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Differential correlation of suicide and homicide rates according to geographical areas: A study with population-level data

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ABSTRACT

The current study investigated the relationship of suicide and homicide rates internationally. WHO database mortality data for 82 countries concerning suicide, homicides, and cancer and traffic accidents as controls were used. The analysis included Pearson correlation and multiple linear regression analysis. Worldwide homicidal rates explained 55.42%, 43.86% and 41.7% of male and 22.0%, 22.14% and 13.25% of female suicides for 2000, 2005 and 2010 respectively. In Europe there was a positive correlation between male suicide rates and all homicide rates including homicide rates in both genders, in male victims, and in female victims. In America there is no significant correlation. In Asia there is a significant correlation of male suicidal rates only with homicide rates of female victims. We observed marked and interesting differences in the pattern of association between Europe and the Americas. Overall the current paper suggests that at least in some human populations, suicidality and homicidality share common etiopathogenetic substrates and could be triggered by the same internal or external events or might develop based on common genetic background. Empirically it has been suggested that suicide is related to higher living standards while murder is related to poor quality of life and lower living standards.

1. Introduction

One of the peculiar facts in psychiatry is the large difference in suicide rates across different countries. When studying the possible causes of suicide, one should have in mind that suicide is probably the end result of an interaction between various types of different risk factors with mental disorders being the decisive one (Gray and Otto, 2001; Mann et al., 2005; Meltzer, 1999; Qin et al., 2003; Rihmer et al., 2004). However there are also other risk factors, including personality disorders and substance and alcohol dependence (Comtois et al., 2004; Oquendo et al., 2007), family history of suicide (Cavazzoni et al., 2007; Hawton et al., 2005; Oquendo et al., 2007), race and ethnic group (Kupfer et al., 2005), problematic coping skills (Johnson et al., 1993), hopelessness (McMillan et al., 2007; Steeg et al., 2016), environmental variables like recent psychosocial stress (Leverich et al., 2003, 2002) and occupational problems or interpersonal problems with spouse or romantic partner (Tsai et al., 1999). The availability and the access to

lethal means (e.g. firearms) might be of importance (Rihmer et al., 2004).

A similar difference concerning homicide rates is observed and it is very difficult to explain. Especially in Europe the difference between countries in suicide and homicide rates is impressive since it happens in a relatively small portion of the world, both in terms of land and population, with little sociocultural differences between countries. A similar although less pronounced difference is observed among US states.

There are a few studies in the literature on the relationship of suicide and homicide rates (Bando and Lester, 2014; Bills and Li, 2005; Kennedy et al., 1999; Lee and Pridmore, 2014; Leenaars and Lester, 1994; Lester, 1986a; Saucer, 1991; Stoupel et al., 2005). Both the possible correlation between suicide and homicide rates as well as any biological factor underlying such a relationship are the focus of unresolved debate for decades.

The current study investigated the relationship of suicide and

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homicide rates in different countries around the world on the basis of population data.

2. Material and methods

Mortality rates related to suicide and homicide were obtained for three years: 2000, 2005 corresponding to years preceding the current economic crisis and 2010 corresponding to a year in the middle of the crisis. The data from different years were used in separate analyses in order to investigate for consistent and reliable findings. This was done because the economic situation could had affected the rates in a differential way and could had changed the correlations.

As the study aimed to investigate the relationship of suicide and homicide rates, the mortality rates of cancer and transportation accidents were used as controls, to exclude a possible generic mortality effect. The standardized male and female mortality rates due to suicide, cancer and traffic accidents and to homicides for males and females for 82 countries were retrieved from the WHO online database available at <http://apps.who.int/healthinfo/statistics/mortality/whodpms/>. In case of homicides, combined mortality rates for both genders were also retrieved.

A graphical representation of the homicide rates and male and female suicides for the year 2005 (or closest) for Europe is shown in Fig. 1 and the list of countries by continent can be found together with all the raw data in webtable 1 in the webappendix.

The statistical analysis included the calculation of Pearson correlation coefficient (R) and standard multiple linear regression analysis with suicide rates (separately by gender and year) as dependent and homicide rates (both with male and female victims) as independent variables separately for each year.

3. Results

The complete data set for all countries is shown in webtable1 in the webappendix. The data set is not complete, since not all data for all years are available concerning all countries. The means and standard deviations by continent and year are shown in webtable 2 in the webappendix.

The correlation between male and female suicide rates was significant and high.

Results are presented according to geographical areas.

3.1. World (N=82)

At the world level there is a significant positive moderately strong correlation ($p < 0.05$) concerning male suicide rates and homicide rates with female victims with all three years investigated. There is only one

additional significant weak negative correlation between female suicidal rates and male victims of homicide for the year 2005 (Table 1).

The regression analyses suggested that homicidal rates explain 55.42% ($F_{2,71}=44.133$, $R^2=0.5542$, $p < 0.01$), 43.86% ($F_{2,67}=26.182$, $R^2=0.4386$, $p < 0.01$), 41.7% ($F_{2,56}=20.025$, $R^2=0.4169$, $p < 0.01$) of male and 22.0% ($F_{2,71}=10.015$, $R^2=0.2200$, $p < 0.01$), 22.14% ($F_{2,67}=9.5292$, $R^2=0.2214$, $p < 0.01$), and 13.25% ($F_{2,56}=4.2791$, $R^2=0.1325$, $p=0.045$) of female suicidal rates for the years 2000, 2005 and 2010 respectively.

3.2. Europe (N=36)

At $p < 0.05$ there is a consistent positive strong correlation between male suicide rates with all homicide rates and it is stable across years. There is also a significant moderate correlation of female suicidal rate with all homicidal rates but only for the year 2000 (Table 1).

The regression analyses suggested that homicidal rates explain 61.6% ($F_{2,32}=25.738$, $R^2=0.6166$, $p < 0.01$), 56.0% ($F_{2,29}=18.471$, $R^2=0.5602$, $p < 0.01$), 49.3% ($F_{2,30}=14.591$, $R^2=0.4930$, $p < 0.01$) of male and 22.2% ($F_{2,32}=4.5717$, $R^2=0.2222$, $p < 0.02$), 10.6% ($F_{2,29}=1.7321$, $R^2=0.1067$, $p > 0.1$), and minimal ($F_{2,30}=2.6767$, $R^2=0.1514$, $p=0.08$) of female suicidal rates for the years 2000, 2005 and 2010 respectively.

3.3. Americas (N=20)

The picture with the data from the American continent is quite different since there is no significant correlation between any of the suicidal with any of the homicidal rates (Table 1).

The regression analyses suggested that homicidal rates explain 33.5% ($F_{2,16}=4.0414$, $R^2=0.3356$, $p=0.04$), 52.5% ($F_{2,16}=8.8403$, $R^2=0.5249$, $p < 0.01$) and 25.9% ($F_{2,6}=1.0499$, $R^2=0.2592$, $p=0.4$) of male and 23.1% ($F_{2,16}=2.4074$, $R^2=0.2313$, $p=0.18$), 52.02% ($F_{2,16}=8.6749$, $R^2=0.5202$, $p < 0.01$) and 41.2% ($F_{2,6}=2.1022$, $R^2=0.4120$, $p=0.20$) of female suicidal rates for the years 2000, 2005 and 2010 respectively.

3.4. Asia (N=20)

For Asian countries there is a significant moderate to strong correlation ($p < 0.05$) of male suicidal rates with homicide rates with female victims across all years. The correlation with homicide rates of male victims showed a tendency towards significance. There was no correlation of female suicidal rate with any homicidal rate (Table 1).

The regression analyses suggested that homicidal rates explain 44.9% ($F_{2,13}=5.3001$, $R^2=0.4491$, $p=0.02$), 44.2% ($F_{2,11}=4.3542$, $R^2=0.4419$, $p < 0.04$) and 68.3% ($F_{2,11}=11.855$, $R^2=0.6830$, $p < 0.01$)

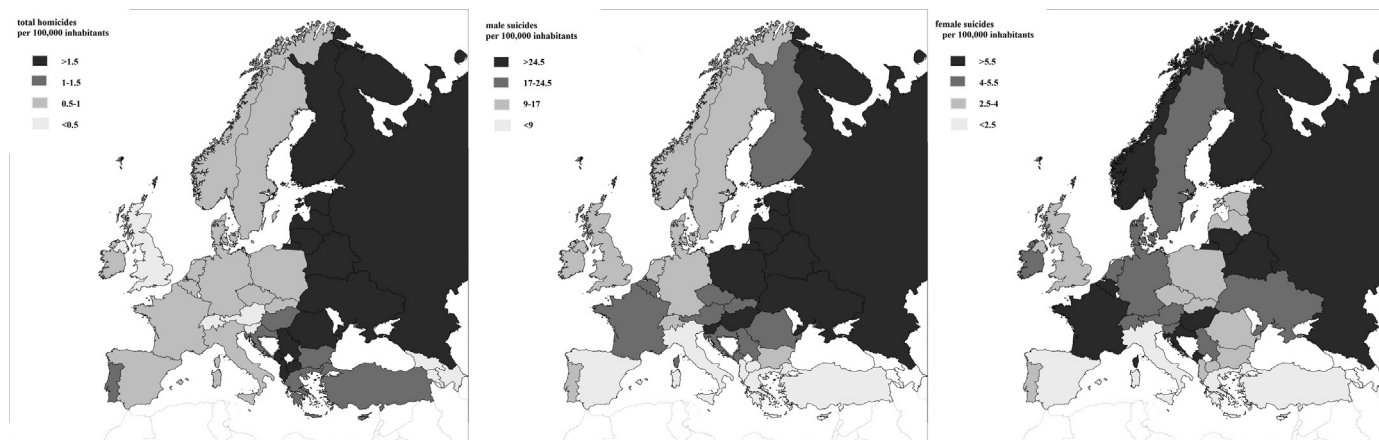


Fig. 1. A graphical representation of the homicide rates and male and female suicides for the year 2005 for Europe.

Table 1

Pearson correlation coefficients between rates of deaths due to suicide and homicide, by gender, continent and year.

	Homicide rate, both sexes			Homicide rate male victims			Homicide rates female victims		
	2000	2005	2010	2000	2005	2010	2000	2005	2010
World									
Male suicide rate	0,07	-0,07	0,03	0,02	-0,10	-0,00	<i>0,51</i>	<i>0,24</i>	<i>0,41</i>
Female suicide rate	-0,08	-0,23	-0,12	-0,11	<i>-0,25</i>	-0,14	0,22	-0,02	0,10
Europe									
Male suicide rate	<i>0,73</i>	<i>0,71</i>	<i>0,66</i>	<i>0,71</i>	<i>0,70</i>	<i>0,65</i>	<i>0,78</i>	<i>0,74</i>	<i>0,70</i>
Female suicide rate	<i>0,41</i>	0,25	0,23	<i>0,39</i>	0,24	0,21	<i>0,45</i>	0,29	0,29
America									
Male suicide rate	-0,21	-0,26	-0,51	-0,21	-0,29	-0,51	-0,02	0,05	-0,43
Female suicide rate	-0,11	-0,26	-0,62	-0,11	-0,29	-0,62	0,05	0,05	-0,44
Asia									
Male suicide rate	0,37	<i>0,59</i>	<i>0,54</i>	0,32	0,52	0,45	<i>0,61</i>	<i>0,66</i>	<i>0,65</i>
Female suicide rate	0,05	0,10	0,16	0,02	0,13	-0,03	0,22	0,21	0,31

Significant values at $p < 0.05$ are in bold italics underlined fonts

of male and 11.2% ($F_{2,13}=0.82116$, $R^2=0.1121$, $p=0.46$), minimal 14,6% ($F_{2,11}=0.94227$, $R^2=0.1462$, $p=0.42$) and 72.0% ($F_{2,11}=14.177$, $R^2=0.7204$, $p < 0.01$) of female suicidal rates for the years 2000, 2005 and 2010 respectively.

3.5. Africa ($N=4$) and Oceania ($N=2$)

The data of African countries, Australia and New Zealand were used only in the analysis of the whole world data because the countries were too few.

The correlation of suicidal and homicidal rates with death rates because of malignant cancers and transportation accidents (webtable 3 in webappendix) do not dispute the specific correlation between the first two, however they clearly suggest there is some kind of inter-correlation between causes of death seemingly unrelated and this correlation differs between continents.

4. Discussion

The current study reports that there is an important difference in the correlation between the rates of deaths due to suicide and homicide in different geographical regions. In Europe there is a consistently strong positive correlation between male suicide rates and all homicide rates. In the American continent there is no significant correlation between any of the suicidal and any of the homicidal rates. In Asian countries there is a significant and moderately strong correlation of male suicidal rates only with homicide rates of female victims. Additionally, there seem to be some inconsistent and non-systematic correlations between death rates from cancer and transportation accidents and suicide and homicide rates.

Overall there are two major theories pertaining to the difference in suicidality rates across Europe. The first is based on geographic characteristics (latitude and longitude) (Voracek and Formann, 2004) while the second is called the Finno-Ugrian suicide hypothesis of Kondrichin and of Marusic and Farmer and hypothesizes that the probable similar ancestry in a group of nations in Central and North-Eastern-Europe constitutes a risk factor. The nature of this risk factor is unknown and both a genetic as well as a linguistic-cultural component have been proposed (Csaszar, 1996; Kandrychyn, 2004; Kondrichin, 1995; Kondrichin and Lester, 1997; Marusic, 2005; Marusic and Farmer, 2001; Melhus, 1996; Mogyrosi, 1996; Voracek, 2006; Voracek et al., 2003, 2007). A genetic component was indirectly suggested by a study in the Russian Federation (Kandrychyn, 2004) and a genetic cause of the distribution of suicide rates has been proposed (Voracek et al., 2003) but the genetics of suicide are very complex in the US because of high population mobility (Voracek,

2006).

It is interesting that the distribution of both suicide and homicide area maps onto the second principal component identified for European gene distribution as these components were reported by Cavalli Sforza et al. However it is also interesting that suicidality is adversely related with the distribution of the fourth component while homicide rates are increased in this particular area (Cavalli-Sforza, 1997; Cavalli-Sforza et al., 1994). However the validity of this assumption has been questioned and as already mentioned, the true utility and meaning of genetic maps is still unclear (Novembre et al., 2008; Novembre and Stephens, 2008).

Unfortunately the elaboration on the issue of homicidal rates and their correlation to suicides is limited. There are only a few studies in the literature on the relationship of suicide and homicide rates. Some suggest a negative (Bando and Lester, 2014; Hutchinson, 2005; Lee and Pridmore, 2014) especially in Asia and the Americas (Bills and Li, 2005) but they also report a strong positive correlation in Europe (Bills and Li, 2005; Kennedy et al., 1999; Stoupel et al., 2005) and especially in Russia (Pridemore and Chamlin, 2006; Pridemore et al., 2013; Pridemore and Spivak, 2003). The data for the US, Canada and Australia are equivocal (Leenaars and Lester, 1994; Lester, 1986a; Saucer, 1991).

There are two major questions the results of the current paper put forward: 1. Why is there a positive correlation between male suicide rates and all homicide rates in Europe and between homicide rates and female victims only in Asia? 2. Why is there a total lack of correlation in America?

The second question could be answered in the frame of the multi-ancestry background of the American population but until reliable data from Africa are available this could serve only as a hypothesis and at best it will shift the focus of the question to 'why are there differences between continents?' However, another answer could be that the homicidal rates are far higher in the American continent and thus a ceiling effect masks any underlying correlation.

The first question is more difficult to address. The only theory that would feasibly fit might be the aggression-turned-inward model of depression. It has been proposed by Sigmund Freud and Karl Abraham on the basis of a 'metaphor' from physics to psychology ('hydraulic mind'). According to this model, during the oral phase (that is during the 12th –18th months of life) disturbances in the relationship between the infant and the mother establish a vulnerability to develop depression. Then during the adult life, a real or imaginary loss leads to depression as the result of aggressive impulses turned inward and directed against the ambivalently loved internalized object which had been lost. The aim of that turned-inwards aggression was supposed to be the punishment of the love object which fails to fulfil the patient's

need to be loved. It is therefore accompanied by guilt which could lead to suicidal behaviour (Abraham, 1911; Freud et al., 1930). Later other authors proposed somewhat different versions of this model. The drawbacks of this model include that it represents a relatively closed circuit independent of the outside world, while the clinical fact is that many depressed patients openly express anger and hostility against others which is reduced after treatment, and that there are no evidence supporting the concept that expressing anger outwards has a therapeutic effect in the treatment of clinical depression.

In social terms it has been suggested that suicide is related to higher living standards when the person is obliged to internalize its depression while murder is related to poor quality of life and lower living standards when stress is turned into anger (Haines et al., 2010; Lester, 1984, 1985, 1986b, 1987, 1989, 1990, 1993; Lester and Natarajan, 1995). Social factors are considered by many authors to play the determinant role in homicidal rates (Briceno-Leon, 2012; Elgar and Aitken, 2011; Hutchinson, 2005; Messner et al., 2010; Pridemore and Kim, 2007).

Overall the current paper suggests that at least in some human populations, suicidality and homicidality share common etiopathogenetic substrates and could be triggered by the same internal or external events or might develop based on common genetic background. Our data indicate the existence of a relevant difference in the correlation between the rates of deaths due to suicide and homicide in different geographical regions, which may suggest the importance of environmental and social determinants in modulating the expression of these phenomena.

The present study suffers from a number of limitations. First it utilizes population statistics and therefore it cannot focus on the micro-scale of the data and cannot distinguish between patient groups and populations. Also, the data of African countries, Australia and New Zealand were used only in the analysis of the whole world data because the countries were too few. Additionally, it has been discussed that the specific geographical distribution of suicidality causes spurious correlations with any variable which for reasons independent of suicidality have a similar geographical distribution. The geographical factor was proven stronger than the Finno-Ugrian ethnic group or the distribution of blood types (Lester and Kondrichin, 2004) while the case of the brain parasite *Toxoplasma gondii* was used as an example of spurious correlation (Lester, 2010). This specific approach has been the focus of debate with Voracek et al. expressing the opposite opinion (Voracek and Formann, 2004). It is unknown how this affects the correlation with homicidal rates.

Conflict of interest

None.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.psychres.2016.12.059.

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