



**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 2021

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EXECUTIVE SUMMARY

The NIOH examined the cardiorespiratory organs of 546 deceased individuals in 2021, similar to 2020 (n=557). The numbers reflect the logistical issues attributable to the COVID pandemic. Of these, 55.5% were black, 44.1% were white and 0.4% were coloured. Of the cases submitted, 64.7% (n=353) were ex-miners, 29.1% (n=159) current miners and 6.2% (n=34) cases could not be classified.

The overall disease rates (per 1000 autopsies) for 2021 are shown in Figure 1.

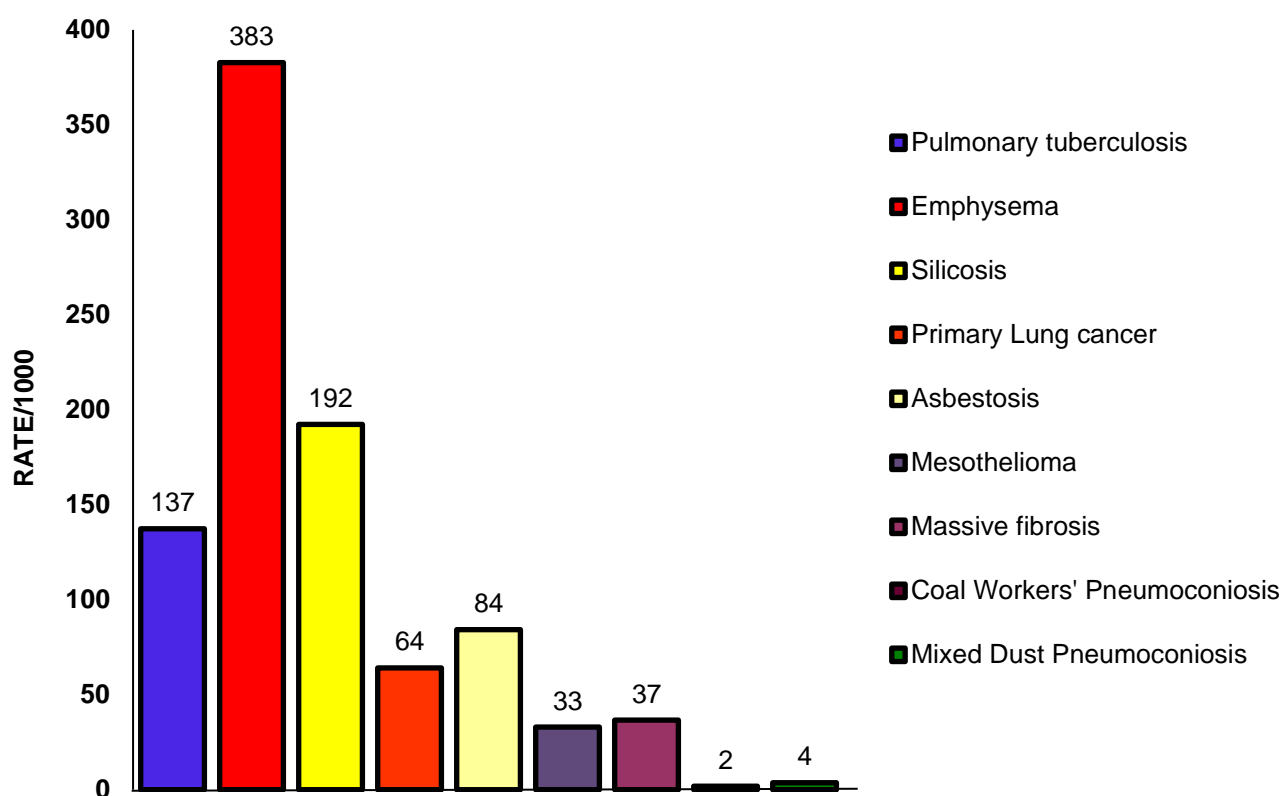


FIG. 1 OVERALL DISEASE RATES FOR 2021

The overall rate of pulmonary tuberculosis (PTB) decreased, from 153/1000 in 2020 to 137/1000 in 2021. The rate of PTB in black gold and platinum miners decreased from 228/1000 in 2020 to 204/1000 in 2021 and from 206/1000 in 2020 to 114/1000 in 2021, respectively (Table 3-1).

The overall rate of silicosis decreased from 223/1000 in 2020 to 192/1000 in 2021. The rate of silicosis in both black and white gold miners decreased in 2021 compared to 2020 (Table 4-1).

The organs of 33 women were submitted for examination with a history of working in the gold mining industry (30.3%), in the asbestos industry (60.6%) and in platinum and manganese mining (17.2%). Seven (21.2%) had diseases related to asbestos exposure, lower than last year, 2020 (51%).

Some cases were received with incomplete exposure information. Active follow-up of cases received has improved the completeness of the information obtained. However, in 2021 information could not be obtained for the following: mine type (commodity) 7(1.3%), duration of service 43 (7.9%) and last mine worked 5 (0.9%).

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 Gauteng (28.2%), North West (27.5%) and Free State (18.3%) and Northern Cape (18.3%) provinces. No cases were received from miners outside South Africa.

TABLE 1-1 DISTRIBUTION OF AUTOPSY CASES BY PROVINCE AND POPULATION GROUP (2021)

Province	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Eastern Cape	4	1.3	3	1.2	0	-	7	1.3
Free State	61	20.1	38	15.8	1	50.0	100	18.3
Gauteng	48	15.8	106	44.0	0	-	154	28.2
Kwazulu-Natal	0	-	7	2.9	0	-	7	1.3
Limpopo	3	1.0	4	1.7	0	-	7	1.3
Mpumalanga	3	1.0	13	5.4	0	-	16	2.9
North West	93	30.7	57	23.7	0	-	150	27.5
Northern Cape	91	30.0	8	3.3	1	50.0	100	18.3
Western Cape	0	-	5	2.1	0	-	5	0.9
Total	303		241		2		546	

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, undertakers and occupational and environmental health university students, however due to COVID pandemic in 2021 similar to the previous year (2020), there were no physical outreach activities, follow-ups on missing case information was done through telephonic communication (Appendix 2).

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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
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
Massive fibrosis	Lung fibrosis caused by exposure to dust and measuring more than 1 cm 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
Standard deviation	Standard deviation (SD) is an indication of how widely scattered the data is in relation to the mean.
Surveillance	The ongoing and systematic collection, analysis, interpretation and dissemination of information related to adverse health outcomes for action

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 2021. This report along with previous reports can be accessed at <https://www.nioh.ac.za/pathology-disease-surveillance-reports/>

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
(1975-2021)**

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
2018	446	58	321	41	6	0.7			2	0.3	775
2019	445	59	307	40	5	0.7			2	0.3	759
2020	304	55	251	45	2	0.3					557
2021	303	55	241	44	2	0.4					546
Total	75 990	66	37 330	32	1 650	1	5		361		115 339

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 93,998 in 2021 (Minerals Council South Africa, <https://www.mineralscouncil.org.za/industry-news/publications/facts-and-figures>).

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 2021. The vast majority (97.4%) of autopsy examinations were performed on the cardio-respiratory organs only.

TABLE 2-2 NUMBER AND PROPORTION OF AUTOPSIES BY TYPE AND POPULATION GROUP (2021)

Autopsy type	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Cardio-respiratory organs only	303	100	227	94.2	2	100	532	97.4
Full autopsy	0	-	14	5.8	0	-	14	2.6
Total	303		241		2		546	

The age distribution of cases for 2021 is shown in Table 2-3 and presented graphically in Figure 2-1. The mean age at autopsy of black men was 55.2 years in 2021, similar to that in 2020 (54.9 years). The mean age of white men at autopsy was 69.4 years in 2021, also similar to that of the previous year (69.9 years).

TABLE 2-3 NUMBER AND PROPORTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2021)

Age group (years)	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
20-29	3	1.0	0	-	0	-	3	0.5
30-39	51	16.8	1	0.4	0	-	52	9.5
40-49	59	19.5	13	5.4	0	-	72	13.2
50-59	82	27.1	30	12.4	1	50.0	113	20.7
60-69	54	17.8	74	30.7	1	50.0	129	23.6
70-79	38	12.5	72	29.9	0	-	110	20.1
80+	16	5.3	51	21.2	0	-	67	12.3
Total	303		241		2		546	

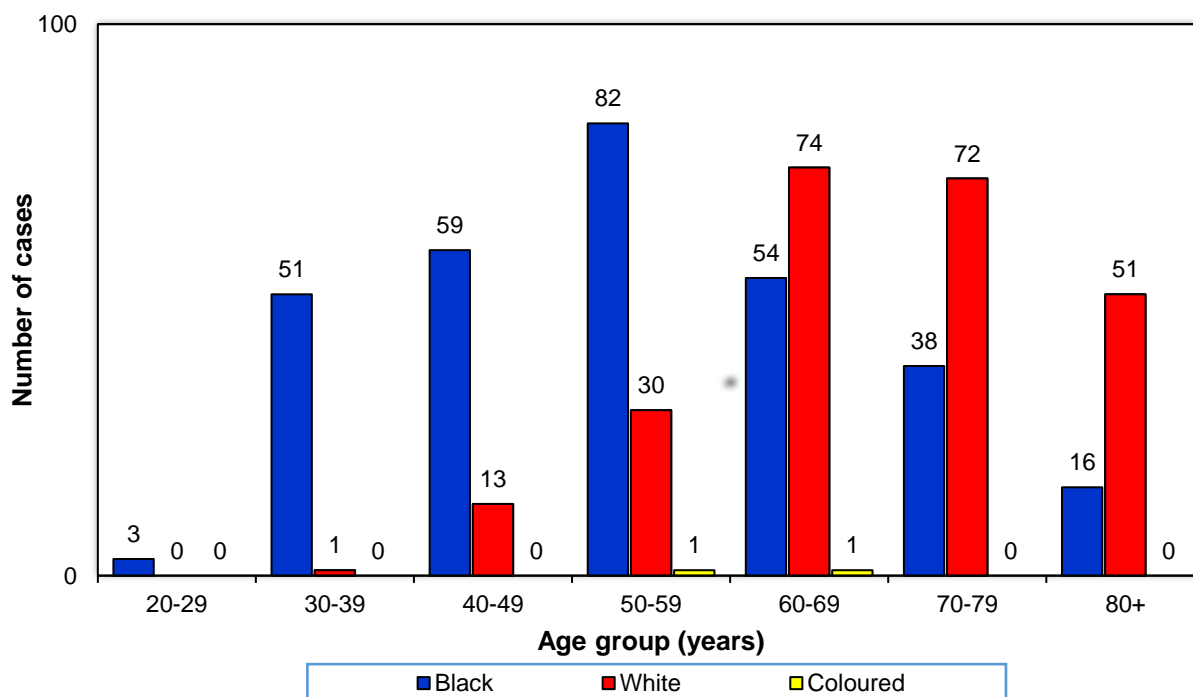


FIG 2-1 DISTRIBUTION OF AUTOPSIES BY AGE AND POPULATION GROUP (2021)

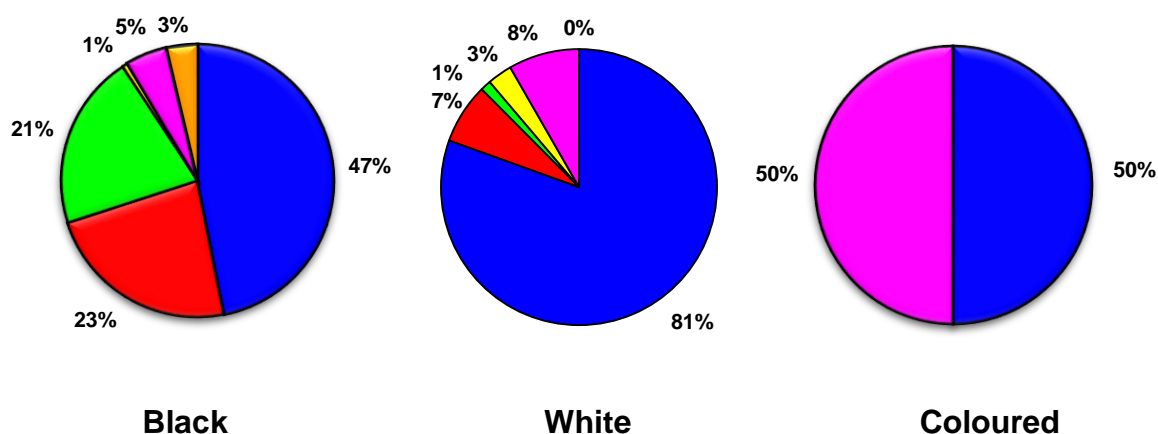
There are men who worked in a number of different mining commodities during their lifetimes and had “mixed” exposures. This was not taken into account in the analysis of exposure type (commodity). Cases were placed in categories according to the commodity in which they had worked for the longest duration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

Table 2-4 and Figure 2-2 show the distributions of autopsies by commodity and population group for 2021. The majority of autopsies (61.7%) were on men from the gold mining industry, which is similar to 2020 (60.1%). The proportion of autopsies from the platinum mining industry increased over the years, from 8.3% in 1999 to 23.1% in 2017, and is now 15.9% in 2021.

TABLE 2-4 NUMBER AND PROPORTION OF AUTOPSIES BY COMMODITY AND POPULATION GROUP (2021)

Commodity	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Gold	142	46.9	194	80.5	1	50.0	337	61.7
Platinum	70	23.1	17	7.1	0	-	87	15.9
Coal	2	0.7	7	2.9	0	-	9	1.6
Asbestos	63	20.8	3	1.2	0	-	66	12.1
Iscor	2	0.7	1	0.4	0	-	3	0.5
Copper	1	0.3	1	0.4	1	50.0	3	0.5
Manganese	11	3.6	0	0.0	0	-	11	2.0
Industry	0	0.0	2	0.8	0	-	2	0.4
Other*	6	2.0	9	3.7	0	-	15	2.7
Unknown	6	2.0	7	2.9	0	-	13	2.4
Total	303		241		2		546	

* Diamond, environmental asbestos, fluorspar, industry, iron, lead, lime, minerals, phosphate, and work



■ Gold ■ Coal ■ Platinum ■ Manganese ■ Asbestos ■ Other*

*Includes copper, diamond, environmental asbestos, fluorspar, industry, iron, lead, lime, minerals, phosphate, and works as well as cases where service histories could not be obtained

FIG 2-2 DISTRIBUTION OF AUTOPSIES BY COMMODITY AND POPULATION (2021)

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 2021, the duration of service was obtained for all but 7.9% (n=43) of cases.

TABLE 2-5 NUMBER AND PROPORTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2021)

Years of service	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
<1	14	4.6	1	0.4	0	-	15	2.7
1-5	54	17.8	19	7.9	0	-	73	13.4
6-10	37	12.2	20	8.3	0	-	57	10.4
11-15	58	19.1	26	10.8	1	50.0	85	15.6
16-20	39	12.9	34	14.1	0	-	73	13.4
21-25	26	8.6	35	14.5	0	-	61	11.2
26-30	23	7.6	35	14.5	0	-	58	10.6
31-35	17	5.6	37	15.4	1	50.0	55	10.1
36-40	8	2.6	13	5.4	0	-	21	3.8
41+	1	0.3	4	1.7	0	-	5	0.9
Unknown	26	8.6	17	7.1	0	-	43	7.9
Total	303		241		2		546	

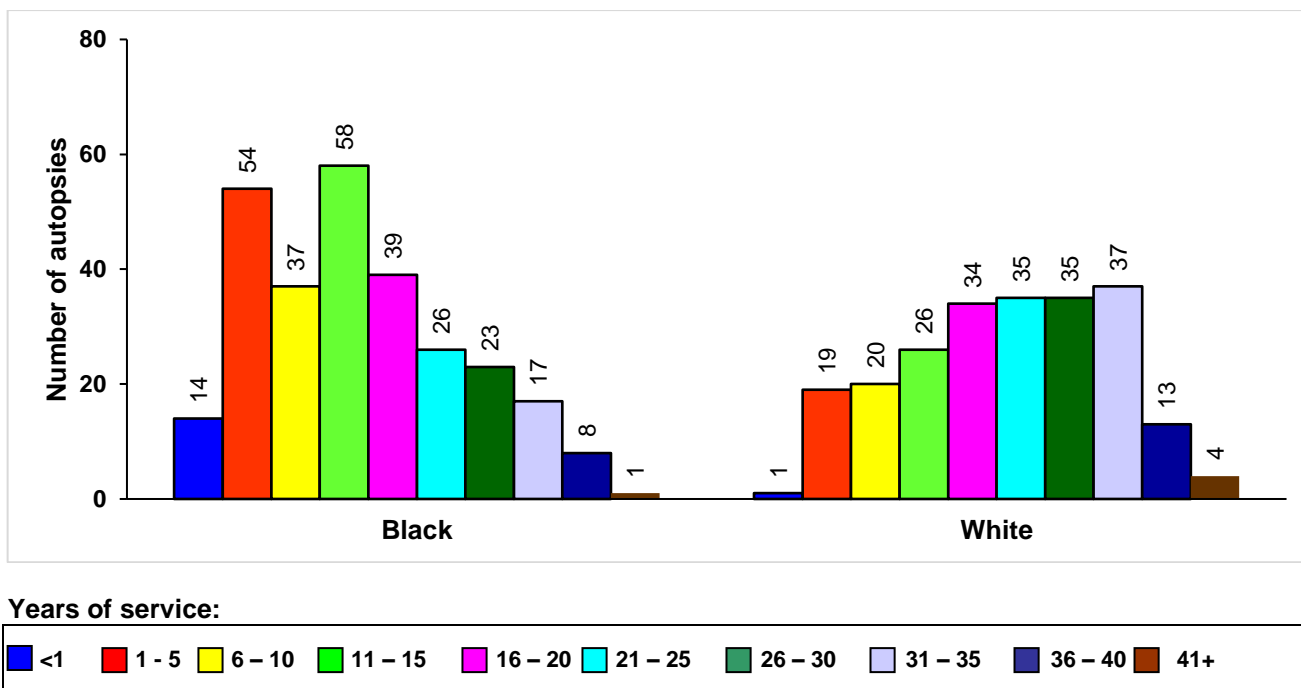


FIG 2-3 DISTRIBUTION OF AUTOPSIES BY YEARS OF SERVICE AND POPULATION GROUP (2021)

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 (2021)

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	142	49	11	194	70	11
Platinum	70	51	12	17	66	15
Coal	2	48	20	7	70	12
Asbestos	63	73	10	3	75	11
Iscor	2	76	1	1	70	-
Copper	1	62	-	1	66	-
Manganese	11	63	12	0	0	-
Industry	0	0	-	2	61	1
Other	6	57	12	9	65	14
Unknown	6	49	14	7	71	13
Total	303	55	15	241	69	11

* Standard deviation: A small SD compared to the mean value shows that the majority of data are found close to the mean, and a large, SD indicates data are more dispersed.

TABLE 2-7 MEAN DURATION OF SERVICE BY COMMODITY AND POPULATION GROUP (2021)

Commodity	Black			White		
	N	Mean (Years)	SD*	N	Mean (Years)	SD*
Gold	142	19	9	191	23	10
Platinum	50	16	10	14	17	11
Coal	2	26	21	6	28	6
Asbestos	63	6	6	3	3	3
Iscor	2	20	0	0	-	-
Copper	1	-	-	1	25	-
Manganese	11	15	2	0	-	-
Industry	0	0	-	2	27	26
Other	6	22	14	7	16	11
Total	277	15	10	224	22	10

*Standard deviation: A small SD compared to the mean value shows that the majority of data are found close to the mean, and a large, SD indicates data are more dispersed.

SECTION 3 – ACTIVE TUBERCULOSIS

The distribution of active tuberculosis (TB) by anatomical site is presented in Figure 3-1 (n=141). Active pulmonary TB (PTB) was diagnosed in 13.7% (n=75) of all autopsies in 2021, compared to 15.3% (n=85) in 2020. Most of the men with PTB were black (n=47; 62.3%), 27 (36.0%) were white and one miner was coloured (1.3%).

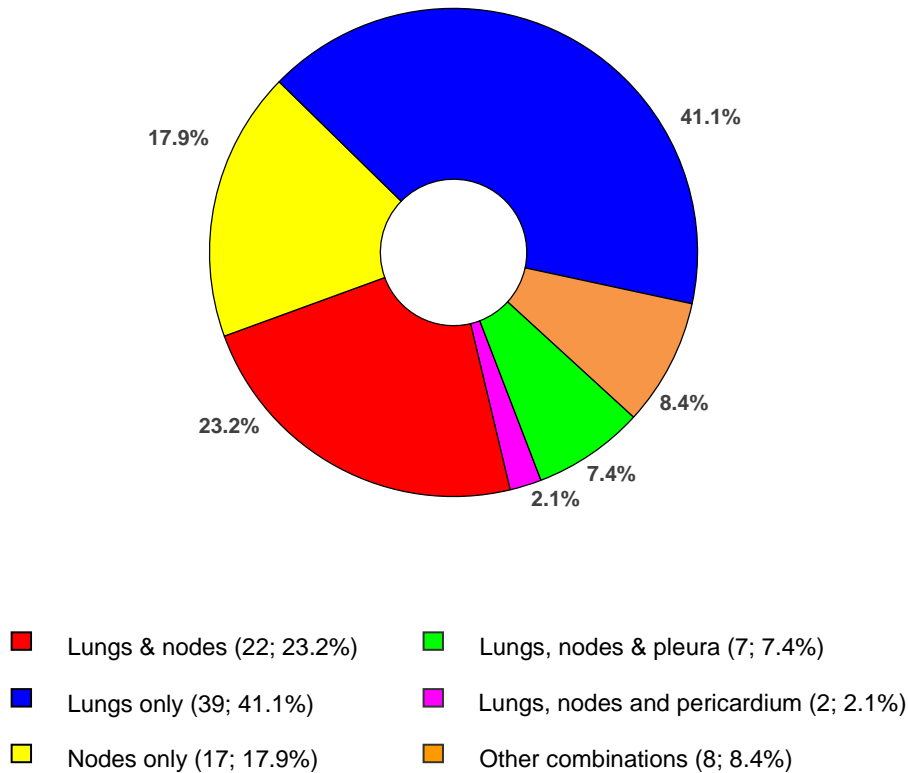


FIG 3-1 DISTRIBUTION OF ACTIVE TB BY SITE (2021)

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

In 2021, the overall PTB rate was 137/1000. In black miners, the rate of PTB has declined in 2021 to 155/1000 from 181/1000 in 2020, the lowest rate since 1997 (Fig 3-2). The rate in white miners was lower than that in black miners, 112/1000 (2021), and declined compared to the rate in 2020 (120/1000).

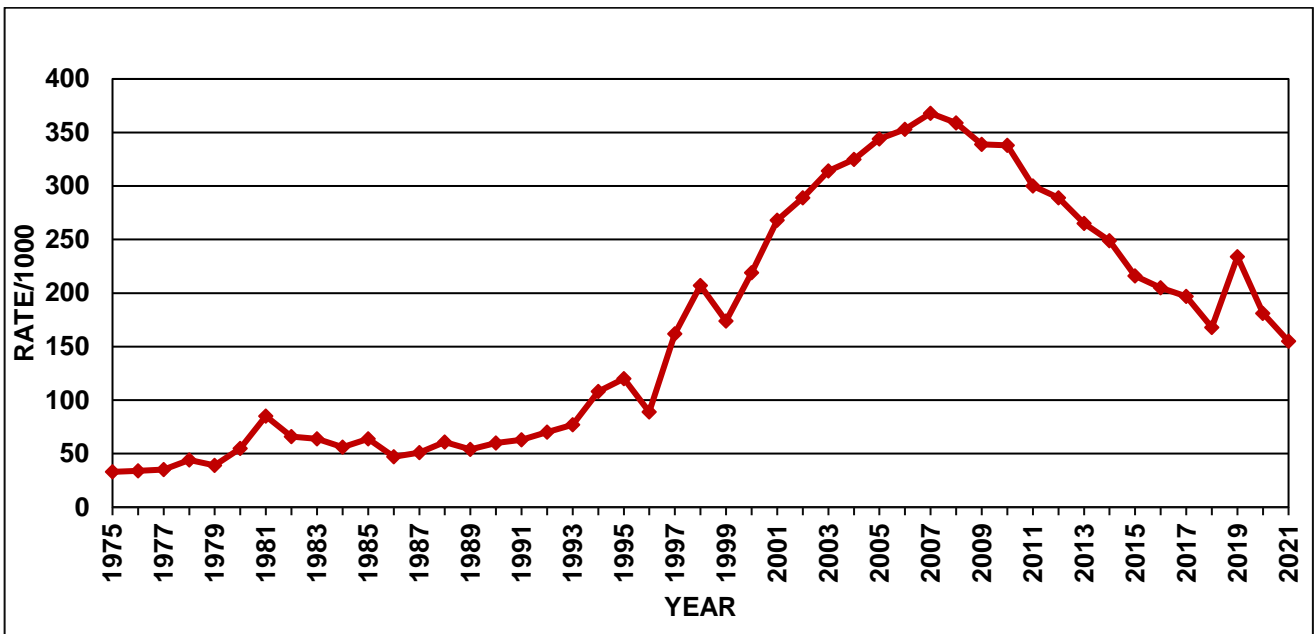


FIG 3-2 ACTIVE PTB RATES IN BLACK MINERS AT AUTOPSY (1975-2021)

The distribution of active PTB cases by commodity is shown in Table 3-1. Most cases of active PTB (73.3%) were from gold (61.2% of all autopsy cases came from that commodity) followed by platinum (10.7% of cases) mining industries.

TABLE 3-1 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY COMMODITY AND POPULATION GROUP (2021)

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	29	204	25	129	1	-	55	163
Platinum	8	114	0	-	0	-	8	92
Coal	0	-	2	-	0	-	2	-
Asbestos	6	95	0	-	0	-	6	91
Copper	1	-	0	-	0	-	1	-
Iscor	1	-	0	-	0	-	1	-
Other	1	-	0	-	0	-	1	-
Unknown	1	-	0	-	0	-	1	-
Total	47	155	27	112	1	-	75	137

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=21; 28.0%) were in the age group 50-59 years, followed by those in the 60-69 years age group (n=16; 21.3%). The highest rate was seen in black miners aged 40-49.

TABLE 3-2 NUMBER OF CASES AND PREVALENCE OF ACTIVE PTB BY AGE AND POPULATION GROUP (2021)

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
20-29	0	-	0	-	0	-	0	-
30-39	8	157	0	-	0	-	8	154
40-49	11	186	0	-	0	-	11	153
50-59	15	183	5	-	1	-	21	186
60-69	7	130	9	122	0	-	16	124
70-79	5	-	8	111	0	-	13	118
80+	1	-	5	-	0	-	6	90
Total	47	155	27	112	1	-	75	137

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

SECTION 4 – SILICOSIS

Silicotic nodules were found in the lungs of 105 cases (19.2% of all autopsies), 88.6% of which came from the gold mining industry. Of all cases with silicosis, occasional silicotic nodules were found in 44 (42%), a few in 24 (22%), a moderate number in 19 (18%) and a large number in 19 (18%) 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 (2021)

Commodity	Black		White		Total	
	N	Rate	N	Rate	N	Rate
Gold	37	261	56	289	93	276
Platinum	5	-	0	-	5	-
Coal	1	-	1	-	2	-
Asbestos	1	-	0	-	1	-
Iscor	1	-	0	-	1	-
Copper	1	-	0	-	1	-
Manganese	1	-	0	-	1	-
Unknown	0	-	1	-	1	-
Total	47	155	58	241	105	192

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. The silicosis rates in black gold miners increased from 39/1000 in 1975, peaked at 403/1000 in 2016 and is now 261/1000. The rate in white gold miners also increased since 1997 from 176/1000 to 328/1000 in 2020. However, the rate has now decreased to 289/1000 in 2021.

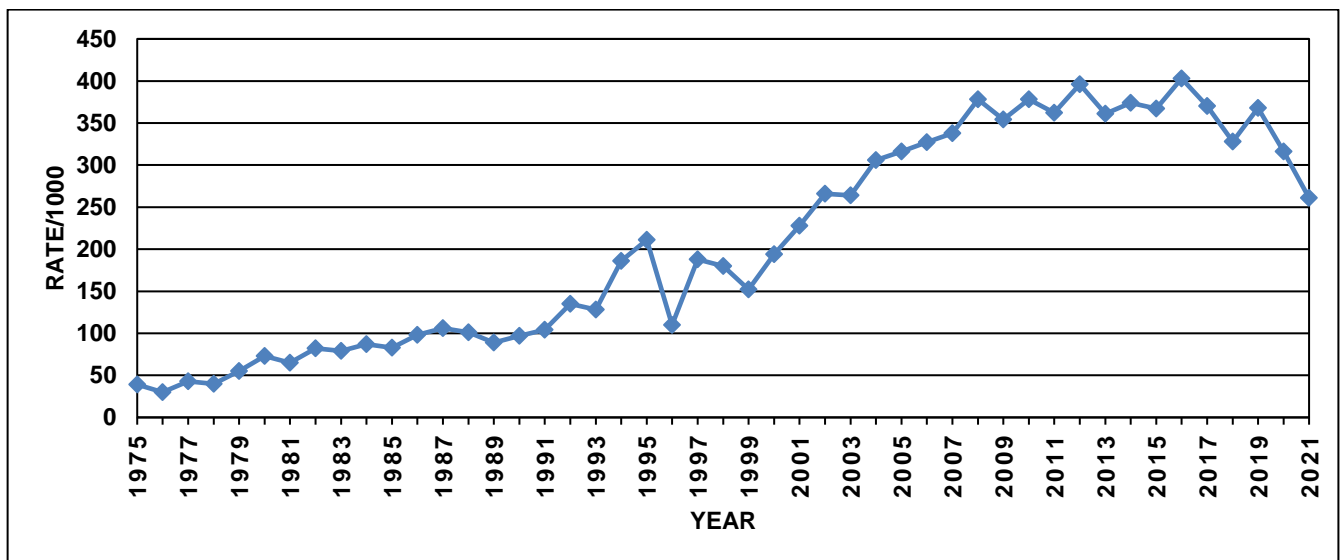


FIG 4-1 SILICOSIS IN BLACK GOLD MINERS AT AUTOPSY (1975-2021)

Silicosis in gold miners is shown in tables, 4-2 and 4-3. The rate of silicosis in all gold miners in 2021 (276/1000) is lower than that of 2020 (322/1000). The age distribution of silicosis differed between the black and white men (Table 4-2). In black men, majority of those diagnosed with silicosis were younger than 60 years old, whilst the majority of white men diagnosed with the same disease were older than 70 years old (Table 4-2). Only one case of silicosis was detected amongst those who had 1-5 years of service (Table 4-3).

TABLE 4-2 NUMBER OF CASES AND PREVALENCE OF SILICOSIS IN THE GOLD MINING INDUSTRY, BY AGE AND POPULATION GROUP (2021)

Age group (years)	Black		White		Total	
	N	Rate	N	Rate	N	Rate
40-49	4	-	0	-	4	-
50-59	22	449	9	375	31	419
60-69	7	467	10	159	17	218
70-79	4	-	19	333	23	365
80+	0	-	18	429	18	429
Total	37	261	56	289	93	276

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 (2021)

Years of service	Black		White		Total	
	N	Rate	N	Rate	N	Rate
<1	0	-	0	-	0	-
1-5	0	-	1	-	1	-
6-10	1	-	3	-	4	-
11-15	6	162	7	304	13	213
16-20	4	-	5	-	9	161
21-25	12	545	12	400	24	462
26-30	4	-	8	267	12	279
31-35	7	500	17	472	24	480
36-40	3	-	2	-	5	-
Unknown	0	-	1	-	1	-
Total	37	261	56	289	93	276

Note: rates have not been calculated where there are fewer than 6 cases; cases with low years of service may have incomplete work histories

SECTION 5 – OTHER PNEUMOCONIOSES

MASSIVE FIBROSIS

There were 20 (3.7%) cases of massive fibrosis: twelve in black and eight in white miners. Sixteen were from the gold mining industry, one from the asbestos mining industry, one from coal mining, one from the platinum mining industry and one with unknown exposure.

Note: There was a change in the definition of massive fibrosis from lung fibrosis measuring 2 cm and more to lung fibrosis measuring 1 cm and more in 2019. The reason for the change was to align the pathology diagnosis with the International Labour Organisation (ILO) radiological measurements.

COAL WORKERS' PNEUMOCONIOSIS

There was one case of coal workers' pneumoconiosis in cases examined in 2021.

MIXED DUST PNEUMOCONIOSIS

There were two (0.4%) cases of mixed dust pneumoconiosis in cases examined in 2021. The two cases were from the platinum and manganese mining industries.

ASBESTOSIS AND PLEURAL PLAQUES

There were 46 cases of asbestosis. Of these, 28.3% (n=13) had slight, 43.5% (n=21) had moderate and 26.1% (n=12) had marked fibrosis. Thirty-nine (84.8%) had worked in the asbestos mining industry and 1 (2.2%) had environmental asbestos exposure at some time in their lives.

There were 15 cases with asbestos plaques and of these 11 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 (2021)

Age group (years)	Black		White		Total	
	N	Rate	N	Rate	N	Rate
50-59	2	-	0	-	2	-
60-69	15	278	1	-	16	124
70-79	17	447	2	-	19	173
80+	9	563	0	-	9	134
Total	43	142	3	-	46	84

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

SECTION 6 – EMPHYSEMA

There were 209 cases of emphysema, the extent of which was mild in 83.3% (n=174), moderate in 15.8% (n=33) and marked in 1.0% (n=2) cases. The overall rate of emphysema remained constant at 382/1000 in 2020 and 383/1000 in 2021. The distribution of emphysema by age and population group is presented in Table 6-1. Emphysema rates increased with age group with highest rates seen in black miners aged 60 to 80+ and 70 to 80+ in white miners.

TABLE 6-1 NUMBER OF CASES AND PREVALENCE OF EMPHYSEMA BY AGE AND POPULATION GROUP (2021)

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
20-29	0	-	0	-	0	-	0	-
30-39	6	118	0	-	0	-	6	115
40-49	10	169	2	-	0	-	12	167
50-59	17	207	11	367	1	-	29	257
60-69	26	481	37	500	0	-	63	488
70-79	15	395	44	611	0	-	59	536
80+	7	438	33	647	0	-	40	597
Total	81	267	127	527	1	-	209	383

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

Most men with emphysema were from the gold mining industry (n=136, 65.1%) (Table 6-2).

TABLE 6-2 NUMBER OF CASES AND PREVALENCE OF EMPHYSEMA BY COMMODITY AND POPULATION GROUP (2021)

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	26	183	109	562	1	-	136	404
Platinum	19	271	6	353	0	-	25	287
Coal	2	-	2	-	0	-	4	-
Asbestos	22	349	1	-	0	-	23	348
Iscor	0	-	0	-	0	-	0	-
Copper	1	-	0	-	0	-	1	-
Manganese	5	-	0	-	0	-	5	-
Industry	0	-	1	-	0	-	1	-
Other	1	-	4	-	0	-	5	-
Unknown	5	-	4	-	0	-	9	692
Total	81	267	127	527	1	-	209	383

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 (2021)

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	352	8	421	0	-	27	370
6-10	8	216	8	400	0	-	16	281
11-15	9	155	15	577	1	-	25	294
16-20	9	231	18	529	0	-	27	370
21-25	8	308	23	657	0	-	31	508
26-30	7	304	14	400	0	-	21	362
31-35	2	-	20	541	0	-	22	400
36-40	3	-	8	615	0	-	11	524
41+	1	-	3	-	0	-	4	-
Unknown	9	346	10	588	0	-	19	442
Total	81	267	127	527	1	-	209	383

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

SECTION 7 – MESOTHELIOMA

There were 18 cases of mesothelioma in 2021.

TABLE 7-1 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY AGE AND POPULATION GROUP (2021)

Age group (years)	Black		White		Total	
	N	%	N	%	N	%
30-39	1	6.3	0	-	1	5.6
40-49	0	-	0	-	0	-
50-59	7	43.8	0	-	7	38.9
60-69	5	31.3	1	50.0	6	33.3
70-79	3	18.8	1	50.0	4	22.2
Total	16		2		18	

The distribution of mesothelioma by commodity and population group is presented in Table 7-2. Fourteen (77.8%) of the cases had worked in asbestos mines at some stage in their careers. Eight of the cases had the longest service in asbestos (most exposure) and seven had mixed exposures that included asbestos.

TABLE 7-2 NUMBER AND PERCENTAGE OF MESOTHELIOMA CASES BY COMMODITY AND POPULATION GROUP (2021)

Commodity	Black		White		Total	
	N	%	N	%	N	%
Asbestos	8	50.0	0	-	8	44.4
Platinum	4	25.0	0	-	4	22.2
Manganese	1	6.3	0	-	1	5.6
Other	2	12.5	2	100.0	4	22.2
Unknown	1	6.3	0	-	1	5.6
Total	16		2		18	

SECTION 8 – PRIMARY LUNG CANCER

Thirty-five cases of primary lung cancer were found at autopsy, 37.1% (n=13) of which were in black miners, 60.0% (n=21) were white miners and 2.9% (n=1) were coloured miners. Most of the cases were squamous cell carcinoma (n=18; 51.4%), followed by those with adenocarcinoma (n=10; 28.6%), large cell carcinoma (n=4; 11.4%) and small cell carcinoma (n=3; 8.6%).

The distribution of primary lung cancer by age and population group is presented in Table 8-1. The highest rate was seen in miners aged 70-79 (109).

TABLE 8-1 NUMBER AND PROPORTION OF PRIMARY LUNG CANCER CASES BY AGE AND POPULATION GROUP (2021)

Age group (years)	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
40-49	0	-	1	-	0	-	1	-
50-59	4	-	0	-	0	-	4	-
60-69	4	-	8	108	1	-	13	101
70-79	5	-	7	97	0	-	12	109
80+	0	-	5	-	0	-	5	-
Unknown	0	-	0	-	0	-	0	-
Total	13	43	21	87	1		35	64

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).

TABLE 8-2 NUMBER AND PROPORTION OF PRIMARY LUNG CANCER CASES BY COMMODITY AND POPULATION GROUP (2021)

Commodity	Black		White		Coloured		Total	
	N	Rate	N	Rate	N	Rate	N	Rate
Gold	3	-	18	93	0	-	21	62
Platinum	2	-	0	-	0	-	2	-
Asbestos	5	-	0	-	0	-	5	-
Copper	1	-	1	-	1	-	3	-
Manganese	2	-	0	-	0	-	2	-
Unknown	0	-	2	-	0	-	2	-
Total	13	43	21	87	1		35	64

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

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 (15.0%). The proportion of unnatural deaths (12.6%) was higher than that in 2020 (8.8%). The clinical cause of death was not stated for 2.4 % of the cases, an improvement in comparison to the previous year, 2020 (8.1%).

TABLE 9-1 CLINICAL CAUSE OF DEATH BY POPULATION GROUP (2021)

Commodity	Black		White		Coloured		Total	
	N	%	N	%	N	%	N	%
Respiratory	20	6.6	62	25.7	0	-	82	15.0
Cardio-vascular	4	1.3	21	8.7	0	-	25	4.6
Central Nervous System	3	1.0	10	4.1	0	-	13	2.4
Gastro-intestinal	0	-	8	3.3	0	-	8	1.5
Genito-urinary	0	-	1	0.4	0	-	1	0.2
Haematological system	1	0.3	0	-	0	-	1	0.2
Unnatural	60	19.8	9	3.7	0	-	69	12.6
Miscellaneous	207	68.3	125	51.9	2	100.0	334	61.2
Not stated	8	2.6	5	2.1	0	-	13	2.4
Total	303		241		2		546	

*Data for the metabolic system included in the hematological system, miscellaneous includes those deaths coded as natural causes

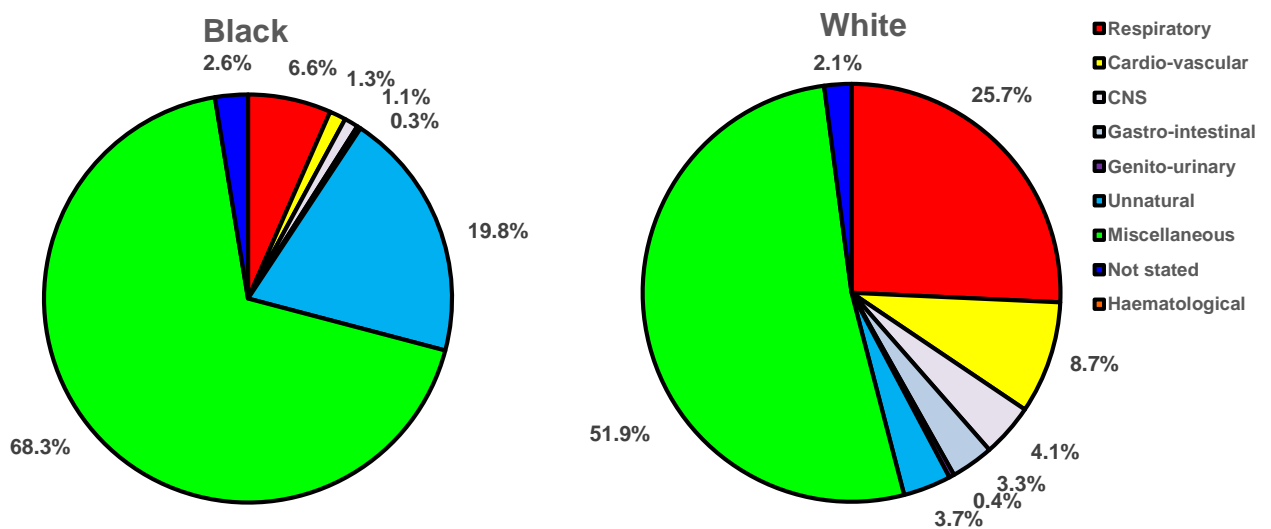


FIG 9-1 CLINICAL CAUSES OF DEATH (2021)

SECTION 10 – AUTOPSY FINDINGS IN WOMEN

Of the 546 cases examined in 2021, 33 (5.2%) were women compared to 29 (5.2%) in 2020, 26 (3.4%) in 2019 and 40 (5.2%) in 2018. All the female autopsies that were done in 2021 were on black females. On average, the women were similar ages to the men (60.1 years and 61.6 years, respectively); a change from the previous year's (2020) observation (women = 69.1 years and men = 61.3 years).

TABLE 10-1 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY AGE AND POPULATION GROUP (2021)

Age group (years)	Black		Total	
	N	%	N	%
30-39	7	21.2	7	21.2
40-49	4	12.1	4	12.1
50-59	2	6.1	2	6.1
60-69	10	30.3	10	30.3
70-79	6	18.2	4	18.2
80+	4	12.1	6	12.1
Total	33		33	

Table 10-2 summarises the distribution of autopsies in women by commodity and population group.

TABLE 10-2 NUMBER AND PROPORTION OF AUTOPSIES IN WOMEN BY COMMODITY AND POPULATION GROUP (2021)

Commodity	Black		Total	
	N	%	N	%
Gold	10	30.3	10	30.3
Asbestos	20	60.6	20	60.6
Platinum	2	6.1	2	6.1
Manganese	1	3.0	1	3.0
Total	33		33	

Six women had pulmonary TB, six had emphysema and seven had asbestos-related diseases: four had asbestosis and three had mesothelioma (Table 10-3).

TABLE 10-3 NUMBER AND PROPORTION OF DISEASES IN WOMEN (2021)

Disease	N	%
PTB	6	18.2
Silicosis	0	0.0
Emphysema	6	18.2
Asbestosis	4	12.1
Mesothelioma	3	9.1
Primary Lung Cancer	1	3.0
No lung disease	13	39.4
Total	33	

APPENDIX 1: DISTRIBUTION OF AUTOPSIES ACCORDING TO THE LAST MINE WHERE THE DECEASED WORKED (2021)

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Asbestos	Asbestos Mine	1				1
	Cape Blue	10	1			11
	Daniel Skuil Asb Mine		1			1
	Gefco	40	1			41
	Pomfret Asb Mine	1				1
	Wandrag Asbestos Mine	1				1
Total from asbestos		53	3	0	0	56
Iron	Iron Ore Mine	1				1
	Sishen Iron Mine	1	2			3
Steel and Iron	Iskor	2	1			3
Total from iron and steel and iron		4	3	0	0	7
Coal	Goedehoop Colliery		1			1
	Greenside Colliery		1			1
	Grootgeluk	1				1
	Khutala Colliery		1			1
	Kleinkopje Colliery		1			1
	Koornfontein Coal		1			1
	Matla Coal		1			1
	Middelburg Colliery		1			1
	New Denmark		1			1
	Sasol Coal Mine	1				1
	Springlake Colliery		1			1
Total from coal		2	9	0	0	11
Copper	O`Kiep Copper		1	1		2
Total from copper		0	1	1		2
Diamond	De Beers Consolidated		2			2
	Diamond Mine	1	2			3
	Finch Diamond Mine		1			1
Total from diamond		1	5			6
Gold	Anglogold Ashanti GM	9	10			19
	Bambanani GM		1			1
	Barberton GM		1			1
	Beatrix Gold	34	10			44

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Gold (contd)	Blyvoorquzicht		8	0		8
	Buffelsfontein Gold		4			4
	Driefontein Cons GM	9	7	0		16
	Durban Roodepoort Deep		2			2
	East Driefontein		4			4
	East Rand Prop	1	4			5
	Elandsrand		1			1
	Evander GM	3				3
	Ezulwini Gold Mine	1	2			3
	Free State Geduld		9			9
	Free State Saaiplaas	1	2			3
	Gencor	11				11
	Goldfields		1			1
	Gold mine	2	1			3
	Grootvlei Prop		1			1
	Harmony	31	18	1		50
	Hartebeesfontein	1	4			5
	J.I.C Gold Mine		1			1
	Kloof	19	13			32
	Kopanang Gold Mine	1				1
	Libanon		3			3
	Lorraine		4			4
	Moab Khotsong GM	1				1
	Pamodzi Mine	1				1
	President Brand		3			3
	President Steyn		2			2
	Randfontein		7			7
	Rand Uranium Gold Mine		1			1
	Simmer & Jack GM	3	1			4
	South Deep GM		7			7
	St Helena		1			1
	Stilfontein		2			2
	Vaal Reefs	6	14			20
	West Driefontein	1	5			6
	West Rand Consolidation	1	1			2
	Western Acres		3			3

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Gold (contd)	Western Deep Levels	9	7			16
	Western Holdings		5			5
	Winkelhaak		1			1
Total from gold		145	171	1	0	317
Fluorspar	Vergenoeg Mining	1				1
Lead	Blackmountain		1			1
Lime	Lime Acres		1			1
Manganese	Associated Manganese	3				3
	Black Rock Asb Mine	1				1
	Hotazel Manganese Mine	3				3
	Manganese Mine	1				1
	S A Manganese	2				2
Total from fluorspar, lead, lime and manganese		11	2	0	0	13
Platinum	Amadelbult Platinum (Rustenburg)		2			2
	Anglo American Platinum	1				1
	Bafokeng	4	2			6
	Eastern Platinum Mine	16				16
	Impala Platinum	24	7			31
	Karee Platinum	17				17
	Kroondal Mine, Rustenburg	1				1
	Kuruman	2				2
	Lebowa Platinum Mine		1			1
	Lonmin Platinum		2			2
	Northam Platinum		4			4
	Rustenburg Platinum		9			9
	Western Platinum	10	2			12
	Unknown Platinum	7	3			10
Total from platinum		82	32	0	0	114
Shaft sinkers	Shaft sinkers	1	2			3
Refinery	Impala Platinum Refinery		1			1
Quarry	Quarry Mine		1			1
Total for shaft sinkers, refinery & quarry		1	4	0	0	5

Commodity	Last mine worked	Black	White	Coloured	Unknown	Total
Non-miner	Chamber of Mines		1			1
	Environmental		1			1
	Industry		2			2
	Non-miner		1			1
Total for non-miners		0	5	0	0	5
Unknown	Unknown	4	6			10
Total for Unknown		4	10		0	10
TOTAL		303	241	2	0	546

APPENDIX 2: PUBLICATIONS AND ACTIVITIES EMANATING FROM PATHAUT DATA OR AUTOPSY SERVICE (2021)

Congresses

Kgokong N, Gildenhuis A. A Surveillance Overview On Occupational Lung Diseases Data for South African Miners at Autopsy. PathRed Congress. Virtual, 19-22 August 2021. (Poster presentation)

Degrees

Manenzhe, Radzilani, MSc (ongoing), School of Pathology, Anatomical Pathology, University of Witwatersrand, The value of minimally invasive tissue sampling in the diagnosis of occupational lung disease in deceased South African Miners.

Mthombeni, Julian, PhD (ongoing), School of Public Health, University of Witwatersrand, Quantification and mapping of manganese deposition and associated histopathological correlates in the lungs of deceased South African miners.

Outreach Programme Activities

There were no meetings or outreach activities in 2021 due to COVID-19 disruptions.

Publications (2020 Continued)

Mhlongo, L.N., Wilson, K.S., Ngcobo, Z.B., Fassom, D., Murray, J. and Lakhoo, D.G., 2023. Occupational lung diseases in South African miners at autopsy: 2020 surveillance report. *Occupational Health Southern Africa*, 29(1), pp.31-35*

*Note: Article published post the 2020 PATHAUT Surveillance Report dissemination.