Risk Factors for Suicide Clusters in Maryland Public Schools

by

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Summary of MPH Goals Analysis

Regarding my skills and experiences

With my background in the social sciences and a unique blend of professional skills, my social-psychological perspective and qualitative research training inform my approach to tackling complex public health problems. Throughout my training in public health, I have learned quantitative methods that augment my approach to complex public health problems, and I have developed strategies for cross-disciplinary collaboration, leadership, and problem-solving. In my capstone project, I intentionally stretched myself to incorporate biostatistical methods and an epidemiological lens to research into the formation of suicide clusters.

Regarding my education and career

It is my goal to serve in an organizational research or leadership position aimed at supporting the mental health and well-being of teens in the education, government, or nonprofit sector, with a focus on using evidence-based interventions to reform industry-based mental health practice. Through evidence-based practice and translational research, I aim to equip educators, mentors, and parents of young adults struggling with suicidality with the life-saving tools they need for supporting their loved one.

As a result of networking and research available through JHSPH, in combination with my capstone focus on suicide clusters, I intend to pursue employment and career growth in a research or leadership role with the Greater Baltimore Regional Integrated Crisis System (GBRICS), the Penn Innovation in Suicide Prevention Implementation Research (INSPIRE) Center, the American Foundation for Suicide Prevention (AFSP), the Suicide Prevention Resource Center (SPRC), the American Association of Suicidology (AAS), or another industry, education, or government partner organization.

Regarding my personal and professional development

In my opinion, there are still two urgent needs for reforming community-based approaches to suicide prevention:

(1) Using evidence-based targeted interventions to identify symptoms of suicidality in young people at an early age, and

(2) Helping the public better understand the social and behavioral consequences of suicidality, as well as the resources that are available to people in crisis and their loved ones before, during, and after a suicidal crisis.

With my capstone, my content focus areas on adolescent suicide and suicide clusters have well-prepared me to pursue systems-level change for suicide prevention and intervention. In addition, I have developed myriad professional skills that will undoubtedly be an asset in suicide prevention research with a public health lens: quantitative methodology, grants portfolio management, budgeting, biostatistical methods, and epidemiological approaches.

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Abstract

In this study, we explored school-level characteristics that might be predictive of adolescent suicide deaths and suicide clusters. We merged the death records of teens who died by suicide with school-level data about Maryland public high schools. Schools were identified for 171 teens between ages 11-18 who died by suicide between 2007-2019. We accessed school-level data from 2019 for 242 Maryland public high schools. After merging the death records and school characteristics to discern which schools experienced one or more student suicide deaths during pre-specified time frames, we used 233 schools in this study. We used univariate logistic regression to determine which school characteristics were predictive of suicide deaths or suicide clusters on their own, and we analyzed those statistically significant school characteristics in the full models. The results indicate that schools from medium metro areas and schools where 20.1-40% of the student body was economically disadvantaged had higher odds of at least one suicide death from the school ("ever suicide"). Schools with a Star Rating of 4 (overall rating) had higher odds of a narrow clusters (i.e. more than one suicide death in a 12-month period). Schools where 40.1-60% of the student body received free or reduced-price meals had lower odds of a wide cluster (i.e. more than one suicide death in a four-year period). These results have important implications for suicide prevention as cluster prevention, and for suicide postvention as prevention. We argue that school-and-community-based suicide prevention efforts are imperative for preventing suicide clusters in schools, as well as suicide deaths.

Keywords: adolescent suicide, suicide clusters, suicide in schools, high schools

Introduction

Adolescent suicide and school-based suicide clusters are complex and urgent public health problems. Suicide is the second leading cause of death among people ages 10-34 in the United States (Centers for Disease Control and Prevention 2020). Suicide clusters in schools, while rare, can have traumatic and long-term effects on the school and community (Hawton et al. 2020; Leenaars et al. 2001). Suicidal ideation among teens poses a particular threat to public mental health, and this is well-documented in existing literature (Mueller and Abrutyn 2015; Mueller, Abrutyn, and Stockton 2015; Wilcox et al. 2010). Suicide contagion is often referred to as a likely cause of suicide clusters, and the effects of suicide contagion among teens are also well-documented (Baller and Richardson 2009; Barash, Cameron, and Macy 2012). Despite researchers' attempts to describe how psychological, psychosocial, social contagion, and social integration mechanisms contribute to suicide clusters (Haw et al. 2013; Lake and Gould 2014; Mueller, Abrutyn, et al. 2021), we know very little about the characteristics that are predictive risk factors for suicide clusters.

Definitions of suicide clusters vary widely (Lake and Gould 2014; Niedzwiedz et al. 2014), and existing research is not sufficient for understanding why suicide clusters occur (Hawton et al. 2020).

This study investigates characteristics of public high schools that may be predictive risk factors for suicide clusters. Point clusters are defined by Lake and Gould as spatial temporal suicide clusters that occur within a localized community, such as a school or town (Lake and Gould 2014). In this study, we analyzed the direct link between suicide clusters and school characteristics, using a retrospective analysis of mortality data to identify where point clusters occurred. We use the term "suicide clusters" in reference to school-based "point clusters," and we use these terms interchangeably.

Background

This study addresses the call for investigation into links between individual suicide deaths and the broader context (Abrutyn, Mueller, and Osborne 2020; Baller and Richardson 2009; Mueller, Abrutyn, et al. 2021; Mueller and Abrutyn 2016; Niedzwiedz et al. 2014). In this study, we combined two of the most common methods for investigating suicide clusters:

(1) We identified groups of suicides that occurred in particular areas within a particular time frame, and mapped the associations between individuals who have died (Robinson et al. 2016). In this study, we used the school that individuals were attending at their time of death to define associations between the deceased. We did this by examining death records from the Office of the Chief Medical Examiner of Maryland. We used death records, social media posts, and obituaries to identify the school the individual was attending at their time of death, and then we were able to identify which schools experienced suicide clusters.

(2) We used a rigorous quantitative logistic regression analysis to investigate school characteristics that may have been predictive of suicide clusters based on greater than expected numbers of suicides that occurred from particular schools within a particular time frame (Haw et al. 2013; Robinson et al. 2016). This was novel for two reasons:

   i. We combined mortality data with education data, using school characteristics from the Maryland State Department of Education (MSDE).

   ii. We investigated clusters of suicide deaths, not clusters of suicide attempts. Previous literature suggests that the broader context surrounding clusters of

suicide attempts may be different but overlapping with those factors that influence clusters of suicide deaths (Fowler et al. 2013; Gould et al. 1994; Too et al. 2017, 2019).

Risk factors that predict point clusters of suicide deaths are still poorly understood. Therefore, we aim to expand the work of previous researchers by elucidating the predictive risk factors of schools that predict possible subsequent suicide deaths that follow in a point cluster.

Epidemiology of suicide

Understanding the epidemiology of suicide among teens is a starting point for understanding the epidemiology of suicide clusters. Turecki and Brent offer a systems-level interactional model for suicide risk, which depicts the interrelationships between distal and proximal factors and environmental factors that contribute to suicidal ideation and death (Figure 1). This model is unique because it outlines environmental and contextual factors that could contribute to individual suicide risk, such as the impact of media reporting, the impact of lethal means, and the impact of access or lack of access to mental health care (Turecki and Brent 2016). However, understanding risk and protective factors for individual suicides, while important, is not enough for understanding the relationship between a sentinel suicide death and subsequent suicide deaths that follow in a point cluster. Environmental and contextual factors inevitably play a role in the formation of point clusters, and these factors must be considered within the context of the school and community.

It is clear from previous research that exposure to another person's suicide is a risk factor that contributes to an individual's suicide risk (Aguirre and Slater 2010; Feigelman and Gorman 2008; Gould et al. 2018; Hawton et al. 2020; Hill, Spittal, et al. 2020; Hill, Too, et al. 2020; Mueller et al. 2015; Swanson and Colman 2013). Researchers refer to sociopsychological phenomena such as diffusion or contagion (Baller and Richardson 2009; Cheng et al. 2014; Hawton et al. 2020; Hazell 1993), network proximity and geographic proximity (Baller and Richardson 2002; Granovetter 1983; Sugg et al. 2021; Too et al. 2017), imitation (Abrutyn and Mueller 2014a, 2014b; Baller and Richardson 2002; Gould 2001; Gould, Wallenstein, and Davidson 1989), suicide acceptability (Kleiman 2015), and social integration (Baller and Richardson 2002; Mueller and Abrutyn 2016; Mueller et al. 2015) to help explain suicide clusters. In one analysis of students' reasons for attempting suicide, six of the most common reasons for attempting suicide involve a social relationship or social interaction (Jacobson et al. 2013), further underscoring the influence of social factors on suicidal ideation and death.

For understanding the epidemiology of suicide clusters, it is imperative to situate individual suicide risk within the context of environmental, contextual, sociocultural, and sociopsychological factors, each of which interplay in a complex system that leads to point clusters.

Epidemiology of suicide clusters

What we know about the epidemiology of suicide clusters is much more limited. Building on the work of previous researchers, we offer a systems-level diagram to illustrate the complex interplay of factors surrounding school-based point clusters (Figure 2). Appendix A provides a detailed description of the systems-level diagram.

We know that suicide clusters happen more frequently in teens and young adults (Fowler et al. 2013; M. S. Gould et al. 1990; Madelyn S. Gould, Wallenstein, and Kleinman 1990; Hawton et al. 2020; Poland and Ferguson 2021; Robinson et al. 2016), and more frequently in rural or remote-access areas (Cheung et al. 2014; Fowler et al. 2013; Hill, Spittal, et al. 2020; Robinson et al. 2016; Sugg et al. 2021). We know that areas of suicide clusters are more susceptible to future suicide clusters (Hawton et al. 2020; Too et al. 2019). However, the

mechanisms that underlie the formation of suicide point clusters are still poorly understood (Too et al. 2017).

Suicide clusters in schools

Death by suicide is a rare event, and subsequent suicide deaths in a geographically related or time-bound period are even more rare. Clusters tend to form in small, proximate groups, such as prisons (McKenzie and Keane 2007) or psychiatric wards (Haw 1994; King et al. 1995; Taiminen, Salmenpsra, and Lehtinen 1992). But, only a small number of researchers to date have explored the epidemiology of point clusters in schools and universities (Abrutyn and Mueller 2014a; Brent et al. 1989; Poijula, Wahlberg, and Dyregrov 2001; Poland and Ferguson 2021; Rickwood et al. 2018).

Researchers postulate that "suicide acceptability" is a cultural norm that may contribute to the formation of suicide clusters in schools. What this means is that small groups or societies develop a shared meaning or understanding of a phenomenon, in this case suicide, and the "acceptableness" of suicide. In other words, the degree to which suicide is perceived as an option becomes culturally agreed upon and more readily accessible to individuals (Abrutyn et al. 2020; Kleiman 2015; Phillips and Luth 2018). Adolescents are particularly susceptible to shared meaning-making (Abrutyn et al. 2020; Kleiman 2015), which could help explain the acceptability of suicide in point clusters in high schools.

Despite limited investigation into point clusters in schools, much has been published on using postvention as prevention, that is, using the aftermath of a suicide death to intervene within schools or communities and implement suicide prevention strategies. Some of the most common suggestions for suicide postvention as prevention include: improving school students' and staff members' knowledge about suicide (Katz et al. 2013), gate keeper training for school staff and adolescent peers (Robinson et al. 2013), bereavement support (Gould et al. 2018; Hawton et al. 2020), and targeting community interventions or community response plans towards specific groups that are vulnerable to suicide (Cox et al. 2012; Gould et al. 2018).

Methods

This study is part of the "School Clustering After Recent Suicide (SCARS) Study," which was reviewed and approved by the Johns Hopkins School of Medicine Institutional Review Board (IRB).

Identifying deaths

All death records of teens in Maryland who died by suicide from 2007 to 2019 were provided by the Office of the Chief Medical Examiner of Maryland. We started with limiting the sample of suicide deaths to only include deaths that occurred between January 1, 2007 and December 31, 2019, and for individuals who were between 11-18 years old at the time of death. 216 deaths met our criteria.

Identifying schools

Using the medical examiner report in the death records, social media posts, and obituaries, we identified the school that the student was attending at the time of death. We limited our search to students who were attending public high schools at their time of death. We identified students from public high schools for 171 deaths. We used this information to identify which public high schools in Maryland experienced any suicide death from 2007-2019, and which schools experienced suicide point clusters.

Identifying school point clusters

We identified schools in Maryland that had at least one suicide death between 2007-2019, but not more than one suicide death in a point cluster. We called these "ever suicide" schools. Based on students' dates of death and the school they were attending at their time of death, we classified schools with "narrow clusters" as having more than one suicide death from the same school within a 12-month period, excluding the sentinel death. The sentinel death is first suicide death event from a school, and the sentinel death was not included in the identification of suicide clusters. We classified schools with "wide clusters" as having more than one suicide death from the same school within a four-year period, excluding the sentinel death.

These definitions of suicide clusters are consistent with previous research suggesting that investigators may use discretion in choosing the time interval of suicide clusters (Lake and Gould 2014). While four years is a broad time frame for classifying point clusters, we based the definition of wide clusters on the premise that a student may have known someone personally or known of someone else from their school who died by suicide during their time as a student at the same school.

There were no suicide clusters that took place among students from non-public schools.

There are two main limitations with this classification of narrow clusters and wide clusters in schools:

(1) We may have missed schools that had a subsequent suicide death in a school-based point cluster if other suicide deaths occurred after December 31, 2019.

(2) We only identified the school the student was attending at the time of their death. If the student transferred between multiple schools, we were unable to identify whether there may have been other suicide deaths related in a point cluster from their previous school(s).

Identifying school characteristics

In this study, the school characteristics are data from the 2019 Maryland School Report Card collected by the Maryland State Department of Education (MSDE) (Department of Education 2019), except for geographic rurality. The Maryland School Report Card provides indicators of academic progress, academic achievement, and school performance. The indicators used in this analysis are Star Rating (overall rating), dropout rate, graduation rate, chronic absenteeism, attendance rate, academic achievement as measured by a rigorous GPA of above 3.0, readiness for postsecondary success as measured by college enrollment within 12 months after graduation, progress in achieving English language proficiency, students receiving free and reduced-priced meals, students with disabilities, and students with economic disadvantage (Department of Education 2019).

The geographic rurality of the school was identified with the National Center for Health Statistics (NCHS) Urban-Rural Classification Scheme for Counties (Ingram, Franco, and US Department of Health and Human Services 2014). The basic framework of the NCHS Urban-Rural Classification Scheme outlines six categories of rurality based on delineations of metropolitan and micropolitan statistical areas, and 2012 postcensal estimates of the US population. The six categories of rurality are large central metro area, large fringe metro area, medium metro area, small metro area, micropolitan area and non-core area (Ingram et al. 2014).

We refer to the geographic rurality and the MSDE School Report Card characteristics collectively as "school characteristics." Appendix B describes the specific and complete definition for each of the school characteristics.

After merging the death records and school characteristics, we used 233 schools in the analysis. We tested the variables in this analysis to gauge which school characteristics were predictive of ever suicide, narrow clusters, or wide clusters. The baseline school characteristics for Maryland public high schools are shown in Table 1.

Analysis

We collapsed the MSDE Report Card measures into covariates with quintiles that represent percentages of the student body, where "low percentage" between 0-20% of the student body is the reference category. For Star Rating, Rating of 1 is the reference category, which is the lowest overall rating on a scale of 1-5 (Department of Education 2019). For the geographic rurality of the school, "large central metro area" is the reference category (Ingram et al. 2014).

We conducted a risk factor analysis to examine which school characteristics were predictive of ever suicide, narrow clusters, or wide clusters. Univariate logistic regression modeling was used to estimate the unadjusted odds ratios and 95% confidence intervals for ever suicide, narrow clusters, and wide clusters. In the full models, we dropped those school characteristics that were not statistically significant predictors at the $p<0.10$ threshold in univariate logistic regression modeling. We also dropped those school characteristics that had zero or very small cell counts for some quintiles. With low statistical power, we chose to set alpha at $p<0.10$ because we believe that there may be some predictive association between certain school characteristics and suicide clusters that are not explained by the models. We expect that setting alpha at $p<0.10$ will help with identifying any predictive factors that are marginally associated with suicide clusters.

The analyses were performed with Stata software version 16.1 (StataCorp, College Station, TX).

Missing data

Our dataset has missing data for the following reasons:

(1) The MSDE Report Card measures were first collected in 2018 (Department of Education 2019), and as such, the dataset was incomplete for 2018 and 2019. Therefore, some schools were missing some school characteristics from the data collection.

(2) We were not able to obtain school characteristics for schools that closed, renamed, or merged with other schools between the year of a student's suicide death and 2019. Because the MSDE Report Card measures were data from 2019, schools that closed, renamed, or merged with other schools are not captured, even if they were schools with at least one suicide death.

(3) Using death records, social media posts, and obituaries, we were not able to identify the school the student was attending at their time of death for about 21% of deaths. Therefore, there may be a school which had one or more student suicide deaths from 2007-2019 that we did not capture.

We have tried to account for missing data by treating it as a separate category in the logistic regression analyses. This is an imperfect solution, but allows us to compare schools with ever suicide, narrow clusters, or wide clusters with schools that have never experienced suicide deaths in their student body.

Results

Table 2 presents the unadjusted odds ratios of school characteristics for schools with ever suicide. Table 3 presents the unadjusted odds ratios of school characteristics for schools with narrow clusters. Table 4 presents the unadjusted odds ratios of school characteristics for schools with wide clusters.

The full model for ever suicide includes seven predictor variables that were statistically significant in univariate logistic regression modeling: Star Rating (overall rating), geographic rurality, chronic absenteeism, attendance rate, college enrollment, students receiving free and reduced-priced meals, and students with economic disadvantage. The full model for narrow clusters includes two predictor variables that were statistically significant in univariate logistic regression modeling: Star Rating (overall rating), and geographic rurality. The full model for wide clusters includes two predictor variables that were statistically significant in univariate logistic regression modeling: students receiving free and reduced-priced meals, and students with economic disadvantage.

Table 5 presents the bivariate correlations among all school characteristics. The bivariate correlations were important for exploring multicollinearity between variables that could be measuring similar constructs. Examples of this may be rigorous GPA and college enrollment, which are measures related to educational attainment, or free and reduced-priced meals and economic disadvantage, which are measures related to socioeconomic status. However, none of the variables showed a correlation above 0.82.

For ever suicide

When controlling for other school characteristics in the full model, there were four statistically significant categorical predictors of ever suicide. The results are shown in Table 6. Schools from medium metro areas compared with schools from large central metro areas had very high odds of ever suicide (OR 11.59, p<.10, 95% CI 0.90-149.89). Schools where 40.1-60% of students had chronic absenteeism compared with schools where 0-20% of students had chronic absenteeism had lower odds of ever suicide (OR 0.07, p<.10, 95% CI 0.00-1.43). Schools where 40.1-60% of the student body received free and reduced-priced meals compared with schools where 0-20% of students received free and reduced-price meals had lower odds of ever suicide (OR 0.02, p<.10, 95% CI 0.00-013). Schools where 20.1-40% of the student body were economically disadvantaged compared with schools where 0-20% of the student body were economically disadvantaged had higher odds of ever suicide (OR 19.17, p<.10, 95% CI 3.45-106.44).

For narrow clusters

The full model for narrow clusters examined Star Rating (overall rating) and geographic rurality. The results are shown in Table 7. Holding geographic rurality constant, schools with a star rating of 4 compared to schools with a star rating of 1 had higher odds of a narrow cluster (OR 7.31, p<.10, 95% CI 0.89-59.65).

For wide clusters

The full model for wide clusters examined students receiving free and reduced-price meals and students with economic disadvantage. The results are shown in Table 8. Holding students with economic disadvantage constant, schools where 40.1-60% of the student body received free and reduced-priced meals compared with schools where 0-20% of students received free and reduced-price meals had lower odds of a wide cluster (OR 0.16, p<.10, 95% CI 0.03-0.80).

Discussion

The results of this analysis are consistent with previous research that "good" schools, such as schools with a high number of academically high-achieving students, schools with a high overall rating, and/or schools from high socioeconomic areas have higher odds of suicide clusters (Mueller and Abrutyn 2016; Too et al. 2017). However, the results were inconclusive for drawing more specific conclusions about which school characteristics predict narrow clusters or wide clusters. This could be because that there was not enough data in our sample. Suicide is a rare event and suicide clusters are even rarer. Because there were instances when the logistic regression models could not converge, we know that some of our comparison groups across schools have too few or zero students in certain quintiles of school characteristics.

The results of this analysis are inconclusive for explaining which school characteristics related to educational attainment are more predictive of suicide clusters. Interestingly, the unadjusted odds ratios of rigorous GPA and college enrollment were not statistically significant for predicting narrow clusters (Table 3) nor wide clusters (Table 4).

Surprisingly, the results of this analysis are inconsistent for explaining which school characteristics related to socioeconomic status are more predictive of suicide clusters. The unadjusted odds ratios for wide clusters indicate that schools with higher numbers of students receiving free and reduced-priced meals or schools with higher numbers of economically disadvantaged students have lower odds of wide clusters when compared to schools with only 0-20% of students in these categories (Table 4). However, in the full model controlling for these variables, only free and reduced-priced meals was a statistically significant predictor of wide clusters (Table 8).

Strengths and limitations

The study has two primary strengths that are ground-breaking in the study of suicide clusters. First, this study is the first of its kind to use school level data from the Maryland State Department of Education in combination with mortality data form the Office of the Chief Medical Examiner of Maryland. The primary strength of our data is that suicide death records have been linked with school characteristics to identify where point clusters occurred. Second, this study uses robust statistical methods, combining two of the most common quantitative methods for investigating suicide clusters. We identified the school attended at the time of death for deaths that occurred in particular areas within a particular time frame and then used logistic regression analyses based on greater than expected numbers of suicide deaths.

There are three primary limitations to report. First, there may be point clusters that occurred from subsequent suicide deaths after 2019, and if this happened, they are not captured in our data. Second, this study does not analyze the difference between schools with suicide clusters and schools with just one suicide death. To do this, further analyses are needed comparing schools with narrow clusters with schools with ever suicide, or schools with wide clusters with schools with ever suicide. This would be helpful to shed more light on what differentiates suicide clusters from a sentinel death. Third, we did not impute missing data for school characteristics. Imputing missing data would allow more statistical power for making inferences about school characteristics that are predictive of suicide clusters.

Implications

Implications for schools. Given that schools are pillars of the community at-large, it is difficult to extrapolate strategies for school-based suicide prevention from the broader community. That said, schools can and must be a vehicle for implementing community-based interventions, as the school characteristics do not tell the whole story about the formation of suicide point clusters in narrow clusters nor wide clusters.

Postvention as prevention: school-level. In the aftermath of a suicide death, it is important that schools have immediate crisis response, grief, and bereavement resources available for the student body (Poland and Ferguson 2021). It is important for students to feel validated in their grief; schools must foster a culture of support and acceptance for students bereaved by the loss of a friend or peer (Aguirre and Slater 2010; American Foundation for Suicide Prevention 2019). In consideration of preventing subsequent suicide deaths, school professionals should be knowledgeable about suicide risk assessment and prepared for recognizing signs of ongoing distress in students (Mueller, Diefendorf, et al. 2021; Poland and Ferguson 2021).

Implications for communities. Suicide deaths impact more than just the school, and schools must be prepared to engage in cross-sector, collaborative approaches with myriad community leaders for suicide prevention strategies that focus on the child as whole, with emphasis on prioritizing mental health and wellbeing (Blanco 2020; Mueller, Diefendorf, et al. 2021).

Postvention as prevention: community-level. In the aftermath of a suicide death, it is important that schools inform the wider community, and acknowledge the community-level trauma following suicide loss (Cox et al. 2016; Leenaars et al. 2001; O'Carroll, Mercy, and Steward 1988). Schools must be prepared to engage with a wide network of community-based resources, forming a "mental health support system" around the student body (Leenaars et al. 2001; Mueller, Diefendorf, et al. 2021; O'Carroll et al. 1988; Rickwood et al. 2018).

Best practices. In 2012, the Substance Abuse and Mental Health Services Administration published a toolkit for high schools for preventing suicide that provides suggestions for building school relationships with community partners, identifying and helping students at risk of suicide, implementing short-term and long-term protocols for the aftermath of a suicide death, and educating students, parents, and staff (US Department of Health and Human Services 2012). In 2018, the American Foundation for Suicide Prevention published a toolkit for schools for the aftermath of a suicide death that provides suggestions for immediate crisis response, helping students cope, working with the community and the media, memorialization of the deceased, and suicide cluster prevention (American Foundation for Suicide Prevention 2018). Taken together, these toolkits provide actionable guidelines for schools to work alongside community partners for implementing best practices for preventing suicide and best practices for the aftermath of a suicide death, ultimately creating a school-and-community-based support network that will minimize the risk of suicide clusters.

Suggestions for future research

Additional analyses. Future research is needed to understand more fully about the formation of suicide clusters in schools. In subsequent analyses:

(1) We could explore whether interaction terms more fully capture the effect modification of certain school characteristics on the likelihood of suicide clusters.

(2) We could further explore the multicollinearity of some school characteristics, then modify the analysis to create a more robust representation of school characteristics that are predictive of point clusters.

(3) We could examine the associations between school characteristics and suicide clusters using probit models, which would model the probability of suicide clusters as a linear combination of the predictors.

Additional data. In future studies, we could include non-public schools in our analyses. To further investigate differences between ever suicide schools and cluster schools, including

non-public schools that were ever suicide schools in the comparison group could yield insightful results.

In future studies, we could combine the school characteristics from the Maryland School Report Card used in this study with data from the Maryland School Survey, which describes the quality, character, and climate of school life. Responses for the Maryland School Survey were collected from each school's students and educators, piloted in 2018 and fully administered in 2019. The items on the Maryland School Survey measure the quality of instructional feedback, student-staff relationships, student-student relationships, substance abuse, bullying, emotional safety, physical safety, physical environment, behavioral and academic supports, participation and engagement, and respect for diversity (Department of Education 2020). In future studies, we could examine how elements of the school climate are predictive of suicide clusters. Importantly, identifying which elements of the school climate are predictive of suicide clusters would shed light on which elements of the school climate need to change to prevent suicide. Examining these actionable predictors, as reported by the attitudes of students and educators within the school, would elucidate specific areas where schools should improve or modify the quality, character, and climate of school life to prevent suicide.

Additional research. For the field of suicide research, using the dates of death and the time frames of point clusters, we could further investigate how earlier point clusters might be predictive of future point clusters within a school (Too et al. 2019). Exploring the mechanisms that drive repeated suicide clusters within a school would have important implications for the community at-large. For understanding the efficacy and utility of intervention programs, we could explore differences in suicide cluster outcomes between schools that have engaged in targeted suicide prevention and intervention training and schools that have not yet implemented suicide awareness programming.

Conclusion

Suicide prevention is an important starting point for the prevention of suicide point clusters. Suicide deaths, and especially multiple subsequent deaths within a given time frame from within the same school, are devastating for students, staff, parents, and community members. While we know a lot about risk and protective factors for individual suicide, we know very little about how to predict subsequent suicide deaths in a point cluster. Suicide postvention, i.e., the aftermath of a suicide death, is a critical time for intervening with students, staff, parents, and community members to prevent subsequent suicide deaths. It takes integrated school-and-community-based resources and support systems to provide support and care for the bereaved student body and surrounding community, prioritizing mental health and overall wellbeing within a culture of safety and acceptance for grief and bereavement. Following the suicide loss of a friend or peer, the moments in the immediate aftermath and the long-term follow-up are crucial intervention times for preventing subsequent suicide deaths. The results of this study showed conflicting evidence about school characteristics that are predictors of narrow clusters or wide clusters. More research is needed to understand this tragic and rare phenomenon.

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Figure 1: Model for suicide risk (Turecki and Brent 2016)
A systems-level interactional model for suicide risk, depicting the interrelationships between distal and proximal factors and environmental factors that contribute to suicidal ideation and death

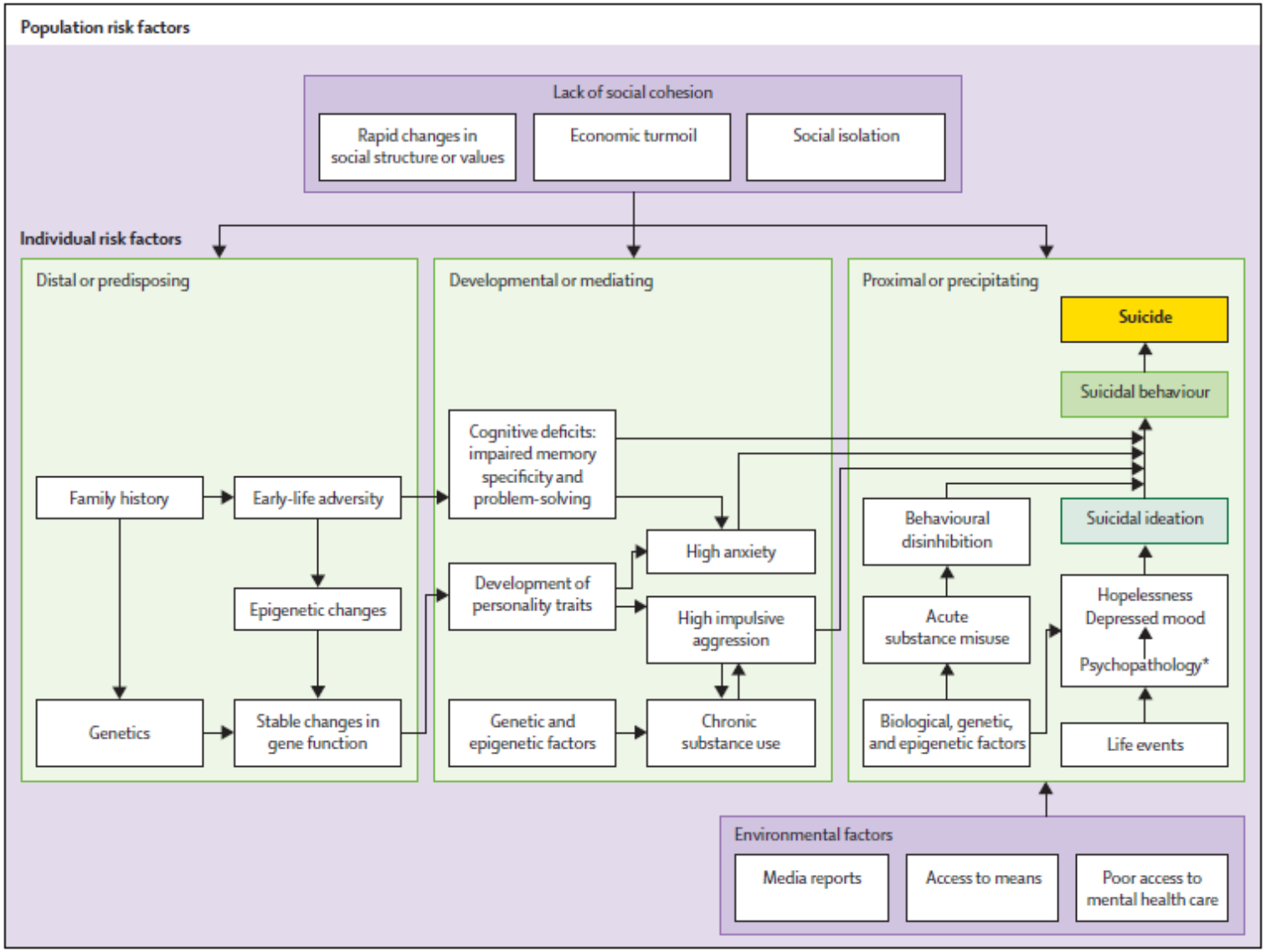

Figure 2: Systems-level diagram for school-based point clusters
A detailed description of the systems-level diagram for school-based point clusters is available in Appendix A.

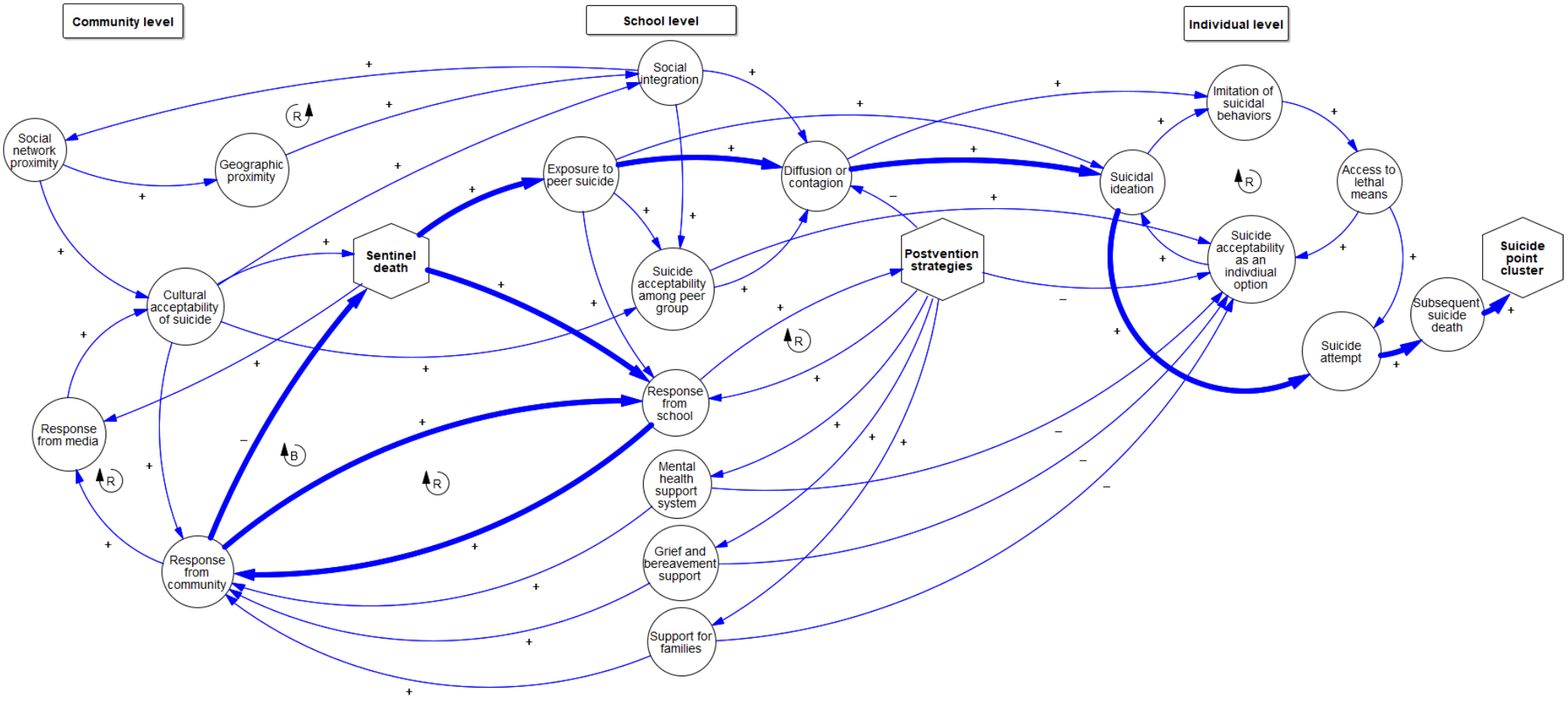

Table 1: Baseline characteristics for schools with and without suicide deaths (n=233)

School Characteristics	Ever suicide (n=98)		Narrow cluster (n=14)		Wide cluster (n=32)	
	No	Yes	No	Yes	No	Yes
	%	%	%	%	%	%
Star Rating (Composite score, 1-5)						
Missing data	0	1	1	0	1	0
	0	100	100	0	100	0
Rating of 1	17	1	18	0	18	0
	94.44	5.56	100	0	100	0
Rating of 2	25	7	32	0	32	0
	78.13	21.88	100	0	100	0
Rating of 3	42	25	65	2	61	6
	62.69	37.31	97.01	2.99	91.04	8.96
Rating of 4	38	37	64	11	56	19
	50.67	49.33	85.33	14.67	74.67	25.33
Rating of 5	13	27	39	1	33	7
	32.5	67.5	97.5	2.5	82.5	17.5
Rurality (NHCS Urban-Rural Classification Scheme, 1-6)						
Large central metro area	32	4	36	0	36	0
	88.89	11.11	100	0	100	0
Large fringe metro area	88	74	151	11	137	25
	54.32	45.68	93.21	6.79	84.57	15.43
Medium metro area	8	11	18	1	17	2
	42.11	57.89	94.74	5.26	89.47	10.53
Small metro area	2	5	5	2	5	2
	28.57	71.43	71.43	28.57	71.43	28.57
Micropolitan metro area	2	2	4	0	2	2
	50	50	100	0	50	50
Non-core area	3	2	5	0	4	1
	60	40	100	0	80	20

Table 1, cont.	Ever suicide		Narrow cluster		Wide cluster	
	No	Yes	No	Yes	No	Yes
	%	%	%	%	%	%
Adjusted 4-year Dropout rate (percentage quintiles of the student body)						
Missing data	34	33	63	4	56	11
	50.75	49.25	94.03	5.97	83.58	16.42
0-20%	71	64	125	10	114	21
	52.59	47.41	92.59	7.41	84.44	15.56
20.1-40%	25	1	26	0	26	0
	96.15	3.85	100	0	100	0
40.1-60%	5	0	5	0	5	0
	100	0	100	0	100	0
60.1-80%	0	0	0	0	0	0
	0	0	0	0	0	0
80.1-100%	0	0	0	0	0	0
	0	0	0	0	0	0
Adjusted 4-year Graduation rate (percentage quintiles of the student body)						
Missing data	34	33	62	5	55	12
	50.75	49.25	92.54	7.46	82.09	17.91
0-20%	2	1	3	0	3	0
	66.67	33.33	100	0	100	0
20.1-40%	7	0	7	0	7	0
	100	0	100	0	100	0
40.1-60%	12	0	12	0	12	0
	100	0	100	0	100	0
60.1-80%	27	6	33	0	33	0
	81.82	18.18	100	0	100	0
80.1-100%	53	58	102	9	91	20
	47.75	52.25	91.89	8.11	81.98	18.02

Table 1, cont.	Ever suicide		Narrow cluster		Wide cluster	
	No	Yes	No	Yes	No	Yes
	%	%	%	%	%	%
Students with chronic absenteeism (percentage quintiles of the student body)						
Missing data	3	3	6	0	5	1
	50	50	100	0	83.33	16.67
0-20%	26	36	57	5	50	12
	41.94	58.06	91.94	8.06	80.65	19.35
20.1-40%	59	52	102	9	92	19
	53.15	46.85	91.89	8.11	82.88	17.12
40.1-60%	18	6	24	0	24	0
	75	25	100	0	100	0
60.1-80%	17	1	18	0	18	0
	94.44	5.56	100	0	100	0
80.1-100%	12	0	12	0	12	0
	100	0	100	0	100	0
Students with good attendance (percentage quintiles of the student body)						
Missing data	17	14	31	0	27	4
	54.84	45.16	100	0	87.1	12.9
0-20%	0	1	1	0	1	0
	0	100	100	0	100	0
20.1-40%	1	0	1	0	1	0
	100	0	100	0	100	0
40.1-60%	3	0	3	0	3	0
	100	0	100	0	100	0
60.1-80%	20	1	21	0	21	0
	95.24	4.76	100	0	100	0
80.1-100%	94	82	162	14	148	28
	53.41	46.59	92.05	7.95	84.09	15.91

Table 1, cont.	Ever suicide		Narrow cluster		Wide cluster	
	No	Yes	No	Yes	No	Yes
	%	%	%	%	%	%
Students with a rigorous GPA (percentage quintiles of the student body)						
Missing data	17	2	19	0	19	0
	89.47	10.53	100	0	100	0
0-20%	28	4	32	0	32	0
	87.5	12.5	100	0	100	0
20.1-40%	33	15	47	1	47	1
	68.75	31.25	97.92	2.08	97.92	2.08
40.1-60%	38	44	75	7	64	18
	46.34	53.66	91.46	8.54	78.05	21.95
60.1-80%	16	28	39	5	33	11
	36.36	63.64	88.64	11.36	75	25
80.1-100%	3	5	7	1	6	2
	37.5	62.5	87.5	12.5	75	25
Students with college enrollment within 12 months after graduation (percentage quintiles of the student body)						
Missing data	7	1	8	0	8	0
	87.5	12.5	100	0	100	0
0-20%	12	1	13	0	13	0
	92.31	7.69	100	0	100	0
20.1-40%	15	1	16	0	16	0
	93.75	6.25	100	0	100	0
40.1-60%	40	22	59	3	55	7
	64.52	35.48	95.16	4.84	88.71	11.29
60.1-80%	44	51	87	8	76	19
	46.32	53.68	91.58	8.42	80	20
80.1-100%	17	22	36	3	33	6
	43.59	56.41	92.31	7.69	84.62	15.38

Table 1, cont.	Ever suicide		Narrow cluster		Wide cluster	
	No	Yes	No	Yes	No	Yes
	%	%	%	%	%	%
Students who are English learners (percentage quintiles of the student body)						
Missing data	93	78	158	13	144	27
	54.39	45.61	7.6	100	84.21	15.79
0-20%	24	16	39	1	35	5
	60	40	2.5	100	87.5	12.5
20.1-40%	14	4	18	0	18	0
	77.78	22.22	0	100	100	0
40.1-60%	2	0	2	0	2	0
	100	0	0	100	100	0
60.1-80%	0	0	0	0	0	0
	0	0	0	0	0	0
80.1-100%	2	0	2	0	2	0
	100	0	0	100	100	0
Students who receive free and reduced-price meals (percentage quintiles of the student body)						
Missing data	4	6	9	1	6	4
	40	60	90	10	60	40
0-20%	13	28	37	4	33	8
	31.71	68.29	90.24	9.76	80.49	19.51
20.1-40%	35	35	64	6	54	16
	50	50	91.43	8.57	77.14	22.86
40.1-60%	55	27	79	3	78	4
	67.07	32.93	96.34	3.66	95.12	4.88
60.1-80%	26	2	28	0	28	0
	92.86	7.14	100	0	100	0
80.1-100%	2	0	2	0	2	0
	100	0	100	0	100	0

Table 1, cont.	Ever suicide		Narrow cluster		Wide cluster	
	No	Yes	No	Yes	No	Yes
	%	%	%	%	%	%
Students with disabilities (percentage quintiles of the student body)						
Missing data	16	5	21	0	19	2
	76.19	23.81	100	0	90.48	9.52
0-20%	96	92	174	14	158	30
	51.06	48.94	92.55	7.45	84.04	15.96
20.1-40%	20	1	21	0	21	0
	95.24	4.76	100	0	100	0
40.1-60%	2	0	2	0	2	0
	100	0	100	0	100	0
60.1-80%	1	0	1	0	1	0
	100	0	100	0	100	0
80.1-100%	0	0	0	0	0	0
	0	0	0	0	0	0
Students who are economically disadvantaged (percentage quintiles of the student body)						
Missing data	15	17	30	2	26	6
	46.88	53.13	93.75	6.25	81.25	18.75
0-20%	56	49	96	9	85	20
	53.33	46.67	91.43	8.57	80.95	19.05
20.1-40%	30	29	56	3	54	5
	50.85	49.15	94.92	5.08	91.53	8.47
40.1-60%	25	2	27	0	26	1
	92.59	7.41	100	0	96.3	3.7
60.1-80%	9	1	10	0	10	0
	90	10	100	0	100	0
80.1-100%	0	0	0	0	0	0
	0	0	0	0	0	0

Table 2: Unadjusted odds ratios of school characteristics for schools with ever suicide

School Characteristics	Unadjusted OR	Pr		95% CI (LL)	95% CI (UL)
Star Rating (Reference category is Rating of 1)					
Rating of 2	4.76	0.16		0.54	42.28
Rating of 3	10.12	0.03	**	1.27	80.73
Rating of 4	16.55	0.01	**	2.10	130.78
Rating of 5	35.31	0.00	**	4.23	294.90
Rurality (Reference category is Large central metro area)					
Large fringe metro area	6.73	0.00	**	2.27	19.90
Medium metro area	11.00	0.00	**	2.76	43.81
Small metro area	20.00	0.00	**	2.87	139.38
Micropolitan metro area	8.00	0.07	*	0.87	73.55
Non-core area	5.33	0.11		0.67	42.23
Adjusted 4-year Dropout rate (Reference category is 0-20% of students)					
20.1-40%	0.04	0.00	**	0.01	0.34
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*a*				
Adjusted 4-year Graduation rate (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	*a*				
60.1-80%	0.44	0.53		0.03	5.74
80.1-100%	2.19	0.53		0.19	24.84
Percentage of students with chronic absenteeism (Reference category is 0-20% of students)					
20.1-40%	0.64	0.16		0.34	1.19
40.1-60%	0.24	0.01	**	0.08	0.69
60.1-80%	0.04	0.00	**	0.01	0.34
80.1-100%	*a*				
Percentage of students with good attendance (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	*a*				
60.1-80%	0.06	0.01	**	0.01	0.44
80.1-100%	*b*				
Percentage of students with a rigorous GPA (Reference category is 0-20% of students)					
20.1-40%	3.18	0.06	*	0.95	10.70
40.1-60%	8.11	0.00	**	2.61	25.19
60.1-80%	12.25	0.00	**	3.64	41.26
80.1-100%	11.67	0.01	**	1.98	68.75

Table 2, cont.

School Characteristics	Unadjusted OR	Pr		95% CI (LL)	95% CI (UL)
Percentage of students with college enrollment within 12 months after graduation (Reference category is 0-20% of students)					
20.1-40%	0.80	0.88		0.05	14.16
40.1-60%	6.60	0.08	*	0.80	54.18
60.1-80%	13.91	0.01	**	1.74	111.28
80.1-100%	15.53	0.01	**	1.83	131.45
Percentage of students who are English learners (Reference category is 0-20% of students)					
20.1-40%	0.43	0.19		0.12	1.54
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*a*				
Percentage of students who receive free and reduced-price meals (Reference category is 0-20% of students)					
20.1-40%	0.46	0.06	*	0.21	1.04
40.1-60%	0.23	0.00	**	0.10	0.51
60.1-80%	0.04	0.00	**	0.01	0.17
80.1-100%	*a*				
Percentage of students with disabilities (Reference category is 0-20% of students)					
20.1-40%	0.52	0.00	**	0.01	0.40
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*a*				
Percentage of students who are economically disadvantaged (Reference category is 0-20% of students)					
20.1-40%	1.10	0.76		0.58	2.92
40.1-60%	0.09	0.00	**	0.02	0.41
60.1-80%	0.13	0.05	**	0.02	1.04
80.1-100%	*a*				

Footnotes

*, **	*p<.10, **p<.05
a	Due to zero or very small counts for some categorical predictors, the model could not converge.
b	Some categorical predictors were eliminated from the model due to collinearity.

Table 3: Unadjusted odds ratios of school characteristics for schools with narrow clusters

School Characteristics	Unadjusted OR	Pr		95% CI (LL)	95% CI (UL)
Star Rating (Reference category is Rating of 1)					
Rating of 2	*a*				
Rating of 3	1.20	0.88		0.11	13.67
Rating of 4	6.70	0.07	*	0.83	53.95
Rating of 5	*b*				
Rurality (Reference category is Large central metro area)					
Large fringe metro area	0.18	0.06	*	0.03	1.05
Medium metro area	0.14	0.14		0.01	1.86
Small metro area	*b*				
Micropolitan metro area	*a*				
Non-core area	*a*				
Adjusted 4-year Dropout rate (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*a*				
Adjusted 4-year Graduation rate (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*b*				
Percentage of students with chronic absenteeism (Reference category is 0-20% of students)					
20.1-40%	1.01	0.99		0.32	3.15
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*a*				
Percentage of students with good attendance (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*b*				
Percentage of students with a rigorous GPA (Reference category is 0-20% of students)					
20.1-40%	0.15	0.20		0.01	2.66
40.1-60%	0.65	0.71		0.07	6.10
60.1-80%	0.90	0.93		0.09	8.89
80.1-100%	*b*				

Table 3, cont.

School Characteristics	Unadjusted OR	Pr	95% CI (LL)	95% CI (UL)
Percentage of students with college enrollment within 12 months after graduation (Reference category is 0-20% of students)				
20.1-40%	*a*			
40.1-60%	0.61	0.56	0.12	3.19
60.1-80%	1.10	0.89	0.28	4.40
80.1-100%	*b*			
Percentage of students who are English learners (Reference category is 0-20% of students)				
20.1-40%	*a*			
40.1-60%	*a*			
60.1-80%	*a*			
80.1-100%	*a*			
Percentage of students who receive free and reduced-price meals (Reference category is 0-20% of students)				
20.1-40%	0.87	0.83	0.23	3.27
40.1-60%	0.35	0.19	0.07	1.65
60.1-80%	*a*			
80.1-100%	*a*			
Percentage of students with disabilities (Reference category is 0-20% of students)				
20.1-40%	*a*			
40.1-60%	*a*			
60.1-80%	*a*			
80.1-100%	*a*			
Percentage of students who are economically disadvantaged (Reference category is 0-20% of students)				
20.1-40%	0.57	0.42	0.15	2.20
40.1-60%	*a*			
60.1-80%	*a*			
80.1-100%	*a*			

Footnotes

*, **	*p<.10, **p<.05
a	Due to zero or very small counts for some categorical predictors, the model could not converge.
b	Some categorical predictors were eliminated from the model due to collinearity.

Table 4: Unadjusted odds ratios of school characteristics for schools with wide clusters

School Characteristics	Unadjusted OR	Pr	95% CI (LL)	95% CI (UL)
Star Rating (Reference category is Rating of 1)				
Rating of 2	*a*			
Rating of 3	0.46	0.20	0.14	1.49
Rating of 4	1.60	0.34	0.61	4.21
Rating of 5	*b*			
Rurality (Reference category is Large central metro area)				
Large fringe metro area	0.73	0.78	0.08	6.80
Medium metro area	0.47	0.58	0.03	6.57
Small metro area	1.60	0.74	0.10	24.70
Micropolitan metro area	4.00	0.36	0.21	75.66
Non-core area	*b*			
Adjusted 4-year Dropout rate (Reference category is 0-20% of students)				
20.1-40%	*a*			
40.1-60%	*a*			
60.1-80%	*a*			
80.1-100%	*a*			
Adjusted 4-year Graduation rate (Reference category is 0-20% of students)				
20.1-40%	*a*			
40.1-60%	*a*			
60.1-80%	*a*			
80.1-100%	*b*			
Percentage of students with chronic absenteeism (Reference category is 0-20% of students)				
20.1-40%	0.86	0.71	0.39	1.92
40.1-60%	*a*			
60.1-80%	*a*			
80.1-100%	*a*			
Percentage of students with good attendance (Reference category is 0-20% of students)				
20.1-40%	*a*			
40.1-60%	*a*			
60.1-80%	*a*			
80.1-100%	*b*			
Percentage of students with a rigorous GPA (Reference category is 0-20% of students)				
20.1-40%	0.15	0.20	0.01	2.66
40.1-60%	0.65	0.71	0.07	6.10
60.1-80%	0.90	0.93	0.09	8.89
80.1-100%	*b*			

Table 4, cont.

School Characteristics	Unadjusted OR	Pr		95% CI (LL)	95% CI (UL)
Percentage of students with college enrollment within 12 months after graduation (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	0.70	0.55		0.22	2.26
60.1-80%	1.38	0.53		0.50	3.76
80.1-100%	*b*				
Percentage of students who are English learners (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*a*				
Percentage of students who receive free and reduced-price meals (Reference category is 0-20% of students)					
20.1-40%	1.22	0.68		0.47	3.17
40.1-60%	0.21	0.02	**	0.06	0.75
60.1-80%	*a*				
80.1-100%	*a*				
Percentage of students with disabilities (Reference category is 0-20% of students)					
20.1-40%	*a*				
40.1-60%	*a*				
60.1-80%	*a*				
80.1-100%	*a*				
Percentage of students who are economically disadvantaged (Reference category is 0-20% of students)					
20.1-40%	0.39	0.08	*	0.14	1.11
40.1-60%	0.16	0.08	*	0.02	1.28
60.1-80%	*a*				
80.1-100%	*a*				

Footnotes

*, **	*p<.10, **p<.05
a	Due to zero or very small counts for some categorical predictors, the model could not converge.
b	Some categorical predictors were eliminated from the model due to collinearity.

Table 5: Correlations among school characteristics

	Star Rating	Rurality	Adjusted 4-year Dropout rate	Adjusted 4-year Graduation rate	Students with chronic absenteeism	Students with good attendance	Students with a rigorous GPA above	Students with college enrollment within 12m	Students who are English learners	Students who receive FARMS	Students with disabilities	Economically disadvantaged
Star Rating (Composite score, 1-5)	1											
Rurality (NHCS Urban-Rural Classification Scheme, 1-6)	0.26	1										
Adjusted 4-year Dropout rate (percentage quintiles of the student body)	-0.69	-0.12	1									
Adjusted 4-year Graduation rate (percentage quintiles of the student body)	-0.29	0.10	0.43	1								
Students with chronic absenteeism (percentage quintiles of the student body)	-0.73	-0.26	0.62	0.27	1							
Students with good attendance (percentage quintiles of the student body)	-0.18	0.12	0.24	0.48	0.22	1						
Students with a rigorous GPA (percentage quintiles of the student body)	0.82	0.34	-0.55	-0.18	-0.67	-0.09	1					
Students with college enrollment within 12 months after graduation (percentage quintiles of the student body)	0.78	0.08	-0.56	-0.08	-0.58	-0.10	0.72	1				
Students who are English learners (percentage quintiles of the student body)	-0.31	-0.10	0.37	0.24	0.25	0.14	-0.11	-0.20	1			
Students who receive free and reduced-price meals (percentage quintiles of the student body)	-0.61	-0.12	0.53	0.37	0.51	0.24	-0.60	-0.46	0.25	1		
Students with disabilities (percentage quintiles of the student body)	-0.37	-0.10	0.42	0.20	0.43	0.14	-0.34	-0.28	-0.02	0.37	1	
Students who are economically disadvantaged (percentage quintiles of the student body)	-0.57	-0.20	0.47	0.26	0.60	0.23	-0.62	-0.42	0.01	0.66	0.45	1

Table 6: Adjusted odds ratios for school characteristics that predict ever suicide

School Characteristics	Adjusted OR[$]	Pr		CI (LL)	CI (UL)
Star Rating (Reference category is Rating of 1)					
Rating of 2	77.30	0.70		0.00	3.42E+11
Rating of 3	1.03	1.00		0.00	4.33E+09
Rating of 4	0.18	0.88		0.00	7.74E+08
Rating of 5	0.47	0.95		0.00	2.15E+09
Rurality (Reference category is Large central metro area)					
Large fringe metro area	3.10	0.32		0.33	29.18
Medium metro area	11.59	0.06	*	0.90	149.89
Small metro area	10.08	0.15		0.43	233.72
Micropolitan metro area	0.47	0.66		0.02	13.29
Non-core area	2.67	0.51		0.15	48.40
Percentage of students with chronic absenteeism (Reference category is 0-20% of students)					
20.1-40%	1.82	0.32		0.57	5.85
40.1-60%	0.07	0.09	*	0.00	1.43
60.1-80%	0.09	0.23		0.00	4.69
80.1-100%	*a*				
Percentage of students with a rigorous GPA (Reference category is 0-20% of students)					
20.1-40%	0.46	0.48		0.05	3.99
40.1-60%	1.92	0.59		0.18	20.24
60.1-80%	2.44	0.49		0.19	31.44
80.1-100%	2.04	0.65		0.10	43.27
Percentage of students with college enrollment within 12 months after graduation (Reference category is 0-20% of students)					
20.1-40%	0.77	0.98		0.00	2.87E+08
40.1-60%	5.06	0.87		0.00	1.89E+09
60.1-80%	9.94	0.82		0.00	3.88E+09
80.1-100%	7.15	0.85		0.00	2.87E+09
Percentage of students who receive free and reduced-price meals (Reference category is 0-20% of students)					
20.1-40%	0.47	0.21		0.14	1.52
40.1-60%	0.02	0.00	**	0.00	0.13
60.1-80%	0.00	0.00	**	0.00	0.03
80.1-100%	*a*				

Table 6, cont.					
School Characteristics	Adjusted OR[$]	Pr		CI (LL)	CI (UL)
Percentage of students who are economically disadvantaged (Reference category is 0-20% of students)					
20.1-40%	19.17	0.00	**	3.45	106.44
40.1-60%	2.44	0.62		0.07	83.36
60.1-80%	1311.86	0.04	**	1.56	1102306.00
80.1-100%	*a*				

Footnotes	
*, **	*p<.10, **p<.05
$	Adjusted for all variables in table
a	Due to zero or very small counts for some categorical predictors, the model could not converge.
b	Some categorical predictors were eliminated from the model due to collinearity.

Table 7: Adjusted odds ratios for school characteristics that predict narrow clusters

School Characteristics	Adjusted OR[$]	Pr		CI (LL)	CI (UL)
Star Rating (Reference category is Rating of 1)					
Rating of 2	*a*				
Rating of 3	1.56	0.72		0.14	17.87
Rating of 4	7.31	0.06	*	0.89	59.65
Rating of 5	*b*				
Rurality (Reference category is Large central metro area)					
Large fringe metro area	0.33	0.24		0.05	2.08
Medium metro area	0.17	0.18		0.01	2.36
Small metro area	*b*				
Micropolitan metro area	*a*				
Non-core area	*a*				

Footnotes	
*, **	*p<.10, **p<.05
$	Adjusted for all variables in table
a	Due to zero or very small counts for some categorical predictors, the model could not converge.
b	Some categorical predictors were eliminated from the model due to collinearity.

Table 8: Adjusted odds ratios for school characteristics that predict wide clusters

School Characteristics	Adjusted OR[$]	Pr		CI (LL)	CI (UL)
Percentage of students who receive free and reduced-price meals (Reference category is 0-20% of students)					
20.1-40%	0.95	0.93		0.32	2.82
40.1-60%	0.16	0.03	**	0.03	0.87
60.1-80%	*a*				
80.1-100%	*a*				
Percentage of students who are economically disadvantaged (Reference category is 0-20% of students)					
20.1-40%	1.26	0.74		0.32	4.97
40.1-60%	0.61	0.70		0.05	7.25
60.1-80%					
80.1-100%					

Footnotes

*, **	*p<.10, **p<.05
$	Adjusted for all variables in table
a	Due to zero or very small counts for some categorical predictors, the model could not converge.
b	Some categorical predictors were eliminated from the model due to collinearity.

Appendix A: Detailed description of systems-level diagram for school-based point clusters

What we know about the epidemiology of suicide clusters is very limited. Researchers know very little about the mechanisms underlying the formation of suicide point clusters. Building on the work of previous researchers, we offer a systems-level diagram to illustrate the complex interplay of factors surrounding school-based suicide point clusters (Figure 2).

This diagram depicts the relationships between community level, school level, and individual level factors that contribute to the formation of suicide point clusters. The primary causal pathway is depicted in bold. The primary causal pathway starts at the moment of a sentinel death within a school community. A sentinel death results in exposure to a peer's suicide for the entire student body. Researchers have theorized about diffusion or contagion mechanisms that contribute to the spread of suicidal thoughts and suicidal ideation (Baller and Richardson 2009). Suicidal ideation must be present at the individual level in order for another student to make a suicide attempt on their own life, which may result in death. Subsequent suicide deaths from within the same school within a particular time frame result in the formation of a suicide point cluster.

At the individual level, suicidal ideation and access to lethal means must be present for another student to attempt suicide (Turecki and Brent 2016). Discussion about another person's suicide or discussion of suicide prevention strategies do not cause suicidal ideation, however, the suicide death of someone in the individual's peer group may make suicide a more acceptable option for an individual who is already considering suicide (Kleiman 2015). Diffusion or contagion mechanisms may reinforce suicidal ideation or lead to imitation of suicidal behaviors (Gould 2001; Stack 2009). A student may become trapped in the reinforcing loop of contemplating suicide, which when combined with access to lethal means may lead to a suicide attempt or death.

The primary point of interruption for this causal pathway comes from postvention strategies at the school level, in the school's response to the aftermath of a suicide death. The school's response following a suicide death and the implementation of postvention strategies are interchangeable and concurrent, and this is depicted with a reinforcing loop.

There are three main postvention strategies depicted in the diagram. These are mental health support systems, grief and bereavement support, and support for families. Each of these postvention strategies decreases the likelihood that suicide would be seen as an acceptable option by another individual student. Also, each of these postvention strategies relies on a collaborative, cross-sectorial network of community-based support mechanisms (Blanco 2020; Mueller, Diefendorf, et al. 2021), which we refer to in the diagram as the response from the community. The school-based postvention strategies then work in tandem with community-based suicide prevention strategies, and this is depicted in bold with a reinforcing loop.

Suicide deaths impact more than just the school. Following the sentinel death, schools must engage in bidirectional collaboration with the wider community, and acknowledge the community-level trauma following suicide loss (Cox et al. 2016; Leenaars et al. 2001; O'Carroll et al. 1988). The postvention as prevention pathway for preventing suicide deaths is the main balancing loop of this causal loop diagram, depicted with bold lines. The coordinated response from the school and community to prevent subsequent suicide deaths is depicted by the balancing loop.

The response from media and the response from community before and after suicide death contribute to shared understanding about the meaning of suicide and the cultural acceptability of suicide, depicted in the diagram by a reinforcing loop. The cultural acceptability of suicide, along with the social network proximity and geographic proximity to community members and peer groups, contribute to the social integration that students experience in school. Community-level social network proximity and geographic proximity along with school-level social integration contribute to peer influence and attitudes about the acceptability of

suicide death, and this is depicted by a reinforcing loop. The influences of the wider community, peer attitudes about suicide, and social integration with peers reinforce messages about suicide acceptability among the peer group (Abrutyn et al. 2020), making suicide acceptability more salient for individuals.

The interplay of community level, school level, and individual level factors are complex, and difficult to disentangle, when it comes to preventing school-based point clusters.

Appendix B: Definitions of school characteristics

School Characteristics	Definition
2019 Maryland School Report Card*	
Star Rating (overall rating)	The Star Rating expresses the school's "overall score" on the Maryland accountability system, along with a school's percent of total earned points percent and percentile rank on Maryland accountability system metrics.
Dropout rate	The age-adjusted four-year dropout rate reflects the students who leave school for any reason, except death, before graduation or completion of a Maryland approved educational program and who are not known to enroll in another school or state-approved program during the current school year.
Graduation Rate	The age-adjusted four-year cohort graduation rate reflects the student cohorts who have graduated with a regular high school diploma within a four-year period of entering high school.
Chronic absenteeism	The chronic absenteeism measure identifies the number of students who are expected to attend school for at least 10 days and who were absent 10% or more of the school days while enrolled at that school.
Attendance rate	The attendance rate is the percentage of students in school for at least half of the average school day during the school year.
Rigorous GPA	The rigorous GPA rate is the percentage of high school completers who have earned a cumulative grade point average (GPA) for 3.0 or higher on a 4.0 scale.
College enrollment	The college enrollment rate reflects the number of students who enroll in a degree-seeking program within 12 months after graduating from high school.
English language learners	Students who are English language learners are students for whom English is not their native language.

Appendix B, cont.

School Characteristics	Definition
Free and reduced-price meals	Students receiving free and reduced-priced meals are identified by the school system.
Students with disabilities	Students with disabilities are students who have current Individualized Education Plans (IEPs) and/or students who are participating in special education programs.
Students with economic disadvantage	Students with economic disadvantage are students who are directly certified by the school system as eligible for free meal benefits using participant data from other means-tested programs.
NCHS Urban-Rural Classification Scheme for Counties[$]	
Rurality	The 2013 Urban-Rural Classification Scheme for Counties is based on the Office of Management and Budget's (OMB) February 2013 delineation of metropolitan statistical areas and micropolitan statistical areas. The levels of the NCHS scheme were chosen for their utility in studying population-level differences across the urban-rural continuum.

Footnotes

*Adapted from *Department of Education, Maryland State. 2019. Maryland School Report Card: Public Use Data for Download. Baltimore, MD*

[$]Adapted from *Ingram, Deborah D., Sheila J. Franco, and Center for Disease Control and Prevention National Center for Health Statistics US Department of Health and Human Services. 2014. "2013 NCHS Urban-Rural Classification Scheme for Counties. National Center for Health Statistics." Vital Health Statistics 2(166):1–73.*

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