)	23 (1·4)	291 (4·3)	41 (0·8)
6	26 (5·4)	9 (0·5)	188 (2·8)	26 (0·5)
7	11 (2·3)	9 (0·5)	135 (2·0)	18 (0·4)
8	10 (2·1)	2 (0·1)	97 (1·4)	7 (0·1)
9	17 (3·5)	2 (0·1)	48 (0·7)	2 (0·0)
10	8 (1·7)	1 (0·1)	51 (0·8)	0 (0·0)
>10	22 (4·5)	1 (0·1)	86 (1·3)	3 (0·0)
Total	482 (100·0)	1597 (100·0)	6720 (100·0)	5369 (100·0)

Excludes absences due to pregnancy.
*Adjusted for duration of follow up.

Results

Included in this study were 484 female production personnel, 1597 female staff, 6270 male production personnel, and 5369 male staff (table 1). The age of entry into the cohort was 8–11 years younger for women than for men. The average number of years of follow up was 5·8 for both male production workers

Table 1 Cohort statistics of workers by sex and work status 1981–8

	Women		Men	
	Production	Staff	Production	Staff
No studied	484	1597	6720	5369
No of person-years observed	2313	7213	39141	31401
Average years of age at entry	29·5	28·8	36·9	40·2
Average years of follow up (1981–8)	4·8	4·5	5·8	5·8
Average total duration of employment (y)	7·0	8·9	14·7	20·1

Table 3 Morbidity frequency rates according to work status, sex, and age*

	Women		*Men*		*Total*	
Age (y)	*Production*	*Staff*	*Production*	*Staff*	*Production*	*Staff*
<30	21·2 (29)	5·6 (71)	20·8 (319)	2·2 (24)	20·8 (348)	4·0 (95)
30–39	52·5 (609)	11·0 (321)	31·4 (5003)	8·4 (709)	32·9 (5612)	9·1 (1030)
40–49	62·0 (509)	16·9 (303)	32·9 (3917)	8·8 (844)	34·8 (4426)	10·1 (1147)
50–59	62·1 (103)	16·5 (131)	32·0 (1844)	12·6 (943)	32·8 (1947)	13·0 (1074)
≥60	79·3 (23)	16·2 (68)	45·5 (1823)	18·9 (910)	45·7 (1846)	18·7 (978)
Total†	58·6‡§ (1273)	14·1‖ (894)	33·1‖ (12906)	10·2 (3430)	34·3¶ (14179)	10·9 (4324)

*Per 100 person-years. Numbers in parentheses are morbidity episodes.
Excludes absences due to pregnancy.
†Age adjusted to the total population using the direct standardisation method.
‡Significantly different from production men at $p < 0.05$.
§Significantly different from staff women at $p < 0.05$.
‖Significantly different from staff men at $p < 0.05$.
¶Significantly different from staff employees at $p < 0.05$.

and staff and 4·8 and 4·5 for female production workers and staff. The total duration of employment for women was less than half that for men.

Of the 14 170 employees included in the study, 6806 (48%) had had at least one illness/absence in excess of five days during the eight year period from 1981 through 1988. Overall, 12% of the employees had had four or more absences, which accounted for 54% of the total number of absences and 52% of the total work days lost. When adjusted for duration of follow up, the percentage of employees who had never had an illness/absence was 31% for female production personnel, 38% for male production personnel, 51% for female staff, and 65% for male staff (table 2). Among staff employees, only 5% of women and 3% of men had had four or more absences but these accounted for almost 30% of each of their total number of absences as well as their total number of days of absence. By contrast, for production employees, 32% of women and 19% of men had had four or more absences. These employees were responsible for 75% of the total number of absences and days among women and 60% among men.

Table 4 Average duration of absence in days according to work status, sex, and age*

	Women		*Men*		*Total*	
Age (y)	*Production*	*Staff*	*Production*	*Staff*	*Production*	*Staff*
<30	3·9	1·1	4·4	0·4	4·4	0·8
30–39	14·4	2·7	7·2	1·9	7·7	2·1
40–49	21·6	5·4	8·8	2·1	9·6	2·7
50–59	25·5	5·2	10·6	4·1	11·0	4·2
>60	26·6	4·8	19·4	7·8	19·5	7·6
Total†	19·4	4·1‡	9·6§	3·0	10·1‖	3·2

*Per person-year.
Excludes absences due to pregnancy.
†Age-adjusted to the total population using the direct standardisation method.
‡Significantly different from staff men at $p < 0.05$.
§Significantly different from staff men at $p < 0.05$.
‖Significantly different from staff employees at $p < 0.05$.

The frequency rates for morbidity generally increased with age, ranging from 20·8 per 100 for those less than 30 years old to 45·7 per 100 for those 60 and older for production workers, and 4·0 per 100 to 18·7 per 100 for corresponding staff workers (table 3). The rate was four times higher for female production workers (58·6 per 100) than for female staff (14·1 per 100) and three times higher for male production workers (33·1 per 100) than for male staff (10·2 per 100). These differences between the total rates for production and staff employees were statistically significant. Women had significantly higher rates than men ($p < 0.05$).

The annual average duration of absence also increased with age (table 4). For production employees, it ranged from 4·4 days for those less than 30 years old to 19·5 days for those 60 and older, whereas for staff counterparts, it ranged from 0·8 to 7·6 days. Statistically significant differences existed between the rates for female and male staff, the rates for male production workers and staff and the rates for all production and staff employees. Table 5 presents the number of episodes and the average duration of absence per episode by diagnosis and sex. Among male employees, the five most common disease categories accounted for 72% of all illness/absences. In decreasing order these were injuries (25%), respiratory illnesses (17%), musculoskeletal disorders (14%), digestive illnesses (9%), and heart disease (7%). For female employees, the five leading disease categories were respiratory illnesses (20%), injuries (16%), musculoskeletal disorders (12%), genitourinary illnesses (10%), and digestive illnesses (8%). These conditions accounted for 66% of all female illness/absences. Across all causes of morbidity, the average duration of absence per episode was 30 days for women and 29 days for men. Among women, the average duration ranged between 13 days for respiratory illnesses and 47 days for musculoskeletal disorders. The next longest average duration of absence was for mental disorders (42 days),

Table 5 Number of morbidity episodes and average duration of absence per episode by diagnosis and sex

Cause of morbidity (ICD-CM 9th revision codes)	Women		Men	
	No (%)	Average duration	No (%)	Average duration
Infective and parasitic diseases (000–139)	62 (2·8)	18·3	502 (3·1)	15·0
All neoplasms (140–239)	79 (3·6)	40·8	366 (2·2)	60·2
Endocrine and metabolic diseases (240–279)	34 (1·6)	32·4	208 (1·3)	33·8
Mental disorders (290–319)	92 (4·2)	41·7	491 (3·0)	35·8
Nervous system (320–389)	78 (3·6)	28·2	700 (4·3)	31·8
Circulatory system (390–459)	58 (2·7)	39·9	1113 (6·8)	53·0
Respiratory system (460–519)	433 (20·0)	12·9	2733 (16·7)	10·9
Digestive system (520–579)	177 (8·2)	20·8	1485 (9·1)	23·9
Genitourinary system (580–629)	215 (9·9)	32·5	577 (3·5)	19·7
Skin and subcutaneous tissue (680–709)	37 (1·7)	20·0	408 (2·5)	18·3
Musculoskeletal (710–739)	270 (12·5)	47·4	2303 (14·1)	41·2
Symptoms and ill-defined conditions (780–799)	67 (3·1)	17·3	454 (2·8)	19·4
Injury and poisoning (800–999)	347 (16·0)	38·9	4052 (24·8)	29·9
All other causes	218 (10·1)	31·1	944 (5·8)	27·0
All causes (000–999)	2167 (100·0)	30·0	16336 (100·0)	28·8

Excludes absences due to pregnancy.

followed by neoplasms (41 days), heart disease (40 days), and injuries (39 days). Among men, the average duration ranged between 11 days for respiratory disorders and 60 days for neoplasms. After neoplasms were heart disease (53 days), musculoskeletal disorders (41 days), mental disorders (36 days), and endocrine and metabolic disorders including diabetes (34 days).

Table 6 shows the age adjusted prevalence rates for disease risk factors by job group. Women generally had higher rates of smoking and lower rates of the other risk factors than men. Overall, production workers of both sexes had higher rates of smoking, hypertension, and obesity and lower rates of hypercholesterolaemia compared with staff workers. For male production personnel, rates for disease risk factors were similar among the three job groups of workers. For male staff, operators and maintenance workers generally had higher rates than the combined group while office workers had lower rates. Among the three job groups the smoking rates (31·4 per 100 for operators, 28·7 per 100 for maintenance workers, and 18·9 per 100 for office workers) and the obesity rates (47·4 per 100 for operators, 45·0 per 100 for maintenance workers, and 34·5 per 100 for office workers) were significantly different from those of the combined population (23·6 per 100 for smoking and 38·8 per 100 for obesity). No clear patterns of rates by job category existed among women.

The annual average duration of absence per person-year (table 7) for the combined population was over four times higher for female production personnel (19·4 days) than for female staff (4·1 days) and over three times higher for male production personnel (9·6 days) than for male staff (3·0 days). Among the three job categories for production employees, other workers had the longest average duration (21·2 days for women, 11·6 days for men), followed by maintenance workers (17·7 days for women, 10·9 days for men) and then operators (16·2 days for women, 8·3 days for men). Operators had the longest duration among female staff (9·1 days) and male staff (4·1 days), followed by maintenance workers (5·8 and 3·4 days) and office workers (4·1 and 2·3 days).

Table 6 Age adjusted prevalence rates† for selected disease risk factors according to work status, job, and sex

Risk factors	Production				Staff			
	Op	M	Others	Combined	Op	M	Office	Combined
Women:								
Smoking	35·3	36·1	47·6	43·1	42·9*	26·2	27·6	28·1
High blood pressure	8·0	1·9*	30·5*	14·2	6·4	—	13·3	13·1
Hypercholesterolaemia	31·7	37·9	49·7	38·9	19·8*	—	47·1	46·4
Obesity	46·9*	12·5*	34·9	34·4	34·7	—	25·4	25·5
Men:								
Smoking	35·8	32·0	39·8	34·2	31·4*	28·7*	18·9*	23·6
High blood pressure	25·6	22·2*	26·5	24·6	23·2	19·9	20·8	21·5
Hypercholesterolaemia	55·9	58·3	54·1	56·7	58·6	59·1	56·6	57·5
Obesity	44·0	43·3	49·9	43·6	47·4*	45·0*	34·5*	38·8

*Significantly different from combined at $p < 0·05$.
†Per 100 workers. Adjusted to the total population using the direct standardisation method. Op = operator, M = maintenance.

Table 7 Age adjusted annual average duration of absence in days† by work status, sex, and job

Jobs	*Women*	*Men*
Production:		
Operator	16·2	8·3*
Maintenance	17·7	10·9*
Others	21·2	11·6
Combined	19·4	9·6
Staff:		
Operator	9·1	4·1*
Maintenance	5·8	3·4*
Office	4·1	2·3*
Combined	4·1	3·0

*Significantly different from combined at $p < 0.05$.
†Per person-year. Excludes absences due to pregnancy.

Tables 8 and 9 present age adjusted morbidity frequency rates for women (table 8) and men (table 9) by cause of morbidity. For both sexes production workers had higher rates than staff workers across all diagnostic categories. Among production employees, operators had the lowest rates followed by maintenance personnel, with other workers having the highest morbidity frequency rates. Among both male and female production personnel, the morbidity rate of musculoskeletal disorders for operators was significantly lower than that for the combined job category ($p < 0.05$). Also, for male production workers, operators had significantly lower rates of injuries and disorders of the respiratory, nervous, and digestive systems ($p < 0.05$).

The three diagnostic categories with the highest morbidity frequency rates for all female production workers were diseases of the respiratory system (125 per 1000 person-years, n = 294), injury and poisoning (115 per 1000,. n = 259), and musculoskeletal disorders (79 per 1000, n = 153). The three leading causes of morbidity were the same for male production workers, but the order was different. Injury and poisoning (87 per 1000, n = 3471) led the list, then diseases of the respiratory system (60 per 1000, n = 2365), and musculoskeletal disorders (48 per 1000, n = 1866).

Among staff workers, operators had the highest frequency rates for morbidity for both men and women. Female staff office workers had the next highest rate, whereas for male staff, maintenance workers had the next highest rate. As was the case for production workers, female staff as a whole had more episodes of disorders of the respiratory system (22 per 1000, n = 138) than any other cause; male staff had more injury and poisoning (19 per 1000, n = 581).

Overall, only about 5% of all illness/absence events were work related. Table 10 presents age adjusted morbidity frequency rates for women by job group for occupational and non-occupational disorders. For both occupational and non-occupational conditions all rates were much higher for production workers than for staff workers. Among female production personnel, "other" workers had the highest rates for all non-occupational disorders. Maintenance workers had the highest rates for occupational injuries and musculoskeletal disorders.

Table 11 shows similar analyses for male employees. As was the case for women, production workers had much higher rates than staff workers for both occupational and non-occupational disorders. Among male production personnel, operators had lower rates than the combined group whereas maintenance workers had higher rates than combined for both occupational and non-occupational disorders. Among male staff, operators had the highest rate for non-occupational illnesses whereas maintenance workers had the highest rates for both non-

Table 8 Age adjusted morbidity frequency rates for women by work status, job, and diagnosis

	Production				*Staff*			
Cause of morbidity (ICD-CM 9th revision codes)	*Op*	*M*	*Others*	*Combined*	*Op*	*M*	*Office*	*Combined*
Infective and parasitic diseases (000–139)	14·7	6·7	26·1	24·8	2·9	0·0	3·8	3·7
All neoplasms (140–239)	9·5	21·0	62·3	11·5	2·9	0·0	8·6	8·5
Endocrine and metabolic diseases (240–279)	3·3	20·0	9·5	6·2	2·9	0·0	2·9	2·9
Mental disorders (290–319)	15·3	11·8	18·1	15·0	9·4	0·0	7·6	7·6
Nervous system (320–389)	19·2	22·6	19·0	23·0	0·0	0·0	4·1	4·0
Circulatory system (390–459)	9·8	29·1	31·6	18·3	7·6	0·0	5·5	5·6
Respiratory system (460–519)	120·2	121·2	130·9	129·4	31·1	51·1	21·5	22·2
Digestive system (520–579)	42·8	18·3	55·2	45·2	10·5	0·0	10·2	10·3
Genitourinary system (580–629)	35·9	34·6	85·9	50·3	27·8	0·0	15·1	15·6
Skin and subcutaneous tissue (680–709)	7·2	9·2	9·4	10·9	9·4	0·0	2·7	3·1
Musculoskeletal (710–739)	51·4*	104·7	102·5	78·8	32·5	0·0	18·8	19·3
Symptoms and ill-defined conditions (780–799)	28·4	22·8	18·6	22·7	0·0	6·7	2·8	2·7
Injury and poisoning (800–999)	92·7	122·2	124·5	114·9	18·8	0·0	13·4	13·6
All other causes	13·7	25·9	19·2	29·4	20·2	0·0	21·0	21·2
All causes (000–999)	485·1*	570·1	662·1	585·4	176·0	64·5	138·1	140·5

*Significantly different from combined at $p < 0.05$.
†Per 1000 person-years. Excludes absences due to pregnancy. Op = operator, M = maintenance.

Table 9 Age adjusted morbidity frequency rates for men† by work status, job, and diagnosis

Cause of morbidity (ICD-CM 9th revision codes)	Production				Staff			
	Op	M	Others	Combined	Op	M	Office	Combined
Infective and parasitic diseases (000–139)	9·1	11·8	9·9	10·5	4·8*	1·5	2·3	2·8
All neoplasms (140–239)	5·4	7·8	6·6	6·4	3·4	1·9	3·4	3·2
Endocrine and metabolic diseases (240–279)	4·6	4·1	3·9	4·3	1·0	1·8	1·3	1·3
Mental disorders (290–319)	10·1	8·5	20·5*	9·9	3·4	2·7	2·4	2·7
Nervous system (320–389)	10·4*	17·6*	18·8	13·9	6·4	6·3	4·0	4·7
Circulatory system (390–459)	18·3	21·3	23·5	19·8	13·7*	13·3	8·0*	10·3
Respiratory system (460–519)	44·6*	77·8*	80·6*	60·1	17·0*	14·1	8·3*	11·2
Digestive system (520–579)	22·7*	32·3*	37·4*	27·8	11·5	13·1	11·4	11·8
Genitourinary system (580–629)	8·5*	13·2*	14·3	10·9	5·3	7·6*	3·3*	4·4
Skin and subcutaneous tissue (680–709)	6·7*	11·5*	11·2	9·0	3·0	1·9	1·2	1·8
Musculoskeletal (710–739)	38·7*	59·6*	53·7	48·4	17·7*	20·1*	9·8*	13·2
Symptoms and ill-defined conditions (780–799)	7·0*	12·3*	12·6	9·7	3·3	4·4	1·3*	2·2
Injury and poisoning (800–999)	72·1*	102·6*	118·3*	86·9	28·2*	33·6*	13·9*	19·1
All other causes	13·8	12·4	7·0*	12·7	21·2*	14·0	9·0*	13·0
All causes (000–999)	271·9*	392·9*	418·2*	330·3	140·0*	136·1*	79·7*	101·7

*Significantly different from combined at $p < 0.05$.
†Per 1000 person-years. Op = operator, M = maintenance.

occupational and occupational injuries and musculoskeletal disorders.

Within the subgroup of persons having four or more absences there were 139 female production workers, 50 female staff, 1276 male production workers, and 183 male staff. Among women the average age at entry (33·3 years for production workers and 37·2 years for staff employees), years of follow up (7·2 and 7·5), and total duration of employment (10·5 and 15·0 years) were higher than those for all employees. Among men, those with four or more absences were also older and employed longer, but the differences were small.

Table 12 compares the age adjusted prevalence rates for the selected disease risk factors between absentees and non-absentees. In general, absentees with one to three absences had higher rates than non-absentees, and absentees with four or more absences had higher rates than those with three or less. Statistically significant differences existed between absentees and non-absentees for smoking, hypercholesterolaemia, and obesity rates. The hypertension rates increased with the number of absences for women but not for men.

The distribution of morbidity episodes by diagnosis for employees with four or more absences was similar to the distribution for all absentees presented in table 5. Overall, the average duration of absence per episode was also about the same. Table 13 shows the age adjusted frequency rates for employees with four or more absences. Production employees had much higher rates than staff employees. They accounted for 75% (439·5 per 1000 *v* 585·4 per 1000) of overall frequency rates for men and 61% (200·7 per 1000 *v* 330·3 per 1000 for women). The difference between the combined job groups was tenfold for women and sevenfold for men.

Subjects who had had at least one illness/absence

Table 10 Age adjusted frequency rates† for women by occupational status, work status, and job

Job	Occupational				Non-occupational			
	Illness	Motor vehicle injury	Non-motor vehicle injury	Musculo-skeletal disorder	Illness	Motor vehicle injury	Non-motor vehicle injury	Musculo-skeletal disorder
Production:								
Operator	6·5 (9)	0·0 (0)	18·8 (31)	4·1 (8)	336·4* (542)	6·2 (11)	67·8 (119)	47·3* (74)
Maintenance	4·7 (2)	0·0 (0)	29·2 (9)	11·2 (5)	338·4 (132)	14·3 (6)	78·8 (34)	93·5 (29)
Others	3·7 (2)	0·0 (0)	18·5 (5)	6·5 (6)	431·4 (176)	14·9 (5)	91·1 (39)	96·0 (33)
Combined	5·9 (13)	0·0 (0)	23·1 (45)	5·8 (17)	387·3 (850)	8·6 (22)	83·2 (192)	73·0 (136)
Staff:								
Operator	0·0 (0)	0·0 (0)	7·6 (2)	0·0 (0)	127·7 (37)	0·0 (0)	11·2 (2)	32·5 (9)
Maintenance	0·0 (0)	0·0 (0)	0·0 (0)	0·0 (0)	95·4 (5)	0·0 (0)	0·0 (0)	0·0 (0)
Others	1·0 (5)	0·0 (0)	0·5 (4)	1·1 (4)	104·6 (641)	2·0 (14)	10·9 (66)	17·7 (102)
Combined	1·0 (5)	0·0 (0)	0·8 (6)	1·0 (4)	106·3 (683)	1·9 (14)	10·9 (68)	18·3 (111)

*Significantly different from combined at $p < 0.05$.
†Per 1000 person-years. Numbers in parentheses are morbidity episodes.

Table 11 Age adjusted frequency rates† for men by occupational status, work status, and job

Job	Occupational				Non-occupational			
	Illness	*Motor vehicle injury*	*Non-motor vehicle injury*	*Musculo-skeletal disorder*	*Illness*	*Motor vehicle injury*	*Non-motor vehicle injury*	*Musculo-skeletal disorder*
Production:								
Operator	3·5 (72)	0·1 (2)	7·0* (151)	3·8* (79)	157·9* (3191)	7·7 (174)	57·2* (1222)	34·8* (694)
Maintenance	5·2 (83)	0·3 (4)	14·9* (157)	9·8* (157)	225·8* (3572)	7·0 (114)	81·3* (1305)	49·8* (788)
Others	1·9* (8)	0·5 (1)	10·3 (29)	5·3 (18)	244·7* (645)	11·2 (27)	96·4* (215)	48·4 (130)
Combined	4·2 (163)	0·2 (7)	10·2 (407)	6·5 (254)	191·1 (7408)	7·7 (315)	68·8 (2742)	41·9 (1612)
Staff:								
Operator	0·4 (5)	0·0 (0)	1·5 (13)	1·0 (9)	93·7* (822)	3·9* (29)	22·8* (179)	16·7* (147)
Maintenance	2·4 (8)	0·0 (0)	3·9 (13)	1·8 (5)	80·1* (388)	2·3 (9)	27·5 (79)	18·3* (77)
Office	0·3 (7)	0·0 (1)	0·8 (15)	0·7 (13)	55·6* (1180)	1·1* (21)	11·9* (222)	9·1* (186)
Combined	0·6 (20)	0·0 (1)	1·4 (41)	0·9 (27)	68·8 (2390)	2·0 (59)	15·7 (480)	12·3 (410)

*Significantly different from combined at $p < 0.05$.
†Per 1000 person-years. Numbers in parentheses are morbidity episodes.

due to injuries, respiratory illnesses, or musculoskeletal disorders were most likely to have had another absence of the same diagnostic type. About one third of all absentees had had more than one absence due to these three causes. Among those who had had four or more absences, about half had had at least one other absence due to these causes.

Overall, one sixth of all absences were longer than two months (42 working days). Of these, 324 or 11% directly preceded the absentee's retirement and contributed 19% of the days of absence. For women, 70% of all absences longer than two months were due to the five most common disorders—namely, musculoskeletal disorders, injuries, genitourinary disorders, neoplasms, and mental disorders. For men the five leading disorders (injuries, musculoskeletal, circulatory, and digestive disorders, and neoplasms) accounted for 78% of total absences longer than two months. Across all causes of morbidity, the average duration of absence for this long term absentee group was 93 days for women and 101 days for men.

Table 13 Age adjusted frequency rates† employees with four or more absences by sex, work status, and job

Jobs	*Women*	*Men*
Production:		
Operator	352·9* (597)	143·1* (2983)
Maintenance	422·5 (160)	261·6* (4174)
Others	583·7* (222)	291·4* (715)
Combined	439·5 (979)	200·7 (7872)
Staff:		
Operator	68·5 (21)	48·1* (411)
Maintenance	0·0 (0)	38·7* (164)
Office	41·4 (241)	18·0* (375)
Combined	42·5 (262)	28·1 (950)

*Significantly different from combined at $p < 0.05$.
†Per 1000 person-years. Numbers in parentheses are morbidity episodes. Excludes absences due to pregnancy.

Discussion

In this study we illustrate the utility of routinely collected health surveillance data for epidemiological monitoring. From 1 January 1981 through 31

Table 12 Age adjusted prevalence rates† for selected disease risk factors: absentees v non-absentees by sex and work status

Risk factors	*Women*			*Men*		
	Absentees (⩾4 absences)	*Absentees (1–3 absences)*	*Non-absentees*	*Absentees (⩾4 absences)*	*Absentees (1–3 absences)*	*Non-absentees*
Production:						
Smoking	60·9*	41·0*	25·8	40·0*	33·6	31·7
High blood pressure	24·0*	8·0	5·3	23·4	25·1	24·2
Hypercholesterolaemia	49·8*	23·8	26·6	57·4	56·8	56·2
Obesity	34·5*	35·3*	18·2	47·1*	44·4*	39·9
Staff:						
Smoking	34·6	34·0*	24·6	26·9	27·6*	20·9
High blood pressure	16·8	13·7	11·6	20·4	22·6	21·2
Hypercholesterolaemia	59·5*	45·7	44·2	69·3*	62·1*	56·0
Obesity	54·5*	30·7*	19·0	56·9*	45·0*	36·0

*Significantly different from non-absentees at $p < 0.05$.
†Per 100 workers. Adjusted to the total population using the direct standardisation method.

December 1988, a total of 18 503 reported episodes of absence with more than half a million (535 487) work days lost were attributed to illness/absence events in excess of five days. This was equivalent to the absence from work of about 270 workers (3% of the average workforce) each year during this period. Substantial numbers of long illness/injury episodes occurred; in fact one third of all absences were longer than four work weeks.

These analyses show the disproportionately large impact on morbidity rates and duration of absence from the small percentage of employees with four or more illness/absences over the eight year period. As had been expected illness/absence rates increased with increasing age. Similar observations have been noted by other researchers.[7 8] The rates for older workers (60 years and older) were more than double those of younger ones (less than 30 years old). Rates for women were greater than those for men in similar occupational categories for all ages except for older men holding staff positions. Differences in illness/absence rates were most pronounced between production and staff workers. Male and female production personnel had much higher rates for diagnostic categories across all job groups than their staff counterparts. Also, both male and female production workers had higher rates regardless of whether the illness/absence episode was work related or not work related.

Personal characteristics related to morbidity frequency in a working population include age, sex, lifestyle, education level, pay status, alcohol use, smoking habits, and occupational factors. These variables influence both occupational and non-occupational morbidity. It is important to note that in this study production workers have significantly higher age adjusted prevalence rates for two lifestyle indicators, smoking and obesity, both of which have been associated with increased morbidity.[5 9-12] Furthermore, the differences in morbidity rates may relate to job duties. For example, for most illnesses and injuries, the duration of absence will be longer for a job that requires greater physical activity than for one that is primarily sedentary.

Comparisons between the experiences of men and women among production workers seen in this study are noteworthy. Female production workers had twice the number of days of illness/absence as did their male counterparts. They also had an approximately 80% higher frequency rate than male workers. The difference came mainly from workers 30 years of age or older. Disorders of the respiratory and genitourinary systems, as well as musculoskeletal disorders and injuries, accounted for two thirds of the difference. It is interesting to note that for injuries, however, male staff had a higher rate than female staff.

The reasons for the disparities between women and men in this study are not clear. The smoking rates among female production workers may be partly responsible for their higher illness/absence and severity rates. Future investigations will address this issue more fully.

The results show consistent relations between morbidity rates of the three job groups. For both female and male production employees, the average duration of absence and the morbidity frequency rates were highest for "other" workers, followed by maintenance workers and operators. For staff employees, on the other hand, operators had the highest rates, followed by maintenance workers and then office workers. These patterns also held true when analyses were done only on non-occupational illnesses and injuries. These results are consistent with the sickness/absence experience of the French National Electric and Gas Company workers.[8]

Illness/absence in a working population is a complex phenomenon incorporating many factors. It is unlikely that the relatively poor health experience of "other" workers among production employees is due to occupational exposure factors as they generally have minimal contact with chemical agents. More likely this experience is in part a product of lifestyle as evidenced by the fact that in this production population "other" workers were more likely to smoke than operators and maintenance workers. The benefits of a healthy lifestyle seem to be represented by the relative good health of the group of staff office workers.

Age adjusted prevalence rates for the four selected disease risk factors (smoking, hypertension, hypercholesterolaemia, and obesity) by levels of absenteeism (non-absentees, absentees with one to three absences, and absentees with four or more absences) were examined in this study, to quantify their impact on illness/absence. It is important to note that among absentees, the proportions of both male and female employees who had the disease risk factors were significantly higher than those of non-absentees. These results suggest that it may be possible to reduce overall illness/absence through implementation of successful health promotion programmes. Further subgroup analyses to assess effects of age, retirement patterns, and risk factor distributions by cause of morbidity are planned to identify appropriate intervention targets and more specific high risk groups.

Health surveillance is one of the important components of occupational epidemiology. Illness/absence statistics are invaluable for answering questions on the health of employees. Medical and administrative recommendations carry much more weight when they are backed by facts. This study has identified worker groups at increased risk of illness/absence. These findings are useful in setting priorities for medical programmes and directing

efforts such as illness/absence control measures, health education programmes, and other preventive strategies. Also, examination of health surveillance data can quickly identify areas of concern and can be a useful prelude to the design of more specific case-control or cohort studies.

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