

## A Bass Diffusion Model of Suicide in the Philippines

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### *Abstract*

A growing number of researches have demonstrated that exposure to suicide through television or newspaper leads to increased suicide risk in vulnerable individuals. Highly publicized celebrity suicides are often rationalized and sensationalized by the media. This phenomenon may result in an imitative, contagious suicide effect. This study uses the Bass diffusion model to forecast suicide deaths in the Philippines from 2020 to 2025 based on suicide data by the World Health Organization (WHO) from 2000 to 2017. The Bass model assumes that exposure to suicide (media, social media, verbal exchange of suicide stories) increases suicide deaths based on the suicide contagion hypothesis. The model depicts the successive increases in suicide deaths across Filipino age groups and predicts a suicide diffusion process. The resulting Bass model also underscores the necessity of a suicide contagion intervention plan to address the country's expected increase of suicide.

Keywords: Suicide, suicide contagion, Bass diffusion model, vulnerable individuals

### *Introduction*

Suicide is a public health priority (WHO, 2018). It is a global phenomenon in all regions affecting families, communities, and entire countries. Nearly 800,000 people die due to suicide every year (WHI, 2018). Hence, it means that one person takes his/her life every 40 seconds. At least over one million people die from suicide each year (WHO, 2018). Suicide leads to more deaths compared to wars and homicides in the world (WHO, 2014). Worldwide suicide rates have increased since their initial records began in 1950. According to reports, suicide rates have steadily climbed by 60% in the last 45 years (WHO, 2009). Several studies are establishing the link between suicide and mental disorders. But while mental illness is not an infectious disease, there is a substantial body of evidence that suicide is contagious.

Numerous studies have been conducted

to develop suicide prediction tools to support vulnerable populations (Kessler et al., 2020). Most suicide models emphasize the interaction between predisposing and precipitating factors (O'Connor et al., 2014; Zalsman et al., 2016). These factors include mental pain, personality traits, interpersonal dynamics, impaired decision-making, and existing psychological problems (Levi-Belz et al., 2019). However, these suicide modeling studies did not take into account suicide contagion.

Several studies demonstrated that exposure to suicide through print and broadcast media increases the suicide risk in vulnerable individuals (Blood & Pirkis, 2001; Stack, 2003). Recent studies have revealed that the media's portrayal of suicide can contribute to suicide contagion (Pirkis et al., 2006). Accordingly,

suicide contagion contributes to approximately 1-5% of all suicides, with some estimates as high as 13% (Calhoun, 2016; Gould, Wallenstein, Kleinman, O'Carroll, & Mercy, 1990; Hazell, 1993; Velting & Gould, 1997). Stack (2003) meta-analyzed 293 findings from 42 studies on the impact of publicized suicide stories. He concluded that the victims' celebrity status is related to the power of imitative effect. Moreover, highly published reports on political or celebrity suicides were 14.3 times most likely to have a contagious suicide effect with non-celebrity suicides. Stack's meta-analysis demonstrated that highly reported celebrity suicides were generally positively portrayed by the media in terms of sensationalism and rationalization of the act. As a result, these suicides are more likely to have an imitative effect.

Suicide contagion may affect all age groups, but it is more prevalent in the teenage population (National Institute of Mental Health, 2015). Approximately 5-10% of all adolescent suicides result from suicide contagion (Calhoun, 2016; Gould, 2013; Gould et al., 1990; Phillips & Cartensen, 1986; 1988). Corollary to this, exposure to suicide increases an individual's relative risk of suicide by two to four times among 15- to 19-year-olds (Gould et al., 1990). Calhoun (2016) states an established relationship exists between initial suicide and subsequent suicide exposure for later suicide victims. This is an essential element in the suicide contagion hypothesis. Hence, investigators can only establish a contagion effect if there is an identified extent of exposure. The exposure can be in the form of real or fictional suicides. This is a challenge because investigators usually cannot accurately determine the size of suicide exposure before the individual's death (Mercy et al., 2001; Stack, 2003). Several contagion investigations have been criticized for failing to provide any evidence demonstrating that suicidal individuals were aware of another person's actions (Berman, 1988). Hence, even if the high profile and highly publicized suicides do not predict contagion for everyone,

vulnerable individuals at risk for self-harm or suicide ideation would be susceptible to the suicide contagion effect.

In this study, the Bass diffusion model was used to forecast suicide deaths in the Philippines from 2020 to 2025 using suicide data from 2000 to 2017. As a diffusion model, the Bass model assumes that exposure to suicide (media, social media, verbal exchange of suicide stories) increases suicide deaths based on the suicide contagion hypothesis. Therefore, the model depicts the successive increases in the number of suicide deaths across Filipino age groups and predicts the continued development of a suicide diffusion process, already in progress. The resulting Bass model underscores the necessity of a suicide contagion intervention plan to address the predicted increase of suicides in the Philippines.

### *Framework*

#### *Suicide Contagion and the Werther Effect*

Suicide contagion refers to a hypothetical process where suicidal thoughts and behaviors are socially transmitted. It explains the occurrence of suicide clusters, the phenomenon of suicides occurring close together in time and space (Calhoun, 2016; Joiner, 2003). Suicide contagion usually spreads through a school system, through a community, or in terms of a celebrity suicide wave, nationally and globally.

A copycat suicide or suicide imitation describes one hypothetical process of suicide contagion (Wasserman, 1984). Copycat suicide happens when a person imitates the suicide of another individual whom he or she has prior knowledge of. The exposure to another suicide might be from word-of-mouth or the portrayal of the suicide in print and broadcast media (Gould, 2013). The sudden increase in emulation suicides immediately after a high-profile and highly publicized suicide is referred to as the Werther effect from Goethe's novel,

*The Sorrows of Young Werther*. In the absence of protective factors, the publicized suicide triggers the subsequent suicide of a susceptible or suggestible person.

Aspects of the social learning theory (SLT) are often used to explain the association between suicide exposure and actual suicide behavior (Blood & Pirkis, 2001). SLT supposes that most human behavior is learned observationally through modeling (Bandura, 1977; Gould et al., 2003). The core concept of SLT states that imitator(s) must identify in some way with their observed model (Bandura, 1977). Blood and Pirkis (2001) noted two significant forms of identification in social learning, vertical and horizontal identification. Vertical identification proposes that inferior individuals copy the behavior of superior individuals (Tarde, 1903). In suicide contagion, suicide by celebrities and other high profile personalities are more likely to be imitated than non-celebrity suicide stories (Wasserman, 1984; Stack, 1987a). Vulnerable individuals may find it easier to identify with the celebrity's highly publicized difficulties (Stack, 2003).

On the other hand, horizontal identification describes situations where imitators copy most similar models (Blood & Pirkis, 2001). Stack (2003) showed that the media effect on suicidal behavior is strongest when the model and observer come from the same demographic group (such as teenagers). Observers demonstrate a stronger sense of identification with non-fictional portrayals of suicide than fictional representations (Bandura, 1977; Stack, 2003). Hence, reports of actual suicides are very compelling to vulnerable individuals who are at risk for suicide. Also, Bandura (1977) stated that the degree of reality is vital for modeling. It means that a suicide-vulnerable individual (observer) deliberates how much the suicide behavior is reinforced before deciding to imitate it. Observers will be more likely to imitate suicide if portrayed positively (O'Carroll & Potter, 1994). Glamorizing or

romanticizing suicide through media reports may increase the imitative consequences. The possibility of suicide contagion suggests that the rapid rise of completed suicides will trigger more suicide deaths should vulnerable individuals be exposed to publicized, positive reports of suicide stories. While the empirical dynamics and even definition of suicide contagion are still subject to scientific debates, the reality of this social phenomenon warrants a closer investigation in so far as it alludes to an emerging diffusion process.

### *The Bass Diffusion Model*

The study used the Bass model or the Bass diffusion model as its anchorage. This forecasting model assumes that the probability of additional first-time adoptions or purchase of a new product in the future is a linear function of the number of preceding purchases or the number of consumers who have adopted the product (Maureal et al., 2020). According to this model, diffusion is the process by which new ideas or technology are adopted over time in a social system vis-à-vis communication channels or word-of-mouth (Maureal et al., 2020). Using suicide contagion as the communication channel where suicides are publicized and spread without intervention, the incidence of new suicides is treated as a Bass diffusion suicide. Hence, the growth in the number of suicide deaths is a function of how the suicide is diffused or spread in an area, like the Bass model. The model generates an S-curve pattern, which implies that new suicides initially grow rapidly, but then the growth rate tapers off and finally declines with time. This is the point where the suicide curve is "flattened" or mitigated. It also forecasts the number of suicides from 2020 to 2025 across three age groups: 15 to 49 years old, 50 to 69 years old, and 70 years old and above. These age groups were considered since they have a high occurrence of suicide deaths based on the WHO report. WHO (2020) also states that the most vulnerable population for suicide deaths is 15 to 29. In addition, suicide is one of the

leading causes of death among adults ages 26 to 55 years (Suicide Prevention Center, 2020), and suicide rates increase during the life course (Conejero et al., 2018). The age group below 15 years old as suicide deaths in this age range tend to be unreported (Gould, 2003).

*Research Objectives*

The present study developed a Bass diffusion model of the epidemiology of suicide deaths across four age groups in the Philippines using 2000 to 2017 data of suicide deaths. The model seeks to forecast suicide deaths among age groups in the Philippines from 2020 to 2025. Specifically, the study sought to:

1. forecast/predict diffusion of suicide deaths in the Philippines from 2018 to 2025 across age groups using Bass modelling of suicide data from 2000 to 2017;
2. analyze suicide diffusion trends across the age groups; and,
3. propose an intervention based on the suicide diffusion trends

*The Model*

Using the suicide contagion hypothesis, it is assumed that suicide can be transmitted through an imitative effect where a vulnerable individual increases his/her risk of committing suicide when exposed to suicide media reports and other word-of-mouth channels. To model the spread of suicide through the contagion hypothesis, the Bass model was used. The potential victims  $m$  is assumed as the population of Filipinos in the identified age group. Let  $F(t)$  be the number of suicide deaths from 2000 to 2025, also known as the cumulative fraction of suicides. Thus, the function  $F(t)$  is a function of time for which the unit of time is identified as a year. The parameter  $p$  is the spontaneous rate of suicide. At the onset of the spread of suicide through media reports and word-of-mouth channels, some individuals are considered susceptible

populations as they possess risk factors for suicide. They are exposed to the publicized suicides, and without being aware, their suicidal tendencies are triggered. Their rate of being infected is  $q$  in symbol.

The basic Bass model is given by

$$\frac{dF(t)}{dt} = (p + qF(t))(1 - F(t)) \tag{1}$$

The rate of suicide on a given year  $\frac{dF(t)}{dt}$  is just the rate of suicides  $p + qF(t)$  times the rate of the potential victim  $(1 - F(t))$  who are not yet infected. Rewriting (1), we have

$$f(t) = (p + qF(t))(1 - F(t)) \tag{2}$$

$$\text{and } S(t) = m f(t) \tag{3}$$

where  $S(t)$  is the number of suicides on year  $t$ , and  $m$  is a total potential victim.

*Estimating the Parameters*

The Bass model has three unknown parameters:  $m$ ,  $p$ , and  $q$ . The epidemiology of suicide deaths in the Philippines was used to estimate the unknown parameters, as derived from the World health Organization and the projected Philippine population by 2025 across age groups. To estimate the parameters, the non-linear least square method (NLS) was used. To obtain the estimates of the parameters using the NLS, the expression for the number of infections  $(t_{i-1}, t_i)$  on the time interval is by definition,

$$S(ii) = m(F(t_i) - F(t_{i-1})) + u_i \tag{4}$$

$$S(ii) = m \left( \frac{(1 - e^{-(p+q(1-c))t_i}}{1 + \frac{q(1-c)}{p} e^{-(p+q(1-c))t_i}} - \frac{(1 - e^{-(p+q(1-c))t_{i-1}}}{1 + \frac{q(1-c)}{p} e^{-(p+q(1-c))t_{i-1}}} \right) + u_i$$

for  $i = 1, 2, \dots, n$

Where  $u_i$  is the additive with the variance  $\sigma^2$

## Results and Discussion

### *The Empirical Data*

The data utilized in this study were the Suicide Report of the Philippines from the World Health Organization (2018). The report enumerated the number of suicide deaths in the Philippines from 2000 to 2017 across four age groups: (a) 5 to 14 years old, (b) 15-49 years old, (c) 50-69 years old, and (d) 70 and above years old. Most suicide deaths in the period occurred in the age bracket of 15 to 49-year-old Filipinos, with the most significant number of suicide deaths occurring in the year 2017. The least number of suicides occurred in the age group of below 15 years old. It is important to note that this trend concurs with statistics saying that the most vulnerable population for suicide deaths is those aged 15 to 29 (WHO, 2020). The suicide data also show an increasing trend in the number of suicides among Filipinos in all age groups, with the most significant number of suicide deaths occurring in 2017.

### *Estimation of Parameters and Bass Forecasting across Age Groups*

Parameters  $m$ ,  $p$ , and  $q$  used the empirical data to obtain the estimates of  $m$  as the potential suicide victims – the estimated Filipino population each year based on the report of the Philippine Statistical Authority for 2018 to 2025. To estimate  $p$  and  $q$ , statistical software was used that fit the Bass model to past data using nonlinear squares. Table 1 shows the estimates of the parameters across the three age groups.

Using the estimates, we can create a suicide curve model of suicide deaths from 2000 to 2025 among Filipinos across all age groups. This is shown in figure 5. It can be surmised from the figure that the predicted number of suicide deaths corollary to the projected 2025 population of Filipinos aged 15 and above would increase from 2018 to 2025. Therefore, by 2025, suicide deaths do not show stability, and the decline of suicide across these age groups is unlikely. Among these age groups,

Filipinos aged 15 to 49 years old show a more rapid suicide rate. Hence, Filipinos in this age group are more susceptible or at risk of suicide or suicide contagion.

It can be noted that this age group contains Filipino adolescents. These are 15 - to 21-year- old individuals based on Erikson's developmental stages. If so, these findings corroborate most studies examining exposure to the suicidal behavior of adolescent peers having a significant association with teenage suicide attempts (Gould, 2003). Gould et al. (2013) stated that the relative risk of suicide following exposure to another individual's suicide was two to four times higher among 15-to-19-year-olds than among other age groups. This may be true because teenagers identify more strongly with the actions of their peers. In addition, adolescence is a period of increased vulnerability to mental health problems as this is a period of transition in several domains of life at the same time. They hurdle significant challenges, make life-changing decisions, and meet high expectations. These situations naturally give rise to helplessness, insecurity, stress, and a sense of losing control (Patton et al., 2016). The presence of these challenges and the absence of protective factors such as support from significant others may lead to mental health issues that increase the risk for suicide.

This is also the age group most exposed to news stories of suicide in many media forms, including social networking sites. The magnitude of the increase in suicides following a suicide story is proportional to the amount, duration, and prominence of media coverage (Gould et al., 2013). The more a susceptible individual is exposed to suicide stories, the higher is the risk for suicide. As mentioned by Gould (2013), Stack further noted that the impact of suicide stories on subsequently completed suicides had been reported to be most significant for teenagers.

While young people are vulnerable to suicide contagion than their adult counterparts, the Bass

**Table 1**  
*Estimates of Parameters for Suicide Deaths among Filipinos*

Parameter	Estimate		
	15 – 49 years old	50 – 69 years old	70 years old and above
The potential victim, m (population in 2025)	61,732,800	17,756,200	4,561,800
Spontaneous rate of suicide, p	0.0023	0.0005	0.0002
Rate of suicide, q	0.0002	0.001	0.0000

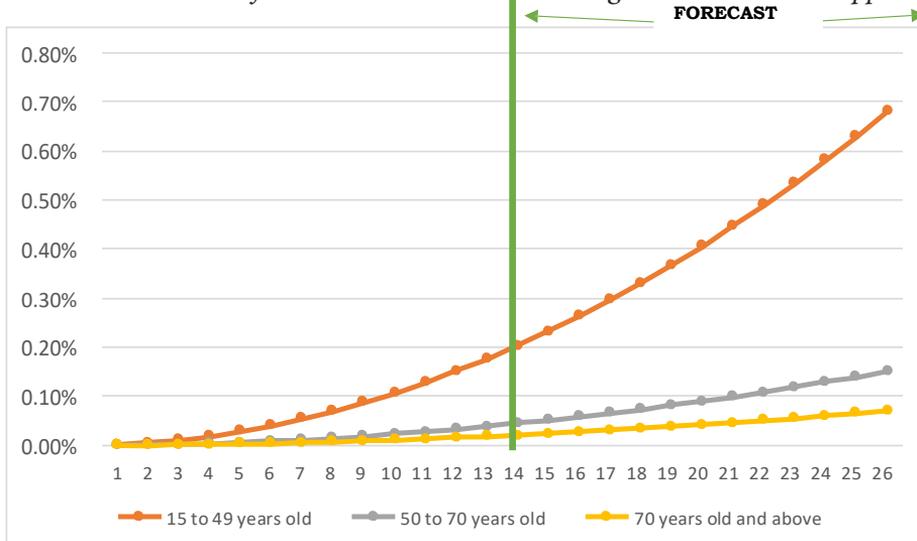
model depicts the same increasing trend in both age groups. Adulthood is a tumultuous period of career, family, and personal choices. Late-life suicide is of interest because, generally, older adults maintain and even increase emotional well-being compared to those at younger ages (Carstensen et al., 2011). Late-life suicides are even more lethal than suicides done at younger generations (Van Orden & Conwell, 2015) and are less likely to be reported. Mental health issues from the challenges of aging and the deterioration of physical health and functioning may increase the risk of older adults to suicide.

The Bass diffusion model suggests reaching a “plateau” in its estimates. However, in this model, there is no presence yet of a plateau in

the cumulative distribution for both the model and the actual data, as revealed in figure 1. This indicates that “flattening” or mitigating the suicide curve brought about by suicide contagion intervention plans are implemented. Since the possibility of suicide contagion is not yet widely accepted, no intervention plans are in place. This explains why, in this diffusion model, there is a rapid increase in suicide deaths without an eminent plateauing in 25 years (from 2000 to 2025). To mitigate suicide contagion, intervention plans must be immediately developed and implemented by stakeholders and institutions.

#### *Recommendations to Prevent Suicide Contagion*

**Figure 1**  
*Suicide Curve Model of Suicide Deaths across Three Age Groups in the Philippines*



Note. Years appear as numbers (1 – 2000, 2 – 2001, 26 – 2005)

Given the prevalence of suicide and the associated risk of contagion per Bass forecast, educational institutions may develop proactive and effective suicide prevention and post-intervention strategies. This might include a program to facilitate the grieving or adjustment process of mourners while, at the same time, minimizing the likelihood of contagion. Guidelines on suicide reporting may be crafted. Because of the proliferation of 'suicide stories, there should also be a move to increase 'resilience stories'. These stories of hope could shape students' desire to "do something." A suicide forum can also correct myths about suicide. Institutions may invest in capability development training for mental health workers and support staff in handling suicide occurrences and suicide ideations among community members. Finally, a screening for suicide risk among the population may be conducted as this can halt the transmission of suicidality by advance identification of individuals susceptible to suicide contagion.

### Conclusion

Suicide is a tragic and complex phenomenon requiring urgent action due to the significant danger to human life. Many studies have tried to develop models to predict suicide by identifying risk and protective factors. However, the hypothesis that suicidal behavior is "contagious" and can be transmitted or spread, directly or indirectly, from one person to another, through media reports and word-of-mouth channels is also worthy of study. Using the Bass diffusion model, this study established that suicide deaths among Filipinos aged 15 and above would rapidly increase until 2025 due to suicide contagion. The most rapid increase will occur in the age group 15 to 49 years old, including teenagers who are the most susceptible to suicide contagion. This suggests that institutions and stakeholders should consider strategies to prevent suicide

contagion and evaluate the effectiveness of such strategies in the long run.

### Ethics Statement

All data used in this study were from verified resources published on official websites.

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### References

- Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191-215.
- Berman, A. L. (1988). Fictional depiction of suicide in television films and imitation effects. *American Journal of Psychiatry*, 145, 982-986.
- Blood, R. W., & Pirkis, J. (2001). Suicide and the media. Part III: Theoretical issues. *Crisis*, 22(4), 163-169.
- Carstensen, L.L., Turan, B., Scheibe, S., Ram, N., Ersner-Hershfield, H., Samanez-Larkin, G.R., Brooks, K.P., & Nesselroade, J.R. (2011). Emotional experience improves with age: Evidence based on over 10 years of experience sampling. *Psychol Aging*, 26(1), 21- 33.
- Conejero, I., Olié, E., Courtet, P., & Calati, R. (2018). Suicide in older adults: Current perspectives. *Clinical Interventions in Aging*, 13, 691-699. <https://doi.org/10.2147/CIA.S130670>
- Colhoun, C. (2016). Suicide contagion: Is the media placing the public at risk? An analysis of suicide reporting in New Zealand newspapers. *Unpublished Dissertation*. Massey University, Palmerston North, New Zealand.

- Gould, M., Jamieson, P., Romer, D. (2003). Media contagion and suicide among the young. *American Behavioral Scientist*, 46(9), 1269-1284. <https://doi.org/10.1177/0002764202250670>
- Gould, M., & Lake, A.M. (2013). The contagion of suicidal behaviour. *National Academies Press (US)*. <https://www.ncbi.nlm.nih.gov>
- Gould, M. S., Wallenstein, S., Kleinman, M., O'Carroll, P., & Mercy, J. (1990). Suicide clusters: An examination of age-specific effects. *American Journal of Public Health*, 80(1), 211-212.
- Hazell, P. (1993). Adolescent suicide clusters: Evidence, mechanisms, and prevention. *Australia and New Zealand Journal of Psychiatry*, 30(1), 653-665.
- Joiner, T. E. Jr. (2003). Contagion of suicidal symptoms as a function of assertive relating and shared relationship stress in college roommates. *Journal of Adolescence*, 26, 495-504.
- Kessler, R.C., Bossarte, R.M., Luedtke, A., et al. (2020). Suicide prediction models: A critical review of recent research with recommendations for the way forward. *Mol Psychiatry*, 25, 168-179. <https://doi.org/10.1038/s41380-019-0531-0>
- Krug, E. G., Dahlberg, L. L., Mercy, J. A., Zwi, A. B., & Lozano, R. (Eds.). (2002). World Report on Violence and Health. Geneva: World Health Organization.
- Levi-Belz, Y., Gvion, Y., Apter, A. (2019). The psychology of suicide: From research understandings to intervention and treatment. *Frontiers in Psychology*. <https://doi.org/10.3389/fpsyg.2019.00214>
- Maureal, Z.L, Dumandan, M.S., Lapates, J., & Bicar, V.K. (2020). Adapted Bass diffusion model for the spread of COVID-19 in the Philippines: Implications to interventions and flattening the curve. *International Journal of Innovation, Creativity and Change*, 14 (3), 1418-1437.
- Mercy, J.A., Kresnow, M., O'Carroll, P.W., Lee, R. K., Powell, K. E., Potter, L. B., et al. (2001). Is suicide contagious? A study of the relation between exposure to suicidal behaviour of others and nearly lethal suicide attempts. *American Journal of Epidemiology*, 154(2), 120-127.
- National Institute of Mental Health. (2015). *Suicide*. [https://www.nimh.nih.gov/health/statistics/suicide#part\\_2560](https://www.nimh.nih.gov/health/statistics/suicide#part_2560)
- O'Carroll, P. W., & Potter, L. B. (1994). Suicide contagion and the reporting of suicide.
- O'Connor R.C., & Nock, M.K. (2014). The psychology of suicidal behaviour. *Lancet Psychiatry*, 1(1), 73-85. doi: 10.1016/S2215-0366(14)70222-6
- Phillips, D. P., & Carstensen, L. L. (1986). Clustering of teenage suicides after television news stories about suicide. *New England Medical Journal*, 5(11), 685-689.
- Phillips, D. P., & Carstensen, L. L. (1988). The effect of suicide stories on various demographic groups, 1968-1985. *Suicide and Life-Threatening Behaviour*, 18, 100-114.
- Pirkis, J. E., Blood, R. W., Beautrais, A., Burgess, P., & Skehan, J. (2006). Media guidelines on the reporting of suicide. *Crisis*, 27(2), 82-87.
- Stack, S. (2003). Media coverage as a risk factor for suicide. *Journal of Epidemiology and Community Health*, 57(4), 238-240.
- Stack, S. (1987). The Sociological Study of Suicide: Methodological Issues. *Suicide and Life-Threatening Behavior*, 17: 133-150. <https://doi.org/10.1111/j.1943-278X.1987.tb01026.x>
- Suicide Prevention Center. (2020). *Adults Ages 26 to 55 Years*. <https://www.sprc.org/populations/adults-26-55>

Tarde, G. (1903). *The laws of imitation*. New York: Henry Holt and Company

Van Orden, K. A., & Conwell, Y. (2016). Issues in research on aging and suicide. *Aging & Mental Health*, 20(2), 240–251. <https://doi.org/10.1080/13607863.2015.1065791>

Velting, D. M., & Gould, M. (1997). Suicide contagion. In R. Maris, S. Canetto, & M. M. Silverman (Eds.), *Annual Review of Suicidology*, 96-136. New York: Guilford.

Wasserman, I. M. (1984). Imitation and suicide: A re-examination of the Werther effect. *American Sociological Review*, 49(3), 427-436.

World Health Organisation. (2009). World suicide report. Preventing suicide: A global imperative. Luxemburg: WHO.

World Health Organisation. (2014). World suicide report. Preventing suicide: A global imperative. Luxemburg: WHO

World Health Organnisation. (2020). DOH and WHO promote holistic mental health wellness in light of World Suicide Prevention Day. World Health Organization. <https://www.who.int/philippines/news/detail/10-09-2020-doh-and-who-promoteholistic-mental-health-wellness-in-light-of-world-suicide-prevention-day>

