



**NATIONAL INSTITUTE FOR  
OCCUPATIONAL HEALTH**

Division of the National Health Laboratory Service

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## **Pathology Division Surveillance Report**

### **Demographic Data and Disease Rates for January to December 2016**

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**NIOH Pathology Report 1/2016**

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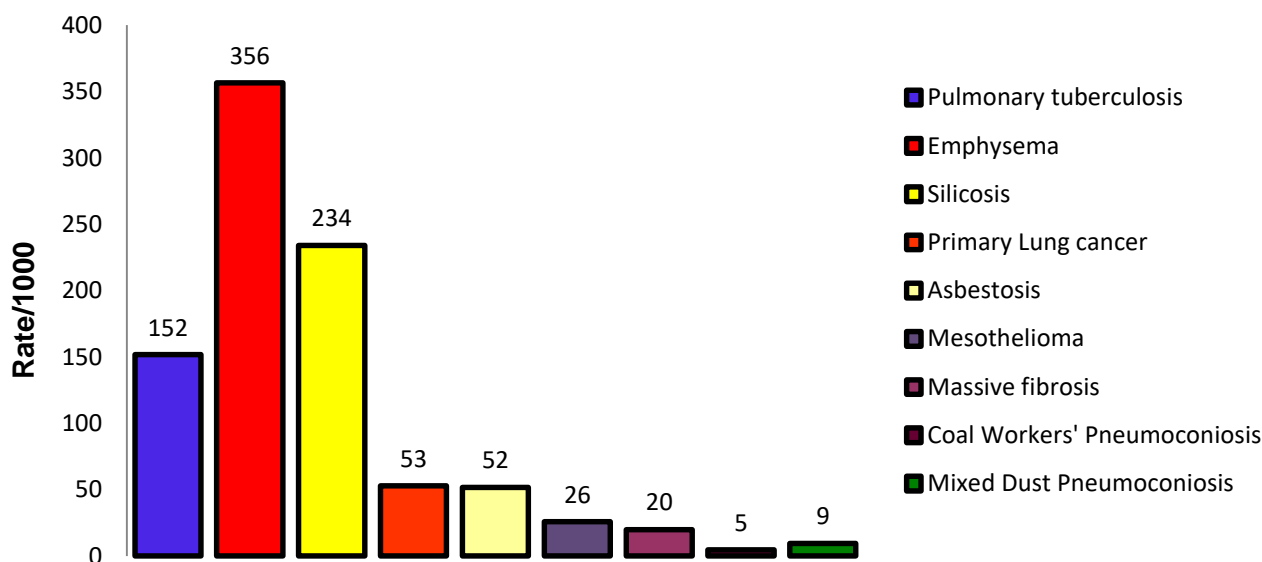
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## EXECUTIVE SUMMARY

The NIOH examined the cardiorespiratory organs of 850 deceased individuals. Of these, 61.3% were black, 38.0% were white and 0.7% were coloured. Of the cases submitted, 51.8% (n=440) were ex-miners, 41.5% (n=353) were current miners and 6.7% (n=57) cases could not be classified.

The overall disease rates (per 1000 autopsies) for 2016 are shown in Figure 1.



**FIG 1 OVERALL DISEASE RATES FOR 2016**

The overall rate of pulmonary tuberculosis (PTB) decreased slightly, from 155/1000 in 2015 to 152/1000 in 2016. The rate in black gold miners decreased from 274/1000 in 2015 to 247/1000 in 2016. In black platinum miners, the PTB rate decreased from 215/1000 in 2015 to 189/1000 in 2016.

The overall rate of silicosis increased from 205/1000 in 2015 to 234/1000 in 2016. The rate in gold miners increased to 351/1000 in 2016 compared to 328/1000 in 2015. In black gold miners, the rate dramatically increased from 367/1000 in 2015 to 416/1000 in 2016 but the rate of 289/1000 in white gold miners in 2016 was similar to that of 290/1000 in 2015.

The organs of 38 women were submitted for examination of whom 34.2% (n=13) had diseases related to asbestos exposure.

Some cases were received with incomplete exposure information. Active follow-up of cases received has improved the completeness of information obtained, however, in 2016 information still could not

be obtained for the following: mine type (commodity) 19 (2.2%), duration of service 48 (5.6%) and last mine worked 21 (2.5%).

Since 2010, the province or foreign country from which the organs were sent has been recorded on the PATHAUT database. Table 1-1 shows the distribution of cases by province and population group. Most cases originated from the North West (40.1%), Gauteng (25.1%) and Northern Cape (12.5%) provinces. No organs were received from other countries.

**TABLE 1-1 DISTRIBUTION OF AUTOPSY CASES BY PROVINCE AND POPULATION GROUP (2016)**

Province	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Eastern Cape	7	1.3	2	0.6	0	-	9	1.1
Free State	66	12.7	33	10.2	0	-	99	11.6
Gauteng	68	13.1	145	44.9	0	-	213	25.1
Kwazulu-Natal	0	-	9	2.8	0	-	9	1.1
Limpopo	10	1.9	3	0.9	0	-	13	1.5
Mpumalanga	26	5.0	29	9.0	0	-	55	6.5
North West	247	47.4	94	29.1	0	-	341	40.1
Northern Cape	97	18.6	3	0.9	6	100.0	106	12.5
Western Cape	0	-	5	1.5	0	-	5	0.6
<b>Total</b>	521		323		6		850	

The Pathology Division has scaled down its outreach activities in recent years due to financial constraints but it continues to engage with stakeholders. These include occupational units on the mines, union representatives, undertakers, and the mine inspectorate (Appendix 2).

Two journal articles using autopsy data were published and research findings were presented at several fora (Appendix 2). There are two ongoing PhD studies utilising the PATHAUT data (one registered with the University of the Witwatersrand and the other at the University of Illinois at Chicago)

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## GLOSSARY

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<b>Asbestosis</b>	Lung fibrosis caused by asbestos fibres
<b>Coal workers' pneumoconiosis</b>	Lung fibrosis caused by exposure to coal dust
<b>Emphysema</b>	Lung disease caused by the destruction of the alveolar walls
<b>Massive fibrosis</b>	Lung fibrosis caused by exposure to dust and measuring more than 1cm in diameter
<b>Mesothelioma</b>	A malignant tumour of the pleural cavity of the lungs
<b>Miner</b>	A person who has worked in a controlled mine or works
<b>Mixed dust pneumoconiosis</b>	Lung fibrosis caused by simultaneous exposure to multiple dust types
<b>Prevalence</b>	The number of cases in a defined population at a given time
<b>Silicosis</b>	Lung fibrosis caused by inhalation of silica dust; detected by the presence of silicotic nodules in the lung tissue
<b>Surveillance</b>	The ongoing and systematic collection, analysis, interpretation and dissemination of information related to adverse health outcomes for action
<b>Environmental asbestos exposure</b>	Non-occupational asbestos exposure. Cases with such exposure are examined by the NIOH but are not submitted to the MBOD for compensation.

## SECTION 1 – BACKGROUND

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The Occupational Diseases in Mines and Works Act, 1973 (Act 78 of 1973) requires that the cardio-respiratory organs of a deceased person who has worked at a controlled mine or a controlled works be examined for the presence of occupational disease, regardless of the clinical cause of death and provided that the next of kin agrees. These examinations are performed by pathologists at the National Institute for Occupational Health (NIOH). A detailed report on each case examined is sent to the Medical Bureau for Occupational Diseases (MBOD). Cases certified as having a compensable disease are then referred to the Compensation Commissioner's office, where the payment for compensation is managed.

Since 1975, the pathological findings from the autopsy examinations have been recorded on the computerised PATHAUT database. PATHAUT comprises data from autopsy examinations and clinical files which include occupational histories. The database is unique and provides an important resource for both surveillance and research. These data are the only comprehensive surveillance data on occupational lung disease in the South African mining industry. Approval to retrospectively review routinely collected autopsy data for reporting on disease prevalence's, time trends and associated factors was obtained from the Human Research Ethics Committee (HREC) at the University of the Witwatersrand (Clearance number M170879).

The data presented in this report summarise the PATHAUT system surveillance results, i.e. the results of the systematic collection, collation, and analysis of the pathology findings in the cardio-respiratory organs of mine workers. Data from PATHAUT are exported into, and analysed, using SAS Enterprise Guide v7.1.

This report describes autopsy cases examined during the year 2016. This report along with previous reports can be accessed at [http://www.nioh.ac.za/?page=pathology\\_disease\\_surveillance\\_reports&id=162](http://www.nioh.ac.za/?page=pathology_disease_surveillance_reports&id=162)

Since 2005, gender has been recorded on the PATHAUT database. To maintain consistency with previous reports, the term 'men' and all data refers to both men and women throughout this report, with the exception of Section 10 which reports findings in women only.

Many of the cases had "mixed" exposures in that they had been employed in mining more than one commodity. For simplicity, cases are categorised according to the commodity in which most years of service were recorded, i.e. the commodity in which the miners had worked for the longest period. In Appendix 1, however, the cases are listed according to the most recent (last) mine at which the miners worked.

All disease rates reported in this document are expressed per 1000. In all calculations, the denominators used are the total numbers of autopsies in specific commodities, age groups or population groups. Some of these rates must be viewed with caution, as the denominators are very small. This applies, for example, to those commodities where few workers are employed (such as manganese mining), and to the older age groups in some instances.



## SECTION 2 – DEMOGRAPHIC DATA

The numbers of autopsies performed annually since 1975 are presented in Table 2-1.

**TABLE 2-1 DISTRIBUTION OF AUTOPSIES BY YEAR AND POPULATION GROUP (1975-2016)**

Year of autopsy	Black		White		Coloured		Indian		Unknown		Total N
	N	%	N	%	N	%	N	%	N	%	
1975	2 190	71	854	28	32	1					3 076
1976	2 335	68	1 072	31	27	1					3 434
1977	2 351	69	1 039	30	33	1					3 423
1978	2 245	67	1 090	32	32	1					3 367
1979	2 118	66	1 026	33	45	1					3 189
1980	2 338	64	1 274	35	46	1					3 658
1981	2 209	66	1 117	33	33	1					3 359
1982	2 312	63	1 302	36	44	1			1		3 659
1983	2 096	65	1 109	34	41	1					3 246
1984	1 966	64	1 098	36	28	1					3 092
1985	2 275	64	1 200	34	66	2					3 541
1986	2 456	68	1 125	31	45	1					3 626
1987	2 594	68	1 168	30	78	2					3 840
1988	2 518	67	1 165	31	77	2					3 760
1989	2 138	65	1 090	33	60	2					3 288
1990	2 172	64	1 155	34	51	2					3 378
1991	2 143	65	1 080	33	66	2					3 289
1992	2 144	66	1 049	32	70	2					3 263
1993	1 863	65	956	33	65	2					2 884
1994	1 737	61	1 021	36	94	3					2 852
1995	2 830	71	1 059	27	99	2			12	0.3	4 003
1996	2 154	67	960	30	56	2			69	2.1	3 239
1997	2 223	69	897	28	70	2			18	0.6	3 208
1998	1 977	69	836	29	49	2	1		17	0.6	2 880
1999	1 656	65	832	33	29	1			12	0.5	2 529
2000	1 798	69	761	29	41	2			8	0.3	2 608
2001	1 690	67	813	32	13	1			13	0.5	2 529
2002	1 677	67	763	30	50	2			28	1.1	2 518
2003	1 536	66	745	32	23	1	1		13	0.6	2 318
2004	1 428	69	596	29	22	1	1		8	0.4	2 055
2005	1 274	68	562	30	22	1			18	1	1 876
2006	1 165	68	535	31	11	1			9	0.5	1 720
2007	1 144	66	539	31	21	1			20	1.2	1 724
2008	1 185	69	556	32	11	1			48	2.7	1 800
2009	1 138	68	500	29	16	1			8	0.5	1 662
2010	960	64	521	35	15	1			6	0.4	1 502
2011	847	64	453	34	11	1			18	1.4	1 329
2012	706	61	445	38	7	1			6	0.5	1 164
2013	744	63	421	35	7	1			16	1	1 188
2014	627	59	432	41	5	1	1		1		1 066
2015	539	59	358	39	9	1			3		909
2016	521	61	323	38	6	1					850
<b>Total</b>	<b>74 019</b>	<b>66</b>	<b>35 897</b>	<b>32</b>	<b>1 626</b>	<b>1</b>	<b>4</b>		<b>352</b>		<b>111 901</b>

It is important to note that a referral bias exists: there is a low autopsy rate for black men who have left employment at the mines, whereas the majority of retired white miners are autopsied. The number of autopsies has decreased steadily over the years, probably reflecting the concomitant decrease in the number of miners employed in the industry. In 1994, there were around 344 000 people employed in the gold mining industry compared to approximately 115 822 in 2016 (Chamber of Mines).

The pathologists at the NIOH perform two types of autopsy examinations. For men dying distant from Johannesburg, the cardio-respiratory organs are removed locally, preserved in formalin and sent to the NIOH. Full autopsies may be undertaken on men who die in close proximity to Johannesburg.

Table 2-2 shows the distribution of autopsies by population group for 2016. The vast majority (94.8%) of autopsy examinations were performed on the cardio-respiratory organs only.

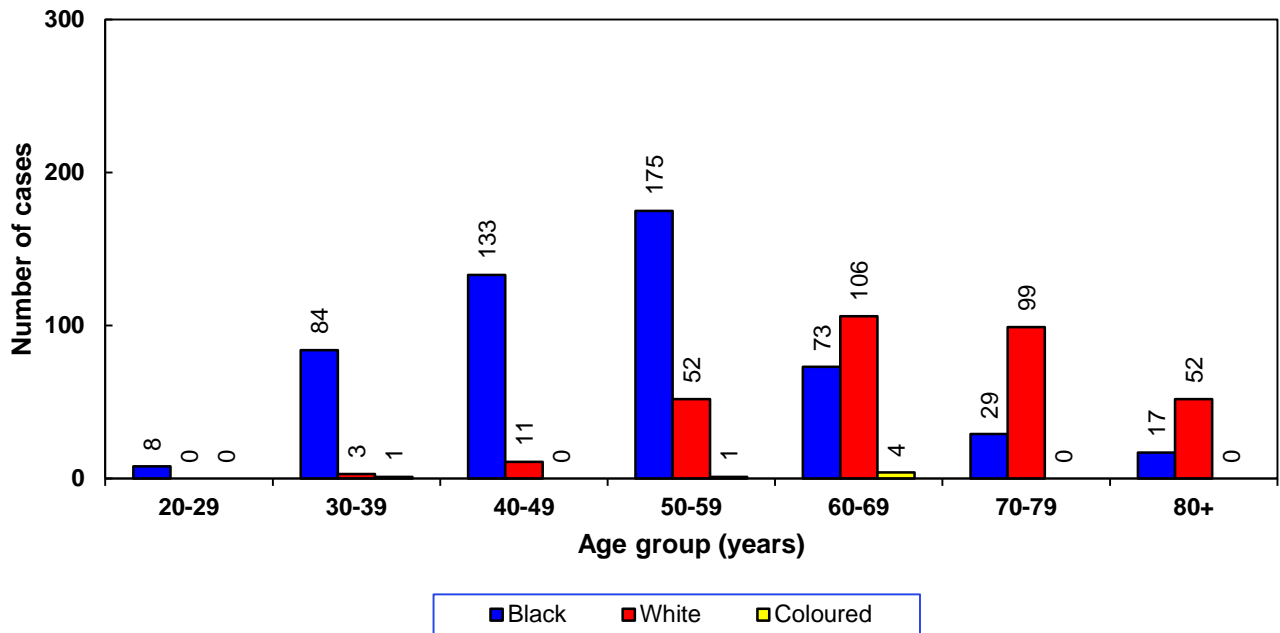
**TABLE 2-2 NUMBER AND PROPORTION OF AUTOPSIES BY TYPE AND POPULATION GROUP (2016)**

Autopsy type	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Cardio-respiratory organs only	520	99.8	280	86.7	6	100.0	806	94.8
Full autopsy	1	0.2	43	13.3	0	-	44	5.2
<b>Total</b>		521		323		6		850

The age distribution of cases for 2016 is shown in Table 2-3 and presented graphically in Figure 2-1. The mean age at autopsy of black men was 52.0 years, slightly higher than that in 2015 (50.9 years). The mean age of white men at autopsy was 68.5 years in 2016, similar to 68.1 years in 2015.

**TABLE 2-3 NUMBER AND PROPORTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
20-29	8	1.5	0	-	0	-	8	0.9
30-39	84	16.1	3	0.9	1	16.7	88	10.4
40-49	133	25.5	11	3.4	0	-	144	16.9
50-59	175	33.6	52	16.1	1	16.7	228	26.8
60-69	73	14.0	106	32.8	4	66.7	183	21.5
70-79	29	5.6	99	30.7	0	-	128	15.1
80+	17	3.3	52	16.1	0	-	69	8.1
Unknown	2	0.4	0	-	0	-	2	0.2
<b>Total</b>		521		323		6		850



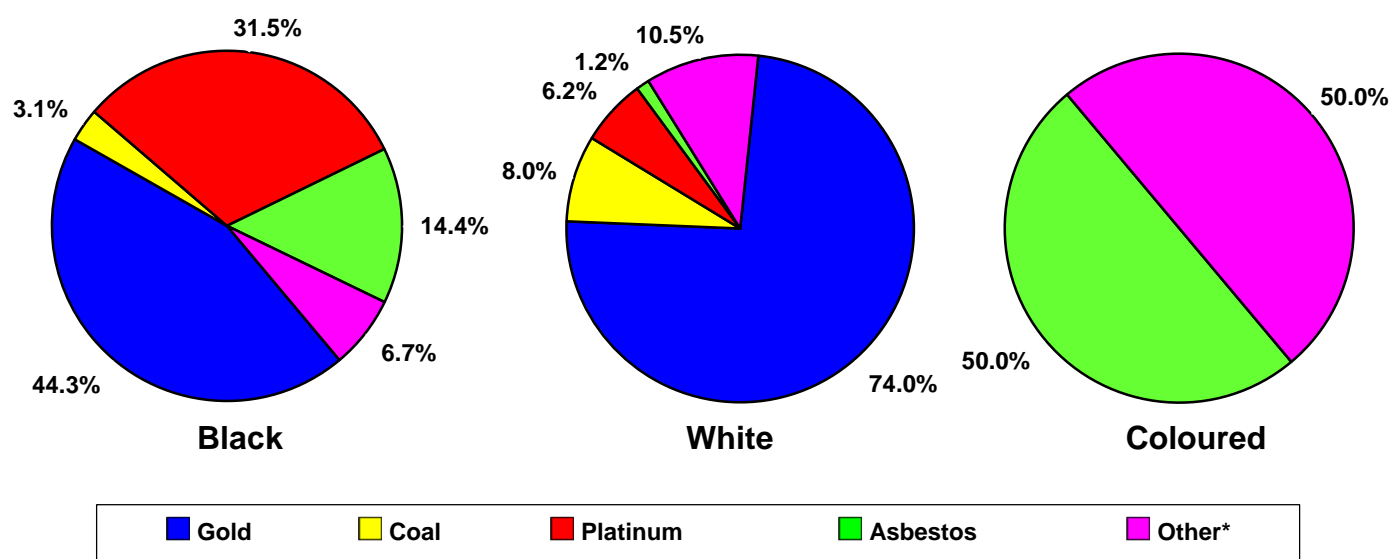
**FIG 2-1 DISTRIBUTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2016)**

There are men who worked in a number of different mining commodities during their lifetimes and had “mixed” exposures. This was not taken into account in the analysis of exposure type (commodity). Cases were placed in categories according to the commodity in which they had worked for the longest duration (most exposure).

Table 2-4 and Figure 2-2 show the distributions of autopsies by commodity and population group for 2016. The majority of autopsies (55.3%) were on men from the gold mining industry, slightly more than in 2015 (51.4%). The proportion of autopsies from the platinum mining industry has increased over the years, from 8.3% in 1999 to 21.6% in 2016.

**TABLE 2-4 NUMBER AND PROPORTION OF AUTOPSIES BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Gold	231	44.3	239	74.0	0	-	470	55.3
Platinum	164	31.5	20	6.2	0	-	184	21.6
Coal	16	3.1	26	8.0	0	-	42	4.9
Asbestos	75	14.4	4	1.2	3	50	82	9.6
Iscor	0	-	4	1.2	0	-	4	0.5
Copper	1	0.2	4	1.2	1	16.7	6	0.7
Manganese	12	2.3	2	0.6	1	16.7	15	1.8
Industry	1	0.2	3	0.9	0	-	4	0.5
Other	14	2.7	10	3.1	0	-	24	2.8
Unknown	7	1.3	11	3.4	1	16.7	19	2.2
<b>Total</b>	<b>521</b>		<b>323</b>		<b>6</b>		<b>850</b>	



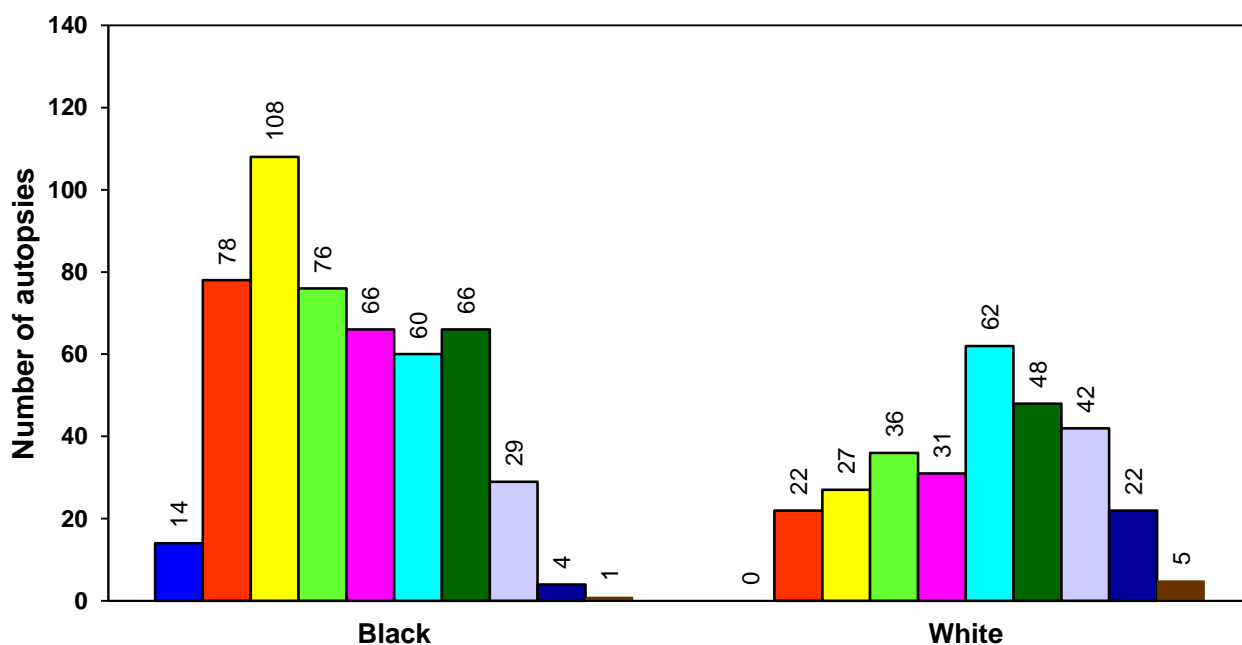
\* Includes cement, chrome, copper, diamond, environmental asbestos, industry, iron, lead, lime, manganese, phosphate, steel, tin, as well as cases where service histories could not be obtained

**FIG 2-2 DISTRIBUTION OF AUTOPSIES BY COMMODITY AND POPULATION (2016)**

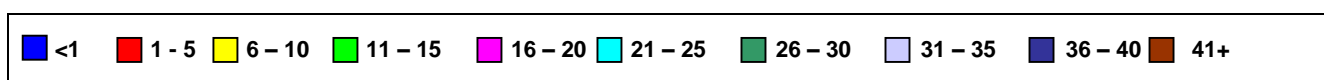
Detailed information about the years in mining service by population group is shown in Table 2-5 and displayed graphically in Figure 2-3. In 2016, the duration of service was obtained for all but 5.6% (n=48) of cases. This figure is an improvement to that of 2015 (7.9%). The improvement in obtaining service histories may be attributable to active case-follow up.

**TABLE 2-5 NUMBER AND PROPORTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2016)**

Years of service	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
<1	14	2.7	0	-	1	16.7	15	1.8
1-5	78	15.0	22	6.8	1	16.7	101	11.9
6-10	108	20.7	27	8.4	1	16.7	136	16.0
11-15	76	14.6	36	11.1	0	-	112	13.2
16-20	66	12.7	31	9.6	2	33.3	99	11.6
21-25	60	11.5	62	19.2	0	-	122	14.4
26-30	66	12.7	48	14.9	0	-	114	13.4
31-35	29	5.6	42	13.0	0	-	71	8.4
36-40	4	0.8	22	6.8	0	-	26	3.1
41+	1	0.2	5	1.5	0	-	6	0.7
Unknown	19	3.6	28	8.7	1	16.7	48	5.6
<b>Total</b>	<b>521</b>		<b>323</b>		<b>6</b>		<b>850</b>	



Years of service:



**FIG 2-3 DISTRIBUTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2016)**

The mean age and duration of service by commodity and population group are shown in Tables 2-6 and 2-7.

**TABLE 2-6 MEAN AGE BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	231	50	10	239	69	10
Platinum	164	46	9	20	67	13
Coal	16	56	8	26	66	13
Asbestos	75	69	10	4	70	9
Iscor	0	-	-	4	75	8
Copper	1	59	-	4	70	2
Manganese	12	59	14	2	78	8
Industry	1	61	-	3	60	3
Other	14	64	14	10	64	11
Unknown	5	57	14	11	72	16
<b>Total</b>	519	52	13	323	69	11

\* Standard deviation

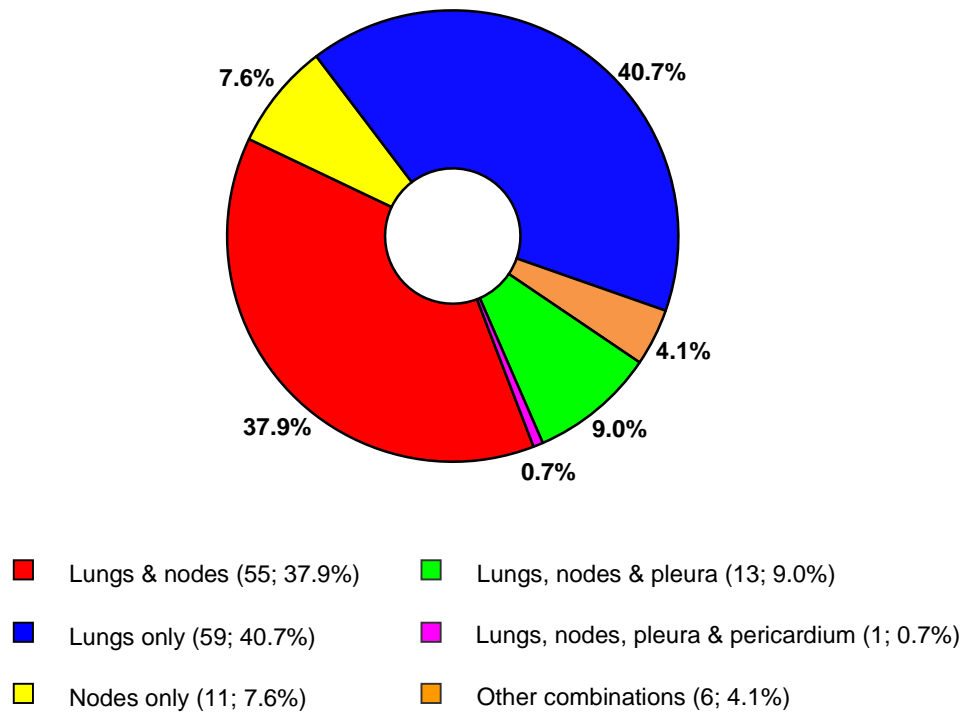
**TABLE 2-7 MEAN DURATION OF SERVICE BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	228	18	9	228	23	10
Platinum	159	15	9	18	16	7
Coal	16	23	11	24	24	13
Asbestos	74	7	8	4	8	6
Iscor	0	-	-	4	26	14
Copper	1	11	-	4	27	3
Manganese	12	17	12	2	36	8
Industry	1	36	-	3	17	10
Other	11	22	11	7	20	11
Unknown	0	-	-	1	3	-
<b>Total</b>	502	16	10	295	23	10

\*Standard deviation

## SECTION 3 – ACTIVE TUBERCULOSIS

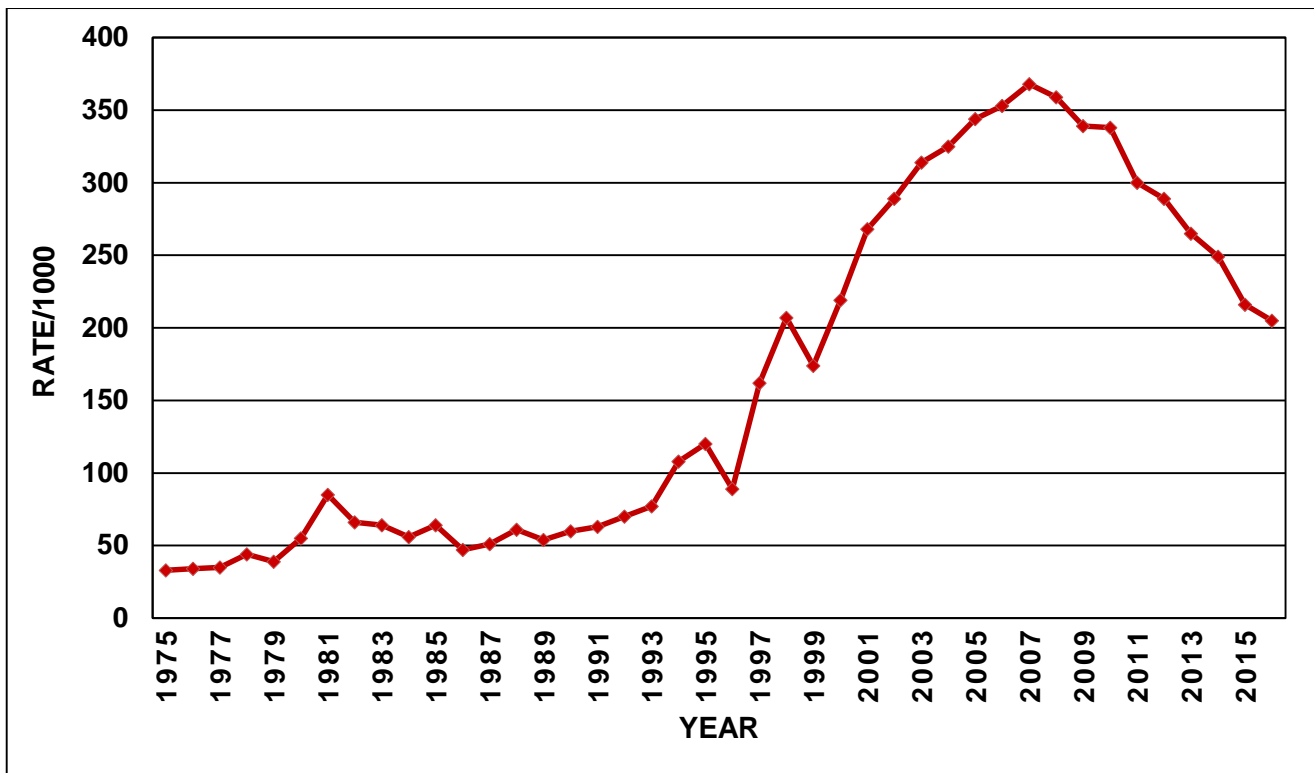
The distribution of active tuberculosis (TB) by anatomical site is presented in Figure 3-1 (n=145). Active pulmonary TB (PTB) was diagnosed in 15.2% (n=129) of all cases autopsied in 2016, compared to 27.4% (n=472) in 2007. Most of the men with PTB were black (n=107; 82.9%) and 20 (15.5%) were white.



**FIG 3-1 DISTRIBUTION OF ACTIVE TB BY SITE (2016)**

Disease rates in subsequent tables and figures are expressed per 1000 miners.

In 2016, the overall PTB rate was 152/1000. In black miners, PTB rates have shown a sharp increase since the early 1990s, peaking at 368/1000 in 2007 but have since declined annually to 205/1000 in 2016 (Fig 3-2). The rate in white men was much lower than that in black men, 62/1000 in 2016 compared to 67/1000 in 2015.



**FIG 3-2 ACTIVE PTB RATES IN BLACK MINERS AT AUTOPSY (1975-2016)**

The distribution of active PTB cases by commodity is shown in Table 3-1. Most cases of active PTB (57.4%) were from the gold (55.3% of all autopsy cases came from that commodity) and platinum (24.0%) mining industries.

**TABLE 3-1 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	57	247	17	71	0	-	74	157
Platinum	31	189	0	-	0	-	31	168
Coal	1	-	0	-	0	-	1	-
Asbestos	9	120	2	-	2	-	13	159
Copper	1	-	0	-	0	-	1	-
Manganese	2	-	0	-	0	-	2	-
Other	6	429	1	-	0	-	7	292
<b>Total</b>	<b>107</b>	<b>205</b>	<b>20</b>	<b>62</b>	<b>2</b>		<b>129</b>	<b>152</b>

Note: rates have not been calculated where there are fewer than 6 cases



The age distribution of cases with active PTB is shown in Table 3-2. Most of the PTB cases (n=39; 30.2%) were in the age group 50-59 years, followed by those in the 40-49 year age group (n=36; 27.9%).

**TABLE 3-2 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
20-29	2	-	0	-	0	-	2	-
30-39	15	179	0	-	0	-	15	170
40-49	35	263	1	-	0	-	36	250
50-59	36	206	3	-	0	-	39	171
60-69	14	192	8	75	2	-	24	131
70-79	3	-	7	71	0	-	10	78
80+	2	-	1	-	0	-	3	-
<b>Total</b>	107	205	20	62	2		129	152

Note: rates have not been calculated where there are fewer than 6 cases

## SECTION 4 – SILICOSIS

Silicotic nodules were found in the lungs of 199 cases (23.4% of all autopsies), 82.9% of which came from the gold mining industry. Of all cases with silicosis, occasional silicotic nodules were found in 87 (43.7%), a few in 57 (28.6%), a moderate number in 48 (24.1%) and a large number in 7 (3.5%) cases.

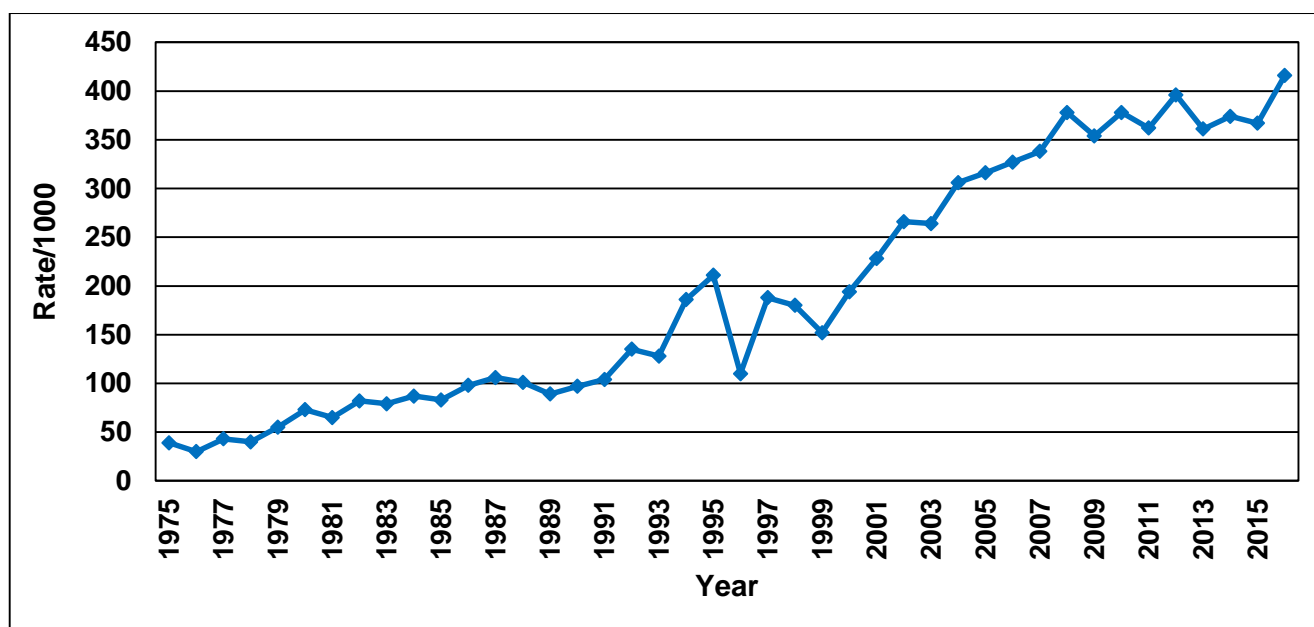
The distribution of cases with silicosis by commodity and population group is presented in Table 4-1.

**TABLE 4-1 NUMBER OF CASES AND PREVALENCE OF SILICOSIS BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	96	416	69	289	0	-	165	351
Platinum	9	55	4	-	0	-	13	71
Coal	3	-	3	-	0	-	6	143
Asbestos	6	80	1	-	0	-	7	85
Copper	0	-	3	-	1	-	4	-
Other	0	-	2	-	0	-	2	-
Unknown	1	-	1	-	0	-	2	-
<b>Total</b>	115	221	83	257	1	-	199	234

Note: rates have not been calculated where there are fewer than 6 cases

The rate of silicosis in black gold miners is presented in Fig 4-1. Silicosis rates in black gold miners have shown a steady increase over the years with a rate of 39/1000 in 1975 to 416/1000 in 2016. The rate in white gold miners has also been increasing since 1997 when it was 176/1000 and is currently at 289/1000.



**FIG 4-1 RATE OF SILICOSIS IN BLACK GOLD MINERS (1975-2016)**

Silicosis in gold miners is shown in the following tables, 4-2 and 4-3. The overall rate of silicosis in gold miners in 2016 (351/1000) is higher than that of 2015 (328/1000). Silicosis was diagnosed in two black men aged below 40 years (Table 4-2).

**TABLE 4-2 NUMBER OF CASES AND PREVALENCE OF SILICOSIS IN THE GOLD MINING INDUSTRY, BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
30-39	2	-	0	-	0	-	2	-
40-49	18	257	3	-	0	-	21	269
50-59	60	632	5	-	0	-	65	508
60-69	10	556	23	284	0	-	33	333
70-79	5	-	20	267	0	-	25	313
80+	1	-	18	450	0	-	19	452
<b>Total</b>	96	416	69	289	0		165	351

Note: rates have not been calculated where there are fewer than 6 cases

**TABLE 4-3 NUMBER OF CASES AND PREVALENCE OF SILICOSIS IN THE GOLD MINING INDUSTRY BY YEARS OF SERVICE AND POPULATION GROUP (2016)**

Years of service	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
<1	0	-	0	-	0	-	0	-
1-5	3	-	3	-	0	-	6	182
6-10	5	-	4	-	0	-	9	145
11-15	10	323	5	-	0	-	15	278
16-20	17	436	8	333	0	-	25	397
21-25	24	558	19	388	0	-	43	467
26-30	24	632	11	275	0	-	35	449
31-35	12	857	15	385	0	-	27	509
36-40	1	-	3	-	0	-	4	-
Unknown	0	-	1	-	0	-	1	-
<b>Total</b>	96	416	69	289	0		165	351

Note: rates have not been calculated where there are fewer than 6 cases

## SECTION 5 – OTHER PNEUMOCONIOSES

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### MASSIVE FIBROSIS

There were 17 (2.0%) cases of massive fibrosis: 11 in black and 6 in white miners. Sixteen were from the gold mining industry and one was from the coal industry.

### COAL WORKERS' PNEUMOCONIOSIS

There were 4 (0.5%) cases of coal workers' pneumoconiosis. All had worked in coal mines.

### MIXED DUST PNEUMOCONIOSIS

There were 8 (0.9%) cases of mixed dust pneumoconiosis. There were 3 cases from the gold mining industry, 2 from asbestos, 1 from manganese and the commodity was not known for 2 cases.

### ASBESTOSIS AND PLEURAL PLAQUES

There were 44 cases of asbestosis. Of these, 59.1% (n=26) had slight, 27.3% (n=12) had moderate and 13.6% (n=6) had marked fibrosis. Forty-one (93.2%) had worked in the asbestos mining industry at some time in their lives and 1 (2.3%) had been exposed to asbestos in the environment.

There were 25 cases with asbestos plaques and of these 9 had asbestosis. However, the parietal pleura (the site where plaque formation usually occurs) is seldom submitted with the lungs.

The distribution of asbestosis by age and population group is shown in Table 5-1.

**TABLE 5-1 NUMBER OF CASES AND PREVALENCE OF ASBESTOSIS BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
50-59	5	-	0	-	0	-	5	-
60-69	13	178	2	-	2	-	17	93
70-79	13	448	1	-	0	-	14	109
80+	7	412	1	-	0	-	8	116
<b>Total</b>	<b>38</b>	<b>73</b>	<b>4</b>		<b>2</b>		<b>44</b>	<b>52</b>

Note: rates have not been calculated where there are fewer than 6 cases

## SECTION 6 – EMPHYSEMA

There were 303 cases of emphysema, the extent of which was mild in 64.0% (n=194), moderate in 28.7% (n=87) and marked in 7.3% (n=22) cases. The overall rate of emphysema further increased from 319/1000 in 2015 to 356/1000 in 2016. The distribution of emphysema by age and population group is presented in Table 6-1.

**TABLE 6-1 NUMBER OF CASES AND PREVALENCE OF EMPHYSEMA BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
30-39	2	-	1	-	0	-	3	-
40-49	18	135	3	-	0	-	21	146
50-59	43	246	27	519	1	-	71	311
60-69	33	452	67	632	2	-	102	557
70-79	14	483	56	566	0	-	70	547
80+	4	-	32	615	0	-	36	522
<b>Total</b>	<b>114</b>	<b>219</b>	<b>186</b>	<b>576</b>	<b>3</b>		<b>303</b>	<b>356</b>

Note: rates have not been calculated where there are fewer than 6 cases

Most of the men with emphysema were from the gold mining industry (n=188, 62.0%) (Table 6-2).

**TABLE 6-2 NUMBER OF CASES AND PREVALENCE OF EMPHYSEMA BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	42	182	146	611	0	-	188	400
Platinum	21	128	11	550	0	-	32	174
Coal	8	500	12	462	0	-	20	476
Asbestos	28	373	1	-	1	-	30	366
Iskor	0	-	1	-	0	-	1	-
Copper	0	-	3	-	1	-	4	-
Manganese	8	667	1	-	1	-	10	667
Industry	0	-	2	-	0	-	2	-
Other	5	-	5	-	0	-	10	417
Unknown	2	-	4	-	0	-	6	316
<b>Total</b>	<b>114</b>	<b>219</b>	<b>186</b>	<b>576</b>	<b>3</b>		<b>303</b>	<b>356</b>

Note: rates have not been calculated where there are fewer than 6 cases

**TABLE 6-3 NUMBER OF CASES AND PREVALENCE OF EMPHYSEMA BY YEARS OF SERVICE AND POPULATION GROUP (2016)**

Years of service	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
<1	6	429	0	-	0	-	6	400
1-5	19	244	13	591	1	-	33	327
6-10	12	111	15	556	0	-	27	199
11-15	17	224	18	500	0	-	35	313
16-20	16	242	19	613	2	-	37	374
21-25	13	217	36	581	0	-	49	402
26-30	15	227	27	563	0	-	42	368
31-35	8	276	26	619	0	-	34	479
36-40	2	-	14	636	0	-	16	615
41+	1	-	2	-	0	-	3	-
Unknown	5	-	16	571	0	-	21	438
<b>Total</b>	114	219	186	576	3		303	356

Note: rates have not been calculated where there are fewer than 6 cases

## SECTION 7 – MESOTHELIOMA

There were 22 cases of mesothelioma in 2016.

**TABLE 7-1 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
50-59	7	38.9	0	-	0	-	7	31.8
60-69	8	44.4	0	-	1	100.0	9	40.9
70-79	3	16.7	1	33.3	0	-	4	18.2
80+	0	-	2	66.7	0	-	2	9.1
<b>Total</b>	<b>18</b>		<b>3</b>		<b>1</b>		<b>22</b>	

The distribution of mesothelioma by commodity and population group is presented in Table 7-2. Fifteen (68.2%) of the cases had worked in asbestos mines at some stage in their careers. Twelve of the cases had the longest service in asbestos (most exposure) and 3 had mixed exposures that included asbestos.

**TABLE 7-2 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Gold	1	5.6	1	33.3	0	-	2	9.1
Platinum	2	11.1	0	-	0	-	2	9.1
Asbestos	11	61.1	0	-	1	100.0	12	54.5
Manganese	2	11.1	0	-	0	-	2	9.1
Other	2	11.1	1	33.3	0	-	3	13.6
Unknown	0	-	1	33.3	0	-	1	4.5
<b>Total</b>	<b>18</b>		<b>3</b>		<b>1</b>		<b>22</b>	

## SECTION 8 – PRIMARY LUNG CANCER

Forty-five cases of primary lung cancer were found at autopsy, 37.8% (n=17) of which were in black miners and 62.2% (n=28) in white miners. Most of the cases had adenocarcinoma (n=24; 53.3%), followed by those with squamous carcinoma (n=9, 20.0%), small cell carcinoma (n=7; 15.6%) and large cell carcinoma (n=5; 11.1%).

The distribution of primary lung cancer by age and population group is presented in Table 8-1.

**TABLE 8-1 NUMBER AND PROPORTION OF PRIMARY LUNG CANCER CASES BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
40-49	2	-	1	-	0	-	3	-
50-59	4	-	4	-	0	-	8	35
60-69	7	96	11	104	0	-	18	98
70-79	3	-	8	81	0	-	11	86
80+	1	-	4	-	0	-	5	-
<b>Total</b>	<b>17</b>	<b>33</b>	<b>28</b>	<b>87</b>	<b>0</b>		<b>45</b>	<b>53</b>

Note: rates have not been calculated where there are fewer than 6 cases

The distribution of primary lung cancer by commodity and population group is presented in Table 8-2. The majority of cases came from the gold mining industry.

**TABLE 8-2 NUMBER AND PROPORTION OF PRIMARY LUNG CANCER CASES BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	8	35	20	84	0	-	28	60
Platinum	3	-	1	-	0	-	4	-
Coal	1	-	3	-	0	-	4	-
Asbestos	3	-	1	-	0	-	4	-
Iscor	0	-	1	-	0	-	1	-
Manganese	1	-	0	-	0	-	1	-
Industry	1	-	1	-	0	-	2	-
Other	0	-	1	-	0	-	1	-
<b>Total</b>	<b>17</b>	<b>33</b>	<b>28</b>	<b>87</b>	<b>0</b>		<b>45</b>	<b>53</b>

Note: rates have not been calculated where there are fewer than 6 cases



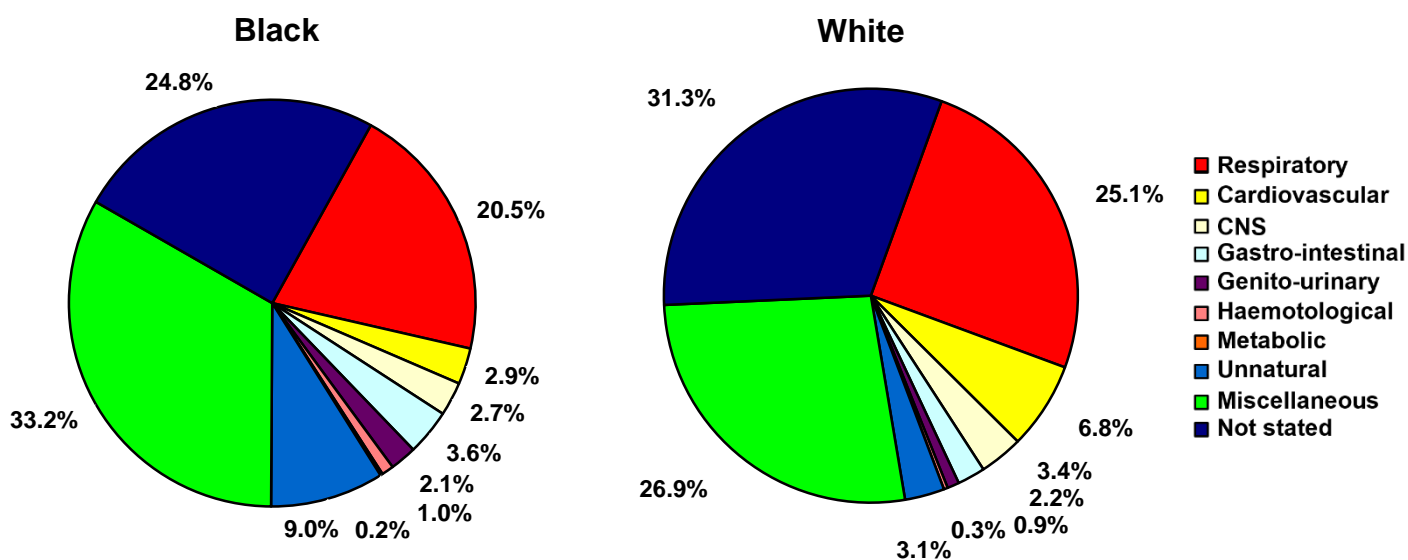
## SECTION 9 – CLINICAL CAUSE OF DEATH

Table 9-1 and Figure 9-1 show the clinical cause of death as stated in the accompanying documents submitted with the cardio-respiratory organs, by population group. Diseases of the respiratory system were the most frequent (22.6%). The proportion of unnatural deaths (6.7%) was higher than that in 2015 (5.9%). The clinical cause of death was not stated for 26.9% of the cases.

**TABLE 9-1 CLINICAL CAUSE OF DEATH BY POPULATION GROUP (2016)**

System	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Respiratory	107	20.5	81	25.1	4	66.7	192	22.6
Cardio-vascular	15	2.9	22	6.8	0	-	37	4.4
Central Nervous System	14	2.7	11	3.4	0	-	25	2.9
Gastro-intestinal	19	3.6	7	2.2	1	16.7	27	3.2
Genito-urinary	11	2.1	3	0.9	0	-	14	1.6
Haematological	5	1.0	1	0.3	0	-	6	0.7
Metabolic*	1	0.2	0	-	0	-	1	0.1
Unnatural	47	9.0	10	3.1	0	-	57	6.7
Miscellaneous	173	33.2	88	27.2	1	16.7	262	30.8
Not stated	129	24.8	100	31.0	0	-	229	26.9
<b>Total</b>	<b>521</b>		<b>323</b>		<b>6</b>		<b>850</b>	

\* Data for the metabolic system was previously included in the haematological system



**FIG 9-1 CLINICAL CAUSES OF DEATH (2016)**

## SECTION 10 – AUTOPSY FINDINGS IN WOMEN

Of the 850 cases examined in 2016 at the NIOH, 38 (4.5%) were women compared to 25 (2.8%) in 2015, 49 (4.6%) in 2014 and 32 (2.7%) in 2013. There were 35 (92.1%) black, 1 (2.6%) white and 2 (5.3%) coloured women. On average, the women were older than men (62.9 years and 58.1 years, respectively).

**TABLE 10-1 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY AGE AND POPULATION GROUP (2016)**

Age group (years)	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
30-39	4	11.4	0	-	0	-	4	10.5
40-49	4	11.4	0	-	0	-	4	10.5
50-59	5	14.3	0	-	0	-	5	13.2
60-69	10	28.6	0	-	2	100.0	12	31.6
70-79	8	22.9	0	-	0	-	8	21.1
80+	4	11.4	1	100.0	0	-	5	13.2
<b>Total</b>	<b>35</b>		<b>1</b>		<b>2</b>		<b>38</b>	

Table 10-2 summarises the distribution of autopsies in women by commodity and population group. Most of the women (n=27, 71.1%) had been exposed to asbestos, with 26 (68.4%) exposed on the mines and 1 (2.6%) having had environmental exposure.

**TABLE 10-2 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY COMMODITY AND POPULATION GROUP (2016)**

Commodity	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Gold	6	17.1	0	-	0	-	6	15.8
Platinum	2	5.7	0	-	0	-	2	5.3
Asbestos	24	68.6	0	-	2	100.0	26	68.4
Diamond	3	8.6	0	-	0	-	3	7.9
Environmental asbestos	0	-	1	100.0	0	-	1	2.6
<b>Total</b>	<b>35</b>		<b>1</b>		<b>2</b>		<b>38</b>	

Thirteen women had asbestos-related diseases: 9 had asbestosis and 4 had mesothelioma (Table 10-3).

**TABLE 10-3 NUMBER OF DISEASES IN WOMEN (2016)**

Disease	N
PTB	10
Silicosis	2
Emphysema	9
Asbestosis	9
Mesothelioma	4
Mixed dust pneumoconiosis	2
No lung disease	16

**TABLE 10-4 NUMBER AND PROPORTION OF DISEASES IN WOMEN (2016)**

Disease	N	%
PTB only	5	13.2
Silicosis only	1	2.6
Emphysema only	3	7.9
Asbestosis only	1	2.6
Mesothelioma only	3	7.9
PTB and Emphysema	1	2.6
PTB and Asbestosis	1	2.6
Asbestosis and Emphysema	2	5.3
Asbestosis and Mixed Dust Pneumoconiosis	1	2.6
Silicosis, Emphysema and Asbestosis	1	2.6
PTB, Emphysema and Asbestosis	1	2.6
PTB, Asbestosis and Mesothelioma	1	2.6
Mixed Dust Pneumoconiosis, PTB, Emphysema and Asbestosis	1	2.6
No Lung Disease	16	42.1
<b>Total</b>	<b>38</b>	

**APPENDIX 1: DISTRIBUTION OF AUTOPSIES ACCORDING TO THE LAST MINE WHERE THE DECEASED WORKED (2016)**

<b>Commodity</b>	<b>Last mine worked</b>	<b>Black</b>	<b>White</b>	<b>Coloured</b>	<b>Total</b>
<b>Asbestos</b>	African Chrysotile Asbestos		2		2
	Asbestos Mine	1			1
	Cape Blue	6		1	7
	Danielskuil Asb Mine	1			1
	Gefco	53	1	2	56
	Koegas		1		1
	Penge Asbestos	1			1
	Pomfret Asb Mine	4			4
	Wandrag Asbestos Mine	2			2
<b>Total from asbestos</b>		<b>68</b>	<b>4</b>	<b>3</b>	<b>75</b>
<b>Cementation</b>	Cementation		1		1
<b>Total from cementation</b>		<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>Chrome</b>	Chrome Mine		1		1
	Rustenburg Chrome		1		1
	Samancor Western Chrome	1	1		2
<b>Total from chrome</b>		<b>1</b>	<b>3</b>	<b>0</b>	<b>4</b>
<b>Coal</b>	Arnot Colliery		1		1
	Black Wattle Colliery		1		1
	Coal Mine	1	2		3
	Coalbrook Colliery		1		1
	Delmas Colliery		1		1
	Douglas Colliery		1		1
	Duiker Colliery		1		1
	Durban Navigation Colliery		1		1
	Ermelo Coal		1		1
	Goedehoop Colliery	5	2		7
	Hlobane Colliery		1		1
	Khutala Colliery		1		1
	Kleinkopje Colliery	1	1		2
	Koornfontein Coal		1		1
	Kriel Colliery		1		1
	Matla Coal	6	1		7
	New Vaal Colliery		1		1

<b>Commodity</b>	<b>Last mine worked</b>	<b>Black</b>	<b>White</b>	<b>Coloured</b>	<b>Total</b>
<b>Coal (contd)</b>	Northfield Colliery		1		1
	S A Coal Estates		2		2
	Samrec Annesley Mine		1		1
	Sasol Coal Mine	1	1		2
	Secunda Colliery		1		1
	Sigma Colliery	1			1
	Spingbok Colliery		1		1
	Van Dyk's Drift			1	1
	Vryheid Coronation		1		1
<b>Total from coal</b>		<b>15</b>	<b>27</b>	<b>1</b>	<b>43</b>
<b>Copper</b>	Copper Mine		1		1
	O`Kiep Copper		2		2
	Phalaborwa		1		1
<b>Total from copper</b>		<b>0</b>	<b>4</b>	<b>0</b>	<b>4</b>
<b>Diamond</b>	De Beers Consolidated		2		2
	Diamond Mine	2	2		4
	Finch Diamond Mine	1			1
	Rex Diamond Mine			1	1
<b>Total from diamond</b>		<b>3</b>	<b>4</b>	<b>1</b>	<b>8</b>
<b>Gold</b>	Anglogold Ashanti GM	28	5		33
	Anglogold Great Noligwa GM	4			4
	Bambanani GM	1			1
	Barberton GM	1			1
	Beatrix Gold	21	5		26
	Blyvoorquzicht	2	6		8
	Buffelsfontein Gold	1	18		19
	Daggasfontein		1		1
	Deelkraal		1		1
	Doornfontein		2		2
	Driefontein Cons GM	23	5		28
	Durban Roodepoort Deep	1	2		3
	East Driefontein	3	6		9
	East Rand Prop	1	5		6
	Elandsrand		1		1
	Evander GM	7	1		8
	Free State Geduld	1	9		10

<b>Commodity</b>	<b>Last mine worked</b>	<b>Black</b>	<b>White</b>	<b>Coloured</b>	<b>Total</b>
<b>Gold (contd)</b>	Gencor	7			7
	Glenhavy GM		1		1
	Gold mine		4		4
	Goldfields		2		2
	Grootvlei Prop		4		4
	Harmony	41	14		55
	Hartebeesfontein		5		5
	J.I.C. Gold Mine		1		1
	Joel	5			5
	Kloof		5		5
	Leslie		2		2
	Libanon		2		2
	Lorraine		3		3
	Luipaardsvlei Estate GM		1		1
	Masimong Gold Mine	3			3
	Moab Khotsoeng GM	3	1		4
	Modderfontein		1		1
	President Brand		4		4
	President Steyn		6		6
	Rand Mines		1		1
	Randfontein		7		7
	Robinson Gold Mine		1		1
	Roodekop GM		1		1
	SA Land		1		1
	Simmer & Jack GM	1	1		2
	South Deep GM	1	4		5
	St Helena		3		3
	Stilfontein	1	7		8
	Target Gold Mine	2	1		3
	Tautona GM	1	1		2
	Tshepone GM	2			2
	Unisel GM	1	1		2
	Vaal Reefs	37	31		68
	Vlakkfontein		1		1
	West Driefontein	3	9		12
	Western Areas		2		2

<b>Commodity</b>	<b>Last mine worked</b>	<b>Black</b>	<b>White</b>	<b>Coloured</b>	<b>Total</b>
<b>Gold (contd.)</b>	Western Deep Levels	2	12		14
	Western Holdings	1	4		5
	Zandpan GM		1		1
<b>Total from gold</b>		<b>205</b>	<b>212</b>	<b>0</b>	<b>417</b>
<b>Iron</b>	Sishen Iron Mine	2			2
<b>Lead &amp; Minerals</b>	Blackmountain	1			1
<b>Manganese</b>	Associated Manganese	3	2		5
	Black rock asb mine	2			2
	Hotazel Manganese Mine	3	1		4
	Manganese mine	2			2
	S A Manganese	2	1		3
<b>Total from manganese</b>		<b>12</b>	<b>4</b>	<b>0</b>	<b>16</b>
<b>Phosphate</b>	Foskor Beperk		1		1
<b>Platinum</b>	Amadelbult Platinum (Rustenburg)		3		3
	Anglo American Platinum	2	1		3
	Concor Plant Mine		1		1
	Eastern Platinum Mine	39	1		40
	Impala Platinum	64	12		76
	Karee Platinum	34	1		35
	Lebowa Platinum Mine	1			1
	Lonmin Platinum	3	3		6
	Modikwa Plat Mine		1		1
	Northam Platinum		2		2
	R.U.C. Platinum Mine		1		1
	Rustenburg Platinum	12	9		21
	Unknown Platinum	2	3		5
	Waterval Plat Mine	1			1
	Western Platinum	37	1		38
	Zondereinde Platinum Mine		1		1
<b>Total from platinum</b>		<b>195</b>	<b>41</b>	<b>0</b>	<b>236</b>
<b>Silicon</b>	Silicon Smelters	4			4
<b>Shaft sinkers</b>	Shaft sinkers		4		4
<b>Steel &amp; Iron</b>	Iscor	2	3		5
<b>Zinc</b>	Zinc Corporation		1		1
<b>Total for silicon, shaft sinkers, steel &amp; iron, zinc</b>		<b>6</b>	<b>8</b>	<b>0</b>	<b>14</b>
<b>Non-miner</b>	Environmental Asbestos	3	1		4

<b>Commodity</b>	<b>Last mine worked</b>	<b>Black</b>	<b>White</b>	<b>Coloured</b>	<b>Total</b>
	Industry	1	2		3
	Transnet		1		1
<b>Total for non-miners</b>		<b>4</b>	<b>4</b>	<b>0</b>	<b>8</b>
<b>Unknown</b>	Unknown	9	11	1	21
<b>TOTAL</b>		<b>521</b>	<b>323</b>	<b>6</b>	<b>850</b>



## APPENDIX 2: PUBLICATIONS AND ACTIVITIES EMANATING FROM PATHAUT DATA OR AUTOPSY SERVICE (2016)

### Journal articles

**Ndlovu N, Murray J, Phillips JI.** The importance of autopsies for miners. *Mining Prospectus*, March/April 2016. Page 26.

**Ndlovu N, Nelson G, Vorajee N, Murray J.** 38 years of autopsy findings in South African mine workers. *American Journal of Industrial Medicine*. 2016; 59(4):307–314.

### Reports

**Ndlovu N, Vorajee N, Murray J.** Pathology Division Report: Demographic data and disease rates for January to December 2015. NIOH Report 1/2016, ISSN 1812-7681. National Institute for Occupational Health, National Health Laboratory Services, South Africa.  
[http://www.nioh.ac.za/?page=pathology\\_disease\\_surveillance\\_reports&id=162](http://www.nioh.ac.za/?page=pathology_disease_surveillance_reports&id=162)

### Congresses

**Vorajee N.** Mesothelioma: Diagnostic Challenges from a pathological perspective. South African Thoracic Society Congress; 2016: 18-21 August Johannesburg, South Africa

Mabila S, **Ndlovu N, Murray J, Vorajee N, R.A. Cohen.** Emphysema Prevalence and Severity in South African Miners: A Pathology Automation (PATHAUT) Study, 1975- 2014. International Society of Environmental Epidemiology Conference; 2016: A 3597 September 1-4. Rome, Italy

Mabila S, **Ndlovu N, Murray J, Vorajee N, R.A. Cohen.** Emphysema Prevalence and Severity in South African Miners: A Pathology Automation (PATHAUT) Study, 1975- 2014. American Public Health Association 2016 Annual Meeting & Expo: Oct. 29 - Nov. 2, 2016. Denver, Colorado

### Degrees

**Mabila Sithembile**, PhD (registered in 2014), Environmental and Occupational Health Sciences Division, University of Illinois at Chicago. Emphysema in Black South African Miners using the Pathology Automation System of South African Miners (PATHAUT) Data 1975-2013 and the US National Coal Workers Autopsy Study (NCWAS).

**Ndlovu Ntombizodwa**, PhD (registered in September 2011), School of Public Health, University of the Witwatersrand. Evaluation of autopsy data for occupational lung disease surveillance.

## Outreach Programme Activities

ACTIVITY	DATE	VENUE	PERSON
A delegation from the Tao Lekoa Gold Mine received teaching and training on dust-related diseases in particular tuberculosis and silicosis.	25 May 2016	NIOH Pathology Division	Dr N Vorajee Mr D Afrika
A delegation from the Pathology Division provided training on prosector lung removal technique, safety in the mortuary, tissue preservation and the Human Tissue Act.	1-2 August 2016	Rustenburg Doves Funeral Parlour	Mr D Afrika Mr G Rani Mr P Mbontsi
The Pathology Division hosted an information session on the role of the division along with the importance of the autopsy service. This was attended by the Principal Inspector of Mines from the North West Province.	16 September 2016	NIOH Pathology Division	Dr N Vorajee Mr D Afrika
The Pathology Division hosted an information session on the role of the division along with the importance of the autopsy service. This was attended by the Mine Safety Society of Ventilation from the North West Province.	23 November 2016	NIOH Pathology Division	Dr N Vorajee Mr D Afrika