Top 10 Mortality Causes for Republic of Korea of the years 2000, 2010, 2015, 2019*

Poisson and Negative Bionimal Modelling of Annual Death Number and Cause

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First sentence. Second sentence. Third sentence. Fourth sentence.

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*Code and data are available at: https://github.com/anggimude/Top-Mortality-Causes-of-South-Korea

1 Introduction

The remainder of this paper is structured as follows. Section 2....

2 Data

2.1 Raw Data

The data used in this paper is derived from WHO(WHO) and was downloaded from the WHO Mortality Database. WHO(WHO) provides data for years country-level Global Health Estimates(GHE2019) for the years 2000-2019. Because the years that have estimates of a list provided of the cause of death categories in terms of International Classification of Diseases, Tenth Revision(ICD-10) in terms of a summary table of number of deaths by cause, age, and sex for WHO(WHO) member states for the years are 2000, 2010, 2015, 2019; the data for these four years are cleaned and analyzed for this paper. The analysis of deaths by cause of the raw data is executed for the age groups from 5 to 85+. This paper looks into the data for Republic of Korea as the author is South Korean but also because WHO methods and data sources(citation) certifies a high quality of data. The raw data includes columns such as code, cause, IS03, year, sex, age group, population, deaths, death rate per 100000 population, DALY, DALY rate per 100000 population.

The cleaning, testing, and modelling of the data for this paper was done through R (R Core Team 2023) with the aid of the following packages: tidyverse (**citetidyverse?**), dplyr (**citedplyr?**), rstanarm (**citerstanarm?**), ggplot2 (**citeggplot2?**), modelsummary (**citemodelsummary?**), bayesplot (**citebayesplot?**), parameters (**citeparameters?**), broom (**citebroom?**), kableExtra (**citekableExtra?**), gt (**citegt?**), readr (**citereadr?**), broom.mixed (**citebroommixed?**).

2.2 Cleaned Data

The data that is needed for this paper is year, cause, and number of deaths, so the raw data is cleaned to contain only the three columns we need. Because we are looking into the top 10 mortality in this paper, we rank the causes based on its number of deaths and merge it into (Table 1). Now that the cleaning is done we can see the top 10 causes of deaths for the years 2000, 2010, 2015, and 2019, however, this isn't enough because to make a graph and create a poisson and negative binomial model, we must find the causes that are common in all of the years. (Table 2) represents the table in which only the causes that appear among all the years descending order of ranking. Now we can recognize the six main causes of death in South Korea is stroke, Ischaemic Heart Disease, Stomach Cancer, Trachea Bronchus Lung Cancer, Liver Cancer, and Self Harm. Looking at (Figure 1), we can see some interesting trends. For example, there is a plunge in the annual number of deaths from stroke over the 9 year span. On the other hand, there has been increases for the causes of Ischaemic heart disease and Trachea, Bronchus, Lung cancer. There is a slight decrease in stomach cancer while liver cancer didn't fluctuate as much. Self harm is interesting because Korea is known to have the highest suicide rates out of all the OECD countries(Citation), and we see an increase in the number deaths from self harm has increased rapidly from 2000 to 2010 and a small decrease from 2010 to 2015. It seems like the death numbers from self harm has plateaued with a very slow rate of increase. In general, the top 10 most common causes of deaths are stroke, heart disease, stomach cancer, lung cancer, road injury, liver cancer, diabetes, Cirrhosis of the liver(liver damage), and self harm.

Table 1: Top 10 Mortality Rates of South Korea

Year	Cause	Deaths	Death Rate	Ranking
2000	Stroke	44109	93	1
2000	Ischaemic heart disease	18837	39	2
2000	Stomach cancer	13205	27	3
2000	Trachea, bronchus, lung cancers	12879	27	4
2000	Road injury	12141	25	5
2000	Liver cancer	10893	22	6
2000	Diabetes mellitus	10414	21	7
2000	Cirrhosis of the liver	9968	21	8
2000	Self-harm	6860	14	9
2000	Chronic obstructive pulmonary disease	6783	14	10
2010	Stroke	31934	64	1
2010	Ischaemic heart disease	23696	47	2
2010	Trachea, bronchus, lung cancers	17121	34	3
2010	Self-harm	16852	34	4
2010	Liver cancer	12204	24	5
2010	Stomach cancer	11507	23	6
2010	Diabetes mellitus	9225	18	7
2010	Lower respiratory infections	9013	18	8
2010	Colon and rectum cancers	8886	17	9
2010	Chronic obstructive pulmonary disease	7904	15	10
2015	Stroke	28655	56	1
2015	Ischaemic heart disease	27336	53	2
2015	Trachea, bronchus, lung cancers	18806	37	3
2015	Lower respiratory infections	17164	33	4
2015	Self-harm	14255	28	5
2015	Liver cancer	12217	24	6
2015	Alzheimer disease and other dementias	11164	21	7
2015	Stomach cancer	9534	18	8
2015	Colon and rectum cancers	9405	18	9

Year	Cause	Deaths	Death Rate	Ranking
2015	Kidney diseases	9188	18	10
2019	Ischaemic heart disease	28042	54	1
2019	Lower respiratory infections	26649	52	2
2019	Stroke	25596	49	3
2019	Trachea, bronchus, lung cancers	20293	39	4
2019	Self-harm	14635	28	5
2019	Alzheimer disease and other dementias	12144	23	6
2019	Liver cancer	11589	22	7
2019	Colon and rectum cancers	10180	19	8
2019	Kidney diseases	10107	19	9
2019	Stomach cancer	8624	16	10

Table 2: Common Mortality Causes of All Four Years 2000, 2010, 2015, 2019

Year	Cause	Deaths
2000	Stroke	44109
2000	Ischaemic heart disease	18837
2000	Stomach cancer	13205
2000	Trachea, bronchus, lung cancers	12879
2000	Liver cancer	10893
2000	Self-harm	6860
2010	Stroke	31934
2010	Ischaemic heart disease	23696
2010	Trachea, bronchus, lung cancers	17121
2010	Self-harm	16852
2010	Liver cancer	12204
2010	Stomach cancer	11507
2015	Stroke	28655
2015	Ischaemic heart disease	27336
2015	Trachea, bronchus, lung cancers	18806
2015	Self-harm	14255
2015	Liver cancer	12217
2015	Stomach cancer	9534
2019	Ischaemic heart disease	28042
2019	Stroke	25596
2019	Trachea, bronchus, lung cancers	20293
2019	Self-harm	14635
2019	Liver cancer	11589
2019	Stomach cancer	8624

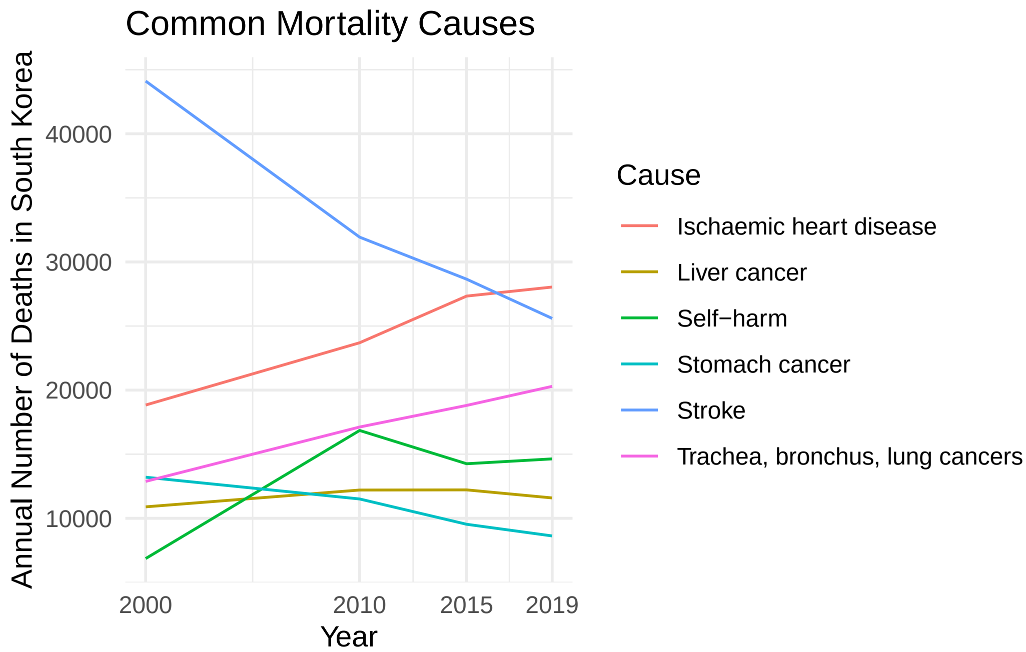


Figure 1: Line Graph of Common Mortality Causes of South Korea

Table 3: Summary statistics of the number of yearly deaths, by cause, in South Korea

	Min	Mean	Max	SD	Var	N
Deaths	6860	18 320	44 109	8927	79 687 233	24

2.3 Basic Summary Statistics

(1) is a representation of the (**?@tbl-intersect_all_data**) showing its minimum, mean, maximum, standard deviation, variance, and sample size. The summary statistics shows that the mean of the number of deaths are 18320, with a minimum of 6860, and a maximum of 44109 for a sample size of 24 as the data selected is from (**?@tbl-intersect_all_data**). The standard deviation and variance may be abnormally high because the range of the data is large, in other words, because the mean is 18320, and the maximum is 44109, there is likely a few outliers in the data creating such a high standard deviation and variance.

3 Model

The goal the Bayesian model is to incorporate prior knowledge such as previous studies or analysis into the choice of model. In this paper we use poisson and negative binomial model because both of these models is often used when there occurs a certain number of events in a certain time period or intervals. The poisson distribution is efficient when used for situations where events occur independently over intervals of time. The data represents the cause and the annual number of death for the selected years, the poisson distribution is a measure that is appropriate. However, the poisson distribution is not the perfect fit because it assumes that the mean and the variance are the same whilst 1 shows us there is a significant difference in the mean and standard deviation. Negative binomial distribution is a perfect for situations like this. The negative binomial distribution accounts for additional variability when the data shows evidence of over dispersion. In addition, the negative binomial distribution has an extra parameter that considers the variance being larger than the mean. Thus, executing both models and comparing the results will determine the goodness of the fit.

3.1 Model set-up

Define y_i as the number of seconds that the plane remained aloft. Then β_i is the wing width and γ_i is the wing length, both measured in millimeters.

$$
\begin{align}
y_i &\sim \text{Poisson}(\lambda_i) \quad (1) \tag{1}\\
\lambda_i &= \exp(\alpha + \beta_i + \gamma_i) \quad (2) \tag{2}\\
\alpha &\sim \text{Normal}(0, 2.5) \quad (3) \tag{3}\\
\beta_i &\sim \text{Normal}(0, 2.5) \quad (4) \tag{4}\\
\gamma_i &\sim \text{Normal}(0, 2.5) \quad (5) \tag{5}\\
& \tag{6}
\end{align}
$$

$$
\begin{align}
y_i &\sim \text{NegBinomial}(\mu_i, \phi) \quad (1) \tag{7}\\
\mu_i &= \exp(\alpha + \beta_i + \gamma_i) \quad (2) \tag{8}\\
\alpha &\sim \text{Normal}(0, 2.5) \quad (3) \tag{9}\\
\beta_i &\sim \text{Normal}(0, 2.5) \quad (4) \tag{10}\\
\gamma_i &\sim \text{Normal}(0, 2.5) \quad (5) \tag{11}\\
\phi &\sim \text{Exponential}(1) \quad (6) \tag{12}
\end{align}
$$

We run the model in R (R Core Team 2023) using the `rstanarm` package of Goodrich et al. (2022). We use the default priors from `rstanarm`.

Table 4: Poisson model of most prevalent cause of deaths in South Korea 2000, 2010, 2015, 2019

	Poisson
Intercept	10.105
Liver Cancer	−0.736
Self Harm	−0.621
Stomach Cancer	−0.826
Stroke	0.286
Trachea, Bronchus, Lung Cancer	−0.349
Num.Obs.	24
Log.Lik.	−8157.665
ELPD	−8835.6
ELPD s.e.	2653.7
LOOIC	17 671.3
LOOIC s.e.	5307.3
WAIC	22 572.8
RMSE	3830.21

3.1.1 Model justification

We expect a positive relationship between the size of the wings and time spent aloft. In particular…

We can use maths by including latex between dollar signs, for instance θ.

4 Results

Our results are summarized in **?@tbl-modelresults**.

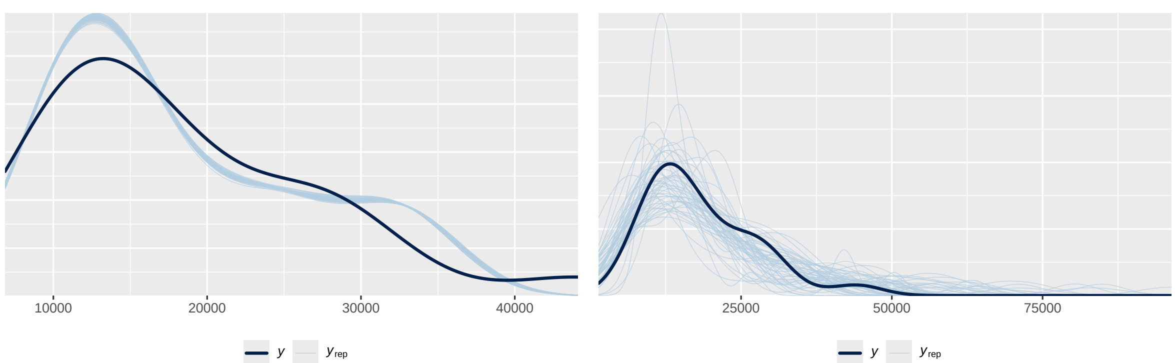
5 Discussion

5.1 First discussion point

If my paper were 10 pages, then should be be at least 2.5 pages. The discussion is a chance to show off what you know and what you learnt from all this.

Table 5: Negative Binomial model of most prevalent cause of deaths in South Korea 2000, 2010, 2015, 2019

	Negative Binomial
Intercept	10.102
	(0.190)
Liver Cancer	−0.726
	(0.266)
Self Harm	−0.610
	(0.268)
Stomach Cancer	−0.814
	(0.276)
Stroke	0.296
	(0.274)
Trachea, Bronchus, Lung Cancer	−0.341
	(0.272)
Num.Obs.	24
Log.Lik.	−237.440
ELPD	−240.6
ELPD s.e.	2.4
LOOIC	481.2
LOOIC s.e.	4.8
WAIC	481.0
RMSE	3832.16



(a) Posterior prediction check

(b) Comparing the posterior with the prior

Figure 2: Examining how the model fits, and is affected by, the data

	elpd_diff	se_diff
cause_of_death_south_korea_neg_binomial	0.0	0.0
cause_of_death_south_korea_poisson	-8595.0	2652.1

Figure 3: Checking the convergence of the MCMC algorithm

5.2 Second discussion point

5.3 Third discussion point

5.4 Weaknesses and next steps

Weaknesses and next steps should also be included.

Appendix

A Additional data details

B Model details

B.1 Posterior predictive check

In Figure 2a we implement a posterior predictive check. This shows…

In Figure 2b we compare the posterior with the prior. This shows…

B.2 Diagnostics

?@fig-stanareyouokay-1 is a trace plot. It shows… This suggests…

?@fig-stanareyouokay-2 is a Rhat plot. It shows… This suggests…

References

Goodrich, Ben, Jonah Gabry, Imad Ali, and Sam Brilleman. 2022. "Rstanarm: Bayesian Applied Regression Modeling via Stan." https://mc-stan.org/rstanarm/.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.