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Timing of suicide attempts by children and adolescents admitted to an inpatient psychiatry unit: a retrospective study

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Abstract

Background Suicide is a leading cause of death in adolescents in Canada and has been documented to occur mainly during evening hours. It is suspected to be due to the accumulation of waking hours combined with sleep disturbances causing poor decision making. Identifying modifiable factors associated with suicide risk remains an important part of suicide prevention.

Aims To examine the timing of suicide attempts in adolescents admitted to a pediatric hospital following a suicide attempt and known to present sleep disturbances, to further strengthen the relationship between sleep disturbance and suicidality and its chronobiological manifestation.

Method Descriptive retrospective study of patients < 18 years ($N = 128$) admitted to a tertiary care hospital for a suicide attempt between January 1, 2022, to June 30, 2023.

Results As expected, a higher percentage of attempts occurred between 18:00–23:59, as compared to other time periods ($p < 0.001$), with peak days Sunday and Monday, for the 18:00–23:59 group. Time of day was not found to differ by gender ($p = 0.45$) nor was weekday/weekend ($p = 0.48$). The most common method of attempt was ingestion.

Limitations Small sample limited to hospitalized patients and retrospective design.

Conclusion The observation that this group of suicidal adolescents is known to present sleep disruptions offers an additional prevention opportunity. Knowledge of the presence of sleep disturbances and the peak time of suicide attempts could help in suicide prevention efforts. Future exploration of the evening phenomenological experience of this population to develop interventions for parents, community resources, pharmacies, and schools to further detect risk factors in adolescent suicidality.

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Background

Suicide risk in adolescents

Suicidal ideation, suicide attempts, and death by suicide are significant mental health problems. In Canada, suicide is the second leading cause of death in children and youth 10 to 19-year-olds; males account for 41% of 10 to 14-year-olds of fatal suicide attempts, increasing to 70% in the 15 to 19-year-olds, and females comprise 72% of self-harm hospitalizations [1]. The ratio of attempted suicides to completed suicides among adolescents is estimated to be 50:1 to 100:1 [2]. Suicide attempts are 3 to 9 times more common in females whereas fatal suicide attempt rates were 2 to 4 times higher in males than in females [3, 4].

Globally, Jang et al. [5] examined temporal trends and patterns in suicide ideation among adolescents 13–15 years in 23 countries from 2003 to 2021 and found and increasing trend in 6 countries (Myanmar, Guyana, Saint Vincent and the Grenadines, Mongolia, Bolivia, and Seychelles), and a declining trend in 5 countries, including Benin, Kuwait, and the Maldives. In the USA, Xiao et al. [6] examined differences in temporal trend between suicidal ideation and suicide attempts in US adolescents from 1991 to 2019 by sex and race/ethnicity. The core finding was the sex and race/ethnic disparities in the 22.5% increase in the prevalence of USA adolescent suicide attempts from 1991 to 2029, and the 18.2% decrease in prevalence of suicidal ideation, over the same period.

Prior studies have examined temporal variations in suicidal attempts as well as days of the week when suicide attempts are likely to occur [7–10]. Garfinkel et al. [9] examined suicide attempts in children and adolescents who presented an emergency room of a large children's hospital in Ontario, Canada and found that suicide attempts usually occurred after school or in the evening. Akkaya-Kalayci et al. [7] noted that for the age group of 15 to 25-year-olds suicide attempts most often occurred from 17:00 to 23:00. Additionally, Doganay et al. [8] found that for the age group of 14 to 25-year-olds suicide attempts were most likely to occur between the hours of 18:00 to 21:00 in males, and 15:00 to 18:00 in females. Nakamura et al. [10] found the peak periods for suicide attempts were in the afternoon and evening. In adult studies, the peak period for suicide attempts was 18:00 to 24:00 [11–13].

The literature mentions some factors which could explain the finding that most of the suicide attempts among adolescents occurred between 18:00 and 23:59. It is suspected to be due mainly attributable to the accumulation of waking hours combined with sleep disturbances causing poor decision making. In a review, Perlis et al. [14] reported that being awake at night, particularly in the presence sleep disturbances can results in "hypofrontality" and diminished executive function leading to suicidal ideation and behavior. Pigeon et al. [15] in a meta-analysis concluded that insomnia, nightmares, and sleep disturbances in general are risk factors suicide thoughts and behavior.

We recently conducted a series of studies of adolescents while they were hospitalized following a suicide attempt. In the first study, we recorded their sleep and compared it to a control group, to observe a longer sleep onset latency, a higher percentage of NREM1 sleep (lighter sleep), and a lower percentage of NREM3 sleep (deep sleep) [16] which could be associated with sleep deprivation. A second study of their sleep and waking brain activity showed that lighter sleep was associated with fewer neural resources mobilized by executive functions such as inhibitory control which could be associated with increased impulsivity [17, 18]. Another sample of this group, revealed that those who had sleep problems before their admission also had needs pertaining to eating disturbances, adjustment to trauma, and school attendance [19]. Finally, we have observed in this population a significantly higher incidence of nightmares and negative dreams [20]. Much of the current research in adolescent suicidality centres on general populations. Our study fills a gap by focusing on a population with arguably the highest risk – psychiatric inpatients [21], mostly depressed and predominantly female [22], with co-morbidities often associated with sleep problems [19, 23]. With this clear profile of disturbances in this suicidal group, it seemed important to determine if the evening incidence of suicide attempts could more precisely inform prevention and treatment options.

Aims

The aim of this study was to expand the exploration of the time-of-day pattern of suicide attempts on a 24-hour clock and the day of the week among a pediatric group admitted to an inpatient psychiatry unit that is known to experience objective sleep disturbance and daytime attention deficit to better understand some of the modifiable risk factors in pediatric suicidality. Based on the available literature, it was expected that suicide attempts would occur mostly in the evening, and on the first or the second day of the week.

Method

The design is a descriptive, retrospective study. The inclusion criteria were children and adolescents less than 18 years who were admitted, due to a suicide attempt, to the 19-bed inpatient psychiatry unit in a tertiary care facility at the CHEO in Ottawa, Canada. The period was 18 months from January 1, 2022 to June 30, 2023. Study participants were identified from the hospital's electronic medical record. Data were abstracted from children and adolescents who had any type of suicide attempt within

one month preceding the hospital admission to capture recent suicide attempts. Data were collected and managed using the Research Electronic Data Capture (REDCap) tool (version 13.5.1) hosted at CHEO. REDCap is a secure, web-based software platform designed to support data capture for research studies [24, 25].

The primary outcome was the time of the suicide attempt divided a priori into four-time blocks as described by Perlis et al. [14]: 00:00 to 05:59 h, 06:00 to 11:59 h, 12:00 to 17:59 h and 18:00 to 23:59 h. The time of suicide attempts was obtained from the electronic medical record. The secondary outcome was the days of the week which were subcategorized into weekday (Monday to Friday inclusive) and weekend (Saturday and Sunday). The covariate of interest was gender.

Analysis

All analyses were performed using the R statistical programming language (version 4.2.1) [26]. Descriptive analysis of the data was performed using median, interquartile range (IQR) for continuous variables and counts with frequency for categorical variables. A chi-squared test of homogeneity was used to test differences in attempts for days of week as well as timing of attempts. To calculate an incidence rate ratio with 95% confidence intervals, a Poisson regression with log number of days in the block as an offset (weekday = 5, weekend = 2) was used.

To test for differences in timing of attempts with gender and for differences in weekend/weekday with gender, a Fisher exact test was used. To check for an interaction between gender and weekday/weekend timing, an adjusted incidence rate ratio with 95% confidence intervals was calculated using Poisson regression with log number of days in the block as an offset (weekday = 5, weekend = 2). Given that a convenience sample was used for descriptive and hypothesis generation purposes, no formal sample size calculation was required.

Table 1 Characteristics of participants and suicide attempts

Characteristic	$N = 128$[1]
Age (years)	15.00 (14.00, 16.00)
Gender	
Female	86 (67%)
Male	22 (17%)
Other[2]	20 (16%)
Day of week	
Monday	23 (18%)
Tuesday	22 (17%)
Wednesday	14 (11%)
Thursday	19 (15%)
Friday	19 (15%)
Saturday	15 (12%)
Sunday	16 (13%)
Method of attempt	
Ingestion	84 (66%)
Laceration	14 (11%)
Motor vehicle event	11 (9%)
Fall from height	10 (8%)
Strangulation	10 (8%)
Other[3]	< 6 (4%)
Timing of attempt	
00:00 to 05:59 h	11 (8.6%)
06:00 to 11:59 h	25 (20%)
12:00 to 17:59 h	37 (29%)
18:00 to 23:59 h	55 (43%)

[1]Median (IQR); n (%)

[2]Other gender includes Trans-female, trans-male or non-binary.

[3]Other suicide attempts include railway event, drowning, insulin injection and firearm use. Note: Percentages are for each independent method.

Results

The study sample comprised 128 participants with a median age of 15 years (range 11 to 17 years). The characteristics of participants and suicide attempts are described in Table 1. Participant gender was female ($n = 86$, 67%), male ($n = 22$, 17%), and non-binary trans-female or trans-male ($n = 20$, 16%). The median (IQR) timing between attempts and admission to the inpatient unit was 0 (0,1) days with 52% of participants being admitted on the same day as the attempt, 32% admitted the next day and the remainder admitted between 2 and 21 days after the attempt.

There was a higher percentage of attempts that occurred between 18:00 to 23:59 (43%), as compared to the other time periods ($p < 0.001$). Females and those who identified as either non-binary, trans-female or trans-male most commonly had attempts between 18:00 to 23:59 h, ($n = 39/86$, 45% and $n = 11/20$, 55% respectively), whereas males most commonly had attempts between 12:00 to 17:59, ($n = 9/22$, 41%). Time of day was not found to differ by gender ($p = 0.41$) nor was weekday/weekend ($p = 0.48$).

Figure 1. illustrates the timing of suicide attempts by weekday (Monday to Friday inclusive) versus weekend (Saturday and Sunday) in four separate time blocks and compares percentage of attempts by timing. Most attempts occurred on a weekday ($n = 97$, 76%). The distribution of attempts throughout the week did not differ ($p = 0.69$). The most common method of suicide attempt was ingestion ($n = 84$, 65.6%) (see Table 1). Most participants ($n = 122$, 95.3%) used only one method, whereas 6 (4.7%) had used two different methods for their suicide attempt.

Overall, the number of attempts was higher on weekdays. The trend in timing followed a similar pattern on both weekdays and weekends, with the highest number of attempts between 18:00 to 23:59 and the lowest number of attempts between 00:00 to 05:59. Figure 2. shows

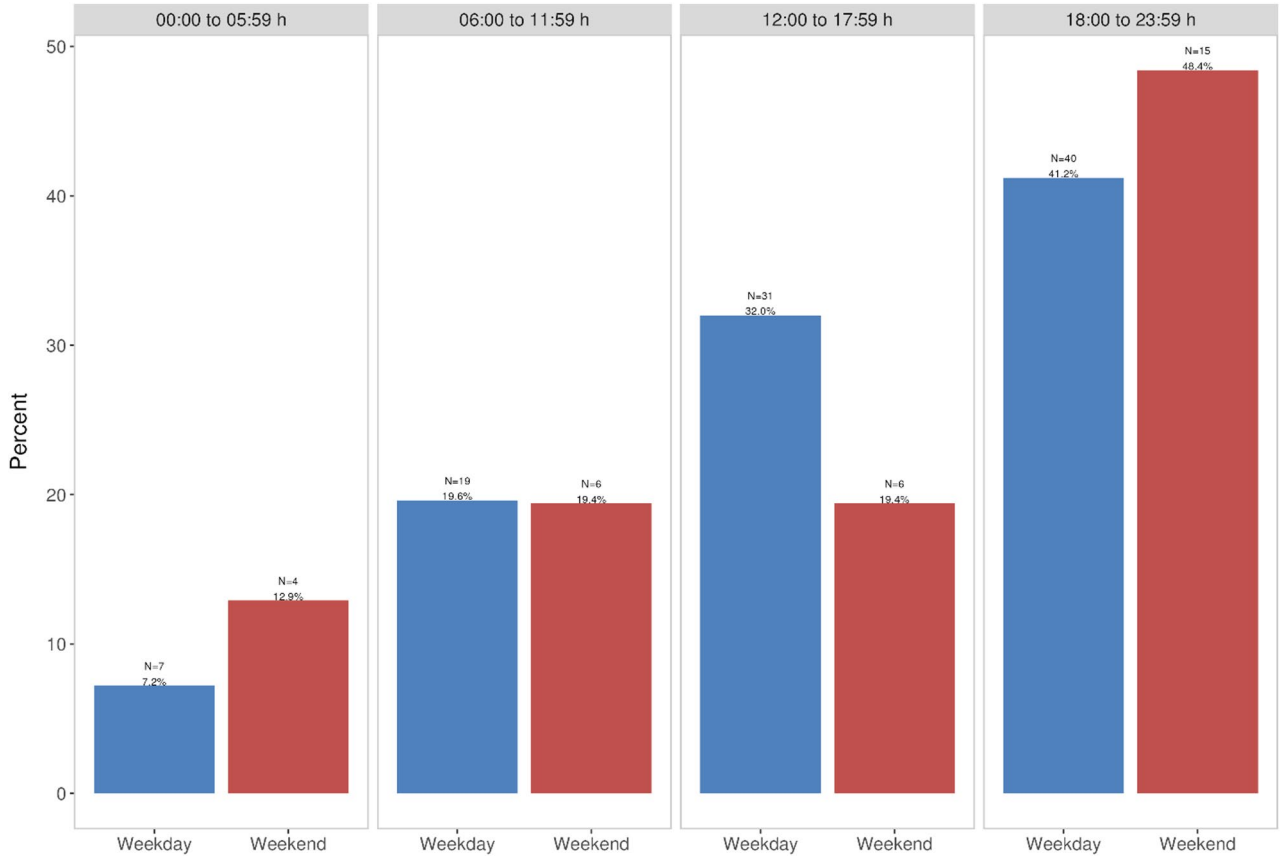

Fig. 1 Timing of attempts on weekday versus weekend. Suicide attempts on weekdays (inclusive of Monday to Friday) ($n=97$) are indicated in the blue bars which sum up to 100%; Suicide attempts on the weekend (inclusive of Saturday and Sunday) ($n=31$) are reflected in the red bars which sum up to 100.1% due to rounding

that for those with attempts between 18:00 to 23:59, suicide attempts occurred more frequently on Sunday and Monday.

We calculated the rate of attempts, accounting for the number of days in the weekend versus the week, using a Poisson regression; while the rate of attempts appears lower on the weekend, this did not reach statistical significance ($p=0.3$) (see Table 2). To see if timing of suicide attempts by weekday versus weekend differed by gender, a multivariable model with no interaction between weekday/weekend and gender was employed which revealed gender was strongly associated with the rate of suicide attempts ($p<0.001$). After including an interaction between weekday/weekend and gender, the association between weekday/weekend and number of attempts was not found to differ by gender ($p=0.5$) (Table 2).

Discussion

Our findings of the evening being the most likely time of the suicide attempt was concordant with previous findings reported in the literature on adolescents [7–10] and adults [11–13]; this trend has been unchanged for nearly four decades. In our study, we found that the distribution of suicide attempts throughout the week did not differ statistically. Although suicide attempts on Monday and Tuesday were slightly higher (18% and 17%) compared to Saturday and Sunday (12% and 13%), it is possible that we did not have sufficient power to detect a significant difference. Sunday and Monday were the more frequent days for suicide attempts occurring between 18:00 to 23:59 h. Our finding of suicide risk starting on Sunday is a novel finding. Other authors have reported that attempts occurred more frequently on Mondays and Tuesdays [10, 27] and beginning of the calendar week [7].

Factors associated with suicide attempts include psychiatric co-morbidities, stress, sleep disturbances/deprivation, and executive function. Depression, mental health comorbidities, and psychosocial stressors may lead to sleep disturbance and deprivation which may predispose to suicide attempts [19, 23, 28]. Adolescents in Canada [29], United States [30], and Australia [31], commonly report experiencing stress, particularly school related stressors. In a Canadian study, Nixon et al. [32] examined fluctuations in admissions to a child and adolescent psychiatry unit in relation to school breaks, school starts, as well as time change transitions in and out of

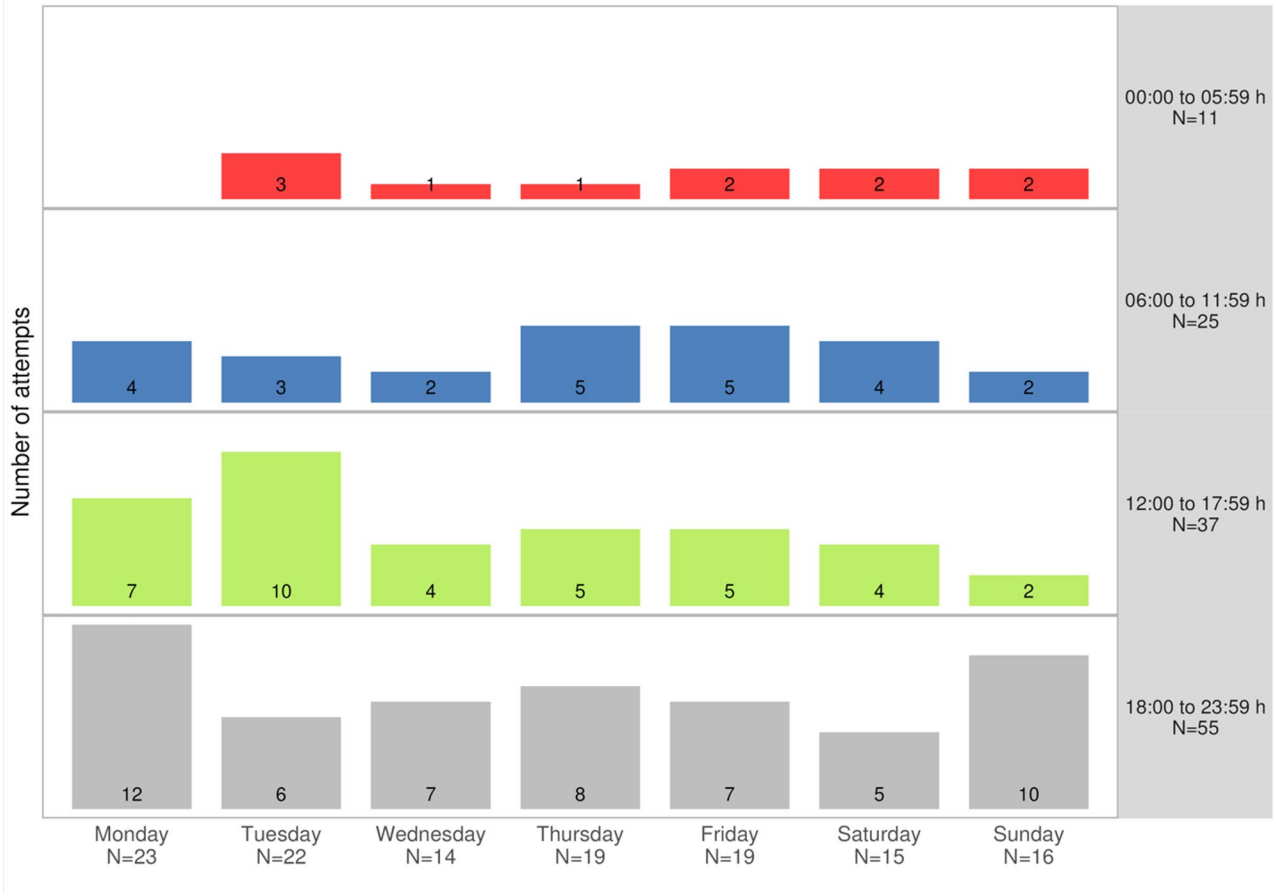

Fig. 2 Attempts by days of week and time block. the colours (red, blue, green and grey) differentiate the time blocks for suicide attempts

Table 2 Rate of suicide attempt comparing weekday versus weekend and comparing gender with timing

		Unadjusted			Adjusted		
Characteristic	**Attempts**	**IRR[1]**	**95% CI[1]**	**p-value**	**IRR**	**95% CI**	**p-value**
Timing				0.3			0.5
Weekday	97	1	—		1	—	
Weekend	31	0.80	0.52, 1.18		0.74	0.24, 1.86	
Gender							<0.001
Male	22				1	—	
Female	86				3.94	2.37, 6.93	
Other[2]	20				0.76	0.36, 1.57	
Timing * Gender							0.5
Weekend * Female	19				0.96	0.33, 3.23	
Weekend * Other	7				1.83	0.48, 7.48	

[1]IRR = Incidence Rate Ratio, CI = Confidence Interval

[2]Other includes those who identified as either non-binary, trans-female or trans-male

Daylight-Saving Time (DST). Admissions were significantly higher during school periods as compared to out of school periods and significantly increased from prior- to post-school starts, indicating school periods and school onset may be significant stressors associated with an increased rate of psychiatric admissions [32]. In adolescence, perception of stress is likely influenced by their appraisal of stressors, such as academic expectations and peer relations [33]. It is possible that anticipatory anxiety, related to returning to school on Monday or first school day of the week, will rise over the course of day on Sunday and may not subside for 1–2 days thereby possibly increasing the risk of suicide attempts on Sunday and Monday from 18:00 to 23:59.

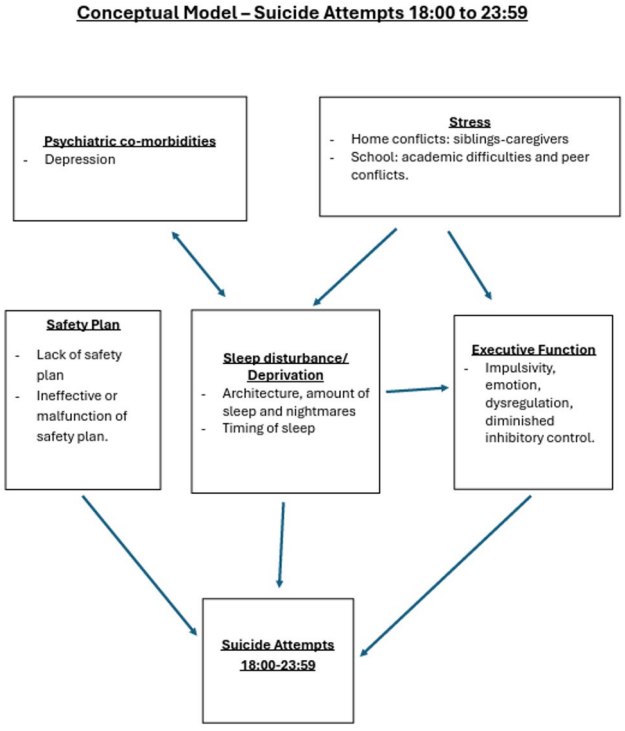

Fig. 3 Conceptual model of suicide attempts between 1800–2359

Multiple factors may be associated with suicide attempts which occur in our study population from 1800 to 2359 h as schematically represented in Fig. 3.

Liu et al. [34] reported a bidirectional relationship between sleep disturbances and suicidality. Sleep problems may impair executive functioning, which may also predispose to suicide attempts. Possible lack of, or failed safety planning, could also predispose to suicide attempts [35]. In a systematic review, it was noted that suicide safety plans reduced suicide behavior by 43% but was ineffective in reducing suicide ideation [35]. A speculative theory related to suicide attempts from 18:00–23:59 pertains to the ability to pay off accumulated sleep debt during weekends. A recent study suggested that catch-up sleep on the weekend may reduce the development of specific depressive symptoms associated with suicidal ideation [36].

Perhaps the most important implication of this study is related to the potential significant alteration of sleep of this inpatient population, such as its amount, its architecture and dream experience along with likely related daytime cognitive and judgment impairment as observed in our earlier studies. The lack of sleep becomes a concrete prevention flag for consideration.

Our sample included a higher proportion of females who attempted suicide compared to males who attempted suicide is consistent with patterns observed in other studies. In adolescents and young adults, suicide attempts were 3 to 9 times more common in females whereas fatal suicide attempt rates were 2 to 4 times higher in males than in females [4]. Females are more likely to experience emotional or sexual abuse, experience higher levels of internalizing symptoms, and are at greater risk for suicidal ideation and attempts [37, 38].

We also found that our study sample included more individuals who identified as either non-binary, trans female or trans male as compared to what would be expected in the general population of adolescents. Wang et al. [39] noted that among Canadian youth aged 12 to 17 years, approximately 0.5% were classified as non-cisgender, with 0.2% identifying as nonbinary and 0.2% transgender which highlights the overrepresentation of sexual minorities in our study population. Kingsbury et al. [40] found that transgender adolescents showed 5 times higher risk of suicidal ideation (RR = 4.95, 95% confidence interval [CI] 3.63 to 6.75) and 7.6 times higher risk of suicide attempt (95% CI 4.76 to 12.10) as compared with cisgender, heterosexual adolescents. Therefore, our study supports the finding that non-binary and transgender adolescents are at higher risk for suicide attempts.

Limitations

Our sample is restricted to suicide attempts resulting in hospitalization. This may limit generalizability to all youth suicide attempts, including all of those that do not lead to inpatient care. Gender differences observed in the study reflect an inpatient clinical population rather than population-based patterns, which may influence interpretation. Not all adolescents who attempted suicide during the study timeframe sought healthcare at a hospital; consequently, our estimations may be reduced. Our study is based on single-centre data, which affects generalizability. Due to the smaller sample size of the cohort, we were unable to get a precise estimate of the association between female and suicide attempts. Finally, we arbitrarily classified the weekend as Saturday and Sunday without including Friday evening as part of the weekend.

Future research directions

More research is needed on chronobiological factors that could explain the different time blocks and the decision-making process of adolescents with suicidal ideation. Specifically, it is necessary to investigate the most vulnerable time block, 18:00 to 23:59, which has not changed in four decades. Circadian rhythm abnormalities may affect the timing of suicide attempts [14], however there are discrepancies in the literature regarding the association between circadian rhythm and timing of suicide attempts. Nocturnal wakefulness is related to insomnia and nightmares and could be contributory [41].

Delayed sleep phase syndrome (DSPS) is common during adolescence and young adulthood with a prevalence

of 3.3%, and significantly higher among girls (3.7%) than boys (2.7%) with a strong overlap between DSPS and insomnia, and more than half of the adolescents with DSPS also meeting the criteria for insomnia (53.8% for boys and 57.1% for girls) [42]. Another study showed delayed sleep timing in 18% of 305 depressed teenagers, compared to only 10% of matched controls [43]. This typical later sleep onset time suggests that more evening time is spent awake thus providing longer time alone ruminating and fostering suicidal thoughts. Therefore, future researchers should consider using objective measures of the quantity and quality of adolescents' subjective sleep, particularly in the month preceding a suicide attempt [44, 45]. Additionally, assessing individual differences in the chronobiological types (morningness vs. eveningness) would be interesting given the evening types may be found to have greater susceptibility [46–48].

Information about wake/sleep cycle may elucidate the role of wakefulness during circadian/biological sleep time as predisposing to nighttime suicide attempts. Regarding the circadian factors measuring the levels of attention deficits and emotional inhibition at different times of the day and evening would provide support of the circadian factor mentioned above [17, 18].

Since there were only 22 males in our sample, the finding of their most common time-period of suicide attempts in males (12:00 to 17:59) may not be significant. It will be important to explore if this finding persists in studies with a larger sample of males, and if there is a difference, to learn more about possible underlying reasons.

It would also be helpful to know if adolescents with suicide attempts had safety plans in place and if yes, what aspects of the safety plans failed. It would be helpful to determine if adolescents sought care at community resources or support from professionals at their schools (e.g. teachers or guidance counsellors) before their suicide attempt. We found that, for those who made attempts between 18:00 to 23:59, the risk appears to begin on Sunday evening and extend into Monday evening. This finding will need further study to see if it can be replicated and to determine underlying factors which could present opportunities for suicide prevention.

Our study identifies additional flags. Ingestions were the most common method of suicide attempts, and clarification regarding how children and adolescents obtain the selected substances would inform prevention efforts. For example, if the substance was a medication such as an analgesic obtained from a local pharmacy, then this could be an opportunity to collaborate with mental health resource providers, pharmacies, schools, as well as children, adolescents and families with lived experience of suicide attempts to identify preventive measures. It is necessary to identify a proactive strategy and response during the evening as this was the most common timeframe for attempts; parents or professionals may not be available to support the children and adolescents at the time of their crisis and alternative strategies must be established. Parents should be alerted to sleep disturbances and nightmares and seek healthcare for their child given the heightened risk for suicide attempt. Sleep disturbances and nightmares are treatable conditions [20].

Additional interventions may include posting suicide prevention hotline numbers in the over-the-counter medication section of pharmacies or creating a response by pharmacy staff when unaccompanied adolescents purchase over-the-counter medications such as the commonly used analgesics. Canada recently implemented a bilingual (English and French) suicide crisis line, available 24 h a day, 7 days a week, which offers specialized services available for individuals who are under 18 years of age, as well as First Nations, Inuit, or Metis [49, 50]. Future research should examine the effectiveness of targeted interventions during peak times to reduce suicide attempts and provide better support for at-risk individuals [7, 50].

Conclusion

In this study, we found that a higher proportion of females attempted suicide, evenings (18:00 to 23:59) were the most common time of day, and more attempts occurred on weekdays. The increase in weekday attempts appear driven mainly by Monday and Tuesday; however, attempts on Sunday already showed an uptick later in the day. Knowledge of when suicide attempts are likely to occur could help in suicide prevention efforts. Future research directions include understanding the factors predisposing suicide attempts and the decision-making process regarding the timing and method of attempts. Community level interventions may involve collaborating with community resources, pharmacies, schools as well as children, adolescents and families with lived experience regarding suicide attempts.

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Author contributions

Addo Boafo- conceptualization, data curation, investigation, funding acquisition, supervision, writing; Christina Cantin- methodology, project administration, writing original draft, reviewing and editingEsperance Kashala Abotnes, Doaa Al Bagshi - investigation, reviewing and editing; Asma Alamri, Khadeeja Tariq, Bayan Bukhari - investigation, writing original draft, reviewing and editing; Paul Slodovnick, Paniz Tavakoli - reviewing and editing; Joseph De Koninck- conceptualization, reviewing and editing; Anne Tsampalieros- methodology, formal analysis, writing original draft, reviewing and editing.All authors approved the final version of the article.

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Data availability
All procedures in studies involving human participants were performed in accordance with the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS2). The Children's Hospital of Eastern Ontario (CHEO) Human Research Ethics Board (REB) granted ethical approval (CHEOREB# 23/93X) and approved a waiver of consent for this study, as all criteria under TCPS2 Article 5.5 A were met. Please contact that authors if you have questions regarding data availability.

Declarations

Ethics approval and consent to participate
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Competing interests
The authors declare no competing interests.

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