

# HEARTS, HEALTH AND COAL MINING

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## Abstract

An increased risk of death from heart attack has been identified in coal miners in the United States. The prevalence of coronary heart disease and the effect on the mortality rate of Australian coal miners has not been previously investigated.

This project examined the question as to whether there is an increased risk of coronary heart disease in the coal mining industry by determining the mortality rate for Australian miners associated with heart disease, and level of risk associated with the work and lifestyle risk factors associated with heart disease in the coal mining industry.

A number of factors are present in the coal mining industry that are known risk factors for cardiovascular disease and coronary heart disease and these are present at a higher level than the general population.

The increased risk has not resulted in an increased mortality rate. The current mortality data is based on historical data and the future may present a different scenario. Monitoring of the risk factors needs to continue to enable continued benchmarking with the general population.

## Introduction

Based on death certificate data from NIOSH's National Occupational Mortality Database, coal miners in the United States appear to have an elevated risk of death from coronary heart disease, specifically heart attacks (NIOSH, 2001). There was not an overall increase in risk from cardiovascular disease generally.

The prevalence of coronary heart disease and the effect on the mortality rate of Australian coal miners has not been previously investigated. This project was funded by the Joint Coal Board (JCB) Health and Safety Trust.

## Methodology

The aim of this project was to determine the mortality rate for Australian coal miners associated with coronary heart disease (CHD), the current prevalence of CHD disease, and examine the work and lifestyle risk factors associated with CHD.

CHD is a generic term describing disease that results from insufficient blood flow to the heart caused by the narrowing of the coronary arteries due to atherosclerosis. Acute myocardial infarction (AMI) is the most severe form of CHD and occurs when the heart muscle is damaged as a result of a sustained blockage in a coronary artery.

There were four stages in the project:

- 1 establishing the mortality rate from heart disease data for coal miners
- 2 establishing the current incidence of heart disease
- 3 identifying the risk of heart disease associated with lifestyle factors
- 4 identifying the risk of heart disease associated with work related factors.

### 1 Mortality and heart disease

A retrospective study was undertaken to identify the mortality of coal miners from heart disease through analysis of the Australian Institute of Health and Welfare (AIHW) data. This was compared to the general population mortality data.

### 2 Incidence of heart disease

The data currently held in the Queensland Coal Mine Employees Health Database and the JCB was examined to provide comparison of the physiological indicators of heart disease with the general population. These indicators included:

- blood pressure
- BMI (BMI)

### 3 Lifestyle factors

Information on lifestyle factors affecting the risk of heart disease available from projects and published information was analysed (Parker et al, 1996; Harris et al, 2000; Bofinger and Mahon, 2001) eg:

- exercise
- stress
- diet
- smoking
- alcohol abuse.

### 4 Work related factors

Work-related factors influencing the risk of heart disease were analysed. These included:

- exposure to atmospheric contaminants eg dust
- shiftwork
- noise.

### Heart disease – general population

Through the 1970s and 1980s, heart disease data was collated by the National Heart Foundation (1990) in their efforts to make the Australian public more aware of the widespread occurrence of heart disease. More recently, the AIHW (2001) has taken the lead in compiling and publishing data on heart disease and health issues generally.

Coronary heart disease was the major cardiovascular cause of death and was the largest

single cause of death in Australia (AIHW 2001). It consists mainly of acute myocardial infarction (heart attack) and angina.

Overall, males were almost twice as likely to die from coronary heart disease as females in 1998, with males aged 25-64 having death rates three to five times those of females. Non-fatal heart attacks were three times more common among men than women in the 35-69 age group (AIHW, 2001).

When comparing Australian data with the data available from other countries, Australian death rates from coronary heart disease rank towards the middle of the countries compared (Figure 1).

### Factors affecting heart disease

Risk factors are defined by the AIHW as determinants, characteristics or exposures that are associated with a greater risk of ill health. For all types of cardiovascular disease they include genetic, behavioural and physiological factors.

The behavioural risk factors can influence physiological risk factors eg poor diet and physical inactivity can lead to being overweight or obese, having high blood pressures and high blood cholesterol.

Increasing age and being male increase the risk of coronary heart disease.

The preventable risk factors for coronary heart disease are:

- tobacco smoking
- high blood pressure
- high blood cholesterol
- overweight and obesity
- insufficient physical activity.

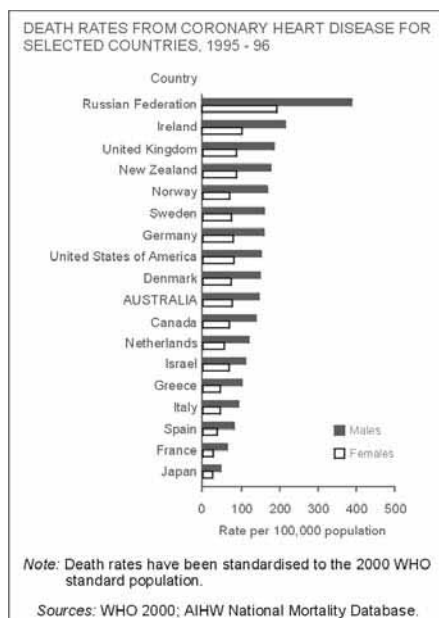
Dietary factors and diabetes have also been associated with a higher risk of coronary heart disease.

There is also evidence that social, economic and environmental factors can contribute to disease.

### Social and economic factors

Marmot (2000) showed that a dominant feature of the occurrence of cardiovascular disease in most industrialised societies is the higher rate of heart disease in people of a lower socio-economic position.

Figure 1



Factors may include material deprivation, standing in society, power relationships and education relating to health and nutrition. Wlazelek (1999) reported that in Pennsylvania, heart disease rate was 145.7 deaths per 100,000 after age correction compared with 134.5 per 100,000 in the general US population.

Factors that were suggested as affecting this rate included mining associated health issues, smoking, eating fatty food, insufficient exercise, high blood pressure, high cholesterol and poorly treated diabetes.

### Environmental factors

Particulate matter (PM) in ambient air is a complex mixture containing particles of different sizes and chemical composition. Epidemiologic studies have described an association between increases in cardiovascular morbidity and mortality and short-term increases in ambient PM – particularly fine particulates with aerodynamic diameters of <2.5 Fm, PM<sub>2.5</sub> (US Environmental Protection Agency, 1996). Cardiac morbidity and mortality have been associated with daily variation in the concentrations of particles lower than 30-50 Fg/m<sup>3</sup>.

### Work related factors

In a review of the literature linking workplace factors to cardiovascular disease, Steenland (2000) noted that risk factors included:

- stress
- shiftwork
- heat, particularly above 27°C
- noise
- numerous chemicals that have some direct effect on the heart function.

As previously discussed, particulate matter also has an impact on the risk of coronary disease.

### Analysis and results

#### Limitations of analysis

There are limitations to the analysis of the mortality data that need consideration. These include:

- The difficulties encountered in the initial matching of the coal miners data with the AIHW data. This resulted in 3049 New South Wales records and 276 Queensland records being disregarded.
- The analysis completed includes the deaths from 1996 to 2000. These years were chosen as reliable death data and miner data was available for both Queensland and New South Wales. This does result in a relatively small number of deaths per year per age group. The coal mining death rates over that period are compared to the 1998 death data from the AIHW.

The AIHW information is based on the surviving population. It was not possible to establish a surviving population for the coal mining industry. The coal population analysis is based on state records. The birth cohort for each age group was the basis of the rate of death analysis. This will result in a lower death rate per 100,000 when compared to the AIHW data. The difference will become more noticeable in the older age groups.

- Workers tend to be healthier than the general population – the 'healthy worker' effect. This will also affect the mortality rate compared to the general population.

### All causes of death

Data of cause of death is shown in Table 1. Deaths from diseases of the circulatory system in the NEW SOUTH WALES population are comparable to the national average.

In Queensland, deaths from diseases of the circulatory system were 26 percent compared to the national population at 40 percent.

### Cardiovascular and coronary heart diseases

Coronary heart disease and stroke are the most common fatal cardiovascular diseases. Queensland and New South Wales data for coal miners matches closely that provided by the AIHW as shown in

Figure 2 and does not indicate an increased risk of coronary heart disease. The test of proportion did not show any statistical difference between the coal mining and general populations.

### Analysis of health database medical factors

Data from the state databases on blood pressure and BMI were analysed to estimate the incidence of cardiovascular and coronary heart disease risk factors.

### High blood pressure

There is considerable difference in the incidence of high blood pressure between the mining community and the general community as shown in Figure 3.

The World Health Organisation definition of high blood pressure was used ie:

- Systolic blood pressure  $\geq 140$  mmHg; and/or
- Diastolic blood pressure  $\geq 90$  mmHg.

Overall, both Queensland and New South Wales

miners show significantly higher percentages of the population with high blood pressure. Using the test of proportions, the difference is statistically significant in all cases, except for Queensland routine and entry, 55-64 age group.

Of particular concern are the high percentages of high blood pressure for the initial medicals in New South Wales. The reason for this high rate is not obvious and is currently being investigated.

### BMI – overweight and obesity

BMI is used as an indicator to assess if a person is overweight or obese. Figure 4 shows that in all age groups, a higher percentage of coal miners are overweight than the same age groups in the general population.

The difference between the mining population and the general population is statistically significant using the test of proportions. There is generally no statistically significant difference between entrants, miners or contractors.

### Lifestyle factors

#### Physical activity

The level of physical inactivity was compared to the general population. Physical inactivity was defined as not participating in some form of exercise for at least 20 minutes more than twice a week. Results are shown in Table 2.

Levels of inactivity in the mining industry do not include any physical activity undertaken for work purposes. The coal industry results are comparable with the general population.

**Table 1**  
**Coal Miners – All Causes of Deaths – 1996 to 2000**

ICD Code Number	Cause of Death Category	NEW SOUTH WALES Number of deaths	QLD Number of deaths	NEW SOUTH WALES % of deaths	QLD % of deaths	Australian Population* % of deaths
II	Neoplasms	987	113	34	39	27
IX	Diseases of the circulatory system	1111	75	38	26	40
X	Diseases of the respiratory system	280	12	10	4	10
XI	Diseases of the digestive system	80	8	3	3	3
XIV	Diseases of the genitourinary system	36	2	1	1	2
XVI	Peri-natal Conditions	0	0	0	0	0
XIX	Injury etc – external causes	117	37	3	13	6
XX	External causes of morbidity and mortality	66	29	3	10	(combine XIX and XX)
	All Others (to compare AIHW)	213	16	7	6	10
<b>Total</b>	All classes	2890	292			

AIHW, 1999

**Alcohol use**

Hazardous alcohol use is based on five or more drinks for five or more days per week. The level of hazardous alcohol use in the general population is 8 percent (AIHW, 2001). The results for the coal mining industry are shown in Table 3.

The overall level of hazardous alcohol use in the mining industry is consistent with the general population level of 8 percent. Of concern is the high level of hazardous use of alcohol in the 18-24 age group.

**Tobacco smoking**

Smoking levels in the mining industry and the general population are shown in Table 4. Smokers are defined as current or occasional smokers. The Queensland medicals have self-reporting questions on smoking. The data from these medicals was included and is consistent with the data from the lifestyle questions from the other projects.

**Diet and nutrition**

The NHMRC Dietary Guidelines (1998) recommend

the following:

- Vegetables 4 serves daily
- Fruit 3 serves daily
- Grains and cereals 5+ serves daily
- Fats and sugars # 2 serves daily

Based on these recommendations, the coal miners maintain a reasonable diet. Increase in the amount of fruit and vegetables, and grains and cereals, would improve the diet. The results of the questionnaires did not provide information on the total intake for a day.

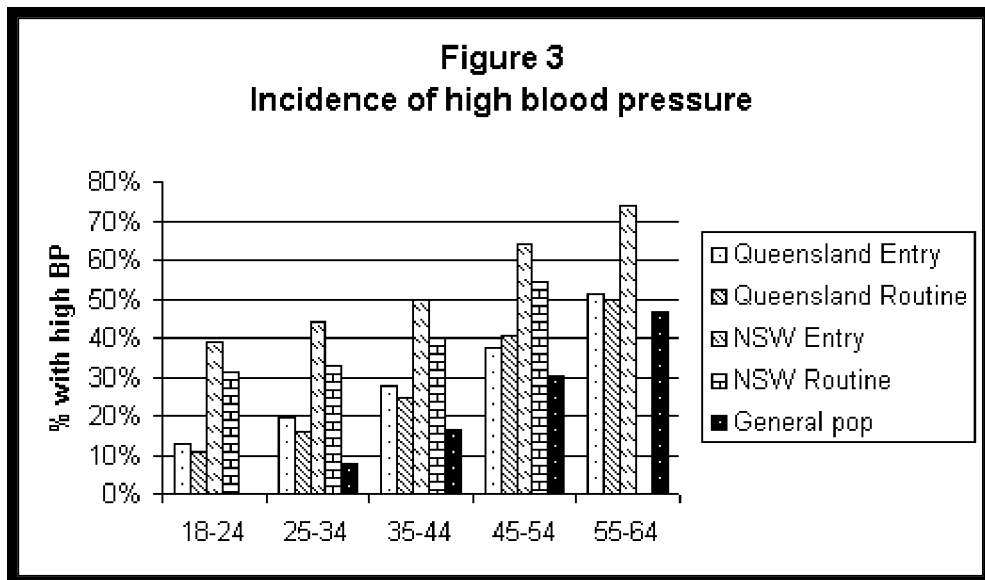
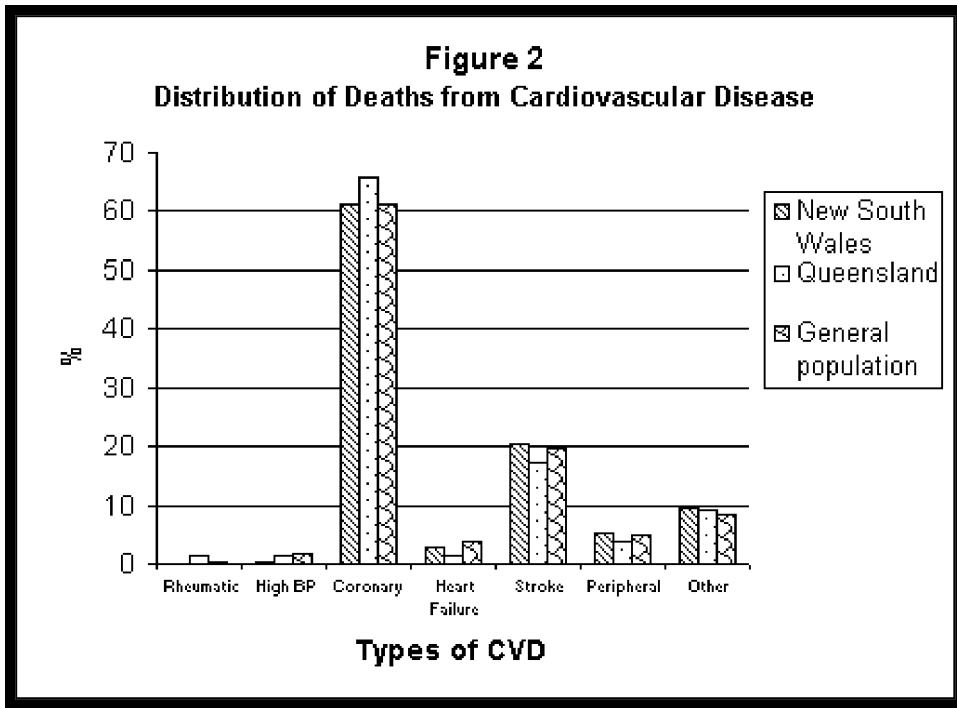
**Occupational factors**

**Noise exposures**

Noise exposures in coal mining are controlled by regulation in Queensland and New South Wales.

In Queensland and New South Wales, legislation refers to the National Standard for Occupational Noise (NOHSC:1007). This specifies a daily noise dose equivalent to 85dB(A) and a peak at not more than 140dB(lin).

From surveys undertaken by Simtars (unpublished data), the following average results can be shown



(Table 5).

These levels indicate that noise levels could contribute to the incidence of CHD in the mining industry.

**Dust exposures**

The average percentage of particles of PM<2Fm generated during coal mining has been estimated at between 1-3 percent of respirable dust when no diesel particulates are present (Burkhart, McCawley and Wheeler, 1987; Unsted, 1996). Data to estimate the PM<2.5 is not available.

Using 2 percent as a working figure, the average exposures of miners to particulate matter of < 2Fm are shown in Table 6.

The limitations of such 'averaged' data are acknowledged. It does, however, indicate that the levels of particulate matter to which underground workers are exposed could increase the risk of coronary heart disease.

The use of diesel equipment underground could increase the level of particulate matter <2Fm.

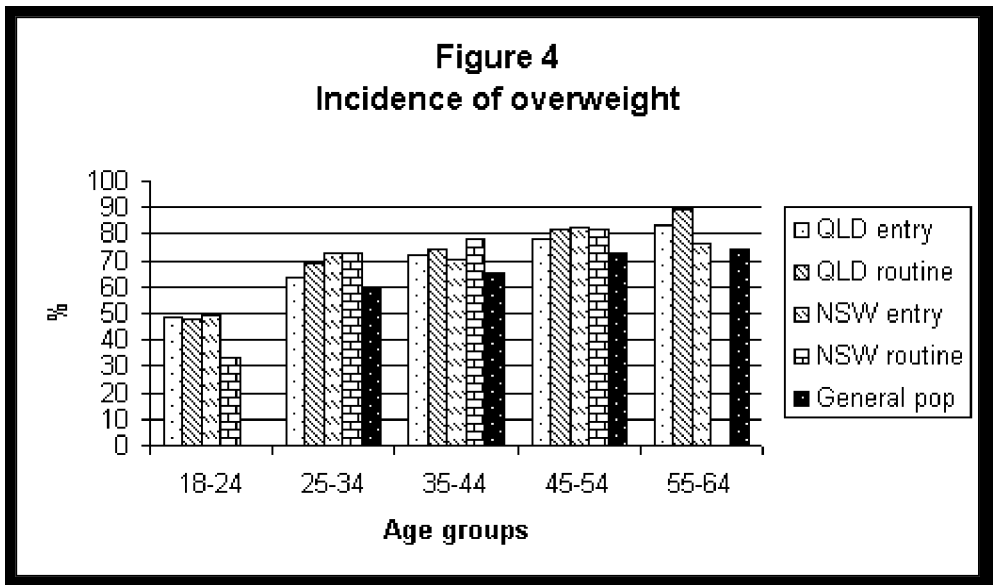
**Shiftwork**

The coal mining industry has a high level of shiftwork with > 80 percent of workers working some form of shift arrangements (Department of Natural Resources and Mines, 2001). Results from investigations into shiftwork in the coal industry (Bofinger and Mahon, 2001) have shown that 10-20 percent of shiftworkers have problems balancing work, family and social life. This is shown in Figure 5.

**Heat**

Surface and underground mines are required to manage exposure to heat. The *Queensland Coal Mining Safety and Health Regulations* (2001), Chapter 4, Part 12 Division 2 – Heat Stress Management, calls for heat to be managed in underground coal mines if the wet bulb temperature exceeds 27°C and work to cease if the wet bulb temperature exceeds 29°C. Surface mines are required to have heat management procedures in place.

As limited data is available to determine the exposure of coal miners to heat, it is not possible to estimate the contribution of heat exposure to the incidence of coronary heart disease.



**Table 2**  
**Levels of Physical Inactivity**

Population group	18-29	30-44	45-59	60-75	18-75	
General population (AIHW, 2001)	31.3%	46.5%	50.0%	46.0%	43.3%	
	18-24	25-34	35-44	45-54	55-64	Overall
Coal Mining - all groups	28%	40%	45%	43%	49%	42%

**Table 3**  
**Levels of Hazardous Alcohol Use**

Population group	18-24	25-34	35-44	45-54	55-64	Overall
Coal Mining – all groups	28%	6%	5%	4%	3%	7%

### Cardiotoxic compounds

Levels of carbon monoxide and other atmospheric contaminants are regulated by legislation in both Queensland and New South Wales.

The level of atmospheric contaminants regulated for and experienced in coal mines is unlikely to affect the incidence of heart disease.

### Conclusions

The results of the analysis show there is no statistically significant difference between the death rate from coronary heart disease for the coal mining industry in New South Wales and Queensland and the general population.

The distribution of the types of cardiovascular disease is consistent with the distribution in the general population.

The Australian coal mining population does not appear to have an increased risk of death from coronary heart disease. The situation in Australia does not appear to reflect the problem identified in the United States of America

There are however, a number of factors that indicate

**Table 4  
Smoking Status**

Population group	18-24	25-34	35-44	45-54	55-64	Overall
General population	39.3	38.3	27.5	28.9	29.3	30.2 (25+)
Coal Mining – all groups	21	28	30	26	16*	27
Data from QLD medicals	30	32	28	22	15	27

**Table 5  
Noise Exposures exceeding 8 hour dose equivalent to 85 dB(A)**

Sector	Measurements exceeding Regulatory limits
Underground Coal	>40%
Surface Coal	>20%

**Table 6  
Dust Exposures of Miners**

Sector	Average respirable dust levels mg/m <sup>3</sup>	Average levels of < 2 $\mu$ m $\Phi$ g/m <sup>3</sup>	Data Source
NEW SOUTH WALES underground	1.5	30	Kizil and Donoghue, 2001)
NEW SOUTH WALES surface	0.6	12	Joint Coal Board, 2000
QLD underground	1.9	38	Bofinger, Cliff and Tiernan, 1995
QLD surface	<0.4	<8	Unpublished data, Simtars

that an increased risk could be expected in the future. These risk factors include the results from the comparison of blood pressure and BMI that are in turn influenced by lifestyle factors.

The long-term nature of lifestyle changes that are needed to modify health risk factors indicates that health promotion needs to be considered as a long-term project.

There are work related factors associated with coal mining that have been shown to increase the risk of heart disease. Dust and noise exposures have been present in the coal industry for considerable time and are more controlled than in past times. There has been an increase in shiftwork in the mining industry.

In addition, there are other factors known to influence the risk of heart disease that were not considered. These include genetics, socio-economic factors and the direct influence of stress.

The inter-relationships of the factors affecting heart disease demonstrates the complexity of the issue.

It is of concern that there are a number of

factors in the coal mining industry that are known risk factors for CVD and CHD and these are present at a higher level than the general population. The current mortality data is based on historical data and the future may present a different scenario. Monitoring of the risk factors needs to continue.

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**Figure 5  
Problems with Shiftwork**

