

Lifestyle Behavior and Mental Health in Early Adolescence

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abstract

BACKGROUND AND OBJECTIVES: Mental illnesses affect >15% of Canadian adolescents. New preventive strategies are critically needed. We examined the associations of meeting established recommendations for diet, physical activity, sleep, and sedentary behavior in childhood with mental illness in adolescence.

METHODS: Population-based prospective study ($n = 3436$) linking 2011 health behavior survey data of 10- to 11-year-olds with administrative health data from 2011 to 2014. Lifestyle behaviors were measured with the Harvard Food Frequency Questionnaire and self- and parental-proxy reports, expressed as meeting recommendations for vegetables and fruit, grain products, milk and alternatives, meat and alternatives, added sugar, saturated fat, sleep, screen time, and physical activity. Mental illness was defined by physician-diagnosed internalizing, externalizing, and other psychiatric conditions. Negative binomial regression was used to determine the independent and cumulative associations of meeting lifestyle recommendations with physician visits for mental illnesses.

RESULTS: Of all participants, 12%, 67%, and 21% met 1 to 3, 4 to 6, and 7 to 9 recommendations, respectively, and 15% had a mental illness diagnosis during follow-up. Compared with meeting 1 to 3 recommendations, meeting 7 to 9 recommendations was associated with 56% (95% confidence interval: 38%–69%) fewer physician visits for mental illness during follow-up. Every additional recommendation met was associated with 15% fewer physician visits for mental illnesses (95% confidence interval: 9%–21%).

CONCLUSIONS: Mental illness in adolescence is associated with compliance to lifestyle recommendations in childhood, with stronger associations seen when more recommendations are met. Emphasizing lifestyle recommendations in pediatric practice may reduce the future burden of mental illness.



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WHAT'S KNOWN ON THIS SUBJECT: Childhood is a crucial period for the development of mental illness and also a time when patterns of lifestyle behaviors are established. Health behaviors have been individually linked to mental health outcomes.

WHAT THIS STUDY ADDS: This study provides knowledge on the associations of individual and cumulative adherence to established lifestyle recommendations in childhood with physician diagnoses of mental illness in adolescence. Adolescents who met more recommendations had fewer health care encounters for mental illness.

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Mental illnesses are a problem of epidemic proportions, affecting 1 in 5 Canadians in any given year.¹ Studies have shown that approximately half of all lifetime cases of mental illness emerge before age 14 years.² In addition to the negative effects on patients' well-being, mental illnesses place a high burden on primary care resources.³ Innovative strategies to promote mental health and reduce illness early in the life course are urgently needed.⁴

The role of lifestyle in the causation of chronic diseases has long been established and provoked recommendations regarding diet, sedentary activity, physical activity (PA), and sleep. The association of lifestyle with mental illness is less established. For adults, a meta-analysis of 4 cohort and 9 cross-sectional studies concluded that those with diets rich in vegetables and fruit, fish, and whole grains were less likely to have depression.⁵ For adolescents, a review of 9 cohort and 3 cross-sectional studies confirmed the association between unhealthy diets and an increased risk of mental illness.⁶ A recent meta-analysis underscored the need for more and larger prospective studies controlling for relevant confounders to advance our understanding of a potential causal role.⁷ Meta-analyses of prospective studies also concluded inverse associations of PA with depression in youth⁸ and children.⁹ Outside of these meta-analyses, most evidence linking PA¹⁰ and sedentary behavior¹¹ with mental health in adolescents is either cross-sectional, derived from small studies, or employing self-reported measures of mental health.^{6,10,11}

Adherence to lifestyle recommendations developed for the prevention of chronic disease has not been well investigated with respect to its potential impact on mental health. In addition, lifestyle behaviors are acknowledged to be interrelated,¹² but few studies have assessed the

independent effects by considering several lifestyle behaviors together,¹³ with none having considered the cumulative effect of meeting several lifestyle behavior recommendations simultaneously. Given the fact that lifestyle behaviors do not occur in isolation and the tremendous burden that mental illness puts on health care systems, a pertinent research objective is to examine the concurrent associations of meeting recommendations for these behaviors with primary care use for mental illnesses.¹⁴

METHODS

The Children's Lifestyle and School-Performance Study (CLASS) is a population-based health survey among fifth-grade students (10–11 years old) in Nova Scotia, Canada. All fifth-grade students, their parent(s) and/or guardian(s), and school administrators were invited to participate in the study. Of all 286 provincial public schools with fifth-grade students, 269 schools participated in the study. Parental consent to participate was given for 6591 of the 8736 students (75.4% consent rate). Of these, 1349 did not complete the survey or were absent the day of the survey (79.5% participation rate of those with consent). An additional 132 students reported unrealistic caloric intakes (<500 or >5000 kcal)¹⁵ and were excluded from analysis, leaving 5110 eligible students (77.5% inclusion rate of those with consent). Given that the threshold for acceptable response rates in school-based research is 60%, our participation rate seems relatively high.¹⁶

The study consisted of a student survey with questions on PA and sedentary activities and a Canadian version of the Harvard Youth/Adolescent Food Frequency Questionnaire¹⁷ administered at school by research assistants. Research assistants measured

students' height and weight. Parent(s) and/or guardian(s) completed a home survey on the adolescents' sleep habits, screen time usage, place of residency, household income, and highest level of parental education. Of the 5110 students who completed the CLASS survey, 3436 (67.2%) provided valid health card numbers that could be linked with their administrative health data. There were no significant differences in sociodemographic factors or body weight status between the linked and unlinked sample.

We examined adherence to 9 established lifestyle recommendations. Eating Well with Canada's Food Guide was used to evaluate students' consumption of age-specific recommendations for daily servings of vegetables and fruit, grain products, milk and alternatives, and meat and alternatives.¹⁸ The World Health Organization's Guideline: Sugar Intake for Adults and Children was used to determine if students met added sugar recommendations,¹⁹ and *Dietary Guidelines for Americans*²⁰ was used to assess saturated fat intake. Meeting PA recommendations was determined by established questionnaire cutoffs and sleep and screen time recommendations determined in the Canadian 24-Hour Movement Guidelines for Children and Youth (recommendations are detailed in Supplemental Table 5).²¹

The outcome of interest was the number of physician visits related to mental illness between the date of the survey, in the spring of 2011, and December 31, 2014. A participant's mental health visit with a physician was counted if he or she received a primary internalizing, externalizing, or other psychiatric diagnosis according to the *International Classification of Diseases, Ninth Revision (ICD-9)* or *International Classification of Diseases, 10th revision (ICD-10)* (see Table 1 for diagnoses and ICD-9 and ICD-10 codes used).

TABLE 1 ICD-9 and ICD-10 Codes Identifying Diagnosis of Mental Health Disorders

Disorder	ICD-9 Code	ICD-10 Code
Internalizing disorders (depressive episode, recurrent depressive disorder, mood disorder, neurotic disorder, general anxiety disorder, reaction to stress, adjustment reaction, emotional disorders)	296, 300, 308, 309, 311, 313	F30–F34, F38–F43, F45, F48, or F92–F93
Externalizing disorders (hyperkinetic syndrome, hyperkinetic conduct disorder, attention-deficit/hyperactivity disorder)	312, 314	F70 or F90
Other mental health disorders	290-219 not aforementioned	F00–F99 not aforementioned

This information was derived from the Medical Service Insurance database and the Canadian Institute for Health Information Discharge Abstract Database.

Associations of meeting recommendations for diet, PA, sedentary behavior, and sleep with mental health visits were examined by using mixed-effects regression models to accommodate clustering of students within schools. As the distribution of the number of physician visits with a psychiatric diagnosis showed overdispersion, we employed negative binomial regression models (NBMs). A univariate NBM was used to assess the associations between each of the health behaviors and the number of mental health visits. Multivariable NBMs (Model 1) were used to adjust for potential confounders. We adjusted for each adolescent's sex, body weight status (normal weight, overweight, or obese using age- and sex-specific cutoffs),²² parental educational attainment (secondary or lower, postsecondary or college, or university), household income (< \$20 000, \$20 001–40 000, \$40 001–60 000, or >\$60 000) as assessed with categorical questions in the home survey, and region of residence (rural or urban) determined by postal code. As recommended, analysis including food frequency data were adjusted for energy intake.¹⁵ Model 2 simultaneously considered all 9 lifestyle behaviors and confounders to quantify the independent associations between meeting each lifestyle behavior recommendation and the number of mental health

visits. To assess the cumulative effects of meeting multiple recommendations, adolescents meeting 1 to 3 recommendations were compared with those meeting 4 to 6 and 7 to 9 recommendations. To ensure that the score was not disproportionately weighted toward dietary recommendations, we repeated this analysis considering dietary and movement recommendations (PA, screen time, and sleep) separately (scored out of 6 and 3 recommendations, respectively). Missing values for confounding variables were considered separate covariate categories in the regression analysis, but their estimates are not presented.

Response rates for CLASS in residential areas with lower household income were slightly lower than average. To minimize the potential nonresponse bias this may cause, analyses were weighted to represent provincial estimates of the fifth-grade student population.²³ The above analyses were repeated with the exclusion of all students with a mental illness diagnosis before the date of the survey ($n = 330$). Additionally, all models were stratified by sex. The Stata/SE 15 (Stata Corp, College Station, TX) statistical software package was used for all data analysis. The human research ethics boards of Dalhousie University and the University of Alberta approved the data collection, parental informed consent forms, and linkage of CLASS survey data with administrative health care data. Health Data Nova Scotia also approved the data linkage.

RESULTS

Of 3436 participants included in analyses, 14.6% had at least 1 physician visit with a mental health diagnosis between the date of completing the survey in 2011 and December 31, 2014. Table 2 shows the percentage of participants meeting each of the recommendations, with 12%, 67%, and 21% of adolescents meeting 1 to 3, 4 to 6, and 7 to 9 recommendations, respectively. A greater percentage of participants diagnosed with mental illnesses were from lower socioeconomic backgrounds and were overweight or obese (Table 2).

After adjusting for potential confounders, meeting recommendations for milk and alternatives, screen time, and PA were associated with a reduced number of mental health visits: 21%, 25%, and 47% less, respectively (rate ratios [RRs] of 0.79, 0.75, and 0.53, respectively; Table 3, Model 1). When considering lifestyle behaviors simultaneously (Table 3, Model 2), meeting screen time and PA recommendations appeared to be the only behaviors with statistically significant independent associations with mental health visits. Sex-stratified analysis revealed the independent associations of meeting milk and alternative recommendations for boys when considering all other lifestyle and confounding variables (RR: 0.65 [95% confidence interval (CI): 0.48–0.88]).

Table 3 further shows that compared with adolescents with normal weight,

TABLE 2 Characteristics of Fifth-Grade Students and Percentage With a Subsequent Mental Health Diagnosis, 2011 Children's Lifestyle and School Performance Study

Characteristics	Total Population (N = 3436)	With a Mental Health Disorder (14.56%)
Vegetables and fruit, avg No. servings (SD)	4.85 (3.24)	—
6+, %	31.4	12.8
<6, %	68.6	15.4
Grain products, avg No. servings (SD)	4.63 (2.27)	—
6+, %	21.5	14.4
<6, %	78.5	14.6
Milk and alternatives, avg No. servings (SD)	3.33 (1.98)	—
3+, %	57.4	14.1
<3, %	42.6	15.3
Meat and alternatives, avg No. servings (SD)	1.47 (0.81)	—
2+, %	86.0	14.9
<2, %	14.0	12.8
Saturated fat, avg intake (SD)	20.9 (10.1)	—
<10% of energy intake, %	53.9	13.5
>10% of energy intake, %	46.1	15.8
Added sugars, avg intake (SD)	45.0 (35.7)	—
<10% of energy intake, %	63.4	13.7
>10% of energy intake, %	36.6	16.0
PAQ-C, avg score (SD)	3.27 (0.67)	—
Sufficiently active, %	76.7	13.8
Not sufficiently active, %	23.3	17.0
Sleep, h, avg duration (SD)	10.1 (0.50)	—
9–11, %	93.1	14.4
<9 and >11, %	6.89	17.2
Screen time (TV and computer), daily h (SD)	3.00 (1.57)	—
<2, %	43.9	13.4
>2, %	59.1	15.5
Children meeting multiple healthy lifestyle recommendations, avg No. (SD)	5.27 (1.47)	—
Low (1–3), %	11.9	18.1
Medium (4–6), %	67.4	14.7
High (7–9), %	20.7	12.1
Body wt status, avg BMI (SD)	19.8 (4.19)	—
Normal wt, %	57.7	13.9
Overweight, %	22.7	15.4
Obese, %	12.5	15.7
Sex, %		
Female	51.0	14.7
Male	49.0	14.4
Parental education, %		
Secondary or less (reference)	17.3	15.3
College diploma	38.1	14.9
University or graduate degree	39.1	12.9
Missing or prefer not to answer	5.51	22.2
Household income, Canadian \$, %		
≤20 000	20.7	20.1
20 000–40 001	14.1	16.0
40 001–60 000	25.3	12.5
≥60 001	21.8	11.4
Missing or prefer not to answer	18.2	14.0
Region of residence, %		
Urban	69.7	15.1
Rural	30.3	13.5

Avg, average; PAQ-C, Physical Activity Questionnaire for Older Children; TV, television; —, not applicable.

those with overweight or obesity had fewer mental health visits. Exclusion of adolescents with a mental health

diagnosis before the survey revealed estimates for RRs of mental health visits similar to those in Table 3.

For each additional recommendation met, the RR of mental health visits during follow-up declined by 15% (Table 4). Compared with those meeting 1 to 3 recommendations, adolescents who met 4 to 6 and 7 to 9 lifestyle recommendations had 39% and 56% fewer mental health visits in the subsequent 4 years, respectively (Table 4). In sex-stratified models, larger effect sizes were observed for boys. For the 6 dietary recommendations, in comparison with adolescents who met ≤2 of these recommendations, those who met 3 to 4 and 5 to 6 had 27% (RR: 0.73 [95% CI: 0.57–0.94]) and 28% (RR: 0.72 [95% CI: 0.53–0.98]) fewer mental health visits, respectively. For the 3 movement recommendations, in comparison with those who met 1 or no recommendation, those who met 2 and 3 had 29% (RR: 0.71 [95% CI: 0.52–0.97]) and 54% (RR: 0.46 [95% CI: 0.33–0.63]) fewer mental health visits, respectively.

DISCUSSION

Our observation of low adherence to lifestyle recommendations is consistent with earlier reports that substantial proportions of Canadian children do not meet healthy lifestyle recommendations.²⁴ We observed that meeting recommendations for milk and alternatives, PA, and screen time in childhood was associated with fewer health care encounters for mental illnesses. We also observed that meeting multiple lifestyle recommendations was associated with fewer health care encounters for mental illnesses in adolescence.

Our finding that adherence to PA recommendations in early adolescence is associated with 47% fewer mental health visits in subsequent years is corroborated by some^{13,25,26} but not all prospective studies.^{27,28} Ströhle et al²⁶ reported for a prospective sample of older

TABLE 3 Associations of Meeting Healthy Lifestyle Recommendations With Physician Visits for Mental Health Disorders in Subsequent 4-Year Follow-up

	Univariate RR (95% CI)	P	Model 1, ^a RR (95% CI)	P	Model 2, ^b RR (95% CI)	P
Vegetables and fruit						
No (reference)	1	—	1	—	1	—
Yes	0.77 (0.59–1.00)	.052	0.85 (0.67–1.07)	.162	0.98 (0.75–1.27)	.850
Grain products						
No (reference)	1	—	1	—	1	—
Yes	1.09 (0.84–1.41)	.508	1.10 (0.86–1.42)	.451	1.16 (0.89–1.50)	.269
Milk and alternatives						
No (reference)	1	—	1	—	1	—
Yes	0.78 (0.62–0.98)*	.029*	0.79 (0.63–0.99)*	.037*	0.83 (0.66–1.05)	.099
Meat and alternatives						
No (reference)	1	—	1	—	1	—
Yes	0.85 (0.62–1.17)	.324	0.89 (0.66–1.20)	.439	0.82 (0.60–1.10)	.181
Saturated fat						
No (reference)	1	—	1	—	1	—
Yes	0.87 (0.68–1.12)	.277	0.90 (0.71–1.15)	.399	0.84 (0.64–1.09)	.196
Added sugars						
No (reference)	1	—	1	—	1	—
Yes	0.70 (0.56–0.87)*	.002*	0.82 (0.65–1.03)	.093	0.93 (0.73–1.20)	.585
Physical activity						
No (reference)	1	—	1	—	1	—
Yes	0.51 (0.39–0.66)*	<.001*	0.53 (0.41–0.68)*	<.001*	0.53 (0.42–0.68)*	<.001*
Sleep						
No (reference)	1	—	1	—	1	—
Yes	0.98 (0.63–1.52)	.914	1.23 (0.78–1.95)	.369	1.24 (0.81–1.89)	.330
Screen (TV and computer)						
No (reference)	1	—	1	—	1	—
Yes	0.64 (0.51–0.79)*	<.001*	0.75 (0.59–0.94)*	.013*	0.76 (0.60–0.96)*	.021
Body wt status						
Normal wt (reference)	1	—	1	—	1	—
Overweight	0.74 (0.55–0.98)*	.032*	0.75 (0.57–0.98)*	.038*	0.84 (0.65–1.10)	.213
Obese	0.73 (0.54–0.98)*	.038*	0.63 (0.47–0.85)*	.002*	0.61 (0.46–0.82)*	.001*
Sex						
Female (reference)	1	—	1	—	1	—
Male	1.91 (1.53–2.38)*	<.001*	2.11 (1.70–2.60)*	<.001*	1.84 (1.48–2.27)*	<.001*
Parental education						
Secondary or less (reference)	1	—	1	—	1	—
College diploma	0.68 (0.50–0.93)*	.017*	0.74 (0.54–1.03)	.072	0.74 (0.48–1.07)	.060
University or graduate degree	0.47 (0.33–0.66)*	<.001*	0.58 (0.40–0.85)*	.005*	0.60 (0.41–0.89)*	.012*
Household income, Canadian \$						
≤20 000	1	—	1	—	1	—
20 000–40 001	0.74 (0.50–1.09)	.126	0.72 (0.48–1.07)	.108	0.72 (0.48–1.07)	.103
40 001–60 000	0.50 (0.36–0.69)*	<.001*	0.51 (0.36–0.72)*	<.001*	0.51 (0.36–0.73)*	<.001*
≥60 001	0.39 (0.27–0.57)*	<.001*	0.44 (0.29–0.65)*	<.001*	0.46 (0.30–0.69)*	<.001*
Region of residence						
Urban	1	—	1	—	1	—
Rural	0.71 (0.55–0.93)*	.011*	0.69 (0.54–0.86)*	.001*	0.64 (0.51–0.81)*	<.001*

Estimates are weighted to represent fifth-grade students in Nova Scotia. TV, television; —, not applicable.

^a Adjusted for sex, body weight status, parental education, parental income, region of residence, and energy intake.

^b Mutually adjusted for all variables in the table.

* $P < .05$.

adolescents and young adults that PA was associated with a lower incidence of mental illness during 4 years of observation. For a prospective sample of fifth-grade students surveyed in 2003, we also demonstrated that low PA was associated with future development of internalizing and externalizing disorders in

adolescence.¹³ In the current study, the associations of PA were more pronounced in boys, in whom we observed 53% fewer mental health visits (RR: 0.47 [95% CI: 0.34–0.64]). An Australian population-based cross-sectional study of 14- to 19-year-olds found that associations with mental health outcomes differed

by sex, with each day (per week) of PA guideline attainment being associated with a 9% decrease in the likelihood of depressive symptoms in boys.²⁹ In the current study, we revealed additional sex differences, with boys having 84% more mental health visits in the follow-up period compared with girls.

TABLE 4 Associations of Cumulative Recommendation Compliance Scores With Physician Visits for Mental Health Disorders in Subsequent 4-Year Follow-up

	Univariate		Multivariable ^a					
	RR (95% CI)	P	All Students ^b		Girls		Boys	
			RR (95% CI)	P	RR (95% CI)	P	RR (95% CI)	P
Per recommendation met ^c	0.80 (0.74–0.87)*	<.001*	0.85 (0.79–0.91)*	<.001*	0.89 (0.81–0.98)*	.022*	0.82 (0.75–0.91)*	<.001*
No. recommendations met ^c								
≤3	1	—	1	—	1	—	1	—
4–6	0.54 (0.39–0.73)*	<.001*	0.61 (0.44–0.84)*	.002*	0.79 (0.45–1.40)	.425	0.54 (0.37–0.78)*	.001*
7–9	0.33 (0.22–0.49)*	<.001*	0.44 (0.31–0.62)*	.004*	0.57 (0.33–0.98)*	.042*	0.25 (0.22–0.57)*	<.001*

Estimates are weighted to represent fifth-grade students in Nova Scotia. —, not applicable.

^a Adjusted body weight status, parental education, parental income, region of residence, and energy intake.

^b Further adjusted for sex.

^c Includes meeting the recommendations for vegetables and fruit, grains, milk and alternatives, meat and alternatives, added sugar, saturated fat, PA, and screen time.

* $P < .05$.

Considering our study captured more externalizing than internalizing disorders, because the former often have an earlier onset, and externalizing disorders are more prevalent in boys, these sex differences are consistent across studies in this age group.^{13,30}

Although the associations between dietary behaviors and mental health in adolescents have been supported by previous literature,^{6,29,31,32} no earlier study had examined mental health in combination with dietary and other lifestyle recommendations.

The associations of adherence to individual lifestyle behaviors with health care use for mental illness are valuable, but more compelling is the cumulative effect of adherence to multiple recommendations. We observed that every additional lifestyle recommendation met was associated with 15% fewer mental health visits and that compared with those meeting 1 to 3 recommendations, those meeting 4 to 6 and 7 to 9 recommendations had 39% and 56% fewer mental health visits, respectively. This accumulation of effects supports the absence of a “magic bullet” notion for avoiding mental illness.³³ Rather, concurrent adherence to recommendations for diet, PA, sleep, and screen time has the potential to reduce the burden of health care use for

mental illnesses in adolescents. Our analyses further suggested that the association of compliance with movement recommendations with mental illness is more pronounced than that of dietary recommendations.

We observed that more children with overweight and obesity relative to those of normal weight received a diagnosis of mental illness (Table 2), which is concordant with literature reporting that obesity in adolescence increases the risk of depression and other mental health symptoms.³⁴ In contrast, when analyzing the volume of health care visits for mental illness, children with overweight and obesity incurred fewer visits for mental illness relative to those of normal weight (Table 3). This paradoxical observation of more diagnoses and, on average, fewer health services among children with excess body weight has to the best of our knowledge not been previously reported. We speculate that more reluctance to seek health services among adolescents with obesity may be a factor as well as a tendency of physicians to use the primary diagnostic field in physician billing records for chronic diseases that are more prevalent among adolescents with obesity³⁵ rather than for mental illnesses. We recommend more research into these relationships.

Our observation that every additional recommendation met was associated with fewer physician visits for mental illnesses is novel. The magnitude of this association, a 15% decrease in the number of physician visits associated with each additional recommendation met, is promising. Clearly, primary prevention of mental illness was the focus of this study, a research area that has received relatively little attention. Somewhat more attention has been given to research on patients with mental illness and the potential of lifestyle interventions as “treatment.” For example, the Supporting the Modification of Lifestyle in Lowered Emotional States (SMILES) trial examined the potential of dietary coaching among adult patients with major depressive episodes. In this 12-week trial, the intervention group reportedly had improved mental health whereby dietary adherence correlated strongly with improvements in mood,³⁶ although selection bias and loss of blinding may have contributed to this effect.³⁷ With respect to PA, a meta-analysis of interventions among children concluded that PA, and specifically circuit training, significantly improved mental health.³⁸ The above examples of interventions among patients with mental illness lend support to our observations among a population-based sample of adolescents.

The recognition of possible benefits of lifestyle for the primary prevention of mental illness, as portrayed in the literature and confirmed in the current study, adds to the importance of physician consultation to children and their family units about meeting lifestyle recommendations. In addition to possible benefits in the prevention of mental illness, effective consultation has established benefits in preventing weight gain and consequent chronic diseases, for which purpose the recommendations were created. Moreover, recent studies have further suggested that meeting lifestyle guidelines may benefit children's cognition and school performance.^{14,39} We suggest that in the clinical setting, physician well-child visits (eg, yearly checkup) provide an opportunity to promote recommendation adherence for all children. Physician consult to the child and family unit could help raise parents' awareness and support their children in adhering to recommendations. Current mental health interventions largely focus on treatment and involve medications with potential side effects. Conversely, the encouragement of recommendation adherence (healthy diet and active, balanced lifestyle) come at no risk to patient outcomes, only gain.⁴⁰ This approach has the potential to reduce the number of future mental health visits and burden on primary care related to mental illnesses.

Among young people, there is a reluctance to seek professional help for mental illness.⁴¹ For example, in a school-based study of 11 154 Norwegian youth, only 29% of students with the highest symptom levels sought professional help.⁴² Although Canada has a public health care system that offers health services free of charge, reluctance to seek health services is most likely at play in the current study as well. The 14.6% prevalence of

mental illness estimated in the current study is in line with national estimates of 10% to 20% among youth,⁴³ suggesting that the underestimation resulting from reluctance to seek health services may have affected both studies to a similar extent. Rickwood et al⁴¹ have identified parents' help-seeking behaviors as a major influence on children receiving mental health services and recommended awareness campaigns targeting parents as a strategy to get youth to seek counseling for mental illness.

Various mechanistic hypotheses have been proposed for the associations of diets⁷ and PA^{8,9} with depression. These include anti-inflammatory effects, increased growth factors leading to neuroplasticity, and activation of the endocannabinoid system,^{7-9,44} but their precise contributions remain to be disentangled and empirically demonstrated, until which time reverse causality cannot yet be refuted.²⁹ Of note is that various studies have documented that subjects with mental illness are more sedentary, engage less in PA, and often report diets of poor quality.^{45,46} However, the growing body of literature supports the forward directionality whereby healthy lifestyle behaviors reduce the risk of mental illness.⁷⁻⁹ With the latter in mind, one is inclined in their analytic approach to adjust for mental illness at baseline. However, as suggested by Molendijk et al,⁷ correcting for mental illness at baseline may cancel out the effects of lifestyle behaviors in the years before the study. Concordant with this concern, we analyzed our sample both with and without correction for mental illness at baseline and revealed associations of similar magnitude.

Findings from the study should be interpreted considering several limitations. Assessment of diet,

sedentary behaviors, and PA were based on self-report and can be prone to error; although the Harvard Youth/Adolescent Questionnaire and Physical Activity Questionnaire for Older Children measures have been validated for children. Despite adjusting for a broad set of potential confounders, the possibility of residual confounding and confounding related to unmeasured factors exist. Family structure, history of parental mental health, and genetics have all been linked to mental illness but were not measured in the current study. Mental illness was investigated as a single outcome; further investigation of the associations of healthy lifestyle behaviors with specific psychiatric disorders is merited.

CONCLUSIONS

Lifestyle recommendations are widely used and primarily intended to promote healthy physical development in children and prevent chronic diseases later in life. Findings from this study suggest that adherence to these recommendations has significant short-term benefits for mental health as well. Emphasizing the importance of adherence to lifestyle behaviors during well-child visits has the potential to improve adolescent mental health and reduce the primary care use burden associated with mental illness. Promotion of multiple health behaviors in childhood may have a more pronounced effect on reducing the primary care use associated with mental illness than targeting a single behavior.

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ABBREVIATIONS

CI: confidence interval
CLASS: Children's Lifestyle and School-Performance Study
ICD-9: *International Classification of Diseases, Ninth Revision*
ICD-10: *International Classification of Diseases, 10th Revision*
NBM: negative binomial regression model
PA: physical activity
RR: rate ratio

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