



**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 2017

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NIOH Pathology Report 1/2017

<http://www.nioh.ac.za/publications/pathology-disease-surveillance-reports/>

ACKNOWLEDGEMENTS

We thank the following staff members of the NIOH Pathology Division for their invaluable contribution to the autopsy service:

Anna Khumalo
Boitumelo Legodi
Busisiwe Mkhonza
Daniel Afrika
Goodman Rani
Jim Phillips
Joseph Mukovhi
Joshua Boshomane
Juliet Buthelezi
Kedibonye Kereeditse
Lungile Magwaza
Nkagiseng Langa
Nqobile Sithole
Ntombizodwa Ramatsebe
Palesa Mothei
Patrick Mbhontsi
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ISSN 1812-7681

EXECUTIVE SUMMARY

The NIOH examined the cardiorespiratory organs of 801 deceased individuals. Of these, 59.1% were black, 39.1% were white, 1.1% were coloured, 0.1% were Indian and 0.6% were submitted without information on their population group. Of the cases submitted, 59.3% (n=475) were ex-miners, 39.5% (n=316) current miners and 1.2% (n=10) cases could not be classified.

The overall disease rates (per 1000 autopsies) for 2017 are shown in Figure 1.

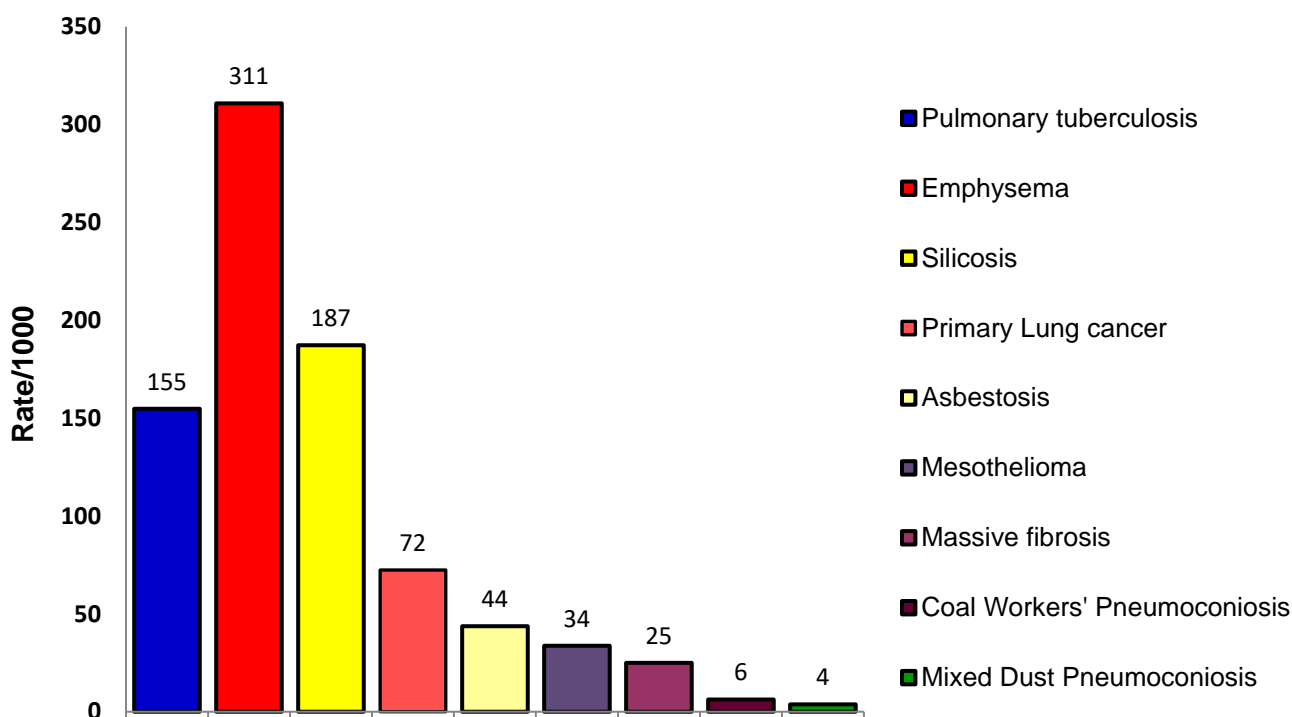


FIG. 1 OVERALL DISEASE RATES FOR 2017

The overall rate of pulmonary tuberculosis (PTB) slightly increased, from 152/1000 in 2016 to 155/1000 in 2017. The rate in black gold miners decreased slightly from 247/1000 in 2016 to 240/1000 in 2017. In black platinum miners, the PTB rate decreased from 189/1000 in 2016 to 166/1000 in 2017.

The overall rate of silicosis decreased from 234/1000 in 2016 to 187/1000 in 2017. The rate in gold miners decreased to 294/1000 in 2017 compared to 351/1000 in 2016. In black gold miners, the rate decreased from 416/1000 in 2016 to 370/1000 in 2017. The rate in white gold miners also decreased from 289/1000 in 2016 to 233 in 2017.

The organs of 42 women were submitted for examination of whom 19.5% (n=8) 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 2017 information could not be obtained for the following: mine type (commodity) 18 (2.2%), duration of service 35 (4.4%) and last mine worked 19 (2.4%).

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 (36.1%), Gauteng (21.2%) and Free State (15.7%) provinces. Thirty-four cases were received from Lesotho

TABLE 1-1 DISTRIBUTION OF AUTOPSY CASES BY PROVINCE AND POPULATION GROUP (2017)

Province	Black		White		Coloured		Indian		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Eastern Cape	7	1.5	1	0.3	0	-	0	-	0	-	8	1.0
Free State	76	16.1	47	15.0	0	-	0	-	3	60	126	15.7
Gauteng	29	6.1	140	44.7	1	11.1	0	-	0	-	170	21.2
Kwazulu-Natal	1	0.2	7	2.2	0	-	0	-	0	-	8	1.0
Limpopo	7	1.5	3	1.0	0	-	0	-	0	-	10	1.2
Mpumalanga	18	3.8	27	8.6	1	11.1	1	100	0	-	47	5.9
North West	206	43.6	80	25.6	1	11.1	0	-	2	40	289	36.1
Northern Cape	95	20.1	5	1.6	6	67.0	0	-	0	-	106	13.2
Western Cape	0	-	3	1.0	0	-	0	-	0	-	3	0.4
Lesotho	34	7.2	0	-	0	-	0	-	0	-	34	4.2
Total	473		313		9		1		5		801	

Although the Pathology Division has scaled down its outreach activities in recent years, it continues to engage with stakeholders. These include occupational health units on the mines, union representatives, undertakers, occupational health university students, and the Mine Health and Safety Inspectorate (Appendix 2).

Two journal articles using autopsy data were published and research findings were presented at conferences (Appendix 2). There is one completed and another ongoing PhD studies utilising the PATHAUT data (registered with the University of the Witwatersrand and the 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. 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 (Medical) 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 2017. This report along with previous reports can be accessed at http://www.nioh.ac.za/publications/publications_pathaut_reports.htm.

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 (1975-2017)

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
2017	473	59	313	39	9	1	1	0.1	5	0.6	801
Total	74 492	66	36 210	32	1 635	1	4		357		112 702

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 112 200 in 2017 (Minerals Council South Africa).

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 2017. The vast majority (95.9%) of autopsy examinations were performed on the cardio-respiratory organs only.

TABLE 2-2 NUMBER AND PROPORTION OF AUTOPSIES BY TYPE AND POPULATION GROUP (2017)

Autopsy type	Black		White		Coloured		Indian		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Cardio-respiratory organs only	470	99.4	283	90.4	9	100	1	100	5	100	768	95.9
Full autopsy	3	0.6	30	9.6	0	-	0	-	0	-	33	4.1
Total	473		313		9		1		5		801	

The age distribution of cases for 2017 is shown in Table 2-3 and presented graphically in Figure 2-1. The mean age at autopsy of black men was 53.2 years, similar to that in 2016 (52.0 years). The mean age of white men at autopsy was 67.6 years in 2017, similar to 68.5 years in 2016.

TABLE 2-3 NUMBER AND PROPORTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2017)

Age group (years)	Black		White		Coloured		Indian		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
20-29	13	2.7	0	-	0	-	0	-	0	-	13	1.6
30-39	61	12.7	1	0.6	2	22.2	0	-	0	-	64	8.0
40-49	101	21.4	20	6.4	0	-	1	100	0	-	122	15.2
50-59	170	35.9	56	17.6	0	-	0	-	1	20.0	227	28.2
60-69	70	14.6	96	30.7	4	44.4	0	-	0	-	170	21.1
70-79	35	7.4	87	27.8	2	22.2	0	-	0	-	124	15.5
80+	22	4.7	52	16.6	1	11.1	0	-	0	-	75	9.4
Unknown	1	0.6	1	0.3	0	-	0	-	4	80.0	6	1.0
Total	473		313		9		1		5		801	

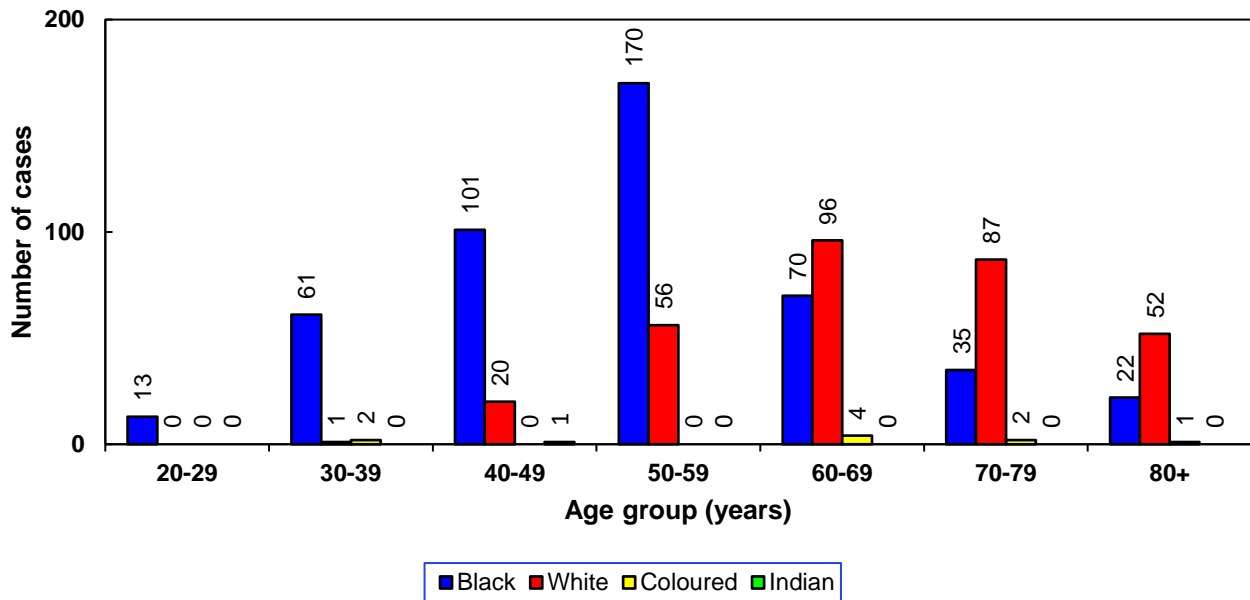


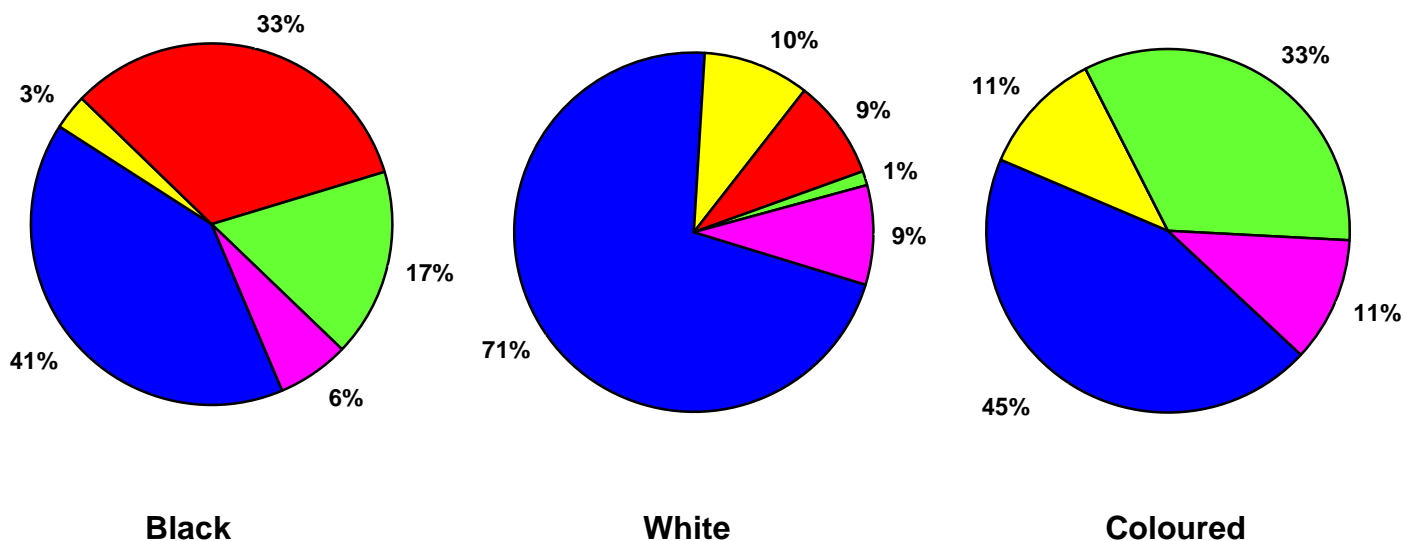
FIG 2-1 DISTRIBUTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2017)

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 2017. The majority of autopsies (52.3%) were on men from the gold mining industry, which was less than in 2016 (55.3%). The proportion of autopsies from the platinum mining industry has increased over the years, from 8.3% in 1999 to 23.1% in 2017.

TABLE 2-4 NUMBER AND PROPORTION OF AUTOPSIES BY COMMODITY AND POPULATION GROUP (2017)

Commodity	Black		White		Coloured		Indian		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Gold	192	40.6	223	71.2	4	44.4	0	-	0	-	419	52.3
Platinum	157	33.2	28	8.9	0	-	0	-	0	-	185	23.1
Coal	15	3.2	30	9.6	1	11.1	1	100	0	-	47	5.9
Asbestos	80	16.9	4	1.3	3	33.3	0	-	0	-	87	10.9
Iscor	0	-	5	1.6	0	-	0	-	0	-	5	0.6
Diamond	4	0.8	3	1.0	0	-	0	-	0	-	7	0.9
Copper	0	-	2	0.6	0	-	0	-	0	-	2	0.2
Manganese	6	1.3	4	1.3	0	-	0	-	0	-	10	1.2
Industry	2	0.4	1	0.3	0	-	0	-	0	-	3	0.4
Other*	11	2.3	8	2.6	1	11.1	0	-	0	-	20	2.5
Unknown	6	1.3	5	1.6	0	-	0	-	5	100	16	2.0
Total		473		313		9		1		5		801



■ Gold
 ■ Coal
 ■ Platinum
 ■ Asbestos
 ■ Other*

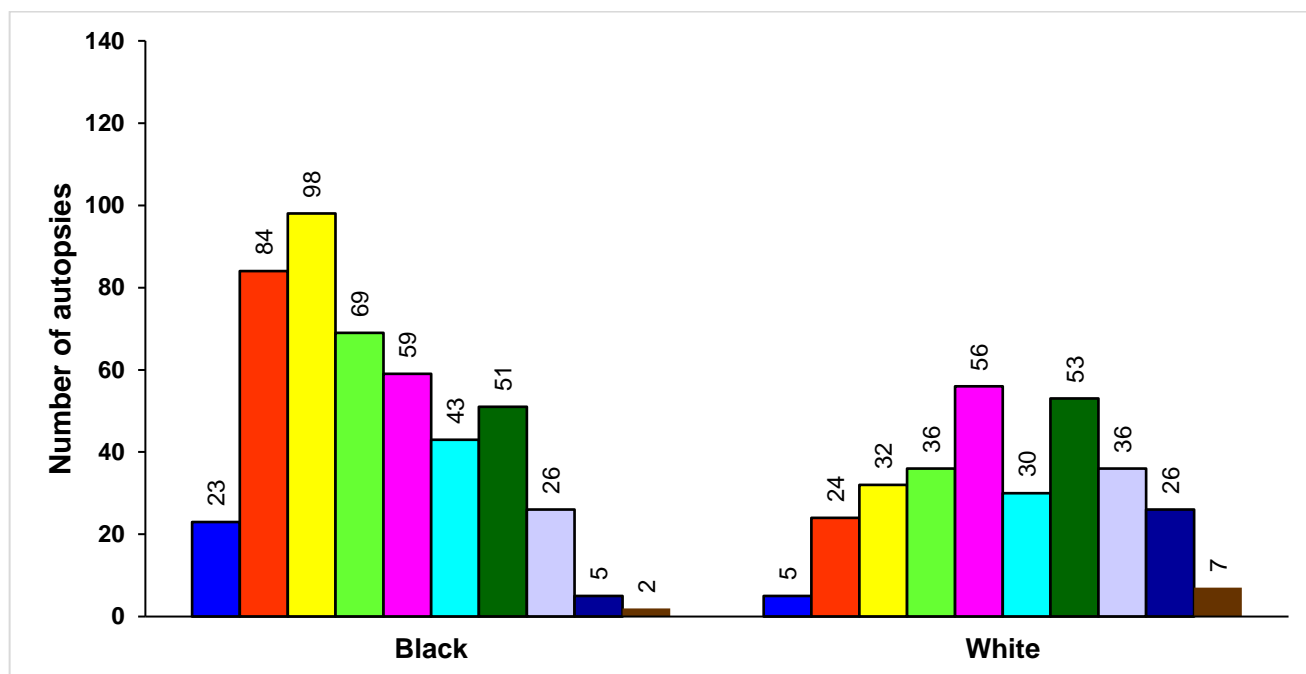
*Includes cement, chrome, copper, diamond, environmental asbestos, industry, iron, lead, lime, manganese, phosphate, steel, tin, as well as cases where service histories could not be obtained

FIG 2-2 DISTRIBUTION OF AUTOPSIES BY COMMODITY AND POPULATION (2017)

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 2017, the duration of service was obtained for all but 4.4% (n=35) of cases. This figure is an improvement to that of 2016 (5.6%). An improvement in obtaining service history may be attributable to active case-follow up.

TABLE 2-5 NUMBER AND PROPORTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2017)

Years of service	Black		White		Coloured		Indian		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
<1	23	4.9	5	1.6	0	-	0	-	0	-	28	3.5
1-5	84	17.8	24	7.7	2	22.2	0	-	0	-	110	13.7
6-10	98	20.7	32	10.2	1	11.1	0	-	0	-	131	16.4
11-15	69	14.6	36	11.5	0	-	1	100	0	-	106	13.2
16-20	59	12.5	56	17.9	3	33.3	0	-	0	-	118	14.7
21-25	43	9.1	30	9.6	1	11.1	0	-	0	-	74	9.2
26-30	51	10.8	53	16.9	0	-	0	-	0	-	104	13.0
31-35	26	5.5	36	11.5	0	-	0	-	0	-	62	7.7
36-40	5	1.1	26	8.3	1	11.1	0	-	0	-	32	4.0
41+	2	0.4	7	2.2	0	-	0	-	0	-	9	1.1
Unknown	13	2.7	8	2.6	1	11.1	0	-	5	-	27	3.4
Total	473		313		9		1		5		801	



Years of service:

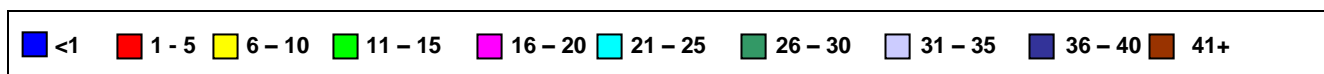


FIG 2-3 DISTRIBUTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2017)

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 (2017)

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	192	51	11	223	68	12
Platinum	157	47	10	28	61	12
Coal	15	46	13	30	67	10
Asbestos	80	69	11	4	66	4
Iscor	0	-	-	5	75	10
Copper	0	-	-	2	69	6
Manganese	6	65	15	4	67	11
Industry	2	64	5	1	78	-
Other	15	62	15	11	68	9
Unknown	5	69	13	4	64	9
Total	472	53	14	312	68	11

* Standard deviation

TABLE 2-7 MEAN DURATION OF SERVICE BY COMMODITY AND POPULATION GROUP (2017)

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	192	17	9	221	23	11
Platinum	156	15	9	28	17	12
Coal	15	16	11	30	18	11
Asbestos	77	5	6	4	8	9
Iscor	0	-	-	4	24	5
Copper	0	-	-	2	34	4
Manganese	6	20	8	4	20	15
Industry	2	18		1	33	-
Other	12	16	14	11	22	9
Total	460	15	10	305	22	11

*Standard deviation

SECTION 3 – ACTIVE TUBERCULOSIS

The distribution of active tuberculosis (TB) by anatomical site is presented in Figure 3-1 (n=137). Active pulmonary TB (PTB) was diagnosed in 15.5% (n=124) of all cases autopsies in 2017, compared to 27.4% (n=472) in 2007. Most of the men with PTB were black (n=93; 75.0%) and 27 (21.8%) were white.

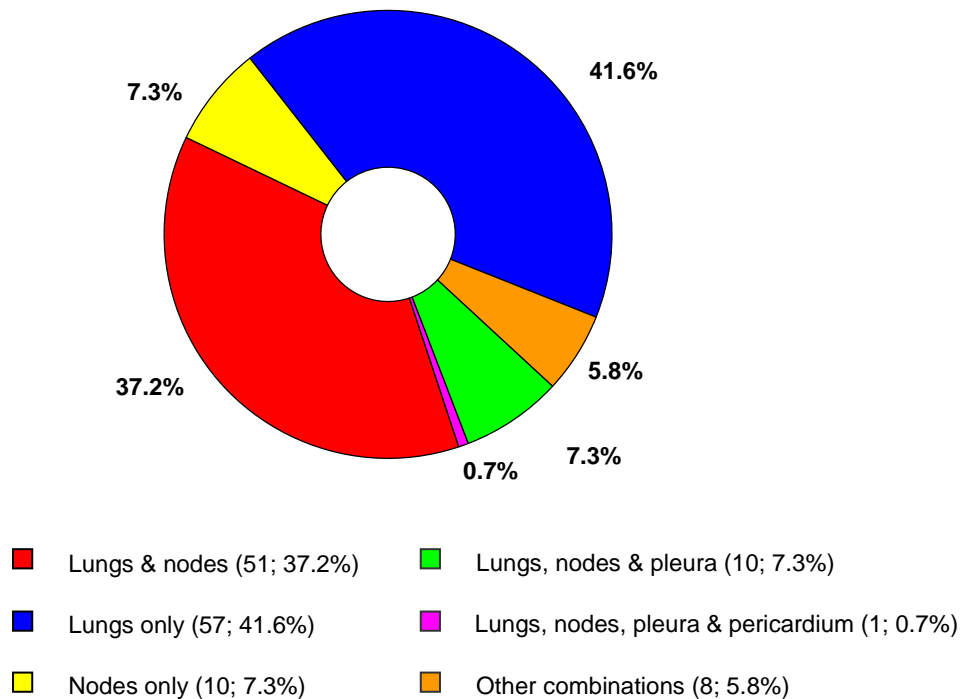


FIG 3-1 DISTRIBUTION OF ACTIVE TB BY SITE (2017)

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

In 2017, the overall PTB rate was 155/1000. In black miners, PTB rates have shown a sharp increase since the early 1990s and peaked at 368/1000 in 2007 but have since declined annually to 197/1000 in 2017 (Fig 3-2). The rate in white miners was much lower than that in black miners, 86/1000 but increased compared to the rate in 2016 (62/1000).

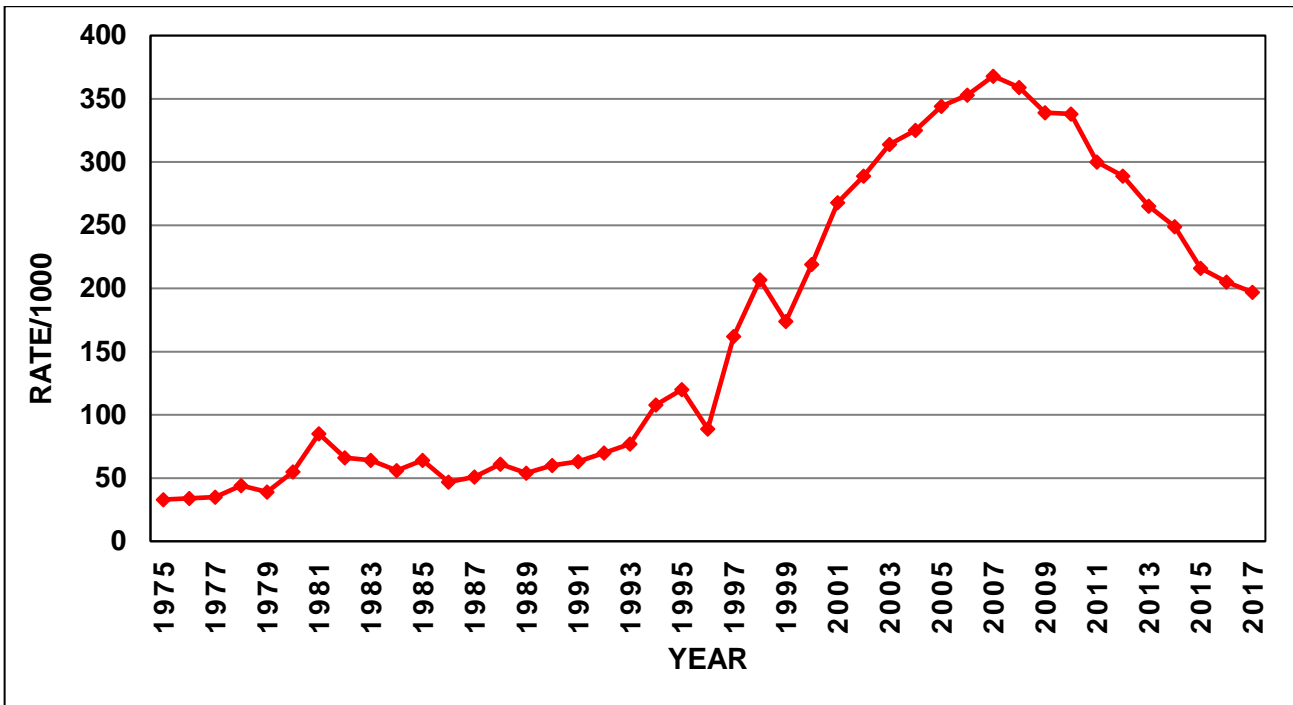


FIG 3-2 ACTIVE PTB RATES IN BLACK MINERS AT AUTOPSY (1975-2017)

The distribution of active PTB cases by commodity is shown in Table 3-1. Most cases of active PTB (55.6%) were from the gold (52.3% of all autopsy cases came from that commodity) and platinum (23.4%) mining industries.

TABLE 3-1 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY COMMODITY AND POPULATION GROUP (2017)

Commodity	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
Gold	46	240	21	94	2	-	0	-	69	165
Platinum	26	166	3	-	0	-	0	-	29	157
Coal	4	-	0	-	0	-	0	-	4	-
Asbestos	12	150	0	-	0	-	0	-	12	138
Manganese	3	-	0	-	0	-	0	-	3	-
Other	0	-	0	-	0	-	0	-	0	-
Unknown	2	-	3	-	0	-	2	-	7	389
Total	93	197	27	86	2		2		124	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=38; 30.6%) were in the age group 50-59 years, followed by those in the 60-69year age group (n=27; 21.8%).

TABLE 3-2 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY AGE AND POPULATION GROUP (2017)

Age group (years)	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	%	N	Rate
20-29	1	-	0	-	0	-	0	-	1	-
30-39	14	230	0	-	0	-	0	-	14	219
40-49	23	228	3	-	0	-	0	-	26	213
50-59	32	188	5	-	0	-	1	-	38	167
60-69	15	214	10	104	2	-	0	-	27	159
70-79	3	-	4	-	0	-	0	-	7	56
80+	5	-	5	-	0	-	0	-	10	133
Unknown	0	-	0	-	0	-	1	-	1	-
Total	93	197	27	86	2		2		124	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 150 cases (18.7% of all autopsies), 80% of which came from the gold mining industry. Of all cases with silicosis, occasional silicotic nodules were found in 64 (42.7%), a few in 36 (24.0%), a moderate number in 39 (26.0%) and a large number in 11 (7.3%) 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 (2017)

Commodity	Black		White		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	71	370	52	233	0	-	123	294
Platinum	8	51	1	-	0	-	9	49
Coal	1	-	0	-	0	-	1	-
Asbestos	9	113	0	-	0	-	9	103
Industry	1	-	2	-	0	-	3	-
Unknown	2	-	0	-	2	-	4	-
Other	1	-	0	-	0	-	1	-
Total	93	197	55	176	2		150	187

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 370/1000 in 2017. This, however, is a decrease from 416/1000 in 2016. The rate in white gold miners has also increased since 1997, from 176/1000 to 233/1000, but is lower than that in 2016 (289/1000).

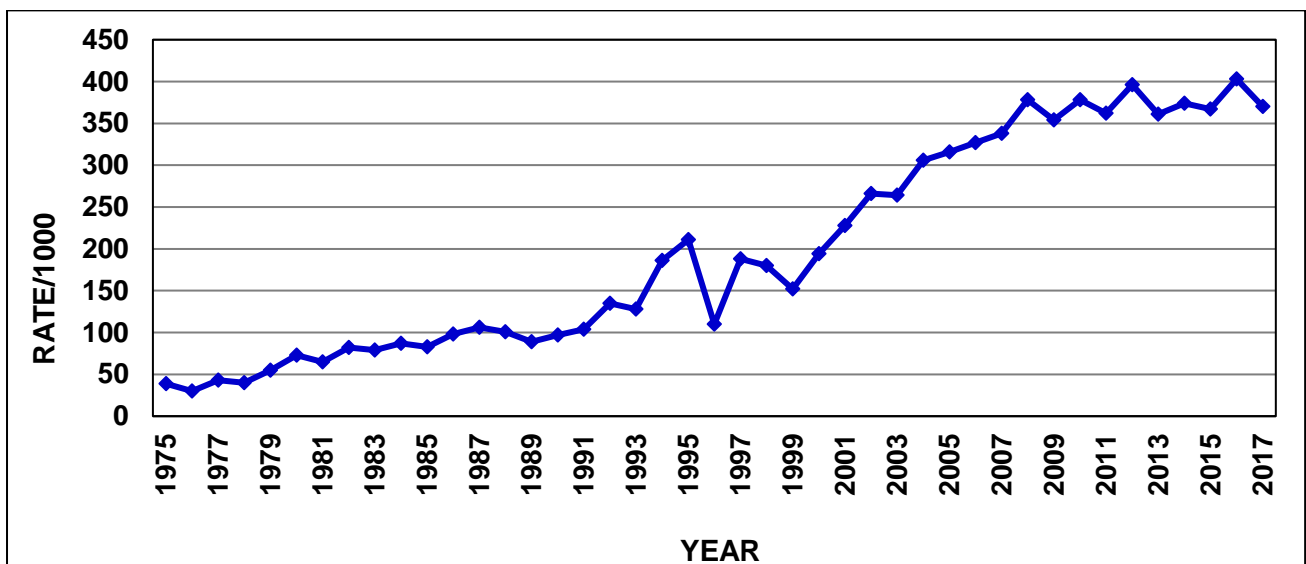


FIG 4-1 SILICOSIS IN BLACK GOLD MINERS AT AUTOPSY (1975-2017)

Silicosis in gold miners is shown in the following tables, 4-2 and 4-3. The rate of silicosis in gold miners in 2017 (294/1000) is lower than that of 2016 (351/1000). The age distribution of silicosis differed between the black and white men (Table 4-2). In black men, silicosis was also diagnosed in one man aged younger than 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 (2017)

Age group (years)	Black		White		Total	
	N	Rate	N	Rate	N	Rate
30-39	1	-	0	-	1	-
40-49	8	200	1	-	9	176
50-59	44	524	3	-	47	373
60-69	16	640	13	206	29	319
70-79	2	-	20	328	22	319
80+	0	-	15	333	15	319
Total	71	370	52	233	123	294

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 (2017)

Years of service	Black		White		Total	
	N	Rate	N	Rate	N	Rate
<1	0	-	0	-	0	-
1-5	1	-	2	-	3	-
6-10	8	250	4	-	12	226
11-15	5	-	2	-	7	125
16-20	17	548	6	-	23	315
21-25	16	667	9	409	25	532
26-30	20	541	9	225	29	377
31-35	3	-	10	357	13	333
36-40	1	-	9	391	10	400
41+	0	-	0	-	0	-
Unknown	0	-	1	-	1	-
Total	71	370	52	233	123	294

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

SECTION 5 – OTHER PNEUMOCONIOSES

MASSIVE FIBROSIS

There were 20 (2.5%) cases of massive fibrosis: 17 in black and three in white miners. Fourteen were from the gold mining industry; two from platinum and one each from was from the coal and diamond industries. Records of service could not be obtained for the remaining two miners.

COAL WORKERS' PNEUMOCONIOSIS

There were 5 (0.6%) cases of coal workers' pneumoconiosis. Four worked in coal mines and one in a gold mine.

MIXED DUST PNEUMOCONIOSIS

There were 3 (0.4%) cases of mixed dust pneumoconiosis. There was one case from the gold mining industry, one from platinum, and the commodity was not known for one case.

ASBESTOSIS AND PLEURAL PLAQUES

There were 35 cases of asbestosis. Of these, 45.7% (n=16) had slight, 20.0% (n=7) had moderate and 34.3% (n=12) had marked fibrosis. Thirty-four (97.1%) had worked in the asbestos mining industry at some time in their lives.

There were 33 cases with asbestos plaques and of these 12 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 (2017)

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
50-59	5	-	0	-	0	-	5	-
60-69	5	-	4	-	1	-	10	59
70-79	9	257	0	-	0	-	9	73
80+	10	455	1	-	0	-	11	147
Total	29	61	5		1		35	44

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

SECTION 6 – EMPHYSEMA

There were 249 cases of emphysema, the extent of which was mild in 77.5% (n=193), moderate in 15.7% (n=39) and marked in 6.8% (n=17) cases. The overall rate of emphysema decreased from 356/1000 in 2016 to 311/1000 in 2017. 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 (2017)

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	12	119	1	-	0	-	0	-	13	107
50-59	42	247	20	357	0	-	1	-	63	278
60-69	27	386	47	490	3	-	0	-	77	453
70-79	14	400	41	471	2	-	0	-	57	460
80+	10	455	23	442	1	-	0	-	34	453
Unknown	0	-	0	-	0	-	2	-	2	-
Total	108	228	132	422	6		3		249	311

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=147, 59.0%) (Table 6-2).

TABLE 6-2 NUMBER OF CASES AND PREVALENCE OF EMPHYSEMA BY COMMODITY AND POPULATION GROUP (2017)

Commodity	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
Gold	49	255	96	430	2	-	0	-	147	351
Platinum	18	115	8	286	0	-	0	-	26	141
Coal	3	-	16	533	0	-	0	-	19	404
Asbestos	27	338	0	-	3	-	0	-	30	345
Iscor	0	-	3	-	0	-	0	-	3	-
Copper	0	-	1	-	0	-	0	-	1	-
Manganese	2	-	1	-	0	-	0	-	3	-
Industry	1	-	0	-	0	-	0	-	1	-
Other	5	-	4	-	1	-	0	-	10	500
Unknown	3	-	3	-	0	-	3	-	9	563
Total	108	228	132	422	6		3		249	311

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 (2017)

Years of service	Black		White		Coloured		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate	N	Rate
<1	8	348	1	-	0	-	0	-	9	321
1-5	19	226	7	292	1	-	0	-	27	245
6-10	16	163	14	438	0	-	0	-	30	231
11-15	9	130	21	583	0	-	0	-	30	283
16-20	19	322	17	304	2	-	0	-	38	322
21-25	10	233	15	500	1	-	0	-	26	351
26-30	12	275	22	434	0	-	0	-	37	356
31-35	6	-	16	444	0	-	0	-	22	355
36-40	2	-	11	423	1	-	0	-	14	438
41+	1	-	3	-	0	-	0	-	4	-
Unknown	4	-	4	-	1	-	3	-	12	444
Total	108	228	132	422	6		3		249	311

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

SECTION 7 – MESOTHELIOMA

There were 27 cases of mesothelioma in 2017.

TABLE 7-1 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY AGE AND POPULATION GROUP (2017)

Age group (years)	Black		White		Total	
	N	%	N	%	N	%
50-59	9	39.1	0	-	9	34.6
60-69	10	43.5	1	33.3	11	42.3
70-79	4	17.4	2	66.7	6	23.1
80+	1	4.2			1	3.7
Total	24		3		27	

The distribution of mesothelioma by commodity and population group is presented in Table 7-2. Nineteen (73.1%) of the cases had worked in asbestos mines at some stage in their careers. Fourteen of the cases had the longest service in asbestos (most exposure) and five had mixed exposures that included asbestos.

TABLE 7-2 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY COMMODITY AND POPULATION GROUP (2017)

Commodity	Black		White		Total	
	N	%	N	%	N	%
Asbestos	14	77.8	0	-	14	63.6
Gold	3	16.7	1	33.3	4	18.2
Platinum	5	27.8	0	-	5	22.7
Industry	0	-	1	33.3	1	4.5
Other	2	5.6	1	33.3	2	9.1
Total	24		3		27	

SECTION 8 – PRIMARY LUNG CANCER

Fifty-eight cases of primary lung cancer were found at autopsy, 44.8% (n=26) of which were in black miners, 53.4% (n=31) were white miners and one miner's population group could not be ascertained. Most of the cases had adenocarcinoma (n=30; 51.7%), followed by those with squamous cell carcinoma (n=19, 32.8%), small cell carcinoma (n=6; 10.3%) and large cell carcinoma (n=3; 5.2%).

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 (2017)

Age group (years)	Black		White		Unknown		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
40-49	1	-	0	-	0	-	1	-
50-59	11	65	3	-	0	-	14	62
60-69	9	129	15	156	0	-	24	141
70-79	4	-	9	103	0	-	13	105
80+	1	-	4	-	0	-	5	-
Unknown	0	-	0	-	1	-	1	-
Total	26	55	31	99	1		58	72

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 (2017)

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	9	47	21	94	0	-	30	72
Platinum	3	-	0	-	0	-	3	-
Coal	1	-	4	-	0	-	5	-
Asbestos	9	113	1	-	0	-	10	115
Copper	0	-	1	-	0	-	1	-
Manganese	1	-	0	-	0	-	1	-
Other	2	-	4	-	0	-	6	-
Unknown	1	-	0	-	1	-	2	-
Total	26	55	31	99	1		58	72

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

SECTION 9 – CLINICAL CAUSES 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 (15.1%). The proportion of unnatural deaths (8.0%) was higher than that in 2016 (6.7%). The clinical cause of death was not stated for 23.8% of the cases.

TABLE 9-1 CLINICAL CAUSE OF DEATH BY POPULATION GROUP (2017)

System	Black		White		Coloured		Indian		Unknown		Total	
	N	%	N	%	N	%	N	%	N	%	N	%
Respiratory	50	10.6	68	21.7	3	33.3	0	-	0	-	121	15.1
Cardio-vascular	10	2.1	30	9.6	1	11.1	0	-	0	-	41	5.1
Central Nervous System	8	1.7	14	4.5	0	-	0	-	0	-	22	2.7
Gastro-intestinal	9	1.9	8	2.6	0	-	0	-	0	-	17	2.1
Genito-urinary	4	0.8	5	1.6	0	-	0	-	0	-	9	1.1
Haematological	2	0.4	1	0.3	0	-	0	-	0	-	3	0.4
Unnatural	50	10.6	14	4.5	0	-	0	-	0	-	64	8.0
Miscellaneous	232	49.0	96	30.7	4	44.4	1	100	0	-	333	41.6
Not stated	108	22.8	77	24.6	1	11.1	0	-	5	100	191	23.8
Total	473		313		9		1		5		801	

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

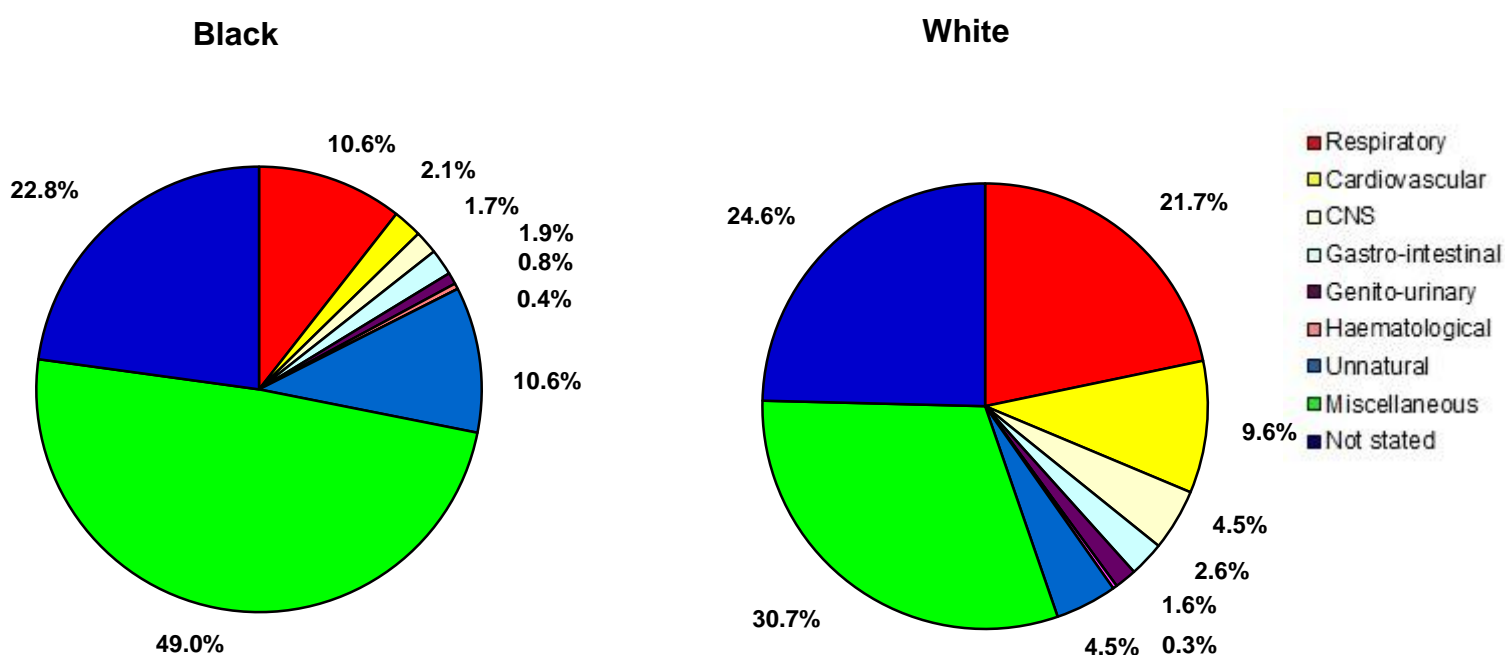


FIG 9-1 CLINICAL CAUSES OF DEATH (2017)

SECTION 10 – AUTOPSY FINDINGS IN WOMEN

Of the 801 cases examined in 2017, 42 (5.2%) were women compared to 38 (4.5%) in 2016, 25 (2.8%) in 2015 and 49 (4.6%) in 2014. There were 38 (90.2%) black and four (9.8%) coloured women. On average, the women were older than men (60.8 years and 58.8 years, respectively).

TABLE 10-1 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY AGE AND POPULATION GROUP (2017)

Age group (years)	Black		Coloured		Total	
	N	%	N	%	N	%
30-39	4	10.5	1	25.0	5	11.9
40-49	9	23.7	0	-	9	21.4
50-59	6	15.8	0	-	6	14.3
60-69	7	18.4	0	-	7	16.7
70-79	6	15.8	2	50.0	8	19.0
80+	6	15.8	1	25.0	7	16.7
Total	38		4		42	

Table 10-2 summarises the distribution of autopsies in women by commodity and population group. Most of the women (n=25, 61%) had been exposed to asbestos, with 22 (52.4%) exposed on the mines and 3 (7.1%) having had environmental exposure.

TABLE 10-2 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY COMMODITY AND POPULATION GROUP (2017)

Commodity	Black		Coloured		Total	
	N	%	N	%	N	%
Gold	10	26.3	0	-	10	23.8
Platinum	3	7.9	0	-	3	7.1
Coal	2	5.3	1	25.0	3	7.1
Asbestos	20	52.6	2	50.0	22	52.4
Environmental asbestos	2	5.3	1	25.0	3	7.1
Other	1	2.6	0	-	1	2.4
Total	38		4		42	

Eight women had asbestos-related diseases: three had asbestosis and five had mesothelioma (Table 10-3).

TABLE 10-3 NUMBER AND PROPORTION OF DISEASES IN WOMEN (2017)

Disease	N	%
PTB	5	11.9
Silicosis	1	2.4
Emphysema	10	23.8
Asbestosis	3	7.1
Mesothelioma	5	11.9
No lung disease	26	61.9

APPENDIX 1: DISTRIBUTION OF AUTOPSIES ACCORDING TO THE LAST MINE WHERE THE DECEASED WORKED (2017)

Commodity	Last mine worked	Black	White	Coloured	Indian	Unknown	Total
Asbestos	Asbestos Mine	2	1				3
	Bewaarkloof Asb Mine	1					1
	Bretby Asbestos	1					1
	Cape Blue	5					5
	Danielskuil Asb Mine	1					1
	Gefco	56		2			58
	Koegas		1	2			3
	Penge Asbestos	1	1				2
	Pomfret Asb Mine	6					6
Total from asbestos		73	3	4	0	0	80
Cementation	Cementation		2				2
Total from cementation		0	2	0	0	0	2
Chrome	Chrome Mine		1				1
	Eastern Chrome mine		1				1
	Smancor Western Chrome		1				1
Total from chrome		0	3	0	0	0	3
Coal	Arnot Colliery	1		1			2
	Coal Mine	1	2		1		4
	Delmas Colliery		4				4
	Douglas Colliery		3				3
	Goedehoop Colliery	1					1
	Greenside Colliery		2				2
	Grootgeluk	2					2
	Khutala Colliery		2				2
	Kroonfontein		1				1
	Kriel Colliery		4				4
	Landau Colliery		1				1
	Matla Coal	10	1				11
	Middelburg Colliery		1				1
	Natal Anthracite Colliery		2				2
	New Denmark		2				2
	Optimum Colliery		1				1
	S A Coal Estates		1				1

Commodity	Last mine worked	Black	White	Coloured	Indian	Unknown	Total
Coal (contd)	Secunda Colliery		2				2
	Spitzkop		1				1
	Tweefontein		1				1
	Vryheid Coronation		1				1
	Witbank Collieries	1					1
Total from coal		16	32	1	1	0	50
Copper	O`Kiep Copper		1				1
Total from copper		0	1	0	0	0	1
Diamond	De Beers Consolidated	1					1
	Cullinan Diamond mine		5				5
	Diamond Mine		1				1
	Finch Diamond Mine	2					2
	Messina Diamond Mine		1				1
	Star Diamond Mine	1					1
Total from diamond		4	7	0	0	0	11
Gold	Anglogold Ashanti GM	24	8				32
	Angilon GM		1				1
	Bambanani GM	3	1				4
	Barberton GM	1	1				2
	Beatrix Gold	29	6				35
	Blyvoorquizicht	1	8				9
	Bracken Mines		1				1
	Buffelsfontein Gold		8				8
	Daggasfontein		1				1
	Deelkraal		1				1
	Driefontein Cons GM	4	8	1			13
	Durban Roodepoort Deep		3				3
	East Driefontein	1	7				8
	East Rand Prop		7				7
	East Rand Gold and Uranium Co		1				1
	Elandsrand		1				1
	Evander GM	4	4				8
	Fairview Mine		1				1
	Freddies Gold		1				1
	Free State Geduld			3			3

Commodity	Last mine worked	Black	White	Coloured	Indian	Unknown	Total
Gold (contd)	Free State Saaiplaas		2				2
	Gencor	7	1				8
	Gold mine	1	5				6
	Goldfields		2				2
	Grinaker GM	1					1
	Harmony	39	16				55
	Hartebeesfontein	3	5				8
	J.I.C. Gold Mine	1	1				2
	Joel	5	1				6
	Kinroos		2				2
	Kloof	5	8				13
	Leeudorn		1				1
	Leslie		1				1
	Libanon		1				1
	Lorraine		2				2
	Modderfontein		1				1
	New Kleinfontein GM	1					1
	Nigel GM		1				1
	Oryx	1					1
	President Brand	1	1				2
	President Steyn	3	2				5
	Randfontein		3				3
	Roodekop GM		1				1
	SA Land		1				1
	Simmer & Jack GM	4					3
	South Deep GM		2				2
	St Helena		1				1
	Stilfontein	2	6				8
	Target Gold Mine		1				1
	Tautona GM	3					3
	Tshepone GM	1	1				2
	Unisel GM	1	1				2
	Vaal Reefs	30	25	2			57
	Ventersport		1				1
	Welkom GM		1				1
	West Driefontein	1	6				7
	Western Deep Levels	3	11				14
	Winkelhaak		2				2

Commodity	Last mine worked	Black	White	Coloured	Indian	Unknown	Total
Gold (contd.)	Wit Nigel GM		1				1
Total from gold		181	196	3	0	0	380
Iron	Consolidated African Mines	1					1
	Iron Ore Mine	4					4
Lime	Union Lime	1					1
Manganese	Associated Manganese	1	2				3
	Black rock asb mine	1					1
	Hotazel Manganese Mine	3					3
	Manganese mine	1					1
	S A Manganese	1	2				3
Total from iron, lime and manganese		13	4	0	0	0	17
Platinum	Amadelbult Platinum (Rustenburg)		1				1
	Eastern Platinum Mine	30	1				31
	Impala Platinum	51	9				60
	Karee Platinum	36	1				37
	Lebowa Platinum Mine		2				2
	Lonmin Platinum	1	6				7
	Messina Platinum Mine	1	1				2
	Northam Platinum	1	1				2
	Rustenburg Platinum	7	10				17
	Swartklip Platinum	1	1				2
	Two Rivers Platinum		1				1
	Union Platinum		2				2
	Unknown Platinum	3	6				9
	Western Platinum	37	3				40
Total from platinum		168	45	0	0	0	213
Quarry	Hippo Quarries		1				1
Refinery	Impala Platinum refinery	1					1
Silicon	Silicon Smelters	4					4
Shaft sinkers	Shaft sinkers		2				2
Steel	Highveld Steel and Vanadium		2				2
	Union Steel Mine		1				1
Steel & Iron	Iskor		5				5

Commodity	Last mine worked	Black	White	Coloured	Indian	Unknown	Total
Tin	Rooiberg Tin Mine		1				1
Total for silicon, shaft sinkers, steel, steel&iron, tin		5	12	0	0	0	17
Non-miner	Environmental	2	0	1			3
	Industry	3	1				4
Total for non-miners		5	1	1	0	0	7
Unknown	Unknown	8	7	0		5	20
TOTAL		473	313	9	1	5	801

APPENDIX 2: PUBLICATIONS AND ACTIVITIES EMANATING FROM PATHAUT DATA OR AUTOPSY SERVICE (2017)

Journal articles

Ndlovu N, Rees D, **Murray J**, **Vorajee N**, Richards G and teWaterNaude J, Asbestos-related diseases in mineworkers: a clinicopathological study, *ERJ Open Research*, 2017; 3: 00022-2017 [https://doi.org/10.1183/23120541.00022-2017].

Mabila SL, Almberg K, Friedman L, **Ndlovu N**, **Vorajee N**, **Murray J**, Cohen RA. Emphysema in South African Miners at Autopsy, 1975 - 2014. *International Archives of Occupational and Environmental Health*. 2018;91(8):981-990

Davies JCA, **Phillips JI**,. How dusty is a task? *Occupational Health Southern Africa*. 2017;23(3):2–4.

Reports

Kgokong N, **Vorster T**, **Vorajee N**, **Lakhoo D**, **Murray J**, **Ndlovu N**. Pathology Division Report: Demographic data and disease rates for January to December 2016. 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

Congresses

Ndlovu N, **Phillips JI**, **Kgokong N**, **Vorster T**, **Murray J**. Occupational lung diseases in deceased South African women in mining. ICOH; 29 April – 4 May 2018. Dublin Ireland

Mabila SL, Almberg K, Friedman L, **Ndlovu N**, **Vorajee N**, **Murray J**, Cohen RA. Emphysema in South African Miners at Autopsy, 1975-2014. *American Journal of Respiratory and Critical Care Medicine* 2017;195: A1747 (Abstract)

Mabila, S., Almberg, K., Freedman, L., Z. **Ndlovu**, **J. Murray**, **N. Vorajee**, R.A. Cohen. Emphysema in South African Miners at Autopsy. American Thoracic Society (ATS) Conference; 2017: PA1747. May 19-24. Washington DC

Degrees

Mabila Sithembile, PhD (registered in 2014, completed in 2017), 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
Information on dust-related diseases (particularly TB and silicosis) as well as the role of the Pathology Division was shared with the occupational and environmental managers present.	03 February 2017	AngloGold Ashanti Klerksdorp	Mr D Afrika
ArcelloMittal hosted a health and safety open day, which was attended by the Pathology department as well as other NIOH departments. The Pathology stall focused on occupational lung diseases with museum lung specimens of TB, silicosis, emphysema and cancer.	20 April 2017	Vanderbijlpark	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 delegates from NEPAD	12 July 2017	NIOH Pathology Division	Dr N Vorajee Prof JI Phillips
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 students from the University of Pretoria's School of Health Systems and Public Health.	25 July 2017	NIOH Pathology Division	Dr N Vorajee Prof JI Phillips
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 delegates from Goldfields South Deep Gold Mine	17 August 2017	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 3 rd year Environmental Health students from DUT	24 August 2017	NIOH Pathology Division	Mr D Afrika
The Pathology Division's staff members attended a Health and Safety Day Campaign hosted by the NUM	21 October 2017	Steelport, Limpopo	Mr D Afrika Ms. S Muthabeni Ms. J Buthelezi Ms P Mothei
The Pathology Division hosted delegates from Lesotho to provide insight into occupational health and the statutory services provided by the Pathology Division.	6 December 2017	NIOH Pathology Division	Prof JI Phillips Ms. J Buthelezi