Modelling suicide and unemployment: a longitudinal analysis covering 63 countries, 2000–11

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Summary

Background As with previous economic downturns, there has been debate about an association between the 2008 economic crisis, rising unemployment, and suicide. Unemployment directly affects individuals' health and, unsurprisingly, studies have proposed an association between unemployment and suicide. However, a statistical model examining the relationship between unemployment and suicide by considering specific time trends among age-sex-country subgroups over wider world regions is still lacking. We aimed to enhance knowledge of the specific effect of unemployment on suicide by analysing global public data classified according to world regions.

Methods We retrospectively analysed public data for suicide, population, and economy from the WHO mortality database and the International Monetary Fund's world economic outlook database from 2000 to 2011. We selected 63 countries based on sample size and completeness of the respective data and extracted the information about four age groups and sex. To check stability of findings, we conducted an overall random coefficient model including all study countries and four additional models, each covering a different world region.

Findings Despite differences in the four world regions, the overall model, adjusted for the unemployment rate, showed that the annual relative risk of suicide decreased by 1·1% (95% CI 0·8–1·4) per year between 2000 and 2011. The best and most stable final model indicated that a higher suicide rate preceded a rise in unemployment (lagged by 6 months) and that the effect was non-linear with higher effects for lower baseline unemployment rates. In all world regions, the relative risk of suicide associated with unemployment was elevated by about 20–30% during the study period. Overall, 41 148 (95% CI 39 552–42 744) suicides were associated with unemployment in 2007 and 46 131 (44 292–47 970) in 2009, indicating 4983 excess suicides since the economic crisis in 2008.

Interpretation Suicides associated with unemployment totalled a nine-fold higher number of deaths than excess suicides attributed to the most recent economic crisis. Prevention strategies focused on the unemployed and on employment and its conditions are necessary not only in difficult times but also in times of stable economy.

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Introduction

Almost 1 million people around the world die by suicide every year,[1] constituting 2% of the global burden by the year 2020.[2] Because suicide is partly preventable (eg, by changes in physicians' education or by restricting access to lethal methods),[3] several countries have adopted appropriate prevention strategies.[1,4]

As in earlier economic downturns,[5–8] the 2008 world economic crisis led to the re-emergence of the debate on the effect of the economy on suicide. Recessions, that is, decreases in the gross domestic product (GDP) over subsequent quarters, exhibit strong reductions in macroeconomic aggregates such as consumption, investment, industrial production, employment, exports, and imports.[9] Accordingly, the 2008 economic crisis saw a 2% decline in world per capita GDP in 2009,[9] and worldwide 31·8 million more people were unemployed in 2013 than in 2007.[10] Whereas evidence suggests that all-cause mortality declines during recession, suicide does not.[11] In line with evidence on former crises, current data from Europe,[12–16] the USA,[13,17] and Asia[18] suggest an association between the 2008 economic crisis, rising unemployment rates, and

increased rates of death by suicide. Men and those of working age seem to be particularly affected.[5,8,12,13,19] The association between unemployment and poor health[20] or suicide probably emerges from its direct effects on the individual via mechanisms such as increased probability of depressive illness, financial strain, decreased affordability of mental health care, or disruption of present treatment regimes.[21] Accordingly, governmental interventions to keep and reintegrate people in jobs might be a promising solution.[8]

However, the significance of the effect of unemployment on suicide has not been clearly shown.[22] This absence of demonstration could be because of variability in research design or differing statistical models. Some studies have linked excess suicides to rising unemployment during the economic crisis by applying only a time indicator of 2007–09,[13,16] although these studies considered linear long-term trends in the suicide rates. Previous evidence supports a time lag between the development of the economy and suicide related to awareness of job insecurity among other factors.[6,14,18] Moreover, there are hints of a non-linear relationship between unemployment and suicide, and

	Americas			Northern and western Europe			Southern and eastern Europe			Non-Americas and non-Europe			Overall (all study countries)		
	Estimate	SE	p value	Estimate	SE	p value	Estimate	SE	p value	Estimate	SE	p value	Estimate	SE	p value
Intercept	−9·0245	0·1256	<0·0001	−8·4071	0·0931	<0·0001	−8·5809	0·1250	<0·0001	−9·6856	0·3669	<0·0001	−8·8106	0·1008	<0·0001
Sex (ref: men)															
Women	−1·5377	0·1062	<0·0001	−1·2490	0·0758	<0·0001	−1·5679	0·1060	<0·0001	−1·0595	0·3080	0·0008	−1·3827	0·0857	<0·0001
Time*	0·0072	0·0033	0·0295	−0·0243	0·0018	<0·0001	−0·0229	0·0021	<0·0001	0·0032	0·0040	0·4274	−0·0114	0·0015	<0·0001
Age, years (ref: 25–44)															
15–24	0·1350	0·1497	0·3691	−0·4411	0·1089	<0·0001	−0·5610	0·1500	0·0003	−0·2136	0·4341	0·6237	−0·2874	0·1214	0·0183
45–64	−0·0194	0·1501	0·8975	0·4159	0·1081	0·0002	0·5310	0·1488	0·0005	−0·0505	0·4325	0·9073	0·2361	0·1208	0·0512
≥65	−0·0607	0·1524	0·6909	0·3710	0·1066	0·0007	0·7758	0·1476	<0·0001	0·0323	0·4356	0·9410	0·2911	0·1212	0·0167
Unemployment rate†	0·1180	0·0166	<0·0001	0·1032	0·0158	<0·0001	0·0928	0·0161	<0·0001	0·2341	0·0528	<0·0001	0·1061	0·0109	<0·0001
D11‡	0·3485	0·0474	<0·0001	0·2456	0·0318	<0·0001	0·4589	0·0553	<0·0001	3·0719	0·4272	<0·0001	1·1275	0·0741	<0·0001
D21§	−0·0039	0·0021	0·061	−0·0046	0·0010	<0·0001	−0·0058	0·0016	0·0003	−0·0246	0·0086	0·0050	−0·0141	0·0020	<0·0001
D22¶	0·0010	0·0002	<0·0001	0·0003	0·0001	<0·0001	0·0005	0·0001	<0·0001	0·0011	0·0002	<0·0001	0·0009	0·0001	<0·0001
K||	0·0005	0·0001	0·0003	0·0019	0·0003	<0·0001	0·0026	0·0003	<0·0001	0·0110	0·0010	<0·0001	0·0036	0·0002	<0·0001
Data points (n)	1224	..	..	1424	..	..	1576	..	..	1248	..	..	5472	..	..
Subgroups (n)	120	..	..	128	..	..	144	..	..	112	..	..	504	..	..
Countries (n)	15	..	..	16	..	..	18	..	..	14	..	..	63	..	..
−2 log likelihood	10357	..	..	11872	..	..	14375	..	..	10639	..	..	48021	..	..
BIC	10410	..	..	11925	..	..	14430	..	..	10691	..	..	48089	..	..

D11=the variance of the intercept of subgroups, the variance of subgroups slopes (D22), and the covariance (D21). BIC=Bayesian information criterion. *Rescaled to 2000 (time=calendar year − 2000). †Natural logarithm of the average of the current and following annual unemployment rate. ‡Variance of the subgroups' intercepts of random effects. §Subgroups' covariance of intercept and time random effects. ¶Variance of the subgroups' time random effects. ||Dispersions parameter of the negative binomial distribution.

Table 1: **Final model estimates on suicide rate in four world regions and overall (non-linear, by 6 month time-lagged unemployment rate)**

of an increased effect of rising unemployment in countries with low levels of unemployment before the crisis.[13] Previous studies mainly examined one country[7,12,18,19] or one world region[5,8,14,16] rather than global data.[13] Further, to better assess the long-term effect of the 2008 economic crisis, a statistical model should account for missing data of recent years.

We aimed to enhance knowledge of the specific effect of unemployment on suicide by analysing global public data classified according to world regions. Besides unemployment, we also considered other basic economic factors and the above-mentioned methodological issues.

Methods

Suicide and population data

In this longitudinal analysis, as was done in a recent study,[13] we extracted data for annual sex-specific and age-specific suicide rates from the WHO mortality database. We then used International Classification of Diseases (ICD) codes (9th and 10th version) to extract suicide data (E950–E959 and X60–X84), selecting all countries with a mean number of more than 20 male suicides per year and covering at least the years 2004–09. Only Cuba had to be excluded, because it showed suicide data but no economic information. We replaced missing population data in the WHO mortality database with information from the UN population database. If population data were missing in both databases (which only concerned population data for 2011, for which 184 of 504 datapoints were not yet available), we replaced missing data within the age group and sex group of the respective country by linear extrapolation.

The 63 countries selected were split into four world geographic regions according to UN classifications:[23] Americas (Argentina, Brazil, Canada, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Nicaragua, Panama, Paraguay, Suriname, Uruguay, the USA; N=15, roughly 92% of the total population in this world region); northern and western Europe (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Ireland, Latvia, Lithuania, Luxembourg, The Netherlands, Norway, Sweden, Switzerland, the UK; N=16; roughly 99% of the total population); southern and eastern Europe (Belarus, Bulgaria, Croatia, Czech Republic, Greece, Hungary, Italy, Macedonia, Moldova, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Ukraine; N=18; roughly 98% of the total population); non-Americas and non-Europe (Australia, Egypt, Georgia, Hong Kong, Israel, Japan, Kazakhstan, Kuwait, Kyrgyzstan, Mauritius, New Zealand, Singapore, South Africa, South Korea; N=14; 25% of the whole population, 12% of the population of Africa, 54% of Asia, and 72% of Oceania).

Similar to Chang and colleagues,[13] we considered the number of suicides per 100 000 population (suicide rate) for the following four age categories by sex: 15–24 years, 25–44 years (reference category), 45–64 years, and 65 years and older.

	Americas	Northern and western Europe	Southern and eastern Europe	Non-Americas and non-Europe	Overall (all study countries)
Sex (ref: men)					
Women	0·215 (0·174–0·265)	0·287 (0·247–0·333)	0·208 (0·169–0·257)	0·347 (0·190–0·634)	0·251 (0·212–0·297)
Time	1·007 (1·001–1·014)	0·976 (0·973–0·979)	0·977 (0·973–0·981)	1·003 (0·995–1·011)	0·989 (0·986–0·992)
Age, years (ref: 25–44)					
15–24	1·145 (0·853–1·535)	0·643 (0·520–0·796)	0·571 (0·425–0·766)	0·808 (0·345–1·891)	0·750 (0·591–0·952)
45–64	0·981 (0·731–1·316)	1·516 (1·226–1·873)	1·701 (1·270–2·277)	0·951 (0·407–2·219)	1·266 (0·999–1·605)
≥65	0·941 (0·698–1·269)	1·449 (1·176–1·786)	2·172 (1·627–2·901)	1·033 (0·440–2·426)	1·338 (1·055–1·697)
Unemployment rate, examples (%)					
3	1·178 (1·126–1·232)	1·154 (1·105–1·204)	1·137 (1·089–1·188)	1·383 (1·198–1·597)	1·158 (1·125–1·193)
6	1·258 (1·181–1·341)	1·222 (1·151–1·298)	1·198 (1·126–1·274)	1·577 (1·289–1·929)	1·229 (1·179–1·282)
9	1·312 (1·217–1·414)	1·268 (1·181–1·362)	1·238 (1·151–1·332)	1·714 (1·351–2·176)	1·277 (1·215–1·341)
12	1·353 (1·245–1·471)	1·303 (1·204–1·411)	1·269 (1·170–1·376)	1·823 (1·398–2·377)	1·313 (1·243–1·387)
15	1·387 (1·267–1·518)	1·331 (1·222–1·451)	1·293 (1·185–1·412)	1·914 (1·436–2·550)	1·342 (1·265–1·424)

Data are RR (95% CI). RR values are transformed (exponentiated) values of the model estimates presented in table 1. Because the unemployment rate is a non-linear predictor in the model, we present RR examples for different unemployment rates between 3–15%.

Table 2: Final model relative risks (RR) of suicides in four world regions and overall (non-linear, by 6 month time-lagged unemployment rate)

Economic data

From the International Monetary Fund's world economic outlook database, we extracted four economic indicators: the unemployment rate gives the percentage of unemployed people to the total labour force; the GDP based on purchasing-power-parity per capita is expressed in current international dollars; the growth rate describes year-on-year changes of annual percentages of constant price GDP; and inflation means year-on-year changes of the annual percentages of average consumer prices. The unemployment rate for Suriname was missing in 2011 and was taken from the corresponding public website.[24]

Statistical analysis

We analysed the annual number of suicides per 100 000 population in the 504 different age-specific and sex-specific groups, each with up to twelve timepoints. We applied a random coefficient model for non-Gaussian longitudinal data with a negative binomial distribution to account for overdispersion, using the procedure NLMIXED in SAS version 9.4 with log as link function. In table 1, *K* shows the estimated value of the parameter for overdispersion, adjusting the variance independently of the mean. The random coefficient model allowed us to specify intercepts and slopes for each of the 504 groups for the calendar years 2000–11 (rescaled to be zero in 2000). The variance of the intercept of subgroups (D11 in table 1), the variance of subgroup slopes (D22), and the covariance (D21) between intercepts and slopes were fitted as drawn from normal distributions. Although both variances must be positive, it is a common finding that the covariance is negative. The chosen random coefficient model estimated the number of suicides for the years with missing data.

Visual inspection of the data pointed to a time lag of a few months between unemployment rate and suicide rate shifted forward. Because of the available annual data, we applied a 6 month time lag by calculating the mean of the unemployment rate in a current year and in the following year. To find an approximation of the time lag and possible non-linearity, we considered six variants of the unemployment rate: 1) linear; 2) linear, time lagged by 6 months; 3) linear, time lagged by 1 year; 4) non-linear (logarithmised); 5) non-linear, time lagged by 6 months; and 6) non-linear, time lagged by 1 year. Other economic factors analysed were inflation, growth rate, and GDP per capita. GDP per capita was divided by 1000 to enhance estimation of the model and interpretation of effects, and also used as a non-linear predictor variable (logarithmised). We examined the model fit and model comparison with Bayesian information criterion (BIC) and checked the stability of the estimated effects of economic variables over world regions. We assumed a probable association between unemployment rate and
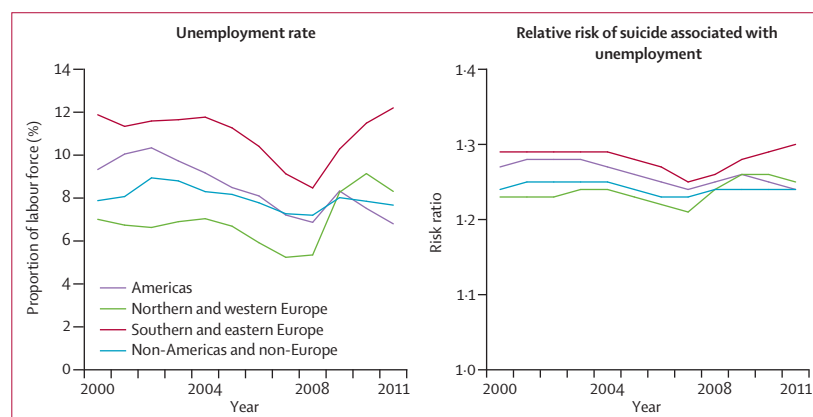
Figure 1: Mean unemployment rates and estimated relative risks of suicide associated with unemployment in four world regions, 2000–11 (final model, overall)

suicide rate to be similar in different world regions as long as potential non-linearity is accounted for.

Estimates of the final statistical model (table 1) were transformed (exponentiated) into relative risks (table 2, figure 1), and suicide rates and numbers (figure 2, table 3). 95% CIs shown in figure 2 and table 3 are based on predictions of the procedure NLMIXED applying the Δ method.
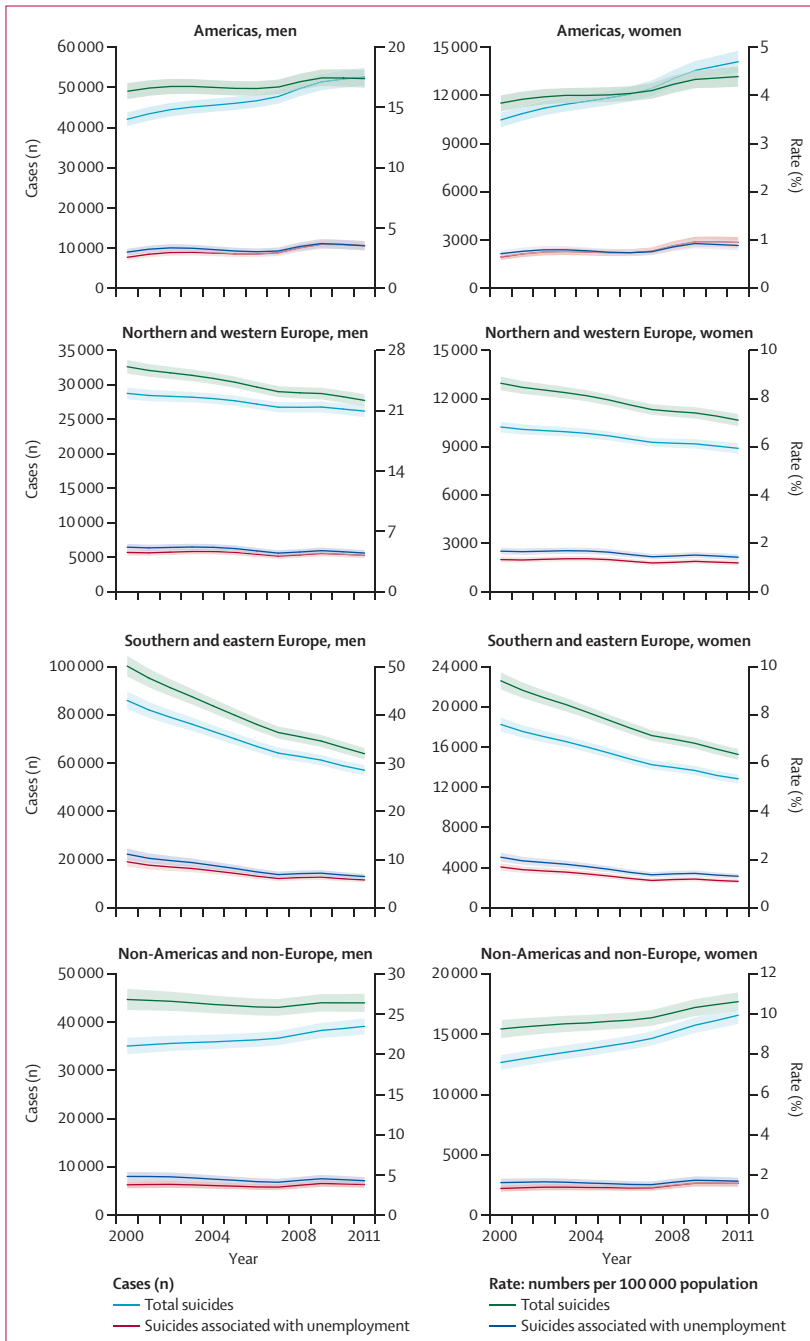
See **Online** for appendix

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Results

Of the four economic variables examined, the non-linear, 6 month time-lagged unemployment rate (table 1) led to the best model fit, while showing comparable estimates between world regions (appendix pp 1–15). Specifically, we noted higher effects for lower baseline unemployment rates, and an increase in the suicide rate preceding the increase in the unemployment rate by 6 months. Interaction effects with unemployment (appendix p 11) did not improve the model fit compared with the final model (table 1; appendix p 15) in any of the four world regions.

In total, preliminary models of other economic variables led to a poorer model fit and less stable results. The inflation rate did not improve the model fit in any of the four world regions. Although the effect of the growth rate was significant in all regions except in the Americas, the estimated effect sizes of the growth rate were generally small. The GDP as a linear or non-linear predictor led to a better model fit in three world regions, but not in the non-Americas and non-Europe. Further, GDP led to unstable and inconsistent findings when considered together with the unemployment rate. Because GDP also showed very strong correlations with calendar year (r≈0·96 within countries between 2000 and 2011; appendix p 16), we finally excluded GDP from statistical analysis because of multicollinearity.

According to our final statistical models, the relative risk of suicide associated with unemployment was elevated by 20–30% in all world regions between 2000 and 2011 (figure 1). After the 2008 economic crisis, the unemployment rate increased most strongly in southern and eastern Europe. In general, the data shows that the unemployment rate decreased before the crisis in all world regions and after the crisis reached a level roughly similar level to that of 2005. However, northern and western Europe had higher unemployment rates after 2009 than in 2008 or before. By contrast to southern and eastern Europe, the unemployment rate decreased in other world regions after a previous short-term increase. The unemployment rates among the world regions differed more than the relative risk of suicides associated with unemployment between 2000 and 2011, reflecting non-linearity.

An increase from 3% to 6% in the unemployment rate corresponds to a rise in the relative risk of suicide from 1·158 (95% CI 1·125–1·193) to 1·229 (1·179–1·282; table 2). This corresponds to a 6·1% increase in the suicide rate (1·229/1·158–1; appendix p 1). If the unemployment rate were to rise from 12% to 15%, the

Figure 2: **Estimated number of suicide cases and rates by world region and sex, 2000–11 (final model, overall)**
Shading shows 95% CI.

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Cases												
Total suicides	243455 (238833–248077)	240725 (236453–244997)	238846 (234838–242854)	236668 (232872–240464)	233783 (230161–237405)	230854 (227352–234356)	227811 (224386–231236)	225920 (222505–229335)	228135 (224625–231645)	229804 (226181–233427)	228311 (224604–232018)	227388 (223570–231206)
Suicides associated with unemployment	49064 (46728–51400)	48383 (46234–50532)	48288 (46238–50338)	47659 (45699–49619)	46108 (44269–47947)	44312 (42577–46047)	42257 (40624–43890)	41148 (39552–42744)	43983 (42243–45723)	46131 (44292–47970)	44979 (43175–46783)	43831 (42066–45596)
Rate per 100000 population												
Total suicides	17·49 (17·16–17·82)	17·11 (16·81–17·42)	16·80 (16·52–17·08)	16·48 (16·21–16·74)	16·11 (15·86–16·35)	15·74 (15·50–15·98)	15·39 (15·15–15·62)	15·11 (14·88–15·34)	15·12 (14·89–15·35)	15·10 (14·86–15·34)	14·87 (14·63–15·12)	14·66 (14·41–14·90)
Suicides associated with unemployment	3·53 (3·36–3·69)	3·44 (3·29–3·59)	3·40 (3·25–3·54)	3·32 (3·18–3·45)	3·18 (3·05–3·30)	3·02 (2·90–3·14)	2·85 (2·74–2·96)	2·75 (2·65–2·86)	2·92 (2·80–3·03)	3·03 (2·91–3·15)	2·93 (2·81–3·05)	2·82 (2·71–2·94)

Data are n (95% CI) or rate per 100 000 (95% CI).

Table 3: Estimated suicide numbers and rates—total and those associated with unemployment (final model, overall)

relative risk of suicide associated with unemployment would change from 1·313 (95% CI 1·243–1·387) to 1·342 (1·265–1·424). Here, the suicide rate increases only by 2·2% (1·342/1·313–1), and, therefore, less than the change in the unemployment rate. In these examples, the rise in the suicide rate is based on the assumption that no other time trends in the relative risk of suicide are present.

The final overall model estimated a total of about 233 000 suicides each year and suicides associated with unemployment of about 45 000, making up about 20% of all suicides (table 3). Suicides associated with unemployment made up 41 148 (95% CI 39 552–42 744) in 2007 and 46 131 (44 292–47 970) in 2009, indicating an increase of 4983 compared with the precrisis year. Over all study countries, the suicide rate associated with unemployment per 100 000 population decreased from 3·53 (95% CI 3·36–3·69) in 2000, to 2·75 (2·65–2·86) in 2007, increased to 3·03 (2·91–3·15) in 2009, and decreased thereafter to 2·82 (2·71–2·94) in 2011 (table 3).

Besides similar effects of unemployment, only the effect of sex was comparable among the four world regions. Women had a four-fold lower relative risk of suicide than men (overall model 0·251 [95% CI 0·212–0·297]; table 2). Men had the highest suicide rates in southern and eastern Europe; women had the highest rates in the non-Americas and non-Europe (figure 2).

In the overall model, the relative risk of suicide decreased by 1·1% (95% CI 0·8–1·4%) per year between 2000 and 2011 (table 2). Notably, the time trends in the relative risk of suicide differed substantially. In the Americas, the relative risk of suicide increased by 0·7% (95% CI 0·1–1·4) per year, whereas in the non-Americas and non-Europe it remained stable (table 2). In northern and western Europe, the relative risk of suicide decreased by 2·4% (95% CI 2·1–2·7) per year and in southern and eastern Europe by 2·3% (1·9–2·7) per year between 2000 and 2011. The different time trends for each world region were also visible for sex (figure 2).

Finally, age groups only differed significantly in Europe, but not in the Americas and non-Americas and non-Europe (table 2). The relative risk of suicide in Europe was increased among older age groups (reference group: 25–44 years; northern and western Europe, 45–64 years: 1·516 [95% CI 1·226–1·873]; northern and western Europe, ≥65 years: 1·449 [1·176–1·786]; southern and eastern Europe, 45–64 years: 1·701 [1·270–2·277]; southern and eastern Europe, ≥65 years: 2·172 [1·627–2·901]). Those individuals aged between 15 and 24 years had a reduced relative risk of suicide (northern and western Europe: 0·643 [95% CI 0·520–0·796]; southern and eastern Europe: 0·571 [0·425–0·766]).

Discussion

We have shown that it is feasible to directly estimate the effect of non-linear and time-lagged unemployment rates on suicide rates in 63 countries while accounting for age and sex including specific time trends among subgroups. Of the economic variables tested, only unemployment is associated with similar effects in each of the four world regions. We noted that unemployment was related to an increased relative risk of suicide by 20–30% in all four world regions. Suicides associated with unemployment contributed 41 148 in 2007 and 46 131 in 2009, meaning an increase of 4983 compared with the pre-crisis year. In the four world regions, a changing unemployment rate affected both sexes as well as different age groups equally.

Generally, our results correspond with previous research indicating that a rise in unemployment is linked with an increase in suicides (panel).[5–8,12–18] As suggested by previous studies, our model was able to corroborate that this association is non-linear[13] and time-lagged.[6,14,18] Therefore, by contrast with others[8,12,25] who have described a linear increase between unemployment and suicide rate, the level of the unemployment rate has to be taken into account. The effect of a change in unemployment on suicide is stronger in countries with a lower rather than with a higher precrisis unemployment rate. Thus, in

Panel: Research in context

Systematic review
We searched PubMed for all studies published up to June 12, 2014, using the key words "suicide" and ("unemployment" or "economic crisis" or "prevention"). The resulting articles were selected manually. We included studies that, like our study, used official databases and conducted retrospective data analyses. We identified only one study[13] that included several world regions in their analysis focusing on the economic downturn in 2008.

Interpretation
Similar to other studies, we noted a relationship between suicide and unemployment. Specifically, we identified a comparable effect size of unemployment on suicide in each of four world regions. Moreover, as shown in some previous studies, our final statistical model showed that the relative risk of suicide increased before the change in unemployment rates, pointing to a time-lag. Further, as stated by a recent worldwide study, the suicide risk associated with unemployment increased particularly in countries with lower unemployment rates, meaning that the effect of unemployment was non-linear. We noted that suicide due to unemployment might be severely underestimated if studies focus only the time period of the economic crisis. By contrast with other studies, we did not find that different age or sex groups were less affected by rising unemployment. As part of suicide prevention, governmental and specific therapeutic interventions are needed to prevent or reduce employment insecurity, thus helping the individuals affected.

countries where unemployment is uncommon, an unexpected increase in the unemployment rate might trigger greater fears and insecurity than in countries with higher precrisis unemployment rates. With respect to the time lag, our final model showed that the suicide rate increased 6 months before the rise in the unemployment rate. Corporate downsizing and labour market restructuring during economic contraction could create additional work stress and a sense of job insecurity among the employed (eg, through an increasing work-load, change to part-time employment, or intermittent lay-offs), which might contribute to poor mental health.[18,26] Besides such circumstances, however, particularly vulnerable individuals have an increased risk of dying by suicide.[14,18]

We did not find a lower effect size of unemployment in the 65 years and older age group in any of the four world regions. Retired individuals might also be affected by changes in unemployment—eg, when their offspring are or become unemployed. Accordingly, job loss can affect the risk of suicide of other household or family members as well.[21] By contrast with our results, other studies have reported that men are more affected by unemployment than are women.[5,8,12,13,19] One main reason for this reported difference could be separate analyses for men and women. To maintain statistical power and to directly assess sex and age differences, we preferred to construct a joint model.

Our study has several limitations. Apart from problems with the definition of and measurement of unemployment, we hold the unemployment rate as a broad indicator of the level of economic stress and uncertainty faced by the whole population. Because of restricted availability, we could not control for age-specific and sex-specific unemployment rates. Even if there were differences in total suicide rates between world regions, which we accounted for, there are numerous unconsidered and difficult to obtain clinical and psychosocial factors associated with suicide.[14] Without question, it is impossible that an analysis on a world region level can be interpreted causally in a narrow sense. Further, because of missing data, the Asian (eg, China and India) and also African countries included in this study are not representative. Therefore, suicide numbers and rates might be underestimated. As our applied model belongs to the group of random coefficient models, we assumed subgroup intercepts to be uncorrelated with predictors, thus effects could be overestimated because of unobserved heterogeneity.

Corresponding with our results, other investigators[13,17] have estimated excess suicide numbers of about 5000 cases associated with the economic crisis of 2008. Looking at our estimated suicide rates associated with unemployment, they had nearly reached pre-crisis level in 2011. Further, focusing on excess suicide alone leads to an underestimation of suicides. As we identified out from our statistical model, besides the additional 5000 cases, a nine-fold higher number of suicides (roughly 46 000) in 2009 can be associated with unemployment when considering all the years from 2000 to 2011 (figure 1).

Despite certain minor differences between world regions, the relative risk of suicide associated with unemployment remained quite similar between world regions and with time. This finding means that there is a continuous need to focus on preventing suicides, even more so in economically prosperous, stable time periods than in times of lower prosperity, when resources are scarcer. These efforts are necessary and valuable not only in countries with high, but also in those with low, unemployment rates. In particular, the interaction of fiscal austerity with economic shocks and weak social protection seems to escalate health and social crises, at least in Europe.[20] Sufficient investment of governments in active labour market policies that enhance the efficiency of labour markets can reduce the unemployment rate and therefore help to generate additional jobs.[10]

Efforts at suicide prevention should be extended to professionals working with individuals at risk of unemployment, such as social workers and human resource management professionals. These professional groups should be informed about the specific risk and trained concerning the practical assessment of suicidality and possible interventions. Further, general programmes in medical education should support physicians to recognise, diagnose, and treat patients with depressions, thus leading to reductions in suicide.[3] This also requires the particular attention of primary physicians to patients who are unemployed or at risk of job loss.

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