RESEARCH ARTICLE

Seasonality of Completed Suicides in Adolescents Under the Age of 18 years in Michigan During 2000-2015

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Abstract

In Michigan, the increase in adolescent suicide is above the national average. Literature identifies that adolescent suicide increases at the beginning of the school calendar suggesting seasonality of suicide deaths based on the school calendar. The purpose of this study was to analyze seasonality of adolescent suicide in Michigan. Six hundred ninety one suicide death records of adolescents 5-17 years of age between 2000 and 2015 were obtained from the Michigan Department of Health and Human Services Vital Statistics Unit. Yearly, monthly, and weekly frequencies were plotted, along with frequency of age using times series analysis. Frequencies of suicide deaths increased, with peak events occurring October 23rd-29th. Suicide deaths were lower when school was not in session, June through August. Data also revealed an increase in younger children completing suicide between the years 2000 and 2015. Findings strongly indicated a pattern of adolescent suicide related to the school calendar.

Keywords: Suicide- Seasonality- Adolescents- Michigan- School-Year- Incidence

Introduction

As suicide rates in the United States continue to increase, it is becoming a collective concern for those who work in the field of public health and beyond [1]. According to the Centers for Disease Control and Prevention (CDC), suicide was the 10th leading cause of death overall in the United States in 2015, eventually claiming the lives of more than 44,000 individuals in that year alone [2]. To shine a light on the issue at hand, the CDC (2015) reported that there were twice as many suicide deaths in the United States in 2015 (44,193) as there were homicides (17,793). Globally, the mortality rate of suicide is 16 per 100,000 and comprises 1.8% of the global burden of disease [3].

With a large body of literature about suicide available, it is useful to accurately define what it means. According to the CDC (2017), suicide is death caused by self-directed injurious behavior with an intent to die as a result of the behavior [4]. On the other hand, a suicide attempt is a non-fatal, self-directed, potentially injurious behavior

with an intent to die. Both of these actions can be started by suicidal ideation, which is when one thinks, considers, and plans suicide. The work completed on suicides by Hamermesh and Soss (1974) resulted in the development of a rational-suicide theory, which argues that suicide rates should increase as individuals get older [5, 6]. While data from the early to mid-1990s supports their predictions that older age groups should have higher suicide rates, recent trends in suicide across many other age groups are steering away from their findings [6]. According to the CDC (2017), there is a combination of individual, relationship, community, and societal factors that contribute to the risk of suicide [4].

While many studies have been published on the topic of seasonality of suicide deaths, or increasing rates of suicides in children and adolescents in the past few years, not a single study focused on seasonality of completed suicide rates specifically in the United States for children and adolescents. Many studies that looked at this

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specific topic took place in other countries, such as Japan or smaller European countries [7-10]. While this is helpful and showed suicide rates are increasing, the results come from a different culture and different part of the world where timing of seasons are not the same as those in the United States. The CDC's Youth Behavioral Risk Survey (YBRS) demonstrated that suicides rates among children and adolescents are increasing yearly. It is important to understand the seasonality and reasons behind this trend so proper public health interventions may be put into place.

Michigan ranks above the national average when comparing state suicide rates among 15- to 24-year-olds, with a rate of 13.9 per 100,000 people in 2015 [2]. More sparsely populated states have higher rates, including Alaska (51.6), Wyoming (34.4) and South Dakota (32.2). However, Michigan has seen a steady rise in suicide rates. Michigan's suicide rate among young people aged less than 18 years has increased from 9.5 per 100,000 in 2009, to the 13.9 mentioned previously, and it has remained above the national average every year since [11]. From 1999 through 2015 in the United States, 18,181 children aged 5 to 17 took their own lives [12]. Michigan during the same time frame had 731 deaths from children aged 5-17 years, with a crude rate of 2.37 per 100,000 [4, 13].

Due to the increase in suicide deaths across the United States, many studies have only addressed the larger population of adults. With that, few address the age group of children and adolescents, with only a handful looking at the seasonality of suicides for these age groups that are most at risk. As identified, there is a gap in the knowledge regarding the individual, community, and societal factors that contribute to the increase in completed suicide deaths in adolescents. This study aimed to assess the seasonality of suicide deaths in adolescents in Michigan based on the school calendar year.

Materials and Methods

Study population

Mortality data was obtained from death records in individuals under the age of 18 years from the Vital Statistics Unit of the Michigan Department of Health and Human Services (MDHHS). Data in the Vital Statistics were based on death certificates issued by physicians that were subsequently reported to the local government. The local government transfers the information to MDHHS where each case is assigned an International Classification of Disease code (ICD) using the information reported in the death certificate. The records cover all reported deaths for individuals under the age of 18 years in Michigan and include the date of birth, death date, age, place of death, and the underlying cause of death based on the ICD-10 standard. The Vital Statistics Data was received by the County Health Department where a data sharing agreement was obtained for analysis of suicide. Data from the death records was electronically transferred in a Microsoft Excel document for analysis.

Inclusion/Exclusion Criteria

Analysis focused on deaths by suicide (ICD-10:X60-X84) among young individuals between 5-17 years of age. Individuals were categorized into one group to reduce risk of identifiable information. Inclusion criteria included the following: 1) individuals between 5-17 years of age, and 2) residing in the state of Michigan. Exclusion criteria included the following: 1) if they were not a U.S. citizen living in the state of Michigan at the time of death, 2) if the death record did not have date of birth or date of death, and 3) if the location of death was unknown.

Analysis of Data

From suicide records, frequencies of suicide deaths were counted on each date from January 1, 2000 to December 31, 2015. Deaths that occurred on February 29 were included. The variables analyzed were the age at death, death date, year, month (calendar and academic) and week (calendar and academic) of death, and number of deaths. Number of deaths were narrowed down to total per month. The number of deaths per week was analyzed to determine which week during the year that children are most at risk for taking their own life.

In Michigan, usually a new academic year begins in September and ends in June. Analysis of public elementary, middle, and high schools in all counties revealed that the following school calendar is typical across the state. The first day of public school begins September 5 with the last day of school being June 15. Thanksgiving break occurs from November 20-25, winter break from December 24-January 7, and spring break between March 26-April 8. Summer break takes place from June 18-September 3. Table 1 identifies the typical time points in an academic year in Michigan.

The study first looked at the number of deaths per year to analyze an increasing or decreasing trend as the years progressed. From 1999 to 2015 in Michigan, 731 deaths from children ages 5 to 17 took their own lives [4, 13]. Number of deaths per age (5-17 years) was analyzed for an age group that was most vulnerable. The relationship between calendar months and frequencies of suicides during those months using times series analysis was completed to determine what season suicides occur more frequently than others. The relationship between the typical calendar year and the frequency of suicide deaths per week was examined using times series analysis. These analyses were used to observe peaks within a normal year. All 52 weeks were included beginning with January 1. Each week was re-coded from 1-52, based on January 1st occurring on week 1 and subsequent weeks following numerically.

In addition, the study completed a time series analysis between the Michigan school calendar year and frequency of suicide deaths by creating dummy variables for each week of the year starting on September 4. If the school calendar impacts suicidal risks among young individuals who are vulnerable to stressful situations around the start of a school session, spikes in the frequencies of suicide deaths around September, January, and April may be seen. In contrast,

frequencies of suicide were expected to decrease during summer months when school is not in session. This study was reviewed by the Institutional Review Board (IRB) of Kent County Health Department's (KCHD) and Grand Valley State University. The project was determined to not meet the definition of federally covered Human Subjects Research (HSR) according to current federal regulations (45 CFR 46.102 (d)). All authors certify responsibility for the conduct of the study, and the manuscript preparation and final review.

Results

The analysis indicated a sharp positive trend of increasing suicide deaths over the years. Analysis included 691 deaths by completed suicide by young individuals 5-17 years of age between 2000 and 2015 in the state of Michigan. Suicide deaths were shown to increase was seen as the years progressed. From 2000-2005 the average number of deaths that occurred was 45.4. There was an increasing number of completed suicides during the time period of 2000-2015, with 39 deaths in 2000 increasing to 51 in 2015. The most completed suicide deaths were in 2013, with 64. From 2006-2010 the average number of deaths was 37.8 and from 2010-2015, the average was 63.8 deaths. A breakdown of number of deaths per year can been seen in Figure 1.

Figure 2 shows that among these deaths, the youngest to complete suicide was adolescents 5 years of age, with adolescents taking their lives more often starting at 12 years. This trend identifies greater numbers of suicides in adolescents in high school age compared to those in middle and elementary school. Figure 2 also shows that the age at which adolescents take their lives is getting younger each year.

The number of suicide deaths were plotted based on month and are identified in Figure 3. October had the greatest number of suicides with 68 and May had the lowest with 48.
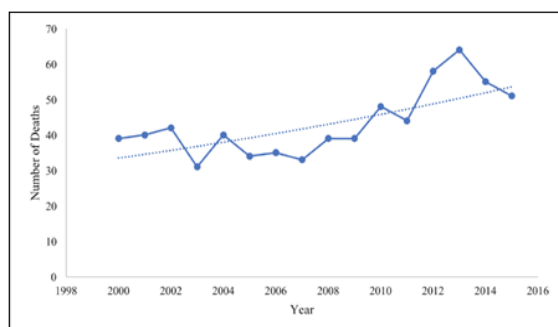

Figure 1. Number of Completed Suicides in Individuals under the age of 18 Years per Year 2000-2015 in Michigan.
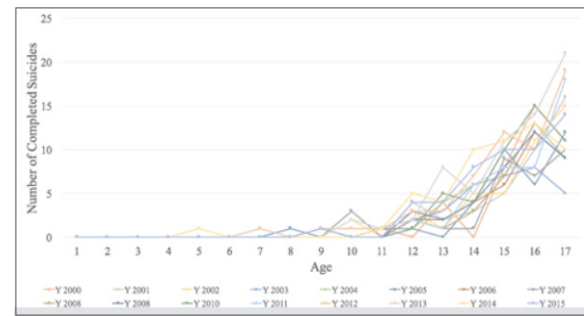

Figure 2. The Number of Completed Suicides by Age in the State of Michigan Per Year Between 2000-2015.
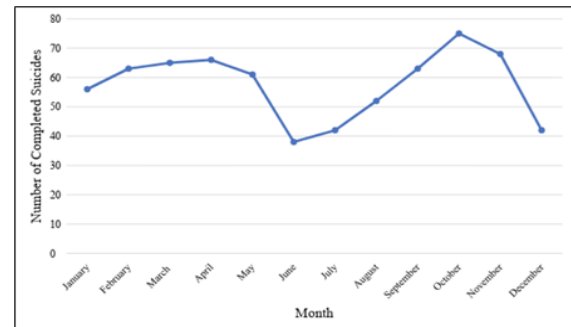

Figure 3. The Number of Completed Suicides in Individuals under the Age of 18 Years per Month from 2000-2015 in Michigan.

Frequencies of suicide deaths plotted against regular calendar weeks can be seen in Figure 4. Patterns showed a noticeable dip in suicides around the middle of the calendar year (weeks 17-29, corresponding to mid-May-July). Additionally, sharp peaks and then dips on alternating weeks occur. However, there are peaks on weeks 37, 41, and 47 (corresponding to mid-September-October). No analyses were completed to generate a significance level.

Frequencies of suicide deaths plotted against school calendar weeks can be seen in Figure 5. There is a peak of suicide deaths at the beginning of the school year, with the highest frequency being week eight, with 24 deaths. However, there is an increase in weeks three (22 suicides) and six (23 suicides) leading up to the peak week eight. Following week eight, there is a drop in the number of suicides until week 27, with a mid-school year peek of 21 suicides before dropping off again. There is also a large decrease in the number of suicide deaths starting after week 33 until week 51, which correlates with summer months of the middle of June to the middle of August. Although the results identify peak prevalence associated with the school year, the correlational impact of the school calendar was not determined based on a lack of data from a non-school population over the same time period.

Table 1. A Typical Academic Calendar in Michigan

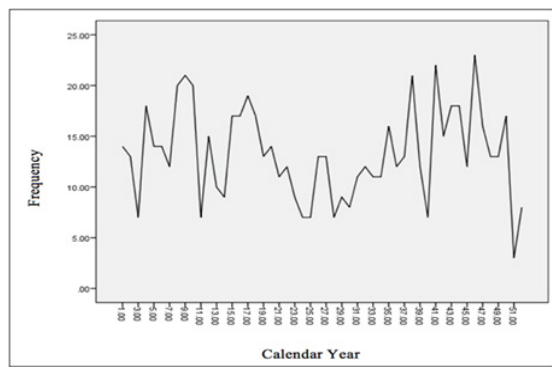| School breaks	First week of School	Thanksgiving Break	Winter Break	Spring Break	Last week of School	Summer Break
Dates	9/4-9/10	11/20-22-26	11/24-1/7	3/26-4/8	6/11-6/17	6/18-9/3

Figure 4. The Weekly Frequencies of Suicide by Individuals under the Age of 18 Years Between 2000 and 2015 in Michigan for a Typical Calendar Year.
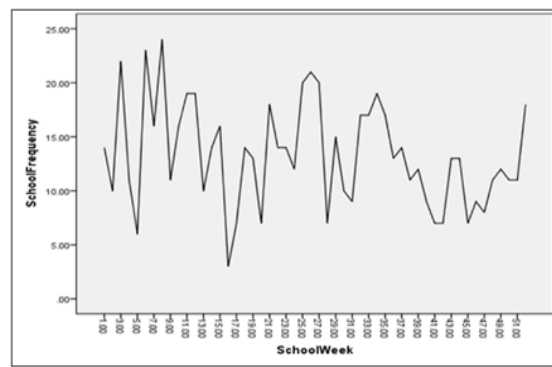

Figure 5. The Weekly Frequencies of Suicide by Individuals under the Age of 18 Years Between 2000 and 2015 in Michigan for a Typical School Calendar Year.

Discussion

Using the weekly frequencies of suicide deaths by those under 18 years of age in Michigan between 2000 and 2015, it was found that adolescents had the highest frequency of suicide around the week of October 23-29 (week eight of the school calendar), with similar numbers seen on the week of September 18-24 (week three of the school calendar) and October 9-15. These dates correspond to the beginning third of a school year. Conversely, the lowest frequency of suicide was seen in the summer months of July and August, when most children were not in school. Although there are a variety of variables that impact a competed suicide, this timing may imply that suicide is related to the school calendar year for most Michigan students. The adolescent's decision to take their own life may be associated with school-related issues. This result can be seen in Gabennesch's (1988) idea that there is a "broken promise" effect of holiday seasons that exists between children in school and temporal fluctuations in suicide [14]. Gabennesch's (1988) research explains that the suicidal person's affective state can be adversely influenced by circumstances which tend to promote the aspiration or expectation for feeling better. It is easy to imagine how an event associated with negative emotion could be the 'last straw' which pushes a despondent person into suicide. However, it is also true that an event which generally induces positive anticipation may itself cause the suicidal individual's outlook to worsen by virtue of the unfavorable contrast between raised expectancy and stubborn reality. (pg. 138)

The broken-promise effect can develop when a school year ends and school-related issues no longer exist. However, there is an elevated sense of expectancy implicitly occasioned by either a positively valued event (e.g. start of school) or the threshold of a new cycle [14], where the adolescent's hope of their troubled situation may improve. If these expectations set by the adolescent are not met (e.g. when the school year starts), it is possible to enhance their feelings of hopelessness and may contribute to their decision to complete suicide. This can be seen in the results where the school year ends and there is a decrease in suicide deaths (July and August) and an expectation of feeling better. But as time goes on the, their feelings do not change, where a positively valued event does not change their feelings (ex. school year starting in September) of hopelessness. This may contribute to the peak of suicide deaths that is the highest in October.

The present study makes four significant contributions to the knowledge and literature that currently exists. First, this study is the first to look at seasonality of completed suicides in individuals under the age of 18 years. Previous studies have been completed outside of the United States and most recently in Japan. Studies that look at seasonality in the United States have only looked at adults aged 18 years and older. Second, this study used a large data set from the State of Michigan from death certificates that were classified as a suicide for the primary cause of death. Third, the study more deeply investigated seasonality over previous studies. For example, in previous studies only months were examined, where specific weeks of the year were analyzed here. Fourth, the study used the most current data available to assess seasonality and to identify if suicide deaths in Michigan are increasing or decreasing. Finally, the study shows the significance of needing prevention methods as suicide deaths are increasing nationwide across all age groups.

Policy Implications

This study has strong policy implications for a prevention program for completed suicides in those under the age of 18 years. Potential school-based programs that address the signs and symptoms of suicide would be helpful for staff and students to identify this behavior or help-seeking behavior. Interviews with students at school provided by outside counseling could help identify at-risk youth [15, 16]. Providing programs that are mandatory within the school year, could identify an individual who is struggling and save a life. Additionally, by making the topic of suicide de-stigmatized, individuals can have open conversations about either themselves or a loved one who is struggling. By making the topic less "hush-hush" and more politically correct, more people will know that they are not alone in their struggles and can find help and hope from those around them.

Limitations

Although the study identified an increased number of suicide deaths, there are some limitations inherent in the data analyzed. One limitation is that the study did not use the deaths that could not be determined a homicide or suicide in the death certificate. The study did not address if the individuals that completed suicide died due to school-related issues or if the children were enrolled in public, private, home-schooled, or not in school at the time of their death. Additionally, data was only from the state of Michigan and can only be applied to Michigan due to its school calendar. As this study only reflects completed suicides in the state of Michigan, the results could be unique to the state itself, which could be a limitation. A cross-state or national analysis would be valuable to understand if Michigan was alone in the seasonality of suicide deaths for a school year, or if similar trends were also seen nationally.

Future Studies

Future research might be able to look deeper into seasonality to see if there is a specific day during these "peak" weeks that adolescents complete suicide more than others. If a certain day of the week has more completed suicides, more prevention efforts could take place days before and help save a life. Further studies might also look for a school-related issue at the time of the child's death, to see whether the child showed any signs of suicidal behavior leading up to his/her completion, and investigate suicide deaths by gender during specific times of the school year. This may help identify the population that is considered to be most at-risk. Additionally, "suicide contagion", or the contact with suicide that produces an increase in suicidal behavior among vulnerable people — especially teens, should also be studied. Finally, additional variables such as specific regions or socio-economic status could be explored for associations with adolescent suicide.

In conclusion, this study investigated the seasonality of completed suicides in adolescents in Michigan from 2000-2015 based on a regular and school calendar year, and concluded that there was not only an increase in adolescent suicides from 2000-2015, there was also a seasonality component that has occurred. This seasonality or "peak" took place during a typical calendar year in the month of October, with the highest number of suicide deaths per week falling during week 46t (November 12-18). When adjusting for weeks of a typical Michigan school calendar, there were increases during the start of the school year and late February, specifically October 23-29 and February 26-March 3. The findings of this study suggest that the weeks of a school calendar, in relation to weeks of a normal calendar year play a role in accounting for the seasonality of completed suicides in those under the age of 18 years.

Compliance with Ethical Standards

Conflict of Interest

There is no conflict of interest for any of the authors involved in this study

Research Involving Human Subjects

This study was reviewed by the Institutional Review Board (IRB) of Kent County Health Department's (KCHD) and Grand Valley State University. The project was determined to not meet the definition of federally covered Human Subjects Research (HSR) according to current federal regulations (45 CFR 46.102 (d)). For this type of study formal consent is not required. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

1. Suicide rates among American adolescents on the increase. Nursing Standard. 2008 Nov 05;23(9):17-17. https://doi.org/10.7748/ns.23.9.17.s19
2. Centers for Disease Control and Prevention. (2015). Suicide and self-inflicted injury. Retrieved from https://www.cdc.gov/nchs/fastats/suicide.htm .
3. Karaman D, Durukan I. Suicide in Children and Adolescents. Psikiyatride Guncel Yaklasimlar - Current Approaches in Psychiatry. 2013;5(1):30. https://doi.org/10.5455/cap.20130503
4. Centers for Disease Control and Prevention. (2017) Definitions: Self-directed violence. Retrieved from https://www.cdc.gov/violenceprevention/suicide/definitions.html .
5. Hamermesh DS, Soss NM. An Economic Theory of Suicide. Journal of Political Economy. 1974 01;82(1):83-98. https://doi.org/10.1086/260171
6. Hansen B, Lang M. Back to school blues: Seasonality of youth suicide and the academic calendar. Economics of Education Review. 2011 Oct;30(5):850-861. https://doi.org/10.1016/j.econedurev.2011.04.012
7. Souêtre E. Seasonality of suicides: environmental, sociological and biological covariations. Journal of Affective Disorders. 1987 Dec;13(3):215-225. https://doi.org/10.1016/0165-0327(87)90040-1
8. Steck N, , Egger M, Schimmelmann BG, Kupferschmid S. Suicide in adolescents: findings from the Swiss National cohort. European Child & Adolescent Psychiatry. 2017 06 29;27(1):47-56. https://doi.org/10.1007/s00787-017-1019-6
9. Volpe FM. Re: "Analyzing Seasonal Variations in Suicide With Fourier Poisson Time-Series Regression: A Registry-Based Study From Norway, 1969–2007". American Journal of Epidemiology. 2015 09 30;182(9):820.1-820. https://doi.org/10.1093/aje/kwv209
10. Wasserman D, Cheng Q, Jiang G. Global suicide rates among young people aged 15-19. World Psychiatry : Official Journal of the World Psychiatric Association (WPA) . 2005;4(2):114-20.
11. Slagter M. Grim report shows teen suicide rate at 40-year high; Washtenaw sets record. MLive. Retrieved from https://www.mlive.com/news/ann-arbor/index.ssf/2017/08/grim_report_shows_teen_suicide.html. 2017 August 30.
12. Centers for Disease Control and Prevention. (2016). Fatal

Injury Reports, National, Regional and State, 1981 – 2016. Retrievedfrom https://webappa.cdc.gov/sasweb/ncipc/mortrate.htm .

13. Maldonado G, Kraus JF. Variation in suicide occurrence by time of day, day of the week, month, and lunar phase. Suicide & Life-Threatening Behavior. 1991;21(2):174.

14. Gabennesch H. When Promises Fail: A Theory of Temporal Fluctuations in Suicide. Social Forces. 1988 09;67(1):129. https://doi.org/10.2307/2579103

15. Nazeer A. Public health aspects of suicide in children and adolescents. International Journal of Public Health. 2016;8(4):427.

16. National Institutes of Health. (2007). Retrieved from https://www.nimh.nih.gov/health/topics/suicide- prevention/index.shtml.