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Early nap cessation in young children as a correlate of language and psychosocial outcomes: Evidence from a large Canadian sample

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ABSTRACT

Objectives: Most children stop napping between 2 and 5 years old. We tested the association of early nap cessation (ie, children who stopped before their third birthday) and language, cognition functioning and psychosocial outcomes.

Methods: Data were from a national, longitudinal sample of Canadian children, with three timepoints. Children were 0-to-1 year old at T1, 2-to-3 years old at T2, and 4-to-5 years old at T3. Early nap cessation was tested as a correlate of children's psychosocial functioning (cross-sectionally and longitudinally), cognitive function (longitudinally), and language skills (longitudinally). There were 4923 children (50.9% male; 90.0% White) and their parents in this study who were included in the main analyses. Parents reported on demographics, perinatal and developmental variables, child functioning, and child sleep. Children completed direct assessments of receptive language and cognitive ability. Nap cessation, demographic, and developmental-control variables were tested as correlates of cross-sectional and longitudinal outcomes using linear regression (with a model-building approach).

Results: Early nap cessation correlated with higher receptive language ability ($\beta = 0.059 \pm 0.028$) and lower anxiety ($\beta = -0.039 \pm 0.028$) at T3, after controlling for known correlates of nap cessation, nighttime sleep, and other sociodemographic correlates of the outcomes. Cognitive ability, hyperactivity-inattention, and aggression were not correlated with nap cessation.

Conclusions: Early nap cessation is related to specific benefits (ie, better receptive language and lower anxiety symptoms). These findings align with previous research. Future research should investigate differences associated with late nap cessation and in nap-encouraging cultures, and by ethnicity.

Most 2-year-old children have a daytime nap, while few 5-year-old children do.[1] Emerging evidence has identified correlates of nap cessation and factors which distinguish children who nap and do not. However, how does napping relate to longitudinal outcomes? Some evidence suggests that children who stop napping earlier may have better developed behavioral and language functioning than still napping peers.[2-5] Other evidence suggests that naps produce at least short-term benefits for children's learning and memory.[6-8] Thus, nap cessation may have implications for specific outcomes. This study aimed to understand the differences in psychosocial (eg, anxiety) and cognitive outcomes (eg, receptive language) between children who cease napping early (ie, before their third birthday), compared to children who nap later into development.

Developmental trajectories of nap cessation

Most children in Western countries transition from polyphasic (many daytime naps and a nighttime sleep period) to biphasic (single daytime nap and a longer sleep period) to monophasic sleep (nighttime sleep period only) during their first 5 years. This process of sleep consolidation is gradual, with nap cessation capturing its endpoint. Meta-analytic findings demonstrate that just 1%-6% of children have stopped napping by 2 years old, 23%-44% of children have ceased by 3 years old, and almost all children (90%-97%) have ceased napping by 5 years old.[1] However, nap cessation rates appear to be lower in North America (ie, children tend to cease napping

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later).[1] Thus, between 2-to-3-years indicates the age where there is marked variability in nap cessation. Other researchers have argued that at about 2 years old, children may no longer require daytime sleep to meet 24-hour sleep requirements.[9] As such, we have operationalized “early nap cessation” as stopping napping before 3 years old,[10] in this manuscript and another study investigating the predictors of early nap cessation. Early nap cessation is a relative term and longitudinal research conducted in multiple countries is needed.

Nap cessation may be a marker of general development[11] and is likely driven by developmental and socioenvironmental factors.[10,12-14] Typically developing children or those who sleep longer at nighttime are more likely to have ceased napping than nontypically developing peers or children who sleep for shorter durations at night.[11,13,14] Socioenvironmental factors also predict nap cessation; for example, non-White children are more likely to nap until older than White children.[12] In a recent longitudinal study of Canadian children ages 0-1-year-old (at baseline) and 2-3-years-old (at follow-up) by our research group, early nap cessation (ie, before age 3) was associated with older child age, the child being female, having an older sibling, achieving more developmental milestones, and longer nighttime sleep duration, whereas continued napping was associated with non-White ethnicity, low birthweight (< 2500 g), the parent working/in school, and the biological mother consuming alcohol during pregnancy.[10] Thus, we have some understanding of the factors associated with nap cessation. However, how nap cessation at an earlier age may in turn influence other outcome measures is unclear. The current study examined how early nap cessation is associated receptive language, cognitive ability, and psychosocial functioning.

Napping and clinical outcomes

Previous research has investigated the relation of napping frequency (eg, number of naps per week), nap duration (eg, minutes spent napping), and sleep consolidation (ratio of daytime to nighttime sleep) to psychosocial functioning, cognitive abilities, and language abilities ([15] for a review). Shorter nap durations are associated with better psychosocial functioning (eg, lower anxious/depressive symptoms) among 4-6-year-old children.[16] Cross-sectional, longitudinal, and quasi-experimental evidence has also demonstrated that preschool-age non-nappers have better receptive language skills than nappers.[2,3,5,6] A recent correlational study reported that inconsistently napping 4-6-year-old children had better general cognitive ability scores than consistently napping peers.[14] In contrast, experimental studies have shown that habitually napping preschool children's learning and memory often benefits from napping after learning, in short-term testing intervals.[7,8,17-20]

Research on napping and cross-sectional and longitudinal outcomes has yet to test *early nap cessation* as a correlate. This aspect of napping behavior differs from alternative definitions (eg, duration, frequency, sleep consolidation) as it identifies the point at which children consolidate biphasic sleep into monophasic sleep. The extent to which early nap cessation is relevant for specific outcomes can inform our understanding of the developmental importance of nap cessation. Further, previous research has inconsistently controlled for other known correlates of functioning, such as the child's age, development in general, and sociodemographic correlates (eg, family income, parental education).

There are at least four competing hypotheses that may account for an association between early nap cessation and our outcomes. (H1) Nap cessation may be a specific developmental marker. If so, there would be a unique and significant contribution of nap cessation on the outcome, after controlling for other correlates of the outcome, such as age and socioeconomic factors. (H2) Differences could be due to general development; that is, nap cessation coincides with other aspects of developmental progression, but does not uniquely contribute to outcomes. Here, nap cessation would not significantly relate to an outcome, after controlling for other general developmental variables and other known correlates of nap cessation. (H3) Differences and nap cessation could be due to better socioeconomic circumstances, which enhance development and in turn contribute to both early nap cessation and improved outcomes. Here, nap cessation would not significantly relate to our outcomes after controlling for key socioeconomic variables, like family income and parental education. (H4) Differences could be due to nighttime sleep duration, rather than nap cessation specifically. Here, nap cessation would not significantly relate to an outcome after controlling for nighttime sleep duration; or nap cessation and nighttime sleep functioning would both relate to an outcome.

The current study

We investigated early nap cessation as a correlate of language, cognitive, and psychosocial outcomes in a large sample of Canadian preschool children, while controlling for previously identified correlates of nap status and demographic correlates of our outcomes, such as child age, ethnicity, and nighttime sleep duration,[10-12] in a series of models linked to the above hypotheses. This was a retrospective analysis of an existing dataset. The original project did not have the main aims of investigating sleep or napping.

Methods

Data from cycles 3-7 of the Canadian National Longitudinal Study of Children and Youth (NLSCY) were used. Cycle 3 was used as the starting point as it was the first cycle with the required variables. The NLSCY was a multi-year (1998-2009) study conducted by Statistics Canada, aimed to monitor the development and well-being of children from infancy to adulthood and was not specifically designed to investigate children's sleep. For more information, visit: https://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&Id=4632. Ethics approval and consent were obtained by Statistics Canada during original data collection. The Social Science and Humanities Research Council approved the present study's objectives and requested variables. Results were reviewed for maintained anonymity by Statistics Canada analysts, prior to release.

The NLSCY has multiple longitudinal cycles. A “cycle” is a data collection period (eg, cycle 4 data was collected between 2000 and 2001). Cycles occurred every 2 years. The present study constructed three longitudinal “cohorts” with three cycles of data per cohort. Each cohort includes three timepoints: Time 1 (T1): a baseline cycle reflecting the inception timepoint for the cohort and when demographic and perinatal variables were gathered; Time 2 (T2): a follow-up cycle when information on napping and cross-sectional outcomes were gathered; and Time 3 (T3): a follow-up cycle when longitudinal outcomes were gathered. Cohort 1 (the first cohort in the present study) is composed of cycle 3 (T1; 1998-1999), cycle 4 (T2; 2000-2001), and cycle 5 (T3; 2002-2003). Cohort 2 is composed of cycle 4 (T1), cycle 5 (T2), and cycle 6 (T3; 2004-2005). Cohort 3 is composed of cycle 5 (T1), cycle 6 (T2), and cycle 7 (T3; 2006-2007).

Participants

The person most knowledgeable (PMK) about the child provided information (N = 4923; $n_{\text{Cohort 1}}$ = 2371, $n_{\text{Cohort 2}}$ = 1366, $n_{\text{Cohort 3}}$ = 1186). The NLSCY was representative of the Canadian population at the time of data collection. Demographic characteristics are presented in Table 1.

The complete inclusion criteria for the NLSCY are explained elsewhere.[21] Briefly, the NLSCY included noninstitutionalized children who lived in Canada's provinces and excluded children who were living in a territory, on Indian reserves or Crown lands, those living in institutions, and those whose parents were full-time members of the Canadian Armed Forces.

Table 1
Parent, child, and family demographic characteristics

Characteristic	Category	% (*n*) or *M* (*SD*)
Parent		
Age	15-24 y	17.3% (852)
	25-29 y	30.2% (1485)
	30-34 y	32.2% (1585)
	35-39 y	15.6% (769)
	40 y or older	4.7% (232)
Marital status	Married/common-law	89.3% (4395)
	Single, widowed, separated, or divorced	10.7% (528)
Employment status	Works or attends school	73.0% (3595)
	Does not work or attend school	27.0% (1328)
Relationship with child	Biological mother	88.9% (4375)
	Other relationship	11.1% (548)
Education completed	Less than secondary school or equivalent	11.8% (579)
	Secondary school or equivalent graduate	14.7% (724)
	Some postsecondary school education	18.6% (918)
	College or university graduate and above	47.2% (2325)
Family		
Income adequacy	Lowest	2.5% (123)
	Lower-middle	10.2% (502)
	Middle	28.4% (1398)
	Upper-middle	39.3% (1936)
	Highest	19.6% (964)
Region of residence	Atlantic (Newfoundland, New Brunswick, Nova Scotia, PEI)	18.7% (923)
	Quebec	18.2% (897)
	Ontario	27.1% (1334)
	Prairie (Manitoba, Saskatchewan, Alberta)	27.0% (1330)
	British Columbia	8.9% (439)
Child		
Age (mo)	At T1 cycle	10.19 (3.95)
	At T2 cycle	30.79 (4.59)
	At T3 cycle	53.91 (4.33)
Sex	Male	50.9% (2507)
Ethnicity[a]	White	90.0% (4429)
	Non-White	9.4% (463)
Siblings	Has an older sibling	54.6% (2688)
	Has a younger sibling	21.6% (1061)
Child Chronic Health Condition (T3)[b]	Has one or more chronic health conditions	18.9% (929)
	No chronic conditions	80.2% (3949)

[a] Non-White includes Arabic, Black, Filipino, Indigenous Persons, Latin American, and Asian: frequencies for these specific ethnicity categories could not be produced for this dataset due to Statistics Canada data vetting regulations.
[b] Chronic health conditions included any health condition lasting or expecting to last 6 months or longer. Examples included epilepsy, heart conditions/disease, bronchitis, and cerebral palsy. Frequencies for specific chronic health condition categories could not be produced for this dataset due to Statistics Canada date vetting regulations.

Study criteria

In the current study, inclusion criteria were children who were (1) 0-1-years-old at baseline (T1), (2) were less than 3 years old at T2 and had valid napping data at T2 (described below), and (3) had at least partial valid outcome data (ie, families who were lost to T3 follow-up were excluded).

Procedure

Data were collected via face-to-face or telephone interviews with PMKs and direct assessments with children. For data in the current study, at T1, PMKs reported on demographic variables and perinatal variables. At T2, PMKs reported on nap status and cross-sectional outcomes. At T3, PMKs reported on longitudinal outcomes and children completed two direct assessment measures in the family's home (see Outcome Variables below).

Table 2
Descriptive statistics for the independent, control, and outcome variables

Variable	Category/Unit	% (*n*) or *M* (*SD*)
Independent variable		
T2 Early nap cessation (Dichotomous)	1 = No longer napping	11.1% (546)
Control variables		
T1 Low birth weight (Dichotomous)	1 = Yes	5.5% (271)
T1 Maternal alcohol use during pregnancy (Dichotomous)	1 = One or more drinks	11.3% (555)
T2 Developmental milestones	Standard Score (M = 100; SD = 15)	100.19 (15.07)
T2 Sleep duration	Hours	9.85 (1.96)
Outcome variables		
T2 Hyperactivity-inattention	Units (range = 0-14)	3.64 (2.33)
T3 Hyperactivity-inattention	Units (range = 0-14)	4.17 (2.67)
T2 Aggression	Units (range = 0-16)	4.92 (2.87)
T3 Aggression	Units (range = 0-16)	1.78 (2.00)
T2 Anxiety	Units (range = 0-12)	1.23 (1.42)
T3 Anxiety	Units (range = 0-12)	1.94 (1.88)
T3 Cognitive ability	Units	21.15 (5.72)
T3 Receptive language	Standard Score (M = 100; SD = 15)	101.49 (14.43)

Note: T1 = Time 1 (Baseline; children were 0-1-year-old); T2 = Time 2 (2-year follow-up; children were 2-3 years old); T3 = Time 3 (4-year follow-up; children were 4-5 years old); Developmental Milestones = standard scores on the Ages and Stages Questionnaire.

Measures

The survey questions and measures used in the NLSCY were selected by an expert advisory group.[21] These scales are established measures or short-form derivatives generated for the NLSCY. The construct validity of each scale was supported in tests by Statistics Canada.[21] Descriptive statistics are presented in Table 2.

Control variables

Demographic variables (T1). PMKs reported on their own age, marital status, employment status, relationship with their child, and educational attainment; their child's age, sex, ethnicity, number of siblings, and whether the child had a chronic health condition (ie, health condition lasting or expected to last 6 months or more); and their family's income adequacy and region of residence.

Perinatal variables (T1). PMKs provided their child's birth weight (reported in grams) and whether the child's biological mother consumed alcohol during the pregnancy. For analyses in this study, maternal alcohol consumption during pregnancy was dichotomized as 0 = no alcohol consumed, 1 = alcohol consumed once or more during pregnancy. Note, gestational age was also available, but was excluded as a control variable as it was highly correlated in our dataset with birthweight and demonstrated multicollinearity in this sample.

Developmental milestones (T2). Developmental milestones were calculated from the Ages and Stages Questionnaire (ASQ[22]) and included five areas of development (Communication, Fine Motor, Gross Motor, Problem-Solving, and Personal-Social). In a review, the ASQ demonstrated excellent test-retest reliability (r = 0.92), sensitivity (87.4%), and specificity (95.7%) for detecting developmental delay.[23] The original factor structure of the ASQ was supported within the NLSCY.[21] Standardized ASQ scores (*M* = 100, *SD* = 15) were constructed using NLSCY cycle 1 data (calculated by Statistics Canada analysts); raw scores were not available. To increase interpretability in the present study, standardized ASQ scores were recoded into half-standard deviation units prior to analyses. Higher scores indicated that more developmental milestones had been achieved.

Nighttime sleep (T1 and T2). PMKs reported on their children's nighttime sleep duration (in hours). Similar parent-report items are strongly associated with objective measures of sleep such as actigraphy (r = 0.74).[24,25]

Dependent variable

Nap cessation (T2). PMKs were asked: "In general, what is the longest time [child's name] naps during the day?." Response options were: (1) less than 1 hour; (2) from 1 hour to less than 2 hours; (3) From 2 hours to less than 3 hours; (4) From 3 hours to less than 4 hours; (5) 4 hours or more; (6) child does not nap anymore. Importantly, the NLSCY only asked this question of parents whose children were 0-3 years old. Responses were dichotomized to operationalize nap cessation. "Child does not nap anymore" was coded as "child ceased napping" (1) and the child napping for any duration was coded as "child still napping" (0).

Outcome variables

Psychosocial functioning (T2 and T3). PMKs reported on psychosocial functioning on three separate scales: (1) anxiety (6 items; scores could range from 0 to 12); (2) hyperactivity-inattention (7 items; scores could range from 0 to 14); and (3) aggression-opposition (8 items; scores could range from 0 to 16). Statistics Canada derived these items primarily from the Child Behavior Checklist,[26,27] with supplements from other sources to adapt to Canadians. PMKs responded about their child's recent behavior on a 3-point scale (0 = "Never or not true" 1 = "Sometimes or somewhat true" 2 = "Often or very true"). The Child Behavior Checklist has demonstrated strong psychometrics outside of the NLSCY.[26,27] The factor structure within the NLSCY was supported via confirmatory factor analyses by Statistics Canada analysts.[21] On each scale, higher scores indicated greater psychosocial problems.

Cognitive ability (T3). Children completed the Who Am I Cognitive Assessment.[28] This nonverbal standardized measure is appropriate for preschool and early school-age children and provides early literacy and numeracy assessments through drawing and copying tasks. Performance is strongly associated with subsequent academic achievement and is valid across cultural groups.[21] Scores could range from 10 to 40; higher scores indicated greater cognitive ability. Raw scores were used for analyses, as we did not want to remove the effects of age on this outcome.[29]

Receptive language ability (T3). Children completed the Peabody Picture Vocabulary Test – Revised (PPVT-R[30]). The PPVT-R is a standardized measure of receptive vocabulary in which the assessor states a word and the child points to the corresponding picture representing that word. In its original validation, the PPVT-R has demonstrated construct validity, using a one-parameter logistic model under an Item Response Theory (IRT) framework. Norms were created using a large, representative sample from the United States. Statistics Canada analysts replicated these IRT analyses using cycle 4 data and found no systematic differences between the NLSCY and the original US sample. The PPVT-R has also demonstrated adequate split-half and alternate-form reliabilities.[31] Standard scores were reported for descriptive purposes and raw scores were used for analyses.[29] Raw scores could range from 0 to 175. Higher scores indicated greater receptive language ability.

Data analyses

Analyses were conducted in Mplus (v8[32]). All analyses were unweighted. Statistics Canada does not provide normalized weights for longitudinal NLSCY datasets, and the usage of population weights would increase power and potentially bias tests of significance (as the sample size would increase to the population level). Our primary interest was in testing the statistical significance of nap cessation on the outcomes of interest, after controlling for key correlates. If significant, this finding may be applicable to young children in general. Our aim was not to derive findings, or estimate specific parameters, that were representative of the Canadian population. For these reasons, we utilized a nonweighted design.[33-35]

Early nap cessation was tested as a correlate of cross-sectional and longitudinal outcomes using linear regressions. Each linear regression was conducted using a model-building approach, where additional control variables were added in three (cross-sectional outcomes) or four models (longitudinal outcomes) to assess the unique contribution of early nap cessation. Cross-sectional models were those in which nap cessation and the outcome was measured at the same timepoint (T2); longitudinal models were those in which nap cessation was measured at T2 and the outcome was measured at T3. These models were: (1) nap cessation; (2) previously established correlates of nap cessation (ie, child's sex, child age, child's ethnicity, child having an older sibling, PMK working/in school, low birthweight, maternal alcohol use during pregnancy, developmental milestones, and T2 nighttime sleep duration); (3) other relevant demographic controls (ie, parental education and income adequacy); (4) T3 nighttime sleep duration (for longitudinal outcomes only) and the T2 assessment of the outcome variable (for longitudinal psychosocial outcomes only; ie, hyperactivity-inattention, aggression, anxiety). As the study's principal aim was to evaluate outcomes associated with early nap cessation, outcomes which did not differ by nap cessation in model 1 (bivariate relation) were not evaluated further. This decision was made a priori to reduce the number of analyses conducted. *P*-values were adjusted using the False Discovery Rate.[36]

Then, we conducted exploratory analyses to investigate whether the key parameter estimate (ie, beta for early nap cessation predicting each outcome) differed significantly between White and non-white children. This was evaluated using a Wald test with a critical value of $P = .05$.

Approach to missing data

The sample sizes for T1 and T2 were N = 4923, meaning all included participants had at least partial data. An additional 11% of cases (n = 581) were lost to T3 follow-up (ie, had no valid outcome data) and were excluded from analyses. Thus, 4923 participants with at least partial data were included. Missing data for outcome and control variables were low: < 10% for all variables, except for PMK highest education attained (14%). Differences between participants who had valid outcome data and those who were lost to follow-up were analyzed using chi-squares and *t* tests, as appropriate. Participants with valid outcome data differed significantly by marital status, income adequacy, PMK's educational attainment, child's birthweight, whether the child had a younger sibling, and child's ethnicity (see Supplementary Table S3). The correlates of missingness were analyzed using a logistic regression; that is, testing variables associated – "participant being lost to T3 follow-up (yes vs. no)." Missing data were handled using Full Information Maximum Likelihood (FIML). FIML is not without risk. However, the variables found to predict missingness (ie, parental education attainment, income adequacy, ethnicity, and low birthweight) were already planned as controls in the models. Inclusion of these variables has the desirable property of rendering the missingness structure as "missing at random."[37] This adjustment also mitigates the potential impact of differential loss, as this study did not utilize sample weights.[38,39]

Results

Preliminary analyses

The assumptions of linear regression were assessed. There were no issues with linearity, normality, or homoscedasticity. The intercorrelations between outcome variables were assessed using Pearson Correlations. All correlations were less than 0.50 suggesting distinctiveness (see Supplementary Table S4). Multicollinearity was assessed using Variable Inflation Factors. All Variable Inflation Factors were below 2, suggesting no substantial multicollinearity.

In T1 cycles, children were 0-1 years old (M = 10.19 months; SD = 3.95 months); in T2 cycles, children were 2-3 years old (M = 30.79 months; SD = 4.59 months); and in T3 cycles, children were 4-5 years old (M = 53.91 months; SD = 4.33 months). Across cohorts, 10.9% (±0.8%, 95% confidence interval) of children (n = 602) had ceased napping by their third birthday (this result has been previously reported by our group and is discussed elsewhere[10]).

Psychosocial functioning

In bivariate analyses, T2 Hyperactivity-inattention (cross-sectional), T2 Anxiety (cross-sectional), and T2 Aggression (cross-sectional) and T3 Aggression (longitudinal) were not associated with nap cessation. Therefore, no further models were tested.

For T3 Hyperactivity-inattention, children who ceased napping before their third birthday tended to have lower T3 Hyperactivity-inattention scores than children who were still napping (β = − 0.038, 95% CI [− 0.066, − 0.010], se = 0.014, p = .016, R^2 = 0.001). However, this relation was not maintained after controlling for known correlates of nap cessation (model 2). Full regression results are presented in Supplementary Table S1.

For T3 Anxiety, children who ceased napping before their third birthday tended to have lower T3 Anxiety scores than children who were still napping (β = − 0.053, 95% CI [− 0.081, − 0.025], se = 0.015, p < .001, R^2 = 0.003). This effect was maintained after controlling for known correlates of nap cessation (model 2), other relevant demographic control variables and T2 anxiety (model 3), and current nighttime sleep duration (model 4; see Table 3). In the fully adjusted model, early nap cessation was associated with lower T3 Anxiety scores (β = − 0.039, 95% CI [− 0.067, − 0.011], se = 0.015, p = .007).

Cognitive ability

Children who ceased napping by their third birthday tended to have higher T3 Cognitive ability than children who were still napping (β = 0.073, 95% CI [0.042,0.104], se = 0.016, p < .001, R^2 = 0.005). However, this effect was not maintained after controlling for other known correlates of nap cessation (model 2; see Supplementary Table S2).

Table 3
Summary of the relations between outcomes and early nap cessation by adjustment

	Early nap cessation							
	Model 1 (Unadjusted beta)		Model 2[a]		Model 3[b]		Model 4[c]	
	Model R^2	β ± 95% CI (se)	ΔR^2	β ± 95% CI (se)	ΔR^2	β ± 95% CI (se)	ΔR^2	β ± 95% CI (se)
Outcomes								
T2 Hyperactivity-inattention	0.001	− 0.026 ± 0.028 (0.015)						
T3 Hyperactivity-inattention	0.001	− 0.038* ± 0.028 (0.014)	0.040	− 0.013 ± 0.029 (0.015)	0.016	− 0.013 ± 0.028 (0.015)	0.144	− 0.007 ± 0.026 (0.013)
T2 Aggression	0.000	0.007 ± 0.028 (0.014)						
T3 Aggression	0.000	− 0.010 ± 0.028 (0.014)						
T2 Anxiety	0.000	− 0.012 ± 0.029 (0.014)						
T3 Anxiety	0.003	− 0.053*** ± 0.028 (0.014)	0.014	− 0.047** ± 0.029 (0.015)	0.008	− 0.044** ± 0.029 (0.015)	0.067	− 0.039* ± 0.028 (0.014)
T3 Cognitive ability	0.005	0.073*** ± 0.031 (0.016)	0.161	0.006 ± 0.030 (0.015)	0.029	0.006 ± 0.029 (0.015)	0.002	0.006 ± 0.029 (0.015)
T3 Receptive language	0.011	0.103*** ± 0.030 (0.015)	0.083	0.055*** ± 0.029 (0.015)	0.050	0.059*** ± 0.028 (0.015)	0.001	0.059*** ± 0.028 (0.015)

Note. This table depicts the standardized betas and standard errors for early nap cessation for each outcome. Full regression results are available in Supplementary Materials. Where early nap cessation was a nonsignificant correlate of an outcome in model 1 (Unadjusted), no further analyses were conducted. T2 = Time 2 (children were 2-3 years old), T2 variables are cross-sectional; T3 = Time 3 (children were 4-5 years old), T3 variables are longitudinal. p-values were adjusted for multiple comparisons using the False Discovery Rate. *p < .05; **p < .01; ***p < .001.

Percentage of sample size with complete data for each outcome are as follows: T2 Hyperactivity-inattention (95.0%); T3 Hyperactivity-inattention (95.3%); T2 Aggression (95.1%); T3 Aggression (95.5%); T2 Anxiety (95.5%); T3 Anxiety (95.3%); T3 Cognitive ability (77.6%); T3 Receptive language (85.3%). As an FIML approach was used, information from individuals without complete data for each outcome was still utilized in the analyses to estimate the models.

[a] This model controlled for the child's cohort and known correlates of early nap cessation (ie, child's sex, child age, child's ethnicity, child has an older sibling, Person Most Knowledgeable is working or in school, low birthweight [< 2500 g], maternal alcohol use during pregnancy [once or more], developmental milestones achieved, and T2 nighttime sleep duration).

[b] This model controlled for all model 2 control variables and other known sociodemographic correlates of functioning (ie, parental education and income adequacy).

[c] This model controlled for all model 2 and 3 control variables, plus T3 nighttime sleep duration and T2 psychosocial variables for T3 psychosocial models (eg, T2 Hyperactivity was controlled for in the T3 Hyperactivity model 4). This control was only applied to longitudinal (ie, T3) outcomes.

Receptive language ability

Children who ceased napping by their third birthday tended to have higher T3 Receptive language scores than children who were still napping (β = 0.103, 95% CI [0.073,0.133], $se = 0.015$, $p < .001$, $R^2 = 0.011$). This effect was maintained after controlling for known correlates of nap cessation (model 2), other known demographic controls (model 3), and current nighttime sleep duration (model 4). In the fully adjusted model, early nap cessation was associated with higher T3 Receptive language scores (β = 0.059, 95% CI [0.031,0.087], $se = 0.015$, $p < .001$). The unstandardized beta in the fully adjusted model was 2.81. That is, children who ceased napping by their third birthday tended to have receptive language scores 2.81 Standard Score points higher than those who were still napping, holding all other modeled variables constant.

Exploratory analyses of ethnicity

These analyses are presented in Supplementary Table S5. In brief, only the parameter estimates for Cognitive Ability differed significantly. For this outcome, non-white children who had ceased napping by their third birthday tended to have lower cognitive ability than non-white still napping children, whereas, among white children, early nap cessation was not significantly related. This result was maintained for non-white children after controlling for variables in models 2-4. In the fully adjusted model, early nap cessation was associated with lower T3 Cognitive ability scores for non-white children (β = − 0.121, 95% CI [− 0.220, − 0.022], $se = 0.050$, $p = .045$).

Discussion

This study investigated whether nap cessation was associated with psychosocial, general cognitive, and receptive language ability, using a large, longitudinal dataset and controlling for other relevant variables. Early nap cessation was associated with higher receptive language ability and lower anxiety, longitudinally, after controlling for other relevant variables. Consistent with our hypotheses, early nap cessation appears to have a unique contribution (ie, H1 from the Introduction) to less anxiety and better receptive language abilities, over and above any effects of simple maturation, better sociodemographic circumstances, or better overall sleep functioning. Early nap cessation was not associated with cognitive ability, aggression, or hyperactivity-inattention after controlling for other variables. These results suggest that nap cessation may coincide with other aspects of development but does not uniquely contribute to these relations (ie, H2).

Our findings align with the extant literature that has quantified napping in various ways and found that children who nap for shorter durations, have stopped napping, or have a lower ratio of daytime-to-nighttime sleep tend to have better receptive language abilities than children who nap for longer durations.[2,3,5,6] However, nap cessation only accounted for 1.1% of the variance in receptive language. Children who ceased napping early had receptive language scores that were 2.81 points higher on a Standard Scale, than still napping children. This effect size is similar to previous research.[2] Our findings advance this literature by demonstrating that early nap cessation is a relevant correlate for better receptive language abilities later in development. Dionne and colleagues proposed a theoretical framework for this relation.[2] In this framework, the relation occurs due to one of three possible explanations: (1) better sleep functioning predicts memory functioning, which in turn promotes language learning; (2) sleep processes are well-organized (ie, consolidated), which supports higher-order cognitive organization (language and social functioning); and/or (3) common genetic or environmental influences, such as general maturation, adverse perinatal events, or sociodemographic factors, underlie both nap cessation and language development. Our results are consistent with these first two explanations, but do not support the third explanation. Recently, Knowland and colleagues proposed that consolidated sleep may lead to nocturnal sleep that is more efficient and richer in slow-wave activity, which could in turn lead to greater consolidation of language.[5] Our results are consistent with this idea, as children with early nap cessation would have more years to benefit from more efficient, slow wave-dense nocturnal sleep, leading to a cumulative benefit in consolidated linguistic knowledge. This hypothesis could be verified through studies incorporating polysomnography.

We provide preliminary evidence that early nap cessation is associated with lower child anxiety later in development. Greater sleep process organization may support greater higher-order cognitive organization (eg, emotional regulation). That is, more developed sleep organization (as observed by daytime sleep consolidated into exclusively nighttime sleep) may be required for emotional regulation organization, which in turn would predict lower anxiety. More research is required to understand the connection between anxiety and nap cessation. Importantly, though nap cessation was significantly related to T3 anxiety, nap cessation only accounted for 0.3% of the variance in T3 anxiety. As such, more research is required to understand the connection between anxiety and nap cessation, as well as its practical significance.

Previous investigations of the relation between napping and psychosocial function vary depending on the specific outcome. Yokomaku and colleagues (2008) assessed psychosocial functioning using parental report for 4-6-year-old children. They found a significant positive correlation between nap duration and internalizing problems (ie, anxiety- and depression-related subscales), but not with attention or aggressive problems. Others have found no relation between nap duration and parent-reported hyperactivity-inattention, or general behavioral functioning.[3,40] This is consistent with our findings. In terms of hyperactivity-inattention, it appears that delayed maturation (ie, fewer milestones) and less favorable family circumstances contribute to both giving up naps later and hyperactivity-inattention, as opposed to of nap cessation uniquely.

Strengths and limitations

Strengths of this study include the longitudinal design, inclusion of multiple cohorts to examine the stability of parameter estimates, and use of statistical control to reduce the influence of competing variables. However, this study also has important limitations. Firstly, we used a dichotomous definition of napping. This definition allows for the evaluation of the developmental importance of nap cessation but does not account for nuances in the developmental trajectory of nap cessation (ie, polyphasic to biphasic to monophasic sleep). Instead, this research focuses on the final phase of this trajectory and defined early nap cessation to capture children who may have stopped napping after daytime sleep was no longer needed to meet 24-hour sleep requirements.[20] Future research should test longitudinal differences between non-napping, inconsistently napping, and consistently napping in 1- to 5-year-old children; this might be done using frequency questions (eg, “in the last month, how often did your child nap?”), as has previously been applied in a cross-sectional sample.[14] Secondly, we did not control for some known correlates of specific outcomes. For example, temperament, consistently associated with psychosocial functioning, was not included.[41] We kept our control variables consistent across the models, as: (1) the primary focus of this study was in understanding differences associated with early nap cessation, not the predictors of the outcomes; (2) this consistency increased interpretability; (3) other possible control variables, including temperament, have *not* been related to nap cessation.[10,14] Thirdly, we utilized a nonweighted design for our analyses. When sampling weights are not used, parameter and standard error estimates can be biased. In particular, standard errors can be smaller in the absence of sample weights. Fourthly, our sample was representative of the Canadian population at the time of data collection (1998-2007), but the current Canadian population has more ethnic diversity and is more educated.[42] The findings may also not be representative of the Canadian population at the time of data collection, as sample weights were not used. We were also unable to examine differences between specific ethnicity groups, due to Statistics Canada restrictions. These demographic differences would be unlikely to affect our parameter estimates but could alter the prevalence of early nap cessation, which was not a focus of this study. Fifthly, this study used a nonexperimental design; as such, causation cannot be inferred. To address this limitation in our longitudinal design, we utilized temporal ordering and control of confounding variables. Finally, cases lost to follow-up at T3 differed from those with data. As is common in longitudinal studies, those lost to follow-up tended to have more adverse family situations, which may have impacted the findings. However, these losses were statistically controlled for.

Future directions and implications

This study demonstrated longitudinal differences by early nap cessation. However, the cross-sectional and longitudinal differences by *late* nap cessation (eg, child stops napping after their fourth or fifth birthday) remain untested. In addition, it is unclear whether the observed differences in receptive language and anxiety would be maintained across a longer follow-up period. Future research should also evaluate differences in additional outcomes, like expressive language and executive function (eg, inhibitory control, working memory, delayed gratification, and shifting). Previous research has tested a subset of these variables using cross-sectional and quasi-experimental designs[3,19,43] but has not tested the effect of nap cessation. This research would expand our understanding of the trajectories related to nap cessation and would help to determine its importance.

Future research should also investigate potential mechanisms of our observed relations. There are likely more complex biopsychosocial nuances. In exploratory analyses, we identified broadly similar effects for white and non-white children; however, for cognitive ability, the effect of early nap cessation was in the opposite direction. Future research must be designed to investigate these differences. For example, there may be important differences between specific ethnicity groups, which may also depend on regional napping attitudes/practices. These future studies can benefit from longitudinal designs (eg, sequential cohort) with multiple timepoints and short follow-up periods (eg, monthly for 6-12 months). These studies can also seek to replicate the prevalence of early nap cessation observed in our sample.

There may be important cultural differences in the relation between nap cessation and outcomes. Data from China suggests that school-age children who nap more often and for longer durations have *higher* academic achievement and verbal abilities and *lower* internalizing problems than peers who nap less often and/or for shorter durations.[44] In Western cultures, napping is typically discouraged during preschool years, and there are few opportunities to nap after school entry. By contrast, habitual napping is encouraged across school years in China.[44] Future research should investigate the impact of napping on these outcomes in other nap-encouraging cultures (eg, Spain, Italy[45]) and how institutional policies and practices (eg, childcare, schools) influence napping patterns.

Our findings can inform childcare policies and parent/provider knowledge related to daytime sleep. Our results suggest that children who stop napping earlier than peers have some better outcomes later in development. We found no evidence that continued napping provides benefits in any of the domains we tested. However, previous research suggests short-term memory and learning benefits from daytime sleep for *consistently* napping children.[7,8,17-20] Together, these findings support flexible napping policies in which children who have stopped napping have access to alternate activities (eg, quiet time) and children who are still napping have opportunities to sleep. This flexible nap policy recommendation aligns with other research groups.[9,14]

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Declaration of conflicts of interest

The authors have no conflicts of interest to disclose.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.sleh.2023.11.010.

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