COMPARING SUICIDE RATES BETWEEN DEVELOPED AND DEVELOPING COUNTRIES

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Introduction

Mental health is something that is very rarely discussed due to various social stigmas. While awareness is growing, researchers are only recently finding the extent of mental health issues in North America and how to address them. What about for still developing countries? Currently healthcare aid is provided to various countries, which indicates that they aren't self-sustainable yet, and this is generally for physical health, not mental health. So, if developed countries are still struggling to address mental health, how much worse off are developing countries?

Background Research

In 2018, roughly 800,000 people around the world committed suicide [1]. 79% of these suicides are in low and middle-income countries [1]. Among individuals ages 15-44, self-inflicted injuries are the fourth leading cause of death [2]. The highest suicide rates in the world are found in Eastern European countries [2]. The lowest rates are found mainly in Latin America and a few countries in Asia [2].

Suicide rates are frequently higher among indigenous groups such as the Aboriginal and Torres Strait Islander populations in Australia and the Inuit in Canada's artic north [2]. Women are more prone to suicide thoughts, but rates of suicide are roughly three times higher for male suicides [2]. In general, suicide rates in gross terms are highest in the 15-29-year age group, but a higher proportion of people aged 60 or older commit suicide [2]. Seniors are three times more likely to commit suicide in comparison the 15-29 age group [2].

The study by the World Health Organization on suicide found links between suicide rates and mental disorders [1]. Pre-dominantly this related to depression and alcohol use, but also moments of crisis were heavily correlated with a person committing suicide [1]. These acute life stresses such as financial problems, relationship problems, chronic pain or illness where the spark needed for a person to take their life [1]. Rates of suicide are higher during economic recessions and periods of high unemployment [2]. They are also higher during periods of social disintegration, political instability and social collapse [2].

Other causes that are not as significant but do still play a role is if the person is subject to: conflict, natural disaster, violence, abuse, loss or a sense of isolation [1]. More specifically, a history of physical or sexual abuse in childhood is the most common type of abuse that leads to suicide [2].

The most common methods of suicide are firearms and hangings [1]. The third most common, which accounts for 20% of suicides globally, are due to pesticide self-poisoning [1]. This occurs primarily in rural agricultural areas in low- and middle-income countries [1].

In many cases, suicide is preventable. Reducing access to means of suicide, media reporting in a responsible way, alcohol policies, early identification for people with mental health issues and increasing non-specialized health workers have all been identified as methods to reduce suicide rates in a given country [1].

One of the reasons suicide rates are still so high are due to the social stigma and taboo [1]. People do not seek the help they need [1]. Only 38 countries report having a national suicide prevention strategy [1].

The World Health Organization's 2014 report on preventing suicide aims to increase the awareness of mental health and issues and make suicide prevention a high priority on the global public health agenda [1]. It also aims to support countries in developing or strengthening their suicide prevention strategies [1]. The "WHO Mental Health Action Plan 2013-2020" had WHO member states commit to reducing the global suicide rate by 10% by 2020 [1].

Notable reductions in suicide has occurred in countries that have removed carbon monoxide from domestic gas and car exhausts or restricted access to concentrated agricultural poisons among people [2]. Restriction on ownership of firearms has also been associated with a decrease of their use for suicide [2].

Some countries have criminalized suicide [3]. This has decreased the suicide rates in the country as individuals are more aversive as there is now a cost if their suicide attempt fails [3]. WHO reports only 10% of people who attempt suicide eventually kill themselves [2]. This means that the chances of a failed attempt are high, and therefore individuals in countries where suicide is illegal are not willing to take the risk. This might be the reason why suicide rates have decreased in these countries, or it could be due to a higher likelihood of under-reporting in order to eliminate their punishment [3].

Initial Hypothesis

Most of the healthcare aid and awareness for developing countries addresses physical health. Mental health is not as significantly emphasized. Therefore, this paper hypothesizes that there should be a big difference in suicide rates per capita between developed and developing countries. However, mental health issues are only recently being brought to awareness in developing countries, so possibly the difference between the two groups is not very significant. This paper will attempt to decipher if it is significant.

Furthermore, the paper will compare methodologies used by countries to reduce suicide rates. It will look at methods which impact mental health and suicide rates to see which ones have been the most effective at reducing suicide rates in both developed and developing countries. These include: methods and programs to address alcohol and substance abuse, healthcare spending, the allocation of healthcare resources, mental health policies, abuse prevention programs and other awareness programs.

One of the methods that will be analyzed are programs and policies that address alcohol and substance abuse within a country. As this is closely related with mental health issues, comparing some of the methods used by countries to reduce alcohol and substance abuse will ideally show what seems to be the most effective program or policy for countries of a certain class.

Additionally, government healthcare spending and health resources will be looked at. Looking at mental health spending will be interesting to see how cost effective and efficient countries are at addressing mental health issues and see if there are differences in this efficiency between developed and developing countries. In terms of mental health resources, the paper will compare expenditure on mental health facilities versus mental health personnel to find which are most effective in reducing mental health issues. This is important as countries with higher suicide rates will be able to allocate their healthcare spending more effectively.

Additional mental health legislation and policies will be analyzed. This will be useful to see if these indeed are effective at addressing mental health issues or not. Furthermore, comparing when a policy

was put into effect or revised will be interesting to see if that has created a beneficial outcome. This will be useful for countries as they would be able to identify if this can be used in a solution for themselves.

Lastly, the paper will look at awareness and prevention programs. These include programs that fight against child abuse, domestic violence, senior abuse, awareness of indigenous people's issues, and many more. Comparing these will show how effective

The importance of these findings is that it can show what the most effective methods for reducing suicide rates are for that given country income class. This can help other countries potentially adopt these methods or adapt their current methods to improve mental health in their country.

Methodology

Initially, each of the different methodologies will be compared individually, followed by an auto-regressive logarithmic model which includes the most relevant variables from the initial regression.

The initial regressions are to find the best predictor variables. This is due to there being a high number of variables present for each aspect that is analyzed. Many of these variables will have similar effects on suicide rates and therefore will lead to a high multi-collinearity, which is naturally undesired. Furthermore, for certain resources, variables represent different aspects of the affecting factor. So, this initial regression will help show which methods appear to be the most relevant for the country income class.

The final auto-regressive logarithmic model will have the statistically significant variables from the initial regression, along with the suicide rates from 2010. An auto-regressive model is used as the suicide rates explain a lot of the variance in the suicide rates in 2015.

Data

Data Quality Issues

Under-reporting and misclassification are big problems regarding data quality [1]. Under-reporting due to the social stigma associated with suicide directly impacts the data provided [1]. Furthermore, deaths due to suicide are commonly misclassified [1]. If a person were to commit suicide due to an illness they had, the data point may be recorded for death by the illness, but not necessarily death by suicide.

Only 60-member states have good quality data to properly estimate suicide rates [1]. High income countries which have good vital registration accounts for 95% of all estimated data for all high-income countries [1]. In contrast, low and middle-income countries do not have good vital registration data [1]. Only 8% of the total suicides in these countries can be properly accounted for [1].

Data Sources

Initially, data from World Development Indicators dataset provided publicly by the World Bank was to be used [4]. While this is a very extensive dataset, unfortunately, it did not fit the needs for this paper. Many of the variables that would have been relevant were only for a single year, which eliminated the options of analyzing a change over time. This would have resulted with the issue of being unable to address causation between the factor and its effects on suicide rates. Additionally, many variables were limited for countries. For example, many of the domestic abuse variables were only available for select African countries in middle and low-income classes, which therefore could not be compared to high

income countries. Lastly, upon reading the metadata for various variables, it became apparent that the year to year change for many abuse-related variables were modelled by the World Bank instead of based on a survey or census of real data [4]. This led incorrect numbers as the regression analysis was picking up the formula for the change rates used by the World Bank.

The main variables collected from the World Bank dataset is their region and income class for various countries.

Other variables collected from this dataset include: current health expenditure, unemployment rates for individuals with advanced education, and risk of impoverishment due to healthcare procedures.

The country's income class is categorized into: high-income, upper-middle income, lower-middle income, and low-income [4]. Countries are classified based on their GNI per capita ratio in US Dollars [5]. A table indicating their category thresholds can be found in Appendix – Threshold Cutoffs Used by World Bank for Income Classifications.

The region variable will be used in the regressions to account for region-based effects on suicide rates. As indicated in the background research, Eastern Europe tends to have the highest suicide rates in the world [1]. As this paper is looking at the changes in suicide rates, region-based effects must be accounted for since certain regions may be affected by certain factors more than others, and we'd like to account for this.

The primary data source used is the World Health Organization's "Global Data Repository" [6]. This paper uses datasets from the "Mortality and Global Health Estimates", "Child Health", "Mental Health", "Resources for the Prevention and Treatment of Substance Use Disorders", "Health Financing", "Health workforce", "Violence Prevention", and "Violence against Women" [6].

Data Transformations and Initial Analysis

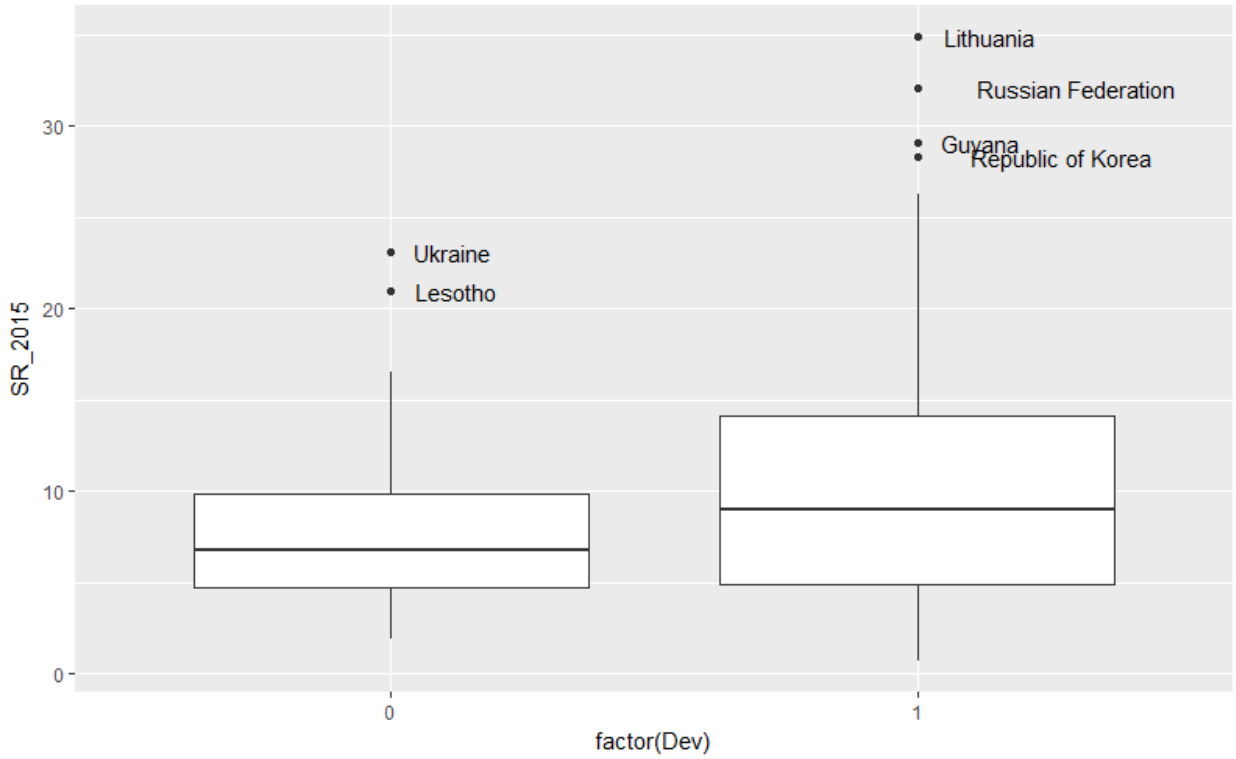
Through the "Mental Health" dataset, suicide rates for all 183 countries recognized by WHO were given for the years 2000, 2005, 2010, 2015 and 2016 [6]. This is given as deaths per 100,000 citizens and therefore represents a per capita suicide rate as opposed to gross numbers. From this point onwards, "suicide rates" in this paper will represent suicide rates per capita. For this paper, only the suicide rates for 2010 and 2015 are used due to limitations in data availability of the factor variables.

One major issue with this data is that it is at five-year intervals. As mentioned in the background research, some of the causes for suicide for "acute life stresses" such as financial problems or relationship problems [1]. This, however, would not be represented in the collected data given that it is a five-year interval and therefore does not reflect acute shocks.

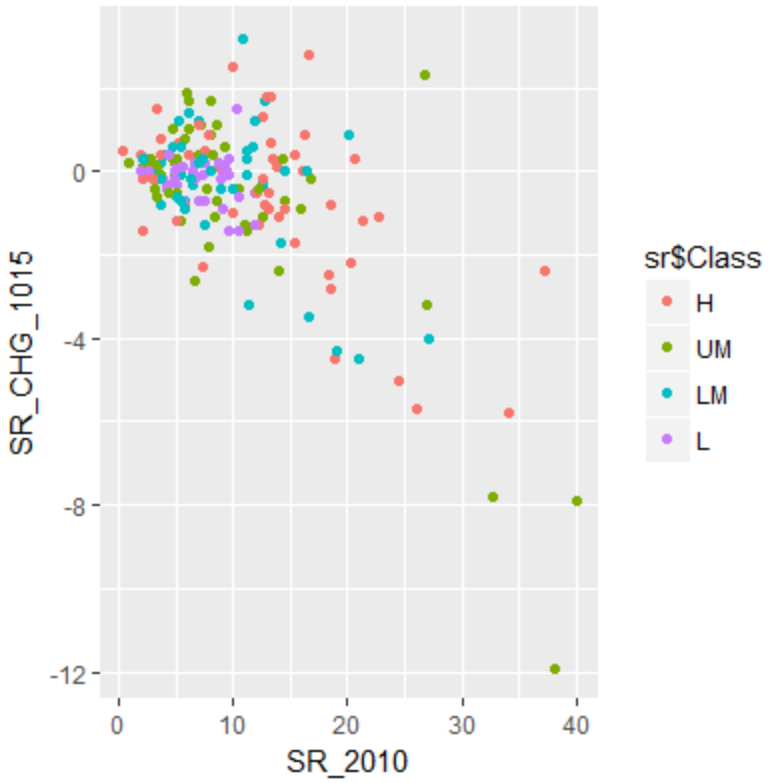
Surprisingly, Higher and upper middle-income countries have a higher per capita suicide rate than lower middle and low-income countries

```
# A tibble: 4 x 5
  Class   obs  mean median standard_dev
  <fct> <int> <dbl>  <dbl>        <dbl>
1 H        53 11.9   12.6          6.55
2 UM       51  8.83   7.10         6.89
3 LM       45  8.61   7.40         5.01
4 L        34  6.78   6.75         2.58
```

This can be seen in the table above. The median suicide rate per capita for high income countries is substantially higher than those from lower income countries. This is surprising as it is not previously mentioned in the World Bank or World Health Organization's research.

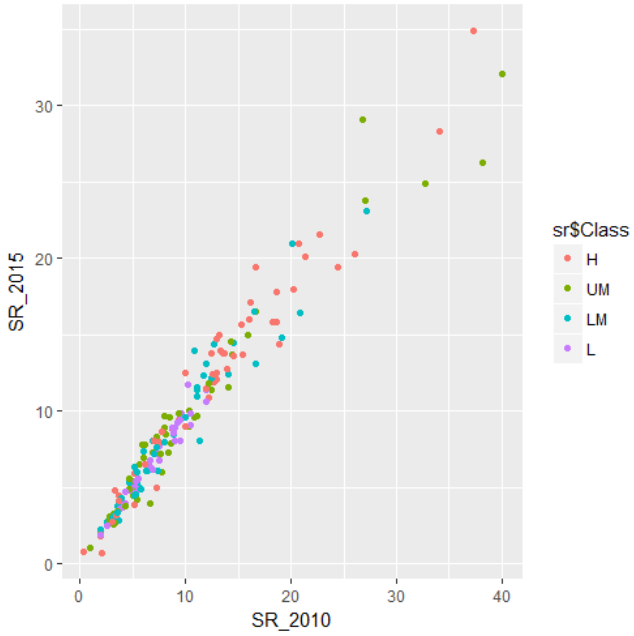


Initially, a change in suicide rates between 2010 and 2015 was going to be used as the dependent variable, however, this was later changed to the suicide rate in 2015. This is because the change in suicide rates is heavily correlated with the 2010 suicide rate. This has been graphed below.



The 2010 suicide rate and change in suicide rate have a correlation of -0.626 which indicates that countries with a higher suicide rate in 2010 experienced a larger, negative change in their suicide rate by 2015 than other countries. This is most likely because countries which have a drastically high suicide rate are more aware of mental health problems in their country as it is significantly larger. Therefore, they have placed a higher focus on addressing these issues and therefore have experienced a better result in dropping their suicide rate.

If 2010 suicide rates are being used as a dependent variable to predict the 2015 suicide rates, an autoregression must be used. Only an AR(1) model is used as the suicide rates in 2005 and 2010 had an extremely high multi-collinearity when used to predict the suicide rate in 2015. The results from the Variance Inflation Factors (VIF) test for multi-collinearity can be seen in Breush-Pagan Tests for Heteroskedacity.



From this graph, it is apparent that a linear regression will result in heteroskedacity due to the datapoints being very linear at lower 2010 suicide rates and significantly more deviated at higher rates. This is further confirmed by the Breush-Pagan test which results in a p value significantly lower than 0.05, which clearly indicated heteroskedacity (Appendix blah blah).

Since the explanatory variable is now a natural logarithm, the coefficients of the dependent variables in the various regressions will be interpreted as how much of a percent change in the 2015 suicide rate per capita is due to the variable.

Assumptions

Initial Regression

Alcohol and Substance Abuse

This regression looks at alcohol consumption, alcohol policies implemented by the government, and awareness programs related with substance abuse.

Alcohol consumption comes from the "Levels of Consumption" category of the data repository [6]. This variable represents the alcohol consumption in litres of alcohol per capita of individuals older than 15 within a country. As this is yearly data, change in alcohol consumption per capita is found between 2010 and 2015. This is important in this regression as naturally decreasing alcohol consumption reduces the likelihood of individuals in that country that commit alcohol abuse, which is a direct cause of suicide [1]. Therefore, in this regression, it is expected that the change in alcohol consumption will be positively correlated with increasing suicide rates as a higher alcohol consumption may indicate more alcohol abuse or mental health issues, which will increase the suicide rates in that country.

Four different awareness programs relating with alcohol or substance abuse given in the "Awareness Activities by Country" dataset [6] are analyzed in this regression. This includes awareness programs for binge drinking, drunk driving, illegal alcohol usage, and youth drinking. Unfortunately, this data is binary and only measures if a country had each of these programs implemented in 2014 or not. Therefore, while a dummy variable can be used to compare its effects, causality cannot be proven. This is because countries may have implemented these awareness programs due to increasing suicide rates, as opposed to the awareness programs reducing suicide rates. Due to this issue, the coefficient for these programs should be negative if it helped reduce suicide rates but may be positive due to causality.

Treatment methods are also looked at. The treatment methods include treatment for alcohol and substance abuse as either an addition to criminal sanctions or as an alternative to criminal sanction. This data comes from the "Governance, policy, and Financing" category in the data repository [6]. These variables are also dummy variables for countries based on their 2014 justice system. They should be negatively correlated with suicide rates as they represent a person who has struggled with substance abuse who is now getting the help they need, which directly reduces the likelihood of them committing suicide [2]. Additionally, confidentiality of alcohol and drug disorders from the same category [6] is included. This is a binary variable which represents if a person obtaining treatment for an alcohol or drug disorder is given privacy rights through national or subnational legislation [6]. This should be negatively correlated with suicide rates as it helps reduce societal pressures on the individual while getting treatment.

Lastly, alcohol policies are included. The data is for when a national alcohol policy was written as well as revised. The data provided comes from the "Alcohol Control Policies" category [6] and is given by the year that a country adopted their national policy as well as the last time the policy was revised. A national policy on alcohol is defined as "a written organized set of values, principles and objectives for reducing the burden attributable to alcohol in a population" [6]. This data has been transformed into two dummy variables: one for if the country had already implemented their alcohol policy before 2010,

and one for adopting a new policy or revising their policy from 2011 to 2014. The second dummy variable can directly indicate causality as it falls within the time-frame that is being analyzed. Both dummy variables should have negative coefficients as they should reduce suicide rates.

Results on Alcohol and Substance Abuse Regression

The regression results can be found in Appendix – Alcohol and Substance Abuse Initial Regression. Surprisingly, none of the tested variables are statistically significant for the 153 countries in the observation. It is difficult to analyze this regression and compare the coefficients of the variables as well as for developed versus developing countries due to having high p-values, but at the very least, the signage for the coefficients are indeed correct as to what was predicted. While technically none of these variables are statistically significant, awareness programs for binge drinking and illegal alcohol consumption, as well as treatment for substance abuse as an alternative to criminal sanction will still be included in the final regression since they have relatively low p-values and may become significant with other factors accounted for.

Mental Healthcare Spending

For this regression we will look at government spending on mental healthcare to see if there are differences between developed and developing countries. This analysis will directly relate to the hypothesis that there are differences in spending per capita between developed and developing countries, indicating if mental health is given the same amount of attention in developed and developing countries. Furthermore, it will show how effective the spending has been on reducing suicide rates in the country.

The data comes from the Mental Health Governance category of the data repository [6]. This includes two variables: Government expenditures on mental healthcare as a percentage of total government expenditure on healthcare, and government expenditure on mental hospitals as a percentage of total government expenditure on healthcare. Two additional variables are created by multiplying each percentage by the healthcare expenditure per capita in PPP to give mental healthcare expenditure per capita in PPP and mental hospital expenditure per capita in PPP. Unfortunately, this data is only provided for 2011, so causality cannot be proven.

The results of the regression can be seen in Appendix – Healthcare Spending. Mental healthcare expenditure per capita in PPP is significant for developed countries at the 95% significance level. However, the coefficient ($2.42*10^{-6}$) is very small and the incorrect sign. With such a small coefficient, its effect on suicide rates, while being statistically significant, is negligible. Furthermore, the coefficient should have been negative as increased mental health expenditure should indicate more resources being spent on mental health which should lead to a decrease in suicide rates. The reason it is positive is most likely because the mental health expenditure data is a cross-section rather than a time series and no change in expenditure is seen. This means that likely reverse causality is true: higher suicide rates lead to governments spending more to try and reduce suicide rates.

This is not the expected outcome due to the data not representing a change in expenditure. Furthermore, very few countries report any numbers and the degree of freedom drops to 30 for this regression. For this reason, mental health expenditure per capita in PPP is omitted from the final regression.

Mental Health Resources

Like mental health spending, this regression will compare the types of resources that countries prioritize to tackle mental health problems. This regression will allude to if mental health specialists or mental health facilities are more effective at reducing suicide rates in developed and developing countries.

The personnel data comes from the "Human Resources" subcategory from the Mental Health category [6]. Using the 2011 and 2014 datapoints for specialists per capita, a change in specialist per capita is used for this regression. This is done for psychiatrists, nurses, social workers, and psychologists. Before all four specialists were added to the regression, another test for multi-collinearity was conducted using just these four changes in number of specialists. It found that there was enough variation that all four could be added into a regression, but the degrees of freedom were drastically reduced due to a lack of data from many countries. Therefore, the change in psychiatrists per capita is the only specialist variable used in this regression as it was the closest to being significant, and because it had the highest number of observations.

The facilities data come from the "Mental Health Service Availability" subcategory from the Mental Health category [6]. This subcategory is split into two: facilities and beds [6] which represent mental health facilities per capita and beds in mental health facilities per capita. The facilities data, however, is only for 2011, whereas the beds data is for 2011 as well as 2014. Therefore, the beds data was used by finding a change in the per capita beds from 2014 to 2011. So, two variables were added to this regression representing facilities: change in per capita beds in mental health hospitals and change in per capita beds in general hospitals.

The results of this regression can be seen in Appendix - Resources with 63 degrees of freedom. The change in beds in mental health hospitals is statistically significant at the 95% significance level for developed countries. The coefficient for this variable is negative, which is what is expected as having a positive change in beds should indicate a higher quantity of individuals can be treated, thus lowering the suicide rate. The change in beds in mental health hospitals for developing countries, as well as the change in beds in general hospitals for all countries are not significant and are also positive. The change in psychiatrists is not significant at the 95% significance level but would be at the 80% significance level.

Both the change in psychiatrists and the change in beds in mental health hospitals are included in the final regression, with a proper comparison in the discussion section.

Mental Health Legislation and Policy

This regression looks at legislation and policy to see if it is effective in reducing suicide rates. While it will be difficult to quantifiably compare legislation and policy, potential differences between developed countries and developing countries may be used as a starting point for further research on the quality, structure, and effectiveness of such policies.

The data for this regression comes from the "Mental Health Governance" subcategory in the Mental Health category of the repository [6]. It contains binary variables for 2011 regarding mental health legislation, mental health plan, and mental health policy. A country having mental health legislation is defined as any existence of dedicated mental health legislation. A country having a mental health plan is based off a WHO survey which asks if the country has a plan which for "implementing strategies for the promotion of mental health, the prevention of mental disorders, and treatment and rehabilitation" [6]. The survey also considers "mental health programmes" as a mental health plan [6]. These programmes

are generally more short-term than a proper mental health plan but are still denoted as a “Yes” for the country having a mental health plan [6]. A country having a Mental health policy is defined as any existence of mental health policy.

Nothing comes out to be statistically significant. The data in regard to mental health legislation, plans and policy is not ideal as they are simply dummy variables in the regression. This is an issue as one cannot analyze causality. Furthermore, there is high collinearity between the variables. This makes sense as a country to have either legislation or a policy are likely to have the either as well as a plan. Therefore, only mental health legislation is used in this initial regression.

The results of the regression can be seen in Appendix – Mental Health Policy. Mental health legislation proves to be insignificant in predicting a change in suicide rates. The p-values are fairly high, and the number of observations (161) is still fairly large. This indicates that simply having mental health legislation is not significant but does not address critical components of it. Having a dummy variable means no change in time can be used, so one cannot see the effects of a newly implemented policy, plan or legislation. Furthermore, it does not address the quality of the legislation, policy or plan. This is a major issue that cannot be addressed with the current data available since measuring the quality and structure of such policies and plans have not yet been collected.

Awareness and Prevention Programs

This regression addresses awareness programs related with some of the major causes of suicide. Collecting data on domestic abuse, child abuse and other issues is very difficult due to stigmas and under-reporting. Therefore, an analysis of awareness programs will be conducted which looks at if countries have programs that try to reduce these abuses. In theory, an effective awareness program will reduce the type of abuse, which in turn reduces mental health issues and suicide rates.

The important indicators which are direct causes of suicide are child abuse, domestic abuse, and abuse of indigenous people [2]. Prevention programs for child abuse and domestic violence comes from “Prevention Programs” subcategory from the Violence Prevention category in the data repository [6]. This dataset is ranked as a factor by the World Health Organization for the quality of the program between 2012 and 2014 and is transformed into a dummy variable for this regression. 0 indicates no program, 1 indicates a “Limited” program, and 2 indicates a “Large Scale” program. Additionally, youth violence and senior abuse prevention programs were collected from this dataset. Awareness programs for indigenous peoples as well as awareness for violence were collected from the “Awareness Activities by Country” subcategory from the “Mental Health” category [6]. These are binary and do not address quality of program.

The results of this regression can be found in Appendix – Awareness Programs. With 101 observations, domestic abuse prevention programs are statistically significant for developed countries at the 95% significance level. This is both for Limited and Large-scale prevention programs with both having negative coefficients. This is what is expected as having the prevention program should reduce domestic violence in the country, which in turn should reduce suicide rates. This is included in the final regression along with child abuse prevention programs given that they address a significant factor in suicide.

Final Regression

The final regression combines the significant and relevant variables from the initial regressions. The alcohol abuse related variables include alcohol consumption change per capita from 2010 to 2015, treatment for substance abuse as an alternative to criminal sanction, and awareness programs for illegal alcohol use and binge drinking. The mental health resources variables are per capita change from 2010 to 2015 of psychiatrists and beds in mental hospitals. The prevention program variables are domestic abuse prevention programs and child abuse programs.

The expected outcome is that the coefficients are negative for all variables except for alcohol consumption per capita. Additionally, the effects of each should be higher in developed countries versus developing countries

Results and Analysis of the Final Regression

The final regression can be seen in Appendix – Final Regression. The regression is limited to 62 degrees of freedom but boasts an adjusted R^2 of 0.9592. The most significant variable for predicting the 2015 suicide rate is naturally the 2010 suicide rate. The F-statistic for this regression is 94.04 which is sufficiently high and indicates that the model can be trusted. The p-value from the Breusch-Pagan test is also sufficiently high and indicates no multi-collinearity.

Alcohol and Substance Abuse

Alcohol consumption per capita and awareness programs for illegal alcohol usage are the only variables that are not statistically significant for either developing or developed countries. This makes sense as alcohol abuse is what impacts suicide rates, and neither of these variables address that as directly as other variables.

The two alcohol-related significant variables are treatment for substance abuse as an alternative to criminal sanction and awareness programs for binge drinking. This is both significant only for developed countries. However, the coefficients for these variables are positive, which is not what was expected. This is most likely due to both variables being dummy variables rather than a time series. So, the causation is flipped, and most likely this treatment program and awareness program was implemented in developed countries which already had high suicide rates. Therefore, this does not provide relevant information for developed or developing countries in reducing suicide rates as the effect of these programs is not truly given in this regression.

Mental Health Resources

The two mental health resources variables end up being significant. The change in per capita of psychiatrists is significant for developing countries, and the change in per capita of beds is significant for developed countries.

The change in psychiatrists has the biggest negative coefficient, indicating it is the most significant resource in reducing suicide rates. This makes sense as naturally psychiatrists help mental health patients which directly can prevent a patient from taking their life. It is interesting as it is significant for developing countries, but not for developed countries. This may be because there already are enough psychiatrists in developed countries, and there are diminishing returns with an increase in psychiatrists. This would also make sense as having an oversaturation of psychiatrists does not necessarily help a mental patient, it just gives them more options for who to see. But an under-saturation means that the

supply of psychiatrists is too low for the demand which means patients with mental disorders are unable to see psychiatrists as they may already be booked up. Furthermore, too few psychiatrists mean that their prices are higher, which can also deter mental health patients from seeking the help they need.

Beds in mental hospitals was the other significant variable; this time for developed countries. It is significant, and the coefficient is negative, but its coefficient is very small. This does make sense though as this is the percent change of suicide for every additional bed. Generally, beds are added in large groups and not in singles. While the change in beds in mental hospitals for developing countries is not significant at the 95% significance level, it is significant at the 80% significance level. While this cannot be accurately analyzed, its coefficient is also negative and more than 8 times greater than change in beds for developed countries. This would make sense as developing countries would have less resources and an additional bed would have a greater impact for them in comparison to developed countries. This regression does show though that for developed countries, adding more beds in mental hospitals results in a decrease in suicide rates at a higher rate than adding personnel (psychiatrists). This can be useful in the future of resource allocation and budgeting by governments.

Prevention Programs

Both domestic abuse and child abuse prevention programs are statistically significant according to the regression for developed countries.

Domestic abuse programs are significant for both factors, Limited and Large-scale, for developed countries. The coefficient sign is negative for both levels and for developed and developing countries. This is the most negative coefficient for developed countries indicating that it is the best method to reduce suicide rates for developed countries. Surprisingly, having a “Limited” domestic abuse program has a more negative coefficient than the “Large-Scale” domestic abuse programs. This might be because large-scale programs have been in existence for longer and therefore has been effective even before 2010, whereas the limited programs are newer and therefore have a higher marginal rate of return. Ultimately, it does show though that having a domestic abuse program in a developed country does significantly reduce their suicide rate.

Child abuse programs are significant for only the large-scale factor in developed countries. Also, its coefficient is positive. This is most likely due to reverse causality, where higher suicide rates have led to countries adopting better child abuse programs. Its effects are therefore yet to be determined as it has not truly been captured in this regression. The coefficient for large-scale child abuse programs in developing countries is the only one which is negative, but its p-value is too high, indicating it is insignificant with the current data. Therefore, no conclusions can be made in regard to child abuse programs and their effects on reducing suicide rates.

Further Improvements

One very necessary improvement is getting better data. This would provide more observations and can further analyze mental healthcare spending as there would be more degrees of freedom.

Many variables were dummy variables due to a lack of data in multiple years. This prevented an analysis of the change over time, which led to issues with causality as can be seen with the child abuse prevention programs in the final regression. Additionally, this could potentially also help look at financial

or employment shocks. Those shocks were significant in a person finally initiating a suicide attempt [2] and therefore can be analyzed.

Additionally, data which ranks the quality of each method would be useful. Comparing quality of legislation/policies might make it significant and can therefore be explored in a greater manner on their impacts with suicide rates. This is difficult to do, but even setting up a factor such as the one used for prevention programs can lead to a further analysis.

A direction that could be moved in is analyzing the mental health resources as that proved to be statistically significant. A future study could incorporate the current rates of Psychiatrists and how much a person can afford them or other treatments. This might be useful as potentially the way a healthcare system is set up might impact mental health issues and suicide rates. Countries may have all the resources they need, but individuals may be unable to properly access them due to financial reasons or logistical issues.

Conclusion

Suicide rates in developing and developed countries do vary, but surprisingly is higher in developed countries when looking at it per capita. There also are different methods that the two groups can use to reduce their suicide rates. Developing countries can further invest in psychiatrists and other health personnel who can help people with mental health issues get the treatment they need.

Developed countries primarily should focus on prevention programs instead of bolstering health resources. Implementing domestic abuse programs resulted in the most significant reduction of suicide rates for developed countries. Secondly, developed countries are better off investing in facilities such as increasing the number of beds in a mental hospital in order to reduce their suicide rates as opposed to more personnel.

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Appendices

Appendix – Threshold Cutoffs Used by World Bank for Income Classifications

Threshold	GNI/Capita (current US$)
Low-income	< 995
Lower-middle income	996 - 3,895
Upper-middle income	3,896 - 12,055
High-income	> 12,055

[5]

Appendix -Multi-collinearity test for suicide rates in 2005 and 2010

```
   Variables      VIF
1 sr.SR_2005 17.75894
2 sr.SR_2010 17.75894
```

Breush-Pagan Tests for Heteroskedacity

Suicide rates in 2010 as a predictor for Suicide rates in 2015

```
        studentized Breusch-Pagan test

data:  sr_het
BP = 49.878, df = 1, p-value = 1.636e-12
```

Natural logarithm of suicide rates in 2010 as a predictor for Suicide rates in 2015

```
        studentized Breusch-Pagan test

data:  sr_het
BP = 12.396, df = 1, p-value = 0.0004303
```

Results for Final Model

```
        studentized Breusch-Pagan test

data:  sr_final_Dev_2015
BP = 22.239, df = 21, p-value = 0.3858
```

Appendix – Alcohol and Substance Abuse Initial Regression

```
Call:
lm(formula = log10(sr$SR_2015) ~ log10(sr$SR_2010) + sr$Alc_Chg_1015:sr$Dev +
    sr$awr_binge_drinking:sr$Dev + sr$awr_dd:sr$Dev + sr$awr_youthdrink:sr$Dev +
    sr$conf_drug_disorder_2014:sr$Dev + sr$awr_illalc:sr$Dev +
    sr$treat_sub_add:sr$Dev + sr$treat_sub_alt:sr$Dev + sr$alc_policy_before:sr$Dev +
    sr$alc_policy_rev.add_during:sr$Dev, data = sr)

Residuals:
     Min       1Q   Median       3Q      Max
-0.49931 -0.03306  0.00134  0.03787  0.32663

Coefficients:
                                    Estimate Std. Error t value Pr(>|t|)
(Intercept)                         0.059843   0.019774   3.026   0.0029 **
log10(sr$SR_2010)                   0.930269   0.019824  46.927   <2e-16 ***
sr$Alc_Chg_1015:sr$Dev0             0.007954   0.012247   0.649   0.5170
sr$Alc_Chg_1015:sr$Dev1             0.004739   0.007760   0.611   0.5423
sr$Dev0:sr$awr_binge_drinking1      0.047482   0.040078   1.185   0.2380
sr$Dev1:sr$awr_binge_drinking1      0.008312   0.019223   0.432   0.6661
sr$Dev0:sr$awr_dd1                 -0.006506   0.025222  -0.258   0.7968
sr$Dev1:sr$awr_dd1                 -0.017325   0.023516  -0.737   0.4624
sr$Dev0:sr$awr_youthdrink1          0.002121   0.024472   0.087   0.9310
sr$Dev1:sr$awr_youthdrink1          0.010456   0.024729   0.423   0.6730
sr$Dev0:sr$conf_drug_disorder_20141 -0.004240   0.018626  -0.228   0.8202
sr$Dev1:sr$conf_drug_disorder_20141 -0.019949   0.017816  -1.120   0.2646
sr$Dev0:sr$awr_illalc1              -0.053790   0.036915  -1.457   0.1471
sr$Dev1:sr$awr_illalc1              -0.023679   0.019983  -1.185   0.2379
sr$Dev0:sr$treat_sub_add1           0.003748   0.024265   0.154   0.8775
sr$Dev1:sr$treat_sub_add1           0.022299   0.019381   1.151   0.2517
sr$Dev0:sr$treat_sub_alt1          -0.025790   0.026208  -0.984   0.3266
sr$Dev1:sr$treat_sub_alt1           0.025296   0.018638   1.357   0.1767
sr$Dev0:sr$alc_policy_before1       0.003486   0.026616   0.131   0.8960
sr$Dev1:sr$alc_policy_before1       0.004388   0.016881   0.260   0.7953
sr$Dev0:sr$alc_policy_rev.add_during1 -0.015419   0.027335  -0.564   0.5735
sr$Dev1:sr$alc_policy_rev.add_during1 -0.012519   0.018329  -0.683   0.4956
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.0737 on 153 degrees of freedom
  (8 observations deleted due to missingness)
Multiple R-squared:  0.9486,    Adjusted R-squared:  0.9416
F-statistic: 134.6 on 21 and 153 DF,  p-value: < 2.2e-16
```

Appendix – Healthcare Spending

```
Call:
lm(formula = log10(sr$SR_2015) ~ log10(sr$SR_2010) + sr$Region +
    sr$govt_exp_mh:sr$Dev + sr$govt_exp_hosp:sr$Dev, data = sr)

Residuals:
      Min        1Q    Median        3Q       Max
-0.150862 -0.028733 -0.000022  0.030874  0.093550

Coefficients:
                                   Estimate Std. Error t value Pr(>|t|)
(Intercept)                       -1.552e-03  4.604e-02  -0.034   0.9733
log10(sr$SR_2010)                  9.310e-01  3.600e-02  25.864   <2e-16 ***
sr$RegionEurope & Central Asia     2.615e-02  3.085e-02   0.848   0.4034
sr$RegionLatin America & Caribbean 6.413e-02  3.461e-02   1.853   0.0737 .
sr$RegionMiddle East & North Africa -1.923e-02  4.108e-02  -0.468   0.6430
sr$RegionSouth Asia                3.517e-02  6.826e-02   0.515   0.6101
sr$RegionSub-Saharan Africa        7.097e-02  4.026e-02   1.763   0.0881 .
sr$govt_exp_mh:sr$Dev0             1.033e-05  2.207e-05   0.468   0.6431
sr$govt_exp_mh:sr$Dev1             2.424e-06  1.356e-06   1.788   0.0839 .
sr$Dev0:sr$govt_exp_hosp           3.300e-05  1.199e-04   0.275   0.7851
sr$Dev1:sr$govt_exp_hosp           1.402e-06  2.004e-05   0.070   0.9447
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.0607 on 30 degrees of freedom
  (142 observations deleted due to missingness)
Multiple R-squared:  0.9718,    Adjusted R-squared:  0.9624
F-statistic: 103.5 on 10 and 30 DF,  p-value: < 2.2e-16
```

Appendix - Resources

```
Call:
lm(formula = log10(sr$SR_2015) ~ log10(sr$SR_2010) + sr$Region +
    sr$psychiatrist_chg:sr$Dev + sr$beds_gen_hosp_chg:sr$Dev +
    sr$beds_mh_chg:sr$Dev, data = sr)

Residuals:
     Min       1Q   Median       3Q      Max
-0.14986 -0.03025  0.00000  0.03578  0.12290

Coefficients:
                                    Estimate Std. Error t value Pr(>|t|)
(Intercept)                         0.0916298  0.0307518   2.980   0.0041 **
log10(sr$SR_2010)                   0.9011168  0.0248051  36.328   <2e-16 ***
sr$RegionEurope & Central Asia     -0.0234399  0.0257045  -0.912   0.3653
sr$RegionLatin America & Caribbean  0.0037795  0.0259713   0.146   0.8848
sr$RegionMiddle East & North Africa -0.0796784  0.0299988  -2.656   0.0100 *
sr$RegionNorth America              0.0523652  0.0662105   0.791   0.4320
sr$RegionSouth Asia                -0.0757788  0.0342506  -2.212   0.0306 *
sr$RegionSub-Saharan Africa        -0.0292260  0.0274030  -1.067   0.2903
sr$psychiatrist_chg:sr$Dev0        -0.0552581  0.0350627  -1.576   0.1200
sr$psychiatrist_chg:sr$Dev1         0.0059581  0.0043579   1.367   0.1764
sr$Dev0:sr$beds_gen_hosp_chg        0.0085496  0.0078123   1.094   0.2780
sr$Dev1:sr$beds_gen_hosp_chg        0.0002432  0.0002184   1.113   0.2697
sr$Dev0:sr$beds_mh_chg              0.0027638  0.0037935   0.729   0.4690
sr$Dev1:sr$beds_mh_chg             -0.0010766  0.0004646  -2.317   0.0237 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.05895 on 63 degrees of freedom
  (106 observations deleted due to missingness)
Multiple R-squared:  0.9651,    Adjusted R-squared:  0.9579
F-statistic:   134 on 13 and 63 DF,  p-value: < 2.2e-16
```

Appendix – Mental Health Policy

```
Call:
lm(formula = log10(sr$SR_2015) ~ log10(sr$SR_2010) + sr$Region +
    sr$mh_legis:sr$Dev, data = sr)

Residuals:
     Min       1Q   Median       3Q      Max
-0.52887 -0.03264  0.00219  0.03702  0.29597

Coefficients: (1 not defined because of singularities)
                                   Estimate Std. Error t value Pr(>|t|)
(Intercept)                        0.063686   0.024720   2.576   0.0109 *
log10(sr$SR_2010)                  0.907410   0.019985  45.405   <2e-16 ***
sr$RegionEurope & Central Asia     0.018430   0.019278   0.956   0.3405
sr$RegionLatin America & Caribbean 0.017896   0.021044   0.850   0.3964
sr$RegionMiddle East & North Africa -0.024432  0.023654  -1.033   0.3032
sr$RegionNorth America             0.059003   0.053671   1.099   0.2733
sr$RegionSouth Asia               -0.021609   0.029910  -0.722   0.4711
sr$RegionSub-Saharan Africa        0.007202   0.018667   0.386   0.7001
sr$mh_legis0:sr$Dev0               0.004345   0.017371   0.250   0.8028
sr$mh_legis1:sr$Dev0              -0.004576   0.017235  -0.266   0.7909
sr$mh_legis0:sr$Dev1               0.003655   0.017249   0.212   0.8324
sr$mh_legis1:sr$Dev1                     NA         NA      NA       NA
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.072 on 161 degrees of freedom
  (11 observations deleted due to missingness)
Multiple R-squared:  0.9463,    Adjusted R-squared:  0.9429
F-statistic: 283.6 on 10 and 161 DF,  p-value: < 2.2e-16
```

Appendix – Awareness Programs

```
Call:
lm(formula = log10(sr$SR_2015) ~ log10(sr$SR_2010) + sr$Region +
    sr$awr_indig:sr$Dev + sr$awr_harmother:sr$Dev + sr$child_abuse_pgm_12.14:sr$Dev +
    sr$youth_viol_pvn_12.14:sr$Dev + sr$dom_abuse_12.14:sr$Dev +
    sr$sen_abuse_12.14:sr$Dev, data = sr)

Residuals:
      Min        1Q    Median        3Q       Max
-0.146073 -0.030299  0.002729  0.036747  0.114365

Coefficients: (1 not defined because of singularities)
                                    Estimate Std. Error t value Pr(>|t|)
(Intercept)                        6.346e-02  3.419e-02   1.856  0.06636 .
log10(sr$SR_2010)                  9.180e-01  2.221e-02  41.337  < 2e-16 ***
sr$RegionEurope & Central Asia     1.294e-02  1.785e-02   0.725  0.47011
sr$RegionLatin America & Caribbean 2.739e-02  2.073e-02   1.321  0.18933
sr$RegionMiddle East & North Africa -3.358e-02  2.228e-02  -1.508  0.13478
sr$RegionNorth America             3.503e-02  4.532e-02   0.773  0.44140
sr$RegionSouth Asia               -8.085e-03  2.830e-02  -0.286  0.77570
sr$RegionSub-Saharan Africa        1.344e-02  1.804e-02   0.745  0.45807
sr$awr_indig0:sr$Dev0             -5.377e-03  3.599e-02  -0.149  0.88153
sr$awr_indig1:sr$Dev0             -3.744e-02  4.767e-02  -0.785  0.43401
sr$awr_indig0:sr$Dev1             -2.711e-02  2.475e-02  -1.095  0.27605
sr$awr_indig1:sr$Dev1                     NA         NA      NA       NA
sr$Dev0:sr$awr_harmother1          2.341e-02  2.383e-02   0.982  0.32830
sr$Dev1:sr$awr_harmother1          1.124e-02  1.471e-02   0.764  0.44685
sr$Dev0:sr$child_abuse_pgm_12.141  8.117e-03  2.275e-02   0.357  0.72202
sr$Dev1:sr$child_abuse_pgm_12.141  2.797e-03  1.948e-02   0.144  0.88612
sr$Dev0:sr$child_abuse_pgm_12.142  5.059e-05  3.497e-02   0.001  0.99885
sr$Dev1:sr$child_abuse_pgm_12.142  2.157e-02  1.896e-02   1.138  0.25782
sr$Dev0:sr$youth_viol_pvn_12.14   -5.216e-03  1.319e-02  -0.396  0.69328
sr$Dev1:sr$youth_viol_pvn_12.14    1.106e-02  1.313e-02   0.842  0.40151
sr$Dev0:sr$dom_abuse_12.141        3.055e-03  1.909e-02   0.160  0.87317
sr$Dev1:sr$dom_abuse_12.141       -5.019e-02  1.795e-02  -2.796  0.00619 **
sr$Dev0:sr$dom_abuse_12.142       -1.885e-02  3.029e-02  -0.622  0.53517
sr$Dev1:sr$dom_abuse_12.142       -4.239e-02  1.908e-02  -2.221  0.02857 *
sr$Dev0:sr$sen_abuse_12.141       -1.458e-02  2.234e-02  -0.653  0.51532
sr$Dev1:sr$sen_abuse_12.141        1.829e-02  2.368e-02   0.772  0.44173
sr$Dev0:sr$sen_abuse_12.142       -1.600e-02  2.582e-02  -0.620  0.53681
sr$Dev1:sr$sen_abuse_12.142        1.727e-02  2.125e-02   0.813  0.41818
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.05623 on 101 degrees of freedom
  (55 observations deleted due to missingness)
Multiple R-squared:  0.9669,    Adjusted R-squared:  0.9584
F-statistic: 113.6 on 26 and 101 DF,  p-value: < 2.2e-16
```

Appendix – Final Regression

```
Call:
lm(formula = log10(sr$SR_2015) ~ log10(sr$SR_2010) + sr$Alc_Chg_1015:sr$Dev +
    sr$treat_sub_alt:sr$Dev + sr$awr_binge_drinking:sr$Dev +
    sr$awr_illalc:sr$Dev + sr$psychiatrist_chg:sr$Dev + sr$beds_mh_chg:sr$Dev +
    sr$dom_abuse_12.14:sr$Dev + sr$child_abuse_pgm_12.14:sr$Dev,
    data = sr)

Residuals:
      Min        1Q    Median        3Q       Max
-0.152661 -0.022842  0.006778  0.034080  0.092021

Coefficients:
                                  Estimate Std. Error t value Pr(>|t|)
(Intercept)                      0.0183407  0.0251605   0.729  0.46878
log10(sr$SR_2010)                0.9466707  0.0257609  36.748  < 2e-16 ***
sr$Alc_Chg_1015:sr$Dev0          0.0461881  0.0322371   1.433  0.15695
sr$Alc_Chg_1015:sr$Dev1          0.0094365  0.0073804   1.279  0.20580
sr$Dev0:sr$treat_sub_alt1       -0.0225857  0.0317618  -0.711  0.47969
sr$Dev1:sr$treat_sub_alt1        0.0304406  0.0171111   1.779  0.08014 .
sr$Dev0:sr$awr_binge_drinking1   0.0415870  0.0423706   0.982  0.33016
sr$Dev1:sr$awr_binge_drinking1   0.0509351  0.0189956   2.681  0.00938 **
sr$Dev0:sr$awr_illalc1          -0.0338659  0.0469764  -0.721  0.47367
sr$Dev1:sr$awr_illalc1          -0.0227453  0.0198467  -1.146  0.25618
sr$Dev0:sr$psychiatrist_chg     -0.1077372  0.0425416  -2.533  0.01387 *
sr$Dev1:sr$psychiatrist_chg      0.0017254  0.0029316   0.589  0.55830
sr$Dev0:sr$beds_mh_chg          -0.0066883  0.0043851  -1.525  0.13229
sr$Dev1:sr$beds_mh_chg          -0.0008169  0.0004536  -1.801  0.07663 .
sr$Dev0:sr$dom_abuse_12.141     -0.0048237  0.0250114  -0.193  0.84770
sr$Dev1:sr$dom_abuse_12.141     -0.0638919  0.0208452  -3.065  0.00322 **
sr$Dev0:sr$dom_abuse_12.142     -0.0411525  0.0460925  -0.893  0.37540
sr$Dev1:sr$dom_abuse_12.142     -0.0515167  0.0241323  -2.135  0.03674 *
sr$Dev0:sr$child_abuse_pgm_12.141  0.0184305  0.0242192   0.761  0.44955
sr$Dev1:sr$child_abuse_pgm_12.141  0.0090636  0.0209253   0.433  0.66642
sr$Dev0:sr$child_abuse_pgm_12.142 -0.0394461  0.0447690  -0.881  0.38167
sr$Dev1:sr$child_abuse_pgm_12.142  0.0354955  0.0197523   1.797  0.07720 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.05669 on 62 degrees of freedom
  (99 observations deleted due to missingness)
Multiple R-squared:  0.9696,    Adjusted R-squared:  0.9592
F-statistic: 94.04 on 21 and 62 DF,  p-value: < 2.2e-16
```