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Seasonality in Attempted and Completed Suicide Using Emergency Department Data

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SEASONALITY IN ATTEMPTED AND COMPLETED SUICIDE USING EMERGENCY DEPARTMENT DATA

By

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ABSTRACT

The goal of this study was to fill gaps in the literature on the consistent and significant link between seasonality and suicide, specifically with regard to recent suicide attempts and deaths in the United States. To accurately determine current seasonality trends in attempted suicide in the US a large, representative, and up-to-date sample of emergency department cases was analyzed using 2006-2011 data from the Nationwide Emergency Department Sample (NEDS) database. Hypothesis 1 stated that there would be significant seasonal differences in attempted suicide and was supported, with spring and fall peaks. Hypothesis 2 stated that there would be significant seasonal differences in deaths by suicide and was supported, but unexpectedly there was only a summer peak in deaths by suicide, but no spring or fall peaks. Hypothesis 3 stated that there would be significant differences in weekday versus weekend suicide attempt rates, and indeed there were more attempts on weekdays versus weekends. Hypothesis 4 stated that there would be significant differences in weekday versus weekend deaths by suicide, but hypothesis 4 was not supported. Hypothesis 5 stated that the magnitude in seasonal year-to-year trends in attempted suicide would decrease over time, and was supported. Hypothesis 6 stated that the magnitude in seasonal year-to-year trends in deaths by suicide would decrease over time, and was partially supported. Hypothesis 7 stated that seasonality differences for attempted suicide would persist in spite of variance explained by a diagnosis of a bipolar or depressive disorder or by income quartile, and was supported. Hypothesis 8 stated that seasonality differences for deaths by suicide would persist in spite of variance explained by a diagnosis of a bipolar or depressive disorder or by income quartile, and was supported. In general, it can be confidently asserted that seasonal effects exist. Much less confidence is given, however, to the various explanations of the mechanisms behind these effects. Further, the magnitude of seasonal effects is small compared to other factors, such as diagnosis.

CHAPTER 1

INTRODUCTION

Suicide is currently the tenth leading cause of death in the United States and kills roughly 38,000 people per year (Murphy, Xu, & Kochanek, 2013). Beyond death by suicide, approximately one million suicide attempts occur per year in the United States (Crosby, Han, Ortega, Parks, & Gfoerer, 2011) and many Americans make a suicide attempt at some time in their life, with a national lifetime prevalence of 5% (Nock et al., 2008). Approximately eight hundred thousand die by suicide per year across countries (World Health Organization, 2015). For those who experience suicidal ideation, there is a 33.6% probability that they will make suicidal plans and there is a 29.0% probability that they will make a suicide attempt (Nock et al., 2008). The ratio of deaths to attempts is estimated to be one death by suicide per 25 suicide attempts (Crosby et al., 2011).

Seasonality effects for attempted and completed suicide are marked, with significant effects persisting across samples. Christodoulou and colleagues (2012) conducted a meta-analysis of 113 studies published between 1979 and 2009. Across studies, a springtime peak was present, in addition to an autumn peak. Based on these findings it is plausible that there is an *enhanced* springtime peak compared to the autumn peak. Another feature was strong seasonal fluctuations in violent suicides. The authors believe this to be due to gender effects, given that men attempt suicide using more violent means than do women (Christodoulou et al., 2012), but explanations are lacking. In another meta-analysis using both time series and cross-sectional data for 28 countries, Chew and McCleary (1995) found evidence for a sizable spring peak in suicidal behavior. These findings represent the fairly wide body of literature on seasonality and suicide.

Although the precise mechanisms are not entirely clear, highly replicated studies have found a springtime peak in suicide (Woo, Okusaga, & Postolache, 2012). In fact, a seasonality effect for suicide has been found in numerous samples ranging from Durkheim's (1897/1951) early landmark sociological study to modern day samples including diverse locations such as Northern Australia (Preti, 2000), Finland (Hiltunen, Suominen, Lönnqvist, & Partonen, 2011), and Turkey (Doganay et al., 2003). Durkheim (1897/1951) found evidence that suicide rates were highest during the spring or early summer months and rates were lowest during the winter months.

Although the overall findings support a peak in suicidal behavior during the spring and possibly autumn, various studies take a more nuanced approach and examine additional factors. For example, seasonality effects have been shown in some studies to only persist for violent suicides and not for nonviolent suicides (e.g., Maes et al., 1993; Maes et al., 1995; Preti & Miotto, 1998). The number of weekly violent deaths by suicide compared to nonviolent deaths by suicide has been found to be significantly higher in the spring than in any other season, but no significant differences were found with regard to seasonal variation in nonviolent deaths by suicide (Maes et al., 1993). Thus, there are seasonal peaks in violence as well as number of attempts.

There are geographical effects for deaths by suicide across countries by latitude, with those closer to an absolute value of 0 degrees North or South having the lowest rates of suicide. From there, the patterns become less clear. While countries having medium distance from the equator tend to have moderate rates of suicide, some countries far from the equator have low rates of suicide (Chew & McCleary, 1995). In general, it is believed that results from the United States are moderately generalizable to other countries.

Maes and colleagues (1993) examined L-Tryptophan (a serotonin precursor) patterns across seasons and found that these patterns matched seasonal violent suicide patterns as well as seasonal depression patterns. Specifically, Maes and colleagues (1995) found that a statistically significant part of variation in L-tryptophan levels could be attributed to seasonal variation, with minimal levels in the spring. The authors also gathered information on five other amino acids, all of which had statistically significant relationships with participants' serum protein levels, leading to the conclusion that seasonal differences in protein homeostasis may explain the variability in L-tryptophan levels. A 19th century biological explanation dealt with temperature, stating that an individual needs to consume less food during warmer seasons and experiences a build-up of energy. This build-up of energy can be diverted into violent behavior, including suicide (Chew & McCleary, 1995). Researchers as early as Durkheim, argued instead that the seasonal differences in suicidal behavior could be better attributed to changes in the pace of social life (Chew & McCleary, 1995).

Other studies have examined additional covariates. In some studies a seasonality effect has been found for men but not for women (e.g., Rock, Greenberg, Hallmayer, 2003). However, some of these findings should be interpreted with caution due to the limitations. For example, in one study an interaction effect was found between gender and time of day, beyond a springtime seasonality peak (Doganay et al., 2003), suggesting that some analyses become nuanced to the point of making interpretation challenging. Additionally, this sample included 1119 suicide attempts from only one hospital in Turkey, which calls into question whether the results can be generalized.

Addressing concerns about generalizability and attempting to fill gaps in the literature on seasonality effects for suicide can help advance psychological science by increasing knowledge

about the etiology of suicidal behavior. Further, this topic could have practical implications for the implementation of care (e.g., plans to increase suicide screening could be implemented at hospitals during the late spring, early summer, and autumn months). There is a need to study both completed and attempted suicide to develop a full understanding of seasonality effects. Understanding both attempts and deaths by suicide is the focus of the present study and using emergency room data is ideal for this purpose because a large sample size can be obtained and such samples can be representative of a country. The primary focus of this study is to understand seasonality effects on suicide in the United States.

When using the search term, "seasonality United States suicide" in Google Scholar, the most recent longitudinal publication utilizing emergency department data included data from 1997-2001 (Doshi et al., 2005). Given that changes in trends have been a recent focus for research in this domain (e.g., Yip, Chao, Chiu, 2000), it makes sense for new research to update the findings of over a decade ago. Specifically, Yip and colleagues (2000) found that seasonality effects had reduced amplitude and explained a smaller proportion of variance in deaths by suicide. Though the authors note that the reasons for reduced seasonality are not entirely clear, they suggest that technological advances have led to more connectedness among people socially, which could lead to greater biosocial regulation throughout the year, thereby dampening seasonal effects.

The most recent study on *death by suicide* is slightly more up-to-date, using data from 2001-2004 (Ceccherini-Nelli & Priebe, 2011). The present study is designed to fill the gaps in the literature described above by conducting an up-to-date analysis of seasonality effects in relation to suicide attempts leading to an emergency room visit between 2006 and 2011, which would provide analysis of data nearly a decade newer than the most recent longitudinal study of

suicide attempts (Doshi et al., 2005). Further, most studies do not examine both deaths by suicide and suicide attempts in the same study. One study using data from 1997 found that suicide attempts significantly peaked in April and May compared to deaths by suicide which peaked in February and March. Interestingly, both attempts and deaths had the same day of week peaks, with 6-10% higher rates of both on Mondays and Tuesdays and 5-13% lower rates on Saturdays (Miller, Furr-Holden, Lawrence, & Weiss, 2012). Though this study examines novel research questions, it is limited by its one year approach, which can be addressed by the present study.

In this study there are four primary research questions 1) Is there a month of year seasonality effect for attempted suicides? 2) Is there a month of year seasonality effect for deaths by suicide? 3) Is there a day of week effect for attempted suicides? 4) Is there a day of week effect for deaths by suicide? The secondary research questions are 5) Are there differences in the yearly trend in attempted suicides between 2006 and 2011? 6) Are there differences in the yearly trend in deaths by suicide between 2006 and 2011? 7) Do diagnosis (of a major affective disorder) and income influence monthly trends in attempted suicide? 8) Do diagnosis (of a major affective disorder) and income influence monthly trends in deaths by suicide?

CHAPTER 2

METHODS

Participants

The total number of cases from the Nationwide Emergency Department Sample (NEDS) across years 2006 to 2011 was 167,011,415. Out of these cases, 162,707,543 had not attempted suicide and did not die, 967,721 had not attempted suicide, but died due to other causes, 1,362,878 attempted suicide but did not die, 6,259 died by suicide, and 1,967,014 were missing. Participants' identities were completely confidential and only aggregate data are reported. Participants identified as male (40%; *n* = 74,034,304) and female (60%; *n* = 90,958,256). Participants' median household incomes by national quartile by patient zipcode were as follows: Quartile 1 (2006 = $1-37,999; 2011 = $1-$38,999; 32%; *n* = 51,749,608), Quartile 2 (2006 = $38,000-$46,999; 2011 = $39,000-$47,999; 28%; *n* = 44,918,550), Quartile 3 (2006 = $47,000-$61,999; 2011 = $48,000-$63,999; 23%; *n* = 36,672,748), Quartile 4 (2006 = $62,000 or more; 2011 = $64,000 or more; 17%; *n* = 27,802,215). Participants' region of hospital was follows: Northeast (19%; *n* = 26,101,117), Midwest (22%; *n* = 29,733,223), South (42%; *n* = 56,900,874), West (17%; *n* = 23,571,986). With regard to age at admission, participants' ages ranged from 0 to 124 (*M* = 38.29, *Mdn* = 36.00, *SD* = 24.44). Of note, Alaska was not included in any of the years, but Hawaii was included in all years.

Apparatus

It is believed that the NEDS was the best choice of database for the purposes of this study. It contains data for over 950 hospitals and is designed to represent a 20-percent stratified sample of emergency department visits in the United States. The dataset is comprised of over 100 variables that include ICD-9-CM codes and other variables relevant to the purposes of this study. Both the Nationwide Inpatient Sample (NIS) and the NEDS contain emergency

department data, but only the NEDS includes emergency department visits that did not involve admission (e.g., transfer, death, left against medical advice, etc.). Thus, it is believed that the NEDS yields more representative results than the NIS, making it the superior choice. Data were purchased from the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality under protection from the FSU Institutional Review Board. A required online data use training program from the agency holding the data (HCUP Data Use Training, 2012) was completed prior to receipt of the data.

CHAPTER 3

RESULTS AND DISCUSSION

Data Management

Data in CSV format were uploaded to SPSS for the years 2006-2011. The files were then merged into a file containing all years. A separate merged file was created containing data for all years, but only cases of attempted suicide and death by suicide.

The observed data take the form of a time series, generated sequentially and discretely in time (Hilas, Goudos, & Sahalos, 2006). Each suicide event happens continuously but is measured discretely, with the smallest unit of measurement being weekday versus weekend. There are two main purposes of time series analysis. One purpose is to model and identify underlying processes, and the other purpose is to forecast future trends in the data (Hilas, Goudos, & Sahalos, 2006). The former is in line with the purposes of the present study. Autocorrelations were run for month of year to examine the past values and future values of each time series. If a system has a tendency to persist in the same state across observations, positive autocorrelation is present (Broersen, 2006). For example, tomorrow is more likely to be the same temperature as today than it is to be the same temperature as it was a few months ago. Autocorrelation is used to detect non-randomness in data, in this case seasonality effects. Rather than a correlation between two different variables, the correlation is between two observations of a single variable at two different time points. Lags are used to compute multiple autocorrelations across the series (Broersen, 2006).

Primary Analyses

Hypotheses 1. Two separate sets of autocorrelation analyses were run for attempts and deaths by suicide and are displayed in Table 1, Figure 1, Table 2, and Figure 2. In Table 1, non-randomness is apparent across the series for suicide attempts. This pattern is confirmed with the

Box-Ljung Statistic, which has a null hypothesis that the data are distributed randomly across the time series (i.e., no autocorrelation) and an alternative hypothesis that the data are distributed non-randomly across the time series (i.e., autocorrelation is present). Positive autocorrelation is present (and can be viewed in Figure 1) because the lags go beyond the positive 95% confidence interval band for random noise.

Next, a multinomial logistic regression analysis was conducted with disposition (hospitalized for natural causes and lived, death by natural causes, survived suicide attempt, death by suicide) as the outcome variable and month of year as the predictor (see Table 3). Results suggested that there were significant seasonality effects for death by natural causes compared to hospitalized for natural causes and lived and for survived suicide attempt compared to hospitalized for natural causes and lived, but not for death by suicide compared to hospitalized for natural causes and lived. More specifically, February through November had lower odds of death by natural causes compared to December in contrast to the baseline category hospitalized for natural causes and lived. For survived suicide attempt in contrast to the baseline category hospitalized for natural causes and lived, every month except February had statistically significant higher odds of attempted suicide compared to December. Further, there was a slight peak in April and a longer slight peak beginning in August-September and increasing somewhat from October-November. Thus, both a spring peak and a late-summer—fall peak appear to be present for suicide attempts. No statistical significance was present when comparing death by suicide to the baseline category hospitalized for natural causes and lived.

Hypothesis 2. In Table 2, randomness is present across the time series for deaths by suicide. This pattern is apparent by viewing the Box-Ljung statistics in Table 2. At each lag there is failure to reject the null hypothesis, leading to the conclusion that there is no evidence for

seasonal patterns in death by suicide. The data displayed in Figure 2 show randomness in the lags both above and below 0 and well-within the 95% confidence bands, supporting the previous conclusion regarding a lack of seasonal patterns in death by suicide.

As previously discussed with regard to the multinomial logistic regression model in Table 3, no statistical significance was present when comparing death by suicide to the baseline category hospitalized for natural causes and lived. However, another multinomial logistic regression analysis was conducted comparing death by suicide to a different baseline category—death by natural causes, thus yielding a more analogous comparison. Results from this analysis are presented in Table 4. These results demonstrated a July peak in the odds ratios, with a somewhat bell-shaped distribution around the center. The odds of dying by suicide compared to dying by natural causes were 55% higher in July compared to December. Relationships for January, February, March, and November were not statistically significant, but all other months had a significantly higher odds of death by suicide versus death by natural causes compared to December.

Hypothesis 3. Day of week was measured as a binary outcome variable in the present dataset as made available by the distributor of the data, with weekday being coded as *0* and weekend being coded as *1*. This measurement strategy is less than the ideal measurement strategy, which would have been to code for each day of the week. Because the predictor variable had only two outcomes, autocorrelation analyses were not run for the hypotheses regarding weekday effects.

Multinomial logistic regression analysis was conducted with day of week as the predictor variable (see Table 5). The baseline category for the dependent variable was hospitalized for natural causes and lived. The odds ratio for death by natural causes compared to hospitalized for

natural causes and lived was 1.05, indicating that there was a 5% higher odds of dying by natural causes on a weekday compared to a weekend. The odds for attempting suicide compared to being hospitalized by natural causes was 1.16, indicating there was a 16% higher odds of attempting suicide on a weekday compared to a weekend. The odds for dying by suicide compared to being hospitalized for natural causes was 1.03, but the relationship was not statistically significant (p = .35).

Hypothesis 4. Similar to the methodology used for hypothesis 2, another model was run using deaths by natural causes as the baseline comparison category for death by suicide (see Table 6). The odds ratio for hospitalized for natural causes and lived compared to death by natural causes was .96, indicating that there was a 4% lower odds of being hospitalized due to natural causes on a weekday compared to a weekend. The odds for attempting suicide compared to dying by natural causes was 1.11, indicating there was an 11% higher odds of attempting suicide on a weekday compared to a weekend. The odds for dying by suicide compared to dying by natural causes was .98, but the relationship was not statistically significant (p = .48).

Hypothesis 5. Hypothesis 5 stated that year-to-year trends would differ for attempted suicide. Month and year were recoded into a seasonal variable taking on 24 distinct values (six years' worth of four seasons). In Table 7 and Figure 3, non-randomness is present across the time series for suicide attempts. This pattern is apparent by viewing the Box-Ljung statistics in Table 7. At each lag the null hypothesis is rejected, leading to the conclusion that there is evidence for seasonal patterns in suicide attempts. The data displayed in Figure 3 show non-randomness in the lags above 0 and well outside the 95% confidence bands, supporting the previous conclusion regarding seasonal patterns in suicide attempts.

Multinomial logistic regression was conducted with hospitalized for natural causes and lived as the baseline category. Table 8 depicts the results of this analysis. There did not appear to be any graphical trends in either died by natural causes or death by suicide, despite statistical significance for died by natural causes. The comparison category of interest, attempted suicide, did display both statistical significance and a graphical trend. This graphical trend is displayed in Figure 4. As reported in previous literature, seasonal effects on attempted suicide appear to be decreasing. As the trend line increases toward an odds ratio of 1.0 the odds of attempting suicide versus being hospitalized for natural causes and living decreases in magnitude.

Hypothesis 6. In Table 9 and Figure 5, non-randomness is present across the time series for deaths by suicide. This pattern is apparent by viewing the Box-Ljung statistics in Table 9. At each lag the null hypothesis is rejected, leading to the conclusion that there is evidence for seasonal patterns in deaths by suicide. The data displayed in Figure 5 show non-randomness in the lags above 0 and well outside the 95% confidence bands, supporting the previous conclusion regarding seasonal patterns in deaths by suicide.

Next, year-to-year trends were examined for death by suicide using multinomial logistic regression analysis with death by natural causes as the baseline category, per the rationale given for the analyses present in previous hypotheses (see Table 9). For the comparison of interest added by this model, 5 seasons were trending toward significance, 8 were non-significant, and 10 were significant. Though the lack of significance tempers the usefulness of interpretations, there are graphical trends consistent with hypothesis 6 displayed in Figure 6.

Hypothesis 7. Hypothesis 7 stated that seasonality differences for attempted suicide would persist in spite of variance explained by a diagnosis of a bipolar or depressive disorder or by income quartile. The following ICD-9-CM codes (no period) were recoded into 1 *Bipolar*

Disorder: 29600 Bipolar I disorder, single manic episode, unspecified; 29601 Bipolar I disorder, single manic episode, mild; 29602 Bipolar I disorder, single manic episode, moderate; 29603 Bipolar I disorder, single manic episode, severe, without mention of psychotic behavior; 29604 Bipolar I disorder, single manic episode, severe, specified as with psychotic behavior; 29605 Bipolar I disorder, single manic episode, in partial or unspecified remission; 29606 Bipolar I disorder, single manic episode, in full remission; 29610 Manic affective disorder, recurrent episode, unspecified; 29611 Manic affective disorder, recurrent episode, mild; 29612 Manic affective disorder, recurrent episode, moderate; 29613 Manic affective disorder, recurrent episode, severe, without mention of psychotic behavior; 29614 Manic affective disorder, recurrent episode, severe, specified as with psychotic behavior; 29615 Manic affective disorder, recurrent episode, in partial or unspecified remission; 29616 Manic affective disorder, recurrent episode, in full remission; 29640 Bipolar I disorder, most recent episode (or current) manic, unspecified; 29641 Bipolar I disorder, most recent episode (or current) manic, mild; 29642 Bipolar I disorder, most recent episode (or current) manic, moderate; 29643 Bipolar I disorder, most recent episode (or current) manic, severe, without mention of psychotic behavior; 29644 Bipolar I disorder, most recent episode (or current) manic, severe, specified as with psychotic behavior; 29645 Bipolar I disorder, most recent episode (or current) manic, in partial or unspecified remission; 29646 Bipolar I disorder, most recent episode (or current) manic, in full remission; 29650 Bipolar I disorder, most recent episode (or current) depressed, unspecified; 29651 Bipolar I disorder, most recent episode (or current) depressed, mild; 29652 Bipolar I disorder, most recent episode (or current) depressed, moderate; 29653 Bipolar I disorder, most recent episode (or current) depressed, severe, without mention of psychotic behavior; 29654 Bipolar I disorder, most recent episode (or current) depressed, severe, specified as with psychotic

behavior; 29655 Bipolar I disorder, most recent episode (or current) depressed, in partial or unspecified remission; 29656 Bipolar I disorder, most recent episode (or current) depressed, in full remission; 29660 Bipolar I disorder, most recent episode (or current) mixed, unspecified; 29661 Bipolar I disorder, most recent episode (or current) mixed, mild; 29662 Bipolar I disorder, most recent episode (or current) mixed, moderate; 29663 Bipolar I disorder, most recent episode (or current) mixed, severe, without mention of psychotic behavior; 29664 Bipolar I disorder, most recent episode (or current) mixed, severe, specified as with psychotic behavior; 29665 Bipolar I disorder, most recent episode (or current) mixed, in partial or unspecified remission; 29666 Bipolar I disorder, most recent episode (or current) mixed, in full remission; 2967 Bipolar I disorder, most recent episode (or current) unspecified; 29680 Bipolar disorder, unspecified; 29681 Atypical manic disorder; 29682 Atypical depressive disorder; and 29689 Other bipolar disorders. The following ICD-9-CM codes (no period) were recoded as 2 *Depressive Disorder*: 29620 Major depressive affective disorder, single episode, unspecified; 29621 Major depressive affective disorder, single episode, mild; 29622 Major depressive affective disorder, single episode, moderate; 29623 Major depressive affective disorder, single episode, severe, without mention of psychotic behavior; 29624 Major depressive affective disorder, single episode, severe, specified as with psychotic behavior; 29625 Major depressive affective disorder, single episode, in partial or unspecified remission; 29626 Major depressive affective disorder, single episode, in full remission; 29630 Major depressive affective disorder, recurrent episode, unspecified; 29631 Major depressive affective disorder, recurrent episode, mild; 29632 Major depressive affective disorder, recurrent episode, moderate; 29633 Major depressive affective disorder, recurrent episode, severe, without mention of psychotic behavior; 29634 Major depressive affective disorder, recurrent episode, severe, specified as with psychotic behavior;

29635 Major depressive affective disorder, recurrent episode, in partial or unspecified remission; 29636 Major depressive affective disorder, recurrent episode, in full remission; 3004 Dysthymic disorder; 311 Depressive disorder, not elsewhere classified. All other ICD-9-CM primary diagnosis codes were recoded into 3 *Other*.

This coding scheme yielded .2% of the sample for this model identified as having a primary diagnosis of *Bipolar Disorder* (*n* = 328,454), .6% of the sample identified as having a primary diagnosis of *Depressive Disorder* (*n* = 850,143), and 99.1% of the sample identified as having a primary diagnosis of *Other* (*n* = 130,588,476). This model had the following distribution for income quartile: Quartile 1 (2006 = $1-37,999; 2011 = $1-$38,999; 32%; *n* = 41,786,117), Quartile 2 (2006 = $38,000-$46,999; 2011 = $39,000-$47,999; 27%; *n* = 36,072,318), Quartile 3 (2006 = $47,000-$61,999; 2011 = $48,000-$63,999; 23%; *n* = 29,913,922), Quartile 4 (2006 = $62,000 or more; 2011 = $64,000 or more; 18%; *n* = 23,994,716).

Results from a multinomial logistic regression analysis with hospitalized due to natural causes and lived as the baseline category with diagnosis and income as covariates is displayed in Table 11. Results suggested that there were significant seasonality effects for death by natural causes compared to hospitalized for natural causes and lived and for survived suicide attempt compared to hospitalized for natural causes and lived, but not significant for death by suicide compared to hospitalized for natural causes and lived. More specifically, February through November had lower odds of death by natural causes compared to December in contrast to the baseline category hospitalized for natural causes and lived. For survived suicide attempt in contrast to the baseline category hospitalized for natural causes and lived, every month except February had statistically significant higher odds of attempted suicide compared to December.

Further, there was a slight peak in April and a longer slight peak beginning in August-September and increasing somewhat from October-November. Thus, both a spring peak and a late-summer—fall peak appear to be present for suicide attempts. No statistical significance was present when comparing death by suicide to the baseline category hospitalized for natural causes and lived. These results are exactly analogous to those found for hypothesis 1, persisting in spite of covariates being included in the model. However, the covariates were both highly statistically significant and diagnosis in particular had very large odds ratios. For suicide attempts compared to the baseline category, Bipolar disorder compared to Other disorder had a 59.82 higher odds of attempting suicide. Depressive disorder compared to Other disorder had a 103.77 higher odds of attempting suicide. Those in income quartile 1 had a 1.01 higher odds of attempting suicide compared to those in income quartile 4, those in income quartile 2 had a 1.04 higher odds of attempting suicide compared to those in income quartile 4, and those in income quartile 3 had a 1.04 higher odds of attempting suicide compared to those in income quartile 4.

Hypothesis 8. Hypothesis 8 stated that seasonality differences for deaths by suicide would persist in spite of variance explained by a diagnosis of a bipolar or depressive disorder or by income quartile. Results from a multinomial logistic regression analysis with deaths by suicide as the baseline category with diagnosis and income as covariates is displayed in Table 12. Results suggested that there were significant seasonality effects for hospitalized for natural causes and lived compared to deaths from natural causes and for survived suicide attempt compared to deaths from natural causes, as well as significant for death by suicide compared to deaths from natural causes. For the primary comparison of interest, death by suicide compared to death by natural causes, January, February, and March were non-significant, with March trending toward significance ($p = .08$). There was a peak in the odds ratio in July ($OR = 1.38$),

with a somewhat bell-shaped distribution in the odds ratios in the other months, with July at the center. Thus, a summer peak appears to be present for deaths by suicide. These results are analogous to those found for hypothesis 2, persisting in spite of covariates being included in the model. However, the diagnosis variables were both highly statistically significant and had very large odds ratios, while income had mixed results. For suicide attempts compared to the baseline category, Bipolar disorder compared to Other disorder had a 46.17 higher odds of dying by suicide. Depressive disorder compared to Other disorder had a 134.69 higher odds of dying by suicide. Those in income quartile 1 did not have significantly higher odds of dying by suicide compared to those in income quartile 4, those in income quartile 2 had a 1.08 higher odds of dying by suicide compared to those in income quartile 4 trending toward significance ($p = .07$), and those in income quartile 3 had a 1.11 higher odds of dying by suicide compared to those in income quartile 4.

Discussion

This study informs understanding about seasonal effects on suicide in the United States. While the exact mechanisms behind expected seasonal effects are largely unknown, it is known that those effects persist across numerous samples (Chew & McCleary, 1995; Woo et al., 2012). Recent research has suggested that the longstanding springtime peak in suicidal behavior may be decreasing in magnitude. A current and comprehensive longitudinal study in the United States is lacking, however. With regard to attempted suicide and self-inflicted injury, this study fills that gap by analyzing data up to 9 years more recent than the data used in comparable analyses in the literature (e.g., Doshi et al., 2005). A major strength of this study is the massive sample size of emergency room visits due to suicide attempts and self-inflicted injuries. With weighting implemented for this sample of 1,362,878 cases, results can be generalized to provide national

estimates for the time period 2006-2011 (HCUP-US NEDS Overview, 2012). The study has good generalizability to the United States, and the study is believed to be moderately generalizable to other countries. Thus, this study has the potential to contribute to psychological science by providing an understanding of current trends in seasonal effects on suicide.

Limitations

The contributions of this study are limited by several factors. One limitation is that the data do not include people who died by suicide who did not have contact with an emergency department, nor does the sample include those who made a suicide attempt but did not have contact with the emergency department. Thus, the sample might not be representative because it excludes an unknown proportion of deaths by suicide and excludes less serious suicide attempts. Thus, violent deaths are likely to be underestimated and violent attempts are likely to be overestimated. Further, the bias for deaths by suicide is likely to be greater than for suicide attempts.

Findings and Implications

The findings for hypothesis 1 supported significant monthly trends in suicide attempts with both a spring peak and a late-summer—fall peak. Thus, results were as expected, except for the fall peak beginning somewhat earlier than previously believed. Indeed, based on the literature it seemed plausible that there is an enhanced springtime peak, but these findings suggested instead an enhanced autumn peak. Interestingly, opposite effects were found with regard to natural deaths compared to being hospitalized for natural causes, suggesting that seasonal effects are indeed specific to suicide attempts. The findings for hypothesis 2 supported seasonal effects for deaths by suicide compared to deaths by natural causes, but the peak was unexpectedly only in the summer, not in the spring or fall. It is not clear why there is only a summer peak, but the

findings lend some support to the previously discussed theory that temperature drives violent behavior.

The results for hypothesis 3 and 4 regarding weekday and weekend effects point to the clinical utility in conducting suicide risk check-ins during the week to prevent suicide attempts compared to weekends. This clinical policy is fairly easy to implement and could reduce the odds of making a suicide attempt for at risk patients. Therapists have some flexibility in choosing when to schedule risk check-ins with their clients. Therefore, this finding provides actionable information that could prevent pain and suffering. However, it does not appear that there is a difference between weekend and weekday for deaths by suicide.

The results for hypothesis 5 confirmed that seasonal effects in attempted suicide appear to be decreasing in magnitude (as can be seen starkly in Figure 4). Previously discussed reasons for this appeal to the social theory of seasonal effects. The idea states that technology and social media have normalized human interactions throughout the seasons, and thereby explain why the magnitude in seasonality effects is decreasing (Yip et al., 2000). The results for hypothesis 6 were partially supportive of a decreasing magnitude in seasonal effects on death by suicide, but lacked consistent statistical significance. In Figure 6, it is noteworthy that there are graphical summer peaks in death by suicide throughout the series, in further support of the unusual findings for hypothesis 2.

The findings for hypotheses 7 and 8 suggested massive effects for bipolar disorders and depressive disorders, as well as small effects for income. More specifically, depressive disorders outranked bipolar disorders with roughly double the odds for suicide attempts and deaths by suicide. For income, all categories had a higher odds of death by suicide than those in the highest income quartile, suggesting that quality of care matters for suicidal behavior as an outcome. It is

worth noting that the odds ratio for depressive disorders is roughly 1000 times the size of the largest income odds ratio. In spite of the effect of these covariates, results were virtually identical to results for hypotheses 1 and 2. Another important implication is that while there is utility in studying seasonality effects, mental disorders explain far more of the variance in suicidal behavior.

In summary, the hypotheses in this study were mostly supportive of lending evidence in favor of seasonal effects on attempted suicide and death by suicide. The limitations that arose from using a secondary data source were tempered by certain advantages such as the extremely large sample size and generalizability. In general, it can be confidently asserted that seasonal effects exist. Much less confidence is given, however, to the various explanations of the mechanisms behind these effects. Theories that attempt to explain these mechanisms have testability issues. More focus is needed on advancing methodology that could be used to test competing theories in this domain.

APPENDIX A

TABLES AND FIGURES

Table 1.

ACF Analysis for Monthly Suicide Attempts

Series: Admission Month; Attempts

Lag	Autocorrelation	Std. Error	Box-Ljung Statistic Value	df	Sig.
1	.009	.001	98.159	1	<.001
2	.012	.001	257.123	2	<.001
3	.007	.001	313.771	3	<.001
4	.010	.001	440.929	4	<.001
5	.007	.001	503.064	5	<.001
6	.008	.001	579.000	6	<.001
7	.007	.001	633.417	7	<.001
8	.008	.001	701.150	8	<.001
9	.007	.001	762.068	9	<.001
10	.009	.001	852.030	10	<.001
11	.009	.001	940.176	11	<.001
12	.009	.001	1043.650	12	<.001

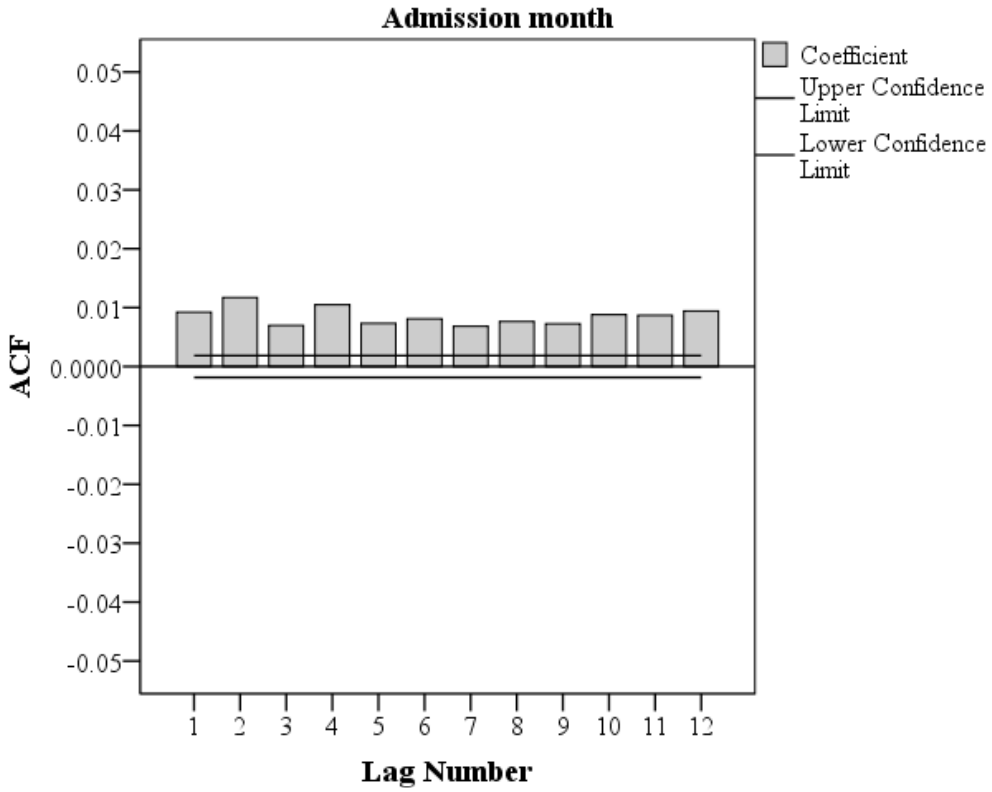

Figure 1. ACF Analysis Graphical Display for Monthly Suicide Attempts

Table 2.
ACF Analysis for Monthly Deaths by Suicide

Lag	Autocorrelation	Std. Error	Box-Ljung Statistic Value	df	Sig.
1	.007	.014	.272	1	.602
2	-.005	.013	.396	2	.820
3	.004	.013	.471	3	.925
4	.019	.013	2.489	4	.647
5	-.015	.013	3.750	5	.586
6	-.006	.013	3.975	6	.680
7	-.016	.013	5.549	7	.593
8	.014	.013	6.745	8	.564
9	.002	.013	6.779	9	.660
10	-.004	.013	6.884	10	.736
11	.003	.013	6.925	11	.805
12	-.002	.013	6.943	12	.861

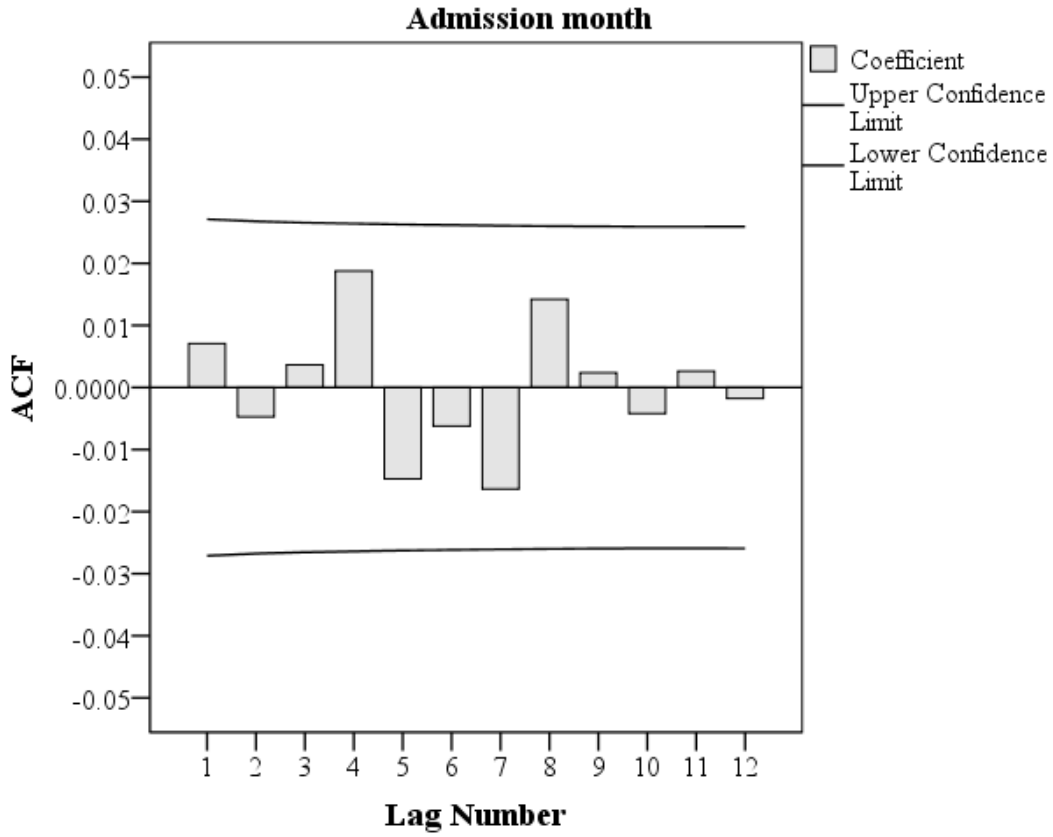

Figure 2. ACF Analysis Graphical Display for Monthly Deaths by Suicide

Table 3.
Multinomial Logistic Regression Analysis for Hypothesis 1

Outcome and Intent		OR	95% CI for OR Lower Bound	95% CI for OR Upper Bound	*p*
Death by natural causes	Intercept				<.001
	January	1.02	1.01	1.03	<.001
	February	.99	.98	1.00	.008
	March	.94	.93	.95	<.001
	April	.89	.88	.90	<.001
	May	.82	.81	.83	<.001
	June	.80	.79	.81	<.001
	July	.79	.78	.80	<.001
	August	.78	.77	.79	<.001
	September	.79	.78	.80	<.001
	October	.85	.84	.86	<.001
	November	.91	.90	.92	<.001
	December	.	.	.	.
Suicide attempt survivors	Intercept				<.001
	January	1.02	1.01	1.02	.001
	February	.97	.96	.98	<.001
	March	1.04	1.03	1.05	<.001
	April	1.06	1.05	1.07	<.001
	May	1.04	1.03	1.05	<.001
	June	1.03	1.02	1.04	<.001
	July	1.04	1.03	1.04	<.001
	August	1.06	1.05	1.07	<.001
	September	1.06	1.05	1.07	<.001
	October	1.08	1.07	1.09	<.001
	November	1.07	1.06	1.08	<.001
	December	.	.	.	.
Death by suicide	Intercept				<.001
	January	.96	.84	1.10	.581
	February	.90	.79	1.04	.159
	March	1.05	.92	1.19	.511
	April	1.05	.92	1.20	.455
	May	.99	.86	1.13	.855
	June	1.02	.89	1.16	.799
	July	1.07	.94	1.22	.292
	August	1.00	.88	1.15	.972
	September	1.02	.89	1.17	.776
	October	1.03	.90	1.18	.636

Table 3—continued

Outcome and Intent	OR	95% CI for OR Lower Bound	95% CI for OR Upper Bound	*p*
November	1.04	.91	1.19	.603
December	.	.	.	.

Note: The reference categories are: hospitalized for natural causes and lived; December

Table 4

Multinomial Logistic Regression Analysis for Hypothesis 2

Outcome and Intent		OR	95% CI for OR Lower Bound	95% CI for OR Upper Bound	*p*
Hospitalized for natural causes and lived	Intercept				<.001
	January	.98	.97	.99	<.001
	February	1.01	1.00	1.03	.008
	March	1.07	1.05	1.08	<.001
	April	1.13	1.12	1.14	<.001
	May	1.21	1.20	1.23	<.001
	June	1.25	1.23	1.26	<.001
	July	1.27	1.25	1.28	<.001
	August	1.28	1.27	1.29	<.001
	September	1.26	1.25	1.28	<.001
	October	1.17	1.16	1.18	<.001
	November	1.10	1.08	1.11	<.001
	December	.	.	.	.
Suicide attempt survivors	Intercept				<.001
	January	1.00	.98	1.01	.520
	February	.99	.97	1.00	.053
	March	1.10	1.09	1.12	<.001
	April	1.20	1.18	1.21	<.001
	May	1.26	1.24	1.28	<.001
	June	1.28	1.27	1.30	<.001
	July	1.31	1.29	1.33	<.001
	August	1.36	1.34	1.38	<.001
	September	1.33	1.32	1.35	<.001
	October	1.27	1.25	1.28	<.001
	November	1.17	1.16	1.19	<.001
	December	.	.	.	.
Death by suicide	Intercept				<.001
	January	.94	.82	1.08	.404
	February	.92	.80	1.06	.226
	March	1.11	.98	1.27	.112
	April	1.19	1.04	1.36	.013
	May	1.20	1.05	1.37	.008
	June	1.27	1.11	1.45	.001
	July	1.36	1.19	1.55	<.001
	August	1.28	1.12	1.47	<.001
	September	1.29	1.13	1.47	<.001
	October	1.21	1.06	1.38	.005

Table 4—continued

Outcome and Intent	*OR*	95% CI for OR Lower Bound	95% CI for OR Upper Bound	*p*
November	1.13	.99	1.30	.067
December	.	.	.	.

Note: The reference categories are: death by natural causes; December

Table 5

Multinomial Logistic Regression Analysis for Hypothesis 3

Outcome and Intent		OR	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
Death by natural causes	Intercept				<.001
	Weekday	1.05	1.04	1.05	<.001
	Weekend	--	--	--	--
Survived suicide attempt	Intercept				<.001
	Weekday	1.16	1.16	1.17	<.001
	Weekend	--	--	--	--
Death by suicide	Intercept				<.001
	Weekday	1.03	.97	1.08	.35
	Weekend	--	--	--	--

Note: The reference categories are: hospitalized for natural causes and lived; Weekend

Table 6

Multinomial Logistic Regression Analysis for Hypothesis 4

Outcome and Intent		OR	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
Hospitalized for natural causes and lived	Intercept				<.001
	Weekday	.96	.95	.96	<.001
	Weekend	--	--	--	--
Survived suicide attempt	Intercept				<.001
	Weekday	1.11	1.11	1.12	<.001
	Weekend	--	--	--	--
Death by suicide	Intercept				<.001
	Weekday	.98	.93	1.04	.48
	Weekend	--	--	--	--

Note: The reference categories are: death by natural causes; Weekend

Table 7

Year to Year ACF Analysis for Suicide Attempts

		Std.	Box-Ljung Statistic		
Lag	Autocorrelation	Error	Value	df	Sig.
1	.971	.001	1093777.422	1	<.001
2	.971	.001	2187156.901	2	<.001
3	.970	.001	3279749.117	3	<.001
4	.970	.001	4371901.816	4	<.001
5	.969	.001	5463342.468	5	<.001
6	.969	.001	6554264.453	6	<.001
7	.969	.001	7644559.041	7	<.001
8	.968	.001	8734300.463	8	<.001
9	.968	.001	9823430.804	9	<.001
10	.967	.001	10912093.655	10	<.001
11	.967	.001	12000221.966	11	<.001
12	.966	.001	13087806.956	12	<.001
13	.966	.001	14174748.902	13	<.001
14	.966	.001	15261175.455	14	<.001
15	.965	.001	16347071.141	15	<.001
16	.965	.001	17432383.449	16	<.001
17	.964	.001	18517037.373	17	<.001
18	.964	.001	19601232.775	18	<.001
19	.963	.001	20684930.631	19	<.001
20	.963	.001	21768078.434	20	<.001
21	.963	.001	22850635.575	21	<.001
22	.962	.001	23932641.887	22	<.001
23	.962	.001	25014219.205	23	<.001
24	.961	.001	26095143.172	24	<.001

Note: The underlying process assumed is independence (white noise). Based on the asymptotic chi-square approximation.

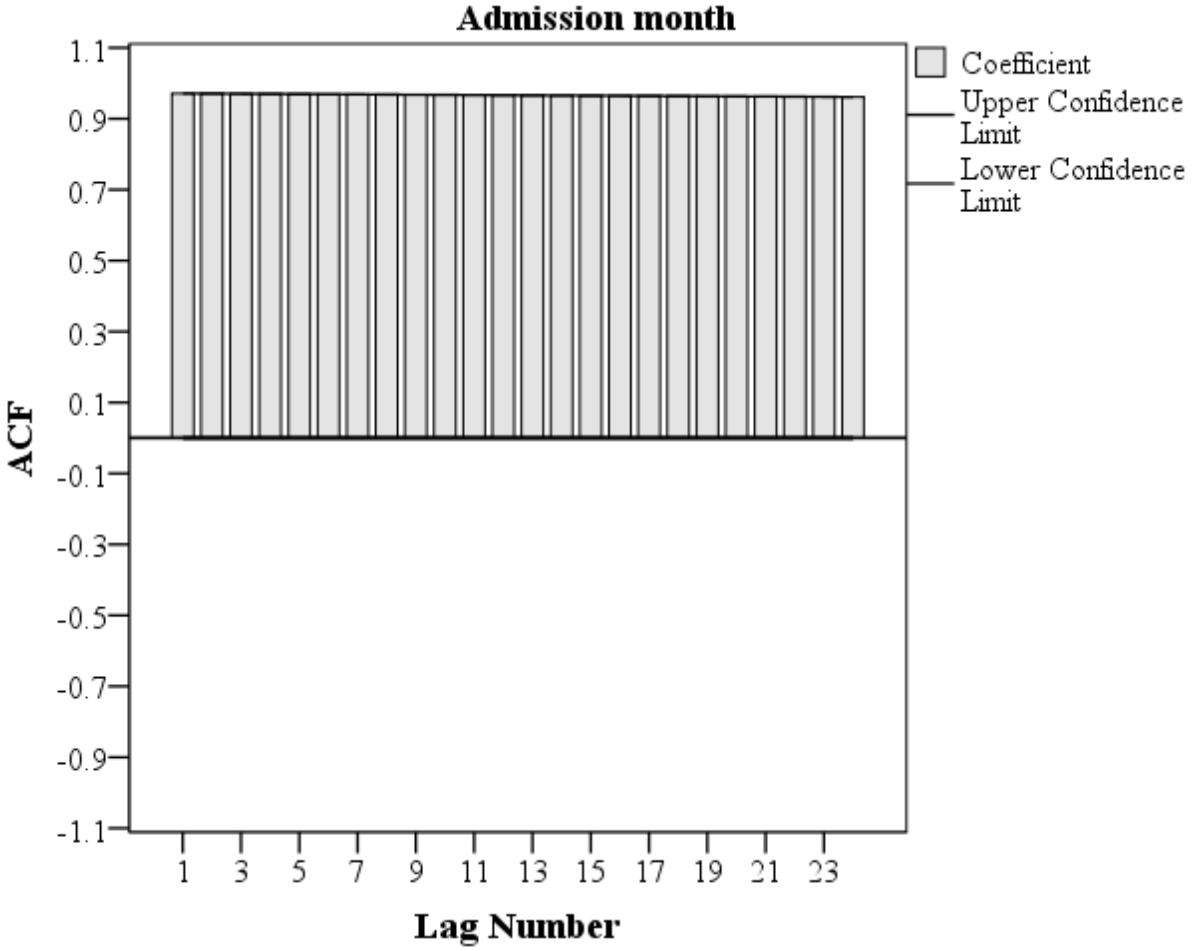

Figure 3. Year to Year ACF Analysis Graphical Display for Suicide Attempts.

Table 8
Multinomial Logistic Regression Analysis for Hypothesis 5

			95% Confidence Interval for Exp(B)		
Outcome		Exp(B)	Lower Bound	Upper Bound	Sig.
Died by natural causes	Intercept				<.001
	Winter 2006	1.302	1.282	1.322	<.001
	Spring 2006	1.118	1.101	1.136	<.001
	Summer 2006	1.073	1.056	1.090	<.001
	Fall 2006	1.231	1.212	1.251	<.001
	Winter 2007	1.295	1.275	1.314	<.001
	Spring 2007	1.138	1.120	1.155	<.001
	Summer 2007	1.042	1.026	1.059	<.001
	Fall 2007	1.194	1.176	1.212	<.001
	Winter 2008	1.278	1.260	1.297	<.001

Table 8—continued

Outcome		Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
	Spring 2008	1.071	1.055	1.088	<.001
	Summer 2008	1.003	.988	1.019	.675
	Fall 2008	1.182	1.165	1.200	<.001
	Winter 2009	1.174	1.157	1.192	<.001
	Spring 2009	.993	.978	1.008	.359
	Summer 2009	.950	.936	.965	<.001
	Fall 2009	1.147	1.130	1.164	<.001
	Winter 2010	1.164	1.147	1.182	<.001
	Spring 2010	.986	.970	1.001	.066
	Summer 2010	.935	.920	.950	<.001
	Fall 2010	1.109	1.092	1.126	<.001
	Winter 2011	1.092	1.076	1.109	<.001
	Spring 2011	.938	.923	.953	<.001
	Summer 2011	.869	.856	.883	<.001
	Fall 2011	.	.	.	.
Attempted Suicide	Intercept				<.001
	Winter 2006	.694	.684	.703	<.001
	Spring 2006	.742	.732	.752	<.001
	Summer 2006	.764	.754	.774	<.001
	Fall 2006	.771	.761	.782	<.001
	Winter 2007	.750	.740	.759	<.001
	Spring 2007	.797	.787	.807	<.001
	Summer 2007	.804	.794	.814	<.001
	Fall 2007	.809	.799	.820	<.001
	Winter 2008	.866	.855	.876	<.001
	Spring 2008	.910	.899	.921	<.001
	Summer 2008	.911	.900	.922	<.001
	Fall 2008	.904	.893	.915	<.001
	Winter 2009	.902	.891	.913	<.001
	Spring 2009	.910	.899	.921	<.001
	Summer 2009	.919	.908	.930	<.001
	Fall 2009	.903	.892	.914	<.001
	Winter 2010	.977	.965	.989	<.001

Table 8—continued

Outcome		Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
	Spring 2010	.959	.948	.970	<.001
	Summer 2010	.957	.946	.969	<.001
	Fall 2010	.970	.959	.982	<.001
	Winter 2011	.945	.934	.956	<.001
	Spring 2011	.991	.979	1.003	.128
	Summer 2011	.997	.985	1.008	.566
	Fall 2011	.	.	.	.
Died by suicide	Intercept				<.001
	Winter 2006	.783	.637	.962	.020
	Spring 2006	.898	.737	1.094	.287
	Summer 2006	.874	.716	1.066	.183
	Fall 2006	.885	.725	1.080	.229
	Winter 2007	.861	.707	1.048	.135
	Spring 2007	.947	.782	1.147	.575
	Summer 2007	.883	.729	1.070	.206
	Fall 2007	.948	.784	1.146	.583
	Winter 2008	.955	.795	1.149	.628
	Spring 2008	1.014	.845	1.218	.879
	Summer 2008	1.104	.924	1.319	.276
	Fall 2008	.964	.800	1.161	.698
	Winter 2009	.953	.791	1.148	.612
	Spring 2009	.873	.724	1.054	.157
	Summer 2009	.960	.799	1.153	.661
	Fall 2009	.966	.804	1.160	.710
	Winter 2010	1.140	.954	1.363	.149
	Spring 2010	1.165	.978	1.388	.088
	Summer 2010	1.185	.995	1.410	.057
	Fall 2010	1.166	.977	1.391	.089
	Winter 2011	.932	.774	1.121	.455
	Spring 2011	1.006	.839	1.206	.949
	Summer 2011	.964	.803	1.157	.692

Table 8—continued

Outcome	Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
Fall 2011	.	.	.	.

Note: The reference category is: hospitalized for natural causes and lived.

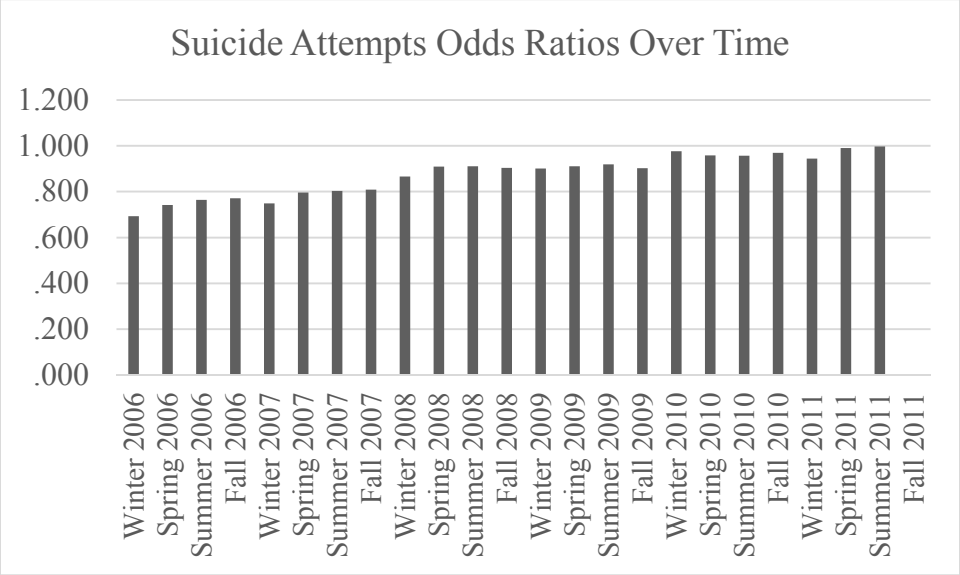

Figure 4. Graphical Display of Odds Ratios in Suicide Attempts Year by Year.

Table 9
Year to Year ACF Analysis for Deaths by Suicide

		Std.	Box-Ljung Statistic		
Lag	Autocorrelation	Error	Value	df	Sig.
1	.924	.014	4644.363	1	<.001
2	.894	.013	9109.748	2	<.001
3	.879	.013	13496.158	3	<.001
4	.869	.013	17831.502	4	<.001
5	.860	.013	22117.066	5	<.001
6	.854	.013	26374.331	6	<.001
7	.847	.013	30597.161	7	<.001
8	.841	.013	34781.980	8	<.001
9	.837	.013	38941.371	9	<.001
10	.834	.013	43089.924	10	<.001
11	.834	.013	47232.846	11	<.001
12	.836	.013	51389.029	12	<.001
13	.835	.013	55541.770	13	<.001
14	.835	.013	59699.416	14	<.001
15	.832	.013	63840.462	15	<.001
16	.833	.013	67987.942	16	<.001
17	.831	.013	72108.798	17	<.001
18	.829	.013	76223.212	18	<.001
19	.827	.013	80326.518	19	<.001
20	.822	.013	84385.927	20	<.001
21	.822	.013	88445.925	21	<.001
22	.821	.013	92502.539	22	<.001
23	.818	.013	96538.683	23	<.001
24	.815	.013	100556.558	24	<.001

Note: The underlying process assumed is independence (white noise). Significance is based on the asymptotic chi-square approximation.

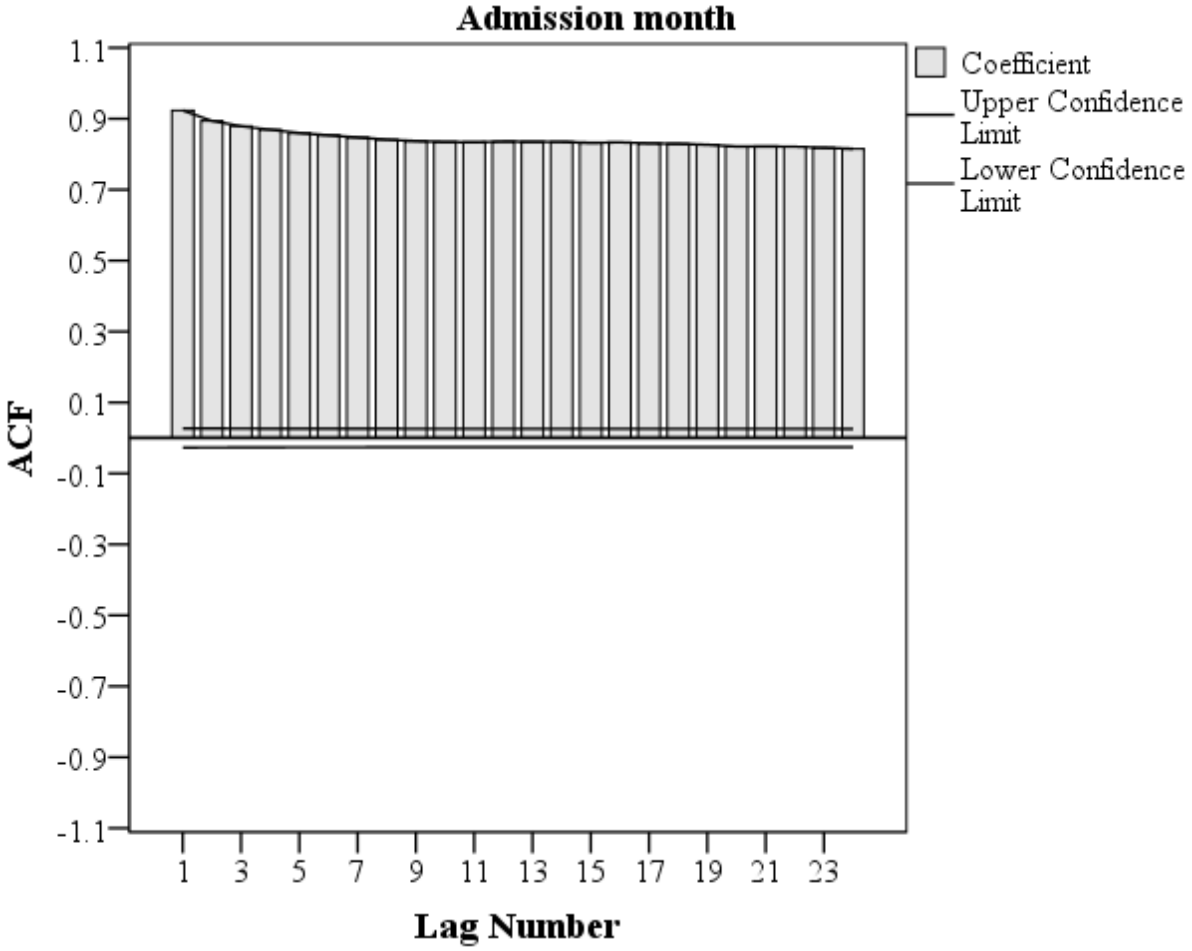

Figure 5. Year to Year ACF Analysis Graphical Display for Deaths by Suicide.

Table 10

Multinomial Logistic Regression Analysis for Hypothesis 6

			95% Confidence Interval for Exp(B)		
Outcome		Exp(B)	Lower Bound	Upper Bound	Sig.
Died by natural causes	Intercept				<.001
	Winter 2006	.768	.756	.780	<.001
	Spring 2006	.894	.880	.908	<.001
	Summer 2006	.932	.917	.947	<.001
	Fall 2006	.812	.800	.825	<.001
	Winter 2007	.772	.761	.784	<.001
	Spring 2007	.879	.865	.893	<.001
	Summer 2007	.959	.945	.975	<.001

Table 10—continued

Outcome		Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
	Fall 2007	.838	.825	.851	<.001
	Winter 2008	.782	.771	.794	<.001
	Spring 2008	.934	.919	.948	<.001
	Summer 2008	.997	.981	1.012	.675
	Fall 2008	.846	.833	.859	<.001
	Winter 2009	.851	.839	.864	<.001
	Spring 2009	1.007	.992	1.023	.359
	Summer 2009	1.052	1.036	1.069	<.001
	Fall 2009	.872	.859	.885	<.001
	Winter 2010	.859	.846	.872	<.001
	Spring 2010	1.015	.999	1.031	.066
	Summer 2010	1.069	1.053	1.086	<.001
	Fall 2010	.902	.888	.916	<.001
	Winter 2011	.916	.902	.930	<.001
	Spring 2011	1.066	1.049	1.083	<.001
	Summer 2011	1.150	1.132	1.169	<.001
	Fall 2011	.	.	.	.
Attempted Suicide	Intercept				<.001
	Winter 2006	.533	.522	.544	<.001
	Spring 2006	.664	.650	.677	<.001
	Summer 2006	.712	.697	.727	<.001
	Fall 2006	.626	.614	.639	<.001
	Winter 2007	.579	.568	.591	<.001
	Spring 2007	.700	.686	.715	<.001
	Summer 2007	.771	.756	.787	<.001
	Fall 2007	.678	.665	.692	<.001
	Winter 2008	.677	.664	.690	<.001

Table 10—continued

Outcome		Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
	Spring 2008	.849	.833	.866	<.001
	Summer 2008	.908	.891	.926	<.001
	Fall 2008	.765	.750	.780	<.001
	Winter 2009	.768	.753	.783	<.001
	Spring 2009	.917	.899	.935	<.001
	Summer 2009	.967	.948	.986	.001
	Fall 2009	.787	.773	.803	<.001
	Winter 2010	.839	.823	.855	<.001
	Spring 2010	.973	.954	.992	.006
	Summer 2010	1.024	1.004	1.044	.018
	Fall 2010	.875	.858	.892	<.001
	Winter 2011	.865	.849	.882	<.001
	Spring 2011	1.056	1.036	1.077	<.001
	Summer 2011	1.146	1.124	1.169	<.001
	Fall 2011	.	.	.	.
Died by suicide	Intercept				<.001
	Winter 2006	.601	.489	.740	<.001
	Spring 2006	.803	.659	.979	.030
	Summer 2006	.814	.667	.994	.043
	Fall 2006	.719	.589	.878	.001
	Winter 2007	.665	.546	.810	<.001
	Spring 2007	.832	.687	1.009	.061
	Summer 2007	.848	.699	1.028	.093
	Fall 2007	.794	.657	.961	.018
	Winter 2008	.748	.621	.899	.002
	Spring 2008	.947	.788	1.138	.561

Table 10—continued

Outcome		Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
	Summer 2008	1.100	.920	1.316	.294
	Fall 2008	.815	.676	.983	.032
	Winter 2009	.811	.673	.978	.028
	Spring 2009	.880	.729	1.062	.182
	Summer 2009	1.010	.841	1.214	.916
	Fall 2009	.842	.701	1.013	.068
	Winter 2010	.979	.819	1.171	.820
	Spring 2010	1.182	.991	1.409	.063
	Summer 2010	1.267	1.064	1.509	.008
	Fall 2010	1.051	.881	1.256	.579
	Winter 2011	.853	.708	1.028	.094
	Spring 2011	1.072	.894	1.287	.452
	Summer 2011	1.109	.923	1.332	.270
	Fall 2011	.	.	.	.

Note: The reference category is: Deaths by natural causes

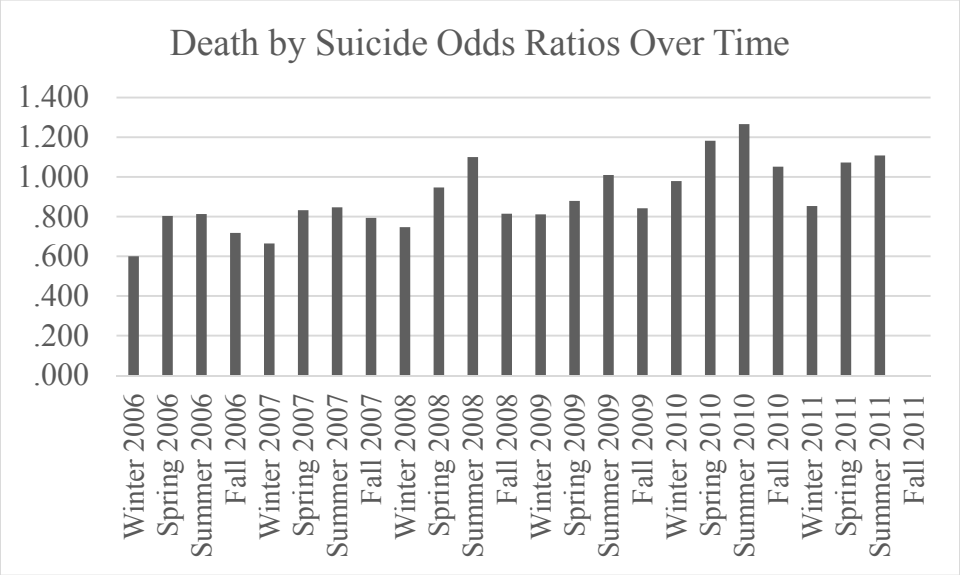

Figure 6. Graphical Display of Odds Ratios in Deaths by Suicide Year by Year. Note the summer peaks each year in the odds ratios.

Table 11

Multinomial Logistic Regression Analysis for Hypothesis 7

Outcome		Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
Death by natural causes	Intercept				<.001
	January	1.022	1.011	1.032	<.001
	February	.987	.977	.997	.013
	March	.941	.931	.951	<.001
	April	.888	.879	.898	<.001
	May	.824	.815	.833	<.001
	June	.803	.794	.812	<.001
	July	.792	.783	.801	<.001
	August	.784	.776	.793	<.001
	September	.794	.786	.803	<.001
	October	.855	.846	.865	<.001
	November	.916	.906	.926	<.001
	December	.	.	.	.
	Bipolar Disorder	.034	.026	.044	<.001
	Depressive Disorder	.030	.024	.036	<.001
	Other	.	.	.	.
	Income 1	.697	.693	.701	<.001
	Income 2	.751	.746	.756	<.001
	Income 3	.832	.827	.838	<.001
	Income 4	.	.	.	.
Suicide attempt	Intercept				<.001
	January	1.006	.996	1.016	.262
	February	.976	.966	.987	<.001
	March	1.025	1.014	1.035	<.001
	April	1.047	1.036	1.058	<.001
	May	1.031	1.020	1.041	<.001
	June	1.029	1.019	1.040	<.001
	July	1.039	1.028	1.049	<.001
	August	1.057	1.047	1.068	<.001
	September	1.050	1.040	1.061	<.001
	October	1.064	1.053	1.075	<.001
	November	1.056	1.045	1.067	<.001
	December	.	.	.	.

Table 11—continued

Outcome		Exp(B)	95% Confidence Interval for Exp(B) Lower Bound	Upper Bound	Sig.
	Bipolar Disorder	59.824	59.318	60.334	<.001
	Depressive Disorder	103.771	103.242	104.303	<.001
	Other	.	.	.	.
	Income 1	1.009	1.002	1.015	.007
	Income 2	1.036	1.029	1.042	<.001
	Income 3	1.044	1.038	1.051	<.001
	Income 4	.	.	.	.
Death by suicide	Intercept				<.001
	January	.984	.856	1.132	.826
	February	.937	.813	1.081	.375
	March	1.062	.927	1.217	.383
	April	1.080	.942	1.238	.271
	May	1.009	.880	1.157	.899
	June	1.018	.887	1.169	.798
	July	1.091	.953	1.248	.207
	August	1.021	.890	1.171	.766
	September	1.037	.904	1.189	.605
	October	1.050	.917	1.204	.479
	November	1.049	.913	1.204	.500
	December	.	.	.	.
	Bipolar Disorder	1.554	.936	2.579	.088
	Depressive Disorder	3.983	3.215	4.936	<.001
	Other	.	.	.	.
	Income 1	.706	.651	.765	<.001
	Income 2	.810	.748	.878	<.001
	Income 3	.927	.855	1.006	.069
	Income 4	.	.	.	.

Note: The reference category is hospitalized for natural causes and lived. Reference categories for other variables are as follows: Month (December), Diagnosis (Other), Income (Quartile 4).

Table 12

Multinomial Logistic Regression Analysis for Hypothesis 8

Outcome		Exp(B)	95% Confidence Interval for Exp(B)		Sig.
			Lower Bound	Upper Bound	
Hospitalized for natural causes and lived	Intercept				<.001
	January	0.979	0.969	0.989	<.001
	February	1.013	1.003	1.024	0.013
	March	1.063	1.052	1.074	<.001
	April	1.126	1.114	1.138	<.001
	May	1.214	1.201	1.227	<.001
	June	1.245	1.232	1.259	<.001
	July	1.263	1.249	1.276	<.001
	August	1.275	1.261	1.289	<.001
	September	1.259	1.245	1.273	<.001
	October	1.169	1.157	1.181	<.001
	November	1.092	1.08	1.104	<.001
	December	.	.	.	.
	Bipolar Disorder	29.715	22.642	38.997	<.001
	Depressive Disorder	33.813	27.821	41.095	<.001
	Other	.	.	.	.
	Income 1	1.435	1.426	1.444	<.001
	Income 2	1.331	1.323	1.34	<.001
	Income 3	1.201	1.194	1.209	<.001
	Income 4	.	.	.	.
Suicide Attempt	Intercept				<.001
	January	0.985	0.971	0.999	0.039
	February	0.989	0.975	1.004	0.157
	March	1.089	1.074	1.105	<.001
	April	1.179	1.162	1.197	<.001
	May	1.251	1.233	1.27	<.001
	June	1.281	1.262	1.301	<.001
	July	1.311	1.292	1.331	<.001
	August	1.348	1.328	1.368	<.001
	September	1.322	1.303	1.342	<.001
	October	1.244	1.226	1.262	<.001
	November	1.153	1.136	1.17	<.001
	December	.	.	.	.
	Bipolar Disorder	1777.638	1354.419	2333.101	<.001
	Depressive Disorder	3508.767	2886.886	4264.611	<.001

Table 12—continued

Outcome		Exp(B)	95% Confidence Interval for Exp(B)		Sig.
			Lower Bound	Upper Bound	
	Other	.	.	.	.
	Income 1	1.447	1.434	1.46	<.001
	Income 2	1.379	1.367	1.392	<.001
	Income 3	1.255	1.243	1.266	<.001
	Income 4	.	.	.	.
Death by suicide	Intercept				<.001
	January	0.964	0.838	1.108	0.604
	February	0.95	0.823	1.096	0.482
	March	1.129	0.985	1.294	0.080
	April	1.216	1.06	1.394	0.005
	May	1.225	1.068	1.405	0.004
	June	1.268	1.104	1.456	0.001
	July	1.377	1.203	1.576	<.001
	August	1.302	1.135	1.494	<.001
	September	1.305	1.138	1.498	<.001
	October	1.228	1.071	1.408	0.003
	November	1.145	0.997	1.315	0.055
	December	.	.	.	.
	Bipolar Disorder	46.166	25.974	82.053	<.001
	Depressive Disorder	134.689	100.796	179.978	<.001
	Other	.	.	.	.
	Income 1	1.013	0.934	1.097	0.762
	Income 2	1.079	0.995	1.169	0.066
	Income 3	1.114	1.027	1.209	0.009
	Income 4	.	.	.	.

Note: The reference category is hospitalized for natural causes and lived. Reference categories for other variables are as follows: Month (December), Diagnosis (Other), Income (Quartile 4).

APPENDIX B

IRB APPROVAL MEMORANDA

The Florida State University
Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673, FAX (850) 644-4392

APPROVAL MEMORANDUM

Date: 7/11/2014

To: Matthew Michaels [**********]

Address: Department of Psychology 1107 West Call Street
Dept.: PSYCHOLOGY DEPARTMENT

From: Thomas L. Jacobson, Chair

Re: Use of Human Subjects in Research
Emergency Department Data on Suicidal Behavior

The application that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Secretary, the Chair, and one member of the Human Subjects Committee. Your project is determined to be Expedited per 45 CFR Â§ 46.110(7) and has been approved by an expedited review process.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If you submitted a proposed consent form with your application, the approved stamped consent form is attached to this approval notice. Only the stamped version of the consent form may be used in recruiting research subjects.

If the project has not been completed by 7/10/2015 you must request a renewal of approval for continuation of the project. As a courtesy, a renewal notice will be sent to you prior to your expiration date; however, it is your responsibility as the Principal Investigator to timely request renewal of your approval from the Committee.

You are advised that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition,

federal regulations require that the Principal Investigator promptly report, in writing any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Human Research Protection. The Assurance Number is FWA00000168/IRB number IRB00000446.

Cc: Thomas Joiner, Advisor
HSC No. 2014.12995

The Florida State University
Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-8673, FAX (850) 644-4392

RE-APPROVAL MEMORANDUM

Date: 5/13/2015

To: Matthew Michaels [**********]

Address: Department of Psychology 1107 West Call Street
Dept.: PSYCHOLOGY DEPARTMENT

From: Thomas L. Jacobson, Chair

Re: Re-approval of Use of Human subjects in Research
Emergency Department Data on Suicidal Behavior

Your request to continue the research project listed above involving human subjects has been approved by the Human Subjects Committee. If your project has not been completed by 5/11/2016, you must request renewed approval by the Committee.

If you submitted a proposed consent form with your renewal request, the approved stamped consent form is attached to this re-approval notice. Only the stamped version of the consent form may be used in recruiting of research subjects. You are reminded that any change in protocol for this project must be reviewed and approved by the Committee prior to implementation of the proposed change in the protocol. A protocol change/amendment form is required to be submitted for approval by the Committee. In addition, federal regulations require that the Principal Investigator promptly report in writing, any unanticipated problems or adverse events involving risks to research subjects or others.

By copy of this memorandum, the Chair of your department and/or your major professor are reminded of their responsibility for being informed concerning research projects involving human subjects in their department. They are advised to review the protocols as often as necessary to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

Cc: Thomas Joiner, Advisor [**********]
HSC No. 2015.15495

REFERENCES

Broersen, P. M. (2006). *Automatic autocorrelation and spectral analysis*. London: Springer-Verlag London Limited.

Ceccherini-Nelli, A., & Priebe, S. (2011). Economic factors and suicide rates: associations over time in four countries. *Social Psychiatry and Psychiatric Epidemiology*, *46*, 975–982.

Chew, K. S. Y., & McCleary, R. (1995). The Spring peak in suicides. *Social Science & Medicine*, *40*, 223-230.

Christodoulou, C., Douzenis, A., Papadopoulos, F. C., Papadopoulou, A., Bouras, G., Gournellis, R., & Lykouras, L. (2012). Suicide and seasonality. *Acta Psychiatrica Scandinavica*, *125*(2), 127-146.

Crosby A. E., Han B., Ortega L. A, Parks S. E., & Gfoerer J. (2011). Suicidal thoughts and behaviors among adults aged ≥18 years—United States, 2008-2009. *MMWR Surveillance Summaries 2011*, *60*. 1-22.

Doganay, Z., Sunter, A. T., & Guz, H. (2003). Climatic and diurnal variation in suicide attempts in the ED. *The American Journal of Emergency Medicine*, *21*, 271-275.

Doshi, A., Boudreaux, E. D., Wang, N., Pelletier, A. J., & Camargo, C. A. (2005). National Study of US Emergency Department Visits for Attempted Suicide and Self-Inflicted Injury, 1997-2001. *Annals of Emergency Medicine*, *46*, 369-375.

Durkheim E. (1897/1951). *Suicide: A study in sociology*. New York: Free Press.

HCUP Data Use Training. Healthcare Cost and Utilization Project (HCUP). May 2012. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/tech_assist/dua.jsp.

HCUP-US NEDS Overview. Healthcare Cost and Utilization Project (HCUP). November 2012. Agency for Healthcare Research and Quality, Rockville, MD. www.hcup-us.ahrq.gov/nedsoverview.jsp.

Hilas, C. S., Goudos, S. K., & Sahalos, J. N. (2006). Seasonal decomposition and forecasting of telecommunication data: A comparative case study. *Technological Forecasting and Social Change*, *73*(5), 495-509.

Hiltunen, L., Suominen, K., Lönnqvist, J., & Partonen, T. (2011). Relationship between daylength and suicide in Finland. *Journal of Circadian Rhythms*, *9*, 1-10. doi:10.1186/1740-3391-9-10

Maes M, Scharpé S, Verkerk R, et al. (1995). Seasonal variation in Plasma L-Tryptophan availability in healthy volunteers: Relationships to violent suicide occurrence. *Archives of General Psychiatry*, *52*(11), 937-946. doi:10.1001/archpsyc.1995.03950230051008

Miller, T. R., Furr-Holden, C. D., Lawrence, B. A., & Weiss, H. B. (2012). Suicide deaths and nonfatal hospital admissions for deliberate self-harm in the United States: Temporality by day of week and month of year. *Crisis: The Journal of Crisis Intervention and Suicide Prevention*, *33*(3), 169.

Murphy, S. L., Xu, J., & Kochanek, K. D. (2013). Deaths: Final data for 2010. National Vital Statistics Report, 61(4), 1–167.

Nock, M. K., Borges, G., Bromet, E. J., Alonso, J., Angermeyer, M., Beautrais, A., ... & Williams, D. (2008). Cross-national prevalence and risk factors for suicidal ideation, plans and attempts. *The British Journal of Psychiatry*, *192*(2), 98-105.

Preti A. (2000). Seasonal variation and meteotropism in suicide. *Current Opinion in Psychiatry*, *13*, 655–660.

Preti A. & Miotto P. (1998). Seasonality in suicides: The influence of suicide method, gender, and age on suicide distribution in Italy. *Psychiatry Research*, *81*, 219–231.

Rock, D., Greenberg, D. M., & Hallmayer, J. F. (2003). Increasing seasonality of suicide in Australia 1970–1999. *Psychiatry Research*, *120,* 43–51.

Woo, J.-M., Okusaga, O., & Postolache, T. T. (2012). Seasonality of suicidal behavior. *International Journal of Environmental Research and Public Health*, *9*, 531-547.

World Health Organization. (2013). Suicide prevention (SUPRE). Retrieved March 31, 2015, from http://www.who.int/mental_health/suicide-prevention/en/prevention/suicide/suicideprevent/en/.

Yaffee, R. A., & McGee, M. (2000). *An introduction to time series analysis and forecasting: with applications of SAS® and SPSS®.* Academic Press.

Yip, P., Chao, A., & Chiu, C. (2000). Seasonal variation in suicides: diminished or vanished Experience from England and Wales, 1982-1996. *The British Journal of Psychiatry, 177*, 366-369 doi: 10.1192/bjp.177.4.366

BIOGRAPHICAL SKETCH

Education

Ph.D., Clinical Psychology 2017

Florida State University

B.S., Psychology; B.A., Sociology; Minors: Philosophy & Statistics 2012

Summa Cum Laude, University of Florida

Research Training

Graduate Researcher 2012-present

Advisor*:* Thomas Joiner, Ph.D.
Lab focus: Suicidal Behavior, Military Suicide Prevention

Undergraduate Researcher 2011 – 2012

Advisor: Chuck Peek, Ph.D.
Lab focus: Longitudinal patterns of disability, Cohort variations in Functional Health
Project Title: Predictors of suicide in Hurricane Katrina survivors. Population: Displaced hurricane survivors.

Undergraduate Researcher 2010 – 2012

Advisor: Bonnie Moradi, Ph.D.
Lab focus: Minority Stressors, Minority Identity
Project Title: Does exposure to muscularity-idealizing images have self-objectification consequences for heterosexual and sexual minority men? Population: Undergraduate and community heterosexual and sexual minority men.

Publications ***h-index***: 2 ***i-10 index***: 2 **Total *Citations***: 27

**indicates a mentored undergraduate student

9. Tucker, R. P., **Michaels, M. S.**, Rogers, M. L., Wingate, L R., & Joiner, T. E. Jr. (under review). Construct validity of a proposed new diagnostic entity: Acute Suicidal Affective Disturbance (ASAD).
8. **Michaels, M. S.**, Chu, C., & Joiner, T. E. (in press). Suicide. In R. J. DeRubeis & D. R. Strunk (Eds.), *The Oxford handbook of mood disorders*. New York: Oxford University Press.
7. **Michaels, M. S.**, Parent, M. C., & Torrey C. (in press). A minority stress model for suicidal ideation in gay men. *Suicide and Life-Threatening Behavior*.
6. **Michaels, M. S.**, Chu, C., Silva, C., **Schulman, B., & Joiner, T. E. (in press). Considerations regarding online methods for suicide-related research and suicide risk assessment. *Suicide and Life-Threatening Behavior.*
5. Buchman-Schmitt, J. B., Chu, C. Chiurliza, B., **Michaels, M. S.**, & Joiner, T. E. (2014). Review of adolescent suicidal behavior. *International Journal of Behavioral Consultation and Therapy*, *9*(3), 26-34.
4. Joiner, T. E., **Michaels, M. S.**, Chu, C., & Buchman-Schmitt, J. M. (2013). "Suicide." In Oxford Bibliographies in Psychology. Ed. Dana S. Dunn. New York: Oxford University Press.
3. Chu, C., Buchman-Schmitt, J. M., **Michaels, M. S.**, Ribeiro, J. D., & Joiner, T. E. (2013). Discussing disgust: The role of disgust with life in suicide. *International Journal of Cognitive Therapy*, *6*(3), 235-247.
2. **Michaels, M. S.**, Parent, M. C., & Moradi, B. (2013). Does exposure to muscularity-idealizing images have self-objectification consequences for heterosexual and sexual minority men? *Psychology of Men & Masculinity*, *14*(2), 175-183.

1. Parent, M. C., Torrey, C., & **Michaels, M. S.** (2012). 'HIV testing is so gay': The role of masculine gender role conformity in HIV testing among men who have sex with men. *Journal of Counseling Psychology*, *59*(3), 465-470.

Presentations

**indicates a mentored undergraduate student

Michaels, M. S., Brausch, A., Cukrowicz, K., & Nadorff, M. (2014, April). Student research panel: research issues for students in suicidology. Symposium scheduled for presentation at the annual meeting of the American Association of Suicidology, Los Angeles, CA.

Gobble, T. D., **Michaels, M. S., & Joiner, T. E. (2014, April). *Gender, relationships, and suicide risk*. Poster scheduled for presentation at the annual meeting of the American Association of Suicidology, Los Angeles, CA.

Michaels, M. S. & Peek, C. W. (2013, April). *An application of the Interpersonal Theory of Suicide to survivors of Hurricane Katrina*. Poster presented at the annual meeting of the American Association of Suicidology, Austin, TX.

Michaels, M. S., Parent, M. C., & Torrey, C. (2013, April). *An application of minority stress theory to suicidality in gay men*. Poster presented at the annual meeting of the American Association of Suicidology, Austin, TX.

Cukrowicz, K. C., Gutierrez, P. M., & Jobes, D. A. (2013, April). In **M. Michaels** (Chair), *Future directions for research: A research panel for students*. Symposium presented at the annual meeting of the American Association of Suicidology, Austin, TX.

Parent, M. C., Torrey, C., & **Michaels, M. S.** (2012, August). *Number of sexual partners, masculine gender role conformity, and HIV testing among U.S. MSM*. Poster presented at the annual meeting of the American Psychological Association, Orlando, FL.

Michaels, M. S., Parent, M. C., & Moradi, B. (2011, August). *Experimental effects of heightened body objectification on men's body perceptions*. Poster presented at the meeting of the American Psychological Association, Washington, D.C.

Parent, M. C., & **Michaels, M. S.** (2010, August). *Moderation of propensity for anabolic-androgenic steroid use by sexual orientation*. Poster presented at the meeting of the American Psychological Association: NIDA Early Career Investigator Poster Session, San Diego, CA.

Research Funding/Awards

MSRC Training Award. Stipend for travel assistance to attend training and mentorship sessions in military suicide research.	2015
MSRC Training Award. Stipend for travel assistance to attend training and mentorship sessions in military suicide research.	2014
APAGS/Psi Chi Junior Scientist Fellowship—Honorable Mention. Award to recognize outstanding research-oriented students. Application scored in the top 14.7% of applicants.	2013
MSRC Training Award. Stipend for travel assistance to attend training and mentorship sessions in military suicide research.	2013

University Scholars. Research grant including stipend & travel expenses to present the research. Project title: *Predictors of suicide in Hurricane Katrina survivors*.	2011-2012
Psi Chi Undergraduate Research Grant. Research grant to help defray the costs of conducting an original research project. Project title: *An application of minority stress theory to suicidality in MSM*.	2010-2011
Inter-University Consortium for Political and Social Research (ICPSR) 2010 Undergraduate Research Paper Competition—Second Place. Paper title: *Americans' ever-changing attitudes toward homosexuality*. Online at: http://www.icpsr.umich.edu/files/ICPSR/prize/michaels.pdf	2010
University Scholars. Research grant including stipend & travel expenses to present the research. Project title: *Does exposure to muscularity-idealizing images have self-objectification consequences for heterosexual and sexual minority men?*	2010-2011

Service

Alachua County Crisis Center: Crisis Phone Counselor (220 hours); Crisis Response Team (228 hours on-call); In-House Trainer for phone counselors; Crisis Intervention Team Trainer for law enforcement officers	2010 -2012
Member: American Association of Suicidology Student Involvement Committee.	2013-present
Chair: American Association of Suicidology Student Conference Committee.	2011-present
Member: American Association of Suicidology Student Conference Committee.	2010-present
Editor: *University of Florida Journal of Psychological Science*.	2009-2011

Academic Awards

Co-Recipient of the Academic Excellence Award in Sociology	2012
Co-Recipient of the Jack B. Humphries Leadership Award	2012
Phi Beta Kappa Honor Society	2012-present
Hazen E. Nutter Endowment: Dean's office scholarship	2011-2012
Phi Kappa Phi Honor Society	2011-present
Golden Key International Honor Society	2011-present
Psi Chi National Psychology Honor Society	2009-present

Professional Memberships

American Psychological Association: Student Affiliate; Student Member of Division 51.

American Association of Suicidology: Student Affiliate.