

# COVID-19, alcohol availability and suicide rates in South Africa

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## DECLARATION OF PLAGIARISM

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Dated: 28 August 2023

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Lastly, I would like to acknowledge explicitly that suicides tend to be very tragic events that affect lots of people profoundly. It is important to conduct quantitative research to improve our understanding of how we might prevent suicides, but we should never lose sight of the deeply personal, sensitive nature of the struggle at the centre of our inquiries.

## ABSTRACT

Investigations into COVID-19 and suicide have predominantly found no significant evidence of increased suicide rates, but few studies have been conducted in low- and middle-income countries and none in Sub-Saharan Africa. We used data from two nationally representative surveys of post-mortem investigations to estimate changes in suicide rates in South Africa associated with the COVID-19 pandemic and related events. We specifically explored variance in suicide rates coinciding with lockdown stages and periods of alcohol prohibition. We found no significant differences between suicide rates during the pandemic period (April 2020 to March 2021) compared to the prior survey period of 2017, but significant variation within the pandemic period. Periods of alcohol prohibition were protective with an estimated 6 fewer suicide deaths per day (RD = 5.82 [5.78, 5.86]) compared to periods of no or partial alcohol restriction. This constituted a 30% decrease in expected suicides under normal trading conditions. Cessation of alcohol prohibition had a negative effect and suicide rates during periods of no or partial alcohol restriction were significantly higher than in 2017. We conclude that in South Africa the observed null effect of the COVID-19 pandemic on annual suicide rates masks considerable temporal variation associated with restrictions, and periods of alcohol prohibition in particular.

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# PART A: RESEARCH PROTOCOL

## **Suicide rates and COVID-19 in South Africa**

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## Background

The WHO recognises suicide as a public health priority, with more than 700 000 people dying due to suicide every year globally. While most suicide research comes from high income countries, it is estimated that over 77% of global suicides in 2019 occurred in low and middle income countries.<sup>1</sup> The last comprehensive study on South African suicide rates was done in 2008, with several improvements having been made in the quality of available data in the interim.<sup>2</sup> In particular, data previously used for this purpose was limited by its heavily urban focus. Thus, the availability of nationally representative data from recent Injury Mortality Surveys (IMS) in 2009, 2017 and 2020/21 presents the opportunity to better understand the status quo with respect to suicide in South Africa.<sup>3,4,5</sup> In particular, this study explores how suicide rates may have been impacted by the COVID-19 pandemic and associated interventions.

### Theory:

Emile Durkheim's *Le Suicidé* was the first major text to theorise about which factors may affect suicide rates based on research using quantitative methods.<sup>6</sup> According to Durkheim, the most prevalent types of suicide were those owing to a lack of social integration or those following rapid social and economic upheaval.<sup>7</sup> Modern evidence has offered some support for these analyses, with research showing a rise in suicide rates in the US and Europe following the 2008 recession, and two new systematic

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<sup>1</sup> WHO suicide fact sheet June 2021. Last accessed at <https://www.who.int/news-room/fact-sheets/detail/suicide> on 4 October 2022.

<sup>2</sup> Burrows, Stephanie, and Lucie Laflamme. "Pattern analysis of suicide mortality surveillance data in urban South Africa." *Suicide and Life-Threatening Behavior* 38, no. 2 (2008): 209-220.

<sup>3</sup> Matzopoulos R, Prinsloo M, Bradshaw D, Pillay-van Wyk V, Gwebushe N, Mathews S, Martin L, Laubscher R, Lombard C, Abrahams N. The Injury Mortality Survey: A national study of injury mortality levels and causes in South Africa in 2009. Cape Town: South African Medical Research Council. ISBN: 978-1-920618-22-3.

<sup>4</sup> Prinsloo M, Mhlongo S, Dekel B, Gwebushe N, Martin L, Saayman G, Vellema J, Dempers J, Ketelo A, Ntsele S, Lombard C, Jewkes R, Abrahams N, Matzopoulos R. (2021). The 2nd Injury Mortality Survey: A national study of injury mortality levels and causes in South Africa in 2017. Cape Town: South African Medical Research Council. ISBN: 978-1-928340-53-9.

<sup>5</sup> The IMS 2021 report is not yet published.

<sup>6</sup> Durkheim, Emile. *Suicide: A study in sociology*. Routledge, 2005.

<sup>7</sup> Durkheim calls these "egoistic" and "anomic" suicide respectively. He also specifies two other kinds called "altruistic" and "fatalistic" suicide but these two are much less common, and thus excluded from the present discussion.

reviews offering some suggestion of increased suicide rates during emerging viral disease outbreaks.<sup>8,9</sup> Similarly, there are many studies which confirm that increased social support and strengthened relationships can be protective against suicide.<sup>10,11,12</sup>

Given that the COVID-19 pandemic clearly represents an example of social and economic upheaval, one might expect an increase in suicide rates as a result. However, many countries put in place additional support mechanisms early on in the pandemic and there is some evidence to suggest that communities may have strengthened their ties, offering added protection to at-risk individuals during this time.<sup>13,14</sup> Thus, Durkheim's two key considerations potentially motivate in opposite directions with respect to expected suicide rates during the pandemic.

### Research context:

From early on in the pandemic many media outlets published inaccurate or misleading reports of spikes in suicide rates.<sup>15,16</sup> Most of these claims have not been supported by subsequent research efforts. Pirkis et al. (2021) used an interrupted time-series

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<sup>8</sup> Zorteza, Tiago C., Connor TA Brenna, Mary Joyce, Heather McClelland, Marisa Tippet, Maxwell M. Tran, Ella Arensman et al. "The impact of infectious disease-related public health emergencies on suicide, suicidal behavior, and suicidal thoughts: A systematic review." *Crisis: The Journal of Crisis Intervention and Suicide Prevention* 42, no. 6 (2021): 474.

<sup>9</sup> Leaute, Edouard, Maeva Samuel, Hans Oh, Emmanuel Poulet, and Jérôme Brunelin. "Suicidal behaviors and ideation during emerging viral disease outbreaks before the COVID-19 pandemic: a systematic rapid review." *Preventive medicine* 141 (2020): 106264.

<sup>10</sup> Kleiman, Evan M., and Richard T. Liu. "Social support as a protective factor in suicide: Findings from two nationally representative samples." *Journal of affective disorders* 150, no. 2 (2013): 540-545.

<sup>11</sup> Šedivy, Nuša Zdravec, Tina Podlogar, David CR Kerr, and Diego De Leo. "Community social support as a protective factor against suicide: a gender-specific ecological study of 75 regions of 23 European countries." *Health & place* 48 (2017): 40-46.

<sup>12</sup> Compton, Michael T., Nancy J. Thompson, and Nadine J. Kaslow. "Social environment factors associated with suicide attempt among low-income African Americans: The protective role of family relationships and social support." *Social psychiatry and psychiatric epidemiology* 40, no. 3 (2005): 175-185.

<sup>13</sup> Chen, Xi, Yuchun Zou, and Haiyan Gao. "Role of neighborhood social support in stress coping and psychological wellbeing during the COVID-19 pandemic: Evidence from Hubei, China." *Health & Place* 69 (2021): 102532.

<sup>14</sup> Wasserman, Danuta, Miriam Iosue, Anika Wuestefeld, and Vladimir Carli. "Adaptation of evidence-based suicide prevention strategies during and after the COVID-19 pandemic." *World psychiatry* 19, no. 3 (2020): 294-306.

<sup>15</sup> Marzano, Lisa, Monica Hawley, Lorna Fraser, Eva Harris-Skillman, Yasmine Lainez, and Keith Hawton. "Have news reports on suicide and attempted suicide during the COVID-19 pandemic adhered to guidance on safer reporting? A UK-wide content analysis study." *Crisis: The Journal of Crisis Intervention and Suicide Prevention* (2022).

<sup>16</sup> Nabila Ashraf, Mir, Hannah Jennings, Nantu Chakma, Noshin Farzana, Md Saimul Islam, Toufiq Maruf, MM Jalal Uddin, Helal Uddin Ahmed, David McDaid, and Aliya Naheed. "Mental health issues in the COVID-19 pandemic and responses in Bangladesh: view point of media reporting." *Frontiers in Public Health* 9 (2021): 704726.

analysis to look at suicide rates in the first four months of the pandemic across 21 countries, finding no evidence of a significant increase relative to expected rates and, in fact, evidence of a *decrease* in 12/21 countries.<sup>17</sup> Secondary analyses which extended the time frame in either direction did generate a few outliers for whom increases were noted but overall the evidence corroborated the primary analysis's conclusions. However, concerns were raised about the fact that all 21 countries were high-income or upper-middle-income and thus account for less than 30% of global suicide deaths.<sup>18</sup> This is particularly problematic considering the increasingly available evidence that lower income countries were hit hardest by the pandemic in a multitude of ways.<sup>19</sup> Furthermore, this study was unable to stratify data by age or sex.

A second paper by Pirkis et al. (2022) ran a similar analysis except looking at a longer period of 9-15 months of pandemic suicide rates and using data from 33 countries, including three lower-middle-income countries.<sup>20</sup> Again, primary analysis supported the conclusion that for the majority of countries there was no evidence of an increase in suicide rates during the pandemic. Nonetheless, it was noted that more greater-than-expected suicide rates were observed over nine months than four, and similarly more were observed over 10-15 months than nine. This offers some suggestion of either a delayed negative effect of the pandemic, or a "bounce back" effect over longer periods. This study did stratify by age and sex, and did find certain groups in certain countries to show concerning increases in risk during the pandemic, but no consistent pattern was observable across all countries. Finally, it was noted that the lower-middle-income countries that were included featured prominently in the exceptional cases where greater-than-expected suicide rates were observed.

In spite of this, in a nested systematic review analysing 22 studies from 12 lower-

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<sup>17</sup> Pirkis, Jane, Ann John, Sangsoo Shin, Marcos DelPozo-Banos, Vikas Arya, Pablo Analuisa-Aguilar, Louis Appleby et al. "Suicide trends in the early months of the COVID-19 pandemic: an interrupted time-series analysis of preliminary data from 21 countries." *The Lancet Psychiatry* 8, no. 7 (2021): 579-588.

<sup>18</sup> Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2019 (GBD 2019) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME); 2020.

<sup>19</sup> Cash, Richard, and Vikram Patel. "Has COVID-19 subverted global health?." *The Lancet* 395, no. 10238 (2020): 1687-1688.

<sup>20</sup> Pirkis, Jane, David Gunnell, Sangsoo Shin, Marcos Del Pozo-Banos, Vikas Arya, Pablo Analuisa Aguilar, Louis Appleby et al. "Suicide numbers during the first 9-15 months of the COVID-19 pandemic compared with pre-existing trends: An interrupted time series analysis in 33 countries." *EClinicalMedicine* 51 (2022): 101573.

middle-income countries, Knipe et al (2022) concluded similarly to the prior two studies: that there was no good evidence of a significant increase in suicide rates, and indeed some evidence of decreased rates.<sup>21</sup> However, it is noted that the majority of studies included in this review were methodologically poor. Furthermore, most of them did not account for sex at all.

This last study is nested within a living systematic review, which also supports the notion of no clear evidence of increases in suicide rates during the pandemic.<sup>22</sup> Thus, while exceptions have been noted, this appears to be the general current in suicide research during this period.

### **Role of present study:**

Some general concerns exist about the possibility of data collection quality decreasing during the pandemic, potentially due to further demands on resources.<sup>23</sup> For all COVID-19 related research, more effort needs to be made to account for sex, whose importance in pandemic analyses has been emphasised by the global public health community as a potential risk factor, confounder or effect modifier.<sup>24</sup> In the present context, high quality research is particularly lacking for lower-middle-income countries. There is also a need for more studies which consider a longer segment of the pandemic period in their analysis. Finally, although the living systematic review has analysed 78 studies, not one of them has been from Sub-Saharan Africa, which naturally compounds the problem of having very few studies from lower-middle-income

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<sup>21</sup> Knipe, Duleeka, Ann John, Prianka Padmanathan, Emily Eyles, Dana Dekel, Julian PT Higgins, Jason Bantjes et al. "Suicide and self-harm in low-and middle-income countries during the COVID-19 pandemic: A systematic review." *PLOS Global Public Health* 2, no. 6 (2022): e0000282.

<sup>22</sup> Ann John, Emily Eyles, Roger T. Webb, Chukwudi Okolie, Lena Schmidt, Ella Arensman, Keith Hawton, Rory C. O'Connor, Nav Kapur, Paul Moran, Siobhan O'Neill, Luke A. McGuinness, Babatunde K. Olorisade, Dana Dekel, Catherine Macleod-Hall, Hung-Yuan Cheng, Julian P.T. Higgins, David Gunnell. The impact of the COVID-19 pandemic on self-harm and suicidal behaviour: update of living systematic review [version 2; peer review: 1 approved, 2 approved with reservations]. *F1000Research* 2021, 9:1097 (<https://doi.org/10.12688/f1000research.25522.2>)

<sup>23</sup> Pergolizzi, Joseph, Frank Breve, Peter Magnusson, Rohit Nalamasu, Jo Ann K. LeQuang, and Giustino Varrassi. "Suicide by opioid: exploring the intentionality of the act." *Cureus* 13, no. 9 (2021).

<sup>24</sup> Hawkes, Sarah, Sonja Tanaka, Athena Pantazis, Abhishek Gautam, Sylvia Kiwuwa-Muyingo, Kent Buse, and Anna Purdie. "Recorded but not revealed: exploring the relationship between sex and gender, country income level, and COVID-19." *The Lancet Global Health* 9, no. 6 (2021): e751-e752.

countries.

Therefore, similar research in South Africa can fulfil multiple roles in supporting existing research, being both a country in Sub-Saharan Africa and a lower-middle income country. Even better, available data allows for stratification by age and sex as well as the possibility of looking at an entire year of pandemic suicide rates. The goal of the present study is thus to contribute to a growing body of research on suicide and the pandemic by analysing how South African suicide rates changed during this period.

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## **Methods**

### **Research Aims:**

The two broad aims of this study are to: (1) explore temporal trends in suicide mortality in South Africa before and during the COVID-19 pandemic, and (2) investigate if various COVID-19 restrictions imposed in South Africa during 2020/21 are associated with significant changes in suicide mortality.

### **Objectives:**

1. To describe and compare the age-standardized mortality rate (ASMR) for suicides in South Africa for 2009, 2017 and 2020/21, for both sexes combined and by each sex separately.
2. To describe and compare age-specific rates of suicide mortality in South Africa for 2009, 2017, and 2020/21 for both sexes combined and by each sex separately.
3. To ascertain whether observed suicide rates in South Africa for the first year of the COVID-19 pandemic period from April 2020 to March 2021 differed

significantly from previous surveys in 2009 and 2017, after adjusting for age and sex.

4. To investigate the association between changes in lockdown levels — as impacting various degrees of curfew and alcohol prohibition — and changes in observed suicide rates in South Africa during the first year of the COVID-19 pandemic, adjusting for age and sex.

### Study Design:

This study uses cross-sectional data to conduct a retrospective interrupted time series analysis on completed suicides in 2009, 2017 and 2020/21.<sup>25,26</sup>

### Data sources:

The proposed analysis will be conducted using IMS data for 2009, 2017 and 2020/21.<sup>27,28,29</sup> The IMS is a nationally representative study of injury mortality in South Africa. Data is collected through a post-mortem investigation process at sampled mortuaries. This is conducted by fieldworkers who analyse post-mortem reports as well as any additional information appearing in case folders such as police reports or hospital records. Analysis weights are calculated and then applied to generate estimated weighted totals for non-natural deaths in South Africa. The present study will consider only those non-natural deaths classified in the IMS as suicides.

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<sup>25</sup> Bernal, James Lopez, Steven Cummins, and Antonio Gasparrini. "Interrupted time series regression for the evaluation of public health interventions: a tutorial." *International journal of epidemiology* 46, no. 1 (2017): 348-355.

<sup>26</sup> While the 2009 and 2017 editions of the IMS were implemented with the goal of informing the national burden of disease study, the 2020/21 survey purposively sampled deaths occurring during the COVID-19 period. The practical upshot of this difference is that the newest data covers a period from April 2020 to March 2021 as opposed to the previous surveys which cover one calendar year from start to finish.

<sup>27</sup> Matzopoulos R, Prinsloo M, Bradshaw D, Pillay-van Wyk V, Gwebushe N, Mathews S, Martin L, Laubscher R, Lombard C, Abrahams N. The Injury Mortality Survey: A national study of injury mortality levels and causes in South Africa in 2009. Cape Town: South African Medical Research Council. ISBN: 978-1-920618-22-3.

<sup>28</sup> Prinsloo M, Mhlongo S, Dekel B, Gwebushe N, Martin L, Saayman G, Vellema J, Dempers J, Ketelo A, Ntsele S, Lombard C, Jewkes R, Abrahams N, Matzopoulos R. (2021). The 2nd Injury Mortality Survey: A national study of injury mortality levels and causes in South Africa in 2017. Cape Town: South African Medical Research Council. ISBN: 978-1-928340-53-9.

<sup>29</sup> The IMS 2021 report is not yet published.

In order to convert suicide counts into rates, population data from the Thembisa Model (version 4.4) will be used.<sup>30</sup>

#### **Variable conceptualisation:**

The outcome variable for this study is *suicide rate*. Objectives 1-3 consider suicide rate as a monthly figure, whereas objective 4 zooms in to suicide rate as a weekly figure to better distinguish the different impacts of different lockdown regulations as they changed from week to week.

The exposure of interest for objective 3 is *IMS-year*, and all the associated experiences it represents ranging from the effects of the pandemic itself to the effects of those measures taken in response to it. This is operationalised with reference to which of the three surveys a given observation comes from.

For objective 4 the exposure of interest is *lockdown stage*. This will be operationalised by categorising different observations into groups based on the level of lockdown restrictions that were in place during the relevant week. The categorisations devised by Moultrie et al (see dummy tables below) will be used to classify which periods of the first year of the pandemic represented which levels of associated lockdown measures.<sup>31</sup>

Two further variables in the form of *sex* and *age* will be included in the analyses for objectives 3 and 4 as potential confounders. It is well established that both of the above variables are associated with suicide.<sup>32,33</sup> It is also extremely plausible that the

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<sup>30</sup>Johnson LF, et al. (2017) Estimating the impact of antiretroviral treatment on adult mortality trends in South Africa: a mathematical modelling study. *PLoS Medicine*; 14: e1002468

<sup>31</sup>Moultrie, T. A., R. E. Dorrington, R. Laubscher, P. Groenewald, C. D. H. Parry, R. Matzopoulos, and D. Bradshaw. "Unnatural deaths, alcohol bans and curfews: Evidence from a quasi-natural experiment during COVID-19." *South African Medical Journal* 111, no. 9 (2021): 834-837.

<sup>32</sup>Hawton, Keith, Carolina Casañas i Comabella, Camilla Haw, and Kate Saunders. "Risk factors for suicide in individuals with depression: a systematic review." *Journal of affective disorders* 147, no. 1-3 (2013): 17-28.

<sup>33</sup>Burrows, Stephanie, Marjan Vaez, and Lucie Laflamme. "Sex-specific suicide mortality in the South African urban context: The role of age, race, and geographical location." *Scandinavian journal of public health* 35, no. 2 (2007): 133-139.

impact of the COVID-19 period on individuals will have varied by age and sex. For instance, age is well understood to be a risk factor for COVID-19 severity.<sup>34,35</sup> Meanwhile, emergent research suggests that COVID-19 lockdowns may have, for example, had a differential effect on the working conditions of men and women; or disproportionately affected the incidence of crimes against women.<sup>36,37</sup> Since it is reasonable to expect age and sex to be responsible for variation in both exposure and outcome, they must be considered as potential confounders.

Sex here refers to biological sex as ascertained by the post-mortem investigation process, and is coded as male, female or undetermined. The ages of victims will be grouped into five categories, 0-14, 15-24, 25-34, 35-44 and 45+ in accordance with prior literature in this area in South Africa.<sup>38</sup> It is expected that both the age group 0-14 and the sex group undetermined will be negligibly small and if this is the case those groups will be excluded from analysis.

#### **Data analysis:**

Objectives 1 and 2 involve the calculation of suicide rates to be presented in tables. Direct standardisation using the WHO's World Standard Population will be used to control for differences in age distributions across sex groups.<sup>39,40</sup> Counts will be converted into rates by using population data from the Thembisa Model (version 4.4)

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<sup>34</sup> Verity, Robert, Lucy C. Okell, Ilaria Dorigatti, Peter Winskill, Charles Whittaker, Natsuko Imai, Gina Cuomo-Dannenburg et al. "Estimates of the severity of coronavirus disease 2019: a model-based analysis." *The Lancet infectious diseases* 20, no. 6 (2020): 669-677.

<sup>35</sup> Dudley, Joseph P., and Nam Taek Lee. "Disparities in age-specific morbidity and mortality from SARS-CoV-2 in China and the Republic of Korea." *Clinical Infectious Diseases* 71, no. 15 (2020): 863-865.

<sup>36</sup> Yildirim, T. Murat, and Hande Eslen-Ziya. "The differential impact of COVID-19 on the work conditions of women and men academics during the lockdown." *Gender, Work & Organization* 28 (2021): 243-249.

<sup>37</sup> Goel, Prarthna Agarwal, Joyita Roy Chowdhury, and Yashobanta Parida. "Can COVID-19 Lockdown Reduce Crimes Against Women? A District-Level Analysis from India." *Journal of Interdisciplinary Economics* (2022): 02601079221111006.

<sup>38</sup> Burrows, Stephanie, Marjan Vaez, and Lucie Laflamme. "Sex-specific suicide mortality in the South African urban context: The role of age, race, and geographical location." *Scandinavian journal of public health* 35, no. 2 (2007): 133-139.

<sup>39</sup> Ahmad, Omar B., Cynthia Boschi-Pinto, Alan D. Lopez, Christopher JL Murray, Rafael Lozano, and Mie Inoue. "Age standardization of rates: a new WHO standard." *Geneva: World Health Organization* 9, no. 10 (2001): 1-14.

<sup>40</sup> Naing, Nyi Nyi. "Easy way to learn standardization: direct and indirect methods." *The Malaysian journal of medical sciences: MJMS* 7, no. 1 (2000): 10.

for the denominator.<sup>41</sup> Rates will be reported as per 100,000 people, and accompanied by 95% confidence intervals.

For Objective 3 Poisson regression using suicide rates as count data will estimate the association between IMS-year (2009, 2017, 2020/21) and suicide count, generating rate ratios with 95% confidence intervals for interpretation.

For Objective 4 Poisson regression using 2020/21 weekly count data organised by different levels of lockdown regulations will estimate whether rates changed differently depending on different aspects of the COVID-19 period. Rate ratios and 95% confidence intervals will once more be reported and interpreted.

All analysis will be done using R.

### Dummy tables

*Table 1: Age-specific and age-standardised mortality rates for suicide in South Africa by IMS-year and sex*

	Suicide deaths per 100,000 (95% CI)						
Age group	0-14	15-24	25-34	35-44	45+	Total (crude)	Total (age-standardised)
2009 IMS							
Male							
Female							
Total							
2017 IMS							
Male							
Female							

<sup>41</sup> Johnson LF, et al. (2017) Estimating the impact of antiretroviral treatment on adult mortality trends in South Africa: a mathematical modelling study. PLoS Medicine; 14: e1002468

Total							
2020/21 IMS							
Male							
Female							
Total							

*Table 2: Relative risk of suicide by IMS-year, unadjusted and adjusted for age and sex, South Africa, 2009, 20017, 2020/21*

	Crude RR (95% CI)	Adjusted RR (95% CI)
IMS-year		
2017	1	1
2009		
2020/21		

*Table 3: Crude and adjusted rate ratios (RRs) with 95% CIs for suicide mortality by lockdown stage (2020/21 IMS-year only)*

	Crude RR (95% CI)	Adjusted RR (95% CI)
Lockdown stage		
No restriction on alcohol, no curfew	1	1
Level 5 lockdown: Full restriction, shelter-in-place curfew		
Full restriction on alcohol, 8 - 9 h curfew		
Partial restriction on alcohol (o-site sale restricted; on-site consumption banned), no curfew		
Full restriction on alcohol, 4 - 7 h curfew		
Partial restriction on alcohol (curbed for o-site sale), 4 - 7 h curfew		

No restriction on alcohol, 4 - 7 h curfew		
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### **Ethical considerations**

The surveys from which the primary datasets for this study come from all obtained ethical approval from the South African Medical Research Council (SAMRC), as well as permission to undertake their studies from each Provincial Department of Health, with access to mortuaries being granted by the respective Provincial Health Research Committees.

No new data will be collected for this study and all data will be de-identified by the SAMRC prior to handing over to Anthony Hodgson for analysis, following the confirmation of ethics approval for the study. De-identified data will be stored securely under password protection. To prevent the possibility of individuals being identified, data will be presented in aggregate form only. Upon completion of the project, and following a copy of the dataset being forwarded to the SAMRC for archival purposes, all datasets containing unit records will be destroyed.

As suicide is a deeply personal topic, whose instances affect individuals in very serious ways regardless of the statistical context, care will be taken to discuss results responsibly and make appropriately sensitive conclusions and recommendations.

### **Limitations**

This study is limited by the fact that, unlike ordinary interrupted time series analyses, we do not have access to data on suicide rates for the period immediately preceding the pandemic. This means that any attempt to improvise a prior trend analysis will be imperfect, and may fail to account for important factors affecting changes in suicide

rates immediately before the pandemic in South Africa. Additionally, there is some evidence to suggest that suicide rates in South Africa tend to fluctuate fairly erratically over time, which might bring into question the plausibility of a trend analysis to begin with.<sup>42</sup>

Thus, while the study is well positioned to measure whether there are significant differences in suicide rates between IMS-years, and between different levels of lockdown regulations, it is less well equipped to reliably comment on whether these results align with or differ from what we might have expected to see without the pandemic or associated lockdown regulations. The study takes seriously the conceptualisation of an appropriate counterfactual, and may make use of more than one conceptualisation for sensitivity analysis, but ultimately its strongest conclusions may be limited to the identification of differences in suicide rates across different periods.

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<sup>42</sup> Suicide mortality rate (per 100,000 population) - South Africa. WHO. Last accessed at <https://data.worldbank.org/indicator/SH.STA.SUIC.P5?end=2019&locations=ZA&start=2000> on 29 November 2022.

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**UNIVERSITY OF CAPE TOWN**  
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14 February 2023

**HREC REF: 036/2023**

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Dear Prof Matzopoulos

**PROJECT TITLE: SUICIDE RATES AND COVID-19 IN SOUTH AFRICA-  
(MASTERS DEGREE-MR A HODGSON)**

Thank you for your response letter, addressing the issues by the Faculty of Health Sciences Human Research Ethics Committee (HREC).

It is a pleasure to inform you that the HREC has **formally approved** the above-mentioned study.

**Approval is granted for one year until the 28 February 2024.**

Please submit a progress form, using the standardised Annual Report Form (FHS016) if the study continues beyond the approval period. Please submit a Standard Closure form if the study is completed within the approval period.

(Forms can be found on our website: [www.health.uct.ac.za/fhs/research/humanethics/forms](http://www.health.uct.ac.za/fhs/research/humanethics/forms))

***The HREC acknowledge that the student: Mr Anthony Hodgson will also be involved in this study.***

**Please quote the HREC REF 036/2023 in all your correspondence.**

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please note that for all studies approved by the HREC, the principal investigator **must** obtain appropriate institutional approval, where necessary, before the research may occur.

Yours sincerely

**PROFESSOR M BLOCKMAN**

**CHAIRPERSON, FACULTY OF HEALTH SCIENCES HUMAN RESEARCH ETHICS COMMITTEE**

Federal Wide Assurance Number: FWA00001637. Institutional Review Board (IRB) number: IRB00001938 NHREC-registration number: REC-210208-007

HREC/ref 036.2023

This serves to confirm that the University of Cape Town Human Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use: Good Clinical Practice (ICH GCP), South African Good Clinical Practice Guidelines (DoH 2020), based on the Association of the British Pharmaceutical Industry Guidelines (ABPI), and Declaration of Helsinki (2013) guidelines. The Human Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

# PART B: JOURNAL READY MANUSCRIPT

## **COVID-19, alcohol availability and suicide rates in South Africa**

Anthony Hodgson

HDGANT004

Word count: 4024 (+1493 Methods section)

Tables: 6 (+3 Supplementary Tables)

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Formatted for submission to Nature Mental Health, in accordance with guidelines for Analysis category presented below.

### **Analysis**

An Analysis is a new analysis of existing data, describes new data obtained in a comparative analysis or introduces a new simulation or model that leads to novel and arresting conclusions of importance to a broad audience. Systematic reviews or meta-analyses of primary research literature in the public health and biomedical fields, or in the social sciences, can also be accommodated by this format.

#### Format

- Main text – up to 4,000 words (excluding abstract, online Methods, references and figure legends).
- Abstract – 100–150 words, unreferenced.
- Display items – up to 8 items (figures and/or tables).
- Analyses should be divided as follows:
  - Introduction (without heading)
  - Results
  - Discussion
  - Online Methods.
- Results and online Methods should be divided by topical subheadings; the Discussion does not contain subheadings.
- References – as a guideline, we typically recommend up to 50.
- Analyses include received/accepted dates.
- Analyses may be accompanied by supplementary information.
- Analyses are peer reviewed.

## **Abstract**

Investigations into COVID-19 and suicide have predominantly found no significant evidence of increased suicide rates, but few studies have been conducted in low- and middle-income countries and none in Sub-Saharan Africa. We used data from two nationally representative surveys of post-mortem investigations to estimate changes in suicide rates in South Africa associated with the COVID-19 pandemic and related events. We specifically explored variance in suicide rates coinciding with lockdown stages and periods of alcohol prohibition. We found no significant differences between suicide rates during the pandemic period (April 2020 to March 2021) compared to the prior survey period of 2017, but significant variation within the pandemic period. Periods of alcohol prohibition were protective with an estimated 5.82 [5.78, 5.86] fewer suicide deaths per day compared to periods of no or partial alcohol restriction. This constituted a 30% decrease in expected suicides under normal trading conditions. Cessation of alcohol prohibition had a negative effect and suicide rates during periods of no or partial alcohol restriction were significantly higher than in 2017. We conclude that in South Africa the observed null effect of the COVID-19 pandemic on annual suicide rates masks considerable temporal variation associated with restrictions, and periods of alcohol prohibition in particular.

## **Main**

The WHO recognises suicide as a public health priority, with more than 700,000 suicide deaths every year globally.<sup>1</sup> While most suicide research comes from high-income countries, it is estimated that 77% of global suicides occur in low- and middle-income countries (LMIC).<sup>2</sup> The last detailed epidemiological study on South African suicide rates was published in 2008,<sup>3</sup> with several improvements having been made in the quality of available data in the interim. In particular, data previously used for this purpose was limited by its urban bias. The availability of nationally representative data from recent Injury Mortality Surveys (IMS) in 2017 and 2020/21 presents the opportunity to better understand the status quo with respect to suicide in South Africa.<sup>4</sup> This study explored how suicide rates may have been impacted by the COVID-19 pandemic and associated interventions — with a particular

interest in the impact of alcohol restrictions which were implemented intermittently during this period.

The pandemic has had far-reaching mental health consequences,<sup>5</sup> with many initially concerned that this would lead to increased suicide rates.<sup>6</sup> Suicide researchers dating as far back as Durkheim have theorised connections between rapid social and economic upheaval and suicide rates.<sup>7</sup> Two recent systematic reviews offer some suggestion of increasing suicide rates during previous viral disease outbreaks.<sup>8,9</sup> However, research has confirmed that factors such as increased social support<sup>10,11</sup> and strengthened relationships<sup>12</sup> can be protective against suicide and many countries did introduce additional mental health support mechanisms early in the pandemic.<sup>13,14</sup>

In practice, the emergent research on COVID-19 has fairly consistently provided evidence to suggest that suicide rates did not increase with the advent of the global pandemic.<sup>15,16</sup> However, it is a major limitation that most of these studies focus almost exclusively on high-income countries, thus accounting for less than 30% of global suicide deaths.<sup>17</sup> This is particularly problematic considering the devastating socioeconomic impact the pandemic has had on LMIC, with one study estimating that 77% of the population across four low-income countries lived in households that had lost income during the pandemic.<sup>18</sup>

In a nested systematic review analysing 22 studies from 12 LMIC, Knipe et al (2022) concluded similarly to prior research: that there was no evidence of a significant increase in suicide rates, and indeed some evidence of decreased rates.<sup>19</sup> The full review also broadly supports the notion of no clear evidence of increases in suicide rates during the pandemic.<sup>20</sup> It must be noted though that the majority of studies reviewed pertaining to LMIC were described as methodologically poor, with many studies lacking comparator data to meaningfully approximate any sort of counterfactual analysis. This, combined with the fact that to our knowledge there have been zero studies looking at suicide rates and the pandemic coming out of Sub-Saharan Africa, exposes an urgent need for the present investigation.

While many high-income countries introduced a host of targeted mental health interventions during the pandemic,<sup>21</sup> solutions of this scale were notably absent in South Africa. However, the South African government did variously limit, restrict, and ban the sale of alcohol during this period in an effort to curb the strain on public health facilities by reducing trauma admissions.<sup>22</sup> Early evidence suggests that bans were effective in reducing access to alcohol, with studies showing a corresponding reduction in unnatural deaths across the board.<sup>23,24,22</sup>

Narrowing in, there is good reason to expect that limiting the availability of alcohol could have a protective effect with respect to mental health in general and suicide in particular.<sup>25</sup> Existing academic literature consistently highlights alcohol as a significant risk factor for suicide.<sup>26,27</sup> Numerous studies have found a strong association between alcohol misuse and increased suicide rates, with individuals who engage in heavy drinking or have alcohol use disorders being particularly vulnerable.<sup>28,29</sup> One meta-analysis reports that individuals engaging in high levels of acute drinking are 37 times more likely to attempt suicide than those who aren't.<sup>26</sup> Alcohol consumption has been shown to be associated with depressive symptoms, impulsive behaviours, and impaired decision-making, all of which are factors strongly linked to suicidal behaviour.<sup>30,31</sup> Moreover, the presence of alcohol in suicide cases often indicates a higher lethality, increasing the likelihood of suicide deaths.<sup>32,33</sup>

South Africa's COVID-19 alcohol bans function as a natural experiment, which can contribute to the knowledge base by directly analysing a clear temporal relationship between alcohol availability and suicide rates. Consequently, this study has two major aims: first, to measure whether the pandemic period itself is associated with a change in suicide rates and, second, to measure whether suicide rates *within* the pandemic period varied according to changes in alcohol availability regulations.

## **Results**

Our initial raw dataset included 7291 suicides recorded across the two years, 2017 and 2020/21. 86 observations (1.18%) were missing age data and thus removed from the dataset ahead of analysis. A further 148 observations (2.03%) were removed due to missing

weighting variables, while a subsequent 3 observations (0.04%) were removed due to missing date of death data. Finally, those observations with sex classified as undetermined were removed on account of the fact they made up only 2/7054 (0.03%) remaining rows. Thus, a total of 239 observations (3.28%) were removed from the raw dataset, resulting in a primary dataset of 7052 observations.

Analysis weights were implemented (as calculated for the IMS reports) and samples of 3330 and 3961 suicide deaths were estimated to weighted totals of 6113 and 6302 for 2017 and 2020/21 respectively. Supplementary Table A details the unweighted and weighted numbers of suicide deaths for each year, for each of South Africa's nine provinces.

### **Age and sex of suicide decedents**

Table 1 shows the age-specific and age-standardised mortality rates per 100,000 population (with 95% confidence intervals) for suicide in South Africa by year and sex. This allows for a first level of comparison between different survey years. Age-standardised rates were fairly consistent between 2017 (10.90 [10.53, 11.27]) and 2020/21 (10.82 [10.48, 11.15]).

Across both years overall suicide rates were 4-5 times higher for males than females but this ratio varied considerably within age groups. For males, we observed a consistent pattern in risk by age group across both surveys, with the highest suicide rates estimated for the age group 25-34 with estimates of 32.73 [31.18, 34.27] and 30.38 [28.88, 31.87] for 2017 and 2020/21 respectively. These were followed by the age groups 35-44, 45+, 15-24 and 0-14.

In contrast, female suicide rates peaked in both surveys at 15-24 with estimates of 6.56 [5.83, 7.29] and 8.14 [7.33, 8.96] for 2017 and 2020/21 respectively. In both years, the second highest female rates of suicide were observed in the age group 25-34, followed by 35-44, 45+ and 0-14.

By comparing the most at-risk age groups for each sex between 2017 and 2020/21, we observed that suicide rates for males aged 25-34 decreased from 32.73 [31.18, 34.27] to 30.38 [28.88, 31.87] whereas suicide rates for females aged 15-24 increased from 6.56

[5.83, 7.29] to 8.14 [7.33, 8.96]. This is also echoed by the overall age-standardised estimates by sex, with male rates decreasing from 18.28 [17.59, 18.97] to 18.01 [17.39, 18.63] and female rates increasing from 4.12 [3.81, 4.44] to 4.16 [3.87, 4.45] between 2017 and 2020/21.

### **Association between year and suicide rate**

Table 2 reports modelled estimates for suicide rate by year, both overall and stratified by sex and age group. Neither the overall model (0.99 [0.96, 1.03]) nor the models stratified only by sex (male: 0.99 [0.95, 1.02]; female: 1.01 [0.93, 1.09]) indicated a statistically significant difference in suicide rate (reference 2017).

However, within age strata we did observe some variation, particularly among females. Estimates suggest an increase among younger females (0-14: 1.41 [0.99, 2.02], 15-24: 1.24 [1.07, 1.45]) combined with a decrease among older females (35-44: 0.90 [0.74, 1.10], 45+: 0.85 [0.73, 0.99]). However, it is important to note the fairly wide confidence intervals for 0-14, as well as the fact that confidence intervals for 35-44 and 45+ include or are very near to the null value.

### **Association between lockdown stage and suicide rate**

We analysed South Africa's broader lockdown restrictions to investigate whether suicide rates varied with them. Lockdown restrictions were organised into stages ranging from 1-5 with stage 5 being the most stringent and stage 1 the most relaxed. Full details of official stage designations are available in Supplementary Table B, including descriptions of the types of restrictions imposed.

Table 3 presents overall and stratified RRs (with 95% confidence intervals) for each lockdown stage. Using stage 5 as a reference level, the overall estimated RRs for stages 4-1 were 1.15 [1.00, 1.33], 1.35 [1.21, 1.51], 1.79 [1.58, 2.04] and 1.62 [1.45, 1.81], respectively. This reveals a pattern of increasing suicide rates in conjunction with lockdown measures being further relaxed, with stages 1, 2 and 3 all significantly higher than the reference level.

## **Overall association between alcohol availability and suicide rate**

Next, we conducted planned subgroup analyses to determine whether suicide rates varied with alcohol availability levels specifically. Table 4 presents daily suicide rates (with 95% confidence intervals) from April 2020 to March 2021, disaggregated by alcohol and curfew restrictions. These categories include three periods of outright alcohol ban and three periods of no or partial restriction on alcohol, and are described in more detail Supplementary Table B. Our preliminary estimates suggested a sizable difference between suicide rates when comparing periods of outright alcohol ban to those of no or partial ban, with per day suicide estimates of 13.55 [12.92, 14.18] for the overall ban period and 19.37 [19.02, 19.73] for the overall no or partial ban period. This amounts to a Rate Difference of 5.82 [5.78, 5.86], or approximately 6 fewer suicides per day when comparing periods of outright alcohol ban to periods of no or partial ban.

Table 5 presents overall and stratified (by sex and age group) RRs with 95% confidence intervals for each Alcohol/Curfew status, using the same categories as above. The initial (stage 4 and 5) hard lockdown period with full restriction on alcohol was taken as the reference level as this represents the first part of the pandemic period chronologically. In what follows, we report estimates in order from most restrictive to least, starting with “Full restriction on alcohol, 8-9h curfew”, and ending with “No alcohol restriction, 4h curfew”.

While we did not observe any significant difference between the three periods that include full restriction on alcohol — with estimated RRs of 1.13 [1.01, 1.26] and 1.06 [0.95, 1.19] respectively — we observed statistically significant evidence that the three other periods saw an increase in suicide rate, with estimated RRs of 1.45 [1.31, 1.60], 1.54 [1.42, 1.66] and 1.38 [1.24, 1.54] respectively. These estimates suggest an increased suicide risk of approximately 40% during periods of unrestricted or partly restricted alcohol access as compared to the initial hard lockdown period used as a reference.

## **Association between alcohol availability and suicide rate, as stratified by sex and age group**

Stratification by sex does reveal more about this picture, but broadly reinforces the notion that periods of no or partial alcohol restriction saw an increase in suicide rates relative to the baseline initial hard lockdown period.

For males, periods of full alcohol restriction yielded estimates of 1.19 [1.05, 1.34] and 0.99 [0.87, 1.13] whereas the three periods of no or partial alcohol restriction yielded estimates of 1.48 [1.32, 1.65], 1.58 [1.45, 1.73] and 1.45 [1.29, 1.64]. Although one of the ban periods has a slightly higher estimate, when considering estimates along with their 95% confidence intervals, the clear upshot of the male results is to reinforce the same thesis as the overall results: that suicide rates were relatively constant across different periods of outright alcohol ban, but higher during periods of no or partial ban.

For females, periods of full alcohol restriction yielded estimates of 0.90 [0.69, 1.16] and 1.31 [1.04, 1.65] compared to the three periods of no or partial restriction at 1.35 [1.16, 1.63], 1.37 [1.16, 1.63], and 1.11 [0.86, 1.42], respectively. Again, while the two total restriction periods have estimates to either side of the null, once including their confidence intervals both are consistent with a null, or very small, effect. Most striking here is that while the two periods of partial restriction show expected increases in suicide among females, the last period, which included no alcohol restrictions at all, indicates only a very small positive effect.

The most striking results from our stratification are revealed when analysing results as stratified by both sex and age group. The majority of age groups among males support the overall pattern described above, with estimates close to the null for periods of full alcohol restriction and estimates considerably higher for periods of no or partial restriction.

However, for females, of the 10 estimates generated based on five age groups and two categories of total alcohol restriction compared to our reference, only three estimates are below the null value, with the other seven distributed above it (ranging from 1.05 [0.36, 2.82] to 2.03 [0.88, 4.82]). This must be qualified by the fact that our female sample is much smaller than our male sample, and our estimates for subgroups are thus much less precise,

with eight out of the above ten estimates having 95% confidence intervals that include the null value. Notable exceptions are the period “Full restriction on alcohol, 6-7 hour curfew” for females aged 15-24, with an estimate of 1.79 [1.14, 2.81] and the period “Full restriction on alcohol, 8-9h curfew” for females aged 35-44 with an estimate of 0.32 [0.12, 0.70].

### **Scaling alcohol/curfew period results to compare to a 2017 baseline**

Table 6 presents simulated annual figures for each restriction period alongside the annual suicide rate for 2017. These are presented with corresponding rates per 100,000 people. Using our 2017 estimate of 10.88 [10.61, 11.15] as a baseline, it was noted rather clearly that the three scaled periods representing full alcohol restriction generated lower estimates of 8.07 [7.51, 8.64], 8.55 [7.80, 9.31] and 9.05 [8.26, 9.84] respectively while the three scaled periods where alcohol was either partially or not restricted at all generated higher estimates of 11.11 [10.19, 12.04], 12.39 [11.96, 12.83] and 11.69 [10.87, 12.50] respectively.

This pattern was even more pronounced when expressed as a daily figure, as in Table 4 above, with 2017 (16.75 [16.54, 16.96]) suicide rates falling somewhere in between 2020/21 alcohol ban rates (13.55 [12.92, 14.18]) and 2020/21 no or partial alcohol restriction rates (19.37 [19.02, 19.73]). As expected from the results of our year model, when taking 2020/21 as a whole, the daily rate of 17.27 [17.05, 17.49] was much more consistent with 2017.

### **Discussion**

This study corroborates the increasing body of evidence from different parts of the world which has by and large failed to find statistically significant evidence of a change in suicide rates following the COVID-19 pandemic. This is an important addition to existing research, given doubts about whether this pattern would also be observed in LMIC, whose less resilient healthcare systems may have been less able to effectively curb the various impacts of the pandemic.<sup>34</sup> To our knowledge this is also the first study of its kind to be done in Sub-Saharan Africa. South Africa is an interesting case because of the government’s decision to institute various restrictions on alcohol during the course of the pandemic, which appear to have mitigated against some of the harms associated with the pandemic period.<sup>35</sup>

The nature of this particular intervention has allowed for robust analytical approaches which treat alcohol prohibition as a type of natural experiment to compare those periods against similar periods where alcohol was available. This is the rationale that informed our second set of analyses, which compared suicide rates across different periods of alcohol availability in South Africa for the first year of the pandemic. We found that periods of outright alcohol ban were associated with a significant protective effect with respect to suicide. We estimated that an average of 6 fewer suicide deaths per day took place during periods of outright alcohol ban when compared to periods of no or partial restriction — an effective 30% decrease in expected suicides under normal trading conditions. In total this amounts to approximately 768 suicide deaths prevented over 132 days of outright alcohol prohibition. This is a large and meaningful number of lives saved, and it further corroborates recent works by Moultrie et al., Barron et al. and Chu et al. who all found evidence of a significant decrease in unnatural deaths, but not suicide specifically, during periods of outright alcohol ban.<sup>24,23,22</sup>

Importantly, when comparing the above intervention periods to our 2017 dataset as a baseline, we also conversely saw higher suicide rates during periods where alcohol was available. This suggests that rather than suicide risk having been entirely unaffected by the pandemic, more likely what we have observed is the aggravating effect of the pandemic being balanced out by the mitigating impact of various alcohol ban periods. This is consistent with Pirkis et al. who have argued that their evidence of non-increasing suicide rates during the pandemic could partly be attributable to rapidly introduced government interventions which may have had a protective effect.<sup>15</sup>

This line of argument is further supported by a closer look at our findings with respect to sex and age group. While the differing observed peak at-risk ages by sex, as well as the overall much higher prevalence for males, are consistent with previous research on suicide rates in South Africa,<sup>3</sup> our results are clear in suggesting a protective effect of total alcohol restriction on male suicide rates, but much more mixed in relation to females, whose suicide rates may have varied in unrelated ways. What is particularly revealing is a comparison of how suicide rates among the highest risk groups shifted between 2017 and 2020/21. Our

results indicated a 7% decrease in suicides among the highest risk male age group, 25-34, and conversely a 19% increase in suicides among the highest risk female age group, 15-24. This appears to support the notion that different causal influences may have pushed suicide rates in competing directions for different subgroups. Specifically, if a key factor driving average suicide rates down during the COVID-19 period was alcohol bans, we would naturally expect this to have a more pronounced impact on men, who make up a much larger proportion of problem drinkers in South Africa.<sup>36</sup> Indeed, according to the South Africa Demographic and Health Survey 2016, 61% of men aged 25-34 had drunk alcohol in the last 12 months, and 22% of men in this age group showed signs of problem drinking. In comparison, only 21% of women aged 15-24 had drunk alcohol in the last 12 months, with only 3% of that age group showing signs of problem drinking.<sup>37</sup> While the above analysis helps to corroborate our interpretation, it should also bring attention to the fact that further research is required to better understand how the pandemic impacted suicide rates among vulnerable subgroups.

While we did further categorise periods of alcohol restriction in relation to their associated curfew durations, our analysis did not focus on the curfews themselves, given that the literature in this area suggests the impacts of curfews on mortality rates to be negligible.<sup>24,22</sup> This is consistent with our Table 4 results, which suggest only minimal variation in suicide rates when alcohol restrictions are held constant and only curfew duration adjusted. Similarly, our analysis grouped alcohol restrictions in relation to “total bans” compared to “no or partial” restrictions, on the basis that the developing research base has found minimal impacts of partial restrictions, in comparison to large and meaningful changes when alcohol was completely banned. Again, this is consistent with our results as reported in Table 4, with periods of partial restriction on average representing similar estimates to periods of no restriction on alcohol.

Ultimately, our results are clear in showing both: evidence of suicide rates decreasing within alcohol ban periods, and no evidence of suicide rates changing overall compared to 2017. Neither of these results is surprising in the context of existing literature, with many studies demonstrating both clear associations between alcohol consumption and suicidal behaviour,<sup>38</sup> and a consistent pattern of non-increasing average suicide rates with the

pandemic.<sup>20</sup> What is novel in the present study is needing to make sense of these two phenomena together. How can it be that pandemic suicide rates are the same as those beforehand if rates decreased at various points during the pandemic? The simplest explanation would be to consider that but for South Africa's alcohol bans, we would expect to have observed an increase in suicide rates. When comparing different periods of alcohol availability to 2017, our results corroborate this explanation. This provides additional support for what were at the time seen as extremely controversial policy decisions with respect to alcohol during the pandemic.<sup>39</sup>

It must however be noted that a key limitation of this study was that we lacked the ideal counterfactual for causal inference because data for the period immediately prior to the pandemic was not available for analysis. This is particularly important for our first analysis as it is impossible to know the extent to which we may actually have measured how suicide rates changed *between* 2017 and 2020/21 rather than subsequent to the advent of the pandemic. Similarly, if suicide rates had increased *before* rather than during the pandemic, this could easily undermine our argument that alcohol bans balanced out what might otherwise have been a pandemic-related increase in rates. Although there is no immediately apparent reason to think that suicide rates would have increased during this interim period, the possibility is nonetheless a challenge to robust counterfactual analysis. More regular and ongoing IMS data collection is necessary for stronger causal claims to be made in this regard.

Although we have described projected annual suicide rates for alcohol ban periods in order to compare them to prior survey periods, it is important to note that extrapolating from these results to demonstrate the actual impact a longer ban might have relies on tenuous speculation. First, there is no reason to take for granted the assumption that periods of alcohol availability would maintain the same characteristics over a much longer duration. Second, it is very likely the presence of a longer term ban would see society shifting to a new equilibrium, perhaps involving illegally acquired or home-made alcohol as an alternative, or substituting alcohol for other recreational drugs, some of which could be even more harmful. Thus, our results should not be seen as evidence supporting long term prohibition but rather evidence of the impact alcohol's presence has on suicide rates,

strengthening arguments that alcohol consumption is an important risk factor for suicide.

It is also unclear how generalisable our results might be to other contexts. Among those who drink, the prevalence of heavy episodic drinking (defined as 60 or more grams of pure alcohol on at least one occasion, at least once per month) in South Africa is 59%, compared to a global average of 40%.<sup>36</sup> It is plausible that alcohol restrictions are more likely to have protective health impacts in contexts where binge drinking is more prevalent.

Caution must also be exercised in interpreting subgroup analyses given the fact that Injury Mortality Surveys use sampling targeted at national representativeness rather than subgroup representativeness. Our results do indicate a need for further research here, to better understand how different risk groups may have been impacted by the pandemic and associated alcohol restrictions.

Finally, as our study only considers the first year of the pandemic, it is unknown whether COVID-19 may have precipitated an increase in suicide rates in the long-run in South Africa. This warrants ongoing monitoring, particularly in the absence of continued alcohol bans, which appear to have mitigated against such an increase in the short-term.

In conclusion, our study supports the growing body of evidence which suggests that suicide rates did not increase with the COVID-19 pandemic. While it has been hypothesized that this may be a result of protective interventions masking potential negative impacts of the pandemic, our study provides some empirical support for such a theory, by demonstrating that periods of outright alcohol ban were associated with lower suicide rates than prior surveyed periods while periods of no or partial alcohol ban were associated with higher suicide rates than prior surveyed periods.

## **Methods**

### **Study Design:**

This study used cross-sectional data to conduct a retrospective before and after study on suicide deaths in 2017 and 2020/21 and explored the impact of alcohol bans on suicide rates in 2020/21.<sup>40</sup>

While the 2017 edition of the IMS was implemented with the goal of informing the national burden of disease study, the 2020/21 survey purposively sampled deaths occurring during the COVID-19 period. The practical upshot of this difference is that the newest data covers a period from April 2020 to March 2021 as opposed to the previous surveys which cover one calendar year from start to finish.

#### **Data sources:**

Analysis was conducted using IMS data for 2017 and 2020/21.<sup>4</sup> The IMS 2021 report is not yet published. The IMS is a nationally representative study of injury mortality in South Africa. Data are collected through a post-mortem investigation process at sampled mortuaries. This is conducted by fieldworkers who analyse post-mortem reports as well as any additional information appearing in case folders such as police reports or hospital records. Analysis weights are calculated and then applied to generate estimated weighted totals for non-natural deaths in South Africa. Weight calculations are based on the number and size of mortuaries randomly selected in each stratum of the total number of facilities in the 8 provinces, with the Western Cape dataset representing a complete sample of all suicide deaths in the province and thus not requiring any estimation. Further methodological details have been published elsewhere.<sup>4</sup>

We considered only those non-natural deaths classified in the IMS as suicides.

Supplementary Table A contains a full breakdown of unweighted and weighted suicides by province for each year. Data were aggregated into counts based on age group (0-14, 15-24, 25-34, 35-44 and 45+), biological sex (male, female, undetermined) and year (2017, 2020/21). Mid-year population estimates from the Thembisa Model (version 4.6) were used to convert counts into rates.<sup>41</sup> The Thembisa Model is a mathematical model, originally designed to answer policy questions related to HIV in South Africa, which has increasingly

also become a reliable source of demographic statistics and projections in South Africa.<sup>42</sup> For the 2020/21 data, as the survey covers exactly 9 months of 2020 and 3 months of 2021, composite population estimates were created by summing the products of 2020-population\*0.75 and 2021-population\*0.25.

### **Variable conceptualisation:**

The outcome variable for this study was *suicide rate*. Each row in our original dataset represents an individual suicide death. These individual observations are aggregated into groups based on our other variables of interest to create *suicide counts*. The counts are then treated as *rates* in Poisson models by using the population estimate for each group as an offset in our models.

The exposure of interest for our first set of models was *year*, and all the associated experiences it represents ranging from the effects of the pandemic itself to the effects of those measures taken in response to it. This was operationalised with reference to which of the two surveys a given observation came from. For the 2017 survey used for comparison, the variable refers to the ordinary calendar year. However, for our exposure year itself the period ranges from 1 April 2020 until 31 March 2021 in order to accurately reflect the first year of the pandemic period.

For our second set of models the exposures of interest were *lockdown level* followed by *alcohol/curfew status*. These were operationalised by categorising different observations into groups based on the level of lockdown restrictions that were in place during the relevant week. In contrast to the year models, which use an offset in modelling to adjust for population, these models include an offset to adjust for *number of days*, given that different lockdown regulations were applied for different lengths of time. The same categories used by Chu et al were used to classify which periods of the first year of the pandemic represented which levels of associated alcohol/curfew restrictions.<sup>22</sup> Curfew measures were considered when analysing alcohol availability because each period of alcohol restriction coincided with some level of curfew and the added layer of stratification could help to clarify the effects of the alcohol restrictions themselves.

Two further variables in the form of *sex* and *age group* were included in our analyses as potential effect modifiers. It is well established that both of the above variables are associated with suicide.<sup>43,3</sup> It is also plausible that the impact of the COVID-19 period on individuals will have varied by age and sex. For instance, age is well understood to be a risk factor for COVID-19 severity.<sup>44,45</sup> Meanwhile, emergent research suggests that COVID-19 lockdowns may have, for example, had a differential effect on the working conditions of men and women; or disproportionately affected the incidence of crimes against women.<sup>46,47</sup> Since it is reasonable to expect age and sex to be responsible for variation in both how the pandemic and associated lockdown measures were experienced, and individuals' propensity for suicidal behaviour, we have good reason to treat these two variables as effect modifiers. Similar evidence exists to suggest associations between age group, sex and patterns of alcohol use and abuse, making it appropriate to consider the same two demographic variables as effect modifiers for our second set of analyses as well.<sup>48</sup>

Sex here refers to biological sex as ascertained by the post-mortem investigation process, and is coded in the raw dataset as male, female or undetermined. The undetermined category was removed ahead of analysis, as only 2/7054 (0.03%) observations were designated this way ahead of our final analysis dataset. The ages of victims were grouped into five categories, 0-14, 15-24, 25-34, 35-44 and 45+ in accordance with prior literature in this area in South Africa.<sup>49</sup>

After reviewing the available data, consideration was also made for a potential temporal effect as captured by *month* or *day of week*. *Month* can easily be motivated for as a potential effect modifier in a similar fashion to *sex* and *age group*. Lots of evidence exists to suggest a seasonal effect on suicide rates,<sup>50,51</sup> and we also know that the pandemic's effects peaked and troughed over time in a pattern commonly referred to as "waves". Thus it is plausible that *month* might causally influence the relationship between our exposure and outcome variables. *Day of week* is also often reported to be associated with suicide deaths.<sup>52,53</sup> We considered both variables to assess whether they might be suitable to operationalise as effect modifiers in this study but ultimately neither was included in final

analyses. Crude RR's for their association with suicide rate are documented in Supplementary Table C.

### **Data analysis:**

For our descriptive tables, direct standardisation using the WHO's World Standard Population was used to control for differences in age distributions across sex groups.<sup>54,55</sup> Counts were converted into rates by using population data from the Thembisa Model (version 4.6) for the denominator.<sup>56</sup> All rates were reported as per 100,000 people, and accompanied by 95% confidence intervals.

We fit models using Poisson regression. The logs of the population/duration parameters were included as offsets in our respective models in order to model rates as opposed to counts and thus implicitly control for changes in underlying population sizes and changes in underlying alcohol/curfew status durations respectively.

Following the activation of weights, our suicide counts contained decimal places which are inappropriate for this type of modelling. As such, counts were rounded off to the nearest integer value as part of the estimation process.

Our first set of models estimated the association between *year* (2017, 2020/21) and *suicide rate*, generating rate ratios (RR) with 95% confidence intervals for interpretation. Overall models, total models by sex, and stratified models by age group within each sex group were fitted and reported. 2017 was used as a reference level as this is the "before" in our before and after study, with the 2020/21 pandemic period therefore being the "after" in the implied counterfactual analysis.

Our second set of models estimated associations between *lockdown stage* as well as *alcohol/curfew status* and *suicide rate*, generating rate ratios with 95% confidence intervals for interpretation. Once again, overall models, total models by sex, and stratified models by age group within each sex group were fitted and reported. For both lockdown stage and alcohol/curfew status, the most extreme level of restriction was used as a reference level,

given that this reflects the first part of the surveyed period.

Finally, using simple arithmetic transformations, we projected crude overall rates per year and rates per 100,000 people (with 95% confidence intervals) for each *alcohol/curfew status* period, in order to scale them up for a comparison against our 2017 estimates as a baseline. This involved calculating daily suicide rates for alcohol/curfew periods, then multiplying them by 365 to compare to 2017. This yearly projected rate could then be divided by a population estimate and multiplied by 100,000 to produce a projected per 100,000 rate for comparison. Both projected rates also include 95% confidence intervals.

Age-adjustment was calculated in Microsoft Excel, version 2305. All modelling was done in R, version 4.3.0.

## Tables

*Table 1: Age-specific and age-standardised mortality rates for suicide in South Africa by year and sex (N = 12415)*

	Suicide deaths per 100,000 [95% CI]						
Age group	0-14	15-24	25-34	35-44	45+	Total (crude)	Age-standardised
<b>2017</b>							
Male	1.61 [1.33, 1.89]	19.83 [18.57, 21.09]	32.73 [31.18, 34.27]	25.05 [23.46, 26.64]	21.59 [20.36, 22.83]	18.04 [17.54, 18.54]	18.28 [17.59, 18.97]
Female	0.64 [0.47, 0.82]	6.56 [5.83, 7.29]	5.52 [4.88, 6.16]	4.96 [4.26, 5.66]	4.74 [4.23, 5.25]	4.08 [3.85, 4.32]	4.12 [3.81, 4.44]
Total	1.13 [0.96, 1.29]	13.21 [12.48, 13.94]	19.23 [18.39, 20.07]	14.93 [14.06, 15.79]	12.06 [11.45, 12.67]	10.88 [10.61, 11.15]	10.90 [10.53, 11.27]
<b>2020/21</b>							
Male	1.60 [1.33, 1.87]	20.79 [19.49, 22.09]	30.38 [28.88, 31.87]	25.91 [24.39, 27.43]	20.96 [19.80, 22.12]	17.78 [17.29, 18.27]	18.01 [17.39, 18.63]
Female	0.91 [0.71, 1.12]	8.14 [7.33, 8.96]	5.32 [4.69, 5.95]	4.48 [3.85, 5.12]	4.03 [3.58, 4.48]	4.12 [3.89, 4.34]	4.16 [3.87, 4.45]
Total	1.26 [1.09, 1.43]	14.50 [13.73, 15.26]	17.92 [17.11, 18.73]	15.22 [14.39, 16.04]	11.45 [10.88, 12.02]	10.78 [10.52, 11.05]	10.82 [10.48, 11.15]

*Table 2: Relative risk of suicide by year (2017 reference), stratified by Sex and Age Group. South Africa, 2017, 2020/21 (N = 12415)*

Group	RR [95% CI]
Male	
Total	0.99 [0.95, 1.02]
0-14	1.00 [0.78, 1.27]

15-24	1.05 [0.96, 1.15]
25-34	0.93 [0.87, 0.99]
35-44	1.03 [0.95, 1.13]
45+	0.97 [0.90, 1.05]
<b>Female</b>	
Total	1.01 [0.93, 1.09]
0-14	1.41 [0.99, 2.02]
15-24	1.24 [1.07, 1.45]
25-34	0.97 [0.82, 1.14]
35-44	0.90 [0.74, 1.10]
45+	0.85 [0.73, 0.99]
<b>Total (all groups)</b>	0.99 [0.96, 1.03]

*Table 3: Relative Risk of suicide by Lockdown stage (Alert level 5 reference), stratified by Sex and Age Group. South Africa, 2020/21 (N = 6302)*

	Lockdown stage [95% CI]			
	Alert level 4	Alert level 3	Alert level 2	Alert level 1
<b>Male</b>				
Total	1.05 [0.90, 1.23]	1.29 [1.14, 1.46]	1.71 [1.49, 1.97]	1.61 [1.43, 1.82]
0-14	0.73 [0.34, 1.53]	0.74 [0.43, 1.33]	0.72 [0.34, 1.49]	0.52 [0.29, 0.96]
15-24	1.21 [0.84, 1.74]	1.35 [1.02, 1.82]	1.93 [1.40, 2.69]	1.83 [1.39, 2.46]
25-34	0.93 [0.71, 1.23]	1.19 [0.97, 1.48]	1.58 [1.24, 2.01]	1.42 [1.16, 1.75]
35-44	0.83 [0.57, 1.22]	1.41 [1.08, 1.88]	1.95 [1.44, 2.67]	1.98 [1.52, 2.62]
45+	1.38 [1.01, 1.89]	1.42 [1.11, 1.85]	1.76 [1.32, 2.37]	1.68 [1.31, 2.18]
<b>Female</b>				
Total	1.64 [1.27, 2.16]	1.62 [1.26, 2.14]	2.21 [1.65, 2.98]	1.64 [1.27, 2.16]
0-14	2.26 [0.63, 10.5]	2.50 [0.90, 10.4]	3.24 [1.01, 14.3]	1.38 [0.47, 5.91]
15-24	3.63 [1.75, 8.50]	3.80 [2.00, 8.45]	7.28 [3.72, 16.40]	3.95 [2.07, 8.78]

25-34	2.37 [1.13, 5.42]	2.74 [1.47, 5.81]	2.94 [1.45, 6.58]	2.56 [1.37, 5.46]
35-44	0.97 [0.48, 1.95]	0.86 [0.51, 1.53]	0.99 [0.51, 1.97]	1.13 [0.68, 2.00]
45+	1.12 [0.66, 1.90]	0.94 [0.62, 1.47]	1.02 [0.60, 1.73]	0.96 [0.64, 1.50]
<b>Total (all groups)</b>	1.15 [1.00, 1.33]	1.35 [1.21, 1.51]	1.79 [1.58, 2.04]	1.62 [1.45, 1.81]

*Table 4: Total suicide deaths by Alcohol/Curfew period, South Africa, 2020/21 (N = 6302)*

<b>Alcohol/Curfew status</b>	<b>Duration (days)</b>	<b>Total suicide deaths</b>	<b>Deaths per day (95% CI)</b>
Full restriction on alcohol, hard lockdown	61	789	12.93 [12.03, 13.83]
Full restriction on alcohol, 6-7h curfew	36	493	13.69 [12.49, 14.90]
Full restriction on alcohol, 8-9h curfew	35	507	14.50 [13.24, 15.76]
No alcohol restriction, 4h curfew	31	552	17.80 [16.31, 19.28]
Partial restriction on alcohol, 4-6h curfew	160	3176	19.85 [19.16, 20.54]
Partial restriction on alcohol, 7h curfew	42	786	18.71 [17.41, 20.02]
<b>Totals (any curfew)</b>			
Full restriction on alcohol	132	1789	13.55 [12.92, 14.18]
No or partial restriction on alcohol	233	4514	19.37 [19.02, 19.73]
2017 (for comparison)	365	6114	16.75 [16.54, 16.96]

Table 5: Relative risk of suicide by Alcohol/Curfew status (full restriction on alcohol, hard lockdown as reference), stratified by Sex and Age Group. South Africa, 2020/21 (N = 6302)

	Alcohol/Curfew status [95% CI]				
	Full restriction on alcohol, 8-9h curfew	Full restriction on alcohol, 6-7h curfew	Partial restriction on alcohol, 7h curfew	Partial restriction on alcohol, 4-6h curfew	No alcohol restriction, 4h curfew
<b>Male</b>					
Total	1.19 [1.05, 1.34]	0.99 [0.87, 1.13]	1.48 [1.32, 1.65]	1.58 [1.45, 1.73]	1.45 [1.29, 1.64]
0-14	0.37 [0.14, 0.84]	0.79 [0.39, 1.49]	1.30 [0.75, 2.22]	0.59 [0.37, 0.95]	1.26 [0.69, 2.27]
15-24	1.16 [0.87, 1.53]	1.01 [0.75, 1.35]	1.33 [1.03, 1.72]	1.64 [1.35, 2.01]	1.59 [1.21, 2.08]
25-34	1.24 [1.00, 1.53]	0.80 [0.63, 1.02]	1.54 [1.27, 1.87]	1.51 [1.30, 1.77]	1.38 [1.11, 1.71]
35-44	1.13 [0.83, 1.52]	1.30 [0.98, 1.73]	1.95 [1.52, 2.51]	2.19 [1.79, 2.70]	1.62 [1.22, 2.15]
45+	0.37 [0.14, 0.84]	0.79 [0.39, 1.49]	1.30 [0.75, 2.22]	0.59 [0.37, 0.95]	1.26 [0.69, 2.27]
<b>Female</b>					
Total	0.90 [0.69, 1.16]	1.31 [1.04, 1.65]	1.35 [1.08, 1.68]	1.37 [1.16, 1.63]	1.11 [0.86, 1.42]
0-14	1.05 [0.36, 2.82]	2.03 [0.88, 4.82]	1.60 [0.67, 3.83]	1.14 [0.58, 2.46]	1.18 [0.40, 3.18]
15-24	1.41 [0.87, 2.28]	1.79 [1.14, 2.81]	1.53 [0.98, 2.41]	2.09 [1.49, 3.01]	1.76 [1.09, 2.81]
25-34	1.35 [0.78, 2.29]	1.48 [0.88, 2.47]	1.92 [1.21, 3.08]	1.62 [1.11, 2.44]	1.27 [0.71, 2.21]
35-44	0.32 [0.12, 0.70]	0.72 [0.37, 1.31]	1.19 [0.71, 1.97]	1.07 [0.73, 1.62]	1.13 [0.63, 1.97]
45+	1.05 [0.36, 2.82]	2.03 [0.88, 4.82]	1.60 [0.67, 3.83]	1.14 [0.58, 2.46]	1.18 [0.40, 3.18]
<b>Total (all groups)</b>	1.13 [1.01, 1.26]	1.06 [0.95, 1.19]	1.45 [1.31, 1.60]	1.54 [1.42, 1.66]	1.38 [1.24, 1.54]

*Table 6: Projected annual 2020/21 suicide rates by Alcohol/Curfew status, compared to 2017 baseline. South Africa*

<b>Alcohol/Curfew status</b>	<b>Rate per year [95% CI]</b>	<b>Rate per 100,000 people [95% CI]</b>
2017 baseline	6114 [5961, 6267]	10.88 [10.61, 11.15]
Full restriction on alcohol, hard lockdown	4718 [4389, 5048]	8.07 [7.51, 8.64]
Full restriction on alcohol, 6-7h curfew	4998 [4557, 5439]	8.55 [7.80, 9.31]
Full restriction on alcohol, 8-9h curfew	5291 [4831, 5752]	9.05 [8.26, 9.84]
No alcohol restriction, 4h curfew	6496 [5954, 7038]	11.11 [10.19, 12.04]
Partial restriction on alcohol, 4-6h curfew	7245 [6993, 7497]	12.39 [11.96, 12.83]
Partial restriction on alcohol, 7h curfew	6831 [6353, 7308]	11.69 [10.87, 12.50]

### **Supplementary Tables**

*Supplementary Table A: Total suicide deaths by province and year, unweighted and weighted, South Africa, 2017 and 2020/21*

	<b>Year</b>			
	2017 (unweighted)	2017 (weighted)	2020/21 (unweighted)	2020/21 (weighted)
<b>Province</b>				
Western Cape	639	639	718	718
Eastern Cape	356	817	505	926
Northern Cape	73	103	113	163

Northwest	223	313	316	407
Mpumalanga	266	396	344	608
Gauteng	586	1429	640	1335
Free State	301	391	262	310
Kwazulu Natal	684	1621	772	1253
Limpopo	202	404	291	582
<b>Total</b>	<b>3330</b>	<b>6113</b>	<b>3961</b>	<b>6302</b>

*Supplementary Table B: South Africa's Lockdown and Alcohol/Curfew levels, 1 April 2020 – 31 March 2021*

	<b>Description</b>	<b>Date range</b>	<b>Duration (days)</b>
<b>Lockdown stage</b>			
Alert level 5	Drastic measures to contain the spread of the virus and save lives	1 April – 30 April 2020	30
Alert level 4	Extreme precautions to limit community transmission and outbreaks, while allowing some activity to resume	1 May – 31 May 2020	31
Alert level 3	Restrictions on many activities, including workplaces and socially, to address high risk of transmission	1 June – 17 August 2020; 29 December 2020 – 28 February 2021	140
Alert level 2	Physical distancing and restrictions on leisure and social activities to prevent a resurgence of the virus.	18 August – 20 September 2020	34

Alert level 1	Most normal activity can resume, with precautions and health guidelines followed at all times.	21 September – 28 December 2020; 1 March – 31 March 2021	130
<b>Alcohol/Curfew status</b>			
Full restriction on alcohol, hard lockdown	No alcohol sales	1 April – 31 May 2020	61
Full restriction on alcohol, 6-7h curfew	No alcohol sales	13 July – 17 August 2020	36
Full restriction on alcohol, 8-9h curfew	No alcohol sales	29 December 2020 – 1 February 2021	35
No alcohol restriction, 4h curfew	Alcohol fully available	1 March – 31 March 2021	31
Partial restriction on alcohol, 4-6h curfew	Alcohol sales for off-site consumption permitted, weekdays 09:00-17:00	18 August – 28 December 2020; 2 February – 28 February 2021	160
Partial restriction on alcohol, 7h curfew	Alcohol sales for off-site consumption permitted, weekdays 09:00-17:00	1 June – 12 July 2020	42

*Supplementary Table C: Univariable models for Relative Risk of suicide by day of week and month, South Africa, 2017 and 2020/21 (N = 12415)*

<b>Covariate</b>	<b>Crude RR [95% CI]</b>
<b>Day of week</b>	
Friday	-
Monday	1.30 [0.77, 2.20]
Tuesday	1.07 [0.63, 1.79]
Wednesday	1.06 [0.63, 1.78]

Thursday	0.95 [0.57, 1.61]
Saturday	1.13 [0.67, 1.89]
Sunday	1.27 [0.75, 2.14]
<b>Month</b>	
January	-
February	0.91 [0.54, 1.56]
March	0.98 [0.58, 1.67]
April	0.90 [0.53, 1.54]
May	0.92 [0.54, 1.57]
June	0.95 [0.55, 1.62]
July	0.99 [0.58, 1.68]
August	0.91 [0.53, 1.55]
September	1.16 [0.68, 1.97]
October	1.20 [0.71, 2.05]
November	1.06 [0.62, 1.81]
December	1.25 [0.73, 2.13]

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