Cross-sectional associations between 24-hour movement guideline adherence and suicidal thoughts among Canadian post-secondary students

Supplementary materials: https://osf.io/bvmye/
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ABSTRACT

Suicide is one of the leading causes of death among post-secondary students. It is, therefore, imperative that we identify behavioral risk factors that can have protective effects in preventing against suicide. This study examined whether adherence to each (i.e., physical activity, sleep, sedentary behavior) of the Canadian 24-Hour Movement Guidelines for Adults and all guidelines concurrently were associated with reduced odds of suicidal ideation and planning among emerging adults attending post-secondary education. This cross-sectional observational study used data from the first cycle of the Canadian Campus Wellbeing Survey, which included a total of 17,633 students (Mean age = 21.7 ± 2.92 years; 67.1% female, 31.5% male, 1.4% other) enrolled in 20 Canadian post-secondary institutions. Logistic regression models with covariate balanced propensity score weighting were computed. Suicidal ideation

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and suicidal planning were reported by 14.4% and 4.9% of students, respectively. Adherence to the sleep (OR=0.73; 95% CI: 0.66-0.80) and sedentary behavior guidelines (OR=0.84; 95% CI: 0.73-0.95) as well as concurrent adherence to all three guidelines (OR=0.71; 95% CI: 0.60-0.85) were associated with significantly reduced odds of suicidal ideation, whereas physical activity guideline adherence was not (OR=0.99; 95% CI: 0.89-1.11). Among students who reported suicidal ideation, concurrent and individual movement behavior guideline adherence were not associated with suicidal planning. Collectively, findings suggest the promotion of healthy movement behavior patterns may be a promising avenue for broad suicide and mental health prevention efforts on campus, although the potency of these effects may not extend to more severe suicidal thoughts.

INTRODUCTION

Suicide is the second leading cause of death among youth and young adults, aged 10 to 34 years, in both the United States and Canada [1,2] and is a serious public health concern. Suicidal thoughts and behaviors, including suicidal ideation, planning for suicide, and making suicide attempts, are prevalent among college students: in a survey by the American College Health Association, 9.7% of U.S. college students report having thought about suicide “often” or “very often” in the past year and 2.7% have made a suicide attempt [3]. Rates of suicide ideation among college students have increased markedly over the past decade, with data from two large, national studies indicating a 76% to 81% increase in the prevalence of suicide ideation from 2011-2012 to 2017-2018 [4]. Other mental and behavioral health concerns among college students have also increased over this period, including moderate to severe depression and anxiety [4].

Emerging evidence from the field of behavioral medicine has begun to establish the importance of engaging in adequate amounts of physical activity [5] and sleep [6] as well as minimizing sedentary behaviors [7] as protective factors for reducing risk of suicidal thoughts and behaviors. Specific to post-secondary students, research has found unfavorable associations between insufficient physical activity [8], sedentary behaviors such as recreational screen time [9,10] and sleep problems [11,12] in relation to suicidal ideation. However, existing work has taken a siloed approach that fails to consider that physical activity, sedentary behaviors, and sleep – collectively referred to as movement behaviors – are co-dependent and may interact to influence suicidal thoughts and behaviors. The recent release of the Canadian 24-Hour Movement Guidelines for Adults represents an integrative approach that recognizes that the whole day matters [13]. Preliminary evidence suggests that 24-hour movement guideline adherence may be associated with lower odds of suicidal behaviors among adolescents [14] and military service members [15], although this work has yet to be extended to post-secondary students. Given the high rates of suicidal thoughts and behaviors reported by post-secondary students [3], modifiable lifestyle factors such as movement behaviors

warrant attention for their potential to prevent or reduce the mental health toll this population experiences.

Thus, the purpose of this study was to examine whether adherence to each (i.e., physical activity, sleep, sedentary behavior) of the Canadian 24-Hour Movement Guidelines for Adults and all guidelines concurrently were associated with reduced odds of suicidal ideation and planning among emerging adults attending post-secondary education. We hypothesized that 1) adherence to each of the Canadian 24-Hour Movement Guidelines for Adults and all guidelines concurrently would be associated with reduced odds of suicidal ideation, and 2) among those who reported suicidal ideation, that adherence to each of the 24-Hour Movement Guidelines and all guidelines concurrently would be associated with reduced odds of suicidal planning.

METHOD

Study sample and data collection

Data for the present study is from Cycle 1 (2019/2020 academic year) of the Canadian Campus Wellbeing Survey (CCWS; www.ccws-becc.ca), which was collected prior to the COVID-19 pandemic. The first cycle of the CCWS included 20 Canadian post-secondary institutions (PSI) consisting of 8 universities, 10 colleges and 2 classified as other. More detailed information regarding the CCWS study design, methods, survey measures and data access policy can be found elsewhere [16]. Across the 20 PSIs, 165,997 students were invited to complete the online survey, and 24,760 students responded to the survey (overall response rate = 14.9%).

The current study included only emerging adults (18-29 years of age), resulting in a total sample of 17,633 participants. This sample had a mean age of 21.7 years (SD = 2.92) and included a higher proportion of females (*n* = 11,830; 67.1%). Complete details of the sample composition can be found in Table 1. The CCWS was approved by the Behavioral Research Ethics Board at the University of British Columbia as well as at each PSI. Complete preregistration details for this study can be found at https://osf.io/ce3xw.

Measures

Demographics.

Participants reported demographic variables assessing their age, gender, race/ethnicity, highest level of parental education, whether they have a chronic health condition and/or disability, relationship status, the extent to which they experience financial stress, sexual orientation, and whether they have trans experience (i.e., their gender identity does not align with their biological sex). PSIs provided information about whether each participant was a full-

or part-time student, and if they were a domestic or international student (as defined by their visa status).

Movement behaviours.

Physical activity. Moderate-to-vigorous physical activity (MVPA) was assessed using the International Physical Activity Questionnaire (IPAQ) [17]. Participants responded to four items that assessed the frequency (days) and duration (hours and/or minutes on an average day) of their moderate *and* vigorous physical activity performed in bouts of greater than 10-minutes over the past seven days. Daily MVPA was calculated by multiplying frequency by duration for moderate and vigorous physical activity, respectively, and then summing these products and dividing by seven. As per the scoring rules for IPAQ, daily MVPA times were capped to 180 minutes for any participants who exceeded 3 hours or 180 minutes of MVPA per day. Participants were classified as having met the guideline for physical activity if they achieved at least 150 minutes/week of MVPA.

Sedentary behavior. Recreational screen time was measured using modified items from the International Sedentary Assessment Tool (ISAT) [18]. Participants responded to two items that asked how many hours and/or minutes on average they spent watching TV or using a computer, tablet, or smartphone during their free time over the past seven days. Sitting time was measured using modified items from the ISAT [18]. Students responded to two items that asked how many hours and/or minutes they usually spend sitting during the full day over the last seven days. Participants who reported engaging in eight hours or less of sitting time per day and three hours or less of recreational screen time per day were classified as having met the sedentary behavior guideline.

Sleep. Participants responded to four items that assessed what time they typically went to sleep and woke up during weekdays and on the weekend over the past seven days. Times were reported to the nearest half hour. Average daily sleep was calculated using the following formula: (5 x hours of sleep on weekdays + 2 x hours of sleep on weekends)/ 7. Students who reported getting seven to nine hours of sleep per night on average were classified as having met the guideline for sleep.

Suicidal Thoughts

Suicidal ideation. To assess suicidal ideation, participants responded to one item that asked, “In the past 12 months have you ever seriously thought about committing suicide or taking your own life?" Response options included: Yes, No, and I prefer not to answer. I prefer not to answer was coded as missing.

Suicidal planning. Participants who responded ‘Yes’ to the suicidal ideation item were also presented a survey item assessing suicidal planning, which asked, “In the past 12 months have you ever made a plan for committing suicide?” Response options included: Yes, No, and I

prefer not to answer. I prefer not to answer was coded as missing. Participants who responded 'No' to the suicidal ideation item were coded as having responded 'No' to the suicidal planning item for multiple imputation purposes.

Data analysis

All analyses were performed in R (Version 4.1.1) and R Studio (Version 2021.09.2). First, we inspected the data for missingness using the *mice* package [19]. Data were considered missing at random and multiple imputation by chained equations was computed using the *mice* package to replace missing values. A total of 15 multiply imputed datasets were created as per recommendations to set $m > 100$ times the highest fraction of missing information (10.9% for physical activity) [20].

For our primary analyses, covariate data were first preprocessed using the *MatchThem* package [21] to calculate covariate balanced propensity score weights. Lack of covariate balance is common in observational studies and covariate balanced propensity score weighting can be used to unconfound comparisons through covariate balance optimization [22]. The *survey* package [23] was then used to compute separate multilevel (participants nested within PSIs) logistic regression analyses to explore associations between adherence to each of the 24-hour movement guidelines and concurrent adherence to all three guidelines with suicidal ideation and planning (among the subsample of participants who responded 'yes' to the suicidal ideation item only). All demographics variables were included as covariates in the propensity score weighted logistic regression models to allow for doubly robust estimation [24]. For the second step of the double robust estimation, each multilevel logistic regression model was adjusted for all of the demographic covariates and adherence to the other 24-hour movement guidelines not being modeled (models examining independent guideline adherence only). Average treatment effects on the treated (ATT) were computed and presented as adjusted odds ratios with 95% confidence intervals. ATT represents how much the odds of reporting suicidal thoughts decreased (or increased) among the typical participant who adhered to a certain guideline relative to if they had not adhered to that specific guideline (i.e., counterfactual argument). Given that emerging evidence suggests non-response on suicide-related items is consistent with elevated risk [25,26], sensitivity analyses were computed with "I prefer not to answer" recoded as "Yes" instead of missing for the suicidal ideation and planning items (see Supplementary Materials), which increased the prevalence of suicidal ideation and planning to 21.1% and 8.1%, respectively. Significance for all analyses was set at $\alpha < 0.05$.

RESULTS

Data inspection

Missingness ranged from 0% for age to 10.9% for physical activity guideline adherence (see Table 1). Missingness for movement behavior guideline adherence and suicidal ideation

were predicted by other observed variables (e.g., more missingness among younger participants, international students), which led us to consider data missing at random and use appropriate procedures to preserve our sample size.

Descriptive statistics

Descriptive statistics for the sample demographic characteristics, movement behaviors, and suicidal thoughts are presented in Table 1.

24-hour Movement Guideline Adherence and Suicidal Ideation

Adherence to all three movement behavior guidelines concurrently was associated with significantly lower odds of suicidal ideation (OR = 0.71; 95% CI: 0.60, 0.85; $p < 0.001$). Among the guidelines, independent adherence to the sleep (OR = 0.73; 95% CI: 0.66, 0.80; $p < 0.001$) and sedentary behavior guidelines (OR = 0.84; 95% CI: 0.73, 0.95; $p = 0.01$) were associated with significantly reduced odds of suicidal ideation, whereas adherence to the physical activity guideline was not associated with suicidal ideation (OR = 0.99; 95% CI: 0.89, 1.11; $p = 0.91$). Similar results were observed in our sensitivity analyses when "Prefer not to answer" was coded as "Yes" (see Supplemental Materials).

24-hour Movement Guideline Adherence and Suicidal Planning

Among participants who reported suicidal ideation, adherence to the sleep (OR = 0.84; 95% CI: 0.69, 1.03; $p = 0.09$), sedentary behavior (OR = 1.28; 95% CI: 0.98, 1.67; $p = 0.08$), and physical activity guidelines (OR = 0.95; 95% CI: 0.76, 1.19; $p = 0.66$), as well as concurrent adherence to all three guidelines (OR = 1.28; 95% CI: 0.86, 1.89; $p = 0.23$) were not associated with suicidal planning. A significant association between adherence to the sedentary behavior guideline and suicidal planning (OR = 1.33; 95% CI: 1.02, 1.73; $p = 0.04$), was observed in our sensitivity analyses when "Prefer not to answer" was coded as "Yes" (see Supplemental Materials).

DISCUSSION

The present study was the first to examine associations between adherence to the Canadian 24-Hour Movement Guidelines for Adults and suicidal ideation and planning among Canadian post-secondary students. Findings showed that concurrent adherence to all three movement guidelines was associated with 29% lower odds of suicidal ideation, which upon closer inspection, was largely driven by sleep and sedentary behavior, but not physical activity guideline adherence. In contrast to our predictions, meeting the 24-hour movement guideline was not related to suicidal planning among students who reported suicidal ideation. Collectively, these findings, along with prior research [27], suggest that the promotion of healthy movement behavior patterns may be a promising avenue for broad suicide and mental health prevention efforts, although the potency of these effects may not extend to more

severe suicidal thoughts (i.e., planning). Related research finds one-third of U.S. adolescents with suicide ideation then develop a plan [28], which we also see in this sample. Suicidal planning may be indicative of more severe distress or entrenched maladaptive behavior patterns, requiring more intensive evidence-based psychosocial treatments, such as the Collaborative Assessment and Management of Suicidality (CAMS-Care) [29]. Moreover, progressing from suicidal ideation to planning may be driven by broader factors not considered here such as connectedness [30].

Although previous research has found favorable associations between adherence to the physical activity component of the 24-hour movement guidelines and indicators of mental health among youth [31] this finding was not replicated in the current study. One potential explanation for this discrepancy in findings could be that the overall quality of the evidence in the systematic review of Sampasa-Kanyinga et al. [31] was rated as very low according to the GRADE framework. Our findings are, however, in line with previous research that has found meeting the 24-hour movement guideline for physical activity was also not associated with lower suicide ideation among an older adolescent sample, and for 15- to 20-year-old girls it was actually associated with higher odds of suicide attempts [14]. Our findings for physical activity guideline adherence and suicidal ideation are also consistent with evidence from a study of over 17,000 military service members [15], which observed the strongest reduction in odds of suicidal ideation for sleep guideline adherence. It should be noted, however, that concurrent adherence to all three guidelines has been shown to have more robust effects for suicidal ideation among military service members – 66% and 70% lower odds among females and males, respectively – than we found for post-secondary students despite both populations reporting rates of suicidal ideation more than double that of population norms. Differences in the types of stressors post-secondary students are exposed to versus what military service members encounter (i.e., combat exposure) is one potential explanation for this discrepancy.

Of note, a significant positive association between adherence to the sedentary behavior guideline and suicidal planning was observed, but only in our sensitivity analyses. Recoding "Prefer not to answer" as "Yes" for both dependent variables increased the percentage of suicidal planning reported in the sample, resulting in increased statistical power. This finding indicates that adherence to the sedentary behavior guideline was associated with greater odds of suicidal planning. Individuals with more severe forms of suicidal thoughts (such as suicidal planning) have reported higher rates of agitation in prior research [32], which may manifest as restlessness, pacing, and reduced sedentary behavior. Additionally, emerging research indicates a significant relationship between negative urgency – the need to take action to alleviate negative emotional states – and suicide-related thoughts and behaviors, which may result in the use of more active coping measures as opposed to passive responses, such as rumination and isolation [33,34]. However, further research is needed to investigate this association in greater detail.

Despite providing novel evidence related to the relationship between 24-hour movement guideline adherence and suicidal thoughts, the current study is not without limitations. First, we employed a cross-sectional design and therefore we cannot infer causality. Second, movement behavior data was self-reported which can be susceptible to recall errors and/or social desirability biases. Third, examining 24-hour movement guideline adherence fails to consider how differences in the prevalence of suicidal thoughts may be attributable to the domains of physical activity and sedentary behaviors that individuals are engaging in. For instance, research has shown that strength training, but not aerobic exercise, is negatively associated with suicidal ideation among college females [35]. Fourth, generalizability to all emerging adults attending higher education in Canada may be limited considering the CCWS is not a nationally representative sample. Finally, survey responses were collected prior to the COVID-19 pandemic, which has been associated with an increase in suicide ideation prevalence among adults age 18 to 34 in Canada [36], and may be driven by unique stressors requiring updated corresponding coping responses. We echo recommendations [14,29] for future research to use high quality longitudinal data sources to further investigate the relationships between the 24-hour movement guidelines and mental health (including suicidal outcomes), particularly by age and sex.

In sum, we found that adherence to certain movement behavior guidelines – sleep and sedentary behavior – are associated with reduced odds of suicidal ideation among emerging adults attending post-secondary education in Canada. Although favorable associations were observed for suicidal ideation, the beneficial influence of movement behaviors for suicidal thoughts does not appear to extend to suicidal planning. Our findings indicate that the promotion of movement behavior guideline adherence on campus may have promise for reducing the mental health toll experienced by post-secondary students, however, research in this area is in its infancy and longitudinal studies are needed to better understand these relationships.

Contributions

Conceptualization (DB, RH), Methodology (DB, RH, JW), Formal analysis (DB), Data curation (DB), Writing – original draft (DB, RH, JW)

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None.

Data and Supplementary Material Accessibility

The CCWS dataset is available through protected access (https://www.ccws-becc.ca/). All R code for the analyses is available at https://osf.io/afmwp.

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Table 1. *Descriptive statistics for demographic characteristics, movement behaviors and suicidal behaviors.*

	Sample (*N* = 17,633) *n* (%)	Missing *n* (%)
Gender		363 (2.1)
Females	11830 (67.1)	
Males	5557 (31.5)	
Other	246 (1.4)	
Age M (SD)	21.7 (2.92)	0 (0)
Ethnicity		148 (0.8)
White	5790 (32.8)	
Middle Eastern	547 (3.1)	
Black	351 (2.0)	
East/Southeast Asian	4825 (27.4)	
South Asian	3478 (19.7)	
Indigenous	181 (1.0)	
Latino	428 (2.4)	
Mixed/Other	2034 (11.5)	
Parental Education		1395 (7.9)
High school or less	3998 (22.7)	
Completed college/university	9479 (53.8)	
Graduate or professional degree	4156 (23.6)	
Chronic Health Condition/Disability status (yes)	5487 (31.1)	2535 (14.4)
International student (yes)	4393 (24.9)	0 (0)
Full-time student (yes)	14606 (82.8)	352 (2.0)
Financial stress		210 (1.2)
No stress at all	1968 (11.2)	
Very little stress	3534 (20.0)	
Some financial stress	5212 (29.6)	
Quite a bit of financial stress	3582 (20.3)	
A great deal of financial stress	3336 (18.9)	
Relationship status		396 (2.2)
Single	10104 (57.3)	
In a relationship	6281 (35.6)	
Married/engage/domestic partnership	1195 (6.8)	
Divorced/separated	37 (0.2)	
Widowed	17 (0.1)	

Trans Experience (yes)	322 (1.8)	647 (3.7)
Sexual Orientation		1541 (8.7)
Heterosexual/Straight	14475 (82.1)	
Bisexual/Pansexual	1725 (9.8)	
Gay/Lesbian	473 (2.7)	
Queer	231 (1.3)	
Questioning/Unsure	484 (2.7)	
Asexual	246 (1.4)	
Physical activity guideline adherence (yes)	11180 (63.4)	1916 (10.9)
Sedentary behavior guideline adherence (yes)	4051 (23.0)	645 (3.7)
Sleep guideline adherence (yes)	10613 (60.2)	584 (3.3)
Concurrent adherence to all guidelines (yes)	1927 (10.9)	N/A*
Suicidal ideation	2541 (14.4)	1576 (8.9)
Suicidal planning	857 (4.9)	1778 (10.1)

Note: *no missing data information due to variable being computed after multiple imputation