

A retrospective analysis of COVID-19 cases seen at a medico-legal mortuary from March 2020 to February 2022

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Background. The global community has grappled with a prolonged pandemic, initiated by the coronavirus outbreak. Understanding the virus' pathogenicity necessitates a comprehensive analysis of autopsy reports. However, in South Africa (SA), limited research has been conducted on coronavirus, primarily due to safety concerns associated with performing autopsies on COVID-19 cases.

Objectives. To analyse demographics, circumstances, chief pathological findings and various causes of death among cases with positive SARS-CoV-2 laboratory results in a medico-legal setting.

Methods. This retrospective study analysed autopsy findings from all positive COVID-19 cases observed at a medico-legal mortuary, in SA, from March 2020 to February 2022.

Results. Ultimately, 208 cases (age range 19 - 75 years, median 46.1 years, 60.1% male) with positive SARS-Cov-2 laboratory results were seen. All 208 individuals were black, which is representative of the demographics in the community. In 11 cases (72.7% males), death was related to COVID-19. Sudden death was reported in 63% of cases. The most predominant chief pathological finding was features of pneumonia in 45% of cases.

Conclusion. Postmortem findings revealed pathological findings mostly in the lungs. These findings contribute to the limited research in SA.

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Student author biography

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The global community has wrestled with a prolonged pandemic for over two years, precipitated by the coronavirus outbreak. Understanding the pathogenicity of the coronavirus disease necessitates a comprehensive analysis of autopsy reports. This study was conducted on cases that tested positive for SARS-CoV-2, at a governmental medico-legal mortuary. Using autopsies to elucidate this disease's nuances offers indispensable insights into its progression, enabling effective management.

Demographic considerations are important in identifying the most impacted age groups and vulnerable populations. Scrutinising the circumstances surrounding the demise of individuals afflicted with COVID-19 aids in identifying factors that may exacerbate complications associated with the disease. Mitigating these complications requires an in-depth understanding of the primary structures within the body affected by the virus, a comprehension achievable through the analysis of chief pathological findings.

COVID-19, caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), predominantly impacts the respiratory system.^[1] Despite its primary respiratory effects, COVID-19 can manifest in other organs, including the heart, liver and kidneys.^[1]

A descriptive whole-body autopsy series ($N=29$) conducted in a hospital in Lusaka, Zambia, revealed a predominance of male cases (58%) compared with female cases (42%).^[2] This observation suggests that men may be more vulnerable to COVID-19 infection than women. Consistent findings were reported in another cohort study, where men constituted 58% (46/80) of COVID-19-related deaths.^[3] Age was another determinant in the pathogenicity and cause of COVID-19, with most deceased patients in a cohort study falling within the age range of 52 - 96 years (mean 79.2 years, median 82.4 years).^[3] From these findings, it can be inferred that men and older individuals are more susceptible to COVID-19 infection and its potentially fatal complications.

In a cohort study involving 26 autopsy cases from eight hospitals in China, the lungs were identified as the most frequently affected organ among COVID-19-diagnosed patients, with pulmonary injuries accounting for 88% of cases.^[1] The autopsied lungs exhibited diffuse alveolar damage, marked infiltration of immune cells (including dysfunctional alveolar macrophages) and an abundance of inflammatory factors and interstitial fibrosis.^[1,3] Another study noted enlarged and heavy lungs due to retained fluid.^[2-4] The primary cause of death was attributed to respiratory failure, characterised by exudative diffuse alveolar damage and massive capillary congestion.^[5]

Severe pulmonary injuries emerged as the predominant cause of death, accounting for 23 out of 26 (88%) cases.^[1] Of the 23 patients who succumbed to severe pulmonary injuries, 21 experienced COVID-19-related respiratory failure without pulmonary fungal infection, while the remaining two patients exhibited pulmonary fungal infection.^[1] Among the patients without pulmonary injury (12%), various causes of death were reported, including pulmonary thromboembolism, dissecting aneurysm rupture and cardiovascular disorders. In contrast, an autopsy series in Lusaka identified pulmonary embolism as the primary cause of death in 48% of cases.^[2] Furthermore, pneumonia due to COVID-19 and diffuse alveolar damage were also implicated as causes of death.

It is important to study COVID-19 autopsies to advance our knowledge of the disease.

The primary objective of this study was to analyse demographics, circumstances, chief pathological findings and various causes of death in autopsies with positive SARS-CoV-2 laboratory results in a medico-legal setting.

Methods

This retrospective study used autopsy findings from all COVID-19-positive cases observed at a medico-legal mortuary from March 2020 to February 2022. Permission was obtained from the mortuary to access post mortem data. Autopsy records of COVID-19 cases documented within the study period were retrospectively analysed.

The study sample encompassed comprehensive autopsy findings of cases with confirmed positive SARS-CoV-2 laboratory results, inclusive of test results obtained from swabs taken both ante-mortem and postmortem. The swabs were conducted at the Ga-Rankuwa Medico-legal Mortuary and subsequently transported to the National Health Laboratory Services (NHLS) at Sefako Makgatho Health Sciences University. Here, the gold standard for testing the disease was conducted using a real-time reverse transcription-polymerase chain reaction (RT-PCR).

Both male and female deceased individuals diagnosed with COVID-19 were included in the study, without restriction based on race or age. Cases involving patients who died of causes unrelated to COVID-19 were not included in the analysis. Those without a formal diagnosis were excluded from the study. Additionally, cases with incomplete autopsy findings, fetuses, bones and decomposed cases were also excluded from the study.

Data for the study were derived from post mortem reports of COVID-19-positive patients, obtained from a medico-legal mortuary. The reports remained securely stored in their original location and were not transferred. Following the authorisation to access post mortem data, autopsy findings of cases with positive SARS-CoV-2 laboratory results

were requisitioned and each case was individually examined. Data collection involved the manual extraction of information from the cases using a printed data collection sheet.

Results

In total, 2 360 autopsies were performed at the Ga-Rankuwa Medico-legal Mortuary. Following exclusions, 1 612 reports were examined further. Of those, 78% were male and 22% female, with an average age of 35.2 with the youngest being 6 weeks and the oldest being 89 years. Ultimately, 208 cases tested positive for COVID-19, 1 222 tested negative, 173 were not tested and 9 had undetermined results (Fig. 1).

Among the 208 deceased patients who tested positive for COVID-19, 125 (60.1%) were male and 83 (39.9%) were female. All of them were black, as no other races were seen. This is in keeping with the demographics in the studied area. The cause of death varied among the 208 included cases. The leading cause of death was homicide ($n=61$ cases, 29%), followed by motor vehicle accidents ($n=56$, 27%), hanging ($n=28$, 14%), unknown cause of death ($n=22$, 11%), COVID-19-related complications ($n=11$, 5%), burns ($n=8$, 4%), suspected poisoning ($n=6$, 3%), drowning ($n=5$, 2%), electrocution ($n=4$, 2%), medical procedure-related ($n=4$, 2%) and falls ($n=3$, 1%) (Fig. 2).

Deaths due to COVID-19 complications were seen in only 11 cases between March 2020 and February 2022, representing an incidence of 0.68% (Table 1). Among the 11 cases, 8 involved male patients (72.7%), while 3 (22.3%) involved female patients. Their ages ranged between 19 - 72 years, with a median age of 46.1 years. The chief autopsy findings included features of pneumonia bilaterally in five cases, features of sepsis in one case, bilateral ground glass appearance with consolidation of lower lobes in one case, COVID-19 pneumonia positive reticulonodular infiltrate in one case, bilateral pleural effusion with pneumonic changes of both lungs in one case, patchy infiltration of the lungs in one case and bilateral diffuse opacity of the lungs in one case (Fig. 3).

Table 1. Demographics and causes of death in COVID-19-positive cases

Variable	Positive COVID-19 cases (N=11), n (%)
Sex	
Male	8 (72.7)
Female	3 (27.3)
Age range	
15 - 25	1 (9.1)
26 - 35	1 (9.1)
36 - 45	2 (18.2)
46 - 55	
56 - 65	2 (18.2)
66 - 75	4 (36.4)
Undetermined	1 (9.1)
Cause of death	
Lobar pneumonia	5 (45.5)
Bronchopneumonia	3 (27.3)
Multilobular pneumonia	3 (27.3)

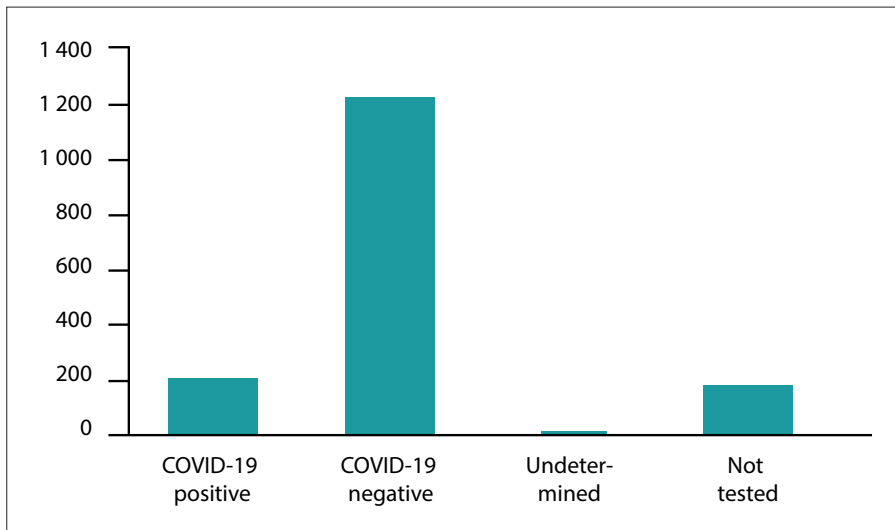


Fig. 1. Reports of cases seen at the Ga-Rankuwa Forensic Pathology Services between March 2020 and February 2022

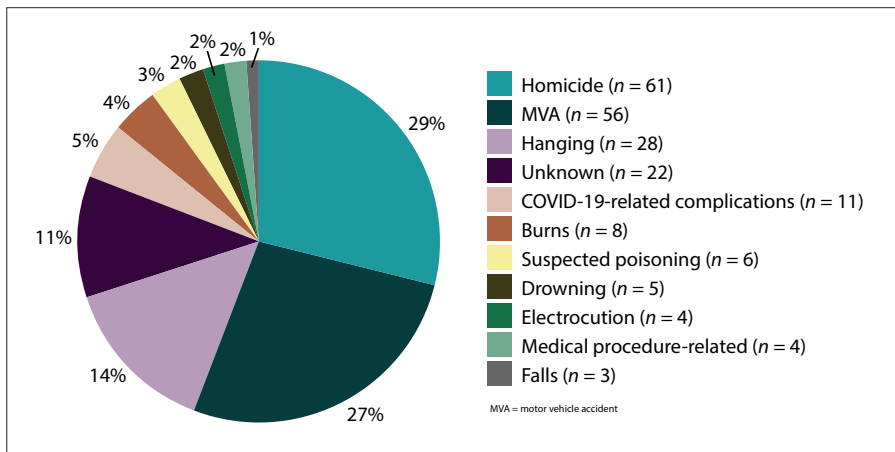


Fig. 2. Causes of death among COVID-19 cases

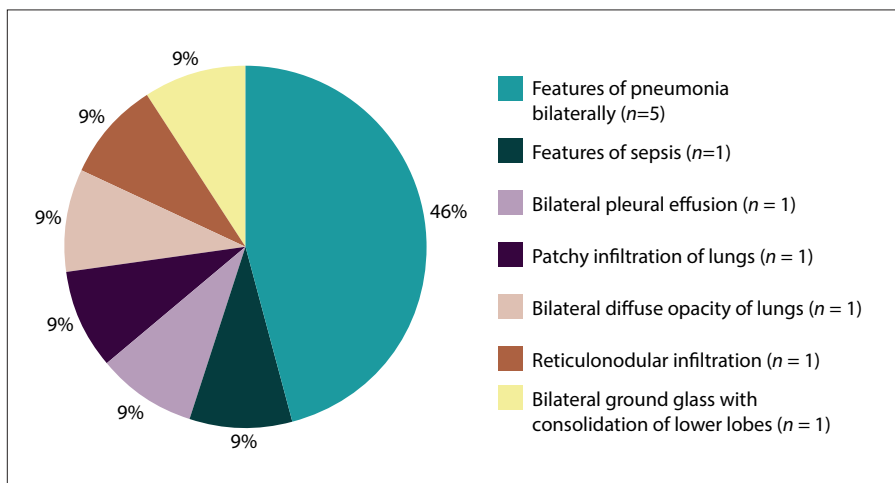


Fig. 3. Chief autopsy findings in COVID-19 cases with COVID-19-related complications.

The leading cause of death among the 11 cases was COVID-19-related pneumonia (n=5 cases), followed by PCR 2 COVID

bronchopneumonia (n=3 cases) and severe multilobar pneumonia with COVID-19 (n=3 cases) (Fig. 4).

Discussion

In this study, we identified 208 cases with positive COVID-19 laboratory results, constituting 12.9% of the total cases observed at Ga-Rankuwa Pathology Services between March 2020 and February 2022. Throughout the pandemic, autopsies especially those associated with positive COVID-19 laboratory results, were infrequently conducted due to safety concerns, resulting in a limited number of autopsies. Notably, only 11 cases had COVID-19 as the primary cause of death, warranting focused attention. This is not surprising as our facility is a medico-legal mortuary and intrinsically conducts post-mortems on unnatural deaths. As such, COVID-19 cases should not have been autopsied if that was the only suspected cause of death. The 11 cases that ended up with COVID-19 as the primary cause of death, were presented to the mortuary mostly as cases of sudden and unexpected death. The incidence of COVID-19 as the cause of death was 0.86% in our study, which is lower than the findings of a similar study in Turkey where they had an incidence of 1%.^[6] A study conducted in the USA had a higher incidence of COVID-19-related causes of death, accounting for 2% of all observed cases.^[7] This could be attributed to the COVID-19 pandemic having a greater impact in Europe and North America. Demographic factors, particularly age, sex and race, play a crucial role in understanding susceptibility, pathogenesis and disease occurrence within a population. The autopsied cases exhibited a higher prevalence among men (60.1%), aligning with a study in Zambia, which reported 58.8% male cases.^[2] In the 11 cases with positive COVID-19 results, 72.7% involved male patients, indicating a more pronounced impact on men. This suggests a higher susceptibility of men to COVID-19 infection. Published reports propose that elevated plasma levels of acetylcholinesterase enzyme 2 in men result in less effective antiviral immune defences compared with women.^[8] All 208 cases involved black individuals, which is reflective of the racial composition in the area.

The age distribution among the cases showed a predilection for the age group older than 65. This is in keeping with other literature.^[3] Age is acknowledged as a factor that contributes to the increased susceptibility to COVID-19 and its complications, and it is also demonstrated in this study.

Among the 11 cases, sudden death was frequently observed (63%). Research suggests

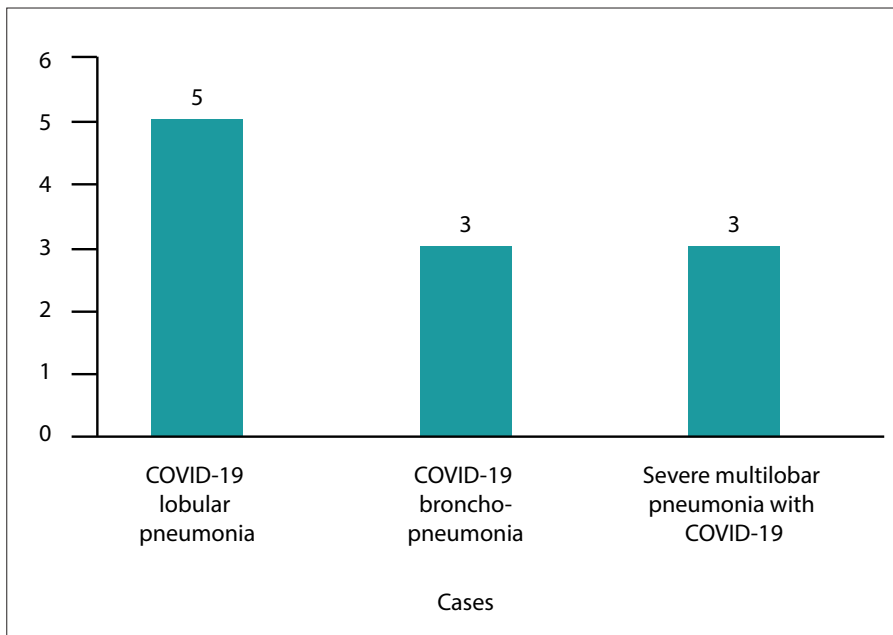


Fig. 4. Causes of death in COVID-19-positive cases.

that this may be attributed to acute cardiac involvement, with elevated cardiac injury markers such as troponin, arrhythmia, ventricular dyskinesia and reduced ejection fraction noted in 16% of cases.^[9] Pneumonia features were evident in 45% of cases in this study, attributed to the sensitivity of type 2 epithelial cells in the lungs to SARS-CoV-2. Their inability to secrete surfactant leads to a reduction in surfactant levels in the alveoli, causing lung collapse and subsequent pneumonia, progressing to acute respiratory distress syndrome in severe cases.^[10] This suggests a likelihood that the type 2 epithelial cells in the majority of patients were more sensitive to COVID-19. Other studies however identified diffuse alveolar damage as the primary pathological finding.^[2,5]

The predominant cause of death among the patients with positive COVID tests was COVID-19 pneumonia, followed by PCR 2 bronchopneumonia and severe multilobar pneumonia. This is consistent with another study that reported COVID-19 pneumonia as the most common cause of death.^[2] Bronchopneumonia, the second leading cause of death, was observed in three cases.

This study had a few limitations. First, the retrospective nature of the study design prevented the standardisation of ancillary examinations and tests conducted on SARS-CoV-2-positive cases. Second, due to uncertainties surrounding the severity and infectivity of the virus, coupled

with the absence of a vaccine during the study period, complete autopsies were not universally performed. Instead, our protocol favoured minimally invasive autopsies. Moreover, among the recorded cases, there were 22 instances where the cause of death remained unknown. It is plausible that some of these patients might have presented with COVID-19-related pathology that went undetected by the ancillary investigations carried out. Future prospective studies are warranted, alongside more comprehensive statistical analyses.

Conclusion

The emergence of the novel coronavirus presented significant challenges for healthcare professionals, including forensic pathologists, hindering comprehensive studies on its pathogenicity and complications. In SA, limited research has been conducted on the coronavirus, primarily due to safety concerns associated with performing autopsies on COVID-19 cases. However, with the existing body of research, including the findings of this study, we have begun to gain insights into the behaviour of this disease.

While challenges persist, the accumulated knowledge provides a foundation for the prevention of some complications associated with COVID-19. It is imperative to emphasise the need for continued research, particularly in the SA context, to effectively manage

COVID-19 based on our unique research findings. This underscores the importance of ongoing efforts to expand our understanding and refine strategies in response to this global health challenge.

Declaration. MKD submitted this research report to the Department of Forensic Pathology as part of the requirements for his degree.

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Author contributions. MKD conceptualised the research, drafted and submitted the protocol for ethics approval, collected the data and did the data analysis. KH was the supervisor and CVW was the co-supervisor. KH, CVW and YB edited the research report for journal submission and made reviewer corrections as suggested.

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