



Access of migrant gold miners to compensation for occupational lung disease: Quantifying a legacy of injustice

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ABSTRACT

Background: A legacy of the South African gold mining industry, now in decline, is a large burden of silicosis and tuberculosis among former migrant miners from rural South Africa and surrounding countries, particularly Lesotho and Mozambique. This neglected population faces significant barriers in filing claims for compensation for occupational lung disease. The objective of the study was to gain insight into the extent of such barriers, particularly for former miners and cross-border migrants.

Methods: The database of a large gold mining company and the statutory compensation authority were analyzed for the period 1973–2018 by country of origin, age, and employment status at the time of claim filing. Proportions and odds ratios (ORs) for each of the compensable diseases were calculated by the above variables. Processing delays of claims were also calculated.

Results: Annual company employment declined from 240,718 in 1989 to 43,024 in 2018 and the proportion of cross-border migrants within the workforce from 51.0 to 28.1%. The compensation database contained 68,612 claims. The majority of compensable claims in all diagnostic categories were from active miners. The odds of cross-border miners relative to South African miners filing a claim depended on employment status. For example, the OR for Lesotho miners filing while in active employment was 1.86 (95% CI 1.81, 1.91), falling to 0.94 (95% CI 0.91, 0.98) among former miners. The equivalent findings for Mozambiquan miners were 0.95 (95% CI 0.91, 1.00), falling to 0.44 (95% CI 0.41, 0.47). Median processing delays over the whole period were from 1.1 years from filing to adjudication, and 3.8 years from filing to payment.

Conclusions: The findings provide a quantitative view of differential access to occupational lung disease compensation, including long processing delays, among groups of migrant miners from the South African gold mines. There is a deficit of compensable claims for silicosis and silico-tuberculosis among former miners irrespective of country of origin. While cross-border miner groups appear to file more claims while active, this is reversed once they leave employment. Current large-scale efforts to provide medical examinations and compensation justice to this migrant miner population need political and public support and scrutiny of progress.

Introduction

For over 120 years, labor practices in South African gold mines have been largely based on recruiting workers from rural areas of South Africa and neighboring countries (Katz, 1994; Harington et al., 2004; Ehrlich et al., 2017). This system was aided by coercive colonial policies and legislation that restricted access to land and forced rural African men into migrant labor (Katz, 1994; Coovadia et al., 2009). Fig. 1 illustrates the districts of recruitment of novices (first-time miners) from across the subcontinent, including migrant workers from within South Africa, to the gold mines between 1973 and 2012.

During this period at least 1.2 million miners, mostly migrant black men, passed through the industry (Ehrlich et al., 2017). Intense exposure to silica dust placed them at risk of silicosis, which by the end of the 20th Century had reached a prevalence of 19% in long service active goldminers (Churchyard et al., 2004). The prevalence is even higher - between 25% and 47% - in former goldminers (Steen et al., 1997; Trapido et al., 1998; Maboso et al., 2020). Pulmonary tuberculosis (TB) was extensively associated with silicosis from the beginning of the industry - and was legislated as a compensable occupational disease in miners in 1916 (Ehrlich, 2012).

Exposure to silica approximately doubles the risk of tuberculosis while the presence of radiological silicosis increases the risk four-fold

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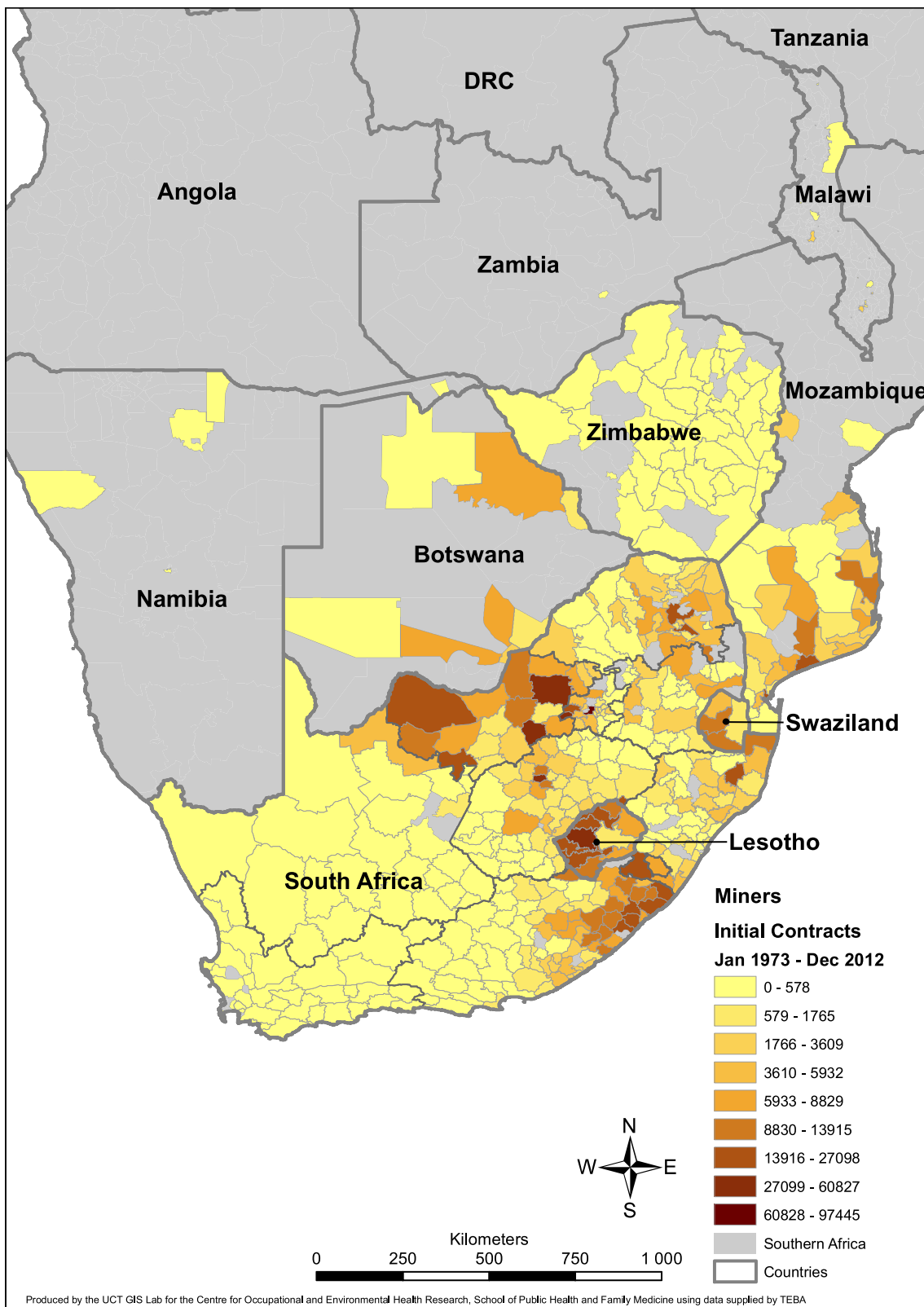


Fig. 1. (Title:) Origin of recruits to the South African mining industry at first contract, by district, 1973–2012 (Footnote:) Ehrlich et al. (2017).

(Ehrlich et al., 2021). Occupational exposure and transmission of tuberculosis in the congregate settings of transport, accommodation and underground work established a cycle of transmission of tuberculosis between the mines and home communities (Packard, 1989; Rees et al., 2010). In recent decades, HIV infection, amplified by migrancy and

single-sex compounds, further drove the spread of tuberculosis among mineworkers and their communities (Stuckler et al., 2011; Corno and de Walque, 2012; Barwise et al., 2013). At its peak in the first decade of the 21st Century, annual tuberculosis incidence in both former and working gold miners reached 3,000 per 100,000 (Churchyard et al., 2014;

Park et al., 2009), higher than any worker or general population globally.

South Africa's workers' compensation legislation for mining-related lung diseases, the Occupational Diseases in Mines and Works Act (ODMWA), 1973, has a long and contested history. From its beginning as the Miner's Phthisis Act of 1912, the system reflected the deeply racialized structure of the mining industry and the Southern African social system (Katz, 1994; McCulloch, 2012). An enduring feature was easier access of white miners to comprehensive "benefit medical examinations" during and after employment and, at death, to postmortem examination of the heart and lungs, as provided for in the legislation. In contrast, migrant black workers had to rely on accessing benefit medical examinations at recruitment stations or at the mines during service. These examinations were limited in scope, and often cursory (Marks, 2004). Although migrant miners have *de jure* rights to post employment benefit examinations and heart and lung autopsy, many migrant miners have had little chance of realizing these rights - owing to limited understanding of the benefits and processes and much reduced access to medical examinations once they have left the industry and returned to rural areas in South Africa and neighboring countries (Roberts, 2009; Smith and Blom, 2019).

While the overtly racially discriminatory elements of ODMWA were removed after the attainment of a democratic polity in South Africa in 1994, and in-service routine medical examinations for all miners were regulated to an acceptable standard (Department of Mineral Resources South Africa, 2017), the compensation system has struggled to achieve the reforms needed to meet the needs of the majority of migrant workers, most of whom live in poverty-burdened regions of South Africa and neighboring countries which are some of the poorest globally (Boyko et al., 2013; Barwise et al., 2013; Kistnasamy et al., 2018; Smith and Blom, 2019; The World Bank, 2021).

Several studies have shown barriers to access by former miners and long delays in the adjudication and payment of claims under this statutory system (Roberts, 2009; White et al., 2001; Maiphetlho and Ehrlich, 2010; Kistnasamy et al., 2018). However, comparisons of access or delay by country of origin and between active and former miners have been lacking. Such information would inform the current attempts to improve the functioning of the compensation system (Kistnasamy and Mtshali, 2017; Kistnasamy et al., 2018; Minerals Council of South Africa, 2020). An important development in recent years has been the availability of employment information from mining companies that were party to a recent civil class action settlement (Broughton, 2019; Minerals Council of South Africa, 2020). This has enabled the linking of company databases with the database of compensation claims held by the MBOD (Kistnasamy et al., 2018).

The objective of this study was to measure the extent of barriers to accessing compensation benefits for occupational lung disease among different groups of migrant gold miners. Of particular interest were country of origin and the precarious change of status from active to former gold miner.

Methods

For purposes of this analysis, the database of one of the large mining companies was used. This contains the records of gold miners employed at any stage between January 1973 and December 2018, with each record including a unique industry identifier, date of birth, country of origin, gender and service record with detailed hire and termination dates of each worker. The company database was linked with the MBOD database via a unique industry identifier.

The MBOD database includes claim outcome (certification as compensable or non-compensable), diagnosis, and the dates the claim was filed, certified and paid, as applicable.

The main compensable lung disease outcomes for gold miners in the MBOD database are tuberculosis, silicosis and combined disease (silico-tuberculosis). Claims are filed ("submitted") by the examining medical

practitioner on behalf of the miner. Tuberculosis on its own is compensable only if diagnosed after 200 work shifts of dust exposed employment or within 12 months after leaving employment. Compensation for tuberculosis covers wage replacement due to lost shifts, and separately, permanent lung impairment determined radiologically and on lung function testing. Silicosis and silico-tuberculosis are compensable whenever diagnosed and are not subject to employment period restrictions. All claims filed are adjudicated by a medical Certification Committee at the Medical Bureau for Occupational Diseases (MBOD) in Johannesburg under the diagnostic categories above or alternatively as "non-compensable disease".

Other variables of interest from the linked databases were dates of employment, country of origin, age and employment status at the time of filing, time elapsed from claim filing to certification, and time elapsed from claim filing to payment if claim successful. Employment status at filing was either that of "active", i.e., employed at the company at the time of the claim, or "former", i.e., while no longer employed at the company. Trends were examined graphically, and counts and proportions compared from tables. For relative associations, odds ratios (OR) and 95% confidence interval were calculated. For numerical variables, the difference between medians was examined using Mood's median test.

Results

The company dataset contained 344,054 unique records. Fig. 2 show the annual employment numbers at this company falling steadily in recent decades, from 240,718 in 1989 to 43,024 in 2018. The total number of former workers with a record on this database as of 2018 was 301,748. Deaths in these former miners could not be ascertained. Of those whose country of origin was known (73.4% of the total, Table 1), 59.1% were South African and 40.9% from neighboring countries. The proportion of cross-border miners in the workforce also declined over this period, from 51.0% in 1973 to 28.1% in 2018.

A total of 68,612 claims (Table 1) were filed by employees of the company during the period studied. These claims were filed by 48,602 individual miners (14.1% of total workforce), with 14,518 individuals filing multiple claims. Of the total, 43% were non-compensable and 57% compensable; the latter made up of 17% for permanent impairment due to silicosis or silico-tuberculosis, 32% for tuberculosis wage loss, and 5.5% for permanent impairment due to tuberculosis (with 1.3% other). The majority of compensable claims in each category of tuberculosis and silicosis came from active workers, overwhelmingly so for tuberculosis wage loss. Correspondingly, the majority of claims certified non-compensable came from former workers, although it was not possible to assign these certifications to specific diagnostic categories.

Table 2 sets out the distribution of claim filing and certification of compensability by national origin. Overall, miners from Lesotho had higher odds of filing a claim than did South African miners (OR 1.40) and were also substantially more likely to have their claim certified as compensable (OR 2.00). By contrast, other national groups were less likely to file a claim than South African miners. However, of these groups, miners from Mozambique and Eswatini who did file a claim had higher odds of success than South African miners - ORs 1.43 and 1.45, respectively (or if filing multiple claims, success in at least one).

Table 3 demonstrates the association between cross-border miners filing a claim and their employment status. For claims filed while active, cross-border miners were more likely to file than South African miners (OR 1.45). However, for claims filed by former miners this relation reversed (OR 0.78). Miners from Lesotho and Eswatini showed this pattern: ORs 1.86 and 1.05, respectively for claims filed while active, reversing among former miners to ORs 0.94 and 0.65, respectively. Miners from Mozambique started off with a slightly lower odds of filing while active (OR 0.95) which decreased substantially among former miners (OR 0.44). Only miners from Botswana showed a different pattern, with

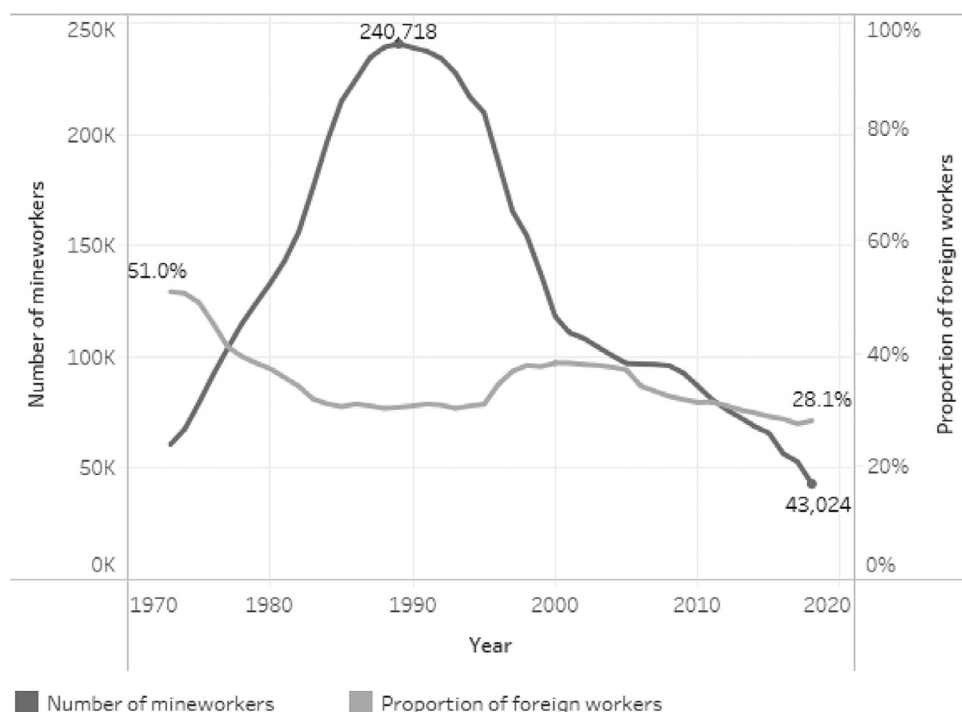


Fig. 2. Annual employment, large South African goldmining company, 1973–2018.

Table 1
Certification outcomes of claims by employment status at time of claim (N = 68,612).

Outcome ^a	Total Claims		From active workers		From former workers		Unknown employment status	
	n	% ^b	n	% ^c	n	% ^c	n	% ^c
Compensable								
Tuberculosis wage-loss	21,935	32.0	15,753	71.8	1,303	5.9	4,879	22.2
Tuberculosis- only: permanent impairment	3,803	5.5	2,032	53.4	1,240	32.6	531	14.0
Silicosis	6,434	9.4	4,002	62.2	1,475	22.9	957	14.9
Silico-tuberculosis	5,226	7.6	2,757	52.8	1,765	33.8	704	13.5
Other	1,123	1.6	262	23.3	305	27.2	556	49.5
Non-compensable								
Total	68,612	100	38,144	55.6	22,656	33.0	7,812	11.4

^a Figures are for claims not persons. Multiple claims filed by 14,518 individuals.

^b Column percentages.

^c Row percentages.

Table 2
Numbers and proportion of workforce filing a claim for occupational lung disease, by country of origin and certification outcome (N = 344,054).

Country	Workforce N (% of workforce)	Claims filed		Odds ratio ^a ever/never, ^b (95% CI)	Claims certified compensable n (% of country N)	Claims certified non-compensable n (% of country N)	Odds ratio compensable / non-compensable (95% CI) ^c
		Ever (% of country N)					
South Africa	149,136 (43.3%)	25,204 (16.9%)		Reference	16,236 (10.9%)	8,968 (6.01%)	Reference
Lesotho	62,312 (18.1%)	13,779 (22.1%)		1.40 (1.36, 1.43)	10,802 (17.3%)	2,977 (4.8%)	2.00 (1.91, 2.10)
Mozambique	26,301 (7.6%)	3,280 (12.5%)		0.70 (0.67, 0.73)	2,368 (9.0%)	912 (3.5%)	1.43 (1.32, 1.55)
Eswatini	8,233 (2.4%)	1,148 (13.9%)		0.80 (0.75, 0.85)	831 (10.1%)	317 (3.9%)	1.45 (1.27, 1.65)
Botswana	4,763 (1.4%)	664 (13.9%)		0.80 (0.73, 0.87)	364 (7.6%)	300 (6.3%)	0.67 (0.57, 0.78)
Other	1,649 (0.5%)	37 (2.2%)		0.11 (0.08, 0.16)	21 (1.3%)	16 (0.97%)	0.72 (0.38, 1.39)
Unknown	91,660 (26.6%)	4,490 (4.8%)		0.25 (0.25, 0.26)	2,739 (3.0%)	1,751 (12.8%)	0.86 (0.81, 0.92)
Total	344,054 (100%)	48,602 (14.1%)		–	33,361	15,241	–

CI, confidence interval.

^a Reference stratum South Africa.

^b Odds of an individual filing a claim versus never filing a claim.

^c Odds of an individual ever filing a compensable claim versus a non-compensable claim, or if filing multiple claims (n = 14,518 individuals), only ever filing non-compensable claim(s).

Table 3
Numbers and proportion of workforce filing a claim for occupational lung disease, by country of origin and employment status ($N = 344,054$).

Country ^a	Workforce N (% of total workforce)	Had a claim filed while active		Had a claim filed while former	
		Ever (% of country N)	Odds ratio ^a ever/never ^b (95% CI)	Ever (% of country N)	Odds ratio ^a ever/never ^b (95% CI)
South Africa	149,136 (43.3%)	13,045 (8.7%)	Reference	10,930 (7.3%)	Reference
Cross-border	103,258 (30.0%)	12,608 (12.2%)	1.45 (1.41, 1.49)	6,034 (5.8%)	0.78 (0.76, 0.81)
Lesotho	62,312 (18.1%)	9,418 (15.1%)	1.86 (1.81, 1.91)	4,324 (6.9%)	0.94 (0.91, 0.98)
Mozambique	26,301 (7.6%)	2,202 (8.4%)	0.95 (0.91, 1.00)	883 (3.4%)	0.44 (0.41, 0.47)
Eswatini	8,233 (2.4%)	755 (9.2%)	1.05 (0.98, 1.14)	400 (4.9%)	0.65 (0.58, 0.72)
Botswana	4,763 (1.4%)	219 (4.6%)	0.50 (0.44, 0.58)	405 (8.5%)	1.18 (1.06, 1.30)
Other	1,649 (0.5%)	14 (0.8%)	0.09 (0.05, 0.15)	22 (1.3%)	0.17 (0.11, 0.26)
Unknown	91,660 (26.6%)	3,114 (3.4%)	0.37 (0.35, 0.38)	1,516 (1.7%)	0.21 (0.20, 0.22)
Total	344,054 (100%)	28,767 (8.4%)	–	18,480 (5.4%)	–

CI, confidence interval.

^a As an individual miner could file a claim both while active and after leaving employment, some workers are counted in both categories.

a lower odds while active (OR 0.5), increasing to 1.18 among former miners.

There was an association of age at filing and specific diseases (not shown). Certified claims for tuberculosis (wage loss only or permanent impairment) were more likely to come from miners younger than 50 years and, those for silicosis or silico-tuberculosis more likely from miners over 50 years. Gender was recorded in only one third of employment records, of which 8978 (approx. 7.7%) were for women. Of those female miners, 625 (6.9%) filed 738 claims. A total of 449 of these were compensable, 26 for silicosis or silico-tuberculosis, 419 involving tuberculosis without silicosis, and four “others”.

The median delay between filing and certification was 413 days [IQR (interquartile range) 224 – 609] for active workers and 372 days (IQR 179 – 601) for former workers (difference 41 days; $p < 0.001$). For payment of successful claimants, the median delay from filing to payment for those who filed while active was 1 793 days (IQR 1 129 – 3 498), much higher than for former miners at 1 087 days (IQR 683 – 1 936) (difference 706 days; $p < 0.001$).

Discussion

The findings throw light on the nature and extent of barriers to accessing compensation for occupational lung disease once migrant gold miners leave service on the South Africa gold mines.

Migration and employment patterns

Analysis of the employment trajectory at this South African gold mining company showed a rapid rise in employment during the 1980s to a peak around 1990 and a decline thereafter (Fig. 2). This finding is consistent with the industry-wide pattern previously reported (Ehrlich et al., 2017) and has two important implications.

First, the recruitment of large numbers of novices in the 1980s followed by declining recruitment of novices (Ehrlich et al., 2017) would have resulted in a growing cohort of miners accumulating long service during the following decades. This is putatively the basis for the high silicosis prevalence reported in long service miners from the late 1990s onwards (Trapido et al., 1998; Churchyard et al., 2004; Park et al., 2009; Maboso et al., 2020). In conjunction with HIV, these high silicosis rates would have contributed to the extremely high incidence rates of tuberculosis recorded in the 2000s. Second, even allowing for post-service mortality in miners, estimated at 2.3% per annum over the period 2001–2013 (Bloch et al., 2018), it can be inferred that the ratio of living former miners to active miners has been rising continuously at least since 1990.

In parallel, miners from neighboring countries have been replaced by South African workers, mostly from areas of Eastern Cape and, at least by current residence if not origin, the Northwest province of South Africa (Ehrlich et al., 2017). An industry-wide study previously showed that the proportion of cross-border miners declined from 51% in the period 1973–1977 to 31% in the period 2008–2012 (Ehrlich et al., 2017),

very close to the findings in this study. Changes in political relations between South Africa and its neighbors, declining employment in competing sectors such as manufacturing, and changes in traditional mine wage policies were some of the forces underlying the turn to local South African national recruitment (Yudelman and Jeeves, 1986).

With the decline in overall employment in the gold mines and shift of employment to South African miners in recent decades, it follows that a substantial proportion of the aging ex-gold miner population is to be found in neighboring countries. With the addition of travelling and quarantine restrictions imposed by COVID-19 controls, and the presence of comorbidity risk factors for severe COVID disease among older miners, it is likely that the number of workers continuing to cross borders to work in the South African gold mines will fall even further (National Council of Provinces, 2020; Naidoo and Jeebhay, 2021).

Compensable disease and employment status at time of filing

Almost 70,000 claims were submitted under ODMWA by company employees or ex-employees between 1973 and 2019. Of these, approximately 44% were certified as non-compensable, a heterogeneous category which includes claims that failed to meet the diagnostic standards for the disease, the impairment thresholds (first or second degree,) or the qualifying period for tuberculosis; as well as claims filed by miners previously compensated at the same grade.

It is notable that former miners contributed substantially fewer claims certified as compensable for silicosis and silico-tuberculosis than active miners. Some of the compensability difference may be due to a higher success rate in claims submitted by mine medical services than in those from external medical practitioners. Claims from former miners may also contain a higher proportion of previously compensated disease and therefore be certified as non-compensable.

However, there are several reasons why higher numbers of claims from former miners than found in this study would be expected if they had equal access to filing. Although working miners are screened at regular intervals during employment, it is likely that over the period studied many miners left the industry without exit examinations (Roberts, 2009). In addition, silicosis is a long latency disease, not detectable by plain chest radiology in its early stages (Ehrlich et al., 2018), and typically appearing on the chest x-ray after 15 years of exposure (Knight et al., 2020). Silicosis can therefore be expected to appear radiologically for the first time after employment in a significant proportion of miners. Diagnosed silicosis has also been shown to progress radiologically after exposure had ended (Hessel et al., 1998).

However, perhaps the clinically most important form of progression of silicosis in South African gold miners is the co-occurrence of active tuberculosis. Silico-tuberculosis is a compensable disease in miners whenever diagnosed and a qualification for advanced impairment (“second degree”). Silicosis is a powerful risk factor for tuberculosis (Ehrlich et al., 2021). Very high rates of active tuberculosis, including recurrent tu-

berculosis, have been demonstrated in former gold miners (Hnizdo and Murray, 1998; Park et al., 2009; Maboso et al., 2020), higher than general population rates in even high TB-burden countries. These high rates were measured in both the pre-antiretroviral HIV era (Park et al., 2009) and the subsequent treatment era (Maboso et al., 2020). It is therefore likely that a substantial proportion of silico-tuberculosis in gold miners occurs after leaving the industry.

Regarding tuberculosis without radiological silicosis, given the statutory limitation of compensable tuberculosis to disease diagnosed during the period of employment or 12 months following, it follows that claims for wage loss or permanent impairment are more likely to be certified in workers under 50 years of age and while still active, as found in this study. The access barrier in this case is legislative rather than socio-geographic – in the form of the statutory 12-month post-employment limit for recognition of tuberculosis as an occupational disease in miners. Given the association with tuberculosis of silica exposure and silicosis (Ehrlich et al., 2021) and the high rates of tuberculosis cited above, the qualifying period restriction on tuberculosis compensation can be viewed as a further injustice borne by the many gold miners who are diagnosed with tuberculosis without radiological silicosis after leaving mine employment.

Cross-border vs South Africa miners and employment status

A notable finding was that the higher claim filing odds of active miners from Lesotho, the largest cross-border group, relative to active South African workers, reversed among former miners. Epidemiological surveys of Basotho former miners have found a very high prevalence of silicosis and tuberculosis (Park et al., 2009; Maboso et al., 2020). Among active gold miners in a cross-company survey carried out between 2003 and 2009, workers from Lesotho were found to have 72% increased odds of silicosis over those of South African miners (Knight et al., 2020). In multivariate analysis, this excess could be substantially explained by variation in mine of employment, years of exposure, age and skill level. The above findings taken together suggest high underlying rates of silicosis among Basotho gold miners, with significant access barriers to compensation once employment has ended.

Mozambiquan miners had slightly lower odds than South African (and Basotho) miners while active, but substantially lower odds once they had left employment. In the Knight et al. (2020) study cited above, Mozambiquan miners had a 39% lower odds of silicosis than South Africa miners after multivariate adjustment for other factors. Explanation of these phenomena are speculative as there have been no other published epidemiological studies of Mozambiquan miners and none of former miners. Relative to miners from South Africa and even Lesotho, such miners may face additional barriers to securing compensation benefits such as the (Portuguese) language barrier, which may partly explain why claims from this group have a high proportion of “deferrals” due to incomplete information (Dr. N. Mtshali, Director, MBOD – personal communication). Mozambiquan miners have also reported the experience of xenophobia while in South Africa, including in health services (Simelane and Modisha, 2008; Barwise et al., 2013), which may limit access to benefit medical examinations while still in the country.

On the institutional side, a major barrier is the lack of a specific budget under ODMWA for medical benefit examinations for former miners (Adams et al., 2013). In addition, the ODMWA provisions regarding medical practitioners’ reporting duties and the Compensation Commissioner’s powers to require practitioners to examine miners, refer only to South Africa (ODMWA, 2019). For examinations outside South Africa, special arrangements are required with individual practitioners or relevant authorities in each country.

The situation has been transformed by a number of initiatives in recent years. Since 2014, the statutory compensation agencies have benefited from administrative and financial support from South African mining industry and international agencies (Kistnasamy et al., 2018; Minerals Council of South Africa, 2020). Between 2017 and 2020, the

Global Fund financed an independent program of medical examinations for tuberculosis and silicosis of former miners in neighboring countries (TIMS 2021), although the country specific programmes are now in the challenging hand-over phase (SATBHSS: Southern Africa TB Health Systems Support Project, 2020). Finally, the TshiamisoTrust was set up as a civil trust following the settlement in 2018 of a class action suit for silicosis and tuberculosis in gold miners (Broughton, 2019; Tshiamiso Trust, 2021). However, these externally supported projects were or are time-limited and the structural budgetary weakness of the statutory authority has yet to be resolved (Balfour, 2017).

Processing delays

Besides the disparities in access to filing claims, the long delays in processing of claims once filed, summarised over the whole period 1973–2019, confirm previous reports (Murray et al., 2002; Maiphethlo and Ehrlich, 2010; Kistnasamy et al., 2018). The median delay was of the order of one year from filing to certification and three to five from filing to payment. These inordinate delays have been reduced in recent years owing to concerted efforts to resource the MBOD and Compensation Commissioner’s office (Kistnasamy and Mtshali (2017); Kistnasamy et al., 2018), but remain substantial. There was little difference in the delay from filing to certification between active and former miners. However, a surprising finding was that successful claims filed while active took, on average, two years longer for the claimant to receive payment than if filed as a former miner. This remains unexplained, especially as active miners, in theory at least, have the benefit of a mine medical service and human resources departments to follow up on these claims.

Study limitations and strengths

Observation of miners ends at exit from employment. Survival rates where thus unknowable and claims incidence rates based on person-time could not be calculated, nor could trends in such rates over time be analyzed. Similarly, an estimate of expected claim counts if there were equal access for former miners could not be made. A number of miners had multiple claims – these were treated as independent events when claim counts were compared.

Data on some variables were missing, the largest deficit being in country of origin. As it is not possible to assume that these were missing at random, some patterns might appear differently in a complete administrative dataset. Generalisability from this large mining company to others may be limited by differences in underlying disease frequency and in administrative processes to detect and report disease and ensure that compensation cases are filed and resolved (Knight et al., 2020). With regard to race-based differences, white miners, who made up approximately 5–10% of the gold workforce over the period examined (Ehrlich et al., 2017), had preferential access to benefit examinations at least until the 1990s (Ehrlich 2012; Adams et al., 2013). As complete information on racial assignment was not available from the databases analyzed, it was not possible to quantify whether or how relative access to compensation benefits by race changed over the period of this study.

The study was not able to identify miners whose service career (or at least part of it) was as a “contractor”, a heterogeneous employment category in which miners’ services are subcontracted to the mine via a labor broker, or alternatively by a subcontractor supplying specialist services to the mining company (Crush et al., 2001). A previous analysis found cross-border miners less likely to have worked as a contractor than South Africans (Ehrlich et al., 2017). The precarious employment conditions of contractors, depending on the intermediary, include under-reporting of injury and lack of access to compensation benefits. It is likely that contractors have reduced access to benefit medical examinations and the administrative support in filing compensation ODMWA claims, even while active. This is a subject which needs further examination.

A strength of the study was the large sample size. The availability of the data was the outcome of a substantial investment in recent years in an information system for compensation purposes (Kistnasamy and Mtshali, 2017; Kistnasamy et al., 2018, Minerals Council of South Africa, 2020).

Conclusion

This is the first study to our knowledge to provide comparative information on miners from South African gold mines by country of origin and to compare active miners with former miners. Although this is not a fully population-based study given the loss-to-follow-up of former miners, and may therefore be an underestimate of access barriers, our findings cast further light on the predicament of the large numbers of former gold miners who passed through employment over a forty-five-year period.

A substantial under-filing of claims by former miners is clearest for silicosis and for silicosis complicated by tuberculosis, a finding consistent with all studies of former miners that have measured compensation history. This is part of the more general phenomenon of loss to observation of migrant former miners once they leave employment and their lack of access to surveillance, medical examination and compensation for what are long latency disease processes. The difficulties of securing compensation under ODMWA affect all miners, whether active or former and whether from South Africa or neighboring countries. Using this merged database to undertake analysis by country of origin serves the additional purpose of directing attention to the plight of cross-border workers. The loss of access is particularly apparent for the largest cross-border migrant populations from Lesotho and Mozambique, although also affecting miners from Eswatini.

In conclusion, the statutory ODMWA system, the TshiamisoTrust and emergent programmes in neighboring countries face a task of unprecedented proportions in their efforts to examine former gold miners and secure compensation for those affected by occupational lung disease - thereby overturning the legacy of a century of neglect. As these projects have both health and social justice impacts, they merit political and public support as well as scrutiny of their progress.

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Ethics approval and informed consent

The study protocol was approved by the Human Research Ethics Committee, Faculty of Health Sciences, University of Cape Town (Ref: 092/2021).

This work received ethical clearance from the University of British Columbia Behavioral Ethics Review Board under certificate H18-01,793.

Declaration of Competing Interest

Prof. Ehrlich has written expert reports for plaintiff lawyers in silicosis litigation. The other authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRedit authorship contribution statement

Rodney Ehrlich: Formal analysis, Writing – original draft. **Stephen Barker:** Formal analysis. **Vivian W.L. Tsang:** Methodology, Writing –

original draft. **Barry Kistnasamy:** Conceptualization, Writing – review & editing. **Annalee Yassi:** Conceptualization, Writing – review & editing.

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