

# Does suicide in New Zealand follow a semi-lunar rhythm?

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## ABSTRACT

The hypothesis that lunar cycles influence human behaviour, particularly incidents recorded by police or coroners, has been a topic of public and media interest around the world for decades. While connections between lunar cycles and numerous cultural practices are well-documented, claims that lunar cycles influence crime or suicide statistics have not been consistently supported. There have been recent media claims that suicide rates in New Zealand follow a lunar cycle, correlating with the Māori Maramataka lunar calendar. Building on prior research, this study scrutinises the postulated association between lunar phases and suicide rates, for general and Māori populations.

Utilising 2 decades (2000–2022) of data from the National Coronial Information System (NCIS) and the New Zealand Ministry of Health – Manatū Hauora, the study employs Poisson regression models and cosine curve analyses. Results reveal no significant correlation between lunar phases and suicide rates for the overall population or the Māori sub-group. The absence of a lunar effect persists across univariate and multivariate analyses, incorporating annual, seasonal and day-of-the-week variations.

Contrary to claims linking lunar phases to Māori suicide rates, this study provides a robust analysis of comprehensive suicide data. While acknowledging potential limitations, such as the diversity among Maramataka systems and unaccounted external factors, this study emphasises the need for evidence-based practices in mental health interventions. Further research is warranted to explore potential lunar influences on less severe mental health indicators and to substantiate claims supporting traditional Māori Maramataka-based treatments.

The practice of keeping time by the moon possibly dates back as far as the Palaeolithic period.<sup>1,2</sup> Many cultural, ethnic and religious groups, including Jews, Chinese, Muslims and Hindus, still use a lunar calendar.<sup>3</sup> For almost as long as the lunar cycle has been observed there has been speculation that human health and energy is altered with different phases of the moon. The words “moon”, “month” and “menses” all have the same etymological root, and a belief in a link between moon phases and menstrual cycling is common in many cultures. However, the scientific debate over whether this link is real, whether in industrialised or non-industrialised societies, remains unresolved, with many papers on both sides being published over decades.

In terms of mental health, the word “lunatic” is derived from *Luna*, the Roman goddess of the moon. This is not just ancient belief, as modern healthcare workers and the general public have said they believe in the influence of the moon on human behaviour.<sup>4</sup> However, various studies around the world have been unable to show any robust link between moon phases and mental health markers.<sup>10</sup> A notable exception is a study of elderly suicide in the Chinese community that showed a lower rate during the Chinese Lunar

New Year, which occurs on the new moon that falls between 21 January and 20 February. The authors attributed a possible cause as family companionship, which is culturally appropriate at that time of year,<sup>11</sup> and might be similar to the finding that suicide rates can reduce during major holidays in Denmark.<sup>12</sup> However, without replication, this may be a false positive result, as was suggested had occurred with a Finnish study that showed a relationship between suicide and a lunar calendar.<sup>13</sup>

Like Chinese, Māori have traditionally noted the movements of the moon to mark time. The Maramataka is a lunar calendar and traditional Māori belief suggests that some days of the lunar cycle are better to do certain activities.<sup>14</sup> In a news article and national broadcast in New Zealand,<sup>15</sup> two Maramataka experts highlighted the well-documented disproportionate rate of suicide among Māori<sup>16,17</sup> and suggested that there is a link between the moon phases and suicide in New Zealand: they are quoted as stating that 35% of Māori suicides occurred on the new moon and 16% on the full moon, based on 10 years of coronial suicide data. They were invited to present the findings to the New Zealand Mental Health Foundation.<sup>18</sup> Another New Zealand researcher

has also claimed that suicides are greater at different lunar phases.<sup>19</sup> However, in both cases the data are unpublished, and the methodology is not well documented. Analysis may be complicated by the fact that different iwi use slightly different calendars, with their respective Ōhua or Huna (days of the full moon) occurring up to 5 days apart.<sup>20,21,22</sup>

If there is a connection between the lunar cycle and suicide, it might be possible to design more effective interventions and preventative programmes. Despite a lack of published evidence, the Maramataka has been suggested as a tool for improving mental health,<sup>23</sup> and the New Zealand Mental Health Foundation and Canterbury Health board support All Right?, which provides Maramataka calendars that they claim “highlight the connection between the moon and our wellbeing.”

This study aims to test the hypothesis that there is an effect of lunar phase on rates of suicide in New Zealand generally and, specifically, among Māori.

## Methods

This study utilised routinely collected health data to analyse the rates of suicide in New Zealand over the lunar cycle.

### Data sources, extraction and processing

With ethics approval (AHREC #AH24778), we extracted date of death and prioritised ethnicity for confirmed suicides in New Zealand from two primary sources: the National Coronial Information System (NCIS) for suicides between 26 October 2006 and 18 September 2022, and the New Zealand Ministry of Health – Manatū Hauora<sup>24</sup> for suicides between 1 January 2000 and 26 December 2018.

The NCIS dataset provided detailed records, including incident and death start and end dates where there was uncertainty around the exact timing of incidents. However, due to only one suicide recorded in 2006, data starting from 29 October 2007, and under-reporting post-2019 caused by a lag in data processing, our analysis was confined to suicides reported from 29 October 2007 to 31 December 2019, inclusive. For consistency and accuracy, we calculated the date of death using the midpoint between the start and end dates of the incident.

Ethnicity data were categorised to closely align with those in the Ministry of Health dataset, following the Ethnicity code tables for the National Collections. Prioritised ethnicity and date of suicide

were extracted from both datasets. We did not control for population size.

Moon phase was calculated for each day using the “lunar.phase” function in the “lunar” package for R (version 4.1.0), which outputs a value between 0 and  $2\pi$  for the moon phase, given a date, where 0 represents a new moon and  $\pi$  refers to a full moon.

## Statistical methods

We conducted Poisson regression analyses with suicide counts modelled against lunar phases. The lunar cycle was divided into 29 uniformly distributed bins to approximate daily intervals and was centred around the new moon. The full model included annual, seasonal, monthly and day-of-the-week effects as covariates. An offset of  $\log(Ndays)$  was added to the model, where  $Ndays$  is the number of days in each lunar period, to account for differences in exposure and ensure the output of the model represented rate per day.<sup>25</sup> Model suitability was confirmed by testing for Pairwise comparisons between levels and was done using the “emmean” package in R.

Additionally, cosine curves with periods of a full- and semi-lunar rhythm were fitted to the data. This was done by fixing the mean and amplitude of the cosine model (with a fixed period of either a period of 29 days or 14.5 days) to be the mean and range of the data, respectively, while altering the phase of the cosine model until it maximised the correlation of the data (using the general-purpose optimisation function, “optim” in R). Furthermore, the moon phases were permuted and the calculations repeated 1,000 times. This allowed for a better estimation of how significantly the data fit a lunar or semi-lunar cycle.

The above analyses were repeated for only Māori deaths, under the hypothesis that they are more likely to be correlated with Maramataka classifications.

## Results

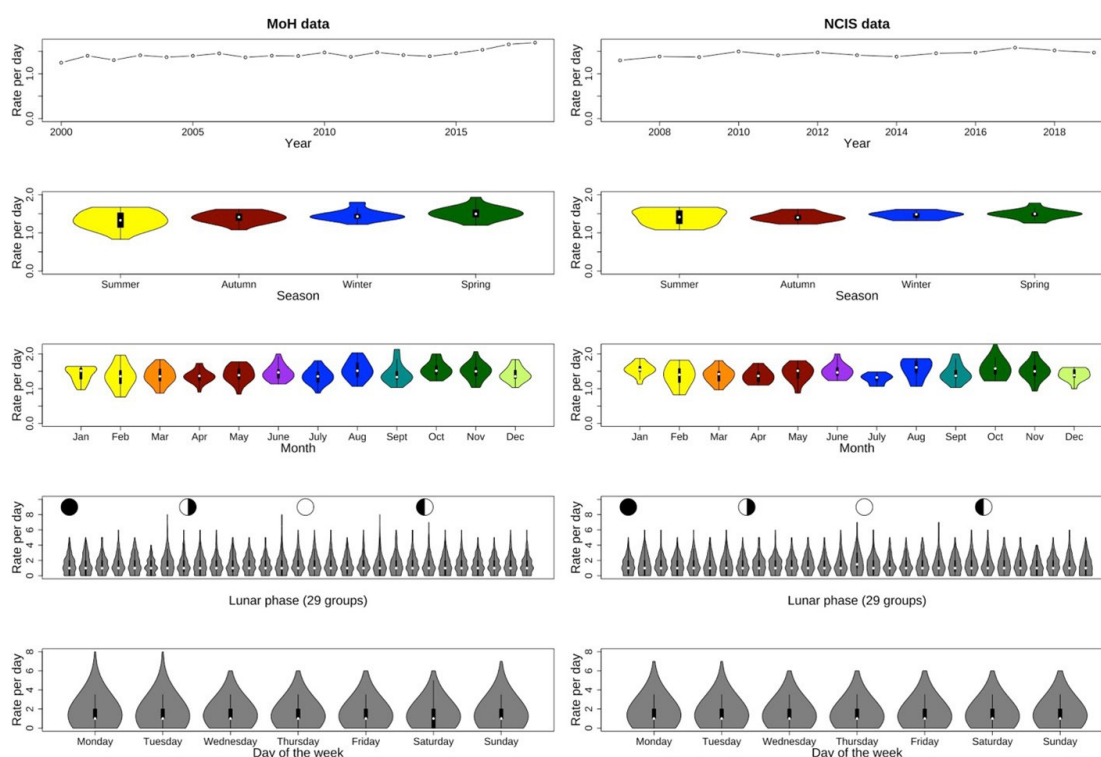
### All data

There was a total of 9,929 suicides recorded by the Ministry of Health (overall rate of 1.43 suicides per day) and 6,447 recorded by NCIS (overall rate of 1.45 suicides per day). Notably, for the same overlapping time (29 October 2007 to 26 December 2018) there were 6,020 deaths recorded by the Ministry of Health and 5,903 recorded by NCIS (overall rates of 1.48 and 1.44 suicides per day, respectively). Māori were over-represented

**Table 1:** Summary of the ethnicity data from the two datasets.

	Ministry of Health data (N = 9,929)	NCIS data (N = 6,447)
<b>Dates</b>	1 Jan 2000–26 Dec 2018	29 Oct 2007–31 Dec 2019
<b>Prioritised ethnicity N (%)</b>		
Māori	1,980 (19.9%)	1,370 (21.3%)
Asian	433 (4.4%)	287 (4.5%)
Pacific	430 (4.3%)	331 (5.1%)
Other	7,086 (71.4%)	4,459 (69.2%)

**Figure 1:** Overview of the data from the Ministry of Health (left) and NCIS (right). The rate of suicide each year is plotted at the top. Below those are violin plots of the rates of suicide by season, year, lunar phase (divided into 29 equal parts, with inlayed lunar phase) and day of the week. Note that these represent the distribution of rates of suicide in each time “bin” over the whole dataset.



in both datasets (Table 1).

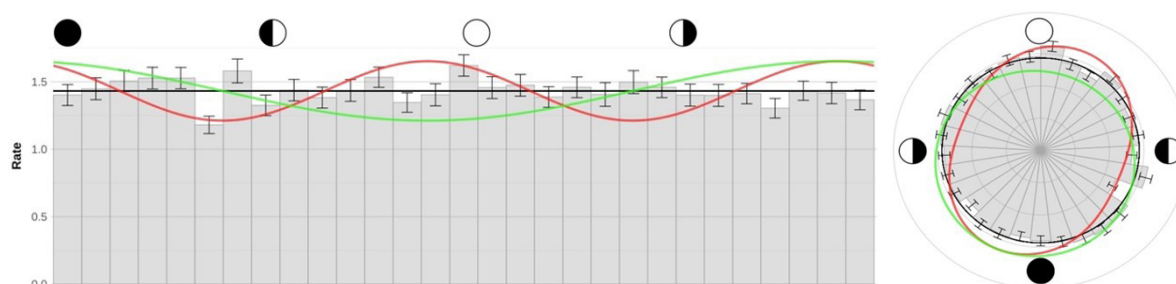
The rates of suicides per day in each year, season, month, lunar phase and day of the week are plotted in Figure 1 for the Ministry of Health (left) and NCIS (right) data.

Univariately, there was a significantly lower suicide rate in the lunar period centred at 1.08

(bin 6 of 29) compared with the period centred at 3.03 (bin 15 of 29; estimated [standard error] difference of 0.32 [0.08]) in the Ministry of Health dataset. There were no significant differences between any periods in the NCIS data.

There was also no significant difference in suicide rate by month in either dataset. However,

**Figure 2:** Rate of suicides by lunar phase with mean (black) and optimised cosine curves overlaid (red and green) in linear (left) and polar (right) coordinates for the 29 periods from the Ministry of Health data.



there was a significant, but moderate, difference in rate of suicide by season in the Ministry of Health dataset, with a higher suicide rate in spring and winter compared to summer (with estimated [standard error, p-value] differences of 0.11 [0.03,  $p < 0.001$ ] and 0.07 [0.03,  $p = 0.05$ ], respectively). There was also a significant difference in rate of suicide between days of the week in the Ministry of Health data (Monday being more likely than Saturday, with an estimated [standard error, p-value] difference of 0.12 [0.04,  $p = 0.03$ ]).

A multivariate Poisson model, with lunar phase (divided into 29 periods), year, month and day of the week as covariates confirms the higher rate of suicide at the phase centred at 3.03 and the lower rate at phase centred at 1.08 (respective estimated risk ratios [95% CI, p-value] are 1.16 [1.0–1.35,  $p = 0.042$ ]) and 0.85 (0.72–0.99,  $p = 0.037$  when compared with the rate centred at 0 [the new moon phase]) in the Ministry of Health data. There were no other statistically significant results in the lunar phases, and there are no significant differences in any lunar phase in the NCIS data. There was no over-dispersion in any of the models.

Considering the correlation with cosine functions, there was no significant correlation with either the lunar (green line in Figure 2) or semi-lunar (red line in Figure 2) cycle in either dataset. The level of correlation was also not significant after permutation testing. The Ministry of Health data are plotted in Figure 2 as a linear bar graph and in polar coordinates.

### Sub-group analysis

We repeated the above analysis for only cases where the deceased was Māori. There was no significant difference in the rate of suicides by season. November had a significantly higher rate compared with March (effect size [standard error, p-value] of 0.42 [0.1],  $p = 0.006$ ) in the Ministry of Health dataset. In the NCIS dataset, Wednesday

was associated with a lower rate of suicide compared with Saturday and Sunday (effect sizes of 0.32 [0.1,  $p = 0.04$ ] and 0.33 [0.1,  $p = 0.03$ ], respectively).

There were no significant differences in the rate of suicide between any of the moon phases. There were also no significant differences in the rate of suicide in a multivariate model. There was also no significant correlation to either lunar or semi-lunar cosine models.

### Discussion

There is no strong evidence of a difference in the rate of suicide during different phases of the moon. This is true for the whole population and for the Māori population, in both univariate analysis and taking into account annual, seasonal and day-of-the-week variations.

The small effect size we saw in the Poisson models in the Ministry of Health dataset were marginally statistically significant and results were not adjusted for the multiple tests we performed (see below), so are most likely a false-positive,<sup>13</sup> especially as the result was not replicated with the NCIS data.

There was no evidence at all for a lunar rhythm in the rate of suicides in New Zealand. Our results are not unique; many other studies around the world have failed to replicate claims about lunar correlations with suicide (or other human behaviours).<sup>10</sup>

We did not do any sub-group analysis for age or gender or other demographic information, as there was no *a priori* reason to think that these covariates would be important. This was also the rationale for not controlling for population size, as we did not expect the population to change significantly over subsequent lunar cycles. Notably, there was a modest increase in national population over time and a relatively constant rate of suicides

over the years, indicating that suicide per capita is reducing.

Similarly, this work did not take any other factors into account, including neglecting possible global or local events that may have contributed to different rates of suicide, such as the COVID-19 pandemic, which occurred within the timeframe of our collected data. Also unaddressed were possible accidental correlations; for example, it is possible that any particular 15-year period might coincidentally have a particular moon phase fall on, or off, particular holidays or days of the week more than would be expected in a longer-term average. However, as the lunar year (12 lunar cycles) is 11 days shorter than the solar year, and thus strongly out of sync, we expect any effect to be small.

On the other hand, some holidays celebrated by substantial numbers of residents are timed with reference to a lunar calendar (e.g., Easter, Chinese New Year, and in 2022, Matariki, the Māori New Year, which became an official public holiday); celebrations or associated work/school holidays might conceivably induce detectable, although likely small, correlations with particular lunar phases. Thus, we did not test for holiday periods or other, more refined, timepoints.

We also recognise that different iwi have different Maramataka,<sup>20</sup> and there are differing interpretations as to which days might contribute to suggestions of “low energy”. The data available do not allow the linkage of individuals to iwi or what their interpretation of Maramataka is. Furthermore, we recognise that a substantial proportion of Māori are urbanised and may have weaker linkages to traditional practices. Nevertheless, the distribution of suicides across the lunar cycle was approximately normal, so it is

unlikely that accounting for urbanisation and iwi-based Maramataka would yield a different result.

This work involved numerous statistical comparisons, which increases the risk of a false positive. We did not correct for multiple testing across the models, and so our negative results are conservative.

We contacted the Ministry of Health and NCIS to try to understand why there are discrepancies between the recorded number of suicides. However, there is no clear reason that emerges. This is a phenomenon that should be considered in future work. Similarly, there is some uncertainty in the timing of some of the suicides in the NCIS data. We do not expect this to have significantly affected our results, given very comparable effects in the Ministry of Health dataset and our permutation tests.

We make no claims about the consideration of lunar or semi-lunar cycles during treatment for mental illness, and there is anecdotal evidence of efficacy for connecting patients to their environment. There may be other rationales for consideration of lunar, or other, cycles in the clinical treatment of particular patients. This deserves further study.

Only suicide was considered in this study. It may be the case that different results are found for less severe indicators of declining mental health, such as hospital admissions, patient self-reported status or medication use. More work is required to establish evidence in these areas to back up the New Zealand Mental Health Foundation and Canterbury Health board claims and provide a science-based rationale for supporting traditional Maramataka-based treatments.

**COMPETING INTERESTS**

Funding for this work came from an internal University of Auckland grant.

**ACKNOWLEDGEMENTS**

Suicide, particularly youth suicide, is a tragedy in every single case. We acknowledge that behind each of the numbers in our somewhat abstract statistical analysis are individuals, their family and wider circle of influence. We hope that our work adds to the knowledge base, however modestly, to help combat suicide in New Zealand.

DC and NM initiated discussions about testing the hypothesised linkage. DC obtained ethics approval and conducted the main statistical analysis in consultation with co-authors. RS provided information on maramataka and background on efforts to better understand and prevent suicide among Māori; he uses maramataka in his practice. There are no other possible conflicts of interest.

We would like to thank the excellent people at NCIS and the NZ Ministry of Health for their assistance exporting and understanding the data in their custody. We would also like to thank numerous colleagues who provided input into the analysis approach, framing of the paper, and encouragement of it.

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<https://nzmj.org.nz/journal/vol-138-no-1608/does-suicide-in-new-zealand-follow-a-semi-lunar-rhythm>

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