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MARTIN GUSTAFSSON
TSEKERE MAPONYA
FAITH KUMALO
MFELA MAHLANGU

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ABSTRACT

An excess deaths method used by South Africa's national authority for schools to understand mortality among publicly employed educators during the COVID-10 pandemic is explained. While pandemic-related deaths in the population were clearly under-reported in South Africa and elsewhere, an initial bottom-up reporting system for the schooling sector resulted in a slight over-reporting of these deaths, probably because schools did not separate out deaths that were likely to have occurred in the absence of the pandemic. Given the importance of understanding teacher mortality in a context of difficult negotiations around the full or partial closure of schools, a more accurate approach was sought, using payroll data, which include information on when an employee dies. It is concluded that the pandemic resulted in the deaths of around 3,500 educators. It is moreover found that the prioritisation of educators in the national vaccination programme reduced mortality for educators in the third and fourth waves of the pandemic. It is estimated that some 870 additional educator deaths would have occurred if vaccinations for educators had not been brought forward. Educator excess deaths during pandemic were clearly concentrated above age 40. The fact that educators at the secondary-level appear to have experienced similar levels of mortality to primary-level educators, despite epidemiological evidence pointing to learners in secondary schools being more likely to infect others, would be in line with the World Health Organization position that the infection of educators was not primarily by learners. A multivariate model finds that black African and coloured educators, and educators in the two provinces Eastern Cape and Northern Cape, experienced particularly high mortality rates.

Martin Gustafsson
Office of the Director-General
Department of Basic Education
Pretoria
E-mail: mgustafsson@sun.ac.za

Tsekere Maponya
Education Human Resource Planning, Provisioning and Monitoring
Department of Basic Education
Pretoria
E-mail: maponya.t@dbe.gov.za

Faith Kumalo
Office of the Director-General
Department of Basic Education
Pretoria
E-mail: kumalo,f@dbe.gov.za

Mfela Mahlangu
Education Human Resource Planning, Provisioning and Monitoring
Department of Basic Education
Pretoria
E-mail: mahlangu.m@dbe.gov.za

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1 Introduction

During the COVID-19 pandemic, one of several concerns behind the debate around how learner attendance should be restricted, was the safety of teachers. In South Africa, schools were officially closed at the end of March 2020. Just two months later, evidence began emerging that children were especially likely to be infected with the SARS-CoV-2 virus without displaying symptoms themselves. This raised concerns among teachers and their unions around the special health risks teachers faced, in particular considering the high average age of South African teachers at the time, this being around age 46[1].

Schools reopened for face-to-face teaching, but with learners attending on a rotational basis, in early June 2020. Restrictions were eased and tightened as the various waves of the pandemic affected South Africa. Decisions were informed by a range of consultations involving government structures, teacher unions, professional medical associations, and civil society organisations.

As in many other countries, health workers were prioritised for vaccinations as soon as these became available. South Africa was also one of several countries where teachers were prioritised after health workers had been vaccinated, and before vaccinations became available to the general population. The vaccination of teachers and related education workers began in early July 2021 and continued for around a month, using the single-dose Johnson & Johnson COVID-19 vaccine. This vaccine had shown a robust immune response detected 15 days after vaccination, with significant protection reached by day 29[2].

Normal face-to-face teaching for learners was only reintroduced in February 2022, through a government notice[3] that formally compelled everyone in the schooling system to return to regular practices.

After the June 2020 reopening, one indicator government monitored was teacher deaths due to COVID-19. Understandably, this statistic became vital within the negotiations between the employer and unions on what restrictions to apply. Monitoring of teacher deaths initially occurred through reports by schools to their provincial education departments, and from there to the Department of Basic Education (DBE) at the national level[4]. To illustrate, this monitoring produced a figure of 1,493 deaths by mid-December 2020[5]. In hindsight, and in view of the type of analysis described in the current paper, the statistics *over*-stated the problem by around 50%. The system for schools to report deaths was put together in a short space of time and it is now believed that school principals included deaths of staff members who were not teachers in their reports, and possibly teacher deaths where the link to a COVID-19 infection had not been established through a seropositive test.

By mid-2021, government was using estimates derived from the excess deaths approach described in the current paper to report on the deaths of teachers, but more specifically the deaths of provincially employed educators, the group of some 400,000 employees for whom data permitted the calculation of excess deaths. As an example of this, the 3,300 deaths referred to by the Minister of Basic Education in her 2022 budget speech to Parliament are based on the excess deaths approach[6]. The final pandemic-related excess deaths count presented in this paper, of around 3,500, represents just under 1 per cent of the workforce.

[1] Gustafsson and Maponya, 2020: 6.
[2] Sadoff *et al*, 2021.
[3] Government Notice 806 of 2022.
[4] Statistics on cases emerging from this system are described in Gustafsson and Chanee (2020).
[5] Eyewitness News, 2020.
[6] Motshekga, 2022.

Section 2 below describes the excess deaths approach as generally understood, the data that were available for South Africa's educators, and the exact approach adopted in line with the structure of these data. Section 3 provides the mortality statistics arising out of the analysis. Section 4 breaks the educator mortality statistics down by categories such as age and gender, while section 5 examines in more depth factors associated with higher and lower probabilities of deaths, using conditional correlations. Finally, section 6 concludes and places pandemic-related deaths within the context of attrition generally occurring in the educator workforce.

2 The excess deaths approach and the available data

In simple terms, an excess deaths, or excess mortality, approach involves comparing deaths occurring during an exceptional time, such as a pandemic, to deaths that would normally occur over an equivalent length of time. This approach can provide valuable information on the overall impact of, for instance, a pandemic on mortality. In the case of a pandemic, there would be deaths caused directly by infections, but also deaths arising indirectly from the wider impact of the pandemic. For instance, during the COVID-19 pandemic, additional mortality arose when health facilities became less able to provide the services they usually provide because the system was over-burdened by the direct effects of the pandemic, and citizens were not inclined or unable to seek medical attention as they normally would.

The excess mortality approach has been used before the COVID-19 pandemic, though its use became widespread during this pandemic. An example of an earlier application of this method would be Huynen *et al* (2001), who examine the impact of heat waves and cold spells on mortality in the Netherlands during the 1979 to 1997 period.

Demetriou *et al* (2022) provide statistics on excess deaths associated with the COVID-19 pandemic for 20 countries, excluding South Africa, in 2020. An international research consortium of organisations with access to non-public data of relevance assembled a standardised dataset with deaths per week for the years 2015 to 2020. Data from the first five years were used to predict weekly deaths in 2020, within a confidence interval. Cumulative 2020 deaths using predicted and actual values were used to arrive at excess deaths, which were disaggregated by age category and sex.

In the case of South Africa, Bradshaw *et al* (2021) used registered deaths, aggregated by week, from the Department of Home Affairs from 2018 and 2019 to predict weekly deaths in 2020. The 2018 to 2019 statistics were adjusted, using sample-based Statistics South Africa household data, to take into account deaths not registered with Home Affairs, either because the individual was not present on the national population register (NPR) in the first place, or because a person's death was not registered, even if the person was on the NPR. Moreover, excess deaths calculations took into account the fact that the mandatory 'lockdowns' during the pandemic *reduced* certain types of mortality, for instance mortality due to road accidents. The COVID-19 pandemic is found to be associated with between 70,000 and 75,000 deaths in 2020, a much higher figure than the officially reported figure of around 28,000. This discrepancy of around 150% is lower than the 200% found for the world as a whole in the analysis of *The Economist* magazine[7]. For the world as a whole, there were three times more pandemic-related deaths than what official reports suggest.

The World Health Organization (2022) has published a detailed methodological guide for calculating excess deaths associated with COVID-19, with methods varying depending on the type of data available. The WHO's guide essentially reflects the methods described above.

[7] "The pandemic's true death toll" at https://www.economist.com/graphic-detail/coronavirus-excess-deaths-estimates (consulted April 2023).

In South Africa, the Persal payroll system covers civil servants employed by the national or provincial governments. Employees who are 'educators' are a clearly distinguished category, of whom around 96% are working in a school. Though the employer is nearly always one of the nine provincial education departments, the national Department of Basic Education archives educator payroll data on a monthly basis. However, much of the year-on-year trend analysis undertaken by the DBE uses the November extract, November being a month when there are relatively few vacancies and employee numbers are high. However, for analysing deaths, monthly termination data were drawn from the archive. These included details on the reason for leaving the system, one reason being death. Cause of death is not recorded. The exact date of death is also included, as well as the date on which the death was entered into Persal.

The choice of an excess deaths method was in part determined by the available data. Moreover, the urgency of the analytical exercise necessitated a relatively straightforward method. Daily deaths in 2019 were used as the expected non-pandemic deaths for corresponding days of the year in the pandemic period. Lags between deaths and the entry of deaths in Persal could be gauged by subtracting the date of data entry from the date of the death. Half of the lags for the deaths occurring between January 2020 and March 2022 were 25 days or shorter, 90% of the lags were 83 days or shorter, and 95% were 120 days or shorter. These lags are considered in the interpretation of the statistics that follow.

The method followed did not take into account historical changes in mortality using pre-2019 data, relating for instance to a changing age structure, or adjust for changes in the size of the overall workforce. These adjustments to the expected deaths during the pandemic would have been possible with the data, but it is is unlikely they would alter the findings substantively. To illustrate, the total size of the educator workforce has changed little over time. The average number of educators in November across the years 2012 to 2021 is 397,100, with the maximum being 2.4% above this (in 2012) and the minimum 2.4% below the mean (in 2015). Moreover, adjustments to take into account reductions in certain types of mortality due to the lockdowns, as in Bradshaw *et al* (2021), were not pursued. The problem of missing data in the form of missing individuals or deaths never recorded can be considered virtually non-existent in Persal given that the function of the system is to pay salaries.

A literature search revealed no other excess deaths analysis using administrative or payroll data, similar to the one presented below, from South Africa or beyond.

3 Excess deaths over time

Figure 1 shows that from 27 March 2020, when the first known COVID-19 death occurred in South Africa, to around 25 June 2020, cumulative deaths in 2020 followed the 2019 pattern closely. The horizontal axis reflects the date of death, not the date of the registration of the death on Persal. After 25 June, the trajectories of the two years began diverging strongly. This is clearly due to pandemic-related deaths. It can be assumed that without the pandemic, 2020 deaths would have followed the 2019 trajectory for the entire year, and that a similar trend would have continued beyond 2020. The expected deaths, derived from the 2019 Persal data, would be repeated in the pre-pandemic curve. For instance, deaths on 1 January 2019 would be the expected deaths on 1 January in 2020, 2021 and 2022. Excess deaths would be the gap between the two curves in Figure 1. On 31 March 2022, excess deaths stood at 3,469, the difference between the 31 March totals of 6,434 and 2,965 illustrated in the graph.

Figure 1: Cumulative deaths and excess deaths among educators

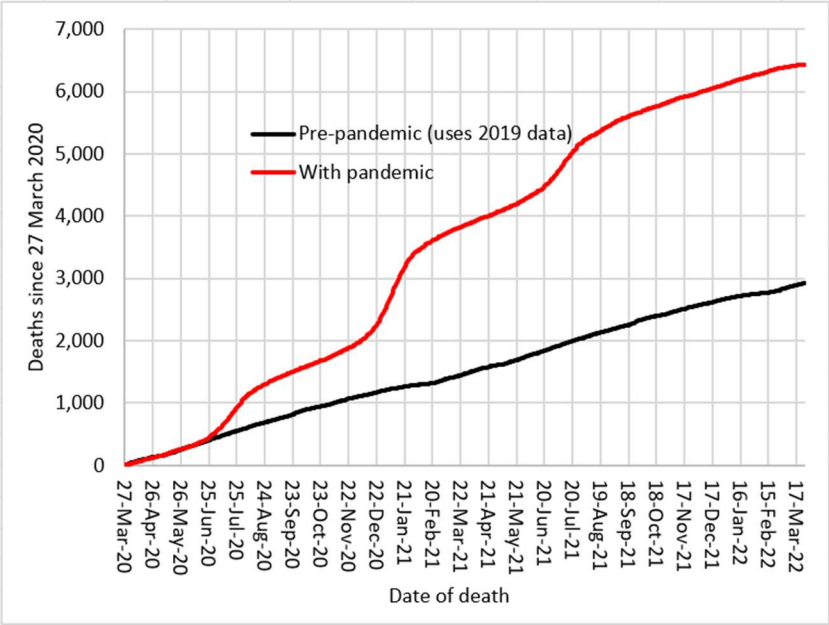
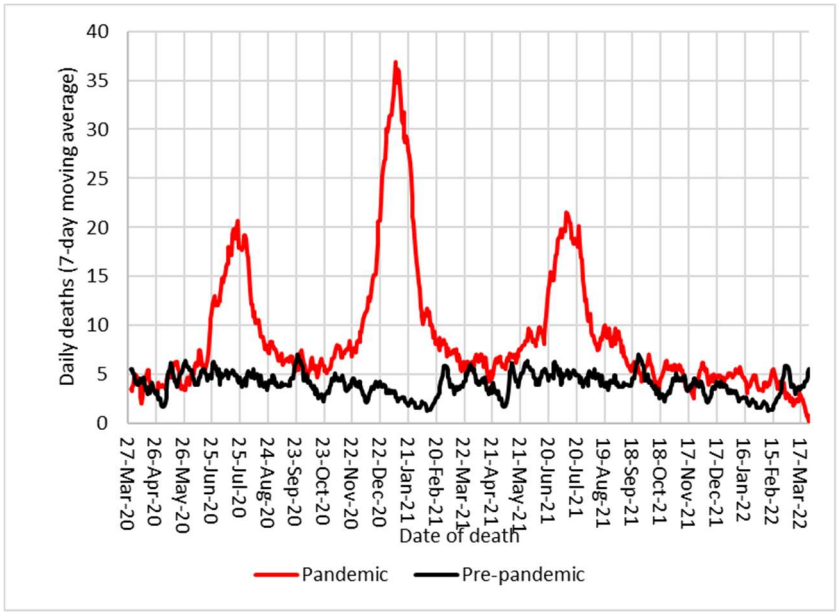


Figure 2 provides an alternative view of the data, focussing on the average across seven days – three days before and three days after the date in question. This smoothing of the curves facilitates the interpretation. The 'waves' of deaths are clearly visible. The decline in the red curve towards the end of the period reflects lags in the registration of deaths discussed previously. The influence of these lags on the excess deaths analysis would be minimal before 1 December 2022, given that 95% of lags are 120 days or shorter.

Figure 2: Daily educator deaths with and without the pandemic



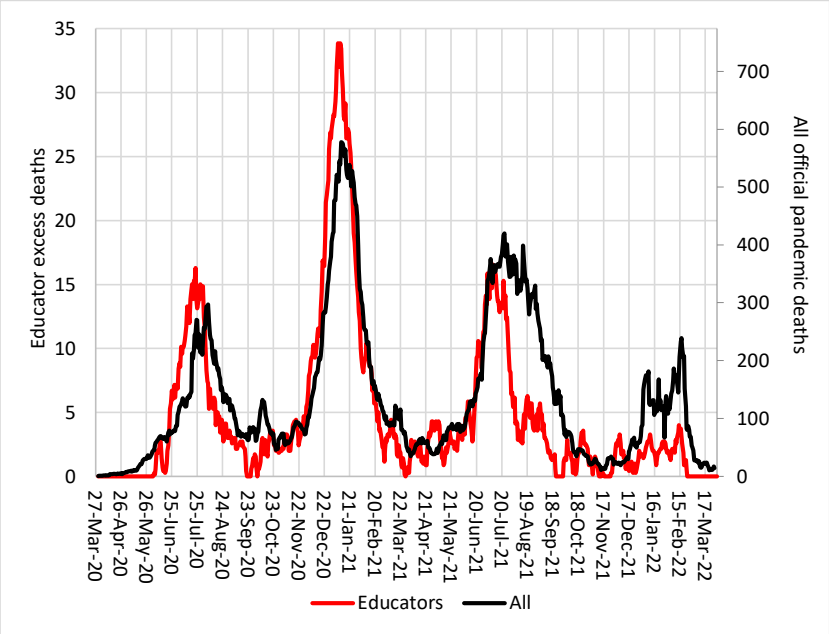
The wave with the worst impact on educator mortality was the second wave, which occurred largely during the break between the 2020 and 2021 school years. The high mortality rate during this period would explain why Shepherd *et al* (2021), drawing from a much earlier version of the current report, under-reported excess educator deaths by the end of February. The figure in Shepherd *et al* (2021: 35) is 1,678, against a considerably higher 2,319 provided by the values

behind Figure 1 above. This difference would be due to reporting lags, lags which may have worsened as a result of the higher number of deaths that had to be processed administratively during the second wave.

Figure 3 superimposes the official overall COVID-19 deaths per day in the South African population on the excess educator deaths, which are derived from the two data series illustrated in the previous graph. The fact that educator waves are positioned slightly to the left of those for the population would largely be driven by delays in the reporting of deaths in the population. The population data refer to day of reporting, not day of death.

The right-hand vertical axis in Figure 3 is scaled in such a manner that the areas under the two curves for the period 1 March 2020 to 30 June 2021 are equal. This is a period during which patterns across educators and the general population can be expected to follow similar patterns. After 30 June 2021 deviations can be expected as educators were prioritised above the general population with respect to vaccinations, as discussed previously.

Figure 3: Excess educator deaths and overall COVID deaths



Source: For the population figures, the OxCGRT dataset was used. See https://www.bsg.ox.ac.uk/research/research-projects/coronavirus-government-response-tracker.

What is noteworthy about Figure 3 is how excess educator deaths declined considerably from around the middle of July 2021. Educators appear to have fared better than the general population in the second half of the third wave and in the fourth wave, presumably due to vaccinations. One way of gauging the magnitude of this is to examine the ratio of deaths between 1 April 2020 and 30 April 2021 (13 months) and deaths between 1 May 2021 and 15 November 2021. 1 May 2021 roughly separates the second and third waves, while 15 November 2021 is roughly the end of the third wave, and is also early enough to be virtually unaffected by death registration lags on Persal. This ratio is 2.55 for educators and 1.55 for the general population. Had the ratio been the same for educators as for the general population, the number of educator deaths for the 1 May 2021 to 15 November 2021 period would have been 1,591, and not the 964 reflected in Figure 3. This suggests some 627 educator deaths in the third wave were avoided through the vaccination campaign.

The fourth wave is more difficult to analyse because of lags in the registration of deaths on Persal. The analysis presented above points to 167 excess deaths among educators during the

period covering the fourth wave of 16 November 2021 to 31 March 2022. An adjusted figure that takes into account patterns with respect to lags raises the 167 value to 230. Using the ratio of deaths in the pre-vaccination period to deaths in this 16 November 2021 to 31 March period, suggests there would have been some 475 excess deaths among educators during the latter period, in other words that vaccinations reduced deaths in the fourth wave by 244. In total then, the reduction in deaths during the third and fourth waves apparently attributable to vaccinations is 871. This concurs with the expected effect of vaccination.

Total excess deaths by province, and thus the breakdown of the 3,469 national total referred to above, are provided in Table 1. To produce this, the provincial versions of the curves seen in Figure 1 were calculated.

Table 1: Excess educator deaths by province 27 March 2020 to 30 March 2022

Province	Excess deaths
Eastern Cape (EC)	619
Free State (FS)	197
Gauteng (GP)	630
KwaZulu-Natal (KN)	745
Limpopo (LP)	447
Mpumalanga (MP)	314
Northern Cape (NC)	104
North West (NW)	239
Western Cape (WC)	174
Total	3,469

4 Basic mortality rates

For Table 2 below, mortality rates were calculated for the set of 394,362 educators found in either the November 2018 or November 2019 Persal extracts. Deaths per 1000 educators occurring in 2019 were found, as well as for the 27 March 2020 to 15 November 2021 period, the period when pandemic-related deaths for educators were concentrated. The mortality rate for the latter period was annualised by multiplying deaths by 599 over 365, 599 being the number of days in the period.

Overall, deaths per 1000 educators was 3.4 before the pandemic, and 8.5 during the pandemic. This latter figure would change if the period considered for the pandemic changed. Table 2 thus largely serves to compare the degree to which mortality worsened for different categories of educators – see the last column. It rose for all the categories reflected in table, but the increase was especially large for older educators aged 50 and above, for educators in Eastern Cape, and for educators above the level of teacher, such as schools-based heads of department and school principals. Mortality moreover worsened most for black African educators, when looking at the four population groups commonly used for population statistics in South Africa. It is noteworthy that mortality in secondary schools, relative to mortality in other locations, mostly primary schools, did not worsen during the pandemic. Higher rates in secondary schools were expected by some, given that the health advice was that children above age twelve were more likely to infect teachers, and assuming that teachers were primarily infected by learners[8]. The evidence in Table 2 lends support to the World Health Organization position, expressed as early as May 2020, that infection of teachers was occurring mainly outside the school classroom[9].

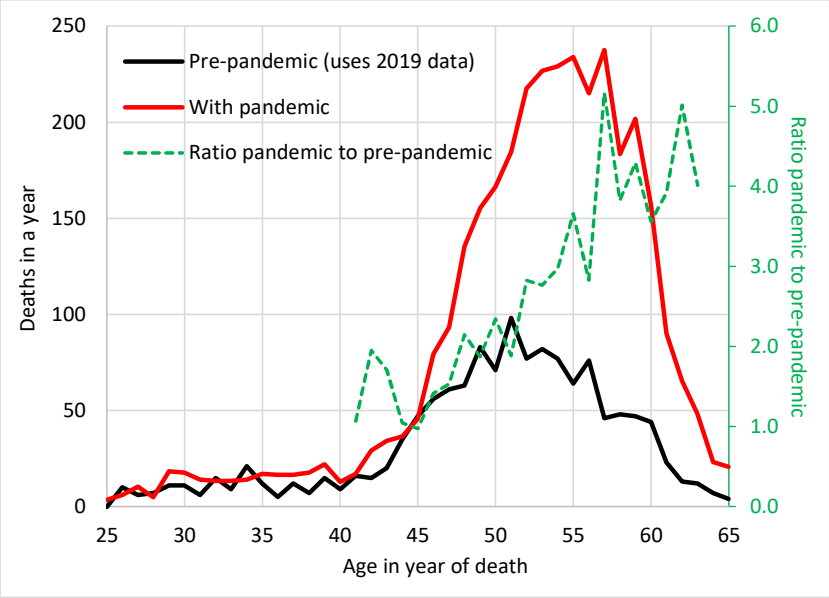
[8] World Health Organization, 2020b: 4.
[9] World Health Organization, 2021a: 1.

Table 2: Mortality rates by category of educator

.	2018-2019	2019		27 Mar 2020 to 15 Nov 2021		
.	Educator count	Deaths	Mortality per 1000	Deaths	Annualised mortality per 1000	Difference in mortality rate
All	394,362	1,343	3.4	5,490	8.5	5.1
Female	274,548	787	2.9	3,355	7.4	4.6
Male	119,814	556	4.6	2,135	10.9	6.2
Age 40+	288,177	1,194	4.1	5,151	10.9	6.7
Age 50+	177,830	789	4.4	4,103	14.1	9.6
EC	56,348	249	4.4	1,035	11.2	6.8
FS	19,888	66	3.3	262	8.0	4.7
GP	66,756	169	2.5	840	7.7	5.1
KN	93,183	343	3.7	1,257	8.2	4.5
LP	54,942	210	3.8	789	8.8	4.9
MP	33,104	129	3.9	505	9.3	5.4
NC	10,131	28	2.8	145	8.7	6.0
NW	26,177	79	3.0	366	8.5	5.5
WC	33,833	70	2.1	291	5.2	3.2
Teacher	307,148	1,055	3.4	3,980	7.9	4.5
Above teacher	87,214	288	3.3	1,510	10.6	7.2
Black African	315,491	1,217	3.9	4,899	9.5	5.6
Coloured	30,820	66	2.1	321	6.3	4.2
Indian	11,219	15	1.3	82	4.5	3.1
White	36,832	45	1.2	188	3.1	1.9
Secondary	140,906	543	3.9	1,989	8.6	4.7
Other	253,456	800	3.2	3,501	8.4	5.3

Ages used for Table 2 are ages in 2019. For Figure 4, which draws from the same set of 394,362 educators as Figure 4, age was adjusted to reflect age on death. For Figure 4, the 'With pandemic' curve reflects annualised. It is clear that below age 45 mortality patterns did not change considerably. It is above age 45 that mortality surged. The higher the age, the greater the increase: the ratio of annualised pandemic deaths to pre-pandemic deaths rises from around 2.0 at age 50 to around 4.0 at age 60.

Figure 4: Excess educator deaths and overall COVID deaths



Note: Ratios should be read against the right-hand vertical axis.

5 Conditional mortality rates

To examine mortality rates associated with specific educator characteristics, conditional on other characteristics, two logit qualitative response models were run, one for deaths in 2019, and another for deaths during the pandemic period of 27 March 2020 to 15 November 2021[10]. In each, dying was regressed on 16 binary explanatory variables, listed in Table 3. As shown in the table, before the pandemic, the conditional probability of dying was particularly high for males, those aged 40 and above, and black African educators. These patterns are not very different from what was seen for the unconditional mortality rates of Table 2. The values in the first column of Table 3 can be considered the probability of dying in a year above what could be expected within the reference category, this being a white female teacher below age 40 in Western Cape. The patterns persisted during the pandemic, but with amplified differences as overall mortality rose. This is illustrated in Figure 5 below.

To illustrate the meaning of the coefficients in the first two columns of Table 3, the *unconditional* probability of dying in a year for the reference category – the white female teacher below age 40 in Western Cape – was 0.1%, against 0.3% for everyone else, a relatively small gap of 0.2 percentage points. In the pandemic period considered, the probability of dying remained essentially unchanged for the reference category, but rose to 0.9% for everyone else. There was thus a gap of some 0.7 percentage points. The gap thus rose from 0.2 percentage points to 0.7 percentage points, a difference of 0.5. The last column of Table 3, which reflects pre-pandemic versus pandemic differences in the relative *conditional* probability of dying should be seen in the light of this 0.5 percentage point increase in the gap. The highest value in the final column, of 5.5 percentage points, is that associated with being aged 50 or above. Because conditional statistics are reflected, the full effect of being aged 50 and above is the sum of the 3.0 for 'Age 40+' and the 5.5 for 'Age 50+' – a person aged 50 is automatically also over age 40.

The fact that the average age of the educator workforce has risen substantially would have increased its vulnerability during the pandemic. Average age increased from 41 to 45 between

[10] Using 'logit' followed by 'mfx compute' in Stata. Educators who died during the specified pandemic period were weighted less than educators not dying, to annualise the analysis.

2004 and 2022. Research into the health of South Africa's educators by Zuma *et al* (2016) found that in 2016 22.1% of educators had been diagnosed with hypertension and 9% had diabetes mellitus, indicators which had worsened since 2004. These are age-linked and non-communicable diseases that have been known to increase serious COVID-19 illness and related morbidity and mortality.

The value in the final column of Table 3 that is highest, after the age-related values, is the 3.2 for coloured educators. This points to being coloured being associated with a particularly high worsening of the probability of dying, after taking into account other factors.

Table 3: Results of a multivariate logit analysis

	Increase in probability associated with the characteristic		
	Before pandemic	During pandemic	Difference
Male	1.8***	3.0***	1.2
EC	1.0*	2.8***	1.7
FS	0.4	1.1*	0.7
GP	-0.1	1.3**	1.4
KN	0.9*	1.9***	0.9
LP	0.0	-0.4	-0.4
MP	0.5	1.1*	0.6
NC	0.4	2.8***	2.4
NW	0.0	1.0	1.0
Age 40+	2.3***	5.2***	3.0
Age 50+	0.8***	6.4***	5.5
Non-teacher	-1.0***	-0.8***	0.2
Indian	-0.5	1.0	1.5
Coloured	1.3*	4.5***	3.2
Black African	1.9***	4.6***	2.6
Secondary	0.4**	0.0	-0.4
N	394,362	394,362	
Pseudo R squared	.026	.049	

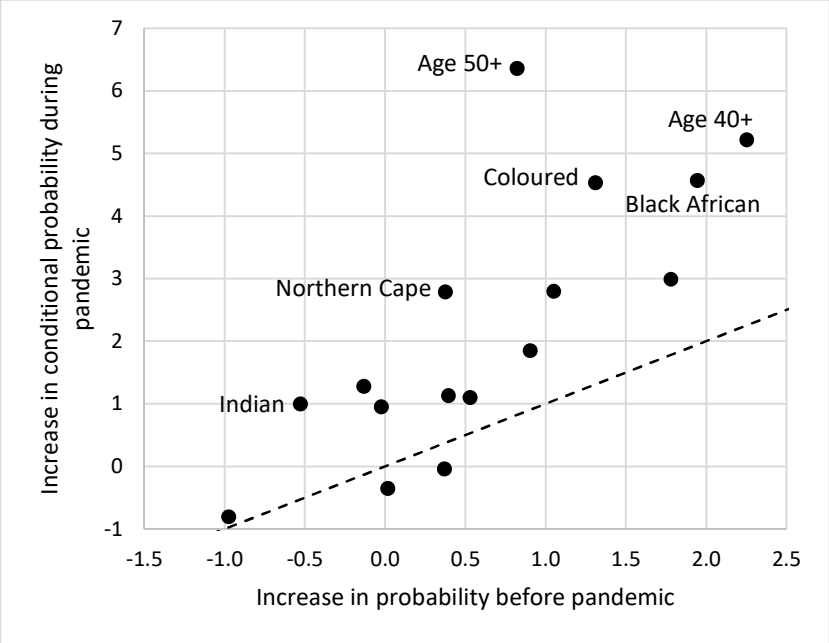
*Note: Missing categories are reference categories, specifically female, Western Cape, below age 40, a teacher (non-manager) and white. *** indicates that the estimate is significant at the 1% level of significance, ** at the 5% level, and * at the 10% level.*

A key difference between the conditional (Table 3) and unconditional (Table 2) analysis is that in the former being a non-teacher, or educator above the level of teacher, is not associated with high excess mortality. This suggests the relatively high mortality for 'Above teacher' in Table 3 is due more to these senior educators being older, not to their being of a senior rank.

Figure 5 uses values from the first two columns of Table 3 and helps identify which of the 16 factors are associated with large changes in mortality. Northern Cape educators appear to have been particularly susceptible to the effects of the pandemic. Inequalities, some of them across provinces, in access to health care described by McIntyre and Ataguba (2017) are likely to explain some of the across-province differences seen in Table 3.

Being an Indian educator was conditionally associated with the lowest mortality among the four population groups before the pandemic. During the pandemic, conditional Indian mortality exceeded that of whites. However, levels of uncertainty in this regard are high: neither the pre-pandemic nor the pandemic coefficients for 'Indian' in Table 3 are statistically significant, which in turn is related to the relatively small number of Indian educators in the workforce.

Figure 5: Changes in conditional mortality rates



6 Conclusion

This paper is intended to document an important and tragic aspect of the harm to the schooling system brought about by the COVID-19 pandemic. The loss of approximately 3,500 largely older educators due to death during the pandemic represents a considerable loss in human resources and experience. To provide some context, around 11,000 educators aged 56 to 65 have left the workforce annually in recent years, mostly due to retirement[11]. The pandemic thus represents a loss in human resources equal to around a third of retirements and other age-related attrition in one year.

There is room to improve the reliability of the 3,500 estimate, through for instance adjustments to deal with overall demographic trends in the South African educator workforce, and through the inclusion of estimates of the extent to which pandemic-related lockdowns *reduced* certain types of mortality, such as that related to road accidents. However, it appears unlikely that such adjustments would result in an estimate that is substantively different to the one provided here.

[11] Gustafsson, 2022: 27.

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