Longitudinal associations throughout adolescence: Suicidal ideation, disturbing dreams, and internalizing symptoms

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ARTICLE INFO

ABSTRACT

Objective/Background: Many studies have reported associations between disturbing dream occurrence and internalizing symptoms in adults, but the extent to which such associations also characterize adolescents remains unknown. The main goal of the present longitudinal study was to evaluate the strength and stability of the associations between disturbing dream frequency, suicidal ideation, and internalizing symptoms from ages 13 to 18.

Methods: Participants (N = 434) drawn from two longitudinal birth cohort studies on child development in the province of Quebec, Canada, completed annual self-reports of disturbing dream frequency, suicidal ideation, and levels of depression and anxiety.

Results: Two separate cross-lagged panel models for symptoms of depression and anxiety were conducted with both models showing similar results. In early adolescence, high levels of and higher change in disturbing dream frequency were associated with increased odds of reporting later suicidal ideation, whereas in mid to late adolescence, increased odds of reporting suicidal ideation at age 17 was associated with increased disturbing dream frequency at age 18. Across adolescence, increased levels of depression and anxiety were associated with increased odds of reporting later suicidal ideation and increased disturbing dream frequency.

Conclusions: These findings support previous literature suggesting that disturbing dream frequency, depression, and anxiety, are risk factors for suicidal ideation throughout adolescence. The present longitudinal study allows for a refinement of our conceptualization of disturbing dream and their relation to suicide and internalizing symptoms throughout adolescence and suggests that the collection of information on disturbing dream and internalizing symptoms during early adolescence may help screen adolescents for suicide risk.

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1. Introduction

Suicide is a major worldwide public health problem with a heterogeneous etiology [1–4]. Overall, approximately 703,000 people die annually by suicide [5]. Several biological, clinical and psychosocial risk factors play a role in the presentation of suicide risk, some of which are non-modifiable, such as age, and others that are potentially modifiable [4]. Because adolescents are not always comfortable reporting the presence of suicidal ideation [6–9], clinicians face the complex challenge of predicting suicide risk in this particularly vulnerable population [10]. Early identification of at-risk individuals is advocated, as epidemiological studies indicate that approximately one third of individuals with suicidal ideation will develop a suicide plan and 56% will attempt suicide [11,12]. It is

thus important to identify modifiable risk factors for suicide and better understand underlying mechanisms to inform prevention programs aimed at this population [1,13,14].

Sleep disturbances are one class of modifiable risk factors related to suicide risk [15]. Studies have repeatedly demonstrated a significant and positive association between various sleep-related problems and suicidal ideation or suicidal behaviors across multiple populations [16,17]. Specifically, disturbing dreams (DD), including nightmares and bad dreams, have been associated with a greater risk of suicidal ideation, suicide attempts and suicide deaths 9,18–32. One longitudinal study has also showed prospective associations between nightmare frequency and suicide risk in adolescents [33]. DD are typically defined as vivid dreams marked by intense negative emotions such as fear, sadness, and anger [34–36]. Two to 10% of the general population report one or more DD per week [35], and DD frequency may be even higher in pediatric populations 26,32,35,37. Thus, DD represent an important factor contributing to suicide risk, but its specific etiological role remains to be clarified [38].

While systematic reviews and meta-analyses report a significant and positive association between DD and suicide risk [10,15,17,39], these results are largely based on cross-sectional or retrospective investigations, studies with small sample sizes, or research examining broad relationships between sleep and suicide. This last point limits our understanding of the association between DD and suicide, despite evidence pointing toward a greater contribution of DD in explaining suicide risk compared to insomnia [19,20,30,40].

In addition to investigating the associations between suicide and DD, it is important to focus on the developmental mechanisms underlying these associations and their correlates to broaden our understanding of this phenomenon in order to help effectively decrease suicide risk [10]. In fact, depression has been shown to correlate with DD frequency, and both are common risk factors for suicidal ideation [1,22,41]. Specifically, DD are related to a range of psychological difficulties, including anxiety, depression, and behavioral problems, thereby suggesting failures in processes underlying emotional regulation that are believed to occur during sleep and possibly in dreams [34,35,37,42–48]. In addition, although depression is considered one of the strongest risk factors for suicide, the longitudinal associations between depression and suicide remain inadequately investigated [49]. Several studies have shown that depression and sleep-related problems are independent risk factors for suicidal behaviors and that DD and insomnia, in particular, increase the risk of suicidal behaviors in patients with depression. These studies highlight the importance of examining the specific role of DD as well as depressive symptoms in suicide risk [4].

Moreover, not only has the frequency of DD been repeatedly associated with depressive symptoms during childhood and adolescence, but it is also associated with anxiety symptoms [48,50–56]. For example, prospective studies of adolescents revealed predictive associations between parent-reported DD in youth aged 10–19 years and subsequent anxiety and depressive symptoms at ages 18–32 [57]. A study in adults revealed that frequencies of anxiety and depressive symptoms were higher in individuals who reported lifetime exposure to suicide (i.e., knowing someone who died by suicide) [58]. To date, no study has examined the longitudinal relationships in adolescents between DD, suicidal ideation, and internalizing symptoms, including depressive and anxiety symptoms. Furthermore, studies have focused primarily on adult populations [15], whereas suicide risk increases most during adolescence [12,59].

In sum, there is a need to clarify the temporal sequence and consistency of these associations across adolescence and to investigate if they are comparable across internalizing symptoms. The main aim of the present study was thus to use transactional analyses to investigate the longitudinal associations between DD frequency, suicidal ideation, and internalizing symptoms (i.e., levels of depression and anxiety) across adolescence.

2. Method

2.1. Participants

Participants were drawn from two cohorts of the Quebec Longitudinal Study of Child Development (QLSCD): a first cohort born in 1996 in which 1000 Quebec families were randomly selected from urban areas from a Quebec birth registry and a second cohort born in 1997 in which 2120 Quebec families were also randomly selected from the Quebec birth registry. In the first cohort, 572 families agreed to participate in the first wave when their child was 5 months old. In order for a participant to be included in the present study, the participant had to have at least one valid data response on the variables of interest at any time point between the ages of 13 and 18, which resulted in a total of 266 participants from the first cohort. A sample of 168 adolescents from the second cohort matched to the urban catchment areas was added to the first cohort sample to increase the statistical power of the analyses, which resulted in a sample of 434 participants in total. The sample in the present study (N = 434) did not differ significantly from the rest of the original sample on household income, family type (i.e., single parent or not), the mother's or the father's age, the father's highest level of education, but did differ in terms of the mother's highest level of education ($p < .001$), with a greater proportion of mothers having reached higher levels of education than in the original sample. Table 1 presents the sociodemographic characteristics for the study sample.

Prior to adolescence, data were collected annually throughout participants' childhood. Consent was provided yearly by the parents and by the child when the child was sufficiently mature to provide consent in addition to that obtained from the parents. Data were reported by parents until the child reached 11 years of age, after which data were self-reported annually by the child. To increase the validity of the responses, confidentiality was assured to the adolescents. This research project was approved by the Institut

Table 1
Sociodemographic characteristics of the present sample (N = 434).

Sociodemographic characteristic	Percentage of sample
Sex	
Girls	55.8
Boys	44.2
First language learned	
French	86.5
English	6.3
Race/Ethnicity	
White	96.0
Black	2.3
Other	1.7
Mother's last completed degree	
Less than high school	8.6
High school	23.9
CEGEP, college, technique graduate	29.0
University graduate or more	38.5
Family annual income	
<30,000$	26.8
30,000$-59,999$	34.3
≥60,000$	39.0
Family composition	
Intact or recomposed	96.5
Single	3.5
Mother's age in years (SD)	30.1 (4.9)

de la statistique du Québec, the Sainte-Justine Hospital Research Center, and the Louis-Hippolyte Lafontaine Hospital Research ethics committees.

2.2. Measures

2.2.1. Disturbing dreams (DD)

Participants self-reported their DD frequency annually beginning at age 11. Adolescents were first asked, "On average, how frequently do you have bad dreams?" using the measurement scale of "Never," "Sometimes," "Often," "Always," or "Don't know." Because "dysphoric dreams" is a less familiar term for many youths, the term "bad dreams," defined as "very disturbing dreams," was used instead. Participants who reported experiencing bad dreams were also asked to "Estimate the number of bad dreams you have had in the past month." The number of bad dreams was coded as 0 for children who reported never having bad dreams in the first question. Because the variance was primarily between 0 and 5 bad dreams per month, frequency categories were formed as follows: "0 DD," "1 DD," "2 DD," "3 or 4 DD," and "5 or more DD" per month. A one-month retrospective unit of measure was used rather than a one-year retrospective measure as the one-month retrospective measure is more consistent with prospectively collected log-based frequency measures of dysphoric dreams [60,61].

2.2.2. Suicidal ideation

Participants were asked the following question, "Have you ever thought about suicide in the past 12 months?" with the following measurement scale "Never," "Rarely," "Quite often," "Very often," "Don't know," or "Does not apply." This question has been extensively validated in other studies [62—65]. Given the non-normality of responses to this item, it was dichotomized with 0 indicating "Absence of suicidal ideation" and 1 indicating "Presence of suicidal ideation."

2.2.3. Depression and anxiety symptoms

The Children's Depression Inventory [66] was used to assess level of depression from age 13 to 18. At age 13 and 17, participants were asked to answer to 14 items, while for the other ages, they were asked to answer to 12 items. The measurement scale includes a three-point scale (1—3), which represents the absence, presence, and frequency of occurrence of the symptom. For each item, the child selected the answer that most closely corresponded to his or her state at the time of testing. Internal consistency for the scale was considered acceptable to moderate from 13 to 18 years of age ($0.75 \leq \alpha \geq 0.87$). For level of anxiety, participants were asked each year to complete four items from the Youth-Self Report [67]. The measurement scale includes a three-point scale (1—3): "Never," "A few times," or "Often." Internal consistency for the scale was considered moderate from 13 to 18 years of age ($0.81 \leq \alpha \geq 0.88$).

2.2.4. Control variable

Sex was included as a control variable in the analyses as it has been shown to be associated with DD [37], suicidal ideation [68] and internalizing symptoms [69—72].

2.3. Statistical analyses

To examine directional effects between DD frequency, presence of suicidal ideation, levels of depression and of anxiety, cross-lagged panel models (CLPM) were conducted in Mplus 7.4 [73]. This analysis allows for the examination of bi-directional (cross-lagged) effects between the different variables at each age, while controlling for stability across time (autoregressive effects). Full information maximum likelihood under the missing at random assumption (FIML) was used to handle missing data and maximum likelihood estimation with robust standard errors (MLR) was used to handle severe normality deviations 74,75. Model fit was assessed by considering the following parameters and their criteria: the model chi-square (should be < 3 times the degrees of freedom), the root mean square error of approximation (RMSEA; acceptable fit <.08), the comparative fit index (CFI; acceptable fit ≥.90), the Tucker Lewis index (TLI; acceptable fit ≥.90), and the standardized root-mean-square residual (SRMR; acceptable fit <.08).

Two models were conducted. The first model focused on the associations between DD frequency, presence of suicidal ideation, and level of depression from ages 13 to 18. The second model focused on the associations between DD frequency, presence of suicidal ideation, and level of anxiety from ages 13 to 18. Thus, the models were compared to examine whether the same patterns exist regardless of the internalizing symptom considered.

3. Results

3.1. Descriptive statistics

Tables 2 and 3 present the descriptive statistics for the key variables included in the models from ages 13 to 18. Scores on the depression and anxiety scales generally increased with age. At age 13, 57.7% of participants reported at least one DD in the last month, 62.5% at age 14, 44.8% at age 15, 56.9% at age 16, 46.4% at age 17 and 60.6% at age 18. These prevalences are consistent with the literature where rates in children aged 9 to 18 ranged between 30 and 60% [76—79]. Presence of suicidal ideation increased from age 13, peaked at age 15 at 14.7%, and then decreased until age 18 (see Fig. 1). Tables S1, S2 and S3 in the supplemental materials present the correlation matrices for the key sets of variables included in the models (DD frequency, suicidal ideation, levels of depression and anxiety) from ages 13 to 18.

Table 2
Descriptive statistics on continuous key variables.

Study variable	M	SD	Skew	Kurtosis
Depression				
Age 13	1.31	0.29	1.16	0.66
Age 14	1.33	0.29	1.39	2.46
Age 15	1.35	0.32	1.51	2.98
Age 16	1.38	0.36	1.44	1.93
Age 17	1.38	0.32	1.08	0.95
Age 18	1.45	0.35	1.00	0.62
Anxiety				
Age 13	1.53	0.47	0.64	−0.44
Age 14	1.54	0.50	0.71	−0.26
Age 15	1.56	0.52	0.73	−0.17
Age 16	1.62	0.57	0.62	−0.59
Age 17	1.65	0.58	0.53	−0.71
Age 18	1.78	0.59	0.38	−0.79

Table 3
Percentages of participants by response options for DD frequency at each year.

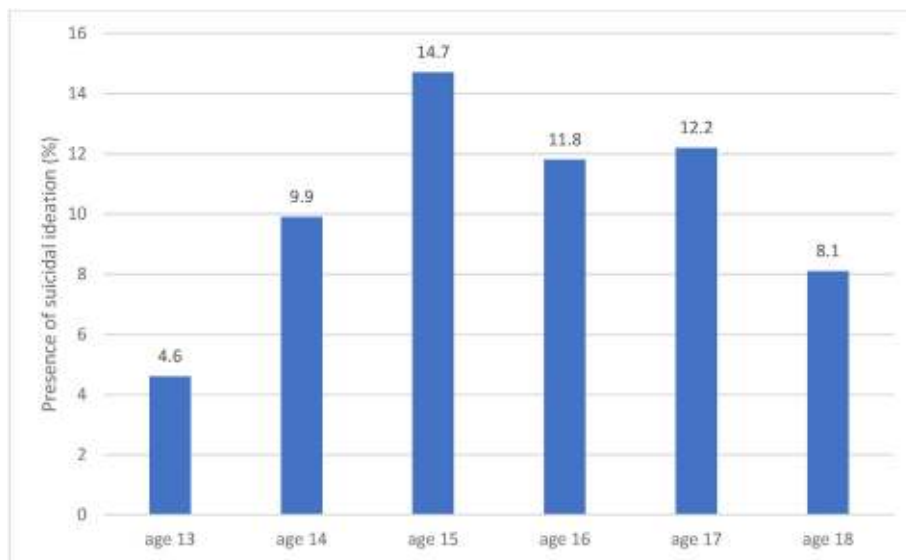|	0 DD	1 DD	2 DD	3 - 4 DD	5+ DD
Age 13	42.3	17.7	16.9	11.5	11.5
Age 14	37.5	20.2	18.6	10.9	12.8
Age 15	55.2	17.2	13.5	8.3	5.8
Age 16	43.1	19.1	16.7	11.8	9.4
Age 17	53.6	15.0	13.1	11.7	6.6
Age 18	39.4	17.7	18.8	15.2	8.9

Fig. 1. Percentages of presence of suicidal ideation at each year.

3.2. Cross-lagged panel models

3.2.1. Model 1: DD frequency, presence of suicidal ideation and level of depression

In Model 1, shown in Fig. 2, longitudinal associations between DD frequency, presence of suicidal ideation, and level of depression were examined from ages 13 to 18. A first model (including only lag-1 paths) did not fit the data well (see Table S4 in the supplemental materials). With the addition of higher order paths (see Table S5), the model fit the data well: $\chi^2(116) = 153.0$, RMSEA = 0.03, 90% CI [0.01 - 0.04], CFI = 0.97, TLI = 0.96, SRMR = 0.06. All three variables were stable across time, with the stationarity assumption respected (i.e., which refers to the unchanging causal structure among the measured constructs; see Table S4). Thus, the autoregressive paths reach a state in which they are the same magnitude from wave to wave [80]. Standardized betas for the stability of DD frequency ranged from 0.29 to 0.36, and for level of depression from 0.32 to 0.46. For presence of suicidal ideation, the odd ratios (OR) were 5.47 from age 13 to 18. The predictive equilibrium assumption was also respected for the concurrent correlations between constructs (i.e., they are the same

magnitude from wave to wave; see Table S1) [81]. The correlations between DD frequency and presence of suicidal ideation at each age were small ($r = 0.04 - 0.06$, p < .10). Those between DD frequency and level of depression were also small but significant ($r = 0.08 - 0.14$, p < .001). Finally, the correlations between level of depression and presence of suicidal ideation were moderate and significant ($r = 0.26 - 0.39$, p < .001).

Several cross-lagged paths were found. Note that in Figs. 2 and 3 variables after 13 years represent residual scores controlling for previous scores and cross-lagged associations. High levels of DD frequency at age 13 and increases in DD frequency from ages 13 to 14 significantly predicted increased odds of reporting suicidal ideation one year later (at 14 and 15 years; OR = 2.07 and 1.35, respectively). High levels of depression at age 13 and increases in subsequent levels of depression significantly and independently predicted increased odds of reporting suicidal ideation one year later, consistently across adolescence (ORs = 1.12—1.26). High levels of depression at age 13 and increases in levels of depression at ages 14 and 15 predicted increased DD frequency one year later (from 14 to 16 years with $\beta = 0.11 - 0.19$). Unexpectedly, the model showed that increased odds of reporting suicidal ideation between ages of
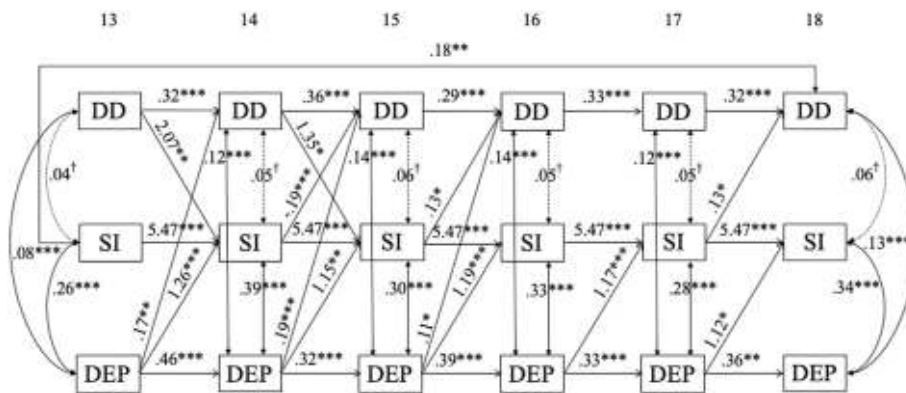

Fig. 2. Standardized results for the cross-lagged model including level of depression. N = 434. Model fit: $\chi^2 = 153.0$, df = 116, p = .01; RMSEA = 0.027; CFI = 0.97; TLI = 0.96; SRMR = 0.062. † = p < .10; * = p < .05; ** = p < .01; *** = p < .001. DD = Disturbing dream frequency; SI=Presence of suicidal ideation; DEP = Level of depression. All coefficients are standardized betas, except for associations predicting presence of suicidal ideation, which are odd ratios. All model coefficients and p values are provided in Table S8 in the supplemental materials. A test of the same associations but controlling for levels of anxiety from 13 to 18 years old is presented in Supplemental Model 1.
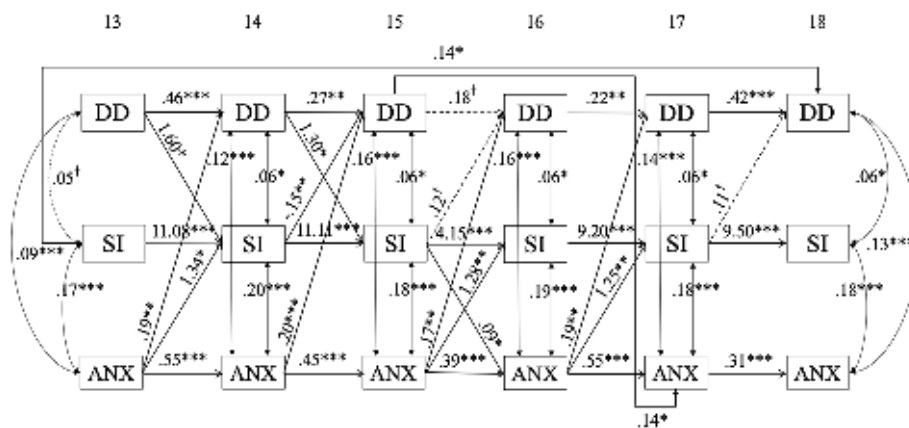
Fig. 3. Standardized results for the cross-lagged model including level of anxiety. N = 434. Model fit: χ^2 = 109.47, df = 92, p = .10; RMSEA = 0.021; CFI = 0.99; TLI = 0.98; SRMR = 0.062. † = p < .10; * = p < .05; ** = p < .01; *** = p < .001. DD = Disturbing dream frequency; SI=Presence of suicidal ideation; ANX = Level of anxiety. All coefficients are standardized betas, except for associations predicting presence of suicidal ideation, which are odd ratios. All model coefficients and p values are provided in Table S8 in the supplemental materials. A test of the same associations but controlling for levels of depression from 13 to 18 years old is presented in Supplemental Model 1.

13 and 14 predicted decreases in DD frequency from ages 14 to 15 (β = -0.19). However, the opposite was found at subsequent ages, where increased odds of reporting suicidal ideation (from previous year) at 15 and 17 significantly predicted increases in DD frequency one year later, at 16 and 18, respectively (both β = 0.13). Even when considering the autoregressive and cross-lagged paths, high odds of reporting suicidal ideation at 13 significantly predicted increases in DD frequency 5 years later at age 18 (β = 0.18). The same patterns were observed when accounting for sex. We also conducted supplemental analyses to take into account the comorbidity between both internalizing symptoms (levels of depression and anxiety) and the results were essentially the same except for minor changes; the role of depression remained the same with suicidal ideation, however increases in levels of depression predicted increases in DD frequency one year later only from ages 13 to 14 (see Supplemental Model 1).

3.2.2. Model 2: DD frequency, presence of suicidal ideation and level of anxiety

In Model 2, shown in Fig. 3, longitudinal associations between DD frequency, presence of suicidal ideation and level of anxiety were examined from ages 13 to 18. A first model (including only lag-1 paths) did not fit the data well (see Table S6). With the addition of higher order paths (see Table S7), the model fit the data well: $\chi^2(92)$ = 109.5, RMSEA = 0.02, 90% CI [0.00 - 0.04], CFI = 0.99, TLI = 0.98, SRMR = 0.06. Standardized betas for the stability of DD frequency ranged from 0.18 to 0.46, and for level of anxiety from 0.31 to 0.55. For presence of suicidal ideation, the odd ratios ranged from 4.15 to 11.11. The correlations between DD frequency and presence of suicidal ideation at each age were small (r = 0.05 - 0.06, p < .10). Those between DD frequency and level of anxiety were also small but significant (r = 0.09 - 0.16, p < .001). Finally, the correlations between level of anxiety and presence of suicidal ideation were also small and significant (r = 0.17 - 0.20, p < .001).

Several cross-lagged paths were found. High levels of DD frequency at age 13 and increases in DD frequency from ages 13 to 14 significantly predicted increased odds of reporting suicidal ideation one year later (at 14 and 15 years; OR = 1.60 and 1.30, respectively). High levels of anxiety at age 13 and increases in levels of anxiety in early and mid adolescence significantly and independently predicted increased odds of reporting suicidal ideation one year later (ORs = 1.25—1.34). High levels of anxiety at age 13 and increases in levels of anxiety across early to mid adolescence (from 14 to 17 years old) also predicted increases in DD frequency one year later

(with β = 0.17 - 0.20). In turn, increased DD frequency from ages 14 to 15 predicted increases in levels of anxiety two years later (from 15 to 17 years old with β = 0.14). Unexpectedly, the model showed that increased odds of reporting suicidal ideation between ages 13 and 14 predicted decreases in DD frequency at age 15 (β = -0.15). However, the opposite was found at subsequent ages, where increased odds of reporting suicidal ideation (from previous year) at ages 15 and 17 marginally predicted increases in DD frequency one year later, at ages 16 and 18 (β = 0.12 and 0.11, p < .10, respectively). Even when considering the autoregressive and cross-lagged paths, high odds of reporting suicidal ideation at 13 significantly predicted increases in DD frequency 5 years later at age 18 (β = 0.14). The same patterns were observed when accounting for sex. Supplemental analyses that took into account both internalizing symptoms in the same model (levels of depression and anxiety) showed essentially the same results except for minor changes. The role of anxiety remained the same with DD frequency, however levels of anxiety did not predict suicidal ideation across adolescence independently when depression was taken into account (see Supplemental Model 1).

4. Discussion

This study's main objective was to examine the potential bidirectional relationships between DD frequency, suicidal ideation, and symptoms of depression and anxiety across adolescence using six time points to parse out the developmental sequence between these variables. To test this, we used a cross-lagged approach which allowed to simultaneously test for predictive relationships between key variables.

Results from the two cross-lagged autoregressive models revealed the possibility of common developmental patterns for symptoms of depression and anxiety. Our main findings, in both models, showed that high levels of DD frequency at age 13 and increases in DD frequency between ages 13 and 14 predicted subsequent increased odds of reporting suicidal ideation, regardless of the presence of depression or anxiety symptoms. This result is consistent with findings in adult populations, where the association between DD frequency and suicidal ideation remained significant even after controlling for depression [15]. This finding is also in line with the results of Liu et al. [33] who found that adolescents' self-reported frequent nightmares at baseline were significantly associated with increased risk of subsequent suicidal behavior. This result adds to the understanding of the developmental sequence of

DD frequency, suicidal ideation, and internalizing symptoms throughout adolescence.

Cukrowicz et al. [20] suggested that a decrease in sleep quality associated with the presence of nightmares affects sleep-related emotional regulation, thereby exacerbating the presence of suicidal ideation. Our models, however, revealed that the direction of the relationship between changes in DD frequency and suicidal ideation from one year to the next varied across adolescence, with increased suicidal ideation being associated with later increases in DD frequency in late adolescence. Unexpectedly, the models revealed one negative relationship between change in suicidal ideation at age 14 and subsequent changes in DD frequency at age 15. In other words, increased odds of reporting suicidal ideation from ages 13 to 14 predicted decreases in DD frequency from ages 14 to 15. More research is needed to clarify the possible developmental mechanisms at play in these associations. What is clear, however, is that our findings point to a bidirectional association between DD and suicide risk across adolescence.

Moreover, our findings are consistent with the idea that DD during adolescence can be related to negative daytime emotional states; these dysphoric states may, in turn, impact nightly dream experiences [82–86]. Just as daytime stressors can impact sleep quality, the results from our models indicate that high levels of or increases in depression and anxiety symptoms are associated with increased DD frequency during early adolescence. These results support the evidence on the interplay between sleep and psychological difficulties and clarify the direction of the association between changes in DD frequency and internalizing symptoms across adolescence. What's more, once suicidal ideation is taken into account, our models highlight developmental psychological mechanisms throughout adolescence in which the presence of internalizing symptoms (levels of depression and anxiety) in early adolescence predicts subsequent increases in DD frequency which, in turn, predict increased odds of reporting suicidal ideation which subsequently predict increased DD frequency. Thus, these results support the view of complex developmental cascades between DD, suicidal ideation, and internalizing symptoms across adolescence.

Our findings are also consistent with findings in adults [58] in showing that high levels of or increases across adolescence in depression and anxiety symptoms predict increased odds of reporting suicidal ideation. Although the third model, presented in supplemental materials, suggests that the associations between internalizing symptoms and suicidal ideation may be more specific to symptoms of depression, this finding needs to be interpreted with caution given the lack of statistical power. Nonetheless, our findings from models 1 and 2 extend previous findings by showing that associations between internalizing symptoms and suicidal ideation are reciprocal, or bidirectional, across early and middle adolescence, and, more importantly, by identifying certain developmental cascades between our factors of interest. A number of developmental cascades from early internalizing symptoms to later DD frequency via suicidal ideation were found across adolescence. The most important, however, for the prevention of suicidal ideation are the developmental cascades identified in early adolescence going from internalizing symptoms (13 years) to suicidal ideation (15 years) via DD frequency (14 years). A major implication of our results is the identification of DD frequency as a potential intermediary variable between waking levels of distress and suicidal ideation and thus as a target for suicide risk prevention.

Findings in adults have shown that the experience of frequent nightmares can generate a level of distress that is above and beyond that associated with internalizing symptoms, highlighting the independent contribution of nightmare frequency to suicide risk [4]. In fact, waking distress and the unpredictable and uncontrollable aspect of nightmares could be linked to feelings of hopelessness, which can account for increased suicide risk [28]. Some authors have hypothesized that sleep can act as an escape strategy from everyday problems, thus offering an alternative to suicide [87]. Our study is consistent with findings in adult populations [4], where DD frequency predict suicidal ideation. Moreover, the bidirectionality of the associations found in our study also highlights that waking psychological distress would in turn exacerbate DD frequency.

To our knowledge, this is the first study to examine the bidirectional effects between DD frequency, suicide risk and internalizing symptoms throughout adolescence while accounting for the stability of these effects across time. Collecting information on DD in clinical contexts may be valuable since studies show that adolescents are generally not comfortable reporting their suicidal thoughts, especially when confidentiality is not assured [6–8]. Thus, focusing on DD as well as developmental mechanisms associated with suicide risk could be socially and clinically meaningful in assessing suicide risk in adolescents.

4.1. Strengths and limitations

The present study has several notable strengths. First, it sheds light on the developmental sequence of DD frequency, suicidal ideation, and levels of depression and anxiety across adolescence. Second, it provides a better understanding of the mechanisms associated with suicide risk during adolescence. Third, it addresses several limitations of cross-sectional studies in the field, including previous studies' inability to assess the developmental sequence and directionality of the associations between DD frequency and suicidal ideation throughout adolescence [10].

The following limitations of the present study must be acknowledged. First, although the vast majority of our results are consistent with the literature, the effect sizes of the associations found were generally small which may limit their clinical relevance. However, small effect sizes are expected given the complexity of the models at work and the number of variables involved. Second, while cross-lagged models adequately address the objective of examining bidirectional effects longitudinally, they do not separate intra-individual from inter-individual variance [88,89]. Third, the use of self-reported retrospective measures for DD frequency is another limitation, although the use of a single item to measure DD frequency yields comparable and equally valid results as those obtained with multiple items [90]. That said, since correlates of retrospective measures of dream recall frequency may differ from those obtained with prospective, log-based measures of dream recall, including for DD, prospective measures are usually favored [61,91,92]. Fourth, we did not assess participants' level of distress associated with their DD. Given that DD-related distress is not always strongly correlated with DD frequency (between $r = 0.26$ and $r = 0.44$) and that it may show stronger relations to measures of psychopathology [93–98], its inclusion in future studies is warranted [2,38]. Fifth, instead of adopting a clinical definition of nightmares in our questionnaire (e.g., repeated awakenings with recollection of intensely disturbing dream mentation), we opted for the more common and easily understood (for adolescents) term "bad dreams" which was defined as "very disturbing dreams." That said, this term avoids having young participants determine whether their awakening was caused by the dream itself, which can lead to confusion, and the use of this term resulted in the investigation of a more common and broader dimension of disturbed dreaming (e.g., Refs. [36,37]), that can be better captured in a normative sample such as this one. Sixth, although we examined key variables across adolescence, other problems, such as sleep disturbances [26] and substance use [99], may be developmentally important in the associations found in our models. Given that our study focused on describing the associations between changes from

one time to another, future studies with a larger sample size should focus on explaining these associations by including other relevant variables. Seventh and finally, cross-lagged models were only estimated with one internalizing symptom at a time because of concerns related to statistical power in already complex models. For example, a more complex model integrating both depression and anxiety in the same model, would result in a low ratio between the number of participants and parameters tested (or high number of parameters for the number of participants). Although our supplementary results support the hypothesis of independent contribution of depression and anxiety symptoms to the association between DD frequency and suicidal ideation, future studies with larger and better powered sample sizes should focus on delineating more reliably the unique and common variance between depression and anxiety symptoms to test for the presence of a latent internalizing factor [100].

5. Conclusions

In conclusion, our results point to a significant developmental sequence of predictive and independent associations between DD and suicidal ideation. These longitudinal associations have both theoretical and clinical implications for understanding the mechanisms underlying suicidal ideation and for identifying adolescents at risk for suicide.

CRediT authorship contribution statement

Mira El-Hourani: Conceptualization, Methodology, Formal analysis, Writing — original draft, Writing — review & editing. **Antonio Zadra:** Conceptualization, Methodology, Writing — original draft, Writing — review & editing, Funding acquisition. **Natalie Castellanos-Ryan:** Conceptualization, Methodology, Formal analysis, Writing — original draft, Writing — review & editing. **Sophie Parent:** Conceptualization, Methodology, Investigation, Writing — original draft, Writing — review & editing, Funding acquisition. **Johanne Renaud:** Writing — original draft, Supervision. **Jean R. Séguin:** Conceptualization, Methodology, Investigation, Writing — original draft, Writing — review & editing, Supervision, Project administration, Funding acquisition.

Declaration of competing interest

None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleep.2022.06.012.

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