



**NATIONAL INSTITUTE FOR
OCCUPATIONAL HEALTH**

Division of the National Health Laboratory Service

Pathology Division Surveillance Report

Demographic Data and Disease Rates for January to December 2015

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NIOH Pathology Report 1/2016

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EXECUTIVE SUMMARY

During 2015, 909 deceased cases were examined at the NIOH. Of these, 59.3% were black, 39.4% were white, 1.0% were coloured and 0.3% were submitted without information on population group. Of the cases submitted, 54.2% (n=493) were ex-miners, 44.0% (n=400) current miners and 1.8% (n=16) cases could not be classified.

The overall disease rates (per 1000 autopsies) for 2015 are shown in Figure 1.

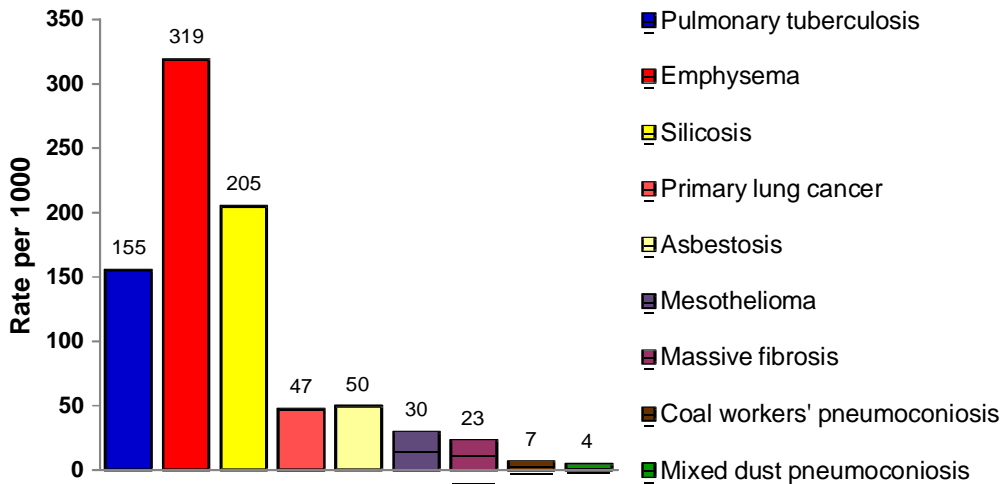


FIG.1 OVERALL DISEASE RATES FOR 2015

The overall rate of pulmonary tuberculosis (PTB) decreased further, from 166/1000 in 2014 to 155/1000 in 2015. The rate in black gold miners decreased from 305/1000 in 2014 to 274/1000 in 2015. In black platinum miners, the PTB rate decreased from 242/1000 in 2014 to 215/1000 in 2015.

The rate of silicosis in gold miners in 2015 (328/1000) is similar to that in 2014 (297/1000). In black gold miners, the rate (367/1000) was similar to that in 2014 (374/1000) but the rate in white gold miners increased from 220/1000 in 2014 to 290/1000 in 2015.

The organs of 25 women were submitted for examination and 40.0% (n=10) had diseases related to asbestos exposure.

Some cases were received with incomplete exposure information. Since the early 2000s, active follow-up of cases received with incomplete information has improved the completeness of information obtained. In 2015, mine type (commodity), duration of service and last mine worked were not provided for 35 (3.9%), 72 (7.9%) and 36 (4.0%) of the cases, respectively.

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 or country from which the organs were sent, by population group. Most cases originated from the North West (37.4%), Gauteng (21.9%) and Free State (13.6%) provinces. Nineteen cases were received from Lesotho.

TABLE 1-1 DISTRIBUTION OF AUTOPSY CASES BY PROVINCE/COUNTRY AND POPULATION GROUP (2015)

Province or country	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
Eastern Cape	7	1.3	1	0.3	0	-	1	33.3	9	1.0
Free State	79	14.6	45	12.6	0	-	0	-	124	13.6
Gauteng	54	10.2	144	40.2	1	11.1	0	-	199	21.9
Kwazulu-Natal	1	0.2	8	2.2	0	-	0	-	9	1.0
Limpopo	5	0.9	7	2.0	0	-	0	-	12	1.3
Mpumalanga	24	4.4	43	12.1	0	-	0	-	67	7.4
North West	245	45.3	94	26.4	0	-	1	33.3	340	37.4
Northern Cape	105	19.4	10	2.8	7	77.8	1	33.3	123	13.5
Western Cape	0	-	6	1.7	1	11.1	0	-	7	0.8
Lesotho	19	3.5	0	-	0	-	0	-	19	2.1
Total	539		358		9		3		909	

Although the Pathology Division has scaled down its outreach activities in recent years, the Division continues to engage with stakeholders in the mining industry (Appendix 2). These include occupational units on the mines, union representatives, undertakers, and the mine inspectorate.

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

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GLOSSARY

Asbestosis	Lung fibrosis caused by asbestos fibres
Coal workers' pneumoconiosis	Lung fibrosis caused by exposure to coal dust
Emphysema	Lung disease caused by the destruction of the alveolar walls
Massive fibrosis	Lung fibrosis caused by exposure to dust and measuring more than 1cm in diameter
Mesothelioma	A malignant tumour of the pleural cavity of the lungs
Miner	A person who has worked in a controlled mine or works
Mixed dust pneumoconiosis	Lung fibrosis caused by simultaneous exposure to multiple dust types
Prevalence	The number of cases in a defined population at a given time
Silicosis	Lung fibrosis caused by inhalation of silica dust; detected by the presence of silicotic nodules in the lung tissue
Surveillance	The ongoing and systematic collection, analysis, interpretation and dissemination of information related to adverse health outcomes for action
Environmental asbestos exposure	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

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.

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 v9.3.

This report describes autopsy cases examined during the year 2015. Some of the earlier reports and this report can be accessed at http://www.nioh.ac.za/publications/publications_pathaut_reports.htm.

Throughout this report, the term 'men' and all data refers to both men and women, 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 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 (1975-2015)

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
Total	73498	66	35577	32	1620	1	4		352		111051

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 white retired miners come to autopsy. The numbers of miners coming to autopsy has decreased steadily over the years, probably reflecting the concomitant decrease in the number of miners. In 1994, there were around 344 000 people employed in the gold mining industry compared to approximately 131 591 in 2014.

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 close to Johannesburg.

Table 2-2 shows the distribution of autopsies by population group for 2015. Autopsies of the cardio-respiratory organs only comprised 96.4% of all examinations.

TABLE 2-2 NUMBER AND PROPORTION OF AUTOPSIES BY TYPE AND POPULATION GROUP (2015)

Autopsy type	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
Cardio-respiratory organs only	539	100.0	314	87.7	8	88.9	3	100.0	864	95.0
Full autopsy*	0	-	44	12.3	1	11.1	0	-	45	5.0
Total	539		358		9		3		909	

*The autopsy type was reclassified and now includes all autopsies undertaken by pathologists at the NIOH.

The age distribution of cases for 2015 is shown in Table 2-3 and Figure 2-1. The mean age at autopsy of black men was 50.9 years, similar to that in 2014 (50.1 years). The mean age of white men at autopsy was 68.1 years in 2015, similar to 67.1 years in 2014.

TABLE 2-3 NUMBER AND PROPORTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
20-29	17	3.1	1	0.3	0	-	0	-	18	2.0
30-39	75	13.9	5	1.4	0	-	0	-	80	8.8
40-49	132	24.4	13	3.7	0	-	0	-	145	16.0
50-59	218	40.3	61	17.1	1	11.1	0	-	280	30.8
60-69	58	10.7	103	28.9	5	55.6	0	-	166	18.3
70-79	21	3.9	118	33.1	2	22.2	0	-	141	15.5
80+	12	2.2	57	16.0	1	11.1	0	-	70	7.7
Unknown	6	1.7	0	-	0	-	3	100.0	9	1.0
Total	539		358		9		3		909	

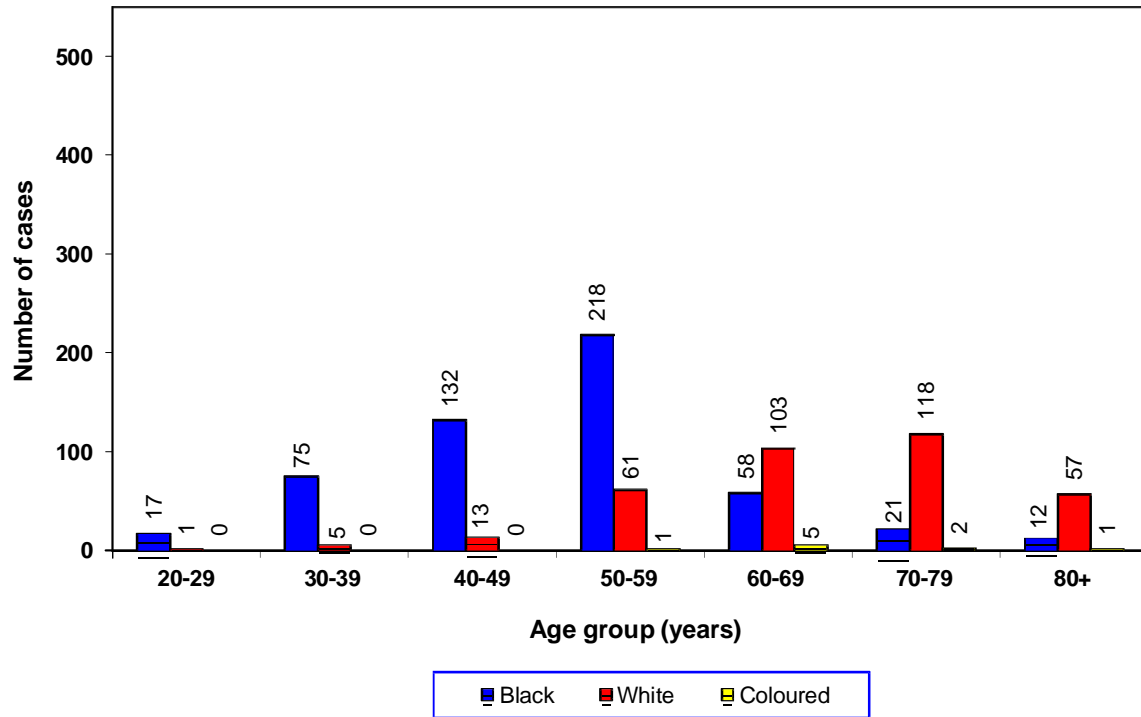


FIG 2-1 DISTRIBUTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2015)

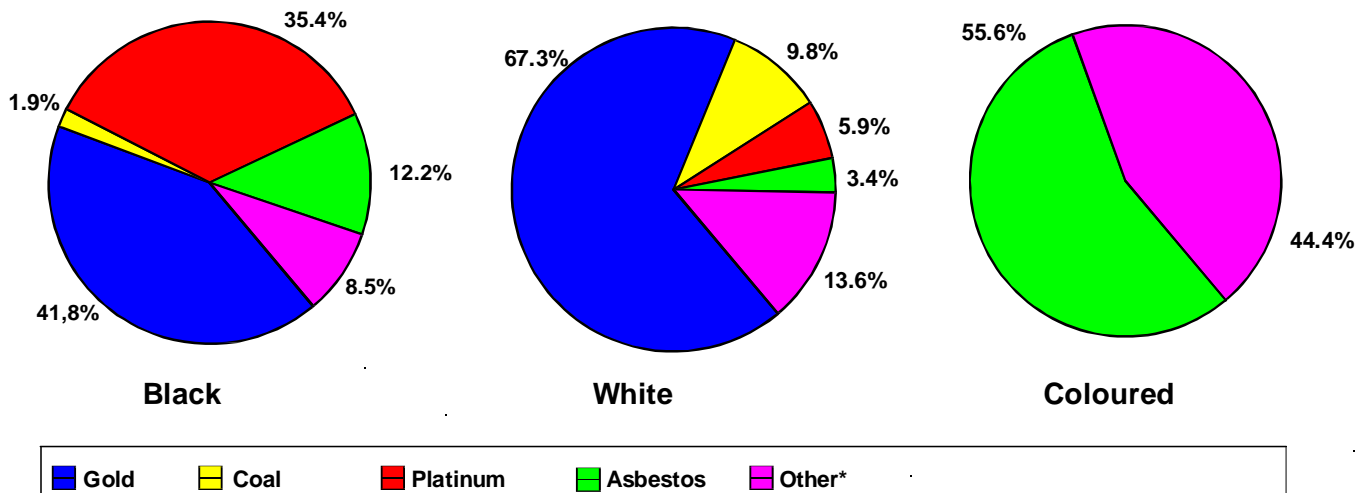
Cases were placed in categories according to the commodity in which they had worked for the longest duration (most exposure). Many men, however, worked in a number of different mining commodities during their lifetimes and had “mixed” exposures. This was not taken into account in the analysis of exposure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

Table 2-4 and Figure 2-2 show the distributions of autopsies by commodity and population group for 2015. Of the cases received, 51.4% were from the gold mining industry; fewer than in 2014 (57.1%). The proportion of autopsies from the platinum mining industry has increased over the years, from 8.3% in 1999 to 23.3% in 2015. Five of the coloured cases autopsies had been exposed to asbestos in the mining industry.

TABLE 2-4 NUMBER AND PROPORTION OF AUTOPSIES BY COMMODITY AND POPULATION GROUP (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
Gold	226	41.8	241	67.3	0	-	0	-	467	51.4
Platinum	191	35.4	21	5.9	0	-	0	-	212	23.3
Coal	10	1.9	35	9.8	0	-	0	-	45	5.0
Asbestos	66	12.2	12	3.4	5	55.6	0	-	83	9.1
Iscor	1	0.2	10	2.8	0	-	0	-	11	1.2
Copper	1	0.2	5	1.4	2	22.2	0	-	8	0.9
Manganese	11	2.0	6	1.7	0	-	0	-	17	1.9
Industry	1	0.2	7	2.0	0	-	0	-	8	0.9
Other	11	2.0	11	3.1	1	11.1	0	-	23	2.5
Unknown	21	3.9	10	2.8	1	11.1	3	100.0	35	3.9
Total	539		358		9		3		909	

Note: this table shows only those commodities where a total of 6 or more cases were received



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

FIG 2-2 DISTRIBUTION OF AUTOPSIES BY COMMODITY AND POPULATION (2015)

Detailed information about the years in mining service by population group is shown in Table 2-5 and Figure 2-3. In 2015, the duration of service was obtained for all but 7.9% of cases. This figure is higher than that for 2014 (5.5%).

TABLE 2-5 NUMBER AND PROPORTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2015)

Years of service	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
<1	14	2.6	2	0.6	0	-	0	-	16	1.8
1-5	101	18.7	27	7.6	4	44.4	0	-	132	14.5
6-10	86	16.0	32	8.9	1	11.1	0	-	119	13.1
11-15	89	16.5	45	12.6	0	-	0	-	134	14.7
16-20	47	8.7	42	11.7	1	11.1	0	-	90	9.9
21-25	70	13.0	41	11.5	1	11.1	0	-	112	12.3
26-30	72	13.4	50	14.0	0	-	0	-	123	13.5
31-35	12	2.2	58	16.2	0	-	0	-	70	7.7
36-40	3	0.6	26	7.3	0	-	0	-	29	3.2
41+	0	-	12	3.4	0	-	0	-	12	1.3
Unknown	45	8.3	23	6.4	1	11.1	3	100.0	72	7.9
Total	539		358		9		3		909	

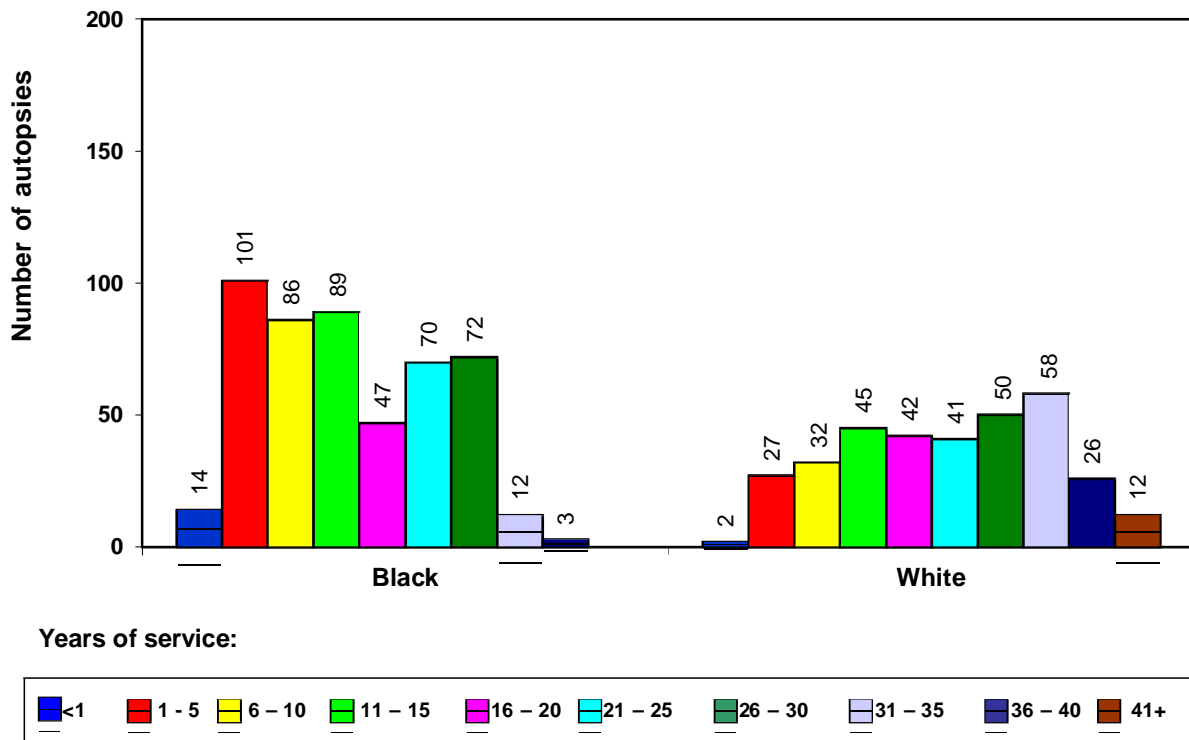


FIG 2-3 DISTRIBUTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2015)

The mean age and duration of service by commodity and population group for those cases for which information was available are shown in Tables 2-6 and 2-7.

TABLE 2-6 MEAN AGE BY COMMODITY AND POPULATION GROUP (2015)

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	226	49	10	241	69	11
Platinum	188	46	9	21	58	13
Coal	10	51	5	35	68	9
Asbestos	66	66	11	12	71	8
Iscor	1	63	-	10	67	12
Copper	1	87	-	5	68	11
Manganese	11	58	8	6	69	11
Industry	1	50	-	7	71	8
Other	11	65	9	11	65	16
Unknown	17	55	11	10	67	8
Total	533	51	12	358	68	11

* Standard deviation

TABLE 2-7 MEAN DURATION OF SERVICE BY COMMODITY AND POPULATION GROUP (2015)

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	222	18	9	236	25	15
Platinum	184	14	9	20	16	7
Coal	7	26	8	33	22	13
Asbestos	65	5	6	12	12	11
Iscor	0	0	-	9	23	11
Copper	1	30	-	5	18	10
Manganese	10	12	11	4	18	5
Industry	1	25	-	6	19	11
Other	4	10	5	10	21	13
Total	494	15	10	335	23	14

*Standard deviation

SECTION 3 – ACTIVE TUBERCULOSIS

The distribution of active tuberculosis (TB) by anatomical site is presented in Figure 3-1 (n=158). Active pulmonary TB (PTB) was diagnosed in 15.5% (n=141) of all cases autopsies in 2015, compared to 27.4% (n=472) in 2007. Most of the men with PTB were black (n=117; 83.0%) and 24 (17.0%) were white.

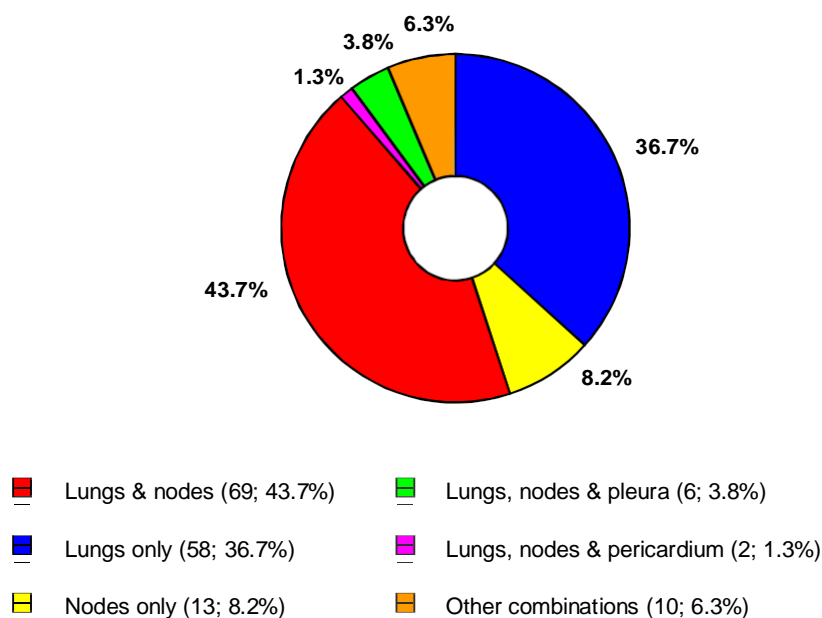


FIG 3-1 DISTRIBUTION OF ACTIVE TB BY SITE (2015)

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

In 2015, the overall PTB rate was 155/1000. In black miners, PTB rates increased from the early 1990s to 368/1000 in 2007 and have declined annually to 217/1000 in 2015 (Fig 3-2). The rate in white men remained lower than that in black men and increased from 49/1000 in 2014 to 67/1000 in 2015.

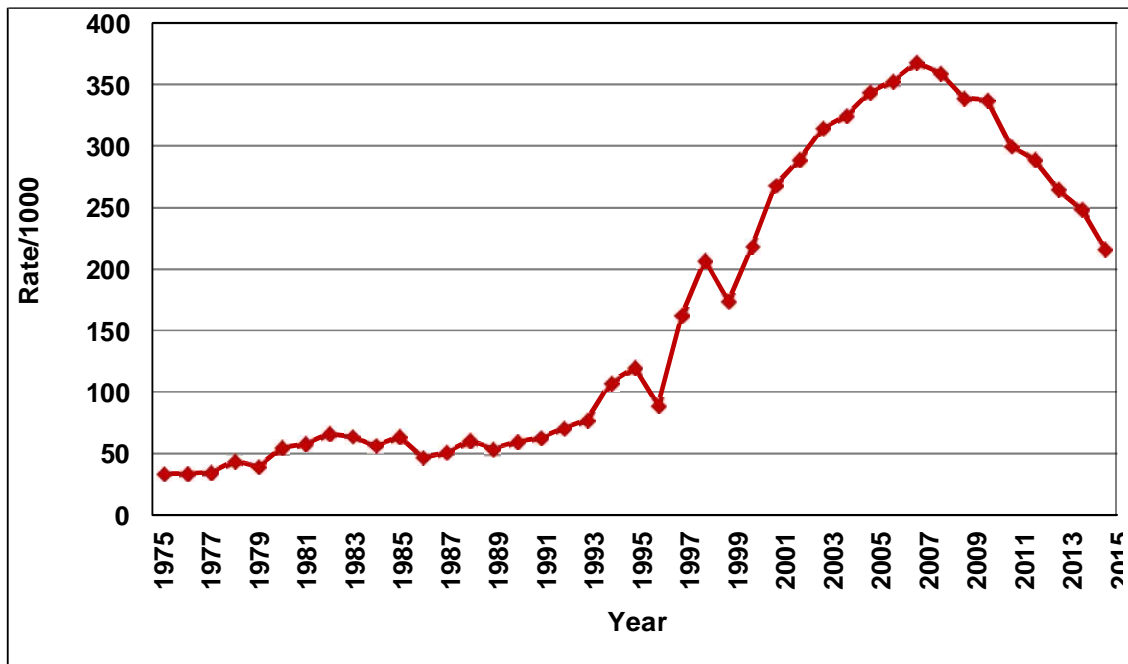


FIG 3-2 ACTIVE PTB RATES IN BLACK MINERS AT AUTOPSY (1975-2015)

The distribution of active PTB cases by commodity is shown in Table 3-1. Most cases of active PTB (56.7%) were from the gold (51.3% of all autopsy cases came from that commodity) and platinum (31.2%) mining industries.

TABLE 3-1 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY COMMODITY AND POPULATION GROUP (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
Gold	62	274	18	75	0	-	0	-	80	171
Platinum	41	215	3	-	0	-	0	-	44	208
Coal	1	-	0	-	0	-	0	-	1	-
Asbestos	10	152	0	-	0	-	0	-	10	120
Iscor	0	-	1	-	0	-	0	-	1	-
Manganese	0	-	1	-	0	-	0	-	1	-
Industry	1	-	0	-	0	-	0	-	1	-
Unknown	2	-	1	-	0	-	0	-	3	-
Total	117	217	24	67	0		0		141	155

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=61; 43.3%) were in the age group 50-59 years, followed by those in the 40-49 year age group (n=32; 22.7%).

TABLE 3-2 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY AGE AND POPULATION GROUP (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
20-29	3	-	0	-	0	-	0	-	3	-
30-39	17	227	0	-	0	-	0	-	17	213
40-49	30	227	2	-	0	-	0	-	32	221
50-59	53	243	8	131	0	-	0	-	61	218
60-69	9	155	7	68	0	-	0	-	16	96
70-79	4	-	4	-	0	-	0	-	8	57
80+	1	-	3	-	0	-	0	-	4	-
Total	117	217	24	67	0		0		141	155

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

SECTION 4 – SILICOSIS

Silicotic nodules were found in the lungs of 186 cases (20.5% of all autopsies), 82.3% of which came from the gold mining industry. Of all cases with silicosis, occasional silicotic nodules were found in 75 (40.2%), a few in 52 (28.0%), a moderate number in 47 (25.3%) and a large number in 12 (6.5%) 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 (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
Gold	83	367	70	290	0	-	0	-	153	328
Platinum	11	58	3	-	0	-	0	-	14	66
Coal	0	106	2	-	0	-	0	-	2	-
Asbestos	7	-	0	-	0	-	0	-	7	84
Copper	0	-	0	-	1	-	0	-	1	-
Unknown	5	-	2	-	0	-	2	-	9	257
Total	106	197	77	215	1		2		186	205

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

Silicosis in gold miners is shown in the following tables. The rate of silicosis in gold miners in 2015 (328/1000) is similar to that in 2014 (297/1000). The age distribution of silicosis differed between the black and white men (Table 4-2). In black men, silicosis was also diagnosed in three 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 (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
30-39	3	-	0	-	0	-	0	-	3	-
40-49	11	183	2	-	0	-	0	-	13	186
50-59	58	542	10	294	0	-	0	-	68	482
60-69	9	563	18	254	0	-	0	-	27	310
70-79	2	-	21	284	0	-	0	-	23	303
80+	0	-	19	388	0	-	0	-	19	380
Total	83	367	70	290	0		0		153	328

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 (2015)

Years of service	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
<1	0	-	1	-	0	-	0	-	1	-
1-5	4	-	1	-	0	-	0	-	5	-
6-10	4	-	4	-	0	-	0	-	8	151
11-15	10	227	9	310	0	-	0	-	19	260
16-20	11	355	6	240	0	-	0	-	17	304
21-25	20	541	13	394	0	-	0	-	33	471
26-30	28	651	10	256	0	-	0	-	38	463
31-35	4	-	19	380	0	-	0	-	23	397
36-40	2	-	4	-	0	-	0	-	6	300
41+	0	-	2	-	0	-	0	-	2	-
Unknown	0	-	1	-	0	-	0	-	1	-
Total	83	367	70	290	0		0		153	328

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

SECTION 5 – OTHER PNEUMOCONIOSES

MASSIVE FIBROSIS

There were 21 (2.3%) cases of massive fibrosis: 13 in black, five in white, one in coloured and two in miners with unknown population group. Sixteen were from the gold industry, one each from the platinum and copper industries, and the commodity was not known for three cases.

COAL WORKERS' PNEUMOCONIOSIS

There were 6 (0.7%) cases of coal workers' pneumoconiosis. All had worked in coal mines.

MIXED DUST PNEUMOCONIOSIS

There were 4 (0.4%) cases of mixed dust pneumoconiosis. There was one case from each of the following mining industries: gold, copper, manganese and lead.

ASBESTOSIS AND PLEURAL PLAQUES

There were 45 cases of asbestosis. Of these, 57.8% (n=26) had slight, 22.2% (n=10) had moderate and 20.0% (n=9) had marked fibrosis. Thirty eight (84.4%) had worked in the asbestos mining industry at some time in their lives and two (4.4%) had been exposed to asbestos in the environment.

There were 24 cases with asbestos plaques and of these 13 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 (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
40-49	0	-	1	-	0	-	0	-	1	-
50-59	9	41	0	-	0	-	0	-	9	32
60-69	11	190	0	-	2	-	0	-	13	78
70-79	8	381	4	-	1	-	0	-	13	92
80+	7	583	1	-	0	-	0	-	8	114
Unknown	1	-	0	-	0	-	0	-	1	-
Total	36	67	6	17	3		0		45	50

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

SECTION 6 – EMPHYSEMA

There were 290 cases of emphysema, the extent of which was mild in 68.3% (n=198), moderate in 23.1% (n=67) and marked in 8.6% (n=25). The overall rate of emphysema increased from 250/1000 in 2010 to 355/1000 in 2013, and decreased to 319/1000 in 2015. 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 (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
30-39	4	-	0	-	0	-	0	-	4	-
40-49	12	91	2	-	0	-	0	-	14	97
50-59	51	234	20	328	1	-	0	-	72	257
60-69	20	345	55	534	3	-	0	-	78	470
70-79	8	381	68	570	2	-	0	-	78	553
80+	7	583	33	579	0	-	0	-	40	571
Unknown	2	-	0	-	0	-	2	-	4	-
Total	104	193	178	497	6	667	2		290	319

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=163, 56.2%) (Table 6-2).

TABLE 6-2 NUMBER OF CASES AND PREVALENCE OF EMPHYSEMA BY COMMODITY AND POPULATION GROUP (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
Gold	42	186	121	502	0	-	0	-	163	349
Platinum	22	115	6	286	0	-	0	-	28	132
Coal	4	-	18	514	0	-	0	-	22	489
Asbestos	27	409	5	-	2	-	0	-	34	410
Iscor	1	-	6	600	0	-	0	-	7	636
Copper	0	-	2	-	2	-	0	-	4	-
Manganese	2	-	5	-	0	-	0	-	7	412
Industry	0	-	5	-	0	-	0	-	5	-
Other	2	-	5	-	1	-	0	-	8	348
Unknown	4	-	5	-	1	-	2	-	12	333
Total	104	193	178	497	6	667	2		290	319

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 (2015)

Years of service	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
<1	5	-	2	-	0	-	0	-	7	438
1-5	25	248	13	481	3	-	0	-	41	311
6-10	11	128	17	531	0	-	0	-	28	235
11-15	16	180	23	511	0	-	0	-	39	291
16-20	6	128	18	429	0	-	0	-	24	267
21-25	15	214	23	561	1	-	0	-	39	348
26-30	13	181	20	400	1	-	0	-	34	276
31-35	4	-	30	517	0	-	0	-	34	486
36-40	1	-	14	538	0	-	0	-	15	517
41+	0	-	7	583	0	-	0	-	7	583
Unknown	8	178	11	478	1	-	2	-	22	306
Total	104	193	178	497	6	667	2		290	319

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

SECTION 7 – MESOTHELIOMA

There were 27 of cases of mesothelioma in 2015.

TABLE 7-1 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY AGE AND POPULATION GROUP (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
40-49	1	5.0	2	29	0	-	0	-	3	11.1
50-59	9	45.0	0	-	0	-	0	-	9	33.3
60-69	8	40.0	1	14	0	-	0	-	9	33.3
70-79	2	10.0	3	43	0	-	0	-	5	18.5
80+	0	-	1	14	0	-	0	-	1	3.7
Total	20		7		0		0		27	

The distribution of mesothelioma by commodity and population group is presented in Table 7-2. Fourteen (51.9%) of the cases had worked in asbestos mines at some stage in their careers and two (7.4%) had been exposed to asbestos in the environment.

TABLE 7-2 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY COMMODITY AND POPULATION GROUP (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
Gold	1	5.0	3	42.9	0	-	0	-	4	14.8
Platinum	3	15.0	0	-	0	-	0	-	3	11.1
Asbestos	10	50.0	2	28.6	0	-	0	-	12	44.4
Iscor	0	-	1	14.3	0	-	0	-	1	3.7
Manganese	2	10.0	0	-	0	-	0	-	2	7.4
Industry	1	5.0	0	-	0	-	0	-	1	3.7
Environmental asbestos	2	10.0	1	14.3	0	-	0	-	3	11.1
Unknown	1	5.0	0	-	0	-	0	-	1	3.7
All	20		7		0		0		27	

SECTION 8 – PRIMARY LUNG CANCER

Forty three cases of primary lung cancer were found at autopsy, 44.2% (n=19) of which were in black, 53.5% (n=23) in white and 2.3% (n=1) in coloured miners. Most of the cases had squamous cell lung carcinoma (n=17, 39.5%) followed by those with adenocarcinoma (n=13; 30.2%), small cell carcinoma (n=9; 20.9%), large cell lung carcinoma (n=3; 7.0%) and broncho-alveolar carcinoma (n=1; 2.3%)

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 (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
40-49	3	-	1	-	0	-	0	-	4	-
50-59	8	37	3	-	0	-	0	-	11	39
60-69	5	-	7	68	0	-	0	-	12	72
70-79	3	-	11	93	1	-	0	-	15	106
80+	0	-	1	-	0	-	0	-	1	-
Total	19	35	23	64	1		0	-	43	47

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 (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
Gold	6	27	14	58	0	-	0	-	20	43
Platinum	5	-	0	-	0	-	0	-	5	-
Asbestos	6	91	0	-	1	-	0	-	7	84
Coal	0	-	3	-	0	-	0	-	3	-
Isacor	0	-	3	-	0	-	0	-	3	-
Manganese	0	-	1	-	0	-	0	-	1	-
Industry	0	-	1	-	0	-	0	-	1	-
Other	1	-	1	-	0	-	0	-	2	-
Unknown	1	-	0	-	0	-	0	-	1	-
Total	19	35	23	64	1		0	-	43	47

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 (23.3%). The proportion of unnatural deaths (5.9%) was lower than that in 2014 (8.1%). The clinical cause of death was not stated for 22.0% of the cases.

TABLE 9-1 CLINICAL CAUSE OF DEATH BY POPULATION GROUP (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
Respiratory	120	22.3	89	24.9	3	33.3	0	-	212	23.3
Cardio-vascular	24	4.4	40	11.2	0	-	0	-	64	7.0
Central Nervous System	21	3.9	22	6.2	0	-	0	-	43	4.7
Gastro-intestinal	16	3.0	16	4.5	0	-	0	-	32	3.5
Genito-urinary	16	3.0	8	2.2	0	-	0	-	24	2.6
Haematological	11	2.0	2	0.6	1	11.1	0	-	14	1.5
Unnatural	43	7.9	11	3.1	0	-	0	-	54	5.9
Miscellaneous	176	32.7	85	23.6	5	55.6	0	-	266	29.3
Not stated	112	20.7	85	23.9	0	-	3	100.0	200	22.0
Total	539		358		9		3		909	

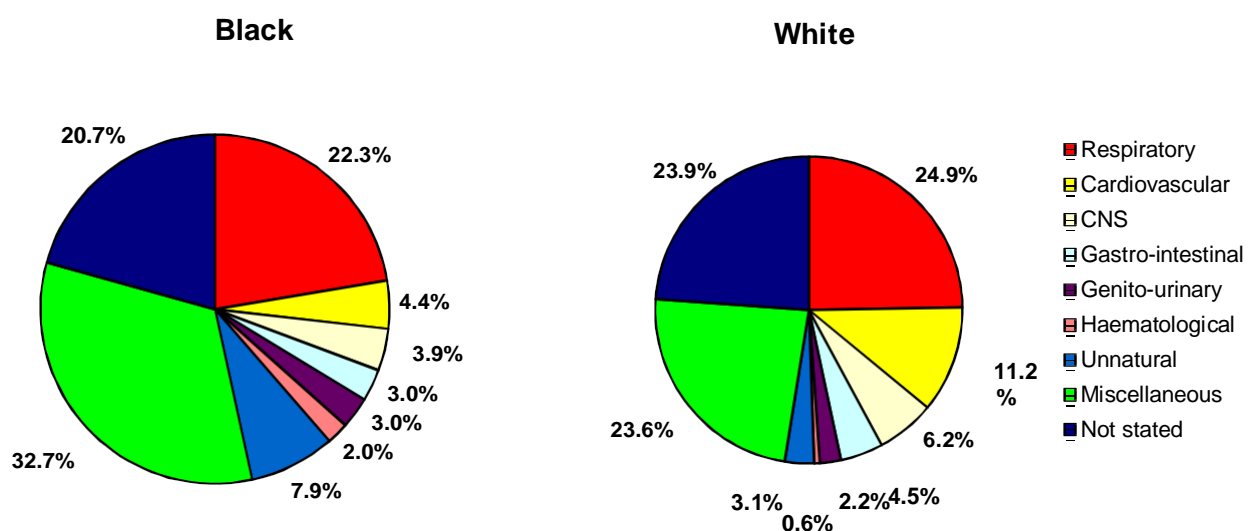


FIG 9-1 CLINICAL CAUSES OF DEATH (2015)

SECTION 10 – AUTOPSY FINDINGS IN WOMEN

The number of women examined in 2015, 25 (2.8%) was lower than in previous years: 49 (4.6%) in 2014, 32 (2.7%) in 2013 and 58 (5.0%) in 2012. There were 21 (84.0%) black, two (8.0%) white and two (8.0%) coloured women. On average, the women were older than men (62.4 years and 57.8 years, respectively).

TABLE 10-1 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY AGE AND POPULATION GROUP (2015)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
30-39	3	14.3	0	-	0	-	0	-	3	12.0
40-49	1	4.8	0	-	0	-	0	-	1	4.0
50-59	6	28.6	0	-	0	-	0	-	6	24.0
60-69	6	28.6	0	-	1	50.0	0	-	7	28.0
70-79	3	14.3	2	100.0	0	-	0	-	5	20.0
80+	2	9.5	0	-	1	50.0	0	-	3	12.0
Total	21		2		2		0		25	

Table 10-2 summarises the distribution of autopsies in women by commodity and population group. Most of the women (n=19, 76.0%) had been exposed to asbestos, with 15 (60.0%) exposed on the mines and 4 (16.0%) having had environmental exposure.

TABLE 10-2 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY COMMODITY AND POPULATION GROUP (2015)

Commodity	Black		White		Coloured		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%
Gold	2	9.5	0	-	0	-	0	-	2	8.0
Platinum	2	9.5	0	-	0	-	0	-	2	8.0
Asbestos	11	52.4	2	100.0	2	100.0	0	-	15	60.0
Environmental asbestos	4	19.0	0	-	0	-	0	-	4	16.0
Unknown	2	9.5	0	-	0	-	0	-	2	8.0
Total	21		2		2		0		25	

Ten women had asbestos-related diseases: 4 had asbestosis and 6 had mesothelioma (Table 10-3).

TABLE 10-3 NUMBER AND PROPORTION OF DISEASES IN WOMEN (2015)

Disease	N	%
PTB Silicosis	2	8.0
Emphysema	0	-
Asbestosis	3	12.0
Mesothelioma	4	16.0
Lung cancer	6	24.0
No lung disease	1	4.0
	9	36.0
Total	25	

APPENDIX 1: DISTRIBUTION OF AUTOPSIES ACCORDING TO THE LAST MINE WHERE THE DECEASED WORKED (2015)

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Asbestos	Cape Blue	6	1	2		9
	Danielskuil Asb Mine		1			1
	Elandsfontein Asbestos Mine	1	1			2
	Gefco	49	3			52
	Koegas		1	2		3
	Mashaba Asb Mine		1			1
	Noupoort Asbestos Mine		1			1
	Penge Asbestos	1				1
	Pomfret Asb Mine	3	2			5
	Stella Asbestos Mine	1				1
Total from asbestos		61	11	4	0	76
Cementation	Cementation		4			4
	Ulco Cement		1			1
Total from cementation			5			5
Chrome	Chrome Mine	1				1
	Smancor Western Chrome		2			2
Total from chrome		1	2			3
Coal	Arnot Colliery	1				1
	Coal Mine	1	5			6
	Cornelia Colliery		1			1
	Coronation Colliery		1			1
	Delmas Colliery		1			1
	Douglas Colliery		1			1
	Duiker Colliery		1			1
	Durban Navigation Colliery		1			1
	Gloria Colliery		2			2
	Goedehoop Colliery	2				2
	Greenside Colliery		1			1
	Khutala Colliery		2			2
	Koornfontein Coal		2			2
	Kriel Colliery		1			1
	Matla Coal	3	3			6
	Natal Anthracite Coll		1			1

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Coal (contd)	New Clydesdale Colliery		1			1
	New Denmark	1	1			2
	Richardsbay Coal Mine		1			1
	Rietspruit Colliery		1			1
	S A Coal Estates		1			1
	Sasol Coal Mine	1	4			5
	Savemore Colliery		1			1
	Sigma Colliery		1			1
	Springfield Colliery		1			1
	Strathrae Collieries		1			1
	Tavistok Colliery		1			1
	Transvaal Navigation Colliery		1			1
	Tweefontein	1				1
Total from coal		10	38			48
Copper	O'Kiep Copper		2	1		3
	Prieska			1		1
	Phalaborwa	1	2			3
Total from copper		1	4	2		7
Diamond	Boart Drilling Diamond		2			2
	Cullinan Diamond Mine		1			1
	De Beers Consolidated	1	3			4
	Diamond Mine		1			1
	Messina Diamond Mine	1	2			3
	Premier Diamond		1			1
Total from diamond		2	10			12
Gold	African Rainbow Minerals & Expl		1			1
	Anglo American GM	1	1			2
	Anglogold Ashanti GM	28	3			31
	Anglogold Great Noligwa GM	3				3
	Bambanani GM	3				3
	Beatrix Gold	24	3			27
	Beisa GM		1			1
	Blyvoorquizicht	2	9			11
	Buffelsfontein Gold		15			15

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Gold (contd.)	Consolidated Modderfontein		1			1
	Doringkop GM	1	1			2
	Driefontein Cons GM	19	2			21
	Durban Roodepoort Deep	0	4			4
	East Driefontein	2	5			7
	East Rand Gold and Uranium Co		1			1
	East Rand Prop		4			4
	Eastern Transvaal Consolidated		2			2
	Elandsrand		1			1
	Elsburg GM		1			1
	Evander GM	10	1			11
	Ezulwini Gold Mine	1	0			1
	Freddies Gold		1			1
	Free State Geduld	1	3			4
	Free State Saaiplaas		4			4
	Gencor	7	0		1	8
	Gold mine		1			1
	Goldfields		1			1
	Grinaker GM		1			1
	Grootvlei Prop		4			4
	Harmony	52	17			69
	Hartebeesfontein	1	3			4
	J.I.C. Gold Mine		1			1
	Joel	1	1			2
	Kinross		3			3
	Kloof	4	12			16
	Leeudoorn		5			5
	Libanon		5			5
	Loraine		6			6
	Masimong Gold Mine	2	1			3
	Moab Khotsong GM	1	0			1
	Nigel GM	1	1			2
	Oryx	1	0			1
	President Brand		7			7
	President Steyn		5			5
	Primrose GM		1			1

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Gold (contd.)	Randfontein	1	7			8
	Simmer & Jack GM	1				1
	South Deep GM		4			4
	St Helena	1				1
	Stilfontein		4			4
	Tshepone GM	2				2
	Unisel GM	1	1			2
	Vaal Reefs	20	26			46
	Ventersport		2			2
	West Driefontein		9			9
	West Rand Consolidation		2			2
	West Witwatersrand	3				3
	Western Areas		4			4
	Western Deep Levels	4	12			16
	Western Holdings		7			7
	Western Reef GM	1	1			2
Total from gold		199	218	1	1	418
Lead & Minerals	Blackmountain	1	1	1		3
Lime	Union Lime	1				1
Manganese	Associated Manganese	4				4
	Black rock asb mine	1				1
	Hotazel Manganese Mine	3	1			4
	Manganese mine	1	1			2
	S A Manganese	2				2
	SAMAT GM		1			1
Total from manganese		11	3			14
Platinum	Atok Platinum		1			1
	Bafokeng	1				1
	Eastern Platinum Mine	35	1			36
	Impala Platinum	82	12			94
	Karee Platinum	45	2			47
	Kroondal Mine, Rustenburg		2			2
	Lonmin Platinum		2			2
	Modikwa Plat Mine		2			2
	Northam Platinum	5	4			9

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Platinum (contd.)	Rustenburg Platinum	2	4			6
	Union Platinum	1	1			2
	Unknown Platinum	3	3			6
	Western Platinum	47	2			49
Total from platinum		221	36			257
Silicon	Delmas Silica		1			1
Shaft sinkers	Shaft sinkers		2			2
Steel & Iron	Isacor	1	10			11
Steel & Vanadium	Highveld Steel and Vanadium		1			1
Vanadium	Rand Carbide Vanadium Mine		1			1
Non-miner	Environmental	6	1			7
	Industry	1	4			5
Total for non-miners		7	5	0	0	12
Unknown	Unknown	23	9	1	3	36
TOTAL		539	358	9	3	909

APPENDIX 2: PUBLICATIONS AND ACTIVITIES EMANATING FROM PATHAUT DATA OR AUTOPSY SERVICE (2015)

Journal articles

Criswell SR, Nelson G, Gonzalez-Cuyar LF, Huang J, Shimony JS, Checkoway H, Simpson CD, Dills R, Seixas NS, Racette BA. Ex-vivo magnetic resonance imaging in South African manganese mine workers. *Neurotoxicology*. 2015; Apr 23;49:8-14. doi: 10.1016/j.neuro.2015.04.002. [Epub ahead of print] PATHAUT

Phillips, J.I. Forty Years On. *Editorial Adler Museum Bulletin*, 2015,41(1) :1-2
[http://www.researchgate.net/publication/281404493_Forty_years_on_Editorial_Adler_Museum_Bulletin_2015_June_Vol_41_\(1\)_pp_1-2](http://www.researchgate.net/publication/281404493_Forty_years_on_Editorial_Adler_Museum_Bulletin_2015_June_Vol_41_(1)_pp_1-2)

Reports

Boshomane J, Ndlovu N, Murray J, Vorajee N. Pathology Division Report: Demographic data and disease rates for January to December 2014. NIOH Report 1/2015, 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

Congresses

Murray J, Ndlovu N, Nelson G. Mesothelioma in South African miners, 1975-2013. 25th European Respiratory Society International Congress. 26-30 September 2015. Amsterdam

Murray J. South African Gold Mines: A Human Rights Perspective on Healthy Work and Compensation. (Invited oral presentation). 31st International Congress on Occupational Health (ICOH). Seoul, South Korea; 28 May – 5 Jun 2015.

Rees D, Phillips JI. The South African Legacy of Asbestos - then and now (oral presentation). 31st International Congress on Occupational Health (ICOH). Seoul, South Korea; 28 May – 5 Jun 2015.

Ndlovu N, Murray J. Evaluation of the usefulness of an autopsy compensation database for occupational disease surveillance. 31th International Conference on Occupational Health (ICOH), 31 May – 5 June 2015, Seoul, Korea. (Oral presentation)

Ndlovu N, Murray J. Utilisation of autopsy data for the detection and monitoring of occupational lung diseases in miners. MineSafe 2015, 26-27 August 2015, Emperor's Palace, Johannesburg, South Africa (Oral presentation)

Degrees

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

Sithembile Mabila, 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)

Outreach Programme Activities

ACTIVITY	DATE	VENUE	PERSON
TB and silicosis workshop for National Union of Mineworkers (NUM) health and safety officers	6 February 2015	NUM, Welkom	Daniel Afrika
Participated in Work TB Day Day organised by the North West Provincial Government.	24 March 2015	Klerksdorp	Daniel Afrika Goodman Rani
Training for mortuary attendants on safety and removal of cardio-respiratory organs	9-10 June	Doves, Rustenburg	Daniel Afrika
Workshop presentation and information sharing session to promote autopsies.	2 October 2015	Sigma Mine, Sasol	Naseema Vorajee