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The ethics behind mandatory COVID-19 vaccination post-Omicron: The South African context

The legitimacy of mandatory vaccine policies is underscored by a public health ethics framework based on the principles of limited autonomy, social justice and the common good. Ideally, vaccine uptake ought to occur on a voluntary basis as an act of solidarity to ensure that everyone is protected. Given that the altruistic approach has failed and vaccine uptake remains sub-optimal in South Africa, in this paper, I argue for vaccine mandates, in a post-Omicron context. This viewpoint is substantiated by several considerations. Healthcare workers are fatigued after 2 years of treating COVID-19 and many are still treating patients with post-viral syndromes, mental health conditions and cardiovascular complications. Health systems remain under pressure as people with non-COVID diseases, neglected during the pandemic, are also now presenting to medical practices and hospitals. Although South Africa has emerged from a relatively less severe fourth wave of COVID-19, there have been many deaths. Vaccine and natural immunity in a relatively young general population has been advantageous. However, the country has a high prevalence of HIV and those who are untreated may not be able to clear the coronavirus easily. Similarly chronic illnesses place many at risk for severe disease from COVID variants, especially if unvaccinated. The future is shrouded in uncertainty. The next variant could be similar to or less severe than Omicron, yet still impact negatively on health systems, education and the economy. Physical distancing is not ideal in many low socio-economic settings, making vaccines an important component of our prevention toolbox. Our safest option now is to ensure that as many South Africans as possible are vaccinated and receive boosters. Vaccine mandates work to achieve this end.

Significance:

The legitimacy of COVID-19 vaccine mandates post-Omicron is explored from an ethical perspective, given that the fifth wave remains unpredictable in South Africa – a country with a high prevalence of HIV, vulnerable unvaccinated adults and children, and fragile public health systems. The emergence of new variants is uncertain. However, vaccines are central to an appropriate response to protect public health, health systems and the economy.

Introduction

A vibrant debate on mandatory vaccines was triggered in 2021.^{1,2} In response to the COVID-19 pandemic, ethicists, scientists and legal experts have argued strongly for compulsory vaccination³⁻⁵, especially in the context of the emergence of new variants and high numbers of unvaccinated people globally⁶. Scientists and clinicians have expressed fears that vaccine hesitancy and poor vaccine coverage have the potential to lead to the development of variants that would be resistant to existing vaccines. On 25 November 2021, South African scientists announced a new variant discovered in Botswana, now globally known as Omicron.⁷ This new ‘variant of concern’ resulted in global chaos – financial markets tumbled, unjustifiable travel restrictions were imposed on various southern African countries, and health facilities started preparing for a new surge of patient admissions.⁸

The Omicron variant, despite its genetically concerning highly mutated profile, has had a variable clinical impact across the globe, depending on a country’s co-morbidity profile, age distribution, obesity prevalence, vaccination status and incidence of prior infection.⁹ High transmissibility has overwhelmed some health systems¹⁰ and some of the vulnerable patients who were unvaccinated or partially vaccinated became seriously ill or died. In the USA, where there are large numbers of unvaccinated people, during a 7-week period from mid-December 2021 to early February 2022, 100 000 people died.¹¹ This brought the death toll from COVID-19 in that country to almost 1 million. In South Africa, the rise of new cases was dramatically faster than in previous waves; the peak of infections was reached rapidly and then started to tail off with approximately 1557 new cases per day at the end of March 2022. By the end of April 2022, new cases had risen to 5062 per day. Of the 1912 COVID patients in hospital in South Africa on 29 March 2022, 76% were unvaccinated.¹² A combination of factors led to a relatively less severe wave in South Africa – high levels of natural immunity from exposure during the previous waves when vaccines were not available in the country, moderate vaccine-induced immunity, mandatory masking policies, warm weather and a relatively younger population compared to many countries in the Global North.¹³ Despite this scenario, and in anticipation of a fifth wave closer to winter in the southern hemisphere, there are several compelling reasons to improve vaccine uptake and to use the most efficient and ethically justifiable way to do so. The ethical and public health justifications for vaccine mandates in South Africa, post-Omicron, are explored in this article.

Ethical justification for vaccine mandates

Pre-requisites: Supply, safety and efficacy

An important pre-requisite for implementing vaccine mandates in high-risk environments is an adequate, free and accessible supply of safe and effective COVID-19 vaccines. This condition has been met in South Africa despite global vaccine inequity.^{14,15} While current vaccination centres are widely distributed throughout the country and are

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supplemented by pop-up vaccination sites, there is room for improvement in terms of even better access via primary healthcare providers and hospitals. The Omicron variant has created concern about vaccine efficacy due to breakthrough infections in partially and fully vaccinated people, especially those with co-morbidities. However, the vaccines currently available in South Africa (Pfizer and Johnson & Johnson) have proven efficacy in reducing severe illness and death.^{16,17} Some argue that rapid development of COVID-19 vaccines means that safety and efficacy standards were bypassed. However, mRNA technology has been in development for the past two to three decades.¹⁸ Furthermore, billions of COVID-19 vaccine doses have been administered globally and have demonstrated good safety data. This includes protection from severe disease and death in most cases. Only a minority, most with underlying risk factors, have experienced serious side effects.¹⁹⁻²² In most cases, these side effects are temporary and reversible.¹⁹⁻²²

Natural COVID-19 infections, on the other hand, may be mild, moderate or severe. Depending on underlying conditions, obesity and other risk factors, irrespective of age, the impact on health could be severe and persist long after the acute infection.²³ Complications described in a recent study of 11 million people who had natural COVID-19 infections included increased risk of cardiovascular disease – cerebrovascular disorders (strokes), dysrhythmias, ischaemic and non-ischaemic heart disease, pericarditis, myocarditis, heart failure and thromboembolic disease.²⁴ These risks were detected among people who were not hospitalised during the acute phase of the infection and increased if they were hospitalised or admitted to intensive care.²⁴ This study provides evidence that ‘the risk and 1-year burden of cardiovascular disease in survivors of acute COVID-19 are substantial’²⁴. Overall, comparing the complications of natural COVID-19 infection, with vaccine side effects, the risk–benefit assessment favours vaccines as a safer option.

A public health ethics approach

Having established the safety and efficacy of COVID-19 vaccines, a public health ethics approach is best suited to guide decision-making and policy development. Such an approach is based on the principles of solidarity, efficiency, effectiveness, transparency and proportionality.²⁵ This approach is intended to save lives and minimise disease during a public health outbreak, to use limited resources efficiently, to create social cohesion in the public interest, and to build public trust. In addition, a human rights framework supports this approach. The Siracusa Principles on the Limitation and Derogation Provisions in the International Covenant on Civil and Political Rights adopted by the United Nations Economic and Social Council in 1985, have reference.²⁶ These principles are now firmly enshrined in international human rights law and standards and are reflected in Section 36 of the South African Constitution²⁷ that deals with limitation of rights. According to these principles, any restriction on human rights must be based in law. The *National Health Act No. 61 of 2003*²⁸, via regulations relating to notifiable medical conditions, and the *Disaster Management Act*²⁹ apply. Furthermore, restrictions on individual rights imposed via vaccination must be based on a legitimate objective and must be strictly necessary for the achievement of the policy objective. The objectives of reducing the risk of transmission of infection, reducing severe disease, minimising death, and preserving health systems and health personnel are unambiguously in the public interest.

Procedural justice

In the corporate setting and other work environments, guidelines for implementing vaccine mandates are based on the rights of employees and employers to a safe working environment.³⁰ Procedural justice underscores the implementation. A process of risk assessment in the workplace, employee engagement, and consideration of exemptions and alternatives are critical. Medical exemptions include a severe allergic reaction to the first dose of a COVID-19 vaccine, allergy to specific components of a vaccine and a few other medical indications. These include a prior diagnosis of an autoimmune inflammatory condition affecting the neurological, haematological or cardiovascular systems such as Guillain-Barré syndrome and immune thrombocytopenic purpura. Some medical conditions (haemophilia or Von Willebrand’s

disease) may be associated with a bleeding risk, especially intramuscular bleeding post vaccination.³¹

Authentic religious objections are rare as most major world religions promote vaccination. Religious teachings generally support vaccination as an ‘act of love’ and a moral obligation towards fellow human beings.³² Some groups have raised arguments based on a misperception that COVID-19 vaccines contain aborted foetal cells. Decades ago, these cells were used to create ‘immortal’ cell lines for vaccine and other drug research including research for several processed food additives. Many commonly used drugs were developed based on this type of research such as aspirin, Brufen®, Tylenol®, Benadryl, azithromycin and Zolof®.³³ Claiming a religious objection based on aborted foetal cell associated research would require people to refuse to take a wide range of medication that they have already been using for decades. Such arguments therefore fail the test of consistency and authenticity.³⁴

The South African Bill of Rights (section 36) specifies that any limitation of rights must be ‘reasonable and justifiable in an open and democratic society based on human dignity, equality and freedom’ and that the restriction must be proportional to the purpose of the limitation. Crucially, such restrictions must be based on scientific evidence and should not be arbitrary, discriminatory or unreasonable.

A public health ethics approach supports limitation of individual rights for the greater good and promotion of solidarity. Despite this, the South African government failed to implement mandates when they were most needed. It is, therefore, mainly private organisations that are implementing vaccine mandates.³⁵ In operationalising vaccination, according to the Siracusa Principles and the limitation clause of the Constitution, the least restrictive and intrusive means must be used. Options that are less restrictive than mandates include nudges and incentives. Some retail outlets are offering incentives to vaccination; these initiatives constitute a less restrictive strategy than mandatory vaccination, but as a behavioural strategy they may have small, only temporary benefits, increasing health promoting behaviours by 2–5 percentage points on average.³⁶ Such strategies have been implemented with variable efficacy in pre-pandemic times. They are unlikely to drive vaccine uptake sufficiently to control the pandemic. Vaccine mandates, on the other hand, have been shown to increase vaccine uptake by around 18 percentage points.³⁷ In South Africa, the private health insurer Discovery Limited successfully increased vaccine uptake amongst employees from 22% in September 2021 to 94% in November 2021.³⁸ Globally, studies are now emerging to demonstrate the efficacy of vaccine mandates.³⁹ Despite legal challenges to vaccine mandates in various work environments, the Commission for Conciliation, Mediation and Arbitration (CCMA), has so far supported vaccine mandates and ruled in favour of employers.^{40,41}

Further ethical and public health considerations

Sub-optimal vaccine uptake

Despite adequate supplies of vaccines in South Africa for over a year, coupled with education campaigns and improved access across the country, we remain well below the target of 300 000 doses per day. For the past month (March 2022), vaccine uptake has consistently remained at under 80 000 doses a day. Under these circumstances, the potential for vaccine wastage looms large. Previous media publications have already alluded to undisclosed wastage.^{42,43} This ought to have been a stimulus for government to introduce mandates because vaccine wastage, in and of itself, is unethical. Further reports from the Department of Health indicate that South Africa has 30 million vaccine doses for 2022. While Johnson & Johnson doses will only expire in 2023, around 90 000 Pfizer vaccines were destroyed due to expiration on 31 March 2022 as vaccine uptake had not improved in South Africa. Further doses of Pfizer vaccines will expire in June–July 2022.⁴⁴

Children are at risk in South Africa and other sub-Saharan countries

Globally, there were higher numbers of hospitalisations of children during the fourth wave than during previous waves due to the high transmissibility of the Omicron variant.⁴⁵ In sub-Saharan African

countries including South Africa, children with underlying conditions had higher morbidity and mortality related to Omicron infection than children in high-income countries.⁴⁶ Given that vaccine rollout started in adults, children over 5 years were offered vaccines only recently and uptake has not been sufficient. With schools reopening in South Africa, this is a high-risk group to trigger further outbreaks. In the Western Cape alone, only 19.27% of those aged 12–17 years are vaccinated with at least one dose.⁴⁷ Given that South Africa has a culture of multigenerational households, the youth risk infecting older family members who are also likely to have a higher prevalence of co-morbidities. Most importantly, compared to the previous three waves, more young people died of COVID-19 during the recent fourth wave.⁴⁴

The immunosuppressed remain at risk

HIV and COVID-19 are synergistic pandemics in South Africa. Almost 8 million of our population of 60 million is infected with HIV.⁴⁸ During the past 2 years, access to antiretroviral treatment has been sub-optimal. Furthermore, socio-economic conditions in South Africa make physical distancing challenging in informal settlements. Unsurprisingly, many HIV-infected people have low CD4 counts and are at risk of contracting other infections, including COVID-19. Studies have shown that HIV infection resulted in doubling of mortality resulting from COVID-19. This group of patients remains at high risk for COVID-19 and must be prioritised for vaccines and boosters.⁴⁹

Health systems remain under pressure

Although severity of disease with Omicron was significantly reduced, and healthcare institutions coped with the fourth wave admissions, it is important not to overlook the context of the national burden of all-cause disease. South Africa has a high burden from diseases including tuberculosis, HIV and non-communicable conditions.⁵⁰ All these may increase the risk of developing severe COVID-19 infection. During the four waves of COVID-19 infection, hospitals diverted treatment away from other non-COVID conditions and de-escalated elective procedures and surgery. For many patients with chronic conditions, treatment was interrupted and illnesses spiraled out of control. This was the harsh reality and consequence of unvaccinated patients occupying hospital beds and ICUs unnecessarily.⁵¹ If the fifth wave has a variant as severe or less severe than Omicron but with similar or higher transmissibility, hospitals could easily be overwhelmed, especially if uptake of booster doses is poor and if the 31.65% over 50 years in the Western Cape alone, remain unvaccinated.⁴⁷ In some high-income countries, monoclonal antibodies are in routine use in hospitals to treat COVID-19 symptoms.⁵² This is not the case in South Africa. Even though antiviral drugs like Paxlovid™ may become available in some settings to treat COVID-19 in the first 3 days of symptom onset, this will not be an option in South Africa due to potential high costs and lack of early diagnosis. Post-viral syndromes or long COVID linger for several months after natural infection and are straining clinical services globally including in South Africa.⁵³ A study of 6180 participants aged 18–69 years compared the risk of the vaccinated contracting long COVID compared to the unvaccinated. Researchers found a 41.1% decrease in the odds of self-reported long COVID at least 3 months later compared to socio-demographically similar study participants who were unvaccinated when infected.⁵⁴ Even more concerning are the long-term cardiovascular complications of natural COVID-19. If up to a year after a natural COVID-19 infection, even those who were not hospitalised for COVID-19 develop serious cardiovascular complications like stroke, thromboses and dysrhythmias, hospitals and medical practices could be busier than during pre-pandemic times.²⁴ Recent studies have also shown that natural COVID-19 infection causes significant brain damage.⁵⁵ As we approach winter, co-infection with SARS-CoV-2 and influenza viruses will pose a substantial risk as studies show worse outcomes when both viral illnesses co-exist.⁵⁶

Compassion fatigue amongst healthcare professionals

The pandemic has been physically and emotionally exhausting for healthcare professionals globally. South Africa is no exception. Healthcare professionals are becoming less sympathetic towards those who deliberately decline vaccines, especially if they have no medical

contraindication to justify an exemption.⁵⁷ Many have witnessed severe illness or death predominantly amongst the unvaccinated or partially vaccinated in the fourth wave.⁵⁸ Critical care staff have noted that patients who do not have COVID-19 have been deprived of timely care or access to an ICU because critical care units have been overrun by non-compliant COVID-19 patients despite an abundant vaccine supply in South Africa. If the fifth wave is closer to winter in South Africa, hospitals could become extremely busy due to a combination of illnesses. This will include COVID-19 and severe influenza, those with post-COVID-19 complications from the previous four waves, and non-COVID illnesses and trauma. A potential ethical dilemma could arise should critical care beds become severely limited. When all these patients are competing for beds, will vaccination status as a surrogate for prognosis become an important deciding factor? The basis for triage criteria is prognosis. Other factors being equal, an unvaccinated person may have a worse chance of recovery from severe COVID-19 than would a fully vaccinated person.⁵⁸ Triage decisions are challenging logistically and raise complex ethical concerns. It is important to document accurately the reasons patients refused to be vaccinated, within a supportive context where health professionals offer appropriate counselling to increase uptake. It may not be easily defensible to use vaccination status as a triage criterion in the absence of full documentation around reasons why vaccination has not taken place. Although it is unlikely that fully vaccinated and boosted patients will develop severe disease in future waves, co-infection with influenza could exacerbate the clinical presentation.⁵⁶ It is highly likely that partially vaccinated patients will be at risk. If, however, unvaccinated patients fill ICU and care facilities, this may reduce access for patients with non-COVID-19 illnesses requiring hospitalisation or critical care, and this is worrying. The death rate in the USA is about 13-fold higher in unvaccinated patients compared to those who have had two vaccine doses.⁵⁹ In South Africa, 90% of hospital patients who died were either unvaccinated or partially vaccinated.⁵⁸

Mandatory vaccination in health or care environments

Healthcare professionals are duty bound to protect patients and prevent harm – *primum non nocere*. Patient safety is a primary ethical obligation. It is also essential that health workers are appropriately protected. The South African Constitution in section 23 indicates that ‘Everyone has a right to fair labour practices’²⁷. Everyone includes employers and employees. It is incumbent on employees as far as possible to ensure a safe working environment for all. Counselling of medical and care staff about the benefits of vaccination is important, but within the context of the *Disaster Management Act*²⁹ and the *National Health Act*²⁸, the issue of public interest, health and safety also needs to be considered. Competing entitlements in the Bill of Rights can be resolved through appropriate application of section 36 of the South African Constitution in which limitation of rights in the interest of the public good may occur.

Vaccine mandates on university campuses

University campuses are high risk because they involve congregate activities in indoor lecture venues and in residences. Furthermore, the nature of academic programmes is such that unnecessary interruptions must be avoided at all costs. Outbreaks at academic institutions will potentially involve large numbers of students and staff making these settings high risk for ‘superspreader’ events.⁵⁹ Despite the potential for a new variant to cause relatively less severe disease, those who are symptomatic will need to isolate for a minimum of a week. Where many students are involved from different disciplines, the potential for disruption of teaching and/or examinations is substantial. Academic and administrative staff who are older and who may have co-morbidities are at risk in multigenerational contexts. Those with immunosuppression due to HIV and other diseases are also at risk. The University of the Witwatersrand and the University of the Western Cape, among others, have implemented vaccine mandates⁶⁰; University of Cape Town and Stellenbosch University are in the process of stakeholder engagement as part of the policy development process^{31,61}. Transitioning from online teaching to in-person education is imperative in South Africa given the digital divide between privileged and historically disadvantaged students. Vaccine mandates on university campuses are in the best interests of students and staff alike.

Vaccine mandates for international travel

International travel currently is impossible without proof of COVID-19 vaccination and negative test results, even post-Omicron. Prior to the pandemic, yellow fever vaccination was mandatory for entry into some countries. This is authorised by annex 7 of the International Health Regulations (2005) that provide an 'overarching legal framework that defines countries' rights and obligations in handling public health events and emergencies that have the potential to cross borders'⁶². Intended to protect the rights of travellers and airline staff, these regulations are legally binding in 196 countries. Article 31 of the International Health Regulations allows governments to require 'proof of vaccination or other prophylaxis, legitimising vaccine mandates in the context of international travel'. Consequently, vaccine mandates for airline travel are likely to be required for several months until COVID-19 is no longer regarded as a public health threat.

Recommendations

As long as COVID-19 incidence is high in some countries (in Europe, UK, Hong Kong), it remains a global threat due to international travel.^{63,64} All indoor congregate settings remain high risk environments in South Africa, even post-Omicron. The duration of exposure and ventilation are important contributing factors. Using the number of occupants as the only factor in indoor settings where prolonged exposure occurs (university campuses), is insufficient. Vaccine mandates and masking are important in such settings. Likewise, in indoor venues where masks are removed, such as restaurants or communal campus dining halls, proof of vaccination or recent negative COVID-19 tests (within 72 hours) are essential.

Conclusion

The combined effect of vaccine derived and natural immunity, warm weather and a younger population resulted in a less severe fourth or 'Omicron' wave in South Africa. Unlike healthcare systems in Europe and the USA, our hospitals were busy but not completely overwhelmed during this wave. In many ways, Omicron provided evidence that vaccines work. As we exit the fourth wave, a cautiously optimistic approach is warranted. However, South Africa has a high burden of disease that increases the risk of developing severe COVID-19 infection. This risk exists even if the next variant, predicted to appear in late April to May 2022^{64,65}, is more or less transmissible than Omicron. Long COVID and cardiovascular complications of COVID-19¹⁸ remain a challenge. Socio-economic impacts could potentially be catastrophic as clinical severity is unpredictable at the time a new variant is announced. The unvaccinated account for the majority of severe infections, blocking beds for patients with serious non-COVID conditions. Vaccines, including boosters, remain the mainstay of prevention and mandates will improve vaccine uptake, protect health and health systems and promote economic revival. A combination of non-pharmacological measures and high vaccine coverage will prepare us better for the fifth wave, irrespective of its severity. In South Africa, vaccine mandates for high-risk congregate settings will help us to achieve this end. The Department of Health has published new and somewhat confusing regulations that require vaccine certificates or negative COVID-19 tests in all indoor congregate settings exceeding 1000 people. Likewise, this requirement holds in outdoor venues exceeding 2000 people.⁶⁶ While this is a small step in the right direction, it leaves many other indoor congregate settings such as university campuses open to potential spread of infection where less than 1000 students spend long hours in indoor settings.

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Competing interests

I have no competing interests to declare.

References

1. De Vos P. The government could – and should – compel vaccinations in South Africa for the greater good. *The Daily Maverick*. 2021 Feb 07 [cited 2022 Mar 29]. Available from: <https://www.dailymaverick.co.za/opinionista/2021-02-07-the-government-could-and-should-compel-vaccinations-in-south-africa-for-the-greater-good/>
2. Moodley K. Why COVID-19 vaccines should be mandatory in South Africa. *The Conversation*. 2021 Nov 10 [cited 2022 Mar 29]. Available from: <https://theconversation.com/why-covid-19-vaccines-should-be-mandatory-in-south-africa-165682>
3. Cheadle H. Mandatory vaccine policies will survive a constitutional challenge. *The Daily Maverick*. 2021 Nov 10 [cited 2022 Mar 29]. Available from: <https://www.dailymaverick.co.za/article/2021-11-10-mandatory-vaccine-policies-will-survive-a-constitutional-challenge-legal-expert-halton-cheadle/>
4. De Vos P. The law and the greater good: Why I support a Covid-19 vaccine requirement at UCT. *The Daily Maverick*. 2021 Sep 15 [cited 2022 Mar 29]. Available from: <https://www.dailymaverick.co.za/article/2021-09-15-the-law-and-the-greater-good-why-i-support-a-covid-19-vaccine-requirement-at-uct-part-two/>
5. Moodley K. Vaccine mandates in South Africa: Where are they most needed? *The Conversation*. 2021 Dec 07 [cited 2022 Mar 29]. Available from: <https://theconversation.com/vaccine-mandates-in-south-africa-where-are-they-most-needed-173253>
6. Meuller B, Lutz E. US has far higher death rate than other wealthy countries. *New York Times*. 2022 Feb 01 [cited 2022 Mar 29]. Available from: <https://www.nytimes.com/interactive/2022/02/01/science/covid-deaths-united-states.html>
7. National Institute of Communicable Diseases. New variant detected in South Africa [webpage on the Internet]. c2021 [cited 2022 Mar 29]. Available from: <https://www.nicd.ac.za/new-covid-19-variant-detected-in-south-africa/#:~:text=The%20National%20Institute%20for%20Communicable,positive%20cases%20of%20variant%20B>
8. Mendelson M, Venter F, Moshabela M, Gray G, Blumberg L, de Oliveira T, et al. The political theatre of the UK's travel ban on South Africa. *Lancet*. 2021;398(10318):2211–2213. [https://doi.org/10.1016/S0140-6736\(21\)02752-5](https://doi.org/10.1016/S0140-6736(21)02752-5)
9. Mahase E. Omicron: South Africa says fourth wave peak has passed as it lifts curfew. *BMJ*. 2022;376, o7. <https://doi.org/10.1136/bmj.o7>
10. Mahase E. Covid-19: Hospital admission 50-70% less likely with omicron than delta, but transmission a major concern. *BMJ*. 2021;375, n3151. <https://doi.org/10.1136/bmj.n3151>
11. Bosman J, Smith M. US Covid death toll surpasses 900 000 as Omicron spread slows. *New York Times*. 2022 Feb 08 [cited 2022 Mar 29]. Available from: <https://www.nytimes.com/2022/02/04/us/us-covid-deaths.html>
12. South African Department of Health. Update on Covid-19 [webpage on the Internet]. SAcoronavirus. c2022 [cited 2022 Mar 30]. Available from: <https://sacoronavirus.co.za/2022/03/29/update-on-covid-19-tuesday-29-march-2022/>
13. The Scientists Collective. Variants, the fourth wave, vaccines and the unlikely of herd immunity: What might happen in South Africa? *Daily Maverick*. 2021 Nov 15 [cited 2022 Mar 30]. Available from: <https://www.dailymaverick.co.za/article/2021-08-15-variants-the-fourth-wave-vaccines-and-the-unlikelihood-of-herd-immunity-what-might-happen-in-south-africa/>
14. Moodley K, Rossouw T. What could fair allocation of an efficacious COVID-19 vaccine look like in South Africa? *The Lancet Global Health*. 2021;9(2):106–107. [https://doi.org/10.1016/S2214-109X\(20\)30474-5](https://doi.org/10.1016/S2214-109X(20)30474-5)
15. Moodley K. Vaccine inequity is unethical. *Nat Hum Behav*. 2022;6(2):168–169. <https://doi.org/10.1038/s41562-022-01295-w>
16. Collie S, Champion J, Moultrie H, Bekker L-G, Gray G. Effectiveness of BNT162b2 vaccine against omicron variant in South Africa. *New Engl J Med*. 2022;386(5):494–496. <https://doi.org/10.1056/NEJMc2119270>
17. Bekker L-G, Garrett N, Goga A, Fairall L, Reddy T, Yende-Zuma N, et al. Effectiveness of the Ad26.COV2.S vaccine in health-care workers in South Africa (the Sisonke study): Results from a single-arm, open-label, phase 3B, implementation study. *The Lancet*. 2022;399(10330):1141–1153. [https://doi.org/10.1016/S0140-6736\(22\)00007-1](https://doi.org/10.1016/S0140-6736(22)00007-1)



18. Zhang C, Maruggi G, Shan H, Li J. Advances in mRNA vaccines for infectious diseases. *Front Immunol*. 2019;10. <https://doi.org/10.3389/fimmu.2019.00594>
19. Polack FP, Thomas SJ, Kitchin N, Absalon J, Gurtman A, Lockhart S, et al. Safety and efficacy of the BNT162b2 mRNA Covid-19 vaccine. *N Engl J Med*. 2020;383(27):2603–2615. <https://doi.org/10.1056/NEJMoa2034577>
20. Anand P, Stahel VP. The safety of Covid-19 mRNA vaccines: A review. *Patient safety in surgery*. 2021;15(1):20. <https://doi.org/10.1186/s13037-021-00291-9>
21. Takuva S, Takalani A, Seocharan I, Yende-Zuma N, Reddy T, Engelbrecht I, et al. Safety of the single-dose Ad26.CoV2.S vaccine among healthcare workers in the phase 3b Sisonke study in South Africa [preprint]. *medRxiv*. 2021 Dec 21. <https://doi.org/10.1101/2021.12.20.21267967>
22. Barda N, Dagan N, Ben-Shlomo Y, Kepten E, Waxman J, Ohana R, et al. Safety of the BNT162b2 mRNA Covid-19 vaccine in a nationwide setting. *New Engl J Med*. 2021;385(12):1078–1090. <https://doi.org/10.1056/NEJMoa2110475>
23. Crook H, Raza S, Nowell J, Young M, Edison P. Long covid-mechanisms, risk factors, and management. *BMJ*. 2021;374, n1648. <https://doi.org/10.1136/bmj.n1648>
24. Xie Y, Xu E, Bowe B, Al-Aly Z. Long-term cardiovascular outcomes of COVID-19. *Nat Med*. 2022;28(3):583–590. <https://doi.org/10.1038/s41591-022-01689-3>
25. Schröder-Bäck P, Duncan P, Sherlaw W, Brall C, Czabanowska K. Teaching seven principles for public health ethics: Towards a curriculum for a short course on ethics in public health programmes. *BMC Med Ethics*. 2014;15(1):73. <https://doi.org/10.1186/1472-6939-15-73>
26. United Nations Economic and Social Council. Siracusa Principles on the limitations and derogation of provisions in the International Covenant on Civil and Political Rights [document on the Internet]. c1984 [cited 2022 Mar 29]. Available from: <https://www.refworld.org/pdfid/4672bc122.pdf>
27. Constitution of the Republic of South Africa. No 108 of 1996. *Government Gazette*; 1996. Available from: <https://www.gov.za/sites/default/files/images/a108-96.pdf>
28. Republic of South Africa. National Health Act 61 of 2003. Available from: <https://www.gov.za/documents/national-health-act>
29. Republic of South Africa. Declaration of a National State of Disaster. *Disaster Management Act, Republic of South Africa. Government Gazette No. 43096.313; 2022*. Available from: https://www.gov.za/sites/default/files/gcis_document/202004/43217gon457s.pdf
30. Department of Employment and Labour. Employment and Labour Minister issues new direction with regard to vaccination in the workplace [webpage on the Internet]. c2021 [cited 2022 Mar 29]. Available from: <https://www.labour.gov.za/employment-and-labour-minister-issues-new-direction-with-regard-to-vaccination-in-the-workplace>
31. University of Cape Town. Call for comment on draft UCT vaccine mandate policy [webpage on the Internet]. c2022 [cited 2022 Mar 29]. Available from: <https://www.news.uct.ac.za/article/-2021-12-20-call-for-comment-on-draft-uct-vaccine-mandate-policy>
32. Watkins D. Pope Francis urges people to get vaccinated against Covid-19. *Vatican News*. 2021 Aug 18 [cited 2022 Mar 29]. Available from: <https://www.vaticannews.va/en/pope/news/2021-08/pope-francis-appeal-covid-19-vaccines-act-of-love.html>
33. Zimmerman RK. Helping patients with ethical concerns about COVID-19 vaccines in light of fetal cell lines used in some COVID-19 vaccines. *Vaccine*. 2021;39(31):4242–4244. <https://doi.org/10.1016/j.vaccine.2021.06.027>
34. Wynia MK, Harter TD, Eberl JT. Why a universal COVID-19 vaccine mandate is ethical today. *Health Affairs Blog*. c2021 [cited 2022 Mar 29]. Available from: <https://www.healthaffairs.org/doi/10.1377/forefront.20211029.682797/full/>
35. Gore A. Why we are mandating vaccines for Discovery's SA based employees. *Business Day*. 2021 Sep 06 [cited 2022 Mar 29]. Available from: <https://www.businesslive.co.za/bd/opinion/2021-09-05-adrian-gore-why-we-are-mandating-vaccines-for-discoverys-sa-based-employees/>
36. Klüver H, Hartmann F, Humphreys M, Geissler F, Giesecke J. Incentives can spur COVID-19 vaccination uptake. *Proc Natl Acad Sci USA*. 2021;118(36), e2109543118. <https://doi.org/10.1073/pnas.2109543118>
37. Community Preventive Services Task Force. Increasing appropriate vaccination: Vaccination requirements for childcare, school and college attendance [document on the Internet]. c2016 [cited 2022 Mar 29]. Available from: https://www.thecommunityguide.org/sites/default/files/assets/Vaccination-Requirements-for-Attendance_1.pdf
38. BusinessTech. Why Discovery introduced mandatory vaccines in South Africa and why some workers said no [webpage on the Internet]. c2021 [cited 2022 Mar 29]. Available from: <https://businesstech.co.za/news/business/543028/why-discovery-introduced-mandatory-vaccines-in-south-africa-and-why-some-workers-said-no/>
39. Mills MC, Rüttenauer T. The effect of mandatory COVID-19 certificates on vaccine uptake: Synthetic-control modelling of six countries. *The Lancet Public Health*. 2022;7(1):15–22. [https://doi.org/10.1016/S2468-2667\(21\)00273-5](https://doi.org/10.1016/S2468-2667(21)00273-5)
40. Medical Brief. CCMA again rules in favour of employers over mandatory vaccinations [webpage on the Internet]. c2022 [cited 2022 Mar 29]. Available from: <https://www.medicalbrief.co.za/ccma-again-rules-in-favour-of-employers-over-mandatory-vaccinations/>
41. Medical Brief. Solidarity's urgent application to stop vaccine mandate dismissed by labour court [webpage on the Internet]. c2022 [cited 2022 Mar 29]. Available from: <https://www.medicalbrief.co.za/solidaritys-urgent-application-to-stop-vaccine-mandate-dismissed-by-labour-court/>
42. Tshikalange S. Low wastage of covid-19 vaccines in Gauteng at 0.12%. *TimesLive*. 2021 Jul 07 [cited 2022 Mar 29]. Available from: <https://www.timeslive.co.za/news/south-africa/2021-07-07-low-wastage-of-covid-19-vaccines-in-gauteng-at-012/>
43. Covid vaccines wasted – Gauteng. *The Citizen*. 2021 Nov 16 [cited 2022 Mar 29]. Available from: <https://www.citizen.co.za/news/covid-19/2909983/3636-covid-vaccines-wasted-gauteng/>
44. Crisp N, Acting Deputy Director General, Department of Health, Republic of South Africa: Cape Talk Radio interview with John Maytham; 2022 [cited 2022 Mar 29]. Available from: <https://lifepodcasts.fm/podcasts/144-afternoon-drive-with-john-maytham/episode/598632-the-sinopharm-roll-out>
45. Wang L, Berger NA, Kaelber DC, Davis PB, Volkow ND, Xu R. COVID infection severity in children under 5 years old before and after Omicron emergence in the US [preprint]. *medRxiv*. 2022 Jan 13. <https://doi.org/10.1101/2022.01.12.22269179>
46. Nachega JB, Sam-Agudu NA, Machezano RN, Rabie H, Van der Zalm MM, Redfern A, et al. Assessment of clinical outcomes among children and adolescents hospitalized with COVID-19 in 6 sub-Saharan African countries. *JAMA Pediatrics*. 2022;176(3), e216436. <https://doi.org/10.1136/bmjgh-2021-008315>
47. Western Cape Department of Health. COVID-19 Dashboard [webpage on the Internet]. c2022 [cited 2022 Mar 29]. Available from: <https://coronavirus.westerncape.gov.za/vaccine-dashboard>
48. Freer J, Mudaly V. HIV and covid-19 in South Africa. *BMJ*. 2022;376, e069807. <https://doi.org/10.1136/bmj-2021-069807>
49. Davies M-A. HIV and risk of COVID-19 death: A population cohort study from the Western Cape Province, South Africa [preprint]. *medRxiv*. 2020 Jul 3. <https://doi.org/10.1101/2020.07.02.20145185>
50. Mayosi BM, Lawn JE, Van Niekerk A, Bradshaw D, Abdool Karim SS, Coovadia HM, et al. Health in South Africa: Changes and challenges since 2009. *The Lancet*. 2012;380(9858):2029–2043. [https://doi.org/10.1016/S0140-6736\(12\)61814-5](https://doi.org/10.1016/S0140-6736(12)61814-5)
51. Mendelsohn AS, de Sá A, Morden E, Botha B, Boule A, Paleker M, et al. COVID-19 wave 4 in Western Cape Province, South Africa: Fewer hospitalisations, but new challenges for a depleted workforce. *S Afr Med J*. 2022;112(2):13496. <https://doi.org/10.7196/SAMJ.2022.v112i2.16348>
52. Ledford H. Hundreds of COVID trials could provide a deluge of new drugs. *Nature*. 2022;603:25–27. <https://doi.org/10.1038/d41586-022-00562-0>
53. Mendelson M, Nel J, Blumberg L, Madhi SA, Dryden M, Stevens W, et al. Long-COVID: An evolving problem with an extensive impact. *S Afr Med J*. 2020;111(1):10. <https://doi.org/10.7196/SAMJ.2020.v111i1.15433>
54. Ayoubkhani D, Bosworth M, King S. Self-reported long COVID after two doses of a coronavirus (COVID-19) vaccine in the UK [webpage on the Internet]. c2022 [cited 2022 Mar 29]. Available from: <https://bit.ly/3jzApx2>



55. Douaud G, Lee S, Alfaro-Almagro F, Arthofer C, Wang C, McCarthy P, et al. SARS-CoV-2 is associated with changes in brain structure in UK Biobank. *Nature*. Forthcoming 2022. <https://doi.org/10.1038/s41586-022-04569-5>
56. Swets MC, Russell CD, Harrison EM, Docherty AB, Lone N, Girvan M, et al. SARS-CoV-2 co-infection with influenza viruses, respiratory syncytial virus, or adenoviruses. *The Lancet*. Forthcoming 2022. [https://doi.org/10.1016/S0140-6736\(22\)00383-X](https://doi.org/10.1016/S0140-6736(22)00383-X)
57. Moodley K. COVID-19: 'A pandemic of the unvaccinated'? Compassion fatigue among healthcare professionals in South Africa. *S Afr Med J*. 2021;111(11):1040–1041.
58. Ebrahim Z. More than 90% of hospital deaths in the 4th wave are unvaccinated. *IOL*. 2021 Dec 17 [cited 2022 Mar 29]. Available from: <https://www.news24.com/health24/medical/infectious-diseases/coronavirus/covid-19-more-than-90-of-hospital-deaths-in-4th-wave-are-in-unvaccinated-partially-vaccinated-people-20211217>
59. Johnson AG, Amin AB, Ali AR, Hoots B, Cadwell BL, Arora S, et al. COVID-19 incidence and death rates among unvaccinated and fully vaccinated adults with and without booster doses during periods of delta and omicron variant emergence - 25 U.S. Jurisdictions, April 4–December 25, 2021. *MMWR Morb Mortal Wkly Rep*. 2022;71(4):132–138. <https://doi.org/10.15585/mmwr.mm7104e2>
60. Makhafola G. UFS joins Wits and UWC in implementing vaccine mandates for staff students on campus. *News24*. 2021 Nov 27 [cited 2022 Mar 29]. Available from: <https://www.news24.com/news24/southafrica/news/ufs-joins-wits-and-uwc-in-implementing-vaccine-mandate-for-staff-students-on-campus-20211127>
61. Stellenbosch University. Have your say about intended vaccine rule [webpage on the Internet]. c2021 [cited 2022 Mar 29]. Available from: <https://www.sun.ac.za/english/Lists/news/DispForm.aspx?ID=8810>
62. World Health Organization. International Health Regulations [webpage on the Internet]. c2021 [cited 2022 Mar 29]. Available from: https://www.who.int/health-topics/international-health-regulations#tab=tab_1
63. Rahimi F, Talebi Bezin Abadi A. The Omicron subvariant BA.2: Birth of a new challenge during the COVID-19 pandemic. *Int J Surg*. 2022;99:106261. <https://doi.org/10.1016/j.ijssu.2022.106261>
64. Gu H, Xie R, Adam DC, Tsui JL-H, Chu DK, Chang LDJ, et al. Genomic epidemiology of SARS-CoV-2 under an elimination strategy in Hong Kong. *Nat Commun*. 2022;13(1):736. <https://doi.org/10.1038/s41467-022-28420-7>
65. Meterlerkamp T. South Africa's fourth wave is waning but don't celebrate just yet say experts. *The Daily Maverick*. 2022 Jan 18 [cited 2022 Mar 29]. Available from: <https://www.dailymaverick.co.za/article/2022-01-18-south-africas-fourth-wave-is-waning-but-dont-celebrate-just-yet-say-experts/>
66. South African Government. Coronavirus alert level 1 [webpage on the Internet]. 2022 [cited 2022 Mar 29]. Available from: <https://www.gov.za/covid-19/about/coronavirus-covid-19-alert-level-1>