Back to School Blues: Seasonality of Youth Suicide and the Academic Calendar

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Abstract

Previous research has found evidence of academic benefits to longer school years. This paper investigates one of the many potential costs of increased school year length, documenting a dramatic decrease in youth suicide in months when school is not in session. A detailed analysis does not find that other potential explanations such as economic conditions, weather or seasonal affective disorder patterns can explain the decrease. This evidence suggests that youth may face increased stress and decreased mental health when school is in session.

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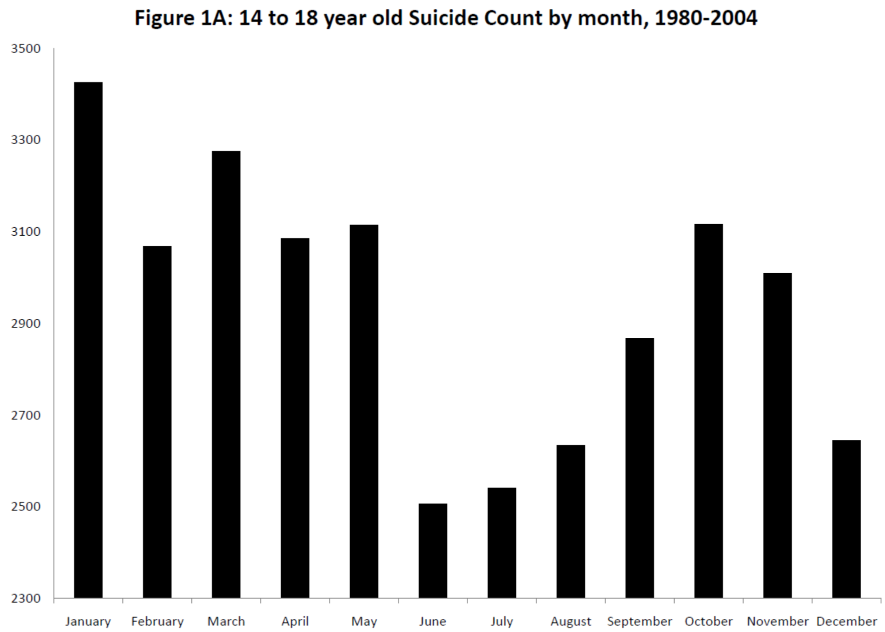
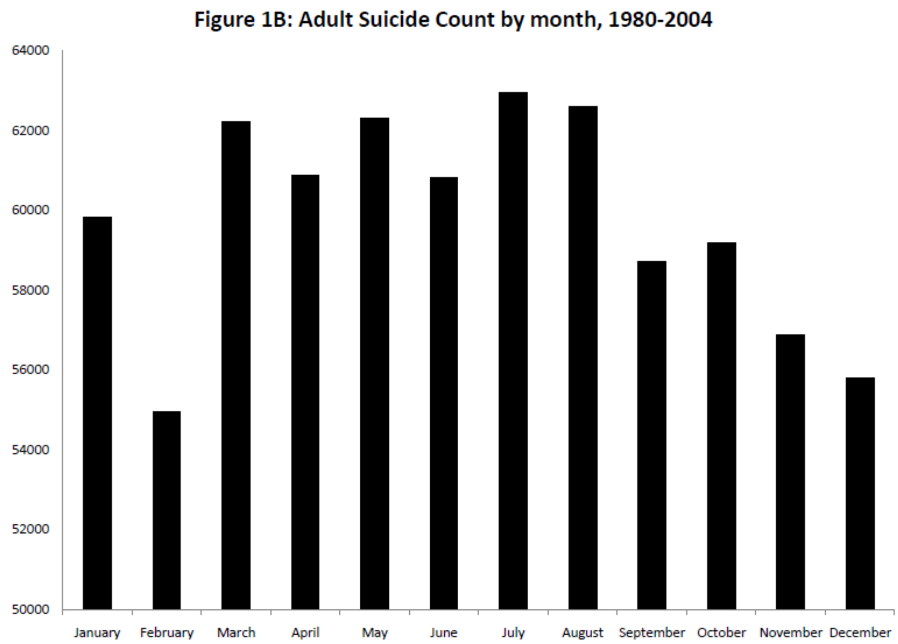


1 Introduction

Suicide is the third leading cause of death among the youth and the suicide rate of 15 to 19 year olds tripled between 1950 and 1990. Over the same time period, suicide rates for older individuals decreased. A significant literature exists exploring the determinants of youth suicide, although no previous work (to our knowledge) has directly explored the relationship between school and youth suicide, despite the fact that for over three-quarters of the year, teens are in school. This paper examines the seasonality of youth suicide with a specific focus on how youth suicide may be related to the typical academic calendar.

The seasonality of suicides is explored in detail below, however, figures 1A and 1B illustrate a striking contrast between the seasonality of suicides for youth aged 14-18 and adults. Figure 1A is the total number of youth suicides by month, in the United States between 1980 and 2004. It is clear that there is a substantial drop in the number of suicides during the summer months (June, July and August), coinciding with summer vacation for students. The non-summer month with the fewest number of suicides is December, when students are typically on winter break for a significant fraction of the month.

Figure 1B rules out the possibility that suicide in general tends to be lower during the summer months. The total number of adult suicides (over 18 years old) by month between 1980 and 2004 is seen in figure 1B. There does not appear to be much of a seasonal pattern, however, the months with the highest number of adult suicides are July



and August, with June also as one of the higher months. This contrasts the pattern seen in the youths, motivating a detailed exploration analyzing the relationship between youth suicide and the typical school calendar.

A possible explanation for the pattern in figure 1A is that youth suicide decreases in the summer months due to seasonal affective disorder (SAD), where individuals become more depressed during the winter months. SAD is most prominent in northern states where the sunlight is limited during the winter, but relatively abundant during the summer. The decrease in suicides during the month of December provides evidence against this argument, but further analysis shows that the decrease in the summer months is not driven by northern states. Furthermore, SAD affects youth females significantly more than youth males, but it is shown below that males are driving the pattern in figure 1A. In addition to investigating the role that SAD plays, economic conditions, weather patterns and divorce rates are also explored and when controlling for these potential factors, the seasonal youth suicide pattern remains.

A significant literature exists that shows the benefits of increased schooling, but rarely is the negative impact of schooling considered. The results below suggest that the increased stress that students face throughout the school year may exacerbate mental health issues and increase youth suicide. This finding is for consideration as a potential cost as school districts debate whether to increase the length of the academic school year.

2 Background

The seminal work on suicide in economics by Hamermesh and Soss (1974) develops a rational-suicide theory that argues that suicide rates should increase as individuals get older. While their data from the early half of the 1900s support their predictions that older age groups should have higher suicide rates, recent trends in suicide across age groups tend to deviate from their findings. Most of the research on youth suicide looks at the patterns of youth suicide across ages, time periods, geography and races.

Freeman (1998) shows youth suicide rates increase when cohort size increases and competition for resources becomes greater. Cutler, Glaeser and Norberg (2000) use National Longitudinal Study of Adolescent Health (AddHealth) data and mortality data from the NCHS and find that unsuccessful youth suicide attempts are usually "cries for help".[1] Cutler, Glaeser and Norberg (2000) also find that teens are more likely to attempt suicide if they hear of another teen attempting suicide and that the rise in youth suicide is strongly correlated with changes in the fraction of youths with divorced parents. They also present stylized facts showing that rural areas are more likely to have high suicide rates, compared to urban areas.

Molina and Duarte (2006) use data from the US National Youth Risk Behavior Surveys to extensively analyze the relationship between youth suicide attempts and demographic and psychosocial characteristics. They find that female youths attempt suicide more often than youth males (although you male suicide rates are significantly higher than youth female suicide rates) and American Indian and Alaskan native adolescents are more like to consider suicide than other races. Drug consumption is positively related to youth suicidal behavior, as is educational failure, access to a gun, low self-esteem, the number of sexual partners and becoming pregnant. On the other hand, they find that participation in sports is negatively related with youth suicidal behavior.

While these papers provide characteristics associated with youth suicide, they do not claim to find a causal effect. A related line of literature has attempted to identify the causal effects of youth suicide. Markowitz, Chatterji and Kaestner (2003) find that taxes on beer and drunk-driving laws lower the suicide rate for males 15-19 and 20-24. Carpenter (2004) looks at the effect of states adopting zero tolerance alcohol laws on suicide. The adoption of the state laws, which revoke the driver's licenses of individuals under 21 if any alcohol is found in their blood, are

[1] This is consistent with Marcotte's (2001) finding that individuals who previousl attempted suicide have higher incomes than their peers who considered suicide, but did not make an attempt.

associated with a significant decrease in male suicide for age 15-17 and 18-20. Using a similar identification strategy as Carpenter, Sabia (2008) shows that when state enact parental involvement laws, female youth suicide significantly decreases.

Although research has shown that alcohol consumption, poor self-esteem and sexual activity is related to youth suicide, there is little discussion about the fact that these risky behaviors tend to originate at school. There has been a recent series of papers suggesting benefits to longer school calendars. Marcotte (2007), Marcotte and Hemelt (2008), Hansen (2008) and Hastedt (2009) take advantage of variation in snow days to address the effect of instructional days on student performance, finding that more days raises test scores on standardized exams. Similarly, Hansen (2008) and Fitzpatrick (2009) utilize variation in test-timing to assess the effect of additional instruction days, finding similar, but smaller estimates. Following this line of literature, Marcotte and Hansen (2010) discuss the policy implications of these results in regards to school calendar policies.

Without taking away from the benefits that are associated with obtaining education, there must be a discussion of the potential costs that come from the social and academic pressure of school. Our paper begins a serious discussion about the relationship between school and resulting pressures or stresses that are ultimately manifested through suicide. In addition to identifying a large contributing factor of youth suicides, we have also identified a potential cost to weigh against the benefits of increased instructional days.

3 Data

The data used in the paper comes from a variety of sources. The mortality data is from the Multiple Cause-of-Death Public Use Files, which are published annually by the National Center for Health Statistics. Between 1977 and 1999, the International Classification of Diseases, 9th Edition (ICD-9) was used to code mortality and currently the ICD-10 is used. Suicides are defined in the ICD-9 using code 350 in the "34 Recode" classification and code 040 in ICD-10 using the "39 Recode" classification. In the years we are investigating, 1980-2004, the public use mortality data contains information on the state of death, month of death and age and race of the deceased person.

In order to control for a variety of factors that may be associated with suicide, divorce rates, unemployment rates and precipitation are controlled for. The divorce rates are obtained from the Vital Statistics, similar to the data used in the Wolfers (2006) and Friedberg (1998) papers on divorce laws. Unemployment rates are from the Bureau of Labor Statistics and are available at the state level for every month. Data on precipitation comes from NOAA, who provide monthly precipitation in inches by state for each month.

3.1 Descriptive Statistics

As seen above in figure 1A and 1B, descriptive statistics can paint a picture of the youth suicide landscape. Table 1 shows the average monthly suicide rate per 100,000 for all individuals in column 1, as well as the suicide rate for 14-18 year olds and 19-25 year olds in columns 2 and 3. The average over all months is reported in the bottom row and each rate is weighted by the population of interest. In table 1, the 14-18 year old suicide rate drops noticeably in June, July and August and then again in December, while the other two columns do not exhibit the same pattern. In fact, the months of June, July and August are all above the overall average suicide rate for the entire population and the 19-25 year olds.

The implications from table 1 can be seen clearly in figure 2, which graphically shows the average suicide rates for 14 to 18 year olds and 19 to 25 year olds over the course of the year. The solid black line depicts the suicide rate for 14 to 18 year olds and the dotted line represents the suicide rate of 19 to 25 year olds. In figure 2, the decrease in suicides for 14 to 18 year olds during the summer months is stark, while the 19 to 25 year olds see a slight rise in suicide rates during the summer, then a gradual non-monotonic decrease until December.

Table 1: Monthly Suicide Rate Averages, 1980-2004

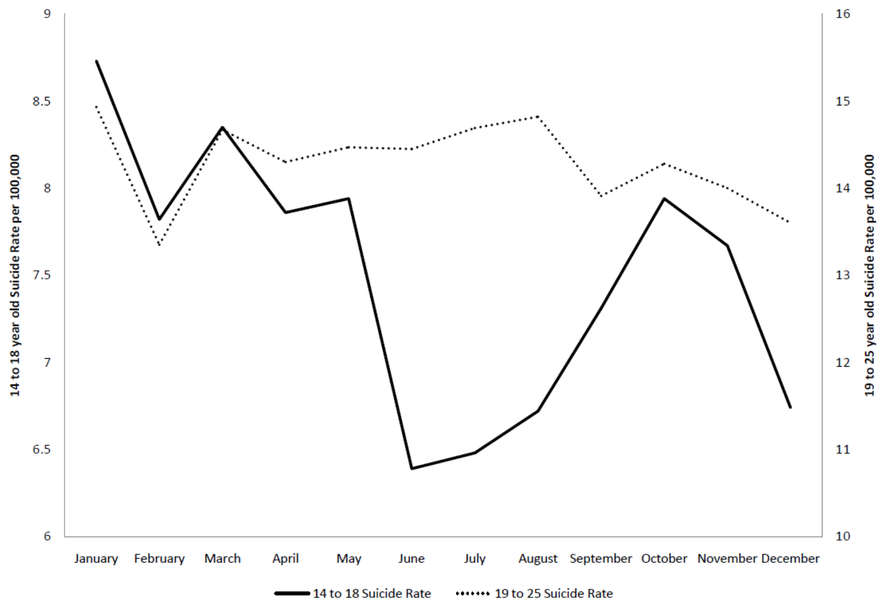
Month	(1) Suicide Rate	(2) 15-18 Suicide Rate	(3) 19-25 Suicide Rate
January	11.94	8.73	14.93
	(3.56)	(6.96)	(7.78)
February	10.95	7.82	13.35
	(3.18)	(6.44)	(6.83)
March	12.35	8.35	14.67
	(3.46)	(6.58)	(7.35)
April	12.04	7.86	14.30
	(3.44)	(6.46)	(7.40)
May	12.30	7.94	14.47
	(3.40)	(6.27)	(7.44)
June	11.89	6.39	14.45
	(3.28)	(5.47)	(7.15)
July	12.28	6.48	14.69
	(3.56)	(5.66)	(7.56)
August	12.23	6.72	14.82
	(3.48)	(5.48)	(7.57)
September	11.54	7.31	13.91
	(3.56)	(6.08)	(7.21)
October	11.67	7.94	14.28
	(3.25)	(6.25)	(6.82)
November	11.21	7.67	14.00
	(3.18)	(6.15)	(7.39)
December	10.92	6.74	13.60
	(3.24)	(6.21)	(7.01)
Total	11.78	7.49	14.29
	(3.40)	(6.22)	(7.31)

Each monthly cell contains 1275 monthly observations that are population-weighted. The bottom row is the average over all months and contains 15300 observations. Standard deviations are shown in parentheses.

Figure 2 shows that the decrease in suicide during the summer months dissipates in the 19 to 25 age group, but it may cause one to wonder what the monthly suicide rate is for each age group. Not all 18 year olds are in high school, particularly those that turn 18 over the summer. An 18 year old born in the summer months that commits suicide would most likely not be in high school and a summer vacation at the age of 18 would not eliminate any high school stress. This is not to say that we should not see a drop in suicide during the summer for 18 year olds, however, if 18 year olds were driving the pattern seen in figure 2, the effect of summer vacation would be in question. Furthermore, if summer vacations in high school are the cause of the summer suicide decline, the pattern of low suicide in the summer should disappear for 19 year olds.

To explore whether 18 year olds are driving the pattern seen in figure 2 and whether the seasonal pattern disappears for 19 year olds, table 2 looks at suicide rates of individuals aged 16 to 21. Similar to table 1, table 2

Figure 2: Average Suicide Rates by Month, 1980-2004



reports the population weighted average of the suicide rate per 100,000 for each month, and then the bottom row reports the average over all months. The 16, 17 and 18 year olds all experience a noticeable decline in suicide during the months of June, July and August. Between the months of May and June, the suicide rate in all three age groups decrease between roughly 1 and 2 per 100,000, with 17 year olds seeing the largest decrease of 2.16 per 100,000. Because 16, 17 and 18 year olds all have declining suicide rates in the summer months, table 2 provides evidence that there is a negative relationship between the months of summer vacation and suicide and not an anomaly driven by 18 year olds. The seasonal suicide pattern seen in those 18 years old and younger disappears in 19 year olds, and does not appear in 20 and 21 year olds as well. The fact that 15 to 18 year old suicide rates decrease in the summer, but the 19 year old suicide does not, suggests that the high school calendar is playing a prominent role in youth suicide.

Table 2: Age-Specific Monthly Suicide Rate Averages, 1980-2004

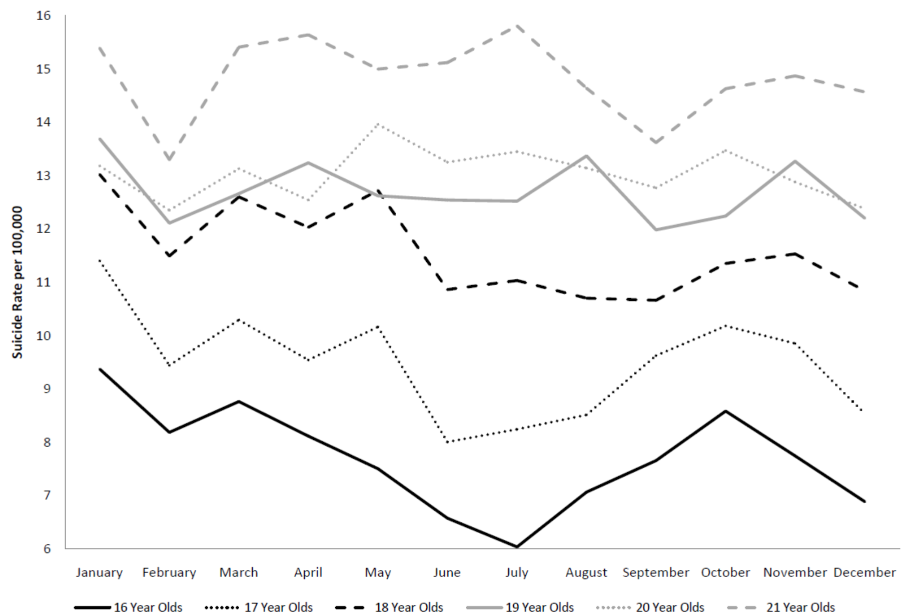
Month	(1) 16 year olds	(2) 17 year olds	(3) 18 year olds	(4) 19 year olds	(5) 20 year olds	(6) 21 year olds
January	9.37	11.40	13.02	13.69	13.18	15.39
	(14.33)	(16.29)	(17.39)	(17.11)	(16.40)	(17.98)
February	8.18	9.44	11.49	12.11	12.35	13.30
	(13.08)	(14.85)	(16.54)	(15.43)	(14.72)	(16.37)
March	8.76	10.29	12.60	12.66	13.13	15.41
	(14.00)	(14.63)	(15.77)	(15.71)	(16.15)	(17.44)
April	8.11	9.54	12.03	13.24	12.54	15.64
	(12.85)	(15.15)	(16.01)	(16.11)	(14.15)	(16.94)
May	7.50	10.16	12.72	12.62	13.96	15.00
	(12.03)	(14.87)	(16.04)	(15.29)	(16.07)	(18.17)
June	6.57	8.00	10.86	12.54	13.25	15.12
	(11.76)	(12.95)	(14.17)	(15.51)	(16.02)	(17.31)
July	6.03	8.24	11.03	12.52	13.45	15.81
	(11.37)	(12.28)	(15.43)	(16.20)	(15.78)	(18.05)
August	7.06	8.51	10.70	13.37	13.14	14.64
	(12.75)	(13.32)	(14.42)	(16.63)	(17.08)	(17.66)
September	7.65	9.62	10.66	11.98	12.77	13.62
	(12.73)	(14.38)	(15.51)	(15.05)	(16.61)	(16.90)
October	8.58	10.18	11.35	12.24	13.47	14.63
	(12.84)	(15.15)	(15.72)	(14.78)	(15.64)	(16.65)
November	7.74	9.85	11.53	13.27	12.88	14.87
	(13.22)	(14.26)	(15.29)	(16.28)	(15.75)	(17.41)
December	6.88	8.53	10.84	12.20	12.38	14.59
	(12.85)	(13.99)	(15.63)	(15.68)	(16.23)	(16.86)
Total	7.70	9.48	11.57	12.70	13.04	14.84
	(12.87)	(14.41)	(15.70)	(15.83)	(15.90)	(17.33)

Each monthly cell contains 1275 monthly observations that are population-weighted. The bottom row averages over all months and contains 15300 observations. Standard deviations are shown in parentheses.

In order to see the results in table 2 more clearly, figure 3 plots the age-specific suicide rates over the year. The black lines represent the monthly suicide rates of those 16 to 18 years old, with the solid black line depicting 16 year olds, the dotted black line showing 17 year olds and the dashed line corresponding to 18 year olds. In the figure, it is clear that between May and June, there is a sharp drop in the suicide rate that persists roughly until September. The 19 to 21 year old suicide rates are shown in gray, and in contrast to the younger ages, the summer months of June, July and August are not associated with a decrease in suicide.

The tables and figures above convincingly show that there is a clear seasonal pattern for youth suicides, but the descriptive statistics are unable to address a number of important issues that may be driving the pattern seen in figures 1 through 3. Economic and social conditions and weather anomalies may play a role in the seasonal pattern. The issue of seasonal affective disorder (SAD) must also be addressed. If youths with SAD are more prone to commit suicide when there is less sunlight, then states with extreme seasons may be driving the pattern. In order

Figure 3: Age-Specific Monthly Suicide Rates, 1980-2004



to convincingly rule out these factors as potential drivers of the seasonal pattern, the next section investigates the effect of summer months on suicide in a panel data framework.

4 Results

This section estimates the size of the decrease in suicides for youth in the summer and explores whether the drop can be explained by variations in observable characteristics. The seasonal pattern in youth suicides is compared with adult suicide patterns and the stability of summer decrease is analyzed. In order to determine the role that SAD plays, the summer decrease is analyzed by region and by gender. The summer pattern of other common causes-of-death for the youth are analyzed in order to rule out the suicide pattern as part of an overall youth death trend.

4.1 Youths vs. Adults

Youth suicides are defined in the current analysis as any suicide between the ages of 14 and 18. This accounts for roughly 91 percent of all youth suicides. Using a larger range of ages does not change the implications of our results, but because suicides committed by youths younger than 14 are so rare, including younger suicides may be representative of mental health issues beyond the ones that might be exacerbated during the school year.

The regressions in table 3 follow from equation (1), with the noted specifications omitting certain control variables to confirm the robustness of the seasonal patterns. The regressions are weighted by the population of the dependent variable.

$$suiciderate_{smy} = m_m + y_y + s_s + precip_{smy} + X^{'}_{smy}\beta + u_{smy} \quad (1)$$

Columns (1) through (3) report the coefficients when youth suicide is the dependent variable (14 to 18 years old). Robust standard errors are reported in column 1 and standard errors clustered at the state level are reported in column 2 and 3 in order to correct for any auto-correlation that may exist in states over time (Bertrand et al., 2004). For these specifications, we chose to omit September, as that is the first month of the school year. The results show that the June, July and August suicide rates (bolded in table 3) are significantly lower than the omitted month, September, which is typically the first full month of school. The only other month that has a negative coefficient is December, however the magnitude of the December coefficient is significantly smaller (at the 10% level) in absolute value than the June coefficient. The months that students are most likely in school all have significantly positive coefficients, with January and March reporting the highest rates of suicide relative to September. The coefficients are robust to the inclusion of state and year fixed-effects, as well as controls for divorce rate, precipitation and the unemployment rate.

Columns (4) through (6) show the results of regressions using the adult suicide rate as the dependent variable. Consistent with the tables and figures above, the adult suicide rate does not decrease during the summer months. In fact, July and August have the highest rates of adult suicide. When comparing the youth suicide results to the adult results, it appears that youth suicide is least likely to occur in months when students are on summer vacation, while adult suicide is most likely to occur during those same months. The contrast between youth and adult suicide in the summer months seen in table 3 suggests that youth and adult suicide follow significantly different seasonal patterns, that appear to revolve around high school summer vacation. However, adults and youth differ on many dimensions beyond school, justifying further exploration of suicide rates for age groups closer to 18 years old.

Table 3: Seasonality in the Suicide Rate-Youth vs. Adult

	Youth Suicide Rate			Adult Suicide Rate		
	(1)	(2)	(3)	(4)	(5)	(6)
October	0.63***	0.63***	0.65***	0.08	0.08	0.12
	(0.24)	(0.19)	(0.21)	(0.18)	(0.09)	(0.09)
November	0.36	0.36	0.48*	-0.42**	-0.42***	-0.39***
	(0.23)	(0.25)	(0.27)	(0.18)	(0.11)	(0.11)
December	-0.57**	-0.57**	-0.52*	-0.66***	-0.67***	-0.64***
	(0.23)	(0.26)	(0.28)	(0.18)	(0.10)	(0.12)
January	1.42***	1.43***	1.62***	0.34*	0.34**	0.30***
	(0.25)	(0.25)	(0.29)	(0.19)	(0.13)	(0.11)
February	0.51**	0.51***	0.58***	-0.73***	-0.73***	-0.71***
	(0.24)	(0.18)	(0.19)	(0.18)	(0.08)	(0.09)
March	1.04***	1.04***	0.99***	0.83***	0.84***	0.85***
	(0.24)	(0.17)	(0.19)	(0.19)	(0.08)	(0.08)
April	0.55**	0.56**	0.51*	0.53***	0.54***	0.53***
	(0.24)	(0.24)	(0.27)	(0.18)	(0.07)	(0.08)
May	0.62***	0.63***	0.56**	0.82***	0.83***	0.83***
	(0.24)	(0.22)	(0.25)	(0.19)	(0.08)	(0.08)
June	**-0.93*****	**-0.92*****	**-0.96*****	**0.49*****	**0.49*****	**0.48*****
	(0.22)	**(0.21)**	**(0.23)**	**(0.19)**	**(0.08)**	**(0.08)**
July	**-0.83*****	**-0.83*****	**-0.89*****	**0.94*****	**0.94*****	**0.93*****
	(0.23)	**(0.21)**	**(0.22)**	**(0.19)**	**(0.08)**	**(0.09)**
August	**-0.60*****	**-0.59*****	**-0.56****	**0.85*****	**0.85*****	**0.85*****
	(0.22)	**(0.20)**	**(0.22)**	**(0.19)**	**(0.07)**	**(0.07)**
Divorce Rate			0.007***			0.002**
			(0.001)			(0.001)
Precipitation			0.02			0.02
			(0.04)			(0.01)
Unemployment Rate			-0.01			0.02
			(0.07)			(0.06)
Constant	7.31***	5.73***	5.61***	12.61***	13.55***	13.08***
	(0.16)	(0.29)	(0.61)	(0.13)	(0.33)	(0.40)
State Fixed Effects	No	Yes	Yes	No	Yes	Yes
Year Fixed Effects	No	Yes	Yes	No	Yes	Yes
N	15300	15300	13536	15,300	15,300	13,536
R^2	0.01	0.19	0.18	0.02	0.64	0.67

***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level
Columns 1, 2, 4 and 5 contain all observations. Columns 3 and 6 drop observations due to missing precipitation and divorce rate data. Standard errors are clustered at the state level in columns 2, 3, 5 and 6. Robust standard errors are reported in columns 1 and 4. Each regression is population weighted.

In table 4, equation (1) is reestimated using 14 to 17 year olds, 17, 18, 19 and 20 year olds, as well as those 19 to 25 years old as dependent variables. In order to not lose observations as a result of missing data from the demographic controls, only state and year fixed effects are included in the regressions, however, including the demographic controls does not change the implications of the results. Similar to table 3, all regressions are weighted by the population of interest and standard errors are clustered at the state level.

Table 4: Seasonality in the Suicide Rate-Specific Age Results

	14 to 17 Years old (1)	17 Years old (2)	18 Years old (3)	19 Years old (4)	20 Years old (5)	19 to 25 Years old (6)
October	0.62***	0.55	0.68	0.26	0.70	0.37
	(0.19)	(0.46)	(0.48)	(0.46)	(0.67)	(0.24)
November	0.23	0.23	0.86	1.29**	0.11	0.09
	(0.29)	(0.48)	(0.58)	(0.57)	(0.42)	(0.32)
December	-0.76**	-1.09*	0.18	0.22	-0.39	-0.31
	(0.30)	(0.59)	(0.44)	(0.48)	(0.57)	(0.26)
January	1.19***	1.77***	2.36***	1.71**	0.41	1.02***
	(0.25)	(0.59)	(0.54)	(0.64)	(0.53)	(0.23)
February	0.43**	-0.18	0.82	0.13	-0.42	-0.56***
	(0.19)	(0.53)	(0.56)	(0.46)	(0.52)	(0.20)
March	0.81***	0.67	1.93***	0.68	0.36	0.75***
	(0.18)	(0.41)	(0.51)	(0.50)	(0.59)	(0.17)
April	0.35	-0.08	1.37**	1.26**	-0.23	0.39*
	(0.21)	(0.52)	(0.56)	(0.61)	(0.51)	(0.22)
May	0.27	0.53	2.06***	0.64	1.19**	0.55**
	(0.25)	(0.54)	(0.61)	(0.53)	(0.51)	(0.24)
June	**-1.20*** **	**-1.63*** **	**0.19**	**0.56**	**0.49**	**0.54*** **
	(0.24)	**(0.48)**	**(0.54)**	**(0.44)**	**(0.47)**	**(0.18)**
July	**-1.13*** **	**-1.38** **	**0.36**	**0.54**	**0.68**	**0.78*** **
	(0.21)	**(0.53)**	**(0.50)**	**(0.52)**	**(0.50)**	**(0.22)**
August	**-0.76*** **	**-1.12** **	**0.04**	**1.39*** **	**0.37**	**0.91*** **
	(0.21)	**(0.53)**	**(0.51)**	**(0.45)**	**(0.53)**	**(0.23)**
Constant	4.84***	8.15***	9.07***	9.65***	12.74***	14.45***
	(0.28)	(0.53)	(0.59)	(0.68)	(0.50)	(0.37)
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	15300	15300	15300	15300	15300	15300
R^2	0.15	0.06	0.06	0.05	0.05	0.25

***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level
All regressions contain state and year fixed effects, but not demographic controls.
Standard errors clustered at the state level are reported. Each regression is population weighted.

The results in table 4 provide further evidence that school summer vacation is associated with a decrease in youth suicide. Column (1), reporting the monthly coefficients for 14 to 17 year olds, is consistent with the results in table 3, with the summer months associated with the most significant decrease in the suicide rate. The 17 year old suicide rate results in column (2) are the same sign as the 14 to 17 year olds in column (1), with the coefficients in the summer months being slightly larger in magnitude for 17 year olds than for 14 to 17 year old group.

The effect of the summer vacation still remains for 18 year olds in column (3), as there is a significant difference between suicide rates in May compared with June, July or August. However, there is not a significant difference between the suicide rate in the summer months and in September. This may be the result of the fact that only 18 year olds born in a small window, which is dependent on school age cutoff dates, are 18 years old in September of their senior year of high school. The majority of seniors are 17 years old when they start their senior year. By September, most 18 year olds have started pursuing post-secondary careers.

The results in column (4) show that the pattern of decreased suicides during the summer months disappears for 19 year olds. The summer decrease in suicides is also absent for 20 year olds in column (5) and the 19 to 25 age group in column (6). Taken all together, the results in table 4 provide strong evidence that summer vacation for high schoolers is strongly associated with a decrease in suicide. The summer decrease disappears once individuals tend to be out of high school.

In order to simplify the interpretation of the coefficients in the tables 3 and 4, table 5 reports results of regressions that replace the monthly dummy variables with a summer dummy variable for the months of June, July and August. This alteration yields the following regression:

$$suiciderate_{mys} = \text{summer}_m + y_y + s_s + u_{smy}. \tag{2}$$

The results from the regression of equation (2) is reported in table 5, where each regression is weighted by the population of interest. Consistent with the results above, 14 to 17 year olds and 17 year olds have a significantly lower suicide rate in summer compared to the rest of the year. Specifically, the summer months decrease the 14 to 17 year old suicide rate by 1.38 per 100,000 and the 17 year old suicide rate by 1.64 per 100,000. By the time 18 year olds reach the summer, their suicide rate is no different in the summer compared to the rest of the year. The 19 year old suicide rate is higher in the summer relative to other months, however, the summer increase is insignificant for 20 year olds. The 19 to 25 age group has a significantly higher suicide rate in the summer than the rest of the year.

Table 5: The Summer Effect-Age Specific Results

	14 to 17 Years Old (1)	17 Years Old (2)	18 Years Old (3)	19 Years Old (4)	20 Years Old (5)	19 to 25 Years Old (6)
Summer	-1.38***	-1.64***	0.04	1.39***	0.49	0.54***
	(0.10)	(0.20)	(0.51)	(0.45)	(0.47)	(0.18)
Constant	5.19***	8.42***	9.07***	9.65***	12.74***	14.45***
	(0.25)	(0.51)	(0.59)	(0.68)	(0.50)	(0.37)
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	15300	15300	15300	15300	15300	15300
R^2	0.14	0.05	0.06	0.05	0.05	0.25

***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level
All regressions contain state and year fixed effects, but not demographic controls.
Standard errors clustered at the state level are reported. Each regression is population weighted.

Table 3, 4 and 5 show that there is a significant effect of summer on suicide for the youth that disappears when they reach 18 years old. While the results above address a number of questions about the differential effect between youths and adults, there are still regional and gender difference that must be explored, as well as whether the summer effect is consistent over time and if youth suicide follows the same pattern as other leading causes-of-death.

4.2 Stability of the Summer Effect

In order to determine the stability of the summer effect found above, equation (2) is estimated separately for each year between 1980 and 2004. Figure 4 plots the summer coefficient for equation (2) with the year on the horizontal axis and the yearly effect of summer months on the youth suicide rate on the vertical axis. Every year the coefficient estimate of summer is negative, and the coefficient is insignificant in only four of the years. In 16 of the 25 years, the coefficient is between -1.00 and -2.00 per 100,000.

While the strong summer pattern appears generally stable over time, since the mid-1990s, the value of the coefficient has become slightly smaller in magnitude. If this were to become more pronounced in the future, it would be consistent with the general movement towards lengthening the school calendar. In the past, the school year typically began in September and ended in May, but more recently, the beginning of the school year has moved to mid-August and ended in June.

Figure 5 plots the yearly summer coefficient for 19 to 25 year old suicides. The graph shows that the 19 to 25 year old summer coefficient is also generally stable, but the coefficient is centered slightly above zero. This is consistent with the coefficient of 0.54 found in table 5. The most noteworthy result from figure 5 is that the summer coefficient for 19 to 25 year olds is negative in only four years, and each of these years, they are highly insignificant. Together, figures 4 and 5 provide further evidence that the summer suicide decrease is absent for those out of high school, but is stable and negative for the youth over time.

4.3 Seasonal Affective Disorder

A possible explanation for the youth suicide pattern is the annual summer decrease is not because of summer vacation, but instead is because of the major depressive disorder, Seasonal Affective Disorder (SAD). Estimates of the prevalence of SAD in the US ranges from 1.5 to 10 percent of the population (Kasper et al., 1989, Rosen et al.,

Figure 4: Stability of Youth Summer Effect

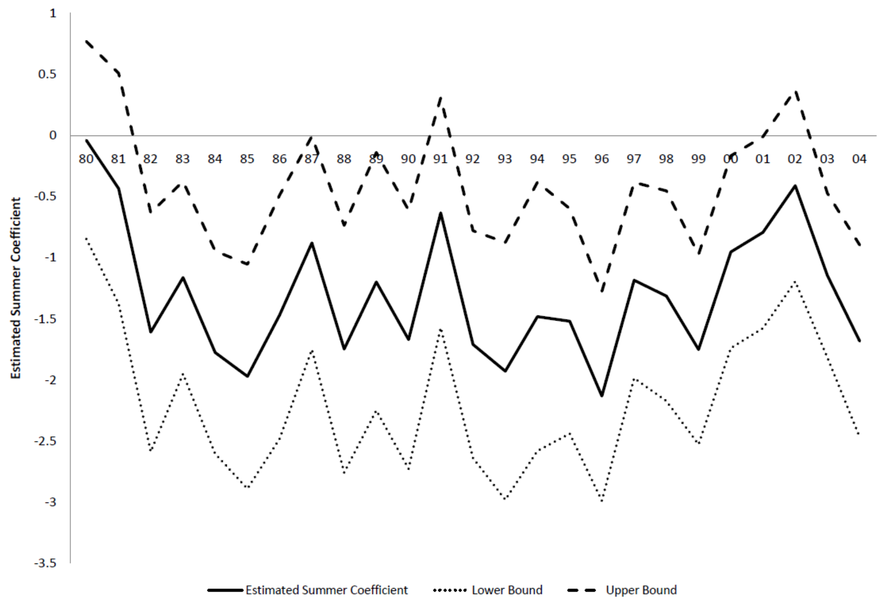
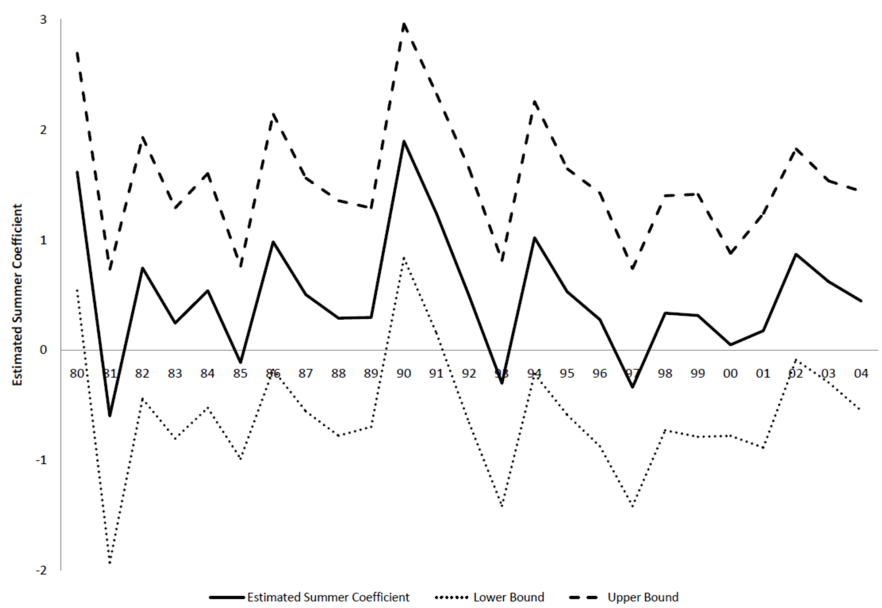


Figure 5: Stability of 19 to 25 Year Old Summer Effect



1990), and cause individuals to experience recurring episodes of depression during the winter months that disappear during the summer (Rosenthal et al., 1984). If the seasons were to drive the results above, it is unlikely there would be such a sudden drop in the suicide rate. In the regressions and figures above, there is a sharp decrease in suicide in June compared with May, not a gradual suicide decline throughout the spring that a SAD driven pattern would predict.

However, in order to convincingly eliminate SAD as a possible explanation for the summer effect, the analysis must go beyond looking at descriptive statistics. There are two prominent characteristics of SAD, gender and regional differences, that can exploited in order to more accurately determine the role that SAD plays in the results above. Specifically, females are diagnosed with SAD three to nine times more than males (Weissman and Klerman., 1977, Lucht and Kasper, 1999, Wirz-Justice et al., 1986, Thompson and Isaacs, 1988, Kasper and Neumeister, 1994). If SAD were playing a significant role, then female suicide would be driving the summer effect, while the change in male suicide over the summer would not be as large. By analyzing the male and female summer effects separately, it is seen that males are driving the results above, further diminishing the role of SAD in the youth summer effect.

A second important characteristic of SAD is that exposure to sunlight plays a significant role in the disorder (Molin et al., 1996). Prior studies have shown that the prevalence of SAD in Florida is only 1.5%, but 9% in the northern US (Rosen et al., 1990, Booker and Hellekson, 1992). Other studies have shown that there is a positive relationship between the prevalence of SAD and latitude in the US (Mersch et al., 1999). This implies that states with harsher winters should experience a larger decrease in suicide over the summer, compared to states with mild winters. By examining the differential summer effect between youths and 19 to 25 year olds in different parts of the country, the role that SAD plays in suicide, as well as in the summer effect can be analyzed. The next two sections explore the gender and regional differences in the youth summer effect.

4.3.1 Gender Differences

As mentioned above, SAD affects females three to nine times more than males. In order to estimate the role SAD plays in the summer effect, male and female suicide rates are measured separately. Table 6 reports the regressions of youth and 19 to 25 year old male and female suicides on the summer dummy, along with state and year fixed-effects. Again, the demographic controls are omitted in order to retain all the observations, but the same conclusions are reached when including them in the regression.

Columns (1) and (2) of table 6 report the results of male suicide rates for 14 to 18 year olds and 19 to 25 year olds, while columns (3) and (4) report the female suicide results. It is straightforward to see that the summer effect for males is larger than females, with male the differential being 2.68 per 100,000 while the female differential is 0.84 per 100,000. While this does not conclusively rule out SAD as a driver of the summer effect, if SAD were playing a significant role in the results above, the female differential would be significantly larger than the male differential.

Table 6: The Summer Effect by Gender

	Males		Females	
	14 to 18 Years Old	19 to 25 Years Old	14 to 18 Years Old	19 to 25 Years Old
	(1)	(2)	(3)	(4)
Summer	-1.90***	0.78***	-0.65***	0.19**
	(0.19)	(0.20)	(0.08)	(0.08)
Constant	10.50***	24.86***	1.86***	4.96***
	(0.39)	(0.62)	(0.20)	(0.22)
State Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
N	15300	15300	15300	15300
R^2	0.15	0.22	0.05	0.07

***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level
All regressions contain state and year fixed effects, but not demographic controls.
Standard errors clustered at the state level are reported. Each regression is population weighted.

The differential summer effect of males and females can be explored in more detail by looking at the effect of the summer on specific age groups. Table 7 reports the results of the summer effect by gender for the ages of 17, 18 and 19 year olds, with male results in the first three columns and female results in the last three. The male 17 year old suicide rate decreases significantly by 2.23 per 100,000 in the summer, but the male 19 year old suicide rate increases by 0.24, and is insignificant, for a total differential of 2.37 per 100,000. Female 17 to 19 year olds only have a differential of 1.06 per 100,000. These results support the previous table and show that the difference in male suicide rates in the summer are driving the summer effect found above. This finding, combined with the fact that SAD is significantly more prevalent in females than males, suggests that the role that SAD plays in explaining the summer effect is limited.

Table 7: The Summer Effect by Gender-Age Specific Results

	Males			Females		
	17 Years Old	18 Years Old	19 Years Old	17 Years Old	18 Years Old	19 Years Old
	(1)	(2)	(3)	(4)	(5)	(6)
Summer	-2.23***	-1.47***	0.24	-1.02***	-0.39**	0.04
	(0.36)	(0.47)	(0.50)	(0.16)	(0.19)	(0.19)
Constant	14.54***	18.15***	16.55***	2.09***	2.25***	4.40***
	(0.85)	(0.85)	(1.19)	(0.38)	(0.38)	(0.48)
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	15300	15300	15300	15300	15300	15300
R^2	0.04	0.05	0.04	0.02	0.01	0.01

***: significant at the 1% level; **: significant at the 5% level; *: significant at the 10% level
All regressions contain state and year fixed effects, but not demographic controls.
Standard errors clustered at the state level are reported. Each regression is population weighted.

4.4 Regional Summer Effect

The previous section clearly shows that males are driving the summer effect, but because SAD is a disorder related to sunlight, it is important to explore what the summer effect is in areas with harsh winters compared to those with mild winters. Column (1) of table 8, that reports the youth summer effect coefficient for the different census division of the country. The only outlier in column (1) is the Mountain division, with a summer effect of -2.62 per 100,000. While the Mountain division does contain states that have harsh winters (Idaho, Montana), it also includes states with considerable sunshine throughout the year (Arizona and Nevada). The summer effect of the remaining divisions all fall between -0.94 per 100,000 and -1.87 per 100,000.

Column (2) shows the summer effect in the census divisions for 19 to 25 year olds. As expected, the coefficients tend to be positive and, for a majority of the divisions, insignificant. Column (3) reports the difference in the summer effect between youths and 19 to 25 year olds for the different census divisions. These results show that the summer effect in the Mountain division is much larger than every other division. The West North Central and West South Central have the next biggest differentials at 2.15 and 2.09 per 100,000, respectively.

One may argue that SAD is driving the results in the West North Central as it includes Minnesota, North and South Dakota and Iowa. If the prevalence of SAD is higher in those states, then differential is expected be larger than in the other regions. By that reasoning, a large differential should also be observed for New England, but the differential summer effect there is the lowest among the divisions. Furthermore, the differential in the West South Central region (Arkansas, Louisiana, Oklahoma and Texas) is nearly the same as the West North Central, but the winters in West South Central are relatively mild compared to the West North Central.

Table 8: Differences in Census Division Summer Suicide Rate

Census Division	Youth (1)	19 to 25 Years Old (2)	Youth - 19-25 Year Olds (3)
New England	-1.61***	-0.62	0.99
	(0.35)	(0.40)	
Mid-Atlantic	-1.03***	0.14	1.17
	(0.19)	(0.26)	
East North Central	-1.44***	0.07	1.51
	(0.22)	(0.27)	
West North Central	-1.87***	0.28	2.15
	(0.35)	(0.41)	
South Atlantic	-0.94***	0.79***	1.73
	(0.22)	(0.28)	
East South Central	-0.95***	0.38	1.33
	(0.35)	(0.44)	
West South Central	-1.03***	1.06***	2.09
	(0.30)	(0.36)	
Mountain Division	-2.62***	1.48***	4.10
	(0.46)	(0.57)	
Pacific Division	-1.18***	0.62**	1.80
	(0.22)	(0.27)	

***: significant at the 1% level; **: significant at the 5% level
All regressions contain year fixed effects, but not demographic controls.
Each regression is population weighted. Robust standard errors are shown.

Table 8 does not show a differential trend in summer effects across the country that can be explained by SAD. But there are considerable differences in weather conditions within the divisions, prompting us to examine the summer effect by tercile of latitude in the country. Table 9 reports the summer effect on suicide for each of the three different latitude terciles for the youth age group, 19 year olds and 19 to 25 year olds. The lowest tercile results in column (3) show the largest summer effect with a decrease of 1.01 suicides per 100,000. If SAD explained the summer effect results in previous regressions, the highest tercile in latitude would be driving the results, as the winters in the northern part of the US are more severe than the south. Instead, not only is the largest summer effect observed in the lowest tercile, but the differential effect between the youth and 19 to 25 year olds is the largest in the lowest tercile as well. This provides further evidence that SAD is not playing a significant role in the summer effect observed above.

Table 9: The Summer Effect by Latitude

	Highest Tercile (1)	Middle Tercile (2)	Lowest Tercile (3)
Summer Effect			
Youth	-0.75	-0.56*	-1.01***
	(0.43)	(0.27)	(0.34)
19 Years Old	1.23	1.34	0.57
	(0.86)	(1.00)	(0.80)
19 to 25 Years Old	0.14	0.73*	1.14***
	(0.48)	(0.41)	(0.23)
Youth - 19 to 25 Year Old	0.89	1.29	2.15

***: sig. at the 1% level; **: sig. at the 5% level; *: sig. at the 10% level
All regressions contain state and year fixed effects, but not demographic controls. Standard errors clustered at the state level are reported.
Each regression is population weighted.

When considering the role that SAD plays in the decrease in youth suicide over the summer, two important characteristics are analyzed in order to eliminate SAD an explanation of the summer effect. First, females are significantly more prone to having SAD than males. In order for SAD to be a direct factor in the summer effect, it would have to be that the summer effect for females is noticeably larger than males. The opposite holds true though, and table 6 and 7 show that males are the gender driving the summer effect results.

A second component of SAD is that it is known to impact more northern areas, where winters are longer, than southern areas of the US. Table 8 shows the summer effect by census division and finds no discernible pattern in the differential summer effect across regions. Regressions are also run by latitude tercile and it is found that both the summer effect and the differential summer effect between the youth and 19 to 25 year olds are largest in southern part of the country. The symptoms of SAD predict that the differential summer effect should be the largest in the highest latitude tercile. These points, along with the fact that there is a sudden drop in suicide instead of gradual decrease over the spring convincingly rules out SAD as an explanation for the summer effect. This is not to say that SAD does not play a role in the suicide decision, however, these points show that the monthly suicide pattern coinciding with the academic calendar drowns out any effect from SAD that may exist.[2]

[2]Related to SAD, is another finding in the psychiatry literature that alergies may be related to suicide seasonality, as discussed in Postolache et. al (2005). However, while we document a sharp drop off in suicides during summer months for youth, they document a seasonality peaks in spring and fall for both older and younger ages.

Figure 6: Youth Murder Count by month, 1980-2004

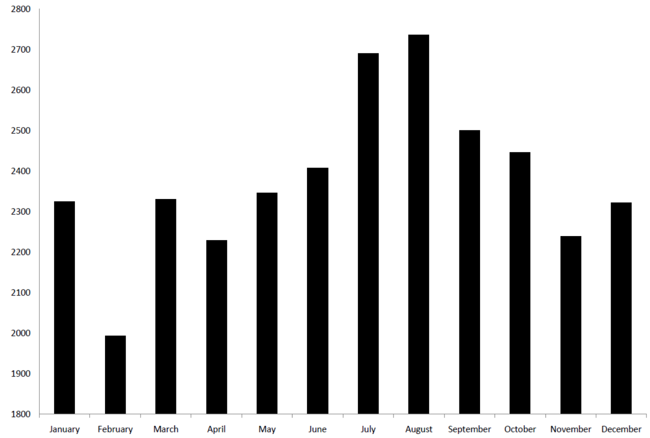
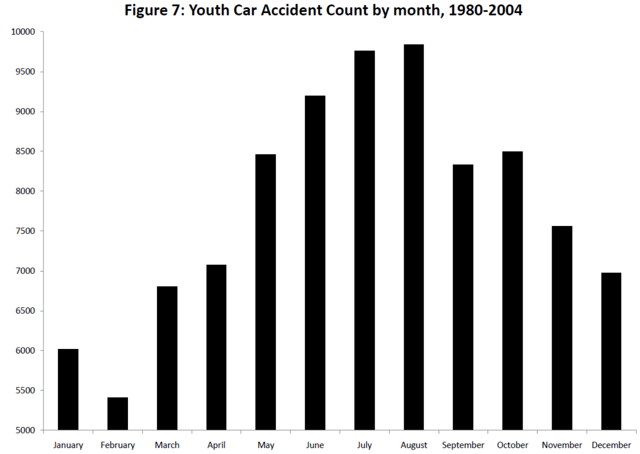


Figure 7: Youth Car Accident Count by month, 1980-2004



4.5 Seasonal Patterns of Youth Murder and Car Accident Deaths

The previous sections have shown that the summer effect has been stable over time and is not being driven by SAD. A final issue that is addressed is whether the summer effect observed in youth suicide is simply the seasonal pattern of unnatural youth deaths in general. To that end, this section analyzes the seasonal pattern of the two largest causes-of-death for youth, murder and car accidents, in order to confirm that the seasonal summer effect is unique to youth suicide.

Figures 6 and 7 show the aggregate youth murder and car accident count by month from 1980 to 2004. Unlike the youth suicide pattern observed in figure 1A, the youth murder and car accident deaths are highest in the summer months of July and August. Both causes-of-death have the general shape of a bell curve, and the only months where there are significant drops in deaths are between August and September and then again in January and February.

The fact that murders and car accidents increase in the summer is interesting in its own right, but beyond the scope of our analysis here. What can be observed from figures 6 and 7 is that the decrease in youth suicide during the summer months is not seen in youth murders and car accidents.

Table 10: The Summer Effect for Murder and Car Accidents

	Youth Murder (1)	Youth Car Accident (2)	Youth Suicide (3)
Summer	0.48**	3.62***	-0.83***
	(0.21)	(0.53)	(0.51)
Constant	8.54***	43.97***	16.55***
	(0.74)	(0.91)	(1.19)
State Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
N	15300	15300	15300
R^2	0.44	0.60	0.19

***: significant at the 1% level; **: significant at the 5% level
All regressions contain state and year fixed effects, but not demographic controls. Standard errors are clustered at the state level. Each regression is population weighted.

Before concluding that murders and car accidents do not have a negative summer effect, regressions can be run to further confirm that murders and car accident do not decrease during the summer months. Table 10 shows the regression results of equation (2) and similar to above, the population weighted regressions include state and year fixed effects and standard errors are clustered at the state level. Column (1) reports the results of the summer effect on the youth murder rate. Consistent with figure 6 above, the murder rate is significantly higher in the summer months compared to the rest of the year. Results for youth car accidents are reported in column (2) and show that in the summer months, the car accident rate increases by 3.62 per 100,000. Both these results contrast the youth suicide results in column (3) showing that youth suicide decreases by 0.83 per 100,000 in the summer months. The results in table 10 confirm the visual evidence in figure 6 and 7 and show that the seasonal pattern of youth murder and car accidents does not mimic the seasonal youth suicide pattern.

5 Conclusion

Recent high profile criminal cases in Massachusetts have anecdotally demonstrated the increased stress and decreased mental health that students can face as a result of being in school. Jacob and Lefgren (2003) start to address the relationship between stress and school empirically and document an increase in school violence due to stress. But until now, there has been no rigorous empirical work on the relationship between youth suicide and school. This paper began by presenting a stylized fact showing that youth suicide appeared to follow the academic calendar closely, but the pattern ceased to persist into adulthood. Age specific graphs confirmed that the summer effect was isolated to those younger than 18. Regression results showed that the summer effect was robust to economic and social indicators and was isolated to high school aged individuals. The summer effect is stable over time, with yearly regressions showing that most years in the data have a significant summer effect for youths.

In order to eliminate Seasonal Affective Disorder (SAD) as a possible explanation for the seasonal suicide pattern, gender specific regressions show that males are driving the results, while females are diagnosed with SAD more often. The effect of SAD on the seasonal pattern is minimized further when analyzing latitude tercile regressions and observing that southern states have a larger summer effect differential than northern states. A last robustness check shows that the summer decrease in suicides is not mimicked by youth murders or car accidents, the two most common causes-of-death for youth.

The results above not only show a distinct drop in suicide during the summer months, coinciding with a break from the stress of secondary school, but may help explain the recent rise in youth suicide over the past half century as the length of the school increases and academic standards rise. The relationship we find between school months and suicide is not meant to take away from the noted benefits of schooling, but instead encourage those in the debate over school length to recognize the hardships that come from more schooling for some students. In order to more accurately diagnose what is leading to the increased suicide during school months, further research is needed. To that end, in future research we intend to isolate the impact of schooling on suicide by exploiting changes in school calendars in the US and abroad, as well as variation in school policies which may minimize the increase in suicide during the school year.

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