

Statistical analysis on correlation between unemployment rate and mortality

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Abstract. Unemployment is a necessary part of social problems. COVID-19 drives unemployment rates around the world to levels unseen in a generation. In this research paper, a secondary statistical analysis of the correlation between the unemployment rate and mortality is made on the data from the National Bureau of Statistics and Local Bureau Of Statistics. (from 2009 to 2019). We collect the unemployment rate and mortality rate for each province in China from 2009 to 2019, along with the data related to GDP. The results show that there is a positive linear correlation between the unemployment rate and the mortality rate in the overall scope.

Keywords: Mortality rate; Unemployment rate; logistic regression.

1. Introduction

Suicide is a major global public health problem. Mental illness and socio-economic factors have been shown to be related to suicide [1]. In different developed countries, the influence of mental factors on suicide rate will vary significantly with their socio-economic status, while the influence of mental factors on suicide rate in developing countries is smaller [1]. Suicide rates are reduced through physician education in depression identification and treatment, as well as limiting access to fatal means. Other treatments require greater evidence of their effectiveness. In order to make the best use of limited resources, it's critical to figure out which components of suicide prevention programs are beneficial in lowering suicide and suicide attempt rates [2-5].

Since the beginning of the last century, discussions on the relationship between socio-economic and suicide rates under stable economic conditions never stop, and experts in various disciplines have reached different conclusions. Economic growth in the United States have been linked to increased mortality for all demographics and causes of death investigated, with the exception of suicide, during the twentieth century. In the postwar years 1945–70, associations appear to be particularly significant for traffic fatalities after the mid-century, as well as flu and pneumonia [6-9]. In the early days, some researchers believed that the change in social economy and suicide rate was positively correlated, that is, the suicide rate increased with the overall economic level. There are also some studies that support this statement. For example, the suicide rate in South Korea has increased in the level of economic development in the past years [10]. From 2003 to 2011, time-series analyses were used to explore the temporal relationships between national unemployment rates and sex-employment-specific suicide rates in South Korea, with a focus on the increases in suicides that occurred during the recession that began in 2008[11]. Many Europeans are becoming increasingly concerned about their employment. Employees in the majority of nations are concerned that they and/or family members may lose their employment. More than 60% of the working population in Spain and Lithuania has expressed similar concerns, although the occurrence of such concerns in Scandinavian nations is significantly lower (around 10 percent) [12]. Since the 2008 global financial crisis, all European nations have suffered severe consequences such as decreased income and increased unemployment. Several studies have found that both unemployment and the threat of unemployment have detrimental health implications [13].

Among the research results in recent years, there are many research reports that believe that the relationship between socio-economic and suicide is negatively correlated. It was pointed out that people's suicide risk was the highest when the socio-economic status was the lowest. Suzuki pointed that there is a negative correlation between average income and average savings [14]; Nandi et al. found that the suicide rate was the lowest during the period when the socio-economic conditions were the best [15]. In view of the results of domestic studies that show that China's suicide rate is negatively correlated with the socio-economic relationship [16].

The unemployment rate represents the number of unemployed workers in a country's total labor force. Unemployment can impose a great burden on the country's economy and is an important reason for social instability. But it also represents the improvement of a country's high-tech level as more and more machines can work in place of the human. Standardized mortality rate refers to the mortality rate calculated according to the standard age composition of the population. The overall mortality rate of the population is influenced not only by the level of mortality in each age group but also by the age composition of the population. Since 2019, due to the global pandemic, COVID-19, unemployment and mortality are more closely related. Many researchers have studied the relationship between the unemployment rate and mortality rate. Recently, an analysis of data from 63 countries and regions shows that employment is an essential factor in suicide risk, which may be responsible for about 45000 suicides every year [4]. This outstanding finding which is published in the *Lancet Psychiatry* journal reminds humans that suicide prevention should focus on unemployment's mental health problem caused by unemployment, especially in the period of economic recession. Researchers at Zurich University in Switzerland used statistical models to investigate data from 2000 to 2011 in many countries and regions. This period's data reveals the impact of unemployment and other socio-economic factors on suicide in the economic crisis and recovery period [15].

According to the previous studies, unemployment is associated with a number of negative factors that contribute to increased mortality, such as suicide or physical problems caused by high levels of stress (financial and psychological). We have noticed that as the mortality rate increases, the unemployment rate also increases in a different area in China. So we have analyzed the relationship between the unemployment rate and the death rate in these areas using the data from 2009 to 2019. Crude mortality rates show the statistical magnitude of the risk to the life of the whole population in a given time and space by a combination of factors. Standardized mortality rate refers to the mortality rate calculated according to the standard age composition of the population. The overall mortality rate of the population is influenced not only by the level of mortality in each age group but also by the age composition of the population.

The mortality rate varies greatly among different age groups, especially the infant mortality rate and the mortality rate of the elderly population is higher than the adolescent mortality rate. Although the crude mortality rate does not take into account the influence of the age and gender structure of the population, it is not accurate to use the crude mortality rate comparison when comparing the differences in death levels among different populations in different regions.

However, we noticed that the economic development level in this region is quite different, so the crude mortality rate is not appropriate.

Due to the many drawbacks of crude mortality, we decided to use an age-standardized mortality rate. The age-standardized mortality rate is a weighted average of the age-specific mortality rates per 100,000 persons, where the weights are the proportions of persons in the corresponding age groups of the WHO standard population [17]. At present, most of the existing studies are mainly cross-sectional studies [18].

2. Method

2.1 Study population

This study analyzed the unemployment rate and mortality rate of 33 provinces in China from 2009 to 2019. We also consider GDP in this study, the 33 provinces selected were then split into three economical levels (provinces with high GDP, middle GDP, and low GDP).

2.2 Data

In this study, we extracted China's annual mortality rate, unemployment rate, and GDP of each province from 2009 to 2019, which is from China National Bureau of Statistics, China Statistical Yearbooks, Hong Kong Census and Statistics Department, and Government of Macao Special Administrative Region Statistics and Census Service (DSEC)[19]. Directly under the State Council, China National Bureau of Statistics is in charge of the national statistics and national economic accounting and provides us with quarterly and annual statistics. China Statistical Yearbooks systematically collect statistics of economy and society the nationwide, which is an annual publication that comprehensively reflects the economic and social development of China. DSEC and Hong Kong Census and Statistics Department are in charge of all kinds of statistics of Macaw and Hong Kong.

2.3 Statistical analysis

We analyzed the tendencies of the unemployment rate and mortality rate of each province, and multiple logistic regression, chi-square test, and t-test were used to examine the correlation between the unemployment rate and age-standardized mortality. All statistical analyses were performed using the R 4.0.4.

3. Results and Discussion

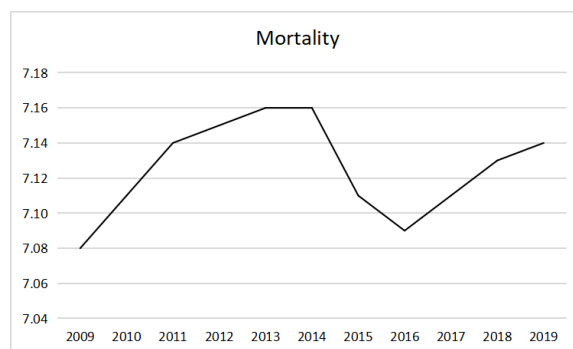


Figure 1. Line chart of 10-year mortality trends in China

A fluctuate pattern can be observed from Figure 1. This indicates that the mortality in China rises and falls year after year, but it is still roughly in the range of 7.08% to 7.16%.

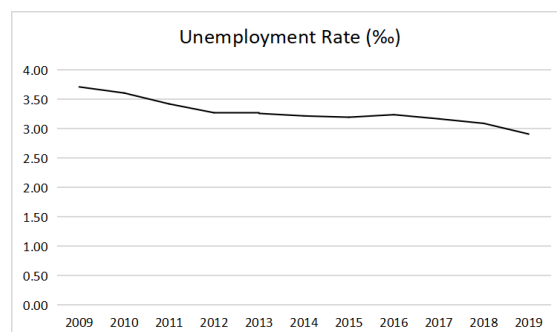


Figure 2. Line chart of 10-year unemployment rate trends in China

A downward pattern can be observed from Figure 2. This indicates a decreasing tendency of the mortality in China. But we can also observe from the following results that the mortality trends various from province to province.

We artificially divided provinces into five groups by their types of unemployment rate tendency. The first group: Shanghai and HongKong (Figure 3); the second group: Liaoning, Hainan, Xizang, Gansu, and Macao (Figure 4) ; the third group: Heilongjiang, Hunan, Sichuan, and Yunnan (Figure 5); the forth group: Anhui, Hubei, and Guangxi (Figure 6); the fifth group (represented by Beijing, Tianjin, and Guangdong): Beijing, Inner Mongolia, Fujian, Guangdong, Qinghai, Tianjin, Jilin, Jiangxi, Chongqing, Ningxia, Hebei, Jianguo, Shandong, Guizhou, Xinjiang, Shanxi, Zhejiang, Henan, and Shaanxi (Figure 7).

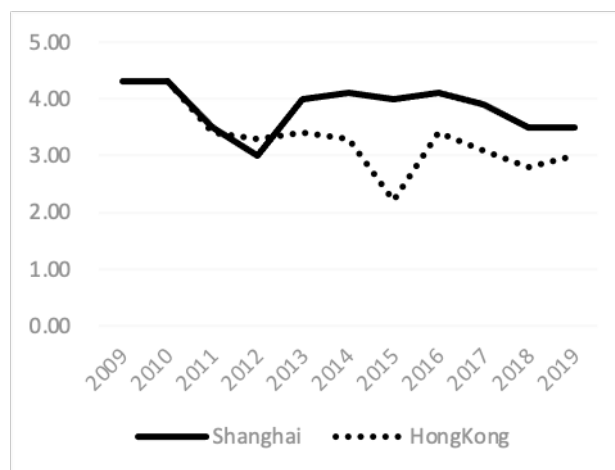


Figure 3. Line chart of 10-year unemployment rate trends in Shanghai and HongKong

A fluctuate pattern can be observed from Figure 3. This indicates that the mortality of Shanghai and HongKong rise and fall year after year, but still, the mortality tendency is roughly downward.

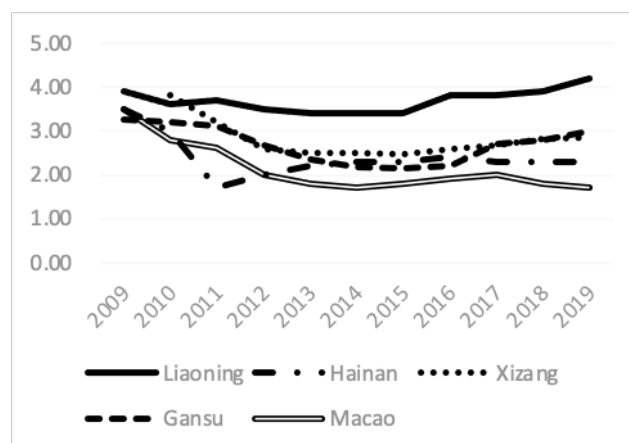


Figure 4. Line chart of 10-year unemployment rate trends in Liaoning, Hainan, Xizang, Gansu, and Macao

A fall-and-rise pattern can be observed from Figure 4. Briefly, before 2014, the unemployment rates in these five provinces present a falling tendency. However, from 2014 to 2019, the unemployment rates in these provinces tend to rise.

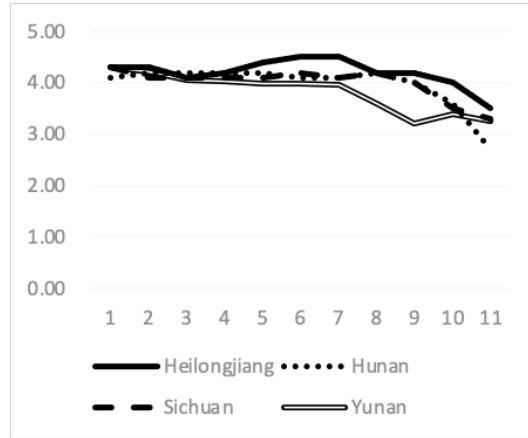


Figure 5. Line chart of 10-year unemployment rate trends in Heilongjiang, Hunan, Sichuan, and Yunnan

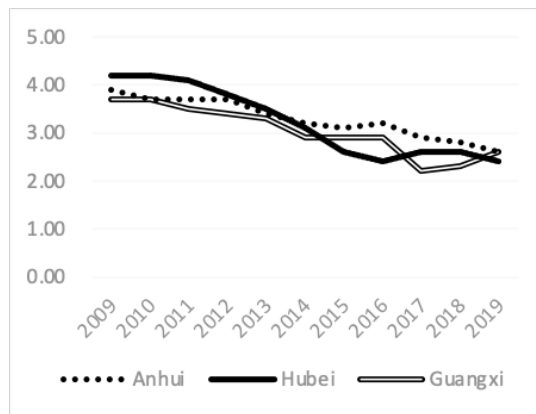


Figure 6. Line chart of 10-year unemployment rate trends in Anhui, Hubei, and Guangxi

Two different types of downward patterns can be observed from Figure 5 and Figure 6. In Figure 5, the unemployment rate is briefly stable before 2015, then decrease. But in Figure 6, there is a continuously declining tendency in unemployment rate.

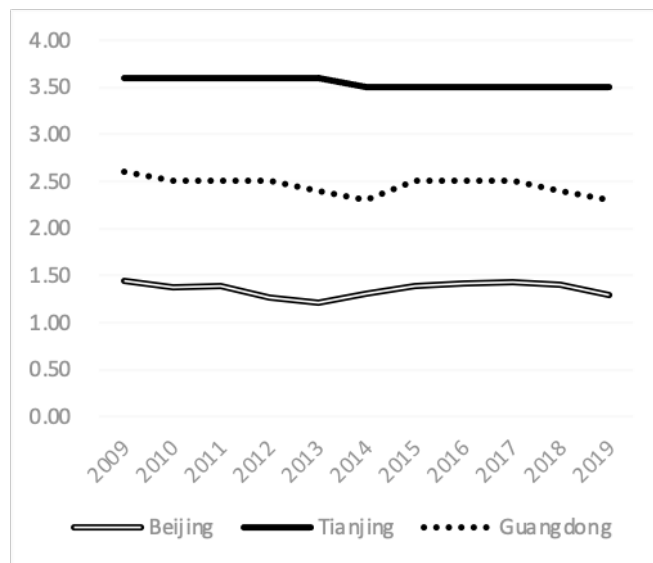


Figure 7. Line chart of 10-year unemployment rate trends in Beijing, Inner Mongolia, Fujian, Guangdong, Qinghai, Tianjin, Jilin, Jiangxi, Chongqing, Ningxia, Hebei, Jiangsu, Shandong, Guizhou, Xinjiang, Shanxi, Zhejiang, Henan, and Shaanxi (represented by Beijing, Tianjin, and Guangdong)

A stable pattern can be observed from Figure 7. This indicates that the unemployment rates in this group are stable in three levels. The lowest level is roughly 1.5%, the middle level is roughly 2.5%, and the highest level is roughly 3.5%.

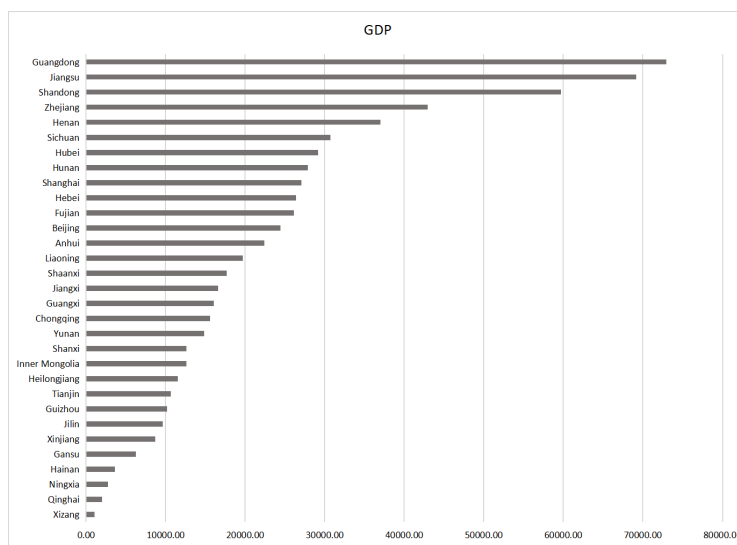


Figure 8. Bar chart of GDP by 31 provinces in China

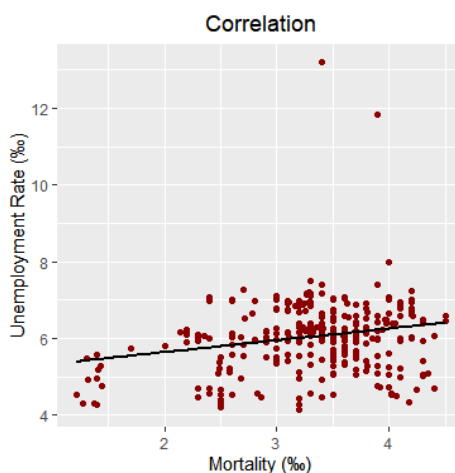


Figure 9. Scatterplot for unemployment rate and mortality.

An uphill pattern can be observed from Figure 9. This indicates a positive relationship between unemployment rate and mortality ($r=0.15$, $P=6.347 \times 10^{-5}$, $se=0.63$). This indicates that each percent increase in mortality means 0.15 unit increase in unemployment rate. And the correlation between unemployment rate and mortality is highly significant.

We artificially divided provinces into three groups by GDP data, then analyze the regression relationship between different groups.

Low GDP: Inner Mongolia, Heilongjiang, Tianjin, Guizhou, Jilin, Xinjiang, Gansu, Hainan, Ningxia, Qinghai, Tibet

Middle GDP: Hebei, Fujian, Beijing, Anhui, Liaoning, Shaanxi, Jiangxi, Guangxi, Chongqing, Yunnan, Shanxi

High GDP: Guangdong, Jiangsu, Shandong, Zhejiang, Henan, Sichuan, Hubei, Hunan, Shanghai

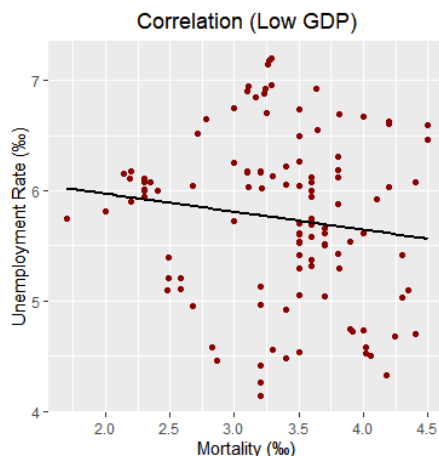


Figure 10. Scatterplot for unemployment rate and mortality in Low GDP group.

A downward pattern can be observed from Figure 10. This indicates a positive relationship unemployment rate and mortality ($r=-0.11$, $P=6.347*10^{-5}$, $se=0.02$). This indicates that each percent increase in mortality means 0.11 unit decrease in unemployment rate in this low GDP group. And the correlation between unemployment rate and mortality in low GDP group is highly significant.

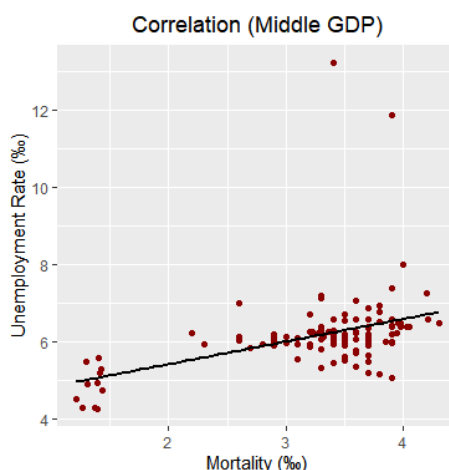


Figure 11. Scatterplot for unemployment rate and mortality in Middle GDP group.

An uphill pattern can be observed from Figure 11, which indicates a positive relationship unemployment rate and mortality ($r=0.29$, $P=3.218*10^{-6}$, $se=0.17$). This indicates that each percent increase in mortality means 0.29 unit increase in unemployment rate in this middle GDP group. And the correlation between unemployment rate and mortality in middle GDP group is highly significant.

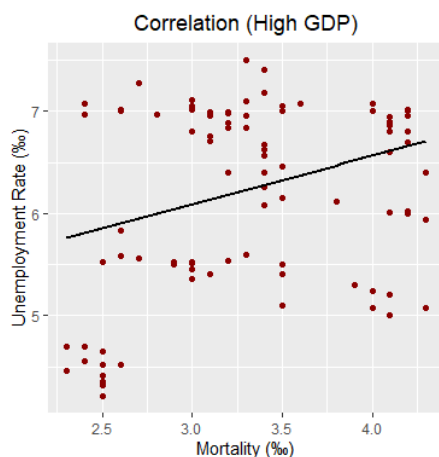


Figure 12. Scatterplot for unemployment rate and mortality in High GDP group.

An uphill pattern can be observed from Figure 12, which indicates a positive relationship unemployment rate and mortality ($r=0.21$, $P=0.001573$, $se=0.10$). This indicates that each percent increase in mortality means 0.21 unit increase in unemployment rate in this high GDP group. And the correlation between unemployment rate and mortality in high GDP group is highly significant.

Through analysis, we found that the death rate and unemployment rate of 31 provinces in China presented a positive linear distribution. Then we classified the provinces according to the size of GDP. After analyzing the classified groups, we found that there was a similar positive correlation between the Middle GDP group and the High GDP group, but a negative correlation between the Low GDP group.

4. Conclusion

Through analyzing the relationship between the unemployment rate and the mortality rate in each province of China in ten years, this study found that there is a positive linear correlation between the unemployment rate and the mortality rate in the overall scope. The influence on suicide rates is variable when they have diverse economic environments. By grouping analysis according to the total amount of GDP, which is the total value of all goods and services produced by a country in one year, we find that the relationship between the unemployment rate and death rate in the Low GDP group is contrary to the data in Middle and High GDP groups. By reviewing the results and progress of international studies on the relationship between suicide and different socio-economic conditions, we can obtain that the relationship between suicide rate and socio-economic conditions is not the same in different countries and regions according to their own characteristics. Therefore, it is more important to study China's own characteristics under the conditions of rapid growth and changing social and economic development in the past 40 years. From the international socioeconomic research status of suicide, we can see the shortcomings of China's research in this field, and at the same time we can find the direction for the future research. Strengthen localized socioeconomic research on suicide, and provide scientific evidence and empirical research support for suicide prevention interventions in China;

Longitudinal studies should be added to in-depth exploration of the relationship between social economy and suicide and its occurrence mechanism; Economic indicators and research methods used in previous studies are different. Thus, it is not convenient to make comparisons on different results. Future research should pay attention to the standardization of research methods and the comparability of results. Suicide prevention and intervention is a long-lasting and complex task that requires the joint efforts of the whole society to reduce the socio-economic impact and life loss caused by suicide.

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