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The Association of Lifestyle Factors and Attention Problems in Adolescents

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ABSTRACT

OBJECTIVE This study aims to explore the associations between lifestyle factors such as physical activity, sleep patterns, media usage, and diet, and attention problems in adolescents.

METHODS This cross-sectional study involved 4,370 adolescents aged 13-18 years in Chiang Mai, Thailand. Lifestyle factors were assessed using the Youth Risk Behavior Surveillance System questionnaire, while attention problems were evaluated with the Youth Self-Report (YSR) Attention Problems subscale. Associations were analyzed using univariable and multivariable regression analysis.

RESULTS Media use exceeding two hours per day was significantly associated with clinical attention problems (aOR = 3.21, 95% CI: 1.81-5.71). Additionally, increased media use (b = 0.24, 95% CI: 0.19-0.28, $p < 0.01$), and high soft drinks consumption (b = 0.19, 95% CI: 0.12-0.26, $p < 0.01$) were positively associated with higher attention problem scores. Conversely, active physical activity (b = -0.09, 95% CI: -0.13 to -0.05, $p < 0.01$), adequate sleep (b = -0.26, 95% CI: -0.33 to -0.19, $p < 0.01$), regular breakfast intake (b = -0.09, 95% CI: -0.12 to -0.05, $p < 0.01$), vegetable consumption (b = -0.07, 95% CI: -0.13 to -0.02, $p = 0.01$), and milk consumption (b = -0.06, 95% CI: -0.11 to -0.01, $p = 0.03$) were negatively associated with attention problems scores.

CONCLUSIONS The study highlights the significant impact of lifestyle factors on attention problems among adolescents. These findings support the integration of lifestyle modifications into the assessment and management of attention issues in this age group, particularly emphasizing the need to reduce excessive media use.

KEYWORDS lifestyle factors, dietary patterns, attention problems, ADHD, adolescence

INTRODUCTION

Attention-deficit/hyperactivity disorder (ADHD) is a prevalent neurodevelopmental disorder in children and adolescents (1-3). The clinical features of ADHD include a persistent pattern of inattention and/or hyperactivity/impulsivity interfering with development or functioning and are frequently comorbid with other psychiatric disorders (4). ADHD may persist into adolescence and adulthood (5), contributing significantly to the global disease burden (2).

Pharmacological treatment, such as methylphenidate, effectively decreases ADHD symptoms (6). However, concerns have been raised about medication safety, adverse effects, and adherence

problems during long-term use, leading to a non-pharmacological approach as part of the multimodal treatment, including lifestyle modifications (7, 8).

Growing evidence suggests that dietary interventions might reduce ADHD symptoms, potentially mediated by the gut-brain axis (9-14). Notably, a diet rich in fruits and vegetables has been linked to symptom alleviation (15). However, research has predominantly focused on younger children, leaving a knowledge gap regarding adolescents (11, 16-19). Sleep disturbances, including difficulties in sleep onset, short sleep duration (<8 hours), and night awakenings, are commonly seen in ADHD patients (20). These sleep disturbances also aggravate ADHD symptoms (21). Furthermore, physical activity exceeding 150 minutes per week has been linked to a decrease in ADHD symptoms among late adolescents (22).

Beyond diet, sleep, and exercise, media use has emerged as a critical factor influencing attention problems. A meta-analysis has highlighted significant associations between excessive screen time and ADHD-related behaviors in children and adolescents (23). These studies underscore the consistent observation of the relationship between screen media use and ADHD-related behaviors across four decades (23, 24), pointing to the growing prevalence of digital media use among adolescents as a potential contributor to attention problems.

This study aimed to explore the associations between lifestyle factors including physical activity, media use, sleep behavior, and dietary habits, and attention problems in adolescents. We hypothesize that a healthy lifestyle could serve as a protective factor against attention problem symptoms in this age group.

METHODS

A cross-sectional study was conducted in Chiang Mai, Thailand, using two-stage cluster sampling. Initially, large schools with over one thousand students were selected. This was followed by random sampling of six secondary and vocational schools. Participants and their parents provided consent before the students completed an anonymous, self-administered web-based questionnaire after their computer class. The study received approval from the Research Ethics Committee of the Faculty of Medicine, Chiang Mai University (PED-2558-03436).

Participant demographics, including age, gender, school type, academic achievement, body weight, and height, were recorded. The weight and height of the participants were self-reported. BMI percentile categories were classified according to the World Health Organization (WHO) cut-off points (underweight, normal weight, overweight, and obesity) based on their age and gender (25).

The Youth Self Report (YSR) questionnaire's Attention Problems (AP) subscale assessed attention problems through nine items scored on a three-point scale, measuring inattention, hyperactivity, and impulsivity, with a higher score indicating more significant attention problems. The YSR is known to have good psychometric properties, with a Cronbach's alpha of 0.83 and test-retest reliability of 0.79 in the original version (26-28). T-scores of 70 or higher, representing two standard deviations above the mean, are considered to be in the clinical range for the clinical scales (29). Dichotomizing the outcome variable facilitated the identification of factors associated with clinically relevant levels of attention difficulties. Lifestyle behaviors were assessed using the Youth Risk Behavior Surveillance System developed by the Centers for Disease Control and Prevention for adolescents aged 13-18 years (30).

Descriptive statistics were used to assess the quantitative data. Bivariate and multivariable logistic regression analyses were conducted to calculate the odds ratio (OR) and adjusted odds ratio (aOR). Additionally, univariable and multivariable linear regression analyses were performed to explore the associations between lifestyle factors and attention problems, adjusting for potential confounders. Collinearity and interaction among the factors were tested. Significant lifestyle factors associated with attention problems were further analyzed by the response score group for lifestyle factors, using analysis of variance (ANOVA). All analyses were performed using SPSS software, version 22.0 (IBM Corp, Armonk, NY, USA) for Windows.

RESULTS

Of the 5,639 students enrolled, 4,370 completed the questionnaires, resulting in a response rate of 77.5%. Males comprised 50.9% of the respondents. According to the YSR-AP scores, 2% of participants were identified with clinical attention problems,

while 4% were on the borderline. The gender distribution was even across all groups. A higher percentage of older adolescents (16-18 years) were observed in the clinical attention problems group. The participant characteristics, stratified by YSR-AP cut points, are detailed in Table 1.

Bivariate logistic regression analysis, as shown in Table 2, revealed that adolescents attending

Table 1. Characteristics of participants stratified by the Youth Self Report-Attention Problems (YSR-AP) cut point score and the associations with clinical attention problems (n=4,370).

Characteristics, n (%)	Overall cohort (n=4,370)	Clinical attention problems (n=87)	Normal to borderline (n=4,283)	OR	aOR
Gender					
Male	2,223 (50.9)	48 (55.2)	2,175 (54.3)	1.19	0.82
Female	2,147 (49.1)	39 (44.8)	2,108 (45.7)	Reference	Reference
Age					
13-15	2,389 (54.7)	39 (44.8)	2,350 (54.9)	0.67	0.66
16-18	1,981 (45.3)	48 (55.2)	1,933 (45.1)	Reference	Reference
School					
Secondary school	3,404 (77.9)	60 (69.0)	3,344 (78.1)	0.62*	0.83
Vocational school	966 (22.1)	27 (31.0)	939 (21.9)	Reference	Reference
BMI percentile (n=4,356)					
Underweight	902 (20.7)	46 (17.8)	856 (20.9)	0.86	1.23
Normal	2,701 (62.0)	157 (60.9)	2,544 (62.1)	Reference	Reference
Overweight	427 (9.8)	27 (10.5)	400 (9.8)	1.10	1.35
Obese	326 (7.5)	28 (10.9)	298 (7.3)	1.12	1.32
Academic achievement (n=4,064)					
Mostly A's or B's	2,809 (69.1)	39 (53.4)	2,770 (69.4)	0.51**	0.59*
Grade C to D	1,255 (30.9)	34 (46.6)	1,221 (30.6)	Reference	Reference
Physical activity ≥60 min per day					
Not every day	3,791 (86.8)	73 (83.9)	3,718 (86.8)	0.79	0.79
Every day	579 (13.2)	14 (16.1)	565 (13.2)	Reference	Reference
Sleep time					
Inadequate sleep	3,210 (73.5)	69 (79.3)	3,141 (73.4)	1.39	1.15
Adequate sleep	1,159 (26.5)	18 (20.7)	1,141 (26.6)	Reference	Reference
Media use					
≥2 hours per day	2,416 (55.3)	72 (82.8)	2,344 (54.7)	3.97**	3.21**
<2 hours per day	1,954 (44.7)	15 (17.2)	1,939 (45.3)	Reference	Reference
Breakfast					
Skipped breakfast	1,749 (40.0)	49 (56.3)	1,700 (39.7)	1.96**	1.46
Breakfast everyday	2,621 (60.0)	38 (43.7)	2,583 (60.3)	Reference	Reference
Consume fruit					
Not everyday	3,141 (71.9)	64 (73.6)	3,077 (71.8)	1.09	1.34
≥1 time per day	1,229 (28.1)	23 (26.4)	1,206 (28.2)	Reference	Reference
Consume vegetable (N=4369)					
Not everyday	2,792 (63.9)	57 (65.5)	2,735 (63.9)	1.08	1.15
≥1 time per day	1,577 (36.1)	30 (34.5)	1,547 (36.1)	Reference	Reference
Consume juice					
Not everyday	3,618 (82.8)	73 (83.9)	3,545 (82.8)	1.09	0.78
≥1 time per day	752 (17.2)	14 (16.1)	738 (17.2)	Reference	Reference
Consume milk					
Not everyday	2,256 (51.6)	54 (62.1)	2,202 (48.6)	1.55	1.27
≥1 time per day	2,114 (48.4)	33 (37.9)	2,081 (51.4)	Reference	Reference
Consume soft drink					
≥1 time per day	3,188 (73.0)	22 (25.3)	1,159 (27.1)	0.91	0.92
Not everyday	1,181 (27.0)	65 (74.7)	3,123 (72.9)	Reference	Reference

OR, odds ratio; aOR, adjusted odds ratio

Model adjusted for gender, age, school, BMI percentile, academic achievement, physical activity, sleep duration, media use, breakfast, fruit, vegetable, juice, milk and soft drink consumption.

*$p < 0.05$; **$p < 0.01$

Table 2. Multiple linear regression analyses predicting attention problems in adolescents 13-18 years old (n=4,370).

Variable	Univariate analysis *p*-value	Multiple linear regression analysis					
		b	SE	β	t	*p*-value	95% CI
Gender	0.090	0.18	0.10	0.03	1.83	0.07	-0.01 - 0.37
Age	<0.001	0.12	0.03	0.07	3.70	<0.01	0.05 - 0.18
School	<0.001	0.10	0.13	0.01	0.74	0.46	-0.15 - 0.34
BMI percentile	<0.001	0.06	0.05	0.02	1.28	0.20	-0.03 - 0.15
Physical activity	<0.001	-0.09	0.02	-0.07	-4.26	<0.01	-0.13 - -0.05
Sleep time	<0.001	-0.26	0.04	-0.11	-7.12	<0.01	-0.33 - -0.19
Media use	<0.001	0.24	0.02	0.16	10.82	<0.01	0.19 - 0.28
Breakfast	<0.001	-0.09	0.02	-0.06	-4.30	<0.01	-0.12 - -0.05
Consume fruit	<0.001	-0.04	0.03	-0.02	-1.05	0.29	-0.10 - 0.03
Consume vegetable	<0.001	-0.07	0.03	-0.04	-2.54	0.01	-0.13 - -0.02
Consume juice	<0.001	-0.04	0.04	-0.02	-1.03	0.30	-0.11 - 0.03
Consume milk	<0.001	-0.06	0.03	-0.03	-2.13	0.03	-0.11 - -0.01
Consume soft drink	<0.001	0.19	0.03	0.08	5.54	<0.01	0.12 - 0.26

b, Unstandardized coefficients; SE, standard error; β, standardized coefficients; CI, confidence interval

vocational schools had a significantly higher likelihood of having clinical attention problems compared to those in secondary schools (OR = 0.62, 95% CI = 0.39-0.99). Lower academic achievement was also associated with a higher risk of clinical attention problems (OR = 0.51, 95% CI = 0.32-0.81). Adolescents who reported media use of 2 hours or more per day were nearly four times more likely to have clinical attention problems (OR = 3.97, 95% CI = 2.27-6.95). Additionally, skipping breakfast was significantly associated with clinical attention problems (OR = 1.96, 95% CI = 1.28-3.01).

In the multivariable logistic regression analysis, after adjusting for potential confounders, media use of 2 hours or more per day remained a significant predictor of clinical attention problems (aOR = 3.21, 95% CI = 1.81-5.71). Lower academic achievement also remained significantly associated with clinical attention problems after adjustment (aOR = 0.59, 95% CI = 0.36-0.96). However, the associations between school type and breakfast habits with clinical attention problems were attenuated and no longer statistically significant after adjustment.

Multivariable linear regression analyses revealed that older age, increased media use, and soft drinks consumption were positively associated with higher attention problem scores. Conversely, physical activity, adequate sleep, regular breakfast intake, and consumption of vegetables and milk showed significant negative associations with attention problems scores.

The analysis of lifestyle factors and their association with attention problem scores revealed several significant findings, as illustrated in Figure 1. Adolescents who engaged in daily physical activity had significantly lower mean YSR-AP scores compared to those physically active less than 3 days per week (4.27 vs 4.89, $p < 0.001$). Regarding sleep duration, those who slept 8-10 hours per night had significantly lower scores than those who slept 6-7 hours or less than 6 hours (4.03, 4.74, and 5.78 respectively, $p < 0.001$). Adolescents who reported media use of 5 hours or more per day had significantly higher scores compared to those who used media for 3-4 hours and less than 2 hours per day (5.83, 4.70, and 4.11 respectively, $p < 0.001$).

Analysis of dietary habits and their association with attention problem scores, as presented in Figure 2, found that regular breakfast consumption was associated with significantly lower mean attention problem scores compared to those who ate breakfast less than 3 days per week (4.37 vs 5.30, $p < 0.001$). Adolescents who consumed vegetables 1-3 times per day had significantly lower scores compared to those who did not consume vegetables daily (4.43 vs 4.91, $p < 0.001$). High soft drink consumption (more than 4 times per day) correlated with significantly higher attention problem scores compared to consuming soft drinks 1-2 times per day (6.08 vs 4.86, $p < 0.001$). Milk consumption 1-3 times per day was linked to lower mean scores compared to no daily milk consumption (4.49 vs 5.00, $p < 0.001$).

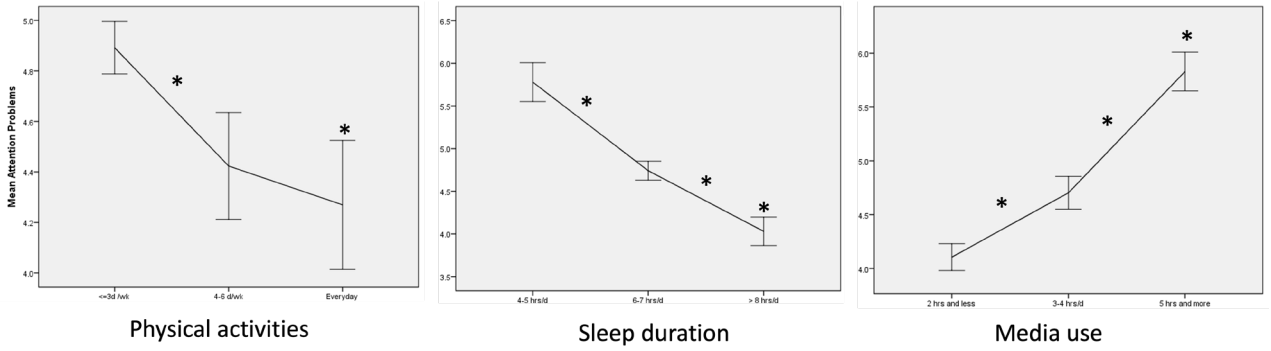

Figure 1. Attention problem scores according to the response scores for the lifestyle factors.
*Statistically significant difference of Youth Self Report-Attention Problems (YSR-AP) scores between 2 groups at $p < 0.05$

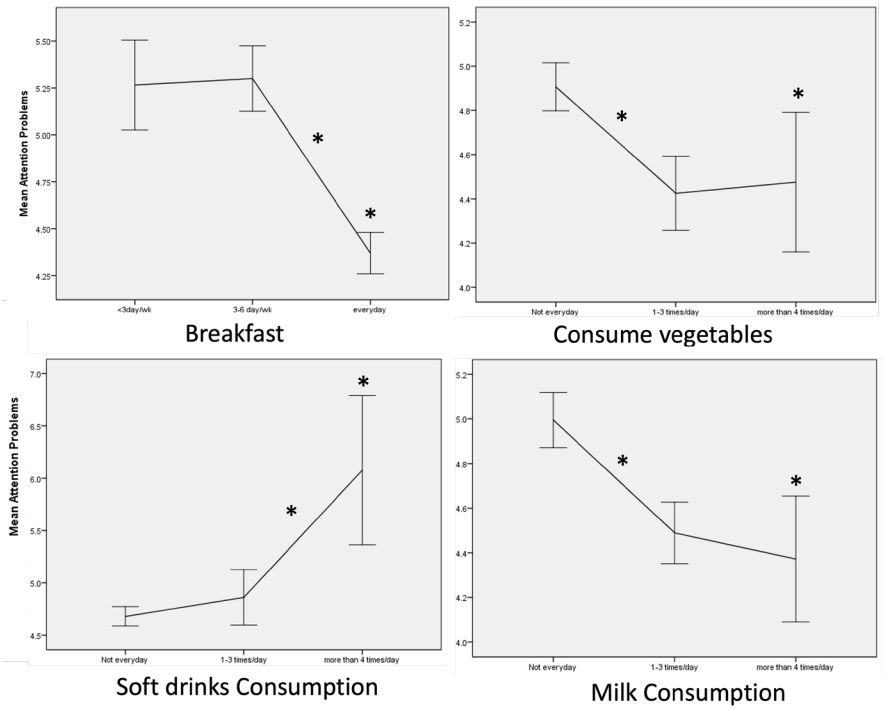

Figure 2. Attention problem scores according to the response scores for the dietary habits.
*Statistically significant difference of Youth Self Report-Attention Problems (YSR-AP) scores between 2 groups at $p < 0.05$

DISCUSSION

Our study reveals a concerning trend of unhealthy lifestyles among adolescents in Chiang Mai, characterized by limited physical activity, inadequate sleep, excessive media use, and poor dietary habits. Notably, we found that media use of 2 hours or more per day was significantly associated with clinical attention problems, even after controlling for potential confounders such as age, gender, BMI percentile, and other lifestyle factors.

This aligns with previous research (23, 24), which identified significant associations between screen media use and ADHD-related behaviors. Extending these findings, our study demonstrates how excessive media use correlates with clinically significant attention problems among Thai adolescents. Thorell et al. (31) suggested reciprocal associations between digital media use and ADHD symptoms, indicating that children with ADHD might be predisposed to developing problematic digital media habits, potentially exacerbating their symptoms and complicating their daily life. Although our cross-sectional design does not allow us to determine causality or the direction of these relationships, it underscores the need to consider the complex, bidirectional interactions between digital media use and ADHD symptoms.

Several mechanisms could potentially explain the link between excessive media use and attention problems. For instance, digital media may displace essential activities such as sleep, physical activity, and face-to-face social interactions, which are

vital for cognitive and behavioral development (31). Moreover, the fast-paced and stimulating nature of digital content could contribute to attentional difficulties and impulsivity in adolescents (32).

Our findings also corroborate previous research indicating significant relationships between various lifestyle factors such as skipping breakfast (33, 34), excessive media use (23, 24), insufficient sleep duration (21), and low physical activity levels (22) and increased attention problems. Notably, adolescents who engaged in daily physical activity and achieved adequate sleep (8-10 hours per night) had significantly lower mean YSR-AP scores than their less active or sleep-deprived counterparts, supporting the notion that insufficient sleep and inadequate physical activity are associated with heightened attention problems (35, 36).

We also discovered protective effects of regular breakfast consumption and the intake of vegetables and milk against attention problems. Adolescents consuming these items 1-3 times per day exhibited significantly lower attention problem scores than those who did not, echoing previous findings that associate high vegetable intake and regular breakfast consumption with reduced ADHD symptoms (18).

Furthermore, our analysis supports the link between high soft drink consumption (more than 4 times per day) and increased attention problems (37-39). Potential mechanisms for these associations might involve sugar intake dynamics, such as sugar tolerance, reactive hypoglycemia post-ingestion, and diminished consumption of essential micronutrients (40). The lack of awareness about healthy dietary habits among adolescents with attention problems, coupled with their propensity for risk-taking behaviors, might explain these patterns (41). Nevertheless, more longitudinal research is needed to verify the effectiveness of dietary interventions for ADHD in this demographic.

It is important to note that while our multivariate linear regression analysis identified associations between lifestyle factors and attention problem scores, these scores do not confirm that participants meet the criteria for clinical attention problems. Although lifestyle modifications should not replace medication as primary treatment, they could serve as a valuable adjunct in managing attention problems in adolescents. Our results have significant clinical implications for assessing and managing attention problems, suggesting that clinicians and parents should consider the potential adverse impacts of excessive media use and other unhealthy lifestyle factors. Implementing strategies to monitor and limit screen time, promote regular physical activity, ensure sufficient sleep, and encourage a balanced diet could form a comprehensive approach to managing attention difficulties.

The strengths of this study include its large, representative sample and the comprehensive assessment of various lifestyle factors associated with attention problems in adolescents. However, some limitations should be noted. Firstly, the cross-sectional design precludes causal inferences. Longitudinal studies are needed to establish the directionality of the observed associations and to evaluate the effectiveness of lifestyle interventions for managing attention problems. Secondly, the reliance on self-reported data may introduce recall bias and other response biases, although the anonymous web-based questionnaire might have mitigated this issue. Thirdly, the YSR-AP scale, while a reliable and valid tool, does not provide a clinical diagnosis of ADHD. Future studies should consider using more comprehensive diagnostic assessments. Lastly, the lack of data on participants' underlying medical conditions, such as pre-existing ADHD and their mood status, which may influence attention problems, should be acknowledged.

CONCLUSIONS

Our study highlights the critical role of lifestyle factors in the management of attention problems among adolescents. We strongly advocate for healthcare professionals to routinely screen for unhealthy lifestyle habits and provide comprehensive guidance on adopting healthier behaviors. This approach should be integral to the management strategies for attention difficulties in this demographic.

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CONFLICTS OF INTERESTS

The authors declared no potential conflicts of interest for the research, authorship, and/or publication of this study.

REFERENCES

1. Polanczyk G, Salum G, Sugaya L, Caye A, Rohde L. Annual research review: A meta-analysis of the worldwide prevalence of mental disorders in children and adolescents. J Child Psychol Psychiatry. 2015;56:345-65.
2. Sayal K, Prasad V, Daley D, Ford T, Coghill D. ADHD in children and young people: prevalence, care pathways, and service provision. Lancet Psychiatry. 2018; 5:175-86.
3. Thomas R, Sanders S, Doust J, Beller E, Glasziou P. Prevalence of attention-deficit/hyperactivity disorder: a systematic review and meta-analysis. Pediatrics. 2015;135:e994-1001. PubMed PMID: 25733754
4. Association Psychiatric Association. Diagnostic and statistical manual of mental disorders, Fifth Edition. Arlington, VA: American Psychiatric Association; 2013.
5. Harpin V, Mazzone L, Raynaud JP, Kahle J, Hodgkins P. Long-term outcomes of ADHD: a systematic review of self-esteem and social function. J Atten Disord. 2016;20:295-305.
6. Challman T, Lipsky J. Methylphenidate: its pharmacology and uses. Mayo Clin Proc. 2000;75:711-21.
7. Storebo OJ, Pedersen N, Ramstad E, Kielsholm ML, Nielsen SS, Krogh HB, et al. Methylphenidate for attention deficit hyperactivity disorder (ADHD) in children and adolescents - assessment of adverse events in non-randomised studies. Cochrane Database Syst Rev. 2018;5:CD012069. PubMed PMID: 29744873
8. Ching C, Eslick GD, Poulton AS. Evaluation of methylphenidate safety and maximum-dose titration rationale in attention-deficit/hyperactivity disorder: a meta-analysis. JAMA Pediatr. 2019;173:630-9.
9. Sonuga-Barke EJ, Brandeis D, Cortese S, Daley D, Ferrin M, Holtmann M, et al. Nonpharmacological interventions for ADHD: systematic review and meta-analyses of randomized controlled trials of dietary and psychological treatments. Am J Psychiatry. 2013; 170:275-89.
10. Pelsser LM, Frankena K, Toorman J, Rodrigues Pereira R. Diet and ADHD, reviewing the evidence: a systematic review of meta-analyses of double-blind placebo-controlled trials evaluating the efficacy of diet interventions on the behavior of children with ADHD. PLoS One. 2017;12:e0169277. PubMed PMID: 28121994
11. Heilskov Rytter MJ, Andersen LB, Houmann T, Bilenberg N, Hvolby A, Molgaard C, et al. Diet in the treatment of ADHD in children - a systematic review of the literature. Nord J Psychiatry. 2015;69:1-18.
12. Henriksson P, Cuenca-Garcia M, Labayen I, Esteban-Cornejo I, Henriksson H, Kersting M, et al. Diet quality and attention capacity in European adolescents: the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) study. Br J Nutr. 2017;117:1587-95.
13. Del-Ponte B, Quinte GC, Cruz S, Grellert M, Santos IS. Dietary patterns and attention deficit/hyperactivity disorder (ADHD): a systematic review and meta-analysis. J Affect Disord. 2019;252:160-73.
14. Boonchooduang N, Louthrenoo O, Chattipakorn N, Chattipakorn SC. Possible links between gut-microbiota and attention-deficit/hyperactivity disorders in children and adolescents. Eur J Nutr. 2020;59:3391-403.
15. Kim K, Lim M, Kwon H, Yoo S, Kim E, Kim J, et al. Associations between attention-deficit/hyperactivity disorder symptoms and dietary habits in elementary school children. Appetite. 2018;127:274-9.
16. Peacock PJ, Lewis G, Northstone K, Wiles N. Childhood diet and behavioural problems: results from the ALSPAC cohort. Eur J Clin Nutr. 2011;65:720-6.
17. Park S, Cho S, Hong Y, Oh S, Kim J, Shin M, et al. Association between dietary behaviors and attention-deficit/hyperactivity disorder and learning disabilities in school-aged children. Psychiatry Res. 2012;198:468-76.
18. Yan S, Cao H, Gu C, Ni L, Tao H, Shao T, et al. Dietary patterns are associated with attention-deficit/hyperactivity disorder (ADHD) symptoms among preschoolers in mainland China. Eur J Clin Nutr. 2018;72: 1517-23.
19. Abbasi K, Beigrezai S, Ghiasvand R, Pourmasoumi M, Mahaki B. Dietary patterns and attention deficit hyperactivity disorder among iranian children: a case-control study. J Am Coll Nutr. 2019;38:76-83.
20. Hvolby A. Associations of sleep disturbance with ADHD: implications for treatment. Atten Defic Hyperact Disord. 2015;7:1-18.
21. Schneider H, Lam J, Mahone E. Sleep disturbance and neuropsychological function in young children with ADHD. Child Neuropsychology. 2016;22:493-506.
22. Rommel A, Lichtenstein P, Rydell M, Kuja-Halkola R, Asherson P, Kuntsi J, Larsson H. Is physical activity causally associated with symptoms of attention-deficit/hyperactivity disorder? J Am Acad Child Adolesc Psychiatry. 2015;54:565-70.
23. Nikkelen S, Valkenburg P, Huizinga M, Bushman B. Media use and ADHD-related behaviors in children and adolescents: a meta-analysis. Dev Psychol. 2014; 50:2228-41.
24. Beyens I, Valkenburg P, Piotrowski J. Screen media use and ADHD-related behaviors: four decades of research. Proc Natl Acad Sci U S A. 2018;115:9875-81.
25. Organization WH [Internet]. BMI-for-age (5-19 years).

2018 [cited 2023 Sep 10]. Available from: https://www.who.int/tools/growth-reference-data-for-5to19-years/indicators/bmi-for-age
26. Achenbach T, Dumenci L. Advances in empirically based assessment: revised cross-informant syndromes and new DSM-oriented scales for the CBCL, YSR, and TRF: comment on Lengua, Sadowksi, Friedrich, and Fischer (2001). J Consult Clin Psychol. 2001; 69:699-702.
27. Achenbach T, Ruffle T. The child behavior checklist and related forms for assessing behavioral/emotional problems and competencies. Pediatr Rev. 2000;21: 265-71.
28. Achenbach T. Manual for ASEBA school-age forms & profiles. University of Vermont, Research Center for Children, Youth & Families. 2001.
29. Biederman J, DiSalvo M, Vaudreuil C, Wozniak J, Uchida M, Woodworth K, et al. The child behavior checklist can aid in characterizing suspected comorbid psychopathology in clinically referred youth with ADHD. J Psychiatr Res. 2021;138:477-84.
30. Centers for Disease Control and Prevention [Internet]. 2015 National Youth Risk Behavior Survey. 2015 [cited 2023 Sep 10]. Available from: https://www.cdc.gov/healthyyouth/data/yrbs/files/2015/pdf/2015_xxh_questionnaire.pdf.
31. Thorell LB, Burén J, Ström Wiman J, Sandberg D, Nutley SB. Longitudinal associations between digital media use and ADHD symptoms in children and adolescents: a systematic literature review. Eur Child Adolesc Psychiatry. 2022.
32. Engelhard MM, Kollins SH. The many channels of screen media technology in ADHD: a paradigm for quantifying distinct risks and potential benefits. Curr Psychiatry Rep. 2019;21:90. PubMed PMID: 31410653
33. Adolphus K, Lawton C, Champ C, Dye L. The effects of breakfast and breakfast composition on cognition in children and adolescents: a systematic review. Adv Nutr. 2016;7:590s-612s. PubMed PMID: 27184287
34. Maffeis C, Fornari E, Surano M, Comencini E, Corradi M, Tommasi M, et al. Breakfast skipping in prepubertal obese children: hormonal, metabolic and cognitive consequences. Eur J Clin Nutr. 2012;66:314-21.
35. LeLeiko N, Dorfzaun S, Picoraro J. The role of diet, nutrition, and exercise in preventing disease. Pediatr Rev. 2022;43:298-308.
36. Asiamah N, Petersen C, Kouveliotis K, Eduafo R, Borkey R. The association between physical activity and self-reported health in older adults: lessons implied by lifestyle factors. Adv Gerontol. 2020;33:289-98.
37. Rios-Hernandez A, Alda JA, Farran-Codina A, Ferreira-Garcia E, Izquierdo-Pulido M. The mediterranean diet and ADHD in children and adolescents. Pediatrics. 2017;139. PubMed PMID: 28138007
38. Woo H, Kim D, Hong Y, Kim Y, Seo J, Choe B, et al. Dietary patterns in children with attention deficit/hyperactivity disorder (ADHD). Nutrients. 2014;6:1539-53.
39. Lien L, Lien N, Heyerdahl S, Thoresen M, Bjertness E. Consumption of soft drinks and hyperactivity, mental distress, and conduct problems among adolescents in Oslo, Norway. Am J Public Health. 2006;96:1815-20.
40. Benton D. Sucrose and behavioral problems. Crit Rev Food Sci Nutr. 2008;48:385-401.
41. Schoenfelder EN, Kollins SH. Topical review: ADHD and health-risk behaviors: toward prevention and health promotion. J Pediatr Psychol. 2016;41:735-40.