A Fractal View on the Suicide Incidence of Countries

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Abstract

Various studies on suicide and the reasons why people commit it across cultures have been conducted. However, a global view of the suicide rates, has not been explored yet. This study will prove helpful in understanding further the effect of specific cultural and social factors of the phenomenon using Fractal Statistics. This statistical method describes the irregularity of the variable. Its appropriateness is anchored on the fact that Fractal Statistics as a tool can measure the non-normal behaviour of a data set such as those found in the suicide incidence report. The data associated with female suicide do not differ much from country to country. However, differences in the male suicide rate are immensely observable. Causes such as family breakdown, overwork, and employment security are identified. Yet, questions linger regarding this psychological "short circuit", especially on the high incidence of suicide in the male population traceable to lack of cultural support and men's unwillingness to talk about suicide..

Keywords: suicide, suicide rate, fractal dimension

1.0 Introduction

The increase in the silent yet potently traumatic phenomenon of suicide is indeed disturbing. The World Health Organization (WHO) record shows that almost a million individuals die of suicide annually. Death by suicide is also identified by the WHO as one of the three leading causes of death among those aged 15-44; it is the second leading cause within the 10-24 age bracket. The idea of resorting to taking one's life has continued to pose questions within society.

Over time, mental health practitioners came to agree that people who resort to suicide are convinced that this is one viable way of ending a hopeless situation. Hence, doing such thing was not really an issue of choosing death but of choosing to put an end to the pain one is going through (Canadian Mental Health, 2013). Thomas Joiner, in his paper The Interpersonal-Psychological Theory of Suicidal Behavior: Current Empirical Status (Joiner, 2009), opined that a person can only die by suicide if he or she has the desire to die and the capacity to do so. The theory of Joiner states that those who desire to commit suicide hold the two psychological states in their mind, namely: perceived burdensomeness and a sense of low belongingness or social alienation. The perceived burdensomeness is the thinking that one and one's existence is a burden to family and the significant other person. Thus, the desire to end one's life. Further, one's sense of belonging and the tendency to commit suicide, according to Joiner, is highly established in diverse population and across cultures. Surprisingly enough, suicidal rates are lowest during times of celebration and hardships. This is so, since these times afford sense of belonging that otherwise may promote dejectedness, alienation and loneliness. Completed suicide is also attributable to fearlessness, being able to tolerate pain and to act impulsively.

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(Springen, 2010).

In the Cultural Theory and Model of Suicide, (Chung et al, 2010), three principles are worth noting in our understanding of attempted and completed suicides: (1) culture affects the types of stressors that lead to suicide, (2) cultural meanings associated with stressors and suicide affect the development of suicidal tendencies, threshold of tolerance of pain, and subsequent suicidal acts, (3) culture affects how suicidal thoughts, intent, plans, and attempts are expressed. In this present day culture that's characterized by low tolerance to stressful situation and instantaneous solutions, the study of the "global" status of suicide is a must. Studies have been conducted on the reasons why people commit suicide, on specific cultures and the incidence of suicide in that particular culture. However, a "global" view of the suicide rates in the world will prove helpful in understanding further the effect of specific cultural, political, and social factors of the phenomenon.

In this paper, Fractal Statistics is utilized (Padua et al, 2013). This statistical method is a good tool in describing the irregularity of the variable. When the data is non-normal, the mean is not an appropriate statistical tool because it is easily affected by the extreme values of the data.

2.0 Research Design and Methodology

Data for the suicide rate for each country were obtained from the databank of the World Health Organization. These then were subjected to normality test which verified the non- normal behaviour of the data. The graph generated verified the inherent ruggedness of the distribution of the data. With histogram and probability plot of these data, the non- normal nature of these data was further confirmed. To address this, fractal analysis is employed in the study. Due to its ruggedness, it is appropriate to segment the data rather than analyze the data set in its entirety.

Fractal statistical analysis applies to situations where the mean or first moment does not exist. It also applies to situations where smaller fluctuations dominate the larger ones. Padua (2012) suggested using a power law distribution similar to Pareto's distribution given by:

$$1....f(x) = \frac{\lambda-1}{\theta}\left(\frac{x}{\theta}\right)^{-\lambda} \quad , \lambda > 0, \theta > 0, x \geq \theta$$

where λ is defined as the fractal dimension of X and θ is the smallest (positive) value of the random variable.

The maximum likelihood estimator of λ is:

$$2.... \quad \widehat{\lambda} = 1 + \frac{1}{\log\left(\frac{x}{\theta}\right)}$$

so that each observation contributes to the fragmentation of the support X. Padua (2013) demonstrated that the distribution of the maximum likelihood estimators obey an exponential type of distribution so that both the mean and variance of the fractal dimensions exist.

A device called fractal spectrum or λ(s) spectrum was suggested by Padua et al. (2013) to identify locations on the support X where high data roughness or fragmentation occur and where smoothness appear to dominate. The spectrum is defined as:

$$3..... \lambda(s) = 1 - \frac{\log(1-\alpha)}{\log\left(\frac{X\alpha}{\theta}\right)} = 1 - s\log(1-\alpha)$$

where, Xα is the αthquantile of X and $s = \frac{1}{\log\left(\frac{x}{\theta}\right)}$

3.0 Results and Discussions

Figure 1 gives a graphical idea of the mean rate of suicide in each country. The result shows high variability among countries, especially among the male population.

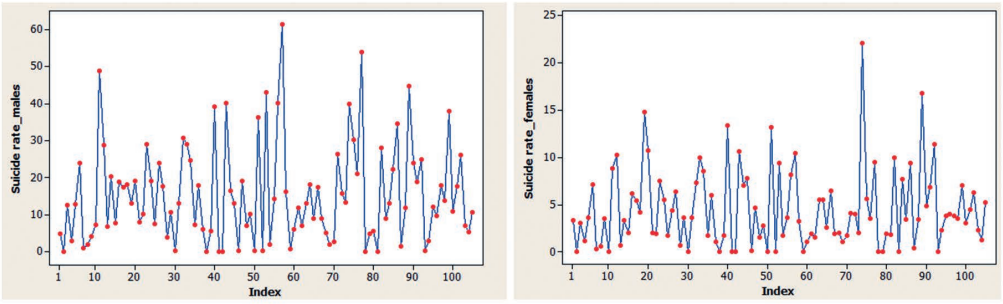

Figure 1: Suicide rate for male and female from 105 sampled countries

Figure 2 shows the histogram of suicide rate of male and female. The graph exhibits physical similarity to exponential and fractal distribution where data of smaller value compose the bigger population. The histogram shows that the mean rate of suicide in the male population in the world aggregate in the 0-20 range. The histogram for females also reflects the same dynamics, except that rates in countries aggregate between 0 to 5. It shows that countries that register a high incidence for suicide among its female population are very rare. Further, the graphs confirm that the male population has a higher rate of suicide incidence compared to their female counterpart.

Figure 3 shows the normality test of the suicide rate of male and female. The test clearly showed that the data did not obey a normal distribution. Hence, fractal analysis is employed in this study.

Figure 4 illustrates the fractal spectrum of the two data. The graph gives a clearer picture

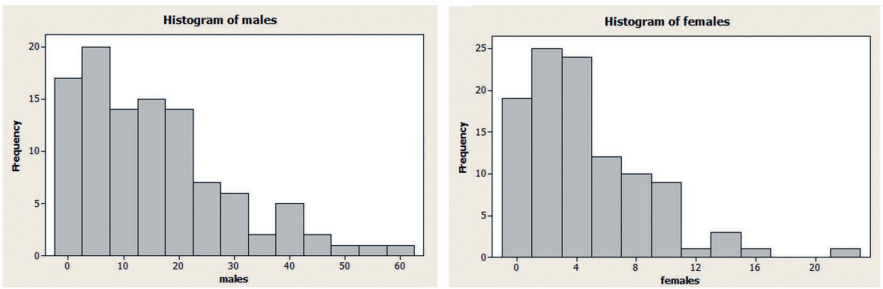

Figure 2: Histogram of suicide rate of male and female

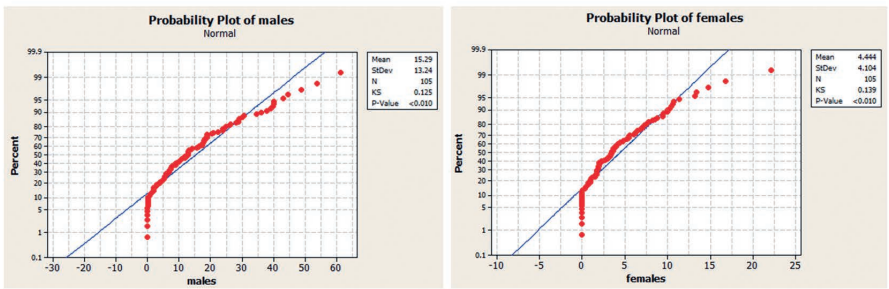

Figure 3: Normality test of Suicide rate for male and female

of the different fractal dimension at different scales. Hence, indicating the presence of a multifractal observation and thus, the need for data segmentation. The data is segmented at three different scale level (low, medium, and high) based on the fractal spectrum shown from figure 4.

The segmentation illustrates that majority of the countries fall under the medium scale category as exemplified in figures 5 and 6.

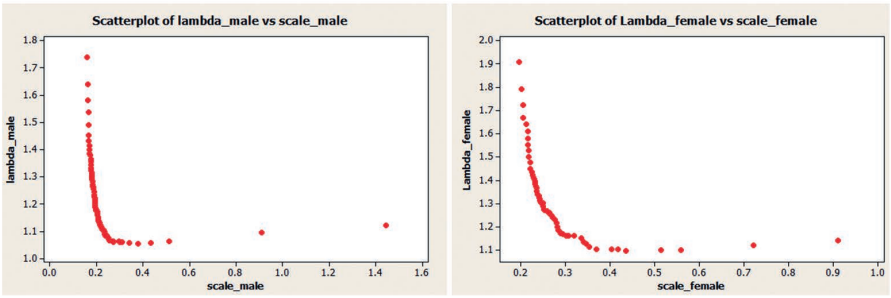

Figure 4(a and b): Fractal Spectrum of Suicide rate

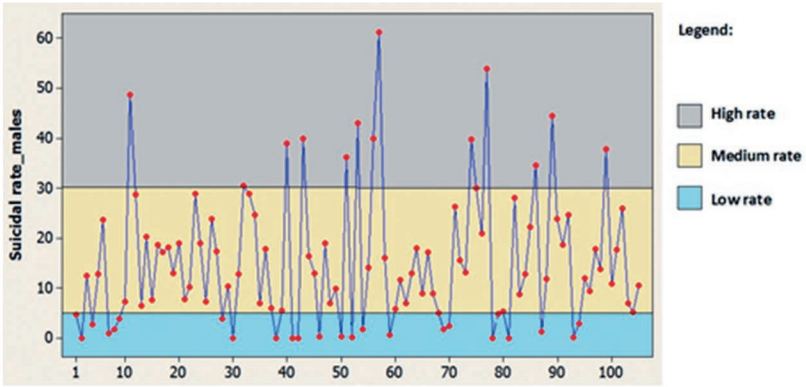

Figure 5: Fractal segmentation of Suicide rate of Male

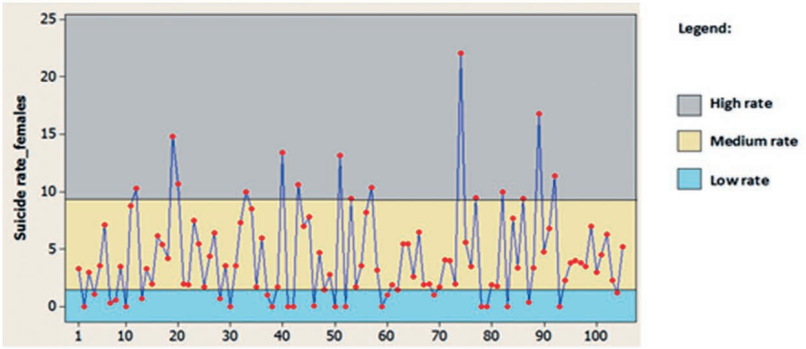

Figure 6: Fractal segmentation of Suicide rate of Male

Table 1: Average and Fractal Dimension of Suicide rate at different scales

	Male		Female	
	Mean Suicide Rate	Fractal Dimension	Mean Suicide Rate	Fractal Dimension
Low	**1.3348**	**1.0717**	**0.925**	**1.1196**
Medium	**14.8623**	**1.1791**	**5.1231**	**1.2745**
High	**42.2769**	**1.4956**	**12.5538**	**1.6244**

Table 1summarizes the corresponding average (using traditional statistics) and fractal dimension (fractal statistics) of the suicide rate at different scales where it describes the ruggedness of the data. Using traditional statistics, the disparity of the mean of the suicide rate between different levels of suicide rate of the male is greater than the female sample. This is true when the analysis assumed a smooth and normal behaviour of the data set, eliminating the impact of the outliers to the result. However, using fractal statistics, it is quite the opposite. As Table 1 shows, the fractal dimension of the female group reflects a more rugged and irregular set of data in all the three scales as compared to the male data set. Worth noting is the 1.6244 fractal dimension in the high scale for the female data that contributed to the very rugged distribution of the data set. Composing the high scale cluster are Republic of Korea, Hungary, China, and Sri Lanka , to name a few. Interesting to note that while half of the countries are in the medium scale (2-9 annual suicide average), there are countries that affect the entire suicide scene by their high incidence. In the case of Korea, with a 22.1 yearly average, authorities saw the challenge to address issues on mental well-being (Kim, 2013). The existing social stigma on mental illness and a difficulty admitting any inability to cope contribute to suicide figures. The high incidence is attributed to the easy access of the Korean women to toxic pesticides which is the easiest means of suicide in the elderly in rural towns. In recent years, the ban on these toxic elements and the promotion of anti-suicide programs, plus the discouragement on the sensationalism of celebrity suicide somehow brought the rate down to 23.8 (per 100,000) from its 26.9 rate in 2011 (Kwanwoo, 2013). Like Korea, China also registers a high incidence of suicide in the female population. The similarity also extends to the tool used in suicide which is pesticides, and that suicide rate is more in the rural area than in cities (WHO,2009). In the case of Sri Lanka, abject poverty, social inequality, and homelessness have worsened as a result of the three-decade communal war against the Tamil minority (Fernando as ctd by Amaranath, 2012). A very interesting study regarding the J-shaped belt from Finland through the Baltic Countries- Russia, Belarus, Ukraine to Central Europe (Hungary, Slovenia, and Austria) underscored genetic and biological contributions to Hungarian suicide rate. The genetic similarities between populations of these countries led to the Finno-Ugrian suicide hypothesis which states that high suicide rate is a consequence of a shared genetic susceptibility (Rihmer et al, 2013). Prevalence of any bipolar disorder, which carries the highest risk of suicide is unusually high in Hungary (5.1%). It also registered the highest mean of major depression disorder. Hence, the high prevalence of affective disorders is considered as a major contributory factor in the suicide scene in these regions. A suicide decline is experienced from 1988-2007. A striking coincidence with this decline is the political transition that the region is

experiencing. Some authors raised the possibility that the decline is also due to the termination of the communist regime. Rihmer et al points out that complex interplay between macro-social and personal suicide risk factors are powerful predictors for the suicide scene.

For the male, it is also in the high scale category that disparity is greatly manifested with a 1.4956 dimension. In the case for example of Estonia, it registered a 30.6 annual average rate. Belarus, on the other hand reflected a 48.7 average while Lithuania a 61.3 average rating. These countries register a 30-61 yearly average of suicides in the male population. In the article The Silent Epidemic of Male Suicide (Bilsker and White, 2011), the use of highly lethal methods like firearms and hanging among males and the propensity for impulsive behaviour are identified as contributory to the high success rate in males. In likewise manner, reluctance to discuss relationship and emotional difficulty is identified as a primary reason for the disparity in committed suicide between males and females. This is supported with the generated data above. European countries comprise more than half of those belonging to high scale incidence of suicide. It also register majority of the countries belonging to medium suicide scale, and dominates the upper limit of this bracket. Family breakdown, overwork, and employment security, along with less contact with formal health care system a year before the committed suicide, are identified further as causes for suicide success rate. Most North American and Asian countries (except Japan, Korea and Sri Lanka) belong to the low rate suicide scale. The same dynamics of irregularity is present in the data for the females, lesser rate of suicide compared to the male data set, but with a higher disparity in all scales.The low incidence of suicide in women can be attributable to their ability to talk about life and life issues openly. The disparity in suicide rate is due to ready access to instruments and opportunities for committing suicide. Culture, nonetheless, plays a vital part, specifically in countries where women are still considered less powerful than the men. However, it is worth noting that in the data set covered in this study, a number of Muslim countries are not included.

4.0 Conclusion

Fractal analysis of suicide incidence continues to explore on the intricacies which may impact those involved in the mental health services. A high incidence in the male population is traceable to lack of cultural support and men's hesitance to talk about life's issues. Women, has low suicide rate. However, because of the disparity of the incidence across countries, the suicide rate in women registers a more rugged scenario. Asia and some parts of Europe posted high contribution to the irregularity in female suicide rate. While for men, it is Europe that gave the highest suicide rate. Family breakdown, overwork, and employment security are identified as causes. Indeed, consideration for cultural disparity, awareness of the dynamics of suicide and the variations of level of support from social groups play a crucial role in the in-depth understanding of the suicide phenomenon.

References

Amaranath, S. Sri Lanka Suicide Rate One of the World's Highest. 2012. World Socialist Web Site.

Barabat, Borres et al. Some Results on Multifractal Spectral Analysis. 2013. Unpublished. Recoleto Multidisciplinary Journal, vol 2.

Borres, Barabat, et al. Societal Offenders in Prison: Global In-Country Analysis By Fractals. 2013. Unpublished. Recoleto Multidisciplinary Journal, Vol 2.

Canadian Mental Health."Suicide". (2013) Chung, J. , et al (2010). The Cultural Theory and Model of Suicide.

Applied and Preventive Psychology vol. 14 issues 1-4. June 2010, pp 25-40

Dan Bilsker, Jennifer White. The Silent Epidemic of Male Suicide.BCMJ, vol. 53, no. 10, December 2011, pp.529-534.http://www.bcmj.org/articles/silent-epidemic-male-suicide http://www.annals-general-psychiatry.com/content/12/1/21

Joiner, Thomas ."The Interpersonal-Psychological Theory of Suicidal Behavior: Current Empirical Status. Psychological Science Agenda. June 2009

Kim, Hyun-Chung. South Korea: Highest Suicide Rate DespitePercent Drops. http://www.euronews.com/2013/09/30/south-korea-highest-suicide-rate-despite-11-percent-drop/

Kwanwoo, J.. Suicide Rates falls in Seoul but still Very High. http://blogs.wsj.com/korearealtime/2013/10/07/suicide-rate-falls-in-seoul-but-still-very-high/

Padua, Barabat et al. Construction of a Simple Multifractal Spectrum as an Alternative to the Legendre Spectra in Multifractal Formalisms. 2013. Recoleto Multidisciplinary Journal, vol 1.

Rihmer, Z.,Gonda,X.,et al. Suicide in Hungary-Epidemiological and Clinical perspectives. Annals of General Psychiatry. 2013

Springen, Karen. Daring to Die: the Psychology of Suicide.2010. Scientific American

World health Organization.Bulletin of the WHO- Women and Suicide in Rural China, 2009. Vol. 87

Appendix

Suicide rates per 100,000 by country, and sex. Most recent year available; as of 2011

Country	Males	Females
ALBANIA	4.7	3.3
ANTIGUA AND BARBUDA	0	0
ARGENTINA	12.6	3
ARMENIA	2.8	1.1
AUSTRALIA	12.8	3.6
AUSTRIA	23.8	7.1
AZERBAIJAN	1	0.3
BAHAMAS	1.9	0.6
BAHRAIN	4	3.5
BARBADOS	7.3	0
BELARUS	48.7	8.8
BELGIUM	28.8	10.3
BELIZE	6.6	0.7
BOSNIA AND HERZEGOVINA	20.3	3.3
BRAZIL	7.7	2
BULGARIA	18.8	6.2
CANADA	17.3	5.4
CHILE	18.2	4.2
CHINA (Selected rural & urban areas)	13	14.8
CHINA (Hong Kong SAR)	19	10.7
COLOMBIA	7.9	2
COSTA RICA	10.2	1.9
CROATIA	28.9	7.5
CUBA	19	5.5
CYPRUS	7.4	1.7
CZECH REPUBLIC	23.9	4.4
DENMARK	17.5	6.4
DOMINICAN REPUBLIC	3.9	0.7
ECUADOR	10.5	3.6
EGYPT	0.1	0
EL SALVADOR	12.9	3.6
ESTONIA	30.6	7.3
FINLAND	29	10

FRANCE	24.7	8.5
GEORGIA	7.1	1.7
GERMANY	17.9	6
GREECE	6	1
GRENADA	0	0
GUATEMALA	5.6	1.7
GUYANA	39	13.4
HAITI	0	0
HONDURAS	0	0
HUNGARY	40	10.6
ICELAND	16.5	7
INDIA	13	7.8
IRAN	0.3	0.1
IRELAND	19	4.7
ISRAEL	7	1.5
ITALY	10	2.8
JAMAICA	0.3	0
JAPAN	36.2	13.2
JORDAN	0.2	0
KAZAKHSTAN	43	9.4
KUWAIT	1.9	1.7
KYRGYZSTAN	14.1	3.6
LATVIA	40	8.2
LITHUANIA	61.3	10.4
LUXEMBOURG	16.1	3.2
MALDIVES	0.7	0
MALTA	5.9	1
MAURITIUS	11.8	1.9
MEXICO	7	1.5
NETHERLANDS	13.1	5.5
NEW ZEALAND	18.1	5.5
NICARAGUA	9	2.6
NORWAY	17.3	6.5
PANAMA	9	1.9
PARAGUAY	5.1	2
PERU	1.9	1

PHILIPPINES	2.5	1.7
POLAND	26.4	4.1
PORTUGAL	15.6	4
PUERTO RICO	13.2	2
REPUBLIC OF KOREA	39.9	22.1
REPUBLIC OF MOLDOVA	30.1	5.6
ROMANIA	21	3.5
RUSSIAN FEDERATION	53.9	9.5
SAINT KITTS AND NEVIS	0	0
SAINT LUCIA	4.9	0
SAINT VINCENT AND THE GRENADINES	5.4	1.9
1SAO TOME AND PRINCIPE	0	1.8
SERBIA	28.1	10
SEYCHELLES	8.9	0
SINGAPORE	12.9	7.7
SLOVAKIA	22.3	3.4
SLOVENIA	34.6	9.4
SOUTH AFRICA	1.4	0.4
SPAIN	11.9	3.4
SRI LANKA	44.6	16.8
SURINAME	23.9	4.8
SWEDEN	18.7	6.8
SWITZERLAND	24.8	11.4
SYRIAN ARAB REPUBLIC	0.2	0
TAJIKISTAN	2.9	2.3
THAILAND	12	3.8
TFYR MACEDONIA	9.5	4
TRINIDAD AND TOBAGO	17.9	3.8
TURKMENISTAN	13.8	3.5
UKRAINE	37.8	7
UNITED KINGDOM	10.9	3
UNITED STATES OF AMERICA	17.7	4.5
URUGUAY	26	6.3
UZBEKISTAN	7	2.3
VENEZUELA	5.3	1.2
ZIMBABWE	10.6	5.2