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Recommendations on screen time, sleep and physical activity: associations with academic achievement in Swiss adolescents

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ABSTRACT

Objectives: This study aimed to investigate how meeting international recommendations for screen time (<2 h/day), moderate-to-vigorous physical activity (MVPA; at least 60 min/day) and sleep (8–10 h/night), as well as media multitasking (MMI) as a form of screen time, impact academic achievement in early adolescence.

Study design: A prospective design was used, where self-report measures were collected during the spring semester and academic achievement at the end of the school year.

Methods: A total of 1208 grade 3 middle school students (M_{age} = 13.55 years, SD_{age} = 0.60) in 37 Swiss schools filled out a paper-and-pencil questionnaire including measures of screen time (covering watching television, playing video games, Internet use, smartphone use and social media use), MMI, sleep time and time for MVPA. To evaluate academic achievement, end-term grades were provided by the collaborating education administration for Italian, Maths, Science, History, Geography, Music and Visual arts.

Results: After adjustment for covariates, such as gender, socio-economic status, body mass index and stressful life events, multivariate linear mixed-effect models, nesting participants in schools, showed that meeting recommendations for screen time (B = 0.12, β = 0.105, $P < 0.001$) and MVPA (B = 0.09, β = 0.09, $P = 0.001$), but not sleep (B = 0.05, $P = 0.087$), were associated with higher academic achievement. Considering the number of recommendations met, meeting all three recommendations improved academic achievement the most (B = 0.24, β = 0.21, $P < 0.001$), followed by meeting the guidelines for screen time + MVPA (B = 0.20, β = 0.15, $P < 0.001$) and for screen time + sleep (B = 0.21, β = 0.13, $P < 0.001$). In the fully adjusted model, multitasking with two or more media was related to a worse academic achievement.

Conclusions: Screen time (including MMI), sleep and MVPA impact academic achievement in adolescence; hence, governmental organisations and schools should raise awareness about the positive and negative effects of following or not recommendations for MVPA, sleep and screen time among adolescents and their parents. In addition, support should be provided to promote sufficient sleep and MVPA while limiting overall screen time and parallel device use.

Introduction

Academic achievement is essential for mastering diverse developmental goals. It has been related to higher subjective well-being[1] and career adaptability.[2] Conversely, lower levels of cognitive performance in childhood and adolescence predict diminished well-being, including more frequent psychological disorders[3] and higher risk for health-related issues and mortality later in life.[4]

Different daily behaviours can affect cognitive development in adolescence, such as screen time, moderate-to-vigorous physical activity (MVPA) and sleep. The impact of screen time on children's and adolescents' well-being, including academic achievement, is a subject of growing concern. In Switzerland, in 2020, Swiss adolescents spent, on average, almost 2 h and 44 min on the Internet and 3 h and 47 min on the smartphone during a typical weekday. This time augmented, respectively, to nearly 4 and 5 h during a typical weekend day, partly because of the ongoing COVID-19

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pandemic.[5] Previous studies showed that screen time (here defined as the total amount of time spent using a smartphone, social media, Internet, television or video games) is related to poorer learning outcomes and augmented risk of premature cognitive decline,[6] already at early developmental stages.[7,8]

According to the 'time displacement hypothesis',[9] screen time interferes with activities such as MVPA and sleep, which are beneficial for academic achievement. Indeed, screen time (especially when ≥2 h/day[10]) is a sedentary behaviour that takes away valuable time for MVPA[11] and augments the risk of overweight and obesity in children and adolescents. Screen time also interferes with sleep by delaying bedtime, interrupting sleep due to incoming notifications and reducing sleep quality due to the continued emotional arousal from screen time before sleep,[12,13] leading to daytime sleepiness and lower academic achievement.[14,15] In a prospective cohort study, the use of electronic devices before bedtime, especially the use of the smartphone, social media and video games, reduced the academic attainment of adolescents,[15] in part by augmenting daytime sleepiness.

Furthermore, the ubiquity of media devices in adolescents' lives has led to a substantial increase in media multitasking, commonly defined as either concurrently engaging in two or more media activities or using media during offline activities (e.g. while doing homework).[9] Previous research highlighted that media multitasking correlates with adverse outcomes, including limited cognitive control capacities and lower academic achievement.[16] According to the 'scattered attention hypothesis',[9] adolescents who frequently multitask on several media have more difficulties in filtering relevant information from their environment due to scattered attention developed during parallel media exposure. Thus, they are more easily distracted in online and offline contexts, with negative consequences for their cognitive processes.

On the contrary, MVPA has been shown to be positively associated with academic achievement.[17] Evidence suggests that MVPA elicits brain plasticity; hence, it is especially beneficial for cognitive functioning, including reaction time, attention, memory, inhibition, as well as multiple domains of academic performance and brain plasticity.[18] A meta-analysis examining the association between MVPA and eight cognitive categories in 4- to 18-year-old subjects found that MVPA was positively associated with better functioning in all domains.[19] Another review found that aerobic exercise was positively associated with cognition and academic achievement in children aged <19 years.[20] Interestingly, moderate-to-vigorous bursts of PA have been found to foster cognitive functions and mental health more than low-intensity PA.[21] In addition, longitudinal findings highlighted that physical fitness in adolescence predicts cognitive performance in young adulthood[22] as well as later in life.[23]

From a biological point of view, the benefits of MVPA include increased expression of molecules (e.g. brain-derived neurotrophic factor) in brain regions important for memory and cognition, increased cerebral blood flow and metabolism, better neurotransmitter regulation, enhanced connectivity between brain regions and modulation of genes' expression.[18] This makes MVPA a crucial component of brain resilience.[24]

Sleep is another pivotal factor in learning and brain development. In youth, inadequate sleep has been associated with negative health outcomes, including somatic and psychosocial health (e.g. increased body mass index [BMI], overweight and obesity, cardiovascular risk, somatic complaints, fatigue, depression, anxiety, inattention, more frequent risk-taking behaviours [e.g. substance use], as well as low academic performance).[25] Shorter sleep time and poor sleep quality and without being consistent in sleep and wake across the week are related to lower grades.[26] On the other hand, good sleep quality and quantity proved to be positively associated with general cognition and academic achievement. A meta-analysis reported that longer sleep duration is related to increased intelligence quotient and verbal skills in children aged 6–13 years.[27] The role of sleep in learning can be well understood for its implications in memory consolidation, during which memory traces are reactivated, analysed and included in long-term memory.[28]

Given the evidence of the impact of screen time, MVPA and sleep on cognitive well-being, different national and international guidelines were formulated. According to the World Health Organisation and the Federal Office of Sport,[29] children and adolescents aged between 5 and 17 years should carry out at least 60 min of MVPA daily.[4] In addition, adolescents between 14 and 17 years should sleep from 8 to 10 h per night, uninterruptedly, as stated by the National Sleep Foundation[30] Finally, recreational screen time should be limited to no more than 2 h per day.[31] Given that many of these guidelines are very recent yet heavily promoted, research is needed to investigate if they are actually met and, if so, what effects they have on academic achievement.

A previous study with US children aged between 8 and 11 years[32] found that participants who met all three recommendations, or at least the screen time recommendation or both the screen time and the sleep recommendations, performed better in psychometric tasks assessing global cognition. Another study[33] with Australian students from grades 12 to 17 years found that meeting recommendations for screen time and/or sleep time was associated with better academic performance in high school students, whereas the strongest association in middle school participants was reported for those who followed all three guidelines. No study, to date, has replicated these findings in the European context and considered media multitasking as an additional risk factor of academic achievement.

Study aims

The present study aims to investigate (1) how many Swiss students aged 13–14 years meet the (inter)national recommendations for screen time, MVPA and sleep; (2) whether meeting none, one, two or all three guidelines predicts better academic achievement; and (3) the role of media multitasking, as an additional measure of screen time that may impact attention and cognition. The study furthermore considers stressful life events as covariates beyond sociodemographic characteristics.

Methods

Study design

The present study used data from the fifth wave of the ongoing longitudinal MEDIATICINO2.0 study, following up students born in 2004/2005 from childhood to adolescence in Italian-speaking Switzerland The study combines students' questionnaire data with end-term school grades obtained from the regional education administration and matched by a unique identifier.

In autumn 2013, all public elementary schools in Italian-speaking Switzerland were invited to participate in the study. Based on this opt-in technique, 39 of 79 schools agreed. Within these schools, 60 grade 4 classes comprised 1083 students were randomly selected. No inclusion or exclusion criteria were specified. In autumn 2015, when the cohort entered middle school, 409 additional students were randomly sampled within schools to compensate for sampling attrition and to ensure that the study sample sufficiently represented all school districts within the region.

Study participation was voluntary. Parents received a letter before their children entered the cohort, informing them about the research, its aims and procedure. They were also informed about the possibility that students could opt-out anytime by simply not completing the questionnaire without any consequences for their evaluation at school. As the anonymity of the students was fully guaranteed, the regional education administration approved the study.

The fifth wave of the MEDIATICINO2.0 study was in 2018 when 1419 questionnaires were distributed among grade 3 middle school students in 37 schools. Of these, 1374 (97%) were returned, of which 27 were blank, and 117 included more than 15% of missing data in the variables of interest. Twenty-two participants were excluded as they reported outlier values (defined as z-scores > ±3.5).

Measures

Screen time

Screen time includes estimates for five different activities during recreational time (i.e. time spent watching television, playing video games, using the Internet, using a smartphone and social media activities). Students were asked to indicate how much time they spend on each activity on a typical school day and on a weekend day. For each question, students estimated their daily media use on a scale with nine-time interval: 0 'never', 1 'up to 0.5 h', 2 'between 0.5 and 1 h', 3 'between 1 and 1.5 h', 4 'between 1.5 and 2 h', 5 'between 2 and 3 h', 6 'between 3 and 4 h', 7 'between 4 and 5 h' and 8 '5 or more hours'. Daily recreational time for each activity was calculated by weighting the interval midpoint for weekdays and weekend days: ([sum of weekday screen time × 5] + [sum of weekend day screen time × 2])/7. A total measure of screen time in hours was then obtained by taking a weighted average of all screen-related activities.

Sleep time

Sleep time was calculated from students' self-report on when they went to bed the day before and when they got up on the day of questionnaire completion. As questionnaires were completed at school, 'the day before' measured sleep time before a school day. Considering that our sample falls in an age range between 13 and 14 years, we decided to use the cut-off value of 8 h 30 min for meeting the recommendation (as a midpoint of the recommendation of 8–10 h for 14-to-17 year-olds and 9–11 h for 11-to-13 year-olds).

Moderate-to-vigorous physical activity

MVPA was measured by asking students to indicate on the abovementioned nine-time interval scale how much time, on a typical school day, they spend doing sports.

Media Multitasking Index

A Media Multitasking Index (MMI) was calculated by asking participants how frequently they engaged in a specific media activity (i.e. watching TV, using the Internet, sending messages and playing video games) with another simultaneous media activity.[34] The response categories ranged from 1 'never' to 4 'very often'. The MMI was then calculated for each activity following Ophir's equation.[34] The MMI indicates the number of additional media an individual is using while using a primary medium.

Academic achievement

Academic achievement was evaluated based on end-term grades in Italian, Maths, Science, History, Geography, Music and Visual arts provided by the regional educational administration. A minimum of 4 is required to pass, whereas the maximum is 6. All grades were pulled together to obtain a general end-term grades score.

Stressful life events

Stressful life events were measured asking participants if one of the following seven events happened in the last year: parents' divorce, a parent with a new partner, a parent's loss of his/her job, a family member who deceased or had severe disease, the worsening of a significant relationship (e.g. with a parent, a teacher, or a friend) or any other negative and significant life event.

Body mass index

BMI was calculated from the reported weight and height. BMI categories were created using the following cut-offs: ≤3rd percentile 'underweight', >3rd and ≤75th percentile 'normal weight', >75th and ≤97th percentile 'overweight' and >97th percentile 'obese'.

Sociodemographic covariates included gender, coded as 0 = male and 1 = female, and socio-economic status (SES), measured by asking participants to rate the financial situation of their family from 0 'definitely not wealthy' to 4 'definitely wealthy'.

Statistical analyses

As data collection was organised at the school level, participant-level associations between self-report predictor variables and academic achievement were fitted using multivariate linear mixed-effects (random intercepts) models, nesting participants' grades within schools (N = 37). Using multilevel modelling allows estimation of the variance between students within the same school and the variance between schools separately. At the first step (Model 1), we tested the model, including only the random intercepts and the covariates. In Model 2, we included participants' screen time, MVPA and sleep recommendations coded as 0 'not met' and 1 'met'. Finally, in Model 3, we tested the effect of meeting one recommendation (screen time or sleep or MVPA) versus two recommendations (screen time + sleep, screen time + MVPA and MVPA + sleep) versus all three recommendations, compared with none met (reference level). The MMI was added as a categorical variable ranging from 0 ('no multitasking') to 4 ('multitasking with four different activities') in Model 2 and Model 3 as an additional measure of screen time. In all models, parameter estimates were calculated with a maximum likelihood algorithm, using the 'lme4' package in R software.

Results

Sample characteristics

The analytical sample included 1208 students (M_{age} = 13.55 years, SD = 0.60), of which 628 (52%) were female and 874 (72.4%) reported to have a good to very good SES. A total of 288 (23.9%) were either overweight or obese. More than half (n = 349 [53.7%]) reported at least one stressful life event. The average end-term grade was 4.78 (SD = 0.52). Most students reported to multitask with one (n = 429 [35.5%]), two (n = 459 [38%]), three (n = 136 [11.3%]) and four (n = 30 [2.5%]) additional media. An overview of the sample characteristics is reported in Table 1.

A Bayesian regression imputation method and a predictive mean matching model were used to impute missing values. All continuous variables were normally distributed with skewness and kurtosis <±1.

Table 1
Sample characteristics (N = 1208).

Variable	n (%)	Mean (SD)
Sex		
Boys	580 (48%)	
Girls	628 (52%)	
Age (years)		13.55 (0.60)
Socio-economic status (SES)		2.85 (0.74)
Not at all good	3 (0.2%)	
Not good	45 (3.7%)	
Adequate	286 (23.7%)	
Good	668 (55.3%)	
Very good	206 (17.1%)	
BMI (kg/m^2)		19.25 (2.68)
Underweight	59 (4.9%)	
Normal weight	861 (71.3%)	
Overweight	252 (20.9%)	
Obese	36 (3%)	
Stressful life events		
None	559 (46.3%)	
One	331 (27.4%)	
Two or more	318 (26.3%)	
Grades (total)		4.78 (0.52)
Italian		4.69 (0.64)
Maths		4.45 (0.76)
Science		4.79 (0.66)
Visual arts		5.19 (0.49)
Media Multitasking Index (MMI)		
No multitasking	154 (12.7%)	
With 1 other media	429 (35.5%)	
With 2 other media	459 (38%)	
With 3 other media	136 (11.3%)	
With 4 other media	30 (2.5%)	

BMI, body mass index.

Recommendations met

Among all students, 905 (74.9%) spent less than 2 h/day on screens, 601 (49.8%) slept for at least 8 h 30 min per night and 813 (67.3%) exercised for at least 60 min per day (see Table 2). With regard to the number of recommendations met, 90 (7.5%) did not meet any of the recommendations, 134 (11.1%) reported doing at least 60 min of MVPA per day, 28 (2.3%) reported sleeping for at least 8 h 30 min, 140 (11.6%) reported spending no more than 2 h on screens and 247 (20.4%) reported following the guidelines for MVPA + screen time, 52 (4.3%) for MVPA + sleep and 153 (12.7%) for sleep + screen time. The remaining 364 students (30.1%) met all three recommendations (see Fig. 1).

Main analyses

The baseline model (Model 1; see Table 3) explained 13.5% of the variance in academic achievement. Being female, having a better SES, having experienced two or more stressful life events and having a higher BMI were all significant predictors of academic achievement. Compared with Model 1, both Models 2 and 3 explained a significant additional proportion of variance. In Model 2 ($R^2 = 0.182$), spending <2 h/day on the screens predicted better academic achievement ($B = 0.12$, $P < .001$), followed by doing PA for at least 60 min/day ($B = 0.09$, $P = 0.001$). In addition, multitasking with two or more other media activities negatively predicted academic achievement in an increasing way ($B_{MMI(2)} = -0.13$, $P = 0.006$; $B_{MMI(3)} = -0.16$, $P = 0.006$; $B_{MMI(4)} = -0.18$, $P = 0.029$). In Model 3 ($R^2 = 0.192$), meeting only one recommendation did not predict academic achievement. However, meeting 2, specifically MVPA + screen time and sleep + screen time, significantly predicted better academic achievement at the end of the school year ($B = 0.20$, $P < 0.001$ and $B = 0.21$, $P = 0.001$, respectively). Meeting all three recommendations was the best predictor of academic achievement ($B = 0.24$, $P < 0.001$). Again, multitasking with two or more media activities predicted worse academic achievement ($B_{MMI(2)} = -0.11$, $P = 0.012$; $B_{MMI(3)} = -0.15$, $P = 0.012$; $B_{MMI(4)} = -0.20$, $P = 0.035$).

Discussion

Academic achievement has been related to (un)healthy behaviours in adolescence. This has led to the formulation of recommendations for screen time, MVPA and sleep, with the aim to promote a healthy lifestyle and development from an early age. The results of the present study, on a Swiss cohort of middle school students aged 13–14 years, adds to those from previous studies in other cultural contexts.[32,33] More precisely, the study found that the majority of adolescents met the recommendations for screen time and MVPA, but only half of them met the recommendations for sleep. In particular, meeting at least two of the three recommendations leads to better outcomes, especially if the recommendation involved screen time. Although it should be kept in mind that the data for this study stem from adolescents' self-report, prone to estimation bias, this result is in line with similar studies based on children's and adolescents' self-report:[32,33] long and frequent media use may have detrimental effects on attention, memory, impulse control and, consequentially, academic performance. Spending no more than 2 h per day in front of screens, sleeping the recommended amount of 8 h and 30 min and exercising at least 1 h per day was associated with better academic achievement. Following the notion of the 'displacement' hypothesis,[9] this demonstrates that reduced screen time should be substituted with more time for sleep and/or MVPA to be beneficial for academic achievements as the latter two activities enhance brain plasticity[18] and memory consolidation.[28]

Furthermore, the present study found that multitasking with two or more media activities leads to worse academic achievement; hence, media multitasking should also be considered as an additional measure of screen time in future research investigating academic achievement. Digital technologies, especially the

Table 2
Average time spent on each behaviour and proportion of students meeting the recommendations.

Behaviour	Time spent [M_{hours} (SD_{hours})]	Recommendation	Number of participants meeting the recommendation (%)
Screen time (total)	1 h 30 min (0 h 58 min)	<2 h/day	905 (74.9%)
Video games	0 h 53 min (1 h 10 min)		1048((86.8%)
Smartphone	1 h 57 min (1 h 26 min)		432 (35.8%)
Social media	1 h 26 min (1 h 21 min)		935 (77.4%)
Television	1 h 11 min (1 h 3 min)		1037 (85.8%)
Internet	2 h 4 min (1 h 25 min)		727 (60.2%)
Sleep	8 h 17 min (1 h 1 min)	8 h 30 min/night	601 (49.8%)
MVPA	1 h 45 min (0 h 58 min)	≥1 h/day	813 (67.3%)

MVPA, moderate-to-vigorous physical activity.

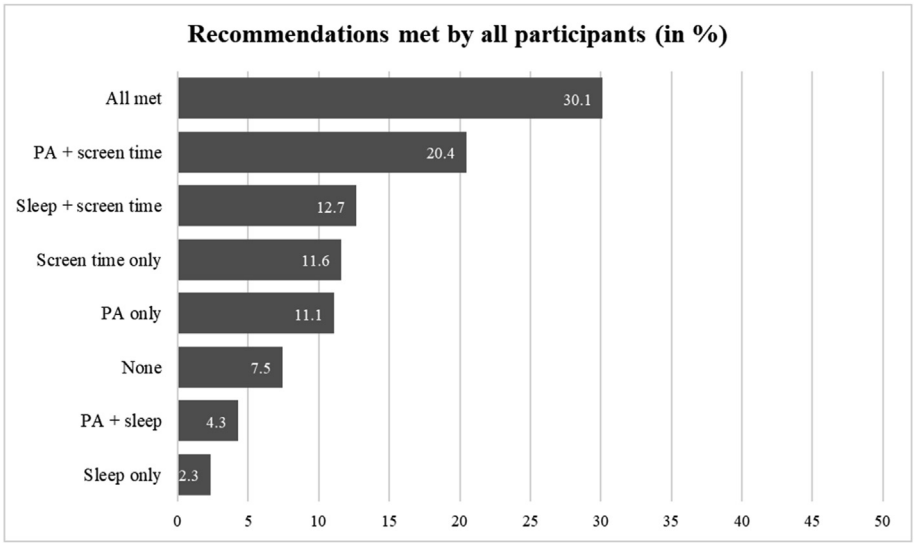

Fig. 1. Recommendations met by all participants (in percentage). PA, physical activity.

smartphone, provide quick and easy gratifications. Adolescents are more willing to use them (simultaneously) to seek short gratifications, particularly when the first, ongoing task is not gratifying enough. According to the 'scattered attention' hypothesis, the parallel use of different media devices impact the capabilities of functioning, reasoning and remembering information in the offline context (e.g. classroom and homework),[35] with negative consequences for academic achievement. It is likely that adolescents who engage in media multitasking (i.e. parallel use of two or more media devices) also engage in multitasking where devices are used while doing other offline activities (such as homework). Limited screen time may not only reduce the interfering effects of screens before bed or while doing homework (e.g. multitasking) but could also substitute them with cognitively engaging and educating activities, such as reading, including in-person social interactions, promoting a healthier lifestyle.

In addition to past studies, the present study also considered sociodemographic characteristics, BMI and stressful life events as potential confounders. Being female and having a better socioeconomic background significantly increased academic achievement, while being overweight and experiencing stressful life events were related to decreased academic achievement. Previous studies

Table 3
Hierarchical regression analyses predicting academic achievement.

Predictors	Model 1		Model 2			Model 3		
	B (95% CI)	*P*	B (95% CI)	β	*P*	B (95% CI)	β	*P*
Intercept	4.50 (4.37 to 4.64)	<0.001	4.37 (4.20 to 0.53)		<0.001	4.39 (4.22 to 4.57)		<0.001
Gender (female)	0.24 (0.19 to 0.30)	**<0.001**	0.28 (0.22 to 0.33)	**0.26**	**<0.001**	0.27 (0.22 to 0.33)	**0.26**	**<0.001**
SES	0.08 (0.04 to 0.12)	**<0.001**	0.07 (0.03 to 0.10)	**0.09**	**<0.001**	0.07 (0.03 to 10)	**0.09**	**<0.001**
Stress events (=1)	−0.00 (−0.07 to 0.07)	0.997	0.02 (−0.04 to 0.09)	0.02	0.510	0.02 (−0.04 to 0.08)	0.02	0.488
Stress events (≥ 2)	−0.12 (−0.19 to −0.05)	**<0.001**	−0.06 (−0.13 to 0.01)	−0.05	0.070	−0.07 (−0.13 to 0.00)	−0.05	0.061
BMI (underweight)	−0.03 (−0.02 to 0.09)	0.638	−0.08 (−0.20 to 0.05)	−0.03	0.229	−0.08 (−0.20 to 0.05)	−0.03	0.224
BMI (overweight)	−0.10 (−0.17 to −0.03)	**0.004**	−0.07 (−0.14 to −0.01)	**−0.05**	**0.032**	−0.08 (−0.15 to −0.01)	**−0.06**	**0.023**
BMI (obese)	−0.18 (−0.34 to −0.02)	**0.029**	−0.11 (−0.27 to 0.05)	−0.03	0.172	−0.11 (−0.27 to 0.05)	−0.03	0.193
Recommendations met (ref = 0 "not met")								
Screen time (<2 h/day)			0.13 (0.06 to 0.20)	**0.105**	**<0.001**			
MVPA (≥60 min/day)			0.10 (0.04 to 0.16)	**0.09**	**<0.001**			
Sleep (≥8 h 30 m/night)			0.05 (−0.01 to 0.10)	0.04	0.104			
MMI (ref = "0")								
With 1 other media			0.02 (−0.07 to 0.10)	0.01	0.717	0.02 (−0.06 to 0.11)	0.02	0.601
With 2 other media			−0.13 (−0.21 to −0.03)	−0.12	**0.006**	−0.11 (−0.20 to −02)	**−0.11**	**0.012**
With 3 other media			−0.16 (−0.28 to −0.04)	−0.09	**0.006**	−0.15 (−0.27 to −03)	**−0.09**	**0.012**
With 4 other media			−0.23 (−0.42 to −0.04)	−0.06	**0.019**	−0.20 (−0.39 to −01)	**−0.06**	**0.035**
Recommendations met (ref = "none")								
MVPA only						0.11 (−0.01 to 0.24)	0.06	0.090
Sleep only						−0.13 (−0.33 to 0.07)	−0.04	0.200
Screen time only						0.02 (−0.10 to 0.15)	0.02	0.704
MVPA + screen time						0.20 (0.08 to 0.32)	**0.15**	**<0.001**
MVPA + sleep						0.04 (−0.13 to 0.19)	0.01	0.670
Sleep + screen time						0.20 (0.07 to 0.33)	**0.13**	**0.001**
All met						0.24 (0.13 to 0.36)	**0.21**	**<0.001**
Explained variance								
R^2	0.135		0.182			0.192		
R^2 change (ref: Model 1)			<0.001			<0.001		

CI, confidence interval; BMI, body mass index; MVPA, moderate-to-vigorous physical activity; SES, socio-economic status.
Results of the hierarchical regression analyses: Model 1 includes covariates only; Model 2 includes if a recommendation is met and multitasking as additional predictors; Model 3 includes more information about the combination of recommendations met and multitasking as additional predictors.

already underlined that factors promoting a sedentary lifestyle, including overweight, are not beneficial for cognitive development.[32] However, future studies should also consider the additional effect of stressful life events: during the developmental years, the brain is still very plastic and thus able to recover from traumatic events when adolescents are guided appropriately. For example, the negative influence of stress may be mitigated by a healthy lifestyle and social support.[36]

Beyond the specific context of academic achievement, the results of this study are also in line with other studies focusing on mental health,[37] internalising and externalising problem behaviours[38] and psychosocial health.[39] In a systematic review of 13 studies,[37] meeting the recommendations for screen time and sleep was associated with mental health (especially lower levels of depressive symptoms), although this association was stronger than the one with meeting the recommendations for MVPA. In addition, meeting recommendations for screen time and sleep, but not MVPA, was associated with a diminished prevalence of internalising and externalising symptoms.[38] Sleep duration and screen time were strongly associated with social behaviour and psychosocial health.[39] In addition, sleep disturbance has been related to higher levels of both internalising and externalising psychopathology in adolescents.[40] However, more studies on the role of meeting recommendations of (un)healthy behaviours on youth well-being are needed, and future research should consider the differential effects of guidelines on cognitive, physical and psychological well-being, making use of longitudinal data.

Some limitations to this study should be acknowledged. First, self-report data are at risk of recall and estimation bias, especially when different reference periods (e.g. 'weekday', 'weekend day', 'typical day' and 'yesterday') are used, which cannot be controlled for in the analyses. Second, although self-report measures were collected in spring and end-term grades in summer, at the end of the school year, this study offers only limited possibilities to conclude on causality. Hence, longitudinal data should be included in the future to replicate our results. Third, the present study only considered school grades as an indicator of academic achievement, but grading can be biased by teacher characteristics. Standard assessment tools would overcome this bias and generate results that are also more easily comparable across countries.

Author statements

Ethical approval

Ethical review and approval were not required for the study on human participants in accordance with the local legislation and institutional requirements. However, the regional education administration approved this study design. Written informed consent from participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements. However, consent was implied via the completion of the questionnaire.

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Competing interests

None declared.

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