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EXECUTIVE SUMMARY

Recordings of elevated blood pressures have been identified among both Queensland and New South Wales (NSW) miners. Of particular concern is the high percentage of elevated blood pressure for both entry and routine medical assessments in NSW. The reason for this high rate is not obvious.

This finding was first identified from the Joint Coal Board Health and Safety Trust funded project "Risk factors for heart disease among coal miners" completed by Simtars in 2002. An extension project was granted to further investigate this phenomena.

The possible causal factors to explain the elevated blood pressure among NSW entrant and routine medicals has not previously been investigated.

This extension project examined the question, are the blood pressure results reported for these medicals in NSW an artefact of the single data set or are they supported by a wider set and what are the possible causes of the elevated blood pressure results.

Data was reviewed from the Coal Services health database, Australian Institute of Health and Welfare – Cardiovascular Diseases database and the Risk Factors for Heart Disease among Coal Miners project completed by Simtars 2002.

Consistency of elevated blood pressure readings across all age groups, mining districts and mine types is apparent. Of particular concern is the younger age categories 25-44 which showed significant blood pressure variation across all mining districts when compared to the Australian male average.

Reports of elevated blood pressure from the data show a statistically significant difference between the entry and routine measurements. People entering the industry are showing higher than average elevated blood pressure readings than those who are already working as compared with the Australian male population data.

Medically based research would need to be undertaken to monitor the consistency of elevated blood pressure and to arrive at a firm conclusion that coal mine workers having both entry and routine medicals are in fact suffering from High Blood Pressure or Hypertension.

1.0 INTRODUCTION

Based on the results of the Joint Coal Board Health and Safety Trust funded project "Risk factors for heart disease among miners", there appears to be a higher percentage of coal mine workers with elevated blood pressure results when compared to the Australian general population.

The reasons for the prevalence of elevated blood pressure among NSW coal mine workers have not previously been investigated.

Key factors involved in elevated blood pressure readings include:

- Physiological factors;
- Psychosocial stressors (inc white coat syndrome);
- Environmental;
- Procedural;
- Reporting and recording.

These factors are considered for this project to determine if the high level of reported elevated blood pressure results from the physiology of the miners or is an artefact resulting from other factors and not a true indicator of the health status of the miners.

This extension project was funded by the Joint Coal Board Health and Safety Trust and used data from the:

- Coal Services Australia health database;
- Risk factors for heart disease among miners project completed by Simtars 2002;
- Australian Institute of Health and Welfare – Cardiovascular Diseases Database.

1.1 AIM

The aim of this extension project was to identify the possible causes of the measurements of elevated blood pressures among New South Wales coal mine workers and to provide recommendations for management.

The World Health Organisation defines blood pressure as:

- Systolic blood pressure ≥140mmHg; and/or
- Diastolic blood pressure ≥90mmHg.

Note: The blood pressure data utilised for this project is based on one measurement only per subject. As high blood pressure is a medical diagnosis, the term elevated blood pressure will be used throughout this report for subjects whose blood pressure readings are ≥140/90.

1.2 PROJECT PERSONNEL

Simtars, Department of Natural Resources and Mines, Qld

Project Manager Carmel Bofinger
Project Officer Elizabeth Mahon

Safety and Health Division, Department of Natural Resources and Mines, Qld

Statistician Murray Wiggins

Coal Services Health – Warners Bay

Manager Mark O'Neill

1.3 METHODOLOGY

There were four parts to this extension project.

Part 1 To determine whether reported elevated blood pressure results of the study are confirmed by data from the past six years.

Part 2 To analyse the variation in blood pressure of entrant and repeat medicals.

Part 3 To determine if there are any differences due to mining districts and open cut in comparison to underground mining.

Part 4 To investigate other possible causes of the results including procedural, environmental, equipment and recording processes.

The following methodology was used to complete the project.

(a) Incidence of elevated blood pressure over last six years.

A retrospective analysis was undertaken to identify the incidence of elevated blood pressure from 1995-2002.

(b) Change in blood pressure.

The data currently held by Coal Services health database was analysed to determine differences in blood pressure between entrant and current NSW personnel. The different mining districts were also investigated.

(c) Mining district/type variation.

The data was further sorted into the mining districts supplied by the Coal Services health database. In addition the data was also sorted according to type of mining operation per district.

(d) Investigate additional causal factors.

Procedural, environmental, equipment and recording processes were analysed to determine the influence on elevated blood pressure readings among New South Wales coal mine workers.

A series of questions were answered by the Coal Services health professionals in each district regarding:

- Type of instrument used (mercury, anemometer etc);
- Calibration requirements;
- Method of BP measurement (lying, standing);
- Frequency and duration of measurements for both entrants and routine;
- Miscellaneous – standards, policy, procedures etc.

2.0 FACTORS AFFECTING ELEVATED BLOOD PRESSURE

2.1 DEFINITION

The World Health Organisation defines high blood pressure as:

- Systolic blood pressure ≥140mmHg; and/or
- Diastolic blood pressure ≥90mmHg;
- Receiving medication for the treatment of high blood pressure.

As previously indicated in Section 1.1, the term elevated blood pressure will be used in this report.

2.2 HIGH BLOOD PRESSURE – MORTALITY AND MORBIDITY

Data and information sourced from the Australian Institute of Health and Welfare (AIHW, 2001) Cardiovascular Diseases database have indicated that:

- More than 3.6 million Australians over the age of 25 had high blood pressure or were on medication for that condition. This equates to 31% of men and 26% of women;
- There has been a decline in the proportion of people with high blood pressure and/or receiving treatment since the 1980s;
- There has been a decline in average blood pressure levels since the 1980s.

However, data from the 1999-00 study of general practice activity in Australia shows that high blood pressure is ***the most common problem*** managed by general practitioners, accounting for 6% of all problems managed (AIHW,2001).

2.3 FACTORS AFFECTING HIGH BLOOD PRESSURE

The causes of high blood pressure are both medical and lifestyle oriented. High blood pressure is caused by the following determinants:

- Overweight and obesity;
- Alcohol consumption;
- Physical activity patterns;
- Nutritional patterns that include dietary salt intake and diets with a low intake of fruit and vegetables and a high intake of saturated fat;
- Stress.

(AIHW, 2001)

2.3.1 Overweight and Obesity

To assess the percentage of the mining population that are overweight or obese, the Body Mass Index (BMI) is used. BMI is calculated by weight in kilograms divided by height in metres squared. A BMI between 25 and 30 is considered to be overweight and above 30 indicates obesity.

In 1999-2000, over seven million adult Australians (aged 25 and over) were considered overweight. This equates to approximately 60% of the population aged 25 and over. Of these 2 million were obese (20% of the population aged 25 and over). Men are more likely to be overweight than women with 67% of men compared with 53% of women (aged 25 years and over) being overweight. (AIHW, 2001)

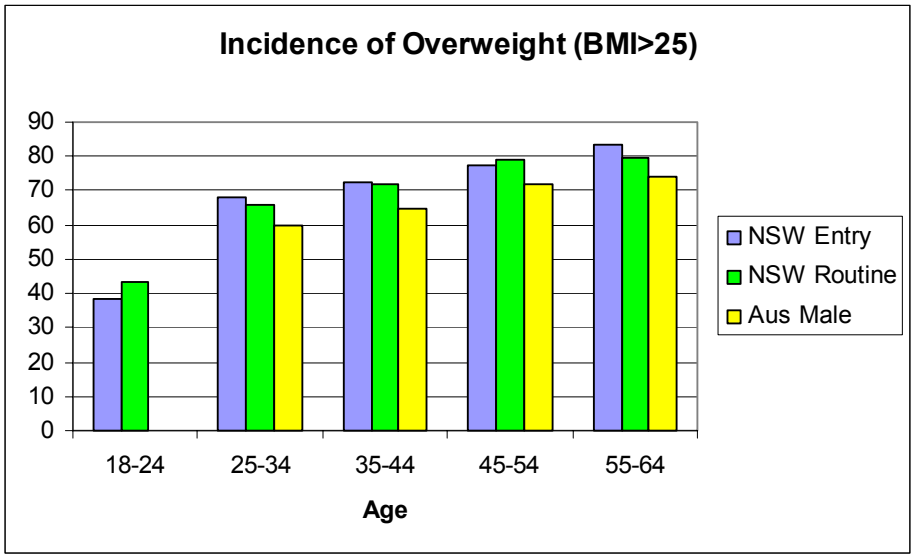
The available information on the incidence of overweight and obesity in the Australian and New South Wales coal mining industry is shown in Table 2.1. The level of overweight and obesity of NSW coal miners reflects the general population

Table 2.1
Incidence of Overweight and Obesity, males only
(%)

Age Group	NSW Coal Mines
25-34	10
35-44	29
45-54	31
55-64	35
65-74	32

(Source, Simtars, 2002)

Figure A1
Incidence of Overweight, males only



The incidence of overweight among NSW mine workers is slightly above the Australian male average across all age categories. No data was available from the Australian Institute of Health and Welfare (AIHW) for the 18-24 year age category. There appears to be no real statistical variation among NSW entry and routine candidates as shown above in Figure A1.

2.3.2 Alcohol consumption

High intakes of alcohol are associated with increases in blood pressure. However, low to moderate levels of alcohol consumption (1-2 drinks per day) can offer some protection against high blood pressure (AIHW, 2002).

The National Health and Medical Research Council (NHMRC) Dietary Guidelines for Australians recommend that it is not advisable for men to drink more than four standard drinks a day and women two standard drinks a day. All persons should have at least two alcohol free days per week (NHMRC, 1998).

Over 80% of the population consumed alcohol in the previous 12 months, with 11% of males and 6% of females drinking daily. In terms of risk of harm in the long term, 10% of males and 9% of females drank alcohol in a pattern that was risky or high risk. In terms of short-term risk, 24% of males and 17% of females drank at least once a month in a manner that was risky or high risk for short-term harm (NHMRC, 1998).

There is some available data on the alcohol consumption levels of coal mine workers. Data collected by Simtars identified drinking levels of workers as detailed in Table 2.2 and 2.3 (Simtars, 2002).

Table 2.2
Frequency of alcohol consumption among mine workers – Qld & NSW (selected mines) (%)

Days per weekly period alcohol is consumed				
Occasionally	1 day	2-3 days	4-6 days	Everyday
6	18	45	21	11

Table 2.3
Levels of Hazardous Alcohol Use – Short and Long term

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

2.3.3 Physical Activity Patterns

The National Physical Activity Guidelines for Australians (2000) refer to the minimum levels of physical activity required for good health. These guidelines recommend at least 30 minutes of moderate intensity physical activity on most, preferably all, days.

Around 5.7 million Australians aged 18–75 years (43% of that population) did not undertake sufficient physical activity. Over 2 million of these (15% of people aged 18–75 years) reported undertaking no physical activity at all. Men and women are equally likely to participate at sufficient levels of activity for health benefits (58% and 56.5%). However, among young adults (aged 18–24 years) men (81.9%) were much

more likely then women (67.6%) to achieve sufficient activity for health (AIHW, 2002).

Table 2.4
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%

(Source: Simtars, 2002)

Physical inactivity is defined as not participating in some form of exercise for at least 20 minutes more than twice a week (Activity Guidelines for Australians, 2001).

There is limited available data on the inactivity levels among New South Wales mine workers. Levels of inactivity for selected mines in Qld and NSW were compared with general population data as part of project work previously undertaken by Simtars, details are shown above in Table 2.4.

Further project work identified that the type of shift arrangement worked appears to have some bearing on the ability to take some form of exercise. About a quarter of employees on afternoon, night and both types of rotating shifts said they never took any exercise compared with just over 10% of those on day shift (Simtars, 2002).

Table 2.5 shows the results in terms of the length of exercise sessions. Night shift and both types of rotating shift workers were more likely than day or afternoon shift workers to exercise for shorter periods of 20 minutes or less. Equally, they were less likely to take longer exercise sessions of over an hour (Simtars, 2002).

Table 2.5
Length of Exercise Sessions
(%)

Type of Shift Worked	0-20 mins	21-40 mins	41-60 mins	61+ mins
Day shift	17	37	25	20
Afternoon shift	14	29	25	33
Night shift	21	30	30	18
Eight hour rotating	29	30	29	13
Twelve hour rotating	24	35	31	10
Total	**21**	**33**	**28**	**18**

2.3.4 Nutritional patterns

Elevated blood pressure cannot be attributed to any one dietary component alone. With a balanced diet, the supply of required nutrients is adequate for tissue maintenance, repair and growth. The vitamins, minerals and proteins required to maintain the human body in good health can be met only through the intake of a well-balanced, wide variety of food.

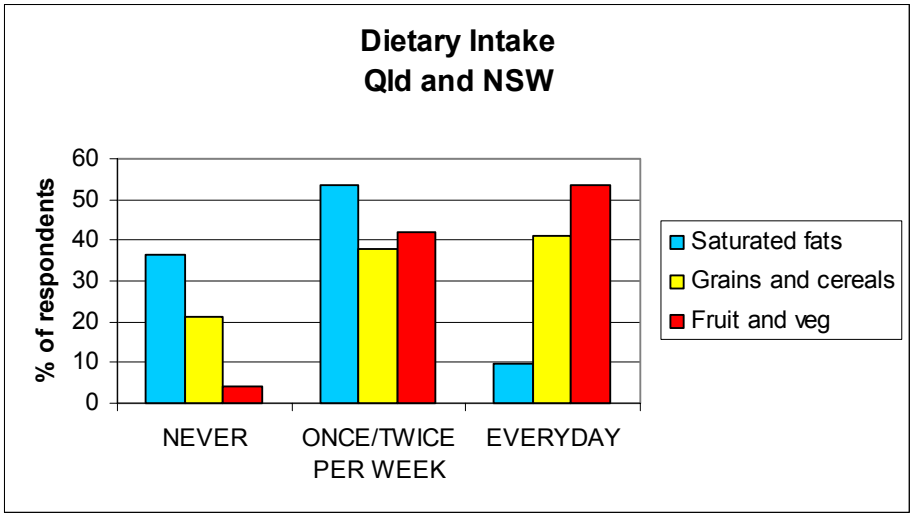
The National Dietary Guidelines for Australians (NHMRC, 2001) recommend consumption of a wide variety of nutritious food. Variety in a diet maximises the possibility of obtaining enough of these essential nutrients.

In particular, to reduce the risk of high blood pressure (hypertension) and other diseases, the dietary guidelines recommend people consume:

- 7 serves of fruit and vegetables per day;
- 30% total energy intake from total fat ;
- 10% total energy intake from saturated fat;
- 100 mmol per day of salt maximum (AIHW, 2001)

Project work undertaken by Simtars identified that generally both Qld and NSW coal workers complied with the national dietary guidelines. Further representation of these results is shown in Figure A2 below (Simtars,2002).

Figure A2
Coal Mine Workers Qld and NSW Dietary Intake (2002)



Some of the eating habits of night shift workers and of workers on rotating rosters who commute long distances to work could be regarded as less healthy than those on other shift patterns. Night shift workers were more likely to eat such foods as lollies, chocolate, cake or biscuits and crispy snacks on a daily basis than workers on other shifts. 20% of night shift workers said that they ate crispy snacks everyday compared to 13% or less of other shift workers. They were also a little less likely to eat fresh fruit and food containing whole grains on a regular basis. 14% of night shift workers reported that they never consumed more than one piece of fresh fruit a day compared

with 8% or less of other shift workers. Employees on rotating shifts commuting long distances were less likely to eat vegetables regularly but more likely to consume fatty foods such as processed meats and battered meat or fish on a daily basis. 15% of these workers said that they ate processed meats everyday compared with 10% or less of other shift workers (Simtars, 2002).

2.3.5 Stress

Stress is a complex workplace issue that strives for an acceptable definition and understanding. Although not scientifically validated stress has long been thought to be an underlying causal factor of many disease processes. The National Occupational Safety and Health Commission (2003) favours the view that working conditions play a primary role in causing stress. Exposure to stressful working and family conditions can have a direct influence on worker safety and health.

Stress raises blood pressure transiently but in the long term may have indirect effects by influencing eating, drinking smoking and physical activity patterns. Tobacco smoking increases the risk of heart attack and stroke threefold in hypertensive individuals (Nowack, 2000).

Nowack (2000), concluded that stress and increase in blood pressure have been identified as a key factor in occupational cardiovascular disease risk.

2.4 FACTORS AFFECTING THE MEASUREMENT OF BLOOD PRESSURE

2.4.1 Psychosocial

In the literature it is well established that constant elevated blood pressure is hard on the body, but what effect has white coat syndrome? White coat syndrome is poorly defined in the literature and is used as a collective term for the reactions or surges that psychological stress has on the human body's ability to maintain homeostasis. No one knows for sure if transient surges cause any harm or even how to treat it if it turns out to be harmfull. A German study researched 1,677 men and women. Eight percent of women and eleven percent of men had white coat syndrome. Those with the syndrome were twice as likely to suffer from heart disease according to the results from this study (Fackelmann, 1998). The means of measuring psychosocial stress are complex and onerous requiring an individual to be both observed and tested using both biological and cognitive assessment methods. The literature is conflicting when determining the impact that white coat syndrome has on blood pressure. Anecdotal evidence suggests that some practitioners rely on both experience and intuition to evaluate the possible impact that white coat syndrome has on a person's blood pressure.

Stress due to unstable industrial environments or economic pressure can be seen to have an impact on a person's homeostasis, which in turn can affect all body systems abnormally (Bunker et al, 2003). Pre employment and ongoing medicals can be a significant source of stress for individuals and may lead to abnormalities being detected in blood pressure at the time of assessment.

2.4.2 Procedural

Some research suggests that varying blood pressure readings can be obtained by using different patient positioning (Matoo, 2002 and Drevenhorn, 2001). Medical evidence suggests that blood pressure readings can differ from between 5-15mmHg, if a person is tested using lying, standing or sitting positions (Matoo, 2002)

Given the possible variations in blood pressure it is important to have consistency among procedures for taking blood pressure to help reduce this variation. Other variations occur during blood pressure procedures if the incorrect cuff size is used. Cuff size is normally reliant upon a visual assessment of the patient to determine if a small, medium or large cuff is to be used. A cuff size that is too small for a person's arm will not only give an abnormally high reading but can cause tissue damage to the arm (Matoo, 2002)

Some of the literature suggests that the following procedures should be followed before a blood pressure is taken:

- Client should be seated at least 5 minutes before blood pressure taken;
- Right sized cuff is to be selected;
- Arm level should be level with the heart;
- Medication history;
- Break of 1-2 minutes between measurements;
- Cuff bladder located over the brachial artery, (if arm measurement).

There appears to be consistency across the mining districts regarding the standards used to benchmark when a person is considered to have high blood pressure. Possibly a more underrated and poorly understood concept is the calibration of blood pressure measurement instrumentation. Calibration requirements are normally supplied as part of the manufacturers instructions when purchasing various blood pressure devices. Compliance with calibration varies among users and among institutions. Traditionally mercury type sphygmomanometers are calibrated informally using visual inspection methods, discussed further in section 4.4.5. Aneroid anemometers which are the second most commonly used devices can also be subject to informal assessment but are more likely to be part of a formal calibration through an independent facility.

3.0 ANALYSIS AND RESULTS

To determine the trends in elevated blood pressure for New South Wales coal mine workers, data from the Coal Services health database was analysed. For this report, elevated blood pressure has been determined as:

- Systolic blood pressure ≥140mmHg; and/or
- Diastolic blood pressure ≥90mmHg.

The data was grouped as entry and routine and sorted according to the above definition.

The second part to this extension project also utilised data supplied from the Coal Services health database. The data was sorted according to the change in blood pressure of entrants compared with repeat medicals.

The third part of the project determined if there are any mining operation or location variations of blood pressure readings among both entrant and repeat medicals. Data was sorted using the Coal Services health database and divided into the following three mining districts:

- Singleton
- Newcastle
- Corrimal (includes Lithgow district), herein referred to as Corrimal district

The final part to this project relied upon interview data supplied by both Occupational Health Physicians and Registered Nurses in the following four areas:

- Singleton
- Lithgow
- Newcastle
- Corrimal

3.1 RETROSPECTIVE ANALYSIS

Analysis of the blood pressure results from 1995 to 2002 was undertaken to determine statistical trends in elevated blood pressure measurements for both entry and repeat medicals. Data was sourced from the Coal Services health database and compared with general population data from the Australian Institute of Health and Welfare.

The medical data supplied was grouped as entry and routine and stratified by age, mine type and mining districts. Chi squared analysis was undertaken to determine significant differences across age groups, entry versus routine and comparing each of those subcategories per year from 1995-2002. Data for 18-65 years is shown in Table 3.1. Further breakdown of the data by age group is shown in Appendix A.

Table 3.1
Elevated blood pressure year/routine/entry
(%)

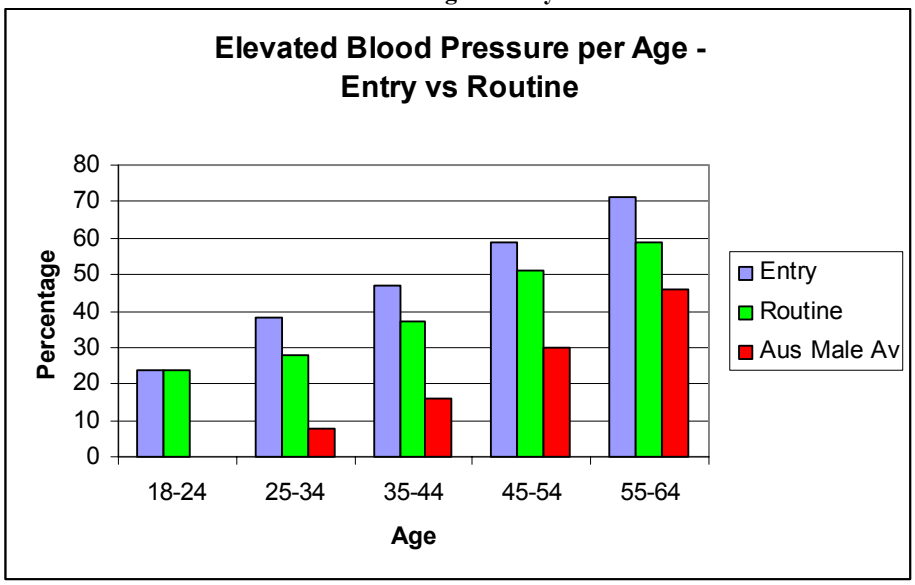
Exam Year	1995	1996	1997	1998	1999	2000	2001	2002	AIHW 1998
Routine %	41	42	39	46	44	45	39	46	31
Entry %	27	41	36	43	48	50	41	32	

Results for all years for routine measurements show a consistently higher percent of coal mine workers reporting elevated blood pressure compared to the general population. This is also shown for the entrants except for 1995.

3.2 ENTRY VS REPEAT MEDICALS

Data supplied by the Coal Services health database was sorted by age group and by entry and routine medicals, to determine the average percentage of persons in each age group that had elevated blood pressure readings recorded. This data was then compared with the general male population data supplied from the Australian Institute of Health and Welfare – Cardiovascular Disease database.

Figure A3
Elevated Blood Pressure vs Age – Entry and Routine



In the age categories from 25-64 elevated blood pressure recordings higher than the general population were recorded. A particular area of concern is the increased percentage of persons in both the routine and entry categories in the age group 25-44 years. The variation between both entry and routine for all age categories shows that entry medicals are recording significantly higher percentages of persons with elevated blood pressure readings. In the 18-24 year age category there is only slight variation between entry and routine with both recording approximately 25% of elevated blood pressure readings.

3.2 MINING DISTRICT ANALYSIS

The data supplied by Coal Services was sorted into the following mining districts:

- Newcastle
- Singleton
- Corrimal (includes Lithgow district), herein referred to as Corrimal district

There was no available health data supplied for the Corrimal surface district so this has not been included in the analysis. Significant differences in blood pressure per mining district are detailed in Tables 3.2 and 3.3 below.

Table 3.2
Significant difference in Blood Pressure variation per mining district – Routine Medicals

Age	Singleton		Corrimal		Newcastle	
	Surface	U/G	Surface	U/G	Surface	U/G
18-24	No	No	-	No	No	No
25-34	Yes	Yes	-	Yes	No	Yes
35-44	Yes	Yes	-	Yes	No	Yes
45-54	Yes	Yes	-	Yes	Yes	Yes
55-64	Yes	Yes	-	Yes	Yes	No

Variations are consistent among mining types and districts for the Singleton area across the majority of age categories, exceptions are noted in the 55-64 year age category for the underground entry medicals. Corrimal blood pressure variations are consistent across all age groups for the underground area. The Newcastle district showed more statistical variance among routine medicals for the 45-64 year age category for surface mines as compared to entry.

Table 3.3
Significant difference in Blood Pressure variation per mining district – Entry Medicals

Age	Singleton		Corrimal		Newcastle	
	Surface	U/G	Surface	U/G	Surface	U/G
18-24	No	No	-	No	No	No
25-34	Yes	Yes	-	Yes	No	Yes
35-44	Yes	Yes	-	Yes	No	Yes
45-54	Yes	Yes	-	Yes	No	Yes
55-64	Yes	No	-	Yes	No	No

Table 3.4
Blood Pressure variation compared to Australian Male Population (entry and routine combined)

Age	Singleton		Corrimal		Newcastle	
	Surface	U/G	Surface	U/G	Surface	U/G
18-24	No	No	-	No	No	No
25-34	Yes	Yes	-	Yes	No	Yes
35-44	Yes	Yes	-	Yes	No	Yes
45-54	Yes	Yes	-	Yes	No	Yes
55-64	Yes	No	-	Yes	No	No

There are significant differences across all age categories for both entry and routine medicals across the majority of mine types when compared to the Australian male population as shown above in table 3.4. It is interesting to note that the younger age categories 25-44 years show significant variation across both entry and routine medicals, with the exception of the Newcastle district surface mines. Graphical representation of mine type and district variation compared with Australian male population is detailed in Figures A4 and A5.

Figure A4
Elevated Blood Pressure measurements for Entry Medicals

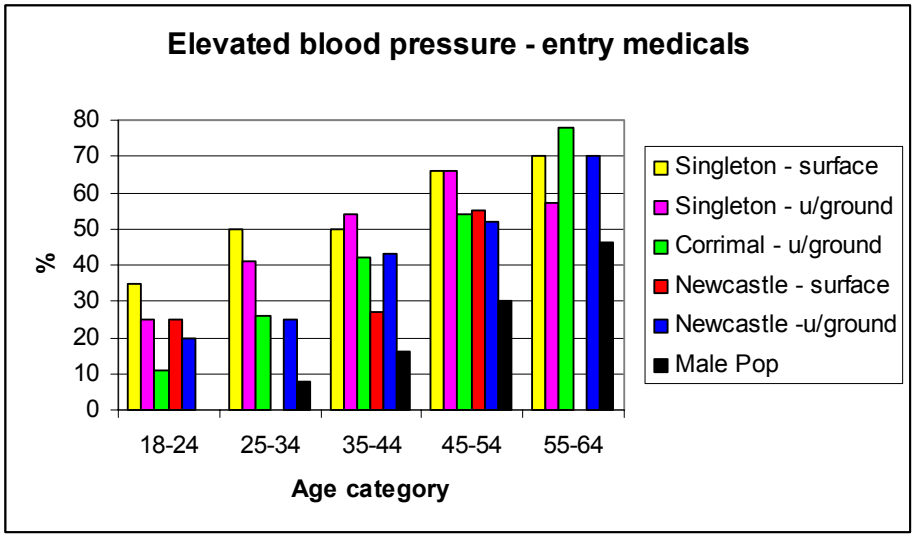
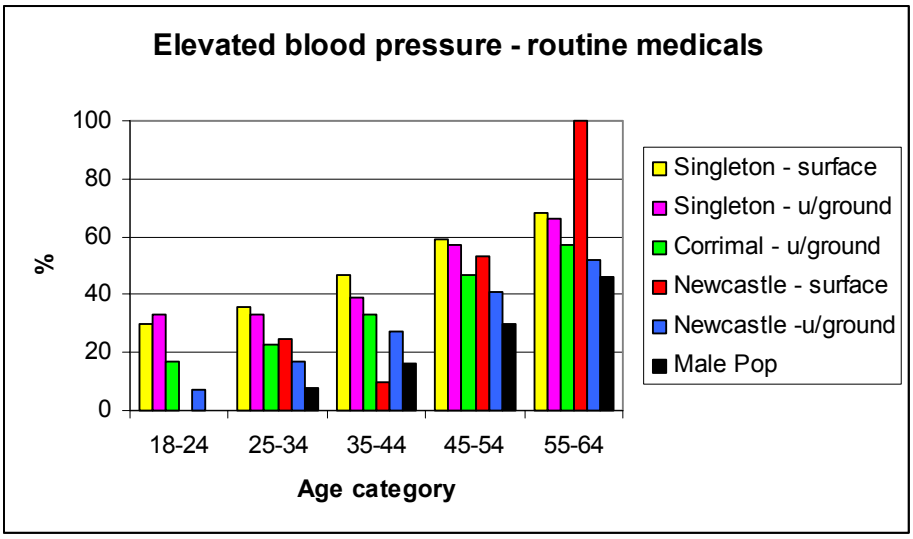


Figure A4 displays the elevated blood pressure readings from each district for the entry medicals only as compared with the general male population. The AIHW cardiovascular diseases database does not collect data on elevated blood pressure readings for the 18-24 year age group so comparisons were from the 25-64 year age group only. All mining districts, except for the Corrimal surface area show higher entry blood pressure as compared with the Australian male population. What is of particular concern is the high percentages of persons in the younger age categories with elevated blood pressure readings.

In Figure A5 it shows that there are similar patterns of variation as with the entry workers when compared with among routine medicals across all mining groups except for Newcastle surface workers in the 35-44 year age category.

Figure A5
Elevated Blood Pressure measurements for Routine Medicals



Further analysis of entry and routine medicals is attached as Appendix B.

3.3 ADDITIONAL CAUSAL FACTORS

To investigate the additional factors that may have influenced the elevated blood pressure readings found in the original project, the following were considered:

- Type of instrument used (mercury, anemometer etc);
- Calibration requirements;
- Method of BP measurement (lying, standing);
- Frequency and duration of measurements for both entrants and routine;
- Miscellaneous – standards, policy, procedures etc.

Occupational Health Nurses from the following districts were interviewed:

- Corrimal
- Lithgow
- Singleton
- Newcastle

Occupational Health Physician, Dr Pollock was also interviewed.

Details from these interviews are shown in table 3.5 below.

Table 3.5
Results of Interviews with Occupational Health Professionals

Factor	CORRIMAL	LITHGOW	SINGLETON	NEWCASTLE
Instrument type	Mercury Sphygmomanometer	Mercury Sphygmomanometer	Anemometer	Anemometer
Calibration performed (how often)	No formal calibration undertaken	6 monthly visual calibration check is performed	Yearly, NATA accredited lab	Yearly John Hunter Hospital
Are various cuff sizes available	Yes	Yes	Yes	Yes
Blood Pressure standards	Heart Foundation	Heart Foundation	Heart Foundation	Heart Foundation
How often are readings taken	Initial on entry Every 2.5-3yrs	Initial on entry Every 2.5-3yrs	Initial on entry Every 2.5-3yrs	Initial on entry Every 2.5-3yrs
Method of measurement	Sitting	Sitting	Sitting	Sitting

If blood pressure measurements are elevated, a repeat measurement is done and if this is still elevated clients are referred to the Occupational Health Physician for further investigation. Lying and standing methods of measurement are used by the medical practitioners to further investigate elevated readings. Some research suggests that variation in blood pressure readings can be obtained by using different patient positioning (Matoo, 2002 and Drevenhorn, 2001).

Discussions with Dr Pollock revealed that in his experience "White Coat Syndrome" should be a consideration for initial elevated readings, however to arrive at a clinical diagnosis of high blood pressure further investigation would be required. It was suggested for accurate measures to be obtained that continuous ambulatory monitoring of blood pressure would need to be done.

Calibration of sphygmomanometers can have a marked effect on the accuracy of blood pressure measurement. Once calibrated, there is no expected difference in performance between aneroid and mercury sphygmomanometers manufactured by reputable companies. All sphygmomanometers need routine calibration checks and regular preventive maintenance. The procedures are different for mercury and aneroid sphygmomanometers, but are otherwise equivalent in frequency, complexity and the amount of attention required. In practice, aneroid and mercury sphygmomanometers require different calibration techniques but otherwise proportionate amounts of attention. Some medical professionals have concerns that aneroid sphygmomanometers are easily damaged during use, resulting in inaccuracy due to the device being dropped or bumped and knocked out of calibration. This is perceived to be less of a concern for mercury sphygmomanometers due to the mercury column's rigid mounting requirements. Because the mercury column must be perfectly vertical in its mounting and the mounting perpendicular to the floor for accuracy, most mercury devices are either wall mounted or mounted on robust mobile stands. Concerns about dropping aneroid devices can be alleviated by purchasing aneroid sphygmomanometers as either wall-mounted units or mounted on mobile stands, comparable to the mercury sphygmomanometers, rather than

selecting portable aneroid devices. Both mercury and aneroid sphygmomanometers require routine maintenance (Bailey & Bauer, 1993).

There are some key issues involved in the calibration and maintenance of mercury sphygmomanometers:

- zero level of mercury;
- replacement of air filter;
- verification that column is perpendicular in its unit and vertical to the ground;
- check for oxidation of mercury, making column appear dirty and difficult to read.

Some of the key issues for calibration and maintenance of aneroid gauges include:

- check needle for smooth rotation;
- test accuracy at several intervals against a reference meter.

(Source:Bailey & Bauer, 1993).

4.0 DISCUSSION

4.1 ELEVATED BLOOD PRESSURE– RETROSPECTIVE ANALYSIS

Blood pressure results over the 1995-2002 period were analysed and sorted to determine if the results were consistent or if they were an artefact of the 2000 data used in the original heart project completed by Simtars.

The routine and entry medical assessment results showed a consistently higher percentage of coal mine workers reporting elevated blood pressure when compared to the general population from 1995-2002. The exception is in 1995 for the entry medicals when the reported levels of elevated blood pressure were 4% below the general population average.

4.2 ELEVATED BLOOD PRESSURE – ENTRY VS REPEAT ANALYSIS

Reports of elevated blood pressure from the data show a statistically significant difference between the entry and routine medicals. People entering the industry are showing higher than average elevated blood pressure readings than those who are already working as compared with the Australian male population data. There is concern with regards to the high percentages of younger persons in the 25-34 year age category who have significantly higher than average blood pressure readings for both entry and routine medicals. Explanations for this may lie in procedural error or another variable such as white coat syndrome, which is discussed further in section 4.4.

4.3 ELEVATED BLOOD PRESSURE – MINING DISTRICT ANALYSIS

4.3.1 Singleton

Blood pressure variation for the Singleton district was consistent among both underground and surface mines for both the entry and routine data. Each mine type was compared to the Australian male population average for elevated blood pressure. Further detail is shown previously in Table 3.4. Population data was not available for comparison in the 18-24 year age category. The age categories 25-54 across both underground and surface mines identified that there was significant variation in blood pressure when compared to the Australian male population data. The only exception to this was the age category 55-64 for the underground entry medicals, which showed no statistical variance in blood pressure when compared with the population data. Details are shown previously in Tables 3.2 and 3.3.

4.3.2 Corrimal

Data for underground mines only in the Corrimal (including Lithgow) district was supplied and analysed for statistical significance. The 25-64 year age category for both entry and underground mines in this district showed statistical variation for blood pressure when compared with the Australian male population data.
Further detail is shown previously in Table 3.4.

4.3.3 Newcastle

Blood pressure variation was also measured for statistical significance among both surface and underground mine workers for the Newcastle district. The underground workers aged from 25-54 were analysed as having significant blood pressure variation when compared with the Australian male population. Details are shown previously in Table 3.4. Data was also compared with entry vs routine measurements for underground and surface mine workers. Both the underground entry and routine medicals in the 25-54 year age category showed significant blood pressure variation. Variation was noted among the surface routine measurements with the 45-64 year age category as being the only group with significant elevated blood pressure measurements. Details are shown previously in Tables 3.2 and 3.3.

4.4 ELEVATED BLOOD PRESSURE– ADDITIONAL FACTOR ANALYSIS

There are many factors that may contribute to the risk of elevated blood pressure measurements. These factors include:

- Physiological factors;
- Exercise and nutritional factors;
- Alcohol consumption;
- Psychosocial factors (inc white coat syndrome);
- Environmental;
- Procedural, reporting and recording.

4.4.1 Physiological factors

Physiological factors such as body mass index and exercise patterns can have a significant impact on a persons ability to maintain a normal blood pressure level. Approximately 67% of Australian males are presently considered to be in the overweight category of that 20% are considered to be obese. New South Wales coal miners during entry medicals were shown to have 78% of persons who are overweight, that is a BMI >25 and 22% who have a BMI of > 30 which is considered obese. There has been much literature on the impact of excess weight on cardiovascular health and consequent control of blood pressure. The majority of research however only details the abnormal effects on blood pressure among older age populations as these are the populations that will present for medical checkups for often other related issues.

Further analysis of Body Mass Index for overweight and obesity is attached as Appendix C.

4.4.2 Exercise and nutritional patterns

Exercise patterns for New South Wales coal miners are not collected as part of pre employment and ongoing medicals. Data extracted from research undertaken by Simtars in Qld and NSW identified that the 35-64 year age category were more inactive than the general Australian population average of 43% inactivity. Younger coal miners in the 18-34 age category are generally more active. Shiftwork was the prime reason given by subjects during this study as being the most significant barrier to raising levels of activity.

Data sourced from research undertaken by Simtars in Qld and NSW identified that overall the nutritional patterns of both surface and underground mine workers was adequate. Dietary benchmarks were sourced from the National Dietary Guidelines for Australians (NHMRC, 2001). Areas of dietary improvement according to these guidelines would be increasing the intake of fresh fruit and vegetables, grains and cereals.

4.4.3 Alcohol consumption

Based on research undertaken by Simtars on the drinking patterns and quantities of alcohol consumed among Qld and NSW coal workers, there is a consistency with the general population average of 7%. Anecdotal evidence would suggest that among some mining communities excessive use of alcohol is much higher than this average. Rigorous investigation of this evidence would be required to determine actual patterns and levels of hazardous drinking.

4.4.4 Psychosocial factors

As discussed throughout this report the link between stress and elevated blood pressure has not been subjected to rigorous research methods. There is however much anecdotal evidence with regards to the phenomena of "white coat syndrome" and its impact on blood pressure readings. Despite the lack of hard research evidence it is not a concept that should be ignored when persons are having blood pressure taken. Ways to assist in the reduction of stress during these situations would be to:

- Ensure adequate communication between doctor and client;
- Use of alternative attention techniques to move the clients focus from the nature of the test;
- Waiting a specified amount of time before the blood pressure reading is taken;
- If initial reading is high waiting for a specified time period before doing a retest.

Due consideration should be given to the impact that the term "pre employment" medical has on an individual. Stress due to this is best allayed by improved communications between both medical practitioner and client.

4.4.5 Procedural /Reporting/ Recording

All districts appear to use similar types of blood pressure instrumentation. Corrimal and Lithgow districts use mercury sphygmomanometers whereas Singleton and Newcastle use aneroid anemometers. There is no evidence in the literature that states one device is more or less accurate than the other. Some research states that automated devices are more likely to cause problems with inaccuracy due to the computerised components as opposed the mercury and anemometer devices.

Calibration across the districts is consistent except for the Corrimal and Lithgow district which do not undertake formal calibration from an external source. Calibration of a mercury sphygmomanometer is done using the following parameters:

- Zero level for mercury;
- Replacement of air filter;
- Verification that column is positioned perpendicular in its unit and vertical to the ground;
- Visual check for oxidation of mercury.

Aneroid anemometer devices need to be calibrated according to the following:

- Check needle for smooth rotation;
- Accuracy of needle at several intervals against reference material.

The availability of varying cuff sizes is uniform across all districts. The interviewees fully understood the impact that a poorly fitting cuff could have on inaccurate blood pressure readings.

All districts use the sitting method for blood pressure measurement. If a reading is higher a repeat is done. If the repeat measurement is still elevated the Occupational Physician does a check but will often use a varying method, usually a dual reading both lying and standing. According to the Occupational Physician interviewed this variation in methods would only account for approximately 5% variation in blood pressure readings in healthy individuals.

All districts use the same recognised blood pressure standards from the National Heart Foundation in Australia. There is also consistency in the frequency of when readings are undertaken for entry and routine measurements. Recording of results is done consistently across all districts and all submitted to Coal Services in approved format at regular intervals for input into the health database.

Both of the terms used to describe abnormal blood pressure readings “elevated” and “high” appear to require further clarification. Blood Pressure data is entered into the Coal Services database as a systolic and diastolic measurement only. Reports issued on these health statistics introduce the term “high” for blood pressure readings that fit within the recognised definition of high blood pressure as previously discussed in section 2.1. Discussions with the Occupational Physician Dr Pollock has highlighted that the term high is really considered a medical diagnosis and is arrived at after further medical investigation. Clarification of these terms would further assist in the sorting of data and the accurate reporting of coal worker numbers who are actually experiencing either short term transient or long term changes to their blood pressure.

5.0 CONCLUSION

Based on data and information included in this project, the following conclusions are made:

- There appears to remain an unexplained proportion of both entry and routine medicals which report abnormally elevated blood pressure results when compared to the Australian male population. This is consistent with the original project which investigated the risk factors for heart disease among coal miners.

- Analysis of blood pressure readings for both entrant and routine coal mine workers indicates significant incidence of elevated blood pressure readings. Of particular concern is the increased percentage of persons in the younger age categories of 25-44 who appear to have higher than average blood pressure readings.

- Further investigation and monitoring is required for NSW coal workers at entry and routine medicals are at serious risk of developing future health complications including cardiovascular damage and high blood pressure due to the significant percentage who are either overweight or obese.

- Monitoring of risk factors such as weight, exercise, stress and nutrition levels should be continued throughout the coal mining industry so that benchmarking against the general population can occur.

- Procedures for taking blood pressure appear to be relatively consistent among all mining districts for both entry and routine medicals.

- Use of the same guidelines for the measurement of blood pressure is also consistent across all districts.

- There needs to be consistency of terminology to be used among those who collect and input statistical data on blood pressure. Confusion appears to lie in the interchange of both the terms “elevated” and “high” when used to explain blood pressure readings that are greater than the accepted definitions and guidelines.

- To arrive at a conclusion of a medical diagnosis of high blood pressure or hypertension further detailed research would need to be undertaken on the individuals with reported elevated readings to determine if extraneous variables such as white coat syndrome are not the prime causal factor.

- Continuous ambulatory monitoring for a twenty-four hour period on particular at risk individuals would need to be undertaken to arrive at a medical diagnosis of high blood pressure or Hypertension.

- The limitations of this study and the available data have made it difficult to arrive at a firm set of conclusions regarding the increase in blood pressure readings for both entry and routine medicals. However, this project can be used as a starting point for further medically supervised research to explain confounding variables such as white coat syndrome, obesity etc.

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