Suicidal ideation in a community-based sample of elementary school children: A multilevel and spatial analysis

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ABSTRACT

OBJECTIVES: To examine whether bullying victimization, psychological status, parental and peer relationships and other risk factors are associated with suicidal ideation and to identify high-risk neighbourhoods for suicidal ideation among the elementary school children in Saskatoon Health Region.

METHODS: A sample of school students ($n = 5340$, grades 5–8; ages 9–14 years) from 109 elementary schools in Saskatoon Health Region, Saskatchewan completed the Student Health Survey in 2010–2011. A multilevel logistic regression model was used to investigate the hierarchical data structure at student, grade and school levels. Bayesian spatial analysis was conducted to examine the spatial disparity in the risk of suicidal ideation among residential neighbourhoods.

RESULTS: Of 5,340 children, 340 (6.4%) indicated they had considered suicide at least once in the previous 12 months. Our findings indicated that school children who were frequently verbally or electronically bullied were more likely to report suicidal thoughts than those who were not bullied. Students who were more depressed or anxious, and those with lower self-esteem and poorer relationships with their parents were also more likely to report suicidal ideation. The Aboriginal elementary school students and those from the west side of the city were at a higher risk of having suicidal ideation.

CONCLUSION: Our findings suggest the need for targeted intervention strategies on suicidal ideation among the elementary school children in Saskatoon Health Region, before they reach high school.

KEY WORDS: Suicidal ideation; bullying; psychological factors; Aboriginals; multilevel analysis; Bayesian spatial models

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Suicide is the second leading cause of death in adolescents and young adults in Canada.¹ Approximately 800,000 to a million people globally per year, across all age groups, die from suicide;² this includes over 3,500 suicides each year in Canada.³ Suicidal ideation is defined as, “thoughts of engaging in behaviour intended to end one’s life”, which is often under-evaluated or under-appreciated in evaluating children’s health. An early study revealed evidence that adolescents who reported suicidal ideation at an early age were much more likely than their counterparts who denied suicidal ideation to later attempt suicide.⁴ Therefore, an examination of childhood suicidal ideation is not only warranted but also timely for an early identification and remediation of suicidal ideation in adulthood.

Previous studies have identified a number of individual risk factors that could contribute to suicidal ideation in adolescents. The most important clinical risk factor for suicidal ideation and suicide attempts is depression.⁵ Low self-esteem, anxiety, poor family environments and impaired parent–child relationships have also been connected with suicidal thoughts.^{6–8} A number of studies have shown that the suicide rates within First Nations youth are alarmingly high; however, little research has examined suicide ideation in this group, nor the extent to which different factors contribute to suicidal thoughts or attempts.⁹

Victims of bullying in children and adolescence are also recognized as being at increased risk for suicidal ideation.¹⁰ Bullying can take various forms,¹¹ traditionally including physical (e.g., assault), verbal

(e.g., threats), relational bullying (e.g., social exclusion) and more recently, electronic bullying (e.g., e-mail, phone).¹² Although a number of studies provided evidence that being a victim of different types of bullying increases the risk of developing mental health problems and committing suicide later in life,^{13,14} few such studies have focused on elementary school children.

This study adds to the ongoing understanding of suicidal ideation among elementary school children by identifying the most relevant predictors. It has also been suggested that suicidal ideation could be more common within schools or classrooms because associating with suicidal people has been shown to “spread” suicidal thoughts to others.^{15,16} According to a major psychological theory – the ecological-transactional model^{15,17} – social behaviours are also affected by ecological context, such as

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(in hierarchical order) neighbourhood, community, school, peer and family groups. Multilevel modelling allows us to explore the importance of social context by dividing the total variation into individuals and groups to be assessed separately. Young¹⁵ found that the contribution of school in relation to suicidal attempts and behaviours is low (<1%), but nevertheless important given the severity of the outcome. School classroom context was also examined in a multilevel analysis,¹⁶ which found small variation was attributed to school classes after accounting for individual-level risk factors, but suicidal ideation is significantly associated with school class composition with regard to student gender and parental education. Multilevel analysis is therefore considered in this study, including the grade within school and school-level random effects, to give an enriched picture of the complexity of suicidal ideation.

The suicide rates among neighbouring regions are often close and typically exhibit spatial dependency, since the neighbourhoods where children reside typically reflect the socio-economic status and cultural peer-groups of their parents, which in turn can influence the contact networks and mental health of children.¹⁸ Therefore, it is also often of interest to identify high-risk regions when designing an effective prevention program with regard to suicidal ideation. However, few such studies have been conducted in Canadian literature, particularly for school children.

As such, the purpose of the current study is twofold: a) to identify the most relevant predictors for suicidal ideation in a multilevel analysis and b) to identify high-risk neighbourhoods for the prevalence of suicidal ideation among the elementary school children in Saskatoon Health Region, Saskatchewan.

METHODS

Survey

Data for this study were collected during the third round of the Student Health Survey from elementary school students in grades 5–8 in Saskatoon Health Region in 2010–2011. Consent was obtained from schools, parents and children. Ethics approval was provided by the Behavioural Research Ethics Board at the University of Saskatchewan. Research assistants, from Saskatoon Health Region, administered the survey. Students completed their survey during class time, enclosed and sealed it in an envelope and returned it to the research assistant.¹⁹ There were 12,391 students registered in grades 5–8 in participating schools and the overall response rate was 46.7% ($n = 5783$).

Variables

The outcome variable, suicidal ideation, was assessed using the following question: “In the past year (12 months), did you seriously consider suicide?” Potential risk factors included socio-demographic variables: gender (male vs. female), age (years) and ethnicity (Aboriginal vs. other), as well as psychological factors, including depression, anxiety levels and self-esteem. Depression was measured according to the 12-item shortened version of Centre for Epidemiological Studies Depression scale (CES – D);²⁰ students with scores of 0–11 were considered as having low depression, 12–20 moderate and ≥ 21 high. Anxiety levels were measured using a 7-item scale:¹⁹ students with scores of 0–7 were considered as having low anxiety levels, 8–14 moderate and ≥ 15 high.

Self-esteem was determined using a 5-item scale:¹⁹ students with scores of 0–6 were considered as having low self-esteem, 7–13 moderate, and ≥ 14 high. Quality of relationships with parents and friends was also evaluated as a potential risk factor in this study based on a set of questions, responses to which were categorized into poor, moderate and good relationship.¹⁹ The questionnaire also includes reported experiences involving physical, verbal, social and electronic bullying (weekly, once or more vs. none).

The deprivation index reflecting the socio-economic inequalities in health at an area level was also measured based on the average income, education, employment levels, living arrangements, marital status, and proportion of single-parent families. It divides a population into five categories by quintiles.¹⁹ Deprivation index scores were not available for the rural students; hence, all rural students were grouped into a single category in this analysis.

Multilevel analysis

Multilevel logistic regression models with random intercepts were used to examine to what extent suicidal ideation varied among students clustered together within grades and schools. In this study, 34.9% of the participants were rural students and could not be assigned a neighbourhood, so we first considered adding neighbours as another hierarchical level in the multilevel analysis excluding the rural students and the resulting neighbourhood variation is close to zero. Therefore, to preserve sample size for gaining statistical power, we did not consider neighbourhood as a hierarchical level in the multilevel analysis.

In the first step, we built a model including only the random effect terms, to investigate variation in the prevalence of suicidal ideation at the grade and school levels before considering individual student attributes. The importance of each random effect was evaluated using variance partition coefficients (VPC),²¹ which describe the percentage of variation in the data that is attributed to a particular organizational level.

To screen the covariates, we examined the univariable association between each risk factor and the outcome. Variables where the p -value was < 0.2 , based on the likelihood ratio test, were retained for consideration in building the final model. Choice of $p < 0.2$ as the threshold is recommended to avoid excluding important variables from the model. Manual backward selection was used to develop a main effects model, retaining only variables where $p < 0.05$. In the final step, all the covariates remaining in the final model were tested for significant interactions.

The association between main effects and the outcome in the final model were reported as adjusted odds ratios (AOR) with 95% confidence intervals (95% CI) and p -values. Multilevel analyses were carried out using maximum likelihood estimation in *glmer* from the *lme4* package in the R Statistical Software (Foundation for Statistical Computing, Vienna, Austria).

Bayesian spatial analysis

To examine neighbourhood risk for suicidal ideation, we conducted a secondary data analysis based on the aggregated counts of suicidal ideation in over 62 neighbourhoods in Saskatoon. Rural students were not included in this analysis, as there was no location information available that was the equivalent of neighbourhood other than the previously considered school.

The number of cases of suicidal ideation from the s th neighbourhood is denoted as y_s , $s = 1, \dots, S$, which is assumed to follow a Poisson distribution, i.e., $y_s \sim \text{Poisson}(\mu_s)$, with mean $\mu_s = n_s r_s$, where n_s is the total number of school children from the s th neighbourhood in the study sample and r_s represents the relative risk. A Poisson random effects model was used: $\log(\mu_s) = \alpha_0 + \log(n_s) + b_s + h_s$, where α_0 is the intercept, b_s is the spatially correlated random effect term, which follows a conditional autoregressive prior distribution²² and h_s is the spatially uncorrelated random effect term that follows a normal distribution. To identify the neighbourhoods where school children are at a higher risk of suicidal ideation, posterior exceedance probabilities, $P(r_s > 1)$, were calculated as the proportion of Markov chain Monte Carlo (MCMC) simulations for neighbourhoods that had a relative risk of suicidal ideation greater than 1.

The Bayesian computation was implemented using publicly available software (WinBUGs version 1.4).²³ Two chains with different initial values were constructed to assess convergence. To ensure the representative samples were drawn for posterior inference, the first 10,000 iterations were discarded as burn-in, and the next 10,000 iterations were used as samples. Convergence was checked by visual inspection of the iterative series using the Gelman-Rubin diagnostic plot.²³

RESULTS

Of the 5,783 grade 5–8 students who completed the survey, 5,340 (92.3%) from 109 elementary schools responded to the question regarding suicide ideation; 340 (6.4%) of these students indicated they had considered suicide at least once in the previous 12 months.

In the null model including only the random intercepts for grade and school, the variation identified among grades within schools was 0.03 ± 0.18 and among schools was 0.24 ± 0.49 . The VPC for grade was 0.8% and for school was 6.7%. In the univariate analysis, there was no significant difference in reported suicidal ideation between males and females or among students of different ages, or from rural and urban schools (Table 1). Almost 13% of the Aboriginal students reported suicidal ideation, compared to 5.5% of non-Aboriginal students. Children who reported higher depression, higher anxiety, lower self-esteem, poorer relationships with friends or parents, as well as those who were more frequently bullied and were from more deprived areas were also more likely to have suicidal thoughts in unconditional models.

In the final multivariable multilevel model, the variation among grades within school and among schools was almost completely accounted for by the individual-level covariates. There was almost no remaining variation among grades within schools ($2.7e-10 \pm 1.6e-5$), and the variation among schools was also substantially reduced (0.017 ± 0.13). The VPC for grade was 0.0% and for school was 4.9%. Aboriginal status, depression, anxiety, self-esteem, parental relationship, verbal bullying and electronic bullying were associated with suicidal ideation in the final multivariable model (Table 2). There was no difference among the urban students residing in different deprivation quintiles or compared with the rural students ($p = 0.73$). We also tested the interactions for the variables remaining in the main effects models and whether gender modifies the effects of those

covariates; none were significant and are not presented. Future studies with larger samples are warranted, so that we have enough statistical power to sort out the interaction among the variables.

After accounting for other risk factors in the final model (Table 2), Aboriginal students were more likely to report suicidal ideation than non-Aboriginal students (AOR = 1.74). Students who suffered from a high level of depressed symptoms were more likely to report suicidal ideation than those with low depressed symptoms (AOR = 4.79). Likewise, the odds of suicidal ideation increased as the anxiety level increased from low to moderate (AOR = 2.43) and low to high (AOR = 3.36). Students who considered themselves to have an excellent relationship with their parents had a lower prevalence of suicidal ideation (AOR = 0.33). The odds of suicidal ideation were also lower for those reporting a moderate relationship with their parents, as compared to those with poor relationships with their parents (AOR = 0.46). Students who were frequently verbally or electronically bullied had higher odds of having suicidal thoughts, as compared to those who were less frequently verbally or electronically bullied. For example, students who reported being verbally or electronically bullied weekly had a significantly higher prevalence of suicidal ideation than those who had never been verbally or electronically bullied (verbal bullying: AOR = 1.82; electronic bullying: AOR = 2.14).

Of the 5,340 school children who responded to the question of suicidal ideation, 3,506 (65.7%) urban school students provided their residential postal codes. Children who attended rural schools were not asked for their residential postal codes. The relative risks of suicidal ideation at the residential neighbourhood level, based on the Bayesian spatial model, were illustrated in Figures 1 and 2. The posterior exceedance probabilities show that high-risk neighbourhoods were primarily located on the west side of Saskatoon (Figure 1). The estimated posterior means of the relative risks shown in Figure 2 indicate that children from the neighbourhoods on the west side of Saskatoon are at higher risk of suicide ideation than those on the east. We also compared our model with the models including only either b_s or h_s term and the results indicated that the difference in the deviance information criterion²⁴ is negligible, so different covariance structure would not impact much on the model fit and the resulting estimates on the exceedance probability.

DISCUSSION

Results from our study support much of the existing work on suicide ideation,^{6–10} but also extend the research in some important areas, which are detailed below. Our study affirmed the relationship between suicidal ideation and various psychosocial factors, such as depression, anxiety, self-esteem and parent–child relationships, after accounting for experiences with bullying. Our study also found that the association between being a victim of verbal or electronic bullying and suicidal ideation is significant. We have also identified that Aboriginal students were more likely to have suicidal thoughts, which demonstrates a need for culturally appropriate interventions to improve the mental health status of Aboriginal elementary school children.

The literature on gender effect on suicidal ideation in adolescence is complex and partly paradoxical.²⁵ While some studies showed either a higher rate either among boys⁷ or among

Table 1. Descriptive statistics for variables used in model building computed from the univariable analysis in grade 5 to 8 school children accounting for clustering within grade and school

Characteristic		Total (%)	Suicidal ideation		p-value
			Yes (%)	No (%)	
Socio-demographic					
Gender (n = 5291)	Male	2523 (47.7)	144 (43.1)	2379 (48.0)	0.083
	Female	2768 (52.3)	190 (56.9)	2578 (52.0)	
Age, years (n = 5257)	<11	971 (18.5)	60 (18.0)	911 (18.5)	0.057
	11	1324 (25.2)	72 (21.6)	1252 (25.4)	
	12	1344 (25.6)	74 (22.2)	1270 (25.8)	
	13	1203 (22.9)	88 (26.4)	1115 (22.6)	
	>13	415 (7.9)	39 (11.7)	376 (7.6)	
Ethnicity (n = 5109)	Aboriginal	537 (10.5)	70 (21.7)	467 (9.8)	<0.001
	Non-Aboriginal	4572 (89.5)	253 (78.3)	4319 (90.2)	
Type of school (n = 5299)	Rural	1355 (25.6)	85 (25.2)	1270 (25.6)	0.65
	Urban	3944 (74.4)	252 (74.8)	3692 (74.4)	
Deprivation index (n = 4793)	1 (most affluent)	1155 (24.1)	54 (18.1)	1101 (24.5)	0.006
	2	810 (16.9)	37 (12.4)	773 (17.2)	
	3	538 (11.2)	40 (13.4)	498 (11.1)	
	4	499 (10.4)	42 (14.1)	457 (10.2)	
	5 (least affluent)	436 (9.1)	40 (13.4)	396 (8.8)	
	Rural	1355 (28.3)	85 (28.5)	1270 (28.3)	
Mental health					
Anxiety (n = 4784)	Low	1963 (41.0)	29 (9.8)	1934 (43.1)	<0.001
	Moderate	1712 (35.8)	73 (24.6)	1639 (36.5)	
	High	1109 (23.2)	195 (65.7)	914 (20.4)	
Self-esteem (n = 5192)	Low	1103 (21.2)	193 (59.8)	910 (18.7)	<0.001
	Moderate	3059 (58.9)	103 (31.9)	2956 (60.7)	
	High	1030 (19.8)	27 (8.4)	1003 (20.6)	
Depression (n = 4821)	Low	4039 (83.8)	124 (39.6)	3915 (86.8)	<0.001
	Moderate	662 (13.7)	132 (42.2)	530 (11.8)	
	High	120 (2.5)	57 (18.2)	63 (1.4)	
Social relation					
Parent relationship (n = 4642)	Poor	1083 (23.3)	192 (63.6)	891 (20.5)	<0.001
	Moderate	2567 (55.3)	94 (31.1)	2473 (57.0)	
	Excellent	992 (21.4)	16 (5.3)	976 (22.5)	
Friend relationship (n = 4176)	Few	1051 (25.2)	151 (60.2)	900 (22.9)	<0.001
	Some	1685 (40.3)	51 (20.3)	1634 (41.6)	
	Many	1440 (34.5)	49 (19.5)	1391 (35.4)	
Bullying experiences					
Physical (n = 5216)	Never	4102 (78.6)	178 (53.6)	3924 (80.3)	<0.001
	Once or twice	945 (18.1)	112 (33.7)	833 (17.1)	
	Weekly	169 (3.2)	42 (12.7)	127 (2.6)	
Verbal (n = 5202)	Never	3111 (59.8)	99 (30.4)	3012 (61.8)	<0.001
	Once or twice	1563 (30.1)	119 (36.5)	1444 (29.6)	
	Weekly	528 (10.1)	108 (33.1)	420 (8.6)	
Social (n = 5193)	Never	3710 (71.4)	134 (41.5)	3576 (73.4)	<0.001
	Once or twice	1109 (21.4)	103 (31.9)	1006 (20.7)	
	Weekly	374 (7.2)	86 (26.6)	288 (5.9)	
Electronic (n = 5184)	Never	4664 (90.0)	229 (70.9)	4435 (91.2)	<0.001
	Once or twice	408 (7.9)	61 (18.9)	347 (7.1)	
	Weekly	112 (2.2)	33 (10.2)	79 (1.6)	

girls,^{15,26} our study found gender difference is insignificant, which was also found in other studies.^{8,27,28} Rhodes et al.²⁵ presented a comprehensive discussion on the reasons and timing of the gender effects in the prevalence and lethality of suicidal behaviours. The inconsistent findings might be partially explained by the shift in the interactive social network during adolescent development. Early adolescents may be influenced more by adults (parents, teachers), later adolescents more by their peers.²⁹ This may also help partially explain our null findings on friend relationship in the final model, but significant association between parental relationship and suicidal ideation, given our study sample focussing on early adolescents.

After adjusting for the individual-level risk factors, very little variation in suicidal ideation was attributable to grouping of students within grades or schools. To examine whether context

variables at the grade within school and school level can explain the variation, we created variables summarizing the proportions of males, Aboriginal students, students reporting psychosocial problems, and students reporting different types of bullying experiences, for each grade within a school and for each school in the study sample, but none of those variables were significantly associated with suicidal ideation in the multivariable analysis, so the results are not presented.

Finally, this study investigated the geographic patterns of suicidal ideation among elementary school children. Although the neighbourhood-level analysis does not consider confounding by individual attributes, it is useful for initial targeting of programs to high-risk areas of the city that were not clearly identified by individual student attributes alone. Further research will need to consider the potential for geographic differences in the needs of rural students.

Table 2. Results of multivariable regression analysis assessing the risk factors associated with suicidal ideation in grade 5 to 8 school children (*n* = 3872) accounting for clustering within grade and school

Independent variables	AOR	95% CI	p-value
Ethnicity			
Non-Aboriginal (reference)			
Aboriginal	1.73	1.18–2.54	<0.001
Depression			
Low (reference)			
Moderate	2.27	1.55–3.34	<0.005
High	4.79	2.66–8.62	<0.001
Anxiety			
Low (reference)			
Moderate	2.43	1.45–4.08	<0.001
High	3.36	1.93–5.85	<0.001
Parent relationship			
Poor (reference)			
Moderate	0.46	0.33–0.65	<0.001
Excellent	0.33	0.17–0.62	<0.001
Self-esteem			
Low (reference)			
Moderate	0.48	0.34–0.68	<0.001
High	0.73	0.41–1.31	0.29
Verbal bullying			
None (reference)			
Once or twice	1.46	1.03–2.08	0.034
Weekly	1.82	1.18–2.79	0.006
Electronic bullying			
None (reference)			
Once or twice	1.38	0.92–2.06	0.12
Weekly	2.14	1.12–4.07	0.02

Figure 1. Map indicating high-risk areas (posterior probability $P(r_i > 1)$), the proportion of MCMC simulations when a neighbourhood has a relative risk of suicidal ideation greater than 1. The 95% credible interval of the variance component for the spatially correlated random effect term (b_i) is (0.0059, 0.403) and for the spatially uncorrelated term (h_i) is (0.0056, 0.180). MCMC = Markov Chain Monte Carlo.

Limitations

While this study had a relatively large sample size for school-based research, the study also has some limitations, including the cross-sectional nature of the survey. This limits potential inferences

Figure 2. Map of the posterior mean estimate of the estimated relative risk of suicidal ideation among the neighbourhoods in Saskatoon.

about causal relationships between suicidal ideation and some of the risk factors examined. Additionally, clustering within families is also worth serious consideration and such information should be collected in the student’s mental health survey, as siblings from the same family typically have extensive and close contact with each other. As well, the response rate was low (46.7%), as the questionnaire was self-completed by the school children. The set of non-respondents may differ from the respondents. For example, students with mental health problems may be more likely to respond due to their interests in this topic. Alternatively, such students may be less motivated to participate because of psychological problems. To address the possibility of such biases, non-respondent adjustments³⁰ should be conducted in the future based on a survey using different recruitment strategy invoking greater incentives among randomly selected non-respondents. Also, in cases where children have missed reporting either intentionally or inadvertently on any of the questions asked, we have used the commonly used technique of listwise deletion, which deletes the cases containing missing data in the variables that are relevant to the analysis being carried out. This is done to avoid potential bias in our analysis. These limitations need to be taken into consideration when generalizing our results.

CONCLUSIONS

Our study is unique in expanding the research area on suicidal ideation in adolescence to the early adolescence period. The findings provide evidence that early adolescent peer aggression must be taken seriously. An integrated preventive intervention strategy, including parenting education programs, mental health services for youth with depression, anxiety and low self-esteem as well as bullying prevention programs, should increase the effectiveness of suicidal ideation prevention efforts. Geographical targeting could also be employed, which may be important for optimizing prevention strategies and enhancing treatment for suicidal ideation.

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RÉSUMÉ

OBJECTIFS : Examiner si le fait d'être victime d'intimidation, l'état psychologique, les relations avec les parents et les pairs et d'autres facteurs de risque sont associés à l'idéation suicidaire et repérer les quartiers à haut risque d'idéation suicidaire chez les élèves des écoles élémentaires de Saskatoon.

MÉTHODE : Un échantillon d'élèves ($n = 5\,340$, 5^e à 8^e année; 9 à 14 ans) de 109 écoles élémentaires de Saskatoon (Saskatchewan) a répondu à un questionnaire sur la santé en 2010–2011. Nous avons utilisé un modèle de régression logistique multiniveaux pour étudier la structure hiérarchique des données au niveau des élèves, de l'année d'étude et des écoles. Nous avons mené une analyse bayésienne spatiale pour examiner la disparité spatiale du risque d'idéation suicidaire entre les quartiers résidentiels.

RÉSULTATS : Sur 5 340 enfants, 340 (6,4 %) ont dit avoir songé au suicide au moins une fois au cours des 12 mois antérieurs. Nos constatations montrent que les enfants d'âge scolaire fréquemment intimidés verbalement ou par voie électronique étaient plus susceptibles de faire état d'idées suicidaires que ceux qui ne subissaient pas d'intimidation. Les élèves déprimés ou anxieux, et ceux dont l'estime de soi et les relations avec leurs parents étaient moins bonnes, étaient également plus susceptibles de faire état d'idées suicidaires. Les écoliers autochtones et ceux de l'ouest de la ville présentaient le plus grand risque d'idéation suicidaire.

CONCLUSION : Nos constatations indiquent qu'il faut des stratégies d'intervention qui ciblent l'idéation suicidaire chez les enfants fréquentant l'école élémentaire à Saskatoon, avant leur entrée à l'école secondaire.

MOTS CLÉS : idéation suicidaire; intimidation; facteurs psychologiques; autochtones; analyse multiniveaux; modèles bayésiens spatiaux