

Original Article

Impact of COVID-19 on lifestyle habits and mental health symptoms in children with attention-deficit/hyperactivity disorder in Canada

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Abstract

Objectives: The COVID-19 pandemic created an environment of restricted access to health and recreation services. Lifestyle habits including sleep, eating, exercise, and screen use were modified, potentially exacerbating adverse mental health outcomes. This study investigates the impact of COVID-19 on lifestyle habits and mental health symptoms in paediatric attention-deficit/hyperactivity disorder (ADHD) in Canada.

Methods: An online survey was distributed across Canada to caregivers of children with ADHD (children aged 5 to 18 years) assessing depression (PHQ-9), anxiety (GAD-7), ADHD (SNAP-IV), and lifestyle behaviours. Data were analyzed by gender (male/female) and age category (5 to 8, 9 to 12, and 13 to 18 years). Spearman's correlations between lifestyle habits and mental health outcomes were conducted.

Results: A total of 587 surveys were completed. Mean child age was 10.14 years (SD 3.06), including 166 females (28.3%). The PHQ-9 and GAD-7 indicated that 17.4% and 14.1% of children met criteria for moderately severe to severe depression and anxiety symptoms respectively. Children met SNAP-IV cut-off scores for inattention (73.7%), hyperactivity/impulsivity (66.8%), and oppositional defiant disorder (38.6%) behaviours. Caregivers reported changes in sleep (77.5%), eating (58.9%), exercise (83.7%), and screen use (92.9%) in their ADHD child, greatly impacting youth. Sleeping fewer hours/night, eating more processed foods, and watching TV/playing videogames >3.5 hours/day correlated with greater depression, anxiety and ADHD symptoms, and exercising <1 hour/day further correlated with depression symptoms ($P < 0.01$).

Conclusions: The COVID-19 pandemic has resulted in less healthy lifestyle habits and increased mental health symptoms in Canadian children with ADHD. Longitudinal studies to better understand the relationship between these factors are recommended.

Graphical Abstract

COVID-19 Pandemic Impacts Lifestyle Habits and Mental Health in Children with ADHD

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587 Survey Responses

Across Canada, Spring 2020

- Average Child Age 10.14 years
- Male (70%) and Female (28%)
- Additional (to ADHD) Diagnosis (58%)
- Learning Disorder Diagnosis (41%)

Mental Health Symptoms



17%

Of children had **severe depression symptoms**



14%

Of children had **severe anxiety symptoms**

How Does Lifestyle Affect Mental Health?

- **Sleeping fewer hours/night** was associated with greater reports of depression, anxiety, hyperactive/impulsive, and oppositional-defiant (ODD) symptoms
- **Eating more processed foods** was associated with higher depression and anxiety scores, and higher inattention and ODD behaviours
- **Low levels of exercise** (<1 hour/day) was associated with greater reports of depression



- **High screen use** (>3.5 hours/day) was associated with higher depression, anxiety, inattention, and ODD symptom scores



Access to Therapy Changed*

- Moved Online (13%)
- Moved to Phone (9%)
- Stopped Completely (13%)

38%

35%

Medication Dosage Changed*

- Dose Increased (15%)
- Dose Decreased (7%)
- Stopped Completely (5%)

11.5% Reported Difficulty Filling Prescription Medications



*A subset of response categories are shown

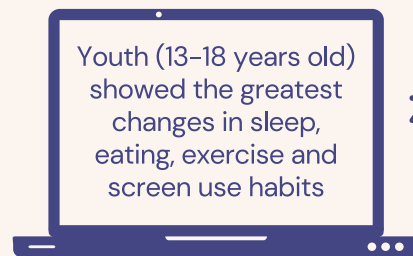
Lifestyle Habits Changed

- Going to Bed Later (65%), Waking-Up Later (45%)
- Eating More (18%) or Less (8%) Processed Foods
- Less Play and Athletic Activity (49%)
- More Hours/Day on a Screen (87%)



Youth (13-18 years old) showed the greatest changes in sleep, eating, exercise and screen use habits

zzz



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Attention-deficit/hyperactivity disorder (ADHD) is a childhood onset neurodevelopmental disorder characterized by inappropriate levels of inattention and/or hyperactivity and impulsivity (1). Prevalence estimates range from 5 to 9% with a recent meta-analysis reporting a pooled estimate of 7.2% in children up to 18 years old (2,3). Children with ADHD receive significantly more psychiatric diagnoses including anxiety and depression; approximately half have a learning disorder, and 50 to 70% experience difficulties with peer relationships leading to lower quality of life reports in children with ADHD compared to their typically developing peers (4–7).

The World Health Organization (WHO) announced the COVID-19 pandemic on March 11, 2020, which led to provinces across Canada mandating school and business closures, encouraging children and adults to stay home (8,9). Recreation facilities including access to teams and clubs were suspended, and provincial and national parks were closed to public access. Previous research has suggested that such isolation procedures are particularly impactful in children and youth, leading to increased prevalence of anxiety and depression, and possible increases in suicide due to stress and loneliness (10,11). A recent parent survey in China (241 respondents) reported that the average behaviour of their child with ADHD, including the abilities to focus, manage anger and routines, was significantly worse during the COVID-19 pandemic (12). A Japanese study (15 children) showed increased hyperactivity/impulsivity and inattention scores during the pandemic (April/May 2020) compared to baseline (February/March 2020) (13). A study from France (533 respondents) found that 35% of ADHD children experienced worsening of wellbeing between days 20 and 30 of the country's lockdown, 34% showed no change, and 31% were doing better (14). Isolation impacts children differently with some struggling due to lack of peer support, and others showing improvement due to reduced anxiety, peer pressure, and exposure to bullying (15).

The COVID-19 pandemic is an unprecedented example of societal restrictions with mental and physical health implications. Restrictions have impacted regular routines, modifying factors including sleep, eating, exercise, and screen use, potentially exacerbating adverse mental health outcomes (16). Children with ADHD often require medical, therapeutic, and educational support to succeed in education and peer situations (17). Therefore, these children may be at high risk for adverse mental health and behavioural outcomes when access to services is restricted. The objective of this study was to understand the impact of the COVID-19 pandemic on lifestyle habits, mental health symptoms, and ADHD behaviours in children with ADHD in Canada.

METHODS

A survey with 113 questions related to family demographics, mental health, quality of life, and lifestyle habits was created in QualtricsSM. Inclusion criteria were 1) caregiver of a child

with ADHD, 2) child aged 5 to 18 years, 3) ability to read and write English, and 4) lives in Canada. The survey was advertised through social media (Facebook, Twitter), University of Calgary affiliated websites, and direct email messages to ADHD families in Alberta (permission to contact database) and ADHD clinics across Canada. Mental health questionnaires included the Patient Health Questionnaire 9 (PHQ-9), Generalized Anxiety Disorder 7 (GAD-7), and the Swanson, Nolan, and Pelham (SNAP-IV) 26-question scale (18–20). Lifestyle questions were created by the study leaders to capture changes in sleep, eating, exercise, and screen use behaviours based on experience working with ADHD children. A daily activities table with the same activity categories as the United Kingdom Co-SPACE study was included (21). The survey was available over a period of five weeks (May 11 to June 15, 2020), and responses at least 90% complete were included in analyses (587 of 663 submissions retained). A response of 587 exceeded the minimum sample size ($n=384$) required to represent the paediatric ADHD population of Canada (430,000 children), based on a sample size calculation (95% confidence interval, 5% margin of error) (3,22,23).

The Statistical Package for the Social Sciences (SPSS) version 26.0 was used to conduct all the data analyses. The data were inspected for missing values and outliers prior to running any statistical analyses. The data were also evaluated for normality, linearity, and homogeneity of variance to meet the assumptions of parametric analysis. Chi-square tests were conducted between gender (male and female) and age categories (5 to 8, 9 to 12, and 13 to 18 years) for categorical variables. Spearman's correlations were conducted between lifestyle variables and mental health symptoms. Summary data are presented in this article (the complete dataset is available upon request to the corresponding author). The study was approved by the University of Calgary Conjoint Health Research Ethics Board (REB20-0672).

RESULTS

Participant demographics

A summary of participant demographics ($n=587$) is presented in [Supplementary Appendix 1](#). Mean child age was 10.14 years (SD 3.06, range 5 to 18), representing 166 females (28.3%), 412 males (70.2%), and 9 other (1.5%). The majority of responses were from Alberta (40.9%) and Ontario (31.3%), with responses from all provinces and territories except Nunavut and the Northwest Territories.

At the time of response, a third (33.6%) of children and/or their parents were participating in therapy (e.g., cognitive behavioural therapy, social skills training), with proportionately more females (39.8%) in therapy than males (31.1%) ($\chi^2(1)=4.008$, $P=0.045$). In contrast, significantly more males (77.2%) were taking medication than females (66.3%) ($\chi^2(1)=6.804$, $P=0.009$). A medication dosage change

was reported by 35.3% of survey respondents, impacting proportionately more females (42.7%) than males (32.5%) ($\chi^2(1)=3.754, P=0.053$), and younger children (46.2%) more than older children (33.0%) and youth (23.1%) ($\chi^2(2)=13.800, P=0.001$).

Mental health

The PHQ-9 identified 17.4% of children with moderately severe to severe depression symptoms (total score 15 to 27) during the pandemic (mean 9.50, SD 5.39). A gender difference was observed for severe depression (total score 20 to 27) impacting more males (6.9%) than females (2.5%) ($\chi^2(1)=4.159, P=0.041$). The GAD-7 indicated 14.1% of children were displaying severe (total score 15 to 21) anxiety symptoms (mean 7.51, SD 5.46). An increase in anxious behaviours impacted young females (24.7%) 5 to 8 years more than young males (17.5%) ($\chi^2(1)=4.408, P=0.036$). A total of 221 (38.4%) and 314 (54.8%) caregivers reported an increase in their child's depression and anxiety symptoms during the pandemic, respectively.

The SNAP-IV indicated that 73.7% of children met parent cut-off scores for inattention (≥ 1.78 ; mean 2.09, SD 0.59), 66.8% for hyperactivity/impulsivity (≥ 1.44 ; mean 1.76, SD 0.76), and 38.6% for oppositional defiant disorder (ODD) (≥ 1.88 ; mean 1.56, SD 0.83). Gender differences were observed in specific age categories: more male youth (17.0%), 13 to 18 years, met the inattention cut-off score than female youth (11.4%) ($\chi^2(1)=4.927, P=0.026$), more male children (29.6%), 9 to 12 years, met the hyperactive/impulsive cut-off score than females (19.9%) ($\chi^2(1)=8.795, P=0.003$), and more male children (17.0%), 9 to 12 years, met the oppositional defiant cut-off score than females (9.6%) ($\chi^2(1)=5.534, P=0.019$). A total of 306 (53.7%) caregivers reported an increase in their child's ADHD behaviours from before the pandemic, impacting proportionately more males (55.1%) than females (44.0%) ($\chi^2(1)=5.103, P=0.024$).

Lifestyle habits

Results are summarized in [Tables 1 and 2](#) and [Supplementary Appendices 1 and 2](#). Caregivers reported changes in sleep (77.5%), eating (58.9%), exercise (83.7%), and screen use (92.9%) behaviours in their ADHD child during the pandemic. Youth showed the greatest changes in sleep ($\chi^2(2)=20.800, P<0.001$), eating ($\chi^2(2)=5.796, P=0.055$), exercise ($\chi^2(2)=6.914, P=0.032$), and screen use ($\chi^2(2)=7.743, P=0.021$), doing the least amount of physical activity and spending the most amount of time on a screen ([Figure 1](#)). When gentle and moderate to intense physical activity categories were combined, 56.7% of youth were doing <1 hour of daily physical activity. Of all children, 35.1% were doing <1 hour of daily physical activity, and 41.5% were spending more than 3.5 hours a day watching

TV and/or playing videogames. Of concern, 16.5% of children were spending more than 6 hours/day watching TV and/or playing videogames.

Caregivers reported that their child was spending at least 30 minutes a day listening to music (42.7%), reading for pleasure (27.7%), doing arts and crafts (24.5%), and playing cards/board games (18.4%). Youth spent the most time listening to music ($\chi^2(2)=36.236, P<0.001$) and children aged 5 to 8 years doing arts/crafts ($\chi^2(2)=13.667, P=0.001$). Time spent doing schoolwork increased with age ($\chi^2(2)=20.025, P<0.001$; [Table 2](#)).

Sleeping fewer hours/night, eating more often and more processed foods were each positively correlated with the PHQ-9 and GAD-7 total scores ($P<0.01$). Reduced sleep was further correlated with greater hyperactive/impulsive and ODD scores, and caregiver reports of increased depression, anxiety and ADHD symptoms during the pandemic ($P<0.01$). Eating more processed food correlated with higher inattention and ODD total scores, and caregiver reports of increased ADHD behaviours ($P<0.01$). Exercising <1 hour/day correlated positively with the PHQ-9 ($P<0.01$) but negatively with the hyperactive/impulsive ($P<0.05$) score. Finally, watching TV/playing videogames >3.5 hours/day correlated positively with the PHQ-9, GAD-7, inattention and ODD total scores, and parent reports of increased depression symptoms during the pandemic ($P<0.05$ to 0.01).

DISCUSSION

This study indicates that the COVID-19 pandemic impacted lifestyle habits and mental health symptoms in Canadian children with ADHD. Approximately one-fifth of children met criteria for moderately severe to severe depression and/or anxiety symptoms, with a significant number of caregivers reporting an increase in their child's symptoms during the pandemic. Correlations were observed between less healthy lifestyle habits and adverse mental health outcomes, which is an important consideration because lifestyle behaviours are modifiable. Therefore, resources to support healthy lifestyle choices in paediatric ADHD may prevent adverse mental health outcomes in times of stress, such as during a pandemic.

Approximately one-third of caregivers reported changes in access to therapy and medication dosage during the pandemic. Upon lockdown measures due to COVID-19, health clinics across Canada halted preventative services, hospitals restructured to provide only emergency services, and pharmacists restricted medication refills for fear of viral spread and/or inability to obtain medical supplies ([24–26](#)). These restrictions increased caregiver stress and burden to manage their child's wellbeing. European guidelines for ADHD management during the pandemic recommended virtual technologies for initial assessments, psychoeducation and follow up,

Table 1. Lifestyle habit changes during the COVID-19 pandemic

		Female		Male		Total Sample	
		N	%	N	%	N	%
Sleeping Habits Changed	Yes	132	81.5	312	75.9	451	77.5
	No	30	18.5	99	24.1	131	22.5
How Sleeping Habits Changed	Sleeping More Hours/Night	44	26.5	78	18.9	126	21.5
	Sleeping Fewer Hours/Night	46	27.7	83	20.1	129	22
	Going to Bed Later	103	62	269	65.3	379	64.6
	Waking up Later	83	50	174	42.2	262	44.6
	Taking More Naps	11	6.6	32	7.8	45	7.7
Eating Habits Changed	Yes	97	59.9	239	58.2	343	58.9
	No	65	40.1	172	41.8	239	41.1
How Eating Habits Changed	In General, Eating More	36	21.7	118	28.6	155	26.4
	In General, Eating Less	25	15.1	36	8.7	63	10.7
	Eating More Processed Foods	33	19.9	73	17.7	108	18.4
	Eating Fewer Processed Foods	18	10.8	26	6.3	45	7.7
Exercise Habits Changed	Yes	132	81.5	349	84.9	487	83.7
	No	30	18.5	62	15.1	95	16.3
How Exercise Habits Changed	In General, More Play and Athletic Activities	12	7.2	28	6.8	41	7
	In General, Less Play and Athletic Activities	82	49.4	202	49	287	48.9
	Playing More Inside	58	34.9	141	34.2	200	34.1
	Playing More Outside	30	18.1	92	22.3	123	21
Screen Use Changed	Yes	154	95.1	378	92.2	540	92.9
	No	8	4.9	32	7.8	41	7.1
How Screen Use Changed	More Hours/Day on a Screen	144	86.7	355	86.2	507	86.4
	Type of Screen Use Changed	57	34.3	139	33.7	197	33.6

and encouraged parents to plan ahead to acquire prescriptions (27). However, planning during a pandemic is difficult, and one-tenth of caregivers reported difficulty filling their child's prescription, which may have contributed to medication changes. In addition, some children were doing well at home, such as those with social anxiety, while others were exhibiting increased ADHD behaviours, and these symptom changes likely contributed to medication modifications. Gender and age differences in symptom profiles, including more males exhibiting increased ADHD behaviours and more young females showing increased anxiety symptoms, may have been a result of, or contributed to treatment changes, but additional inquiry is needed. Previous research has suggested that child health outcomes are worse for children of highly distressed caregivers (28). Recognizing that supportive, responsive parenting can play important protective roles against adverse mental health outcomes in children with ADHD, the Canadian Paediatric Society published guidelines for parent self-care and managing child ADHD during the pandemic (29,30). These guidelines emphasize the importance of routines, sleep hygiene, physical activity, and social connection, as an increase in ADHD behaviours due to pandemic restrictions can adversely impact social distancing requirements and family functioning (27).

Lifestyle factors were significantly impacted during the pandemic with less healthy behaviours correlating with higher depression, anxiety, and ADHD symptom scores. Eating processed foods and high screen use correlated positively with inattention and ODD behaviours, and reduced sleep correlated positively with hyperactive/impulsive and ODD behaviours. A recent systematic review found that junk food consumption exacerbated ADHD symptoms, and a review of screen use in children reported associations between ADHD behaviours and screen time, showing increased attention problems with increased TV viewing/videogame playing (31,32). Screen use has been linked to sleep problems in children including shorter sleep duration and delayed sleep timing, which has been associated with increased ADHD behaviours (32–34). Therefore, the increased likelihood of adverse mental health outcomes with high junk food consumption, screen use and disturbed sleep supports Canadian food and activity guidelines of minimal processed food consumption, ≤ 2 hours of daily recreational screen time, and 8 to 12 hours of nightly sleep to prevent increases of ADHD behaviours and mental health symptoms (35,36).

Table 2. Average daily time ADHD children were doing schoolwork and recreational activities during the COVID-19 pandemic

Activity	Time category	5-8 years		9-12 years		13-18 years	
		N	%	N	%	N	%
Schoolwork	<0.5 h	66	33.5	39	15.5	30	23.6
	0.5–2 h	106	53.8	161	63.9	59	46.5
	>3 h	25	12.7	52	20.6	38	29.9
Audio/Video Talk	<0.5 h	152	77.2	146	57.9	54	42.5
	0.5–2 h	37	18.8	79	31.3	36	28.3
	>3 h	8	4.1	27	10.7	37	29.1
Email/Text Messaging	<0.5 h	179	90.9	192	76.2	62	48.8
	0.5–2 h	16	8.1	45	17.9	32	25.2
	>3 h	2	1	15	6	33	26
Browsing the Internet	<0.5 h	185	93.9	196	77.8	52	40.9
	0.5–2 h	11	5.6	39	15.5	59	46.5
	>3 h	1	0.5	17	6.7	16	12.6
Watching TV/Movies	<0.5 h	32	16.2	37	14.7	13	10.2
	0.5–2 h	121	61.4	147	58.3	76	59.8
	>3 h	44	22.3	68	27	38	29.9
Playing Video/Computer Games	<0.5 h	55	27.9	43	17.1	17	13.4
	0.5–2 h	92	46.7	106	42.1	43	33.9
	>3 h	50	25.4	103	40.9	67	52.8
Playing Card/Board games	<0.5 h	155	78.7	199	79	116	91.3
	0.5–2 h	41	20.8	52	20.6	11	8.7
	>3 h	1	0.5	1	0.4	127	0
Doing Arts/Crafts	<0.5 h	135	68.5	190	75.4	110	86.6
	0.5–2 h	61	31	61	24.2	10	7.9
	>3 h	1	0.5	1	0.4	7	5.5
Reading for Pleasure	<0.5 h	147	74.6	172	68.3	97	76.4
	0.5–2 h	46	23.4	69	27.4	24	18.9
	>3 h	4	2	11	4.4	6	4.7
Listening to Music	<0.5 h	133	67.5	153	60.7	44	34.6
	0.5–2 h	52	26.4	75	29.8	55	43.3
	>3 h	12	6.1	24	9.5	28	22
Gentle Physical Activity	<0.5 h	56	28.4	105	41.7	85	66.9
	0.5–2 h	124	62.9	135	53.6	38	29.9
	>3 h	17	8.6	12	4.8	4	3.1
Moderate to Intense Physical Activity	<0.5 h	95	48.2	180	71.4	99	78
	0.5–2 h	90	45.7	61	24.2	26	20.5
	>3 h	12	6.1	11	4.4	2	1.6

5-8 years (N=197), 9-12 years (N=252), and 13-18 years (N=127).

Physical activity was greatly modified during the pandemic, with half of caregivers reporting decreased athletic activity in their ADHD child. Low physical activity correlated positively with depression symptoms, a result also reported in a Chinese study that showed higher physical activity was significantly related to higher positive mood in youth during the pandemic (37). A recent meta-analysis of physical activity in paediatric ADHD reported significant improvements in depression, anxiety and aggressive behaviours due to physical activity

intervention, and nonsignificant improvements in hyperactive/impulsive and inattention symptoms (38). Recognizing the importance of physical activity (i.e., to reduce symptoms of depression and anxiety, enhance learning, and prevent/manage noncommunicable disease), the WHO recently published guidelines that children and youth (≥ 3 years) should average 60 minutes of moderate to vigorous physical activity each day (39). A recent editorial recommended monitored playground access, street closures, trainer-led outdoor exercise, and

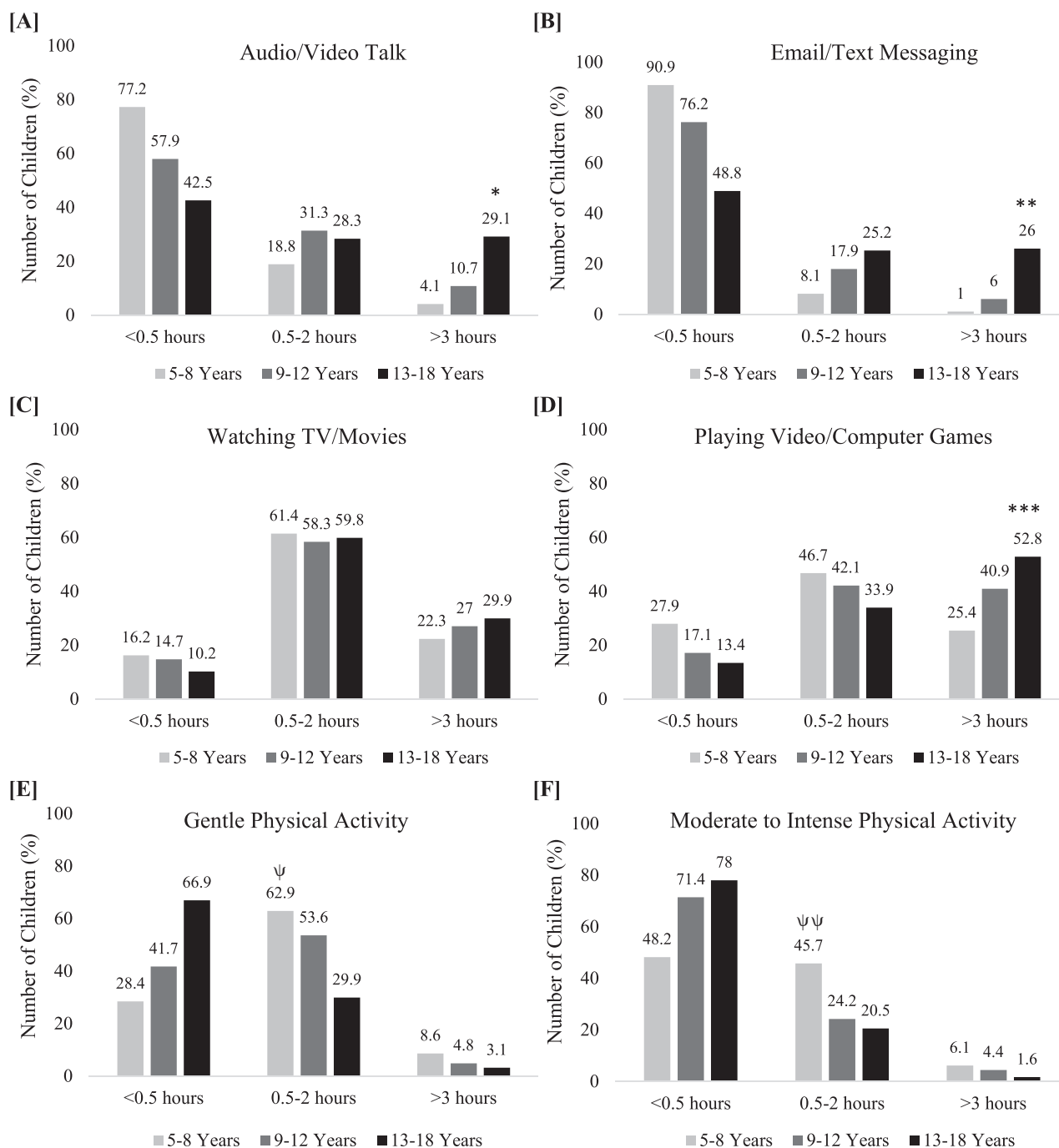


Figure 1. Average daily time ADHD children were spending on screens (A–D) and doing physical activity (E,F) during the pandemic. Youth aged 13 to 18 years (N=127) spent the most time on *audio/video calls ($\chi^2(4)=62.731, P<0.001$), **email/text messaging ($\chi^2(4)=92.278, P<0.001$), and ***playing video/computer games ($\chi^2(4)=29.1000, P<0.001$). In contrast, children aged 5 to 8 years (N=197) spent the most time doing Ψ gentle ($\chi^2(4)=48.378, P<0.001$) and $\Psi\Psi$ moderate to intense physical activity ($\chi^2(4)=39.231, P<0.001$).

at-home guided exercise through video platforms to encourage physical activity (40). In addition, active-play video games have been shown to improve physical activity in adolescents, which may be an effective approach to increase physical activity in children during a pandemic (41).

A recent Canadian study found that children who met seven to nine of nine lifestyle recommendations (e.g., food

intake, physical activity, and screen use guidelines) at ages 10 to 11 years had a 62% lower incidence of ADHD diagnosis by age 14 than children who met one to three recommendations, suggesting correlation between lifestyle factors and development of ADHD behaviours (42). Research has shown lower physical activity and reduced fruit and vegetable intake in winter months (43,44), highlighting a need

to support healthy movement, food, screen use, and sleep behaviours through Canadian winters. In summary, caregiver education, community supports (e.g., respite, coaches), access to recreational spaces and healthy, affordable foods might prevent and potentially alleviate adverse mental health outcomes in paediatric ADHD.

The strengths of this study include sample size (highlighting an interest in ADHD research in Canada), a representative ADHD population (e.g., ethnicity, household income, gender) and the ability to reach remote communities. The limitations of the study included the following: 1) the self-selecting nature of recruitment, 2) families who were struggling less were likely more able to complete a 30 to 45-minute survey than families in crisis, 3) Alberta and Ontario represented the majority of survey responses, and 4) the child's perspective was not captured.

In conclusion, the COVID-19 pandemic has resulted in less healthy lifestyle habits and increased mental health symptoms in Canadian children with ADHD. Longitudinal studies to better understand the relationships between these factors are recommended, including possible protective effects of healthy lifestyle interventions.

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This study was approved by the University of Calgary Conjoint Health Research Ethics Board (REB20-0672).

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