Top Mortality causes in young adults and middle age adults in Switzerland*

Analyzing Switzerland Mortality causes data in 2010, 2015, adn 2019 from WHO database

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Motivated by the lack of findings on different mortality causes for different age groups, this paper examines the main causes of mortality among young adults and middle-aged adults in Switzerland using data from the WHO Mortality Database for the years 2010, 2015, and 2019. The paper found that the leading causes of death for young adults are self-harm and drug use disorders, while middle-aged adults are most affected by ischemic heart disease and trachea, bronchus, and lung cancers. Moreover, it is also found that one of the main mortality causes in both age groups is self-harm which highlights the importance of mental health.

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*Code and data are available at: https://github.com/thu2912/Top-mortality-causes-of-age-groups-in-Switzerland.git

1 Introduction

Mortality study has become increasingly important in modern society. Understanding mortality causes is vital for medicine and health research, as well as implementing policies that can help increase the quality of living and life expectancy. With Switzerland being the country with the 4th highest life expectancy in the world, there has been much research about the causes of death in Switzerland. However, there have not been a lot of studies that focus on the different causes of death in young adults (20 to 39) and middle-aged adults (40 to 59) in the country.

Therefore, in this paper, we will investigate the top mortality causes in young adults and middle-aged adults in Switzerland and discuss some trends and patterns in healthcare that were witnessed in the data. The estimand that we're trying to estimate is the number of deaths by different mortality causes in young adults and middle-aged adults. We aim to provide empirical evidence on different causes of death in two age groups and investigate the reasons behind the differences in health issues in two age groups. This paper uses data obtained from the open database, WHO Mortality database, which exhibits information on mortality causes of deaths filtered by country, sex, year, and age group. The data used in this paper were the Mortality causes in Switzerland in the years 2010, 2015, and 2019 as it gives a general idea of the mortality causes from 2010 to 2019, filtered by age group.

We found that on average, the top causes of death in young adults are self-harm and drug use disorder, and the top mortality causes in middle-aged adults are Ischaemic heart disease, as well as trachea, bronchus, and lung cancers. Additionally, we found a trend of high rate of self-harm in both young adults and middle-aged adults. The findings of the paper highlight the importance of healthy habits such as a healthy diet and exercise and the reduction of harmful substance use, such as tobacco, to maintain a healthy heart and lungs. Additionally, the paper also highlights the importance of mental health and policies that allow for accessible

mental health support. Moreover, this paper's findings demonstrate how policymakers play a major role in addressing public health issues through effective interventions.

The remainder of the paper is structured as follows: Section 2 introduces the data used for analysis and findings, including visualizations of the variables of interest, Section 3 presents the Negative Binomial regression model to justify the relationship between the number of deaths and causes of deaths, Section 4 displays the interpretations of the model alongside other findings from analyzing the data, and Section 5 provides a discussion on the implications of the findings as well as the weaknesses of this paper and its next steps for further study on this subject.

2 Data

2.1 Data Sources

The data utilized in this paper is provided by the World Health Organization WHO) specifically from the WHO Mortality Database ("Global Health Estimates: Leading Causes of Death" 2021) which focuses on health estimates and global mortality. At present, the WHO Mortality database contains data concerning top mortality causes in 120 different countries from 2000 until 2019, covering large age groups from 0 to above 85. WHO is a data source that offers openly available data to the public and can be downloaded free from the website. Key elements of the WHO Mortality Database include country-specific data categorized by age group, sex, and year; detailed data on causes of death by number of deaths; a visualization portal for data exploration which enhanced user experience; and raw data files for download.

The database's data collection methods include collaborating with health authorities and statistical agencies from over 120 countries. One of the steps in the data collection process is using the Civil Registration and Vital Statistics (CRVS) Systems as it records events like deaths, births, causes of deaths, etc which is reported and maintained by national health authorities. Another step of collecting data is processing data with death data obtained by count and population size by sex and age estimated by using census data and annual population estimates. Other steps after collecting the data are standardized coding and quality assurance. Although different steps of the collection have been highlighted, the specifics of each step were not available publicly.

2.2 Clean Data

he data utilized for this paper is downloaded manually through the WHO Mortality Database. All the data analysis was done through R programming language (R Core Team (2023)) with the aid of the following packages:rstanarm (Goodrich et al. (2022)), tidyverse (Wickham et al. (2019)), knitr (Xie (2014)), modelsummary (Arel-Bundock (2022)), ggplot2 (Wickham

(2016)), dplyr (Wickham et al. (2023)), parameters (Lüdecke et al. (2020)), broom (Robinson, Hayes, and Couch (2023)), broom.mixed (Bolker and Robinson (2022)).

The data is prepared specifically by downloading data for each age group separately (20 to under 40 and 40 to under 60). Then, the variables selected for the analysis are year, population, number of deaths, and causes of death. Additionally, two other variables were created: age which takes values 'below 40' and 'above 40' to respectively refer to young adults and middle-aged adults. Overall, 2 different data sets were created based on age groups. For each age group, data was then merged from the years 2010, 2015, and 2019. This resulted in two data sets, one for young adults, and one for middle-aged adults. Finally, I ensured consistency in variable naming and format during the merging process. This two data sets are created to analyze trends in mortality causes among young and middle-aged adults in Switzerland using data from 2010, 2015, and 2019. The two analysis datasets include 30 observations each and 6 variables each: Year, deaths, causes, death rate, and age. Each observation shows one of the mortality causes in one of the 3 years researched. For example, Table 1 and Table 2 display the top 10 causes of death in Switzerland in 2010. In both tables, year recorded the years that this data was reported from, causes recorded some mortality causes such as self-harm, drug use disorders, road injury, breast cancer, etc, the population is constant for an age group in a year, deaths recorded the number of deaths attributed to each cause within the population. Furthermore, the death rate is the number of deaths per 100,000 population for each cause, calculated based on the number of deaths over population, and the age variable reports the age category which is "below 40" when looking at young adults (20 to under 40), and "above 40" for middle age adults (40 to under 60). Similar datasets with the same attributes can be used for this analysis. However, since we were unable to find data that have separated observations into each age group. Therefore, the data that is used for this paper is created using data from WHO Mortality Database.

Table 1: Top 10 Mortality Causes in Switzerland for young adults in 2010

Year	Causes	Population	Deaths	Death rate	Age
2010	Self-harm	1507608	202	13.3987084	below 40
2010	Drug use disorders	1507608	95	6.3013728	below 40
2010	Road injury	1507608	85	5.6380704	below 40
2010	Breast cancer	1507608	33	2.1888979	below 40
2010	Ischaemic heart disease	1507608	31	2.0562374	below 40
2010	Brain and nervous system cancers	1507608	27	1.7909165	below 40
2010	Falls	1507608	25	1.6582560	below 40
2010	Congenital anomalies	1507608	20	1.3266048	below 40
2010	Colon and rectum cancers	1507608	19	1.2602746	below 40
2010	Stroke	1507608	15	0.9949536	below 40

Table 2: Top 10 Mortality Causes in Switzerland for middle ages in 2010

Year	Causes	Population	Deaths	Death rate	Age
2010	Ischaemic heart disease	1840659	623	33.846573	above 40
2010	Trachea, bronchus, lung cancers	1840659	572	31.075827	above 40
2010	Self-harm	1840659	427	23.198213	above 40
2010	Breast cancer	1840659	300	16.298510	above 40
2010	Cirrhosis of the liver	1840659	236	12.821495	above 40
2010	Colon and rectum cancers	1840659	213	11.571942	above 40
2010	Pancreas cancer	1840659	172	9.344479	above 40
2010	Stroke	1840659	141	7.660300	above 40
2010	Brain and nervous system cancers	1840659	134	7.280001	above 40
2010	Mouth and oropharynx cancers	1840659	117	6.356419	above 40

2.3 Variable of interest.

2.3.1 Causes of death among young adults in Switzerland.

Table 3 shows the common causes of death in 2010, 2015, and 2019 and the total number of deaths per cause in young adults in Switzerland. It is shown that in those 3 years, there were 595 deaths caused by Self-harm, 260 deaths caused by Drug use disorders, 181 deaths caused by Road injury, 79 deaths caused by Brain and nervous system cancers, and 73 deaths caused by Falls.

Figure 1 shows the line plot that illustrates the trend of the number of deaths for common causes among young adults over the years 2010, 2015, and 2019. Self-harm appears to have the highest number of deaths across all three years, with a slight decrease from 2010 to 2019. Drug use disorders also show a fairly constant number of deaths from 2010 to 2015, followed by a slight decline by 2019. Additionally, Road injuries show a stable decrease in the number of deaths throughout the 3 years, from approximately 75 in 2010 to around 40 in 2019. Brain and nervous system cancers and Falls show a constant low number of deaths in both, at approximately 25 cases in each in all 3 years.

Table 3: Common Mortality Causes for young adults in 2010,1015,and 2019

Cause	Deaths
Self-harm	595
Drug use disorders	260
Road injury	181
Brain and nervous system cancers	79

Cause	Deaths
Falls	73

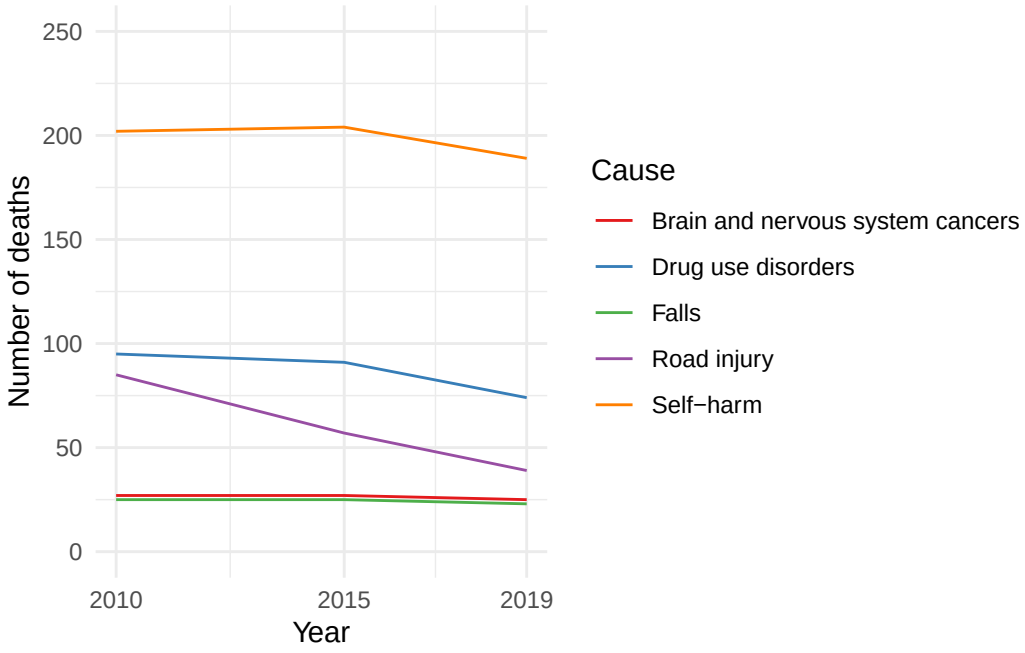

Figure 1: Common mortality causes in young adults in 2010, 2015, and 2019

2.3.2 Causes of death among Middle-aged adults in Switzerland.

Table 4 shows the common causes of death in 2010, 2015, and 2019 and the total number of deaths per cause in middle-aged adults in Switzerland. It is shown that in those 3 years, there were 1656 deaths caused by Ischaemic heart disease, 1548 deaths caused by Trachea, bronchus, lung cancers, 1285 deaths caused by Self-harm, 825 deaths caused by Breast cancer, and 618 deaths caused by Cirrhosis of the liver.

Table 4: Common Mortality Causes for middle age adults in 2010,1015,and 2019

Cause	Deaths
Ischaemic heart disease	1656
Trachea, bronchus, lung cancers	1548
Self-harm	1285
Breast cancer	825
Cirrhosis of the liver	618

Figure 2 is the line plot that illustrates the number of deaths for common causes among middle-aged adults in 2010, 2015, and 2019. Ischaemic heart disease appears to have the highest number of deaths across all three years. However, there was a significant decrease in the number of deaths caused by Ischaemic heart disease from 2010 to 2015, followed by a slight decrease from 2015 to 2019. Compared to 2019, there were over 100 more deaths caused by Ischaemic heart disease in 2010. Trachea, bronchus, and lung cancers constantly decreased in the number of deaths throughout the 3 years, from approximately 580 in 2010 to around 480 in 2019. Self-harm also shows a fairly constant number of deaths in those 3 years, at approximately over 400. Additionally, Breast cancer demonstrates a slight decrease in the number of deaths from 2010 to 2019. There was also a small decrease in the number of deaths from Cirrhosis of the liver from 2010 to 2015 and remained constant in 2019.

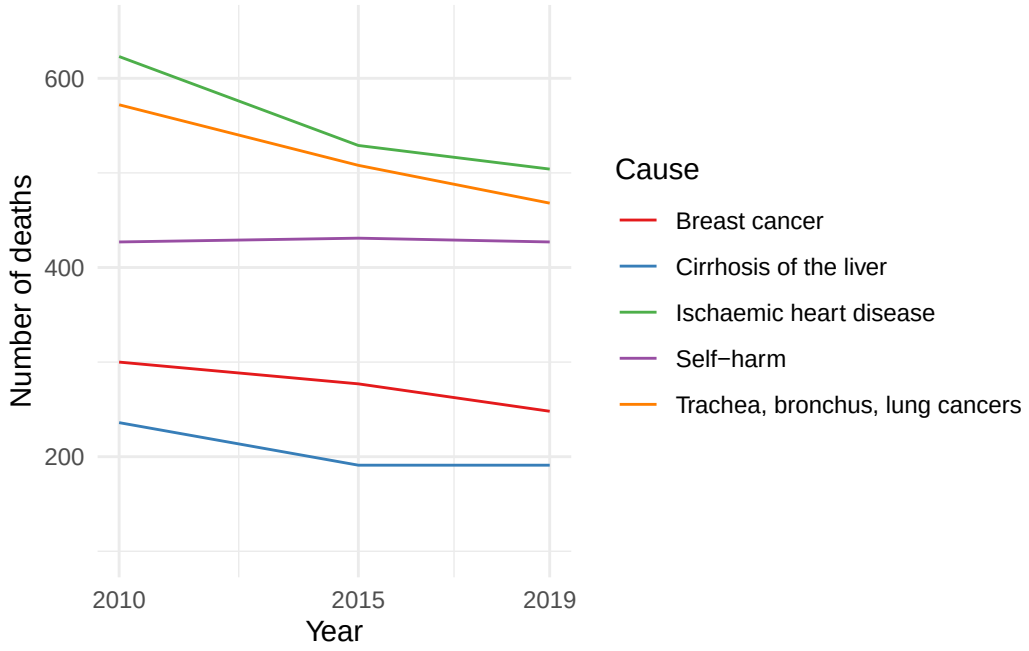

Figure 2: Common mortality causes in middle-aged adults in 2010, 2015, and 2019

2.3.3 Basic Summary statistics

Table 5 is the summary statistics of Table 1 showing its minimum, mean, maximum, standard deviation, variance, and sample size of young adults' top mortality causes data in 2010, 2015, and 2019. The summary statistics show that the mean number of deaths is 50, with a minimum of 14, and a maximum of 204 for a sample size of 30. The variance is high because the range of the data is large as the variance is 3077.

Table 6 is the summary statistics of Table 2 showing its minimum, mean, maximum, standard deviation, variance, and sample size of middle-aged adults' top mortality causes data in 2010,

Table 5: Summary statistics for young adults

	Min	Mean	Max	SD	Var	N
Deaths	14	50	204	55	3077	30

Table 6: Summary statistics for middle-aged adults

	Min	Mean	Max	SD	Var	N
Deaths	103	272	623	162	26 240	30

2015, and 2019. The summary statistics show that the mean number of deaths is 272, with a minimum of 103, and a maximum of 603 for a sample size of 30. The variance is high because the range of the data is large as the variance is 26240.

The variable in the data set is measured by using the results of the data collection in the WHO Mortality Database. The number of deaths is measured in integers and by the total number of deaths reported to the national database that year. Population is also an integer that is measured using the demographic data of the country. Additionally, Causes is a categorical variable that records all popular causes that lead to death in a year. Age group is a categorical variable that records whether or not a person is "above 40" or "below 40". While "below 40" measures young adults, "above 40" measures middle-aged adults. Finally, death rate per 100,000 is measured by dividing the total number of death of a specific mortality causes by the population and times 100,000.

3 Model

3.1 Model set-up

Understanding the impact of different causes of death on mortality rates can allow policymakers to create policies that target certain alarming health issues and reduce the death rates in the country. Furthermore, policymakers and researchers can prioritize efforts to address the leading causes of mortality and allocate resources effectively. Therefore, to further understand the relationship between causes of death and death rates, we construct a negative binomial regression with the Bayesian framework:

$$y_i \sim \text{NegBin}(\mu_i, \sigma) \tag{1}$$
$$\log(\mu_i) = \beta_0 + \beta_1 x_i \tag{2}$$
$$\beta_0 \sim \text{Normal}(0, 2.5) \tag{3}$$
$$\beta_1 \sim \text{Normal}(0, 2.5) \tag{4}$$
$$\sigma \sim \text{Exponential}(1) \tag{5}$$

- y_i is the number of deaths in young adults or middle aged adultsin Switzerland
- β_0 is the coefficient of intercept
- β_1 is the coefficient for an average increase in the number of death of a mortality cause
- x_i is the causes of death in young adults or middle aged adults

3.1.1 Model justification

A negative binomial is used to analyze the relationship between the number of deaths and the causes of death in each age group. We assume that there is a relationship between the causes of death and the number of deaths which was somewhat demonstrated in Figure 1 and Figure 2. The reason why we use a negative binomial regression to analyze this relationship is that negative binomial regression is suitable for counting data such as the number of deaths. Moreover, it takes into account overdispersion which happens when variance exceeds the mean which is shown in the summary statistics. Therefore, we pick the Negative Binomial regression over the Poisson regression. Additionally, we apply the Bayesian framework to our analysis as it allows for prior knowledge to be included in the model. Therefore, we assume that all coefficient follows a normal distribution with a mean of 0 and a standard deviation of 2.5 which means we allow some variation in the coefficient of the model.

4 Results

4.1 Model 1

Table 7 shows the result of the relationship between the cause of death and the number of deaths for young adults in Switzerland. The intercept represents the expected log count when a young adult has Brain and nervous system cancers which is approximately 3.283. The expected log count of deaths among young adults with drug use disorder increases by 1.192 which is associated with more death for individuals with drug disorder compared to individuals with Brain and nervous system cancers. Additionally, young individuals who passed away because of a fall are associated with a 0.090 decrease in the expected log count compared to young individuals with Brain and nervous system cancers which means that deaths because of Falling in youth are associated with fewer deaths than Brain ner. Notably, it is witnessed that more

Table 7: Relationship between causes of deaths and number of deaths in young adults

	Below 40
(Intercept)	3.283
	(0.285)
CauseDrug use disorders	1.192
	(0.389)
CauseFalls	−0.090
	(0.405)
CauseRoad injury	0.832
	(0.392)
CauseSelf-harm	2.019
	(0.404)
Num.Obs.	15
Log.Lik.	−66.433
ELPD	−68.6
ELPD s.e.	3.2
LOOIC	137.2
LOOIC s.e.	6.3
WAIC	136.9
RMSE	9.95

young adults pass away due to Road injuries than Brain and nervous system cancer with a 0.832 increase in the expected log count. Finally, young adults who have self-harm tendencies have a 2.019 increase in the expected log count compared to Brain and nervous system cancer which indicates that self-harm is associated with a higher number of deaths in young adults.

4.2 Model 2

Table 8 shows the result of the relationship between the cause of death and the number of deaths for middle-aged adults in Switzerland. The intercept represents the expected log count when a young adult has Breast cancer which is approximately 5.634. This indicates that on average, breast cancer is associated with 279.77 deaths in a year. The expected log count of middle-aged adults with Self-harm increases by 0.445 which indicates that self-harm is associated with more death than Breast cancer in middle-aged adults. Additionally, middle-aged individuals who passed away because of Cirrhosis of the liver are associated with a 0.277 decrease in the expected count compared to middle-aged individuals with Breast Cancer. Notably, it appears that more middle-aged adults pass away due to Trachea, bronchus, and lung cancers than Breast cancer with a 0.629 increase in the expected log count. Finally, middle-aged adults who have Ischaemic heart disease have a 0.694 increase in the expected

Table 8: Relationship between causes of deaths and number of deaths in middle-aged adults

	Above 40
(Intercept)	5.634
	(0.244)
CauseCirrhosis of the liver	−0.277
	(0.345)
CauseIschaemic heart disease	0.694
	(0.357)
CauseSelf-harm	0.445
	(0.337)
CauseTrachea, bronchus, lung cancers	0.629
	(0.339)
Num.Obs.	15
Log.Lik.	−92.059
ELPD	−93.9
ELPD s.e.	1.6
LOOIC	187.7
LOOIC s.e.	3.1
WAIC	187.6
RMSE	33.54

log count compared to Breast cancer. This indicates that Trachea, bronchus, lung cancer, and Ischaemic heart disease are associated with a higher number of deaths in middle-aged adults.

5 Discussion

5.1 The differences between mortality causes of young adults and middle-aged adult

After analyzing the data, it appears that the number of deaths in middle-aged adults is much higher than in young adults. For example, **?@tbl-tbl3** and table—tbl4 shows that in 2010,2015, and 2019, the number of deaths by Ischaemic heart disease and Trachea, bronchus, and lung cancers in middle-aged adults is over 3 times the number of deaths by Self-harm in young adults. witnessed that top mortality causes are vastly different between young adults and middle-aged adults.

Figure 2 demonstrates that most of the top causes of death in middle-aged adults are non-communicable diseases such as Ischaemic heart disease, Trachea, bronchus, and lung cancers, Breast cancer, and Cirrhosis of the liver. This number indicates that the number of deaths that

are caused by a decline in heart and lung health skyrockets as soon as they become middle-aged adults as diseases like Ischaemic heart disease, Trachea, bronchus, and lung cancers were not among the top mortality causes in young adults.

While middle-aged adults experience physical health decline, it appears that deaths caused by mental health issues such as Self-harm and Drug use disorder, and injuries such as road injuries are the main causes of deaths in young adults. Notably, the two main causes of death in young adults are self-harm and drug use disorder with a total of approximately 600 cases of Self-harm and 260 cases of drug use disorder. One of the reasons why young adults tend to experience fewer noncommunicable diseases is the resilience in their youthful bodies and healthy habits of diet and regular exercise.

5.2 Leading cause of death in middle-aged people in Switzerland.

As shown in Table 4, Ischaemic heart disease (IHD) is the leading cause of death in middle-aged adults. Notably, the leading cause of death for the whole population in Switzerland is Ischaemic heart disease with approximately 11,000 cases per year since 2010. ("Coronary Heart Disease in Switzerland" 2020). This disease is not only common in Switzerland, but it is also common worldwide, It results from reduced blood flow to the heart muscle due to narrowed or blocked coronary arteries. Some risk factors for this disease include high blood pressure, high cholesterol, smoking, diabetes, and obesity. It is reported that IHD is responsible for approximately 16% of total deaths worldwide1.(World 2020).

One of the reasons why IHD is the highest cause of death in Switzerland is because of the citizen's tobacco usage. It is known that tobacco usage is one of the risk factors for IHD. In 2017, Swiss smokers used an average of 9.5 cigarettes per day. Additionally, approximately 21% of smokers consumed at least 20 cigarettes per day. Overall, 6% of the Swiss population aged 15 and over were smokers. ("Level of Use - Swiss Association for Tobacco Control" 2016). It is shown that smokers are 2 or 4 times more likely to develop IHD than non-smokers. With these statistics in mind, policymakers passed regulations such as banning smoking indoors and banning selling tobacco to people under 18.

5.3 Self-harm is one of the prevalent causes of death in Switzerland

Among the top mortality causes in young adults and middle-aged adults, Self-harm is the common cause of death in both age groups. As shown in Figure 1 and Figure 2 , self-harm is the leading cause of death among young adults in Switzerland and it is the 3rd most common mortality cause in middle-aged adults. Notably, the number of deaths caused by self-harm in middle-aged adults is higher than in young adults. Figure 1 and Figure 2 demonstrate that on average, there were approximately 200 cases of deaths by self-harm in young adults in a year while there were approximately 400 deaths by self-harm in middle-aged adults in a year on

average. This illustrates that self-harm is a concerning issue in Switzerland and understanding its underlying factors is crucial to prevent it.

Switzerland witnessed an alarming rate of self-harm incidents. A government-commissioned study in the French-speaking part of Switzerland documented 554 cases of self-harm by 490 patients over a ten-month period. Additionally, half of the patients were aged 18 to 34, and 65% of them were reported to have a difficult socioeconomic situation. (SWI swissinfo.ch 2019). In 2016, Switzerland launched a national action plan on self- harm/ suicide prevention with some key measures: raise awareness about these issues, provide accessible help, recognize early behavior of self-harm and timely intervene, reduce means of suicide and self-harm, etc.

5.4 Weaknesses and next steps

5.4.1 Weaknesses

A limitation that affects external validation of the analysis is that since we use data from Switzerland in specific age groups, we can make the same conclusion for the same age group in another country. Moreover, the number of years used in the research is limited. Therefore, the results could be inconclusive. Additionally, another limitation is that data from the WHO Mortality Database is only available from 2000 to 2019, we are unsure of the mortality causes in recent years. Moreover, a limitation regarding the research's internal validity is that by using the Negative Binomial models, we assume a previously existing relationship between the number of deaths and causes of death. Additionally, since we're using the Negative Binomial models, we may missed other models that may provide better results that we have not considered.

5.4.2 Next step

In the future, we will extend the study to include more years and possibly conduct a time-series analysis to observe trends over a continuous period. This change can also help us study for effect of different policies on mortality rates. Additionally, we can also compare the mortality causes and trends in Switzerland with those in other countries with similar socioeconomic conditions. As a result, we can identify the unique factors that make Switzerland one of the countries with the longest life expectancy.

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