



The effect of national suicide prevention programs on suicide rates in 21 OECD nations

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ABSTRACT

Suicide has become a serious and growing public health problem in many countries. To address the problem of suicide, some countries have developed comprehensive suicide prevention programs as a collective political effort. However, no prior research has offered a systematic test of their effectiveness using cross-national data. This paper evaluates whether the national suicide prevention programs in twenty-one OECD nations had the anticipated effect of reducing suicide rates. By analyzing data between 1980 and 2004 with a fixed-effect estimator, we test whether there is a statistically meaningful difference in the suicide rates before and after the implementation of national suicide prevention programs. Our panel data analysis shows that the overall suicide rates decreased after nationwide suicide prevention programs were introduced. These government-led suicide prevention programs are most effective in preventing suicides among the elderly and young populations. By contrast, the suicide rates of working-age groups, regardless of gender, do not seem to respond to the introduction of national prevention programs. Our findings suggest that the presence of a national strategy can be effective in reducing suicide rates.

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Introduction

Suicide has become a serious and growing public health problem in many countries. According to statistics from the World Health Organization (World Health Organization, 2010), the situation surrounding suicide is alarming. For example, about one million people worldwide die as a result of suicide every year, which amounts to one death every forty seconds. Mortality by suicidal acts has steadily increased over the last several decades at the global level. In some countries, suicide constitutes one of the leading causes of death among relatively young populations. The youth suicide rate has recently become a more serious problem, while seniors have exhibited high suicide rates for years.

To address the problem of suicide, some countries have developed comprehensive suicide prevention programs as a collective political effort. According to the WHO European monitoring surveys on national suicide prevention programs, 17 of 37 member states that responded to the surveys have launched national suicide prevention initiatives as of 2004 (World Health Organization

Regional Office for Europe Copenhagen, 2002). Among those 17 nations, Finland was the first country to launch a nationwide suicide prevention program in 1992 (De Leo & Evans, 2003). Comprehensive national programs for suicide prevention are also seen outside of Europe. Australia and New Zealand established national programs to prevent suicide among young people in the 1990s (De Leo & Evans, 2003; Taylor, Kingdom, & Jenkins, 1997). In Asia, Japan and South Korea enacted legislation in the 2000s that sets up a comprehensive suicide prevention program to tackle the growing problem of suicide, according to Japanese Cabinet Office and Korean Ministry of Health and Welfare.

Despite the prevalence of nationwide suicide prevention programs around the world, no prior research has offered a systematic test of their effectiveness using cross-national data. Do nationwide programs for suicide prevention reduce the suicide rate? To answer this question, this paper evaluates whether government intervention through a comprehensive suicide prevention program has a notable impact on the total suicide rate as well as the age- and gender-specific suicide rates in subsequent years, using panel data from twenty-one developed nations between 1980 and 2004.

Table 1 lists the countries included in our analysis by the presence of a nationwide suicide prevention program as of 2004. If countries “have countrywide integrated activities carried out by government bodies,” we code countries as having a national

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Table 1
National suicide prevention program as of 2004.

<i>Nations with a national suicide prevention program</i>
Australia (1995, expanded in 1999)
Denmark (1998)
Finland (1992)
France (1998)
Germany (2003)
Ireland (2001, expanded in 2005)
New Zealand (1998, expanded in 2004)
Norway (1994)
Sweden (1995)
United Kingdom (2002)
United States (2001)
<i>Nations without a national suicide prevention program</i>
Austria
Belgium
Canada
Greece
Italy
Japan (initiated in 2006)
Netherlands
Portugal
Spain
Switzerland

program for suicide prevention using an elite survey conducted by the World Health Organization Regional Office for Europe Copenhagen (2002, 8). As reported in Table 1, eleven nations had nationwide programs for suicide prevention as of 2004. Austria developed a national plan for suicide prevention in 2000, but it has not been approved and implemented by the national government. Belgium has an official document on suicide prevention but conducts a comprehensive program only in the Flemish region (World Health Organization Regional Office for Europe Copenhagen, 2002). Ireland initiated a prevention program when the government developed the “Health Strategy” in 2001, which it subsequently expanded into a comprehensive program in 2005. The Netherlands developed a national policy on suicide prevention in 1989 (Taylor et al., 1997), but the expert survey by the WHO Regional Office for Europe (2002) suggests that the government had implemented no action at the national level as of 2002. In this paper, we follow the definition of the WHO’s expert survey. Both Australia and New Zealand initiated prevention programs for youth and expanded them for the entire population later. Both Finland and Norway completed their national programs in 1998, but we assume that they have a spill-over effect on suicide rates after 1998 because the infrastructure for suicide prevention remains. Thus, we treat Finland and Norway as having suicide prevention programs after 1992 and 1994, respectively.

These national suicide prevention strategies share common themes. They include “public education, responsible media reporting, school-based programs, detection and treatment of depression and other mental disorders, attention to those abusing alcohol and drugs, attention to individuals experiencing somatic illness, enhanced access to mental health services, improvement in assessment of attempted suicide, postvention, crisis intervention, work and unemployment policy, training of health professionals, and reduced access to lethal means” (Anderson & Jenkins, 2005, 249).

At the same time, specific components and the focus of the nationwide suicide prevention programs can differ across countries. Taylor et al. (1997) summarized the differences in the components of the national programs across five countries with respect to the degree of community involvement, the targeted demographic groups, the agencies that are involved, and the themes of intervention. While we anticipate that the differences in the national programs play an important role because some prevention methods are more useful than others (Mann et al., 2005), we decided not to

explore these differences. Instead, our focus lies on testing whether the initiation of any comprehensive program by the government causes any change in the rate of death by suicide.

Data and method

We examine the impact of national suicide prevention programs on suicide rates using panel data from twenty-one OECD (Organization for Economic Co-operation and Development) countries between 1980 and 2004. Our dataset includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and the United States. These countries and years are chosen on the basis of the availability of data. Data on national suicide prevention programs and other control variables for our regression analysis are not available for other OECD countries (i.e., Chile, Czech Republic, Estonia, Hungary, Iceland, Israel, South Korea, Luxembourg, Mexico, Poland, Slovak Republic, Slovenia, and Turkey) and non-OECD countries. The data on suicide rates are unavailable for some nations after 2004. The total number of observations included in our analysis is 525, representing the data of 21 countries over a period of 25 years.

Statistical model

We estimate a statistical model by assuming that suicide rates in each country are determined as a linear function of the presence of national suicide prevention programs and other time-specific factors such as macroeconomic and political conditions and socio-demographic characteristics in each nation. Then, the model to be estimated can be written as:

$$s_{jt} = \beta[\text{prevention}]_{jt} + \lambda w_{jt} + \eta_j T + \phi_t + \rho_j + \varepsilon_{jt}, \quad (1)$$

where s_{jt} denotes the suicide rate in country j in year t . $[\text{prevention}]_{jt}$ is an indicator variable that equals 1 if country j has a national suicide prevention program in place in year t , and 0 otherwise. The variable equals 0 if a country initiated no nationwide suicide prevention program between 1980 and 2004. If national programs for suicide prevention have an anticipated effect of reducing suicide rates, β associated with $[\text{prevention}]_{jt}$ in Equation (1) should be negative. The vector w_{jt} in (1) includes all control variables that capture time-varying characteristics of country j in year t that can affect suicide rates. Such variables include the macroeconomic conditions (e.g., unemployment rate), government partisanship, welfare policies, and socio-demographic characteristics of a country. They are explained in more detail below. ρ_j is the country fixed effect, while ϕ_t is the year fixed effect. ε_{jt} is a country-year-specific error term. We also include the country-specific time trend $\eta_j T$, in the model. All time-invariant characteristics of country j are captured by the country fixed effect, ρ_j .

Time-invariant characteristics include stable and potentially unobservable cultural norms and beliefs that could be related to suicide rates and suicide prevention strategies. Since we include the fixed effect for each country in Equation (1), our estimation exploits variations within each country. In other words, we test whether there is a statistically meaningful difference in the suicide rates before and after the implementation of suicide prevention programs. Those countries without a nationwide prevention program are included as a control group. Thus, the comparison is not made across countries but, rather, within each country.

Any time-specific shock is captured by the year fixed effect, ϕ_t . Year fixed effects could capture the effects of the global availability of antipsychotic drugs and antidepressants, global economic depression,

and any other major events that occurred in a particular year that might be associated with the implementation of national suicide prevention strategies and suicide rates. The omission of the year fixed effect would cause a bias in the coefficient of primary interest.

Suicide rates

The suicide rate, s_{jt} , equals the number of suicides per 100,000 persons in country j in year t . We compute the suicide rate for the (1) total population; (2) total male population; (3) total female population; (4) male population under 24 years old; (5) male population from 25 to 64 years old; (6) male population over 65 years old; (7) female population under 24 years old; (8) female population from 25 to 64 years old; and (9) female population over 65 years old. In the following analysis, we use the total suicide rate as well as the age- and gender-specific rates. The impact of national suicide prevention programs may differ across different age and gender groups because demographic groups with higher suicide rates such as men and the elderly are more likely to be affected by the implementation of comprehensive national programs (De Leo, 2002) and also because some national programs specifically target high-risk groups (e.g., young men). The data for suicide and population size are obtained from the WHO Mortality Database as of July 2010. Data on the number of suicides are unavailable for some years in a few countries. We linearly interpolated values for those years. Levin, Lin, and Chu's unit root test with a trend variable for panel data (Levin, Lin, & Chu, 2002) indicates that most of our dependent variables are stationary.

Identifying the timing of suicide prevention programs

In equation (1), $[\text{prevention}]_{jt}$ is our key explanatory variable. The coefficient associated with this variable measures whether there is a statistically meaningful difference in the suicide rates before and after the implementation of national suicide prevention programs. This variable takes a value of 1 when a country j has a suicide prevention program in year t . To code this variable, we identified the beginning year of the program by consulting several sources such as De Leo and Evans (2003), Taylor et al. (1997), and the World Health Organization Regional Office for Europe Copenhagen (2002). When no relevant information is found in these documents, we consult official documents published by the national governments. It is challenging to identify the exact year of the initial implementation of some national programs. In this paper, we define a national program as having begun when the respective government first published an official document or enacted a law that set up a nationwide strategy for suicide prevention. In the subsequent section, we conduct a robustness check to assess whether our coding of the prevention programs drives the estimated results reported.

Control variables

As control variables, the vector w_{jt} in (1) includes variables that capture the time-varying characteristics of country j that are likely to be correlated with the initiation of the national suicide prevention program and the suicide rates. Specifically, w_{jt} includes three sets of variables. The first set of variables represents the political features of country j in year t , such as government partisanship and welfare policies. We measure government partisanship using the share of cabinet seats of left parties and Christian democratic parties. The cabinet shares of these parties have a strong impact on the formation of welfare policies (Allan & Scruggs, 2004; Huber & Stephens, 2001) and the level of human well-being (Radcliff, 2001). The cabinet shares of left and Christian democratic parties range from 0 to 1, where

larger values denote greater cabinet shares. The data pertaining to cabinet seats come from the Comparative Parties Data Set developed by Duane Swank (available on his Web site as of 2010). Swank classified parties in twenty-one OECD nations into left, right, Christian democratic, and center parties using expert judgment developed by Castles Francis and Mair (1984).

In addition to government partisanship, we also take into account the level and generosity of welfare provisions. Prior research has found that the level and generosity of welfare provisions increase the well-being of citizens (Di Tella, MacCulloch, & Oswald, 2003; Minoiu & Andres, 2008). The level of welfare provision is measured by total government social expenditures as a percentage of the gross domestic product (GDP). These social expenditures are spent on benefits with a social purpose, such as family assistance, support for children, cash benefits for low-income households, employment training, support for the elderly, and disability benefits. Following Di Tella and MacCulloch (2002), the level of welfare generosity is measured by unemployment benefit replacement rates that are equal to the unemployment benefit entitlement divided by the corresponding wage. Higher values denote higher replacement rates. Data on the replacement rates are available only for odd-numbered years; thus, we used a linear interpolation for even-numbered years. The data on government expenditures and unemployment benefit replacement rates are obtained from the OECD Stat Extracts.

The second set of control variables captures the economic characteristics of country j in year t such as the growth rate of real GDP per capita in constant U.S. dollars, the unemployment rate, and the inflation rate. These macroeconomic variables are likely to be correlated with the well-being of citizens (Di Tella et al., 2003) and may affect the initiation of suicide prevention programs. The growth rate of real GDP per capita is obtained from the Penn World Table 6.3. The inflation rate is measured by an annual change in the consumer price index. The unemployment rate is measured by the percentage of the unemployed in the total labor force. The data for the inflation rate and the unemployment rate come from the OECD Stat Extracts.

Other control variables include socio-demographic variables such as the level of economic development, economic inequality, union density, female labor participation, divorce rate, the percent of the dependent population, and the size of the total population. The level of economic development is measured by real GDP per capita in constant dollars. The data come from the Penn World Table 6.3. The level of economic inequality is measured by the Gini coefficient. It ranges from 0 to 1, where the larger values denote a higher level of economic inequality. The data for the Gini coefficient come from the Standardized World Income Inequality Database (Solt, 2009). The union density is measured by the percentage of union members among wage and salary earners. The female labor participation is measured by the size of the female civilian working population divided by the total size of the female labor force. The divorce rate is the number of divorces per 100,000 persons. Data for the last three variables come from the OECD Stat Extracts. The percent of dependent population is equal to the sum of percentages of the populations under 15 years old and over 65 years old. The population data come from the WHO Mortality Database. We take a natural log of the real GDP per capita and the total population size for our regression analysis. All summary statistics are presented in Table 2.

Results

Table 3 reports the results of the estimation. The analysis was conducted with Stata version 11. To address the potential heterogeneity and autocorrelation within each nation and

Table 2
Summary statistics.

	Mean	SD	Min	Max
Suicide rate: total	20.901	9.090	4.522	47.850
Suicide rate: male	21.352	9.390	4.602	49.308
Suicide rate: female	7.728	4.109	0.868	22.317
Suicide rate: male, under 24 years old	7.462	4.027	1.241	20.985
Suicide rate: male, 25–64 years old	26.616	12.207	5.041	66.261
Suicide rate: male, over 65 years old	38.933	19.314	8.388	93.660
Suicide rate: female, under 24 years old	2.000	1.033	0.138	6.137
Suicide rate: female, 25–64 years old	9.562	5.103	1.010	32.316
Suicide rate: female, over 65 years old	13.127	8.992	1.231	44.147
Left party	0.359	0.392	0.000	1.000
Christian Democratic party	0.127	0.224	0.000	1.000
Social expenditure	0.206	0.053	0.102	0.358
Benefit replacement rate	0.286	0.129	0.003	0.649
GDP growth rate	0.020	0.024	-0.089	0.112
Unemployment rate	0.076	0.040	0.002	0.242
Inflation rate	0.025	0.014	-0.009	0.085
Log GDP per capita	10.065	0.253	9.263	10.697
Economic inequality	0.286	0.043	0.003	0.392
Female labor participation	0.603	0.113	0.320	0.809
Union density	0.395	0.204	0.080	0.839
Divorce rate	2.038	0.995	0.000	5.300
Dependent population	0.335	0.018	0.299	0.412
Log population size	9.752	1.219	8.049	12.590
Number of observations	525			

Note: All variables except for the following are measured in proportion from zero to one. Suicide rates equal the number of death by suicide per 100,000 persons. Log GDP per capita equals the log of GDP per capita in constant U.S. dollars. Economic inequality equals the Gini coefficient. Log population size equals the log of the total population. Divorce rate equals the number of divorces per 100,000 persons.

contemporaneous correlation across nations, standard errors are estimated by using Driscoll and Kraay's (1998) covariance matrix estimator. In column (1), the suicide rates of the entire population in each country are regressed on the indicator variable of national suicide prevention programs as well as on political variables, macroeconomic variables, and the socio-demographic characteristics of countries. The negative coefficient associated with national suicide prevention programs indicates that, after the government initiated a national program for suicide prevention, the overall suicide rates in the country decreased. The coefficient is statistically significant at the 0.05 level. The other control variables have no statistically significant impact on the suicide rates when the total suicide rates are analyzed.

The estimated coefficient associated with national suicide prevention programs in column (1) suggests that the number of suicides per 100,000 decreased by 1.384 after national programs for suicide prevention were initiated. This is a large effect because the average total suicide rate per 100,000 persons is 21, as reported in Table 2. This suggests that, since the nationwide programs for suicide prevention were initiated, countries with a population of 10 million people (e.g., Sweden) have seen the number of deaths by suicide decrease by 140 per year on average. In countries with 50 million people (e.g., the UK), the number of deaths by suicide decreased by 650; and in countries with more than 100 million people (e.g., Germany), an estimated 1350 suicides were prevented because of the comprehensive national suicide prevention programs.

In columns (2)–(3), male and female suicide rates are analyzed separately. The suicide rates of males are estimated to have decreased after the government initiated a national suicide prevention program. In contrast, the national suicide prevention program has no statistically significant impact on the overall female suicide rates at the 0.05 level.

In columns (4)–(9), we analyze the effect of the suicide prevention programs on the suicide rates of various age and gender groups. The most notable effect can be found among the elderly

Table 3
The effect of national suicide prevention program on suicide rates.

	(1) Total	(2) Male	(3) Female	(4) Male, under 24	(5) Male, 25–64	(6) Male, over 65	(7) Female, under 24	(8) Female, 25–64	(9) Female, over 65
National suicide prevention program	-1.384* (0.500)	-1.427* (0.513)	-0.374 (0.215)	-1.330* (0.500)	-0.999 (0.603)	-3.457* (1.030)	-0.276* (0.088)	0.026 (0.323)	-1.709* (0.608)
Left party	-0.808* (0.288)	-0.849* (0.293)	-0.504* (0.144)	-0.047 (0.238)	-1.376* (0.370)	-0.027 (0.573)	-0.029 (0.126)	-0.715* (0.179)	-0.519 (0.297)
Christian Democratic party	-1.129* (0.444)	-1.224* (0.457)	-1.200* (0.245)	-0.973* (0.379)	-1.797* (0.712)	-0.097 (1.017)	-0.293* (0.119)	-1.526* (0.384)	-2.261* (0.574)
Social expenditure	20.946* (7.176)	22.029* (7.483)	9.113* (2.615)	6.872 (4.743)	29.800* (10.675)	-12.168 (10.623)	2.209 (3.008)	11.512* (3.995)	9.353* (4.232)
Benefit replacement rate	3.914 (2.181)	3.966 (2.263)	-2.032 (0.981)	4.351* (1.620)	4.375 (3.196)	-1.079 (5.789)	-0.927 (0.772)	-1.413 (1.274)	-5.932* (2.565)
GDP growth rate	-9.122* (4.321)	-9.265 (4.462)	-0.202 (1.811)	-3.422 (2.830)	-13.615 (7.109)	-3.475 (7.040)	-0.768 (1.602)	-1.058 (2.625)	5.564 (3.303)
Unemployment rate	-5.623 (9.337)	-5.756 (9.758)	-3.705 (4.759)	-0.935 (4.899)	-6.971 (14.201)	1.656 (11.312)	-4.009 (2.784)	-2.353 (7.241)	-2.802 (6.184)
Inflation rate	7.947 (7.447)	7.914 (7.592)	2.368 (2.301)	-3.627 (6.452)	15.863 (12.402)	23.244 (17.655)	-1.278 (2.306)	9.775* (4.006)	-0.034 (6.394)
Economic inequality	-8.980* (3.017)	-9.347* (3.129)	-0.689 (1.149)	-2.728 (1.341)	-10.835* (4.532)	-14.673* (4.748)	1.361* (0.631)	0.555 (1.058)	-5.913 (3.363)
Log GDP per capita	-13.621* (3.274)	-13.866* (3.340)	-3.728* (1.325)	-5.641* (2.165)	-20.362* (4.475)	-10.872 (5.545)	-1.311 (0.784)	-5.123* (1.627)	-6.137* (3.826)
Union density	0.512 (5.780)	0.827 (5.901)	0.784 (1.874)	-5.438 (5.775)	2.908 (7.322)	9.289 (10.867)	-2.107 (1.582)	-0.606 (3.002)	7.879* (3.288)
Female labor participation	15.552* (3.333)	15.867* (3.378)	-0.307 (2.009)	22.383* (4.651)	14.053* (3.904)	-18.960 (10.153)	2.374 (1.547)	-1.926 (3.547)	-8.482 (4.744)
Divorce rate	2.064* (0.650)	2.128* (0.669)	0.498 (0.261)	0.440 (0.366)	2.881* (0.778)	3.298* (1.420)	0.089 (0.136)	0.814 (0.414)	0.402 (0.416)
Dependent population	2.774 (16.699)	2.324 (17.595)	-21.332* (7.197)	-25.691* (8.414)	16.490 (26.080)	-0.028 (39.560)	-6.904* (2.984)	-15.029 (10.128)	-48.641* (19.794)
Log population size	1.675 (4.720)	0.990 (5.014)	3.413 (2.408)	-9.676* (3.240)	4.814 (5.981)	28.609* (9.192)	-1.306 (1.013)	4.607 (2.589)	12.366* (5.835)
Adjusted R ²	0.973	0.974	0.979	0.927	0.971	0.967	0.811	0.972	0.963

Note: Table entries are fixed effects regression estimates and standard errors in parentheses. Standard errors are estimated by Driscoll and Kraay's (1998) covariance matrix estimator. Estimates are based on data from 21 OECD nations between 1980 and 2004. The dependent variables are the suicide rates. Country and year fixed effects and country-specific time trends are included in the models. The number of observations is 525. * $p < 0.05$ (two-tailed tests).

(columns (6) and (9)); column (6) indicates that suicide prevention programs are most effective in preventing suicides among the male elderly population. The number of suicides per 100,000 seniors decreased by about 3.5 after national programs for suicide prevention were initiated. Although the magnitude is slightly lower, the programs also have had a statistically significant impact on the suicide rate of female senior citizens (column (9)). According to columns (4) and (7), the suicide prevention programs also have a negative impact on the suicide rates among populations younger than 25 years old. Interestingly, even among youth, the suicide rates of the male population are more responsive to the prevention programs than those of the female population, but their effectiveness is estimated to be statistically significant for both male and female young populations. By contrast, the suicide rates of working-age groups, regardless of gender, do not seem to respond to the introduction of national prevention programs. According to columns (5) and (8), the estimated coefficients on the prevention program are indistinguishable from zero for both the male and female working-age groups.

Discussion

This paper evaluates how government-led comprehensive suicide prevention programs affected suicide rates in twenty-one OECD nations between 1980 and 2004. Our panel data analysis shows that the suicide rates became lower after the government initiated a nationwide suicide prevention program. The impact of the nationwide programs is particularly strong on the suicide rates of the youth and elderly. Notably, the suicide rates are not very high among the youth, yet the prevention programs in some countries such as Australia and New Zealand are indeed working. However, these strategies seem to have a limited effect on the suicide rates of working-age populations, and our analysis also suggests that suicide prevention strategies should target working-age populations more effectively. Although one may not be able to make a causal argument based on this analysis, the findings strongly suggest that a negative relationship existed between suicide rates and the introduction of suicide prevention programs.

One of the notable findings of this study was that the presence of national suicide prevention programs has a larger effect on the suicide rates of men than on those of women. We find two potential reasons as to why the effectiveness is asymmetrical across gender groups. First, some of the suicide prevention strategies include a goal to reduce access to firearms and/or to improve firearm education (e.g., in the United States and Sweden), and firearm suicide is much more common among men than among women (Ajdacic-Gross et al., 2008). Thus, male suicide rates are more likely to be affected by the effort to restrict access to firearms. Limiting access to firearms has been shown to reduce firearm suicides (e.g., Chapman, Alpers, Agho, & Jones, 2006; Baker & McPhedran, 2006). Second, some of the national programs specifically target male subpopulations (e.g. in the United Kingdom and Ireland), such as young men, and these targeted efforts may have had intended consequences. However, these observations are somewhat speculative, and we need to wait for more refined analysis in the future to fully understand why the programs are most effective in reducing male suicide rates.

We conducted a few robustness checks of our analysis. First, we re-estimated the model by dropping one of the countries sequentially. This works as a check to see whether the coding of the prevention program for any particular country is driving the results reported in Table 3. The results are almost identical to those in Table 3. Second, because there are often various ways to define the implementation years of national programs, we use alternative definitions of the “year of implementation” and conduct the same analysis. For example, we code Australia as having begun a national

program in 1995 in the main analysis, but we use 1999 as the initial year in this robustness check because this is when the target population was expanded to include the entire population. The analysis using these alternative definitions yields substantively similar results. Finally, we took a one-year lag of the prevention program and re-estimated the model with the lagged indicator variable because the prevention program might not have had an immediate impact on the suicide rates in the first year. The results using the lag are similar to those shown in Table 3. These results are available upon request.

We also examined the presence of nonlinear trends by including quadratic and cubic terms of the country-specific time trend. According to the AIC (Akaike Information Criterion), the inclusion of those terms improves our model specification, but the new results do not differ from the original ones. Since our goal does not lie in approximating the trend of suicide rates in each nation, we decided not to include the quadratic or cubic terms of the trends in the baseline model.

This study has a couple of limitations. First, the study does not investigate how particular components of prevention programs affect suicide rates. Ideally, we should track all specifics of national suicide prevention policies and examine their impacts on suicide rates. However, it is extremely challenging to collect data on specific aspects of prevention programs for all nations. Due to this limitation, we decided to assess whether the presence of national suicide prevention programs reduced suicide rates, which has not been systematically tested in the past. More refined analysis is an agenda for future studies.

The second limitation of our study is potential simultaneity. One may argue that the national prevention strategies were implemented in response to the suicide rates in preceding years. This potential simultaneity can pose a challenge to our estimation, especially when suicide prevention programs are likely to be implemented when suicide rates are already declining. This is because it can be difficult to distinguish the effect of national programs from that of the decreasing trend. In this paper, we address the issue of potential simultaneity by including the country-specific linear time trends. While these time trends and the inclusion of other covariates take care of some simultaneous relationships between the national programs and suicide rates, our statistical analysis may not allow us to completely untangle this simultaneous relationship. Thus, the findings should be interpreted carefully.

Our findings imply that the implementation of a national strategy, regardless of its form, can be effective in reducing suicide rates. Those countries that face the growing problem of suicide may be able to decrease their suicide rates by developing comprehensive programs that include all of specific approaches employed in the existing national strategies of other nations. While this paper does not distinguish the distinct parts of these programs, further research should be able to shed light on what parts of the programs play a more important role in effective policy-making. Such an analysis should also reveal how the existing suicide prevention programs can be improved so that they become effective in reducing the suicide rates of the working-age population.

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