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Influence of Sedentary Behavior on School Engagement Among Youth Aged 10 to 18 in Southern Spain

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Abstract: The increasing prevalence of sedentary behavior among adolescents raises concerns about its impact on academic engagement. This study examines the association between negative and positive sedentary behavior and behavioral, emotional, and cognitive school engagement in adolescents. A total of 270 students aged 10 to 18 from southern Spain participated. Sedentary behavior was assessed via self-report, and school engagement was measured using the School Engagement Measure (SEM). ANCOVA and binary logistic regression were applied, adjusting for age, BMI, and maternal education level. The findings indicate that low negative sedentary behavior is associated with higher cognitive engagement ($p = 0.009$), while high positive sedentary behavior correlates with greater behavioral ($p = 0.018$) and cognitive engagement ($p = 0.008$). Moreover, high negative sedentary behavior more than doubles the risk of low cognitive engagement, and low positive sedentary behavior significantly increases the likelihood of low behavioral and cognitive engagement. These results suggest that while some sedentary behaviors may hinder academic engagement, structured activities like reading and studying can positively contribute to school performance. Encouraging active learning strategies, structured study habits, and responsible screen use may help to maximize school engagement. Future research should explore longitudinal effects and intervention strategies to optimize adolescent learning and well-being.

Keywords: adolescents; cognitive engagement; school engagement; screen time; sedentary behavior

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1. Introduction

Sedentary behavior has become increasingly prevalent in modern society, particularly among young people [1]. It is generally defined as engaging in activities that require minimal energy expenditure, often associated with screen use, prolonged reading, or extended study periods in static positions [2,3]. A recent systematic review has expanded this definition to include unhealthy dietary habits, low levels of physical activity, and excessive screen time [4]. Given the increasing integration of digital technology in both academic and recreational settings, understanding the impact of different types of sedentary behavior on adolescents' learning processes and school engagement has become a pressing issue [5,6].

Traditionally, sedentary behavior has been linked to negative physical and mental health outcomes [7]. However, in contemporary academic and professional environments, prolonged sedentary time has become nearly unavoidable. For this reason, recent research emphasizes the need to differentiate between various forms of sedentary behavior [8].

Negative sedentary behavior includes passive activities, such as excessive digital content consumption without interaction or prolonged inactivity, which have been associated with adverse cognitive and emotional effects when exceeding the recommended limits [9]. In Spain, more than 65% of children and adolescents aged 10 to 15 own a mobile phone [10], leading to increased screen exposure. In response, the World Health Organization (WHO) recommends avoiding screen exposure for children under 2 years old, limiting it to one hour per day for those aged 2 to 4, and restricting it to a maximum of three hours for individuals aged 5 to 17 [11,12]. Conversely, positive sedentary behavior refers to cognitively engaging activities that provide academic and personal benefits, such as reading, practicing music, or completing school assignments [13]. However, excessive engagement in academic tasks, particularly when perceived as obligatory, can lead to cognitive overload, reduced motivation, and emotional distress, especially when the effort does not translate into expected academic outcomes [13]. Nevertheless, a certain level of study dedication is essential in modern education. Research suggests that adolescents who dedicate at least one hour per day to academic tasks, whether involving screen use or not, tend to achieve better academic outcomes than those who study less [14].

Excessive recreational screen use has been linked to increased stress, anxiety, and mental fatigue, which in turn impairs concentration and information processing [15–17]. Additionally, prolonged exposure to electronic devices without an educational purpose can reduce self-regulation in learning and decrease academic motivation, hindering the development of effective study habits [18]. Furthermore, while negative sedentary behavior can be detrimental, an unbalanced dedication to positive sedentary activities can also lead to demotivation and cognitive exhaustion, ultimately affecting students' engagement with their learning process [13,19].

In this context, school engagement emerges as a crucial factor influencing students' persistence and academic success [20]. It is a multidimensional construct comprising three interrelated dimensions [21,22]: (1) behavioral engagement, reflected in class attendance, the completion of assignments, and adherence to school norms [18,23]; (2) emotional engagement, associated with students' sense of belonging within the school environment and the quality of their interpersonal relationships with teachers and peers, which significantly influence academic motivation and overall well-being [24,25]; and (3) cognitive engagement, involving intellectual effort, the use of metacognitive strategies, and the ability to approach academic challenges autonomously and flexibly [18,26].

Both positive and negative sedentary behaviors could influence school engagement in distinct ways. While excessive engagement in negative sedentary activities has been linked to lower academic motivation, concentration difficulties, and decreased academic achievement [16,27,28], positive sedentary behavior, such as reading or completing a school assignment, can foster cognitive development and self-regulated learning [13]. However, excessive engagement in even beneficial sedentary activities may lead to mental fatigue and negatively impact students' emotional well-being [13]. Furthermore, school engagement is influenced by various sociodemographic and individual factors. Previous studies have found that age and body mass index (BMI) are associated with school engagement, potentially affecting students' academic participation and motivation [29]. Additionally, maternal education level has been linked to children's attitudes toward school and academic performance, as parents with higher education levels tend to provide greater academic support and a more stimulating learning environment [30,31].

Despite increasing concerns about the effects of sedentary behavior on education, a significant gap remains in the literature regarding the distinct contributions of positive and negative sedentary activities to school engagement [32]. Understanding how these two forms of sedentary behavior differentially influence behavioral, emotional, and cognitive

engagement remains an open question [33,34]. Therefore, this study aims to analyze the association between positive and negative sedentary behavior and school engagement (behavioral, emotional, and cognitive) in adolescents. It is hypothesized that lower levels of negative sedentary behavior and higher levels of positive sedentary behavior will be associated with greater school engagement across all three dimensions.

2. Materials and Methods

2.1. Design and Sample

This study employed a cross-sectional and correlational design. It included 270 students (130 boys and 140 girls), aged 10 to 18 years (13.37 ± 1.67), enrolled in primary and secondary schools across different provinces in southern Spain. The educational centers were chosen based on their accessibility and willingness to participate, following a convenience sampling approach. Within each center, participants were recruited through a random selection of intact classroom groups. The body mass index (BMI) was 21.03 ± 3.84 kg/m^2 for boys and 20.94 ± 4.53 kg/m^2 for girls. Anthropometric characteristics (age, weight, height, and BMI), sociodemographic factors (maternal education level), independent variables (negative and positive sedentary behavior), and the dependent variable (behavioral, emotional, and cognitive engagement) are detailed in Table 1.

Table 1. Anthropometric; sociodemographic; negative and positive sedentary behavior; and behavioral, emotional, and cognitive engagement characteristics of participants, overall and by sex.

	All (*n* = 270)		**Boys (*n* = 130)**		**Girls (*n* = 140)**		
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	***p***
Age (years)	13.37	1.67	13.44	1.68	13.30	1.68	0.528
Weight (kg)	54.00	13.69	56.19	14.27	51.96	12.86	0.001
Height (m)	1.59	0.09	1.63	0.11	1.57	0.07	<0.001
BMI (kg/m^2)	20.98	4.20	21.03	3.84	20.94	4.53	0.802
Mother's level of education (%)							
No education	2.35%		2.42%		2.28%		
Primary	6.81%		6.76%		6.85%		0.695
Secondary	12.91%		11.59%		14.16%		
Vocational training	13.38%		13.04%		13.70%		
University	42.72%		40.58%		44.75%		
Don't know	21.36%		24.64%		18.26%		
Negative sedentary behavior	162.20	88.04	162.98	84.37	161.44	91.61	0.556
Positive sedentary behavior	89.45	46.68	84.42	47.59	94.10	45.45	0.336
Behavioral engagement	4.21	0.68	4.12	0.74	4.30	0.60	0.031
Emotional engagement	3.62	0.94	3.57	0.94	3.66	0.93	0.663
Cognitive engagement	3.07	0.74	2.96	0.72	3.18	0.74	0.640

Notes. Mean values (M); frequency (%); BMI = body mass index (kg/m^2); standard deviation (SD).

2.2. Measures

2.2.1. Dependent Variables: School Engagement

The School Engagement Measure (SEM) questionnaire was used to assess school engagement. This instrument consists of 19 items distributed across three dimensions: behavioral engagement (four items), emotional engagement (five items), and cognitive

engagement (eight items). Responses were recorded using a 5-point Likert scale, ranging from 1 = never, 2 = almost never, 3 = sometimes, 4 = often, to 5 = always. Higher scores in these subscales indicate greater involvement in school-related activities, such as active participation in learning tasks (behavioral engagement), stronger emotional connections with teachers and peers (emotional engagement), and higher levels of cognitive investment in academic tasks (cognitive engagement). Conversely, lower scores reflect disengagement, such as passive classroom behavior, lack of motivation, or emotional detachment from the learning environment [25]. The psychometric properties of the SEM questionnaire showed acceptable internal consistency indices (α = 0.81 for emotional engagement, α = 0.74 for behavioral engagement, and α = 0.77 for cognitive engagement) [25].

2.2.2. Independent Variables: Time Spent in Sedentary Behavior

A self-reported questionnaire was used to assess the sedentary time, offering a detailed overview of participants' daily behavior. The questionnaire consisted of three items for each day of the week, requiring participants to report the number of minutes dedicated to: (1) recreational screen time (e.g., watching TV, playing video games, or using electronic devices for entertainment); (2) academic screen time (e.g., using a computer, tablet, or mobile phone for studying, homework, or tutoring); and (3) non-screen-based academic activities (e.g., studying, doing homework, or attending tutoring without using any electronic devices). Participants reported their screen and study time separately for weekdays and weekends. A custom ad hoc questionnaire was chosen instead of a validated measure to obtain specific and detailed information on sedentary behavior, particularly to distinguish between positive sedentary behavior (academic tasks) and negative sedentary behavior (recreational screen use), following the previous categorization criteria [9,13]. Although this instrument has not undergone a formal psychometric validation, similar question formats and cutoff criteria have been used in prior research with satisfactory results in identifying behavioral patterns related to sedentary lifestyles [8,9,14].

Additionally, this classification allows adolescents to be categorized into low or high sedentary behavior groups based on the time spent on each activity. Low negative sedentary behavior was defined as $\leq$3 h of recreational screen time per day, while high negative sedentary behavior exceeded this threshold. Similarly, low positive sedentary behavior corresponded to $\leq$1 h of academic tasks (with or without screens), whereas more than 1 h per day was classified as high positive sedentary behavior. These cutoffs were based on prior research linking excessive sedentary time to lower academic engagement and cognitive performance [8,9], while the 1-h homework threshold aligns with recommendations supporting its benefits for academic achievement and cognitive development [14].

Furthermore, this questionnaire is adapted to participants' daily schedules, ensuring a more representative assessment of their daily routines. Its flexible design allows for a more precise evaluation of the impact of sedentary time, considering school schedules and the differences between weekdays and weekends, a factor that is often overlooked in standardized instruments.

2.2.3. Confounding Variables: Age, Maternal Education Level, and BMI

Age and maternal education level were recorded using a sociodemographic questionnaire. Age was included as a covariate because cognitive, emotional, and behavioral development vary significantly throughout adolescence, influencing both engagement in learning strategies and participation in physical activity [35]. Maternal education level was also recorded, as higher maternal education has been associated with more positive attitudes toward school, a better academic performance, and greater support for structured learning environments [30].

Finally, body mass index (BMI) was calculated using Quetelet's formula: weight (kg)/height^2 (m) and was considered a covariate due to its potential influence on energy levels, fatigue, and overall physical well-being, which may affect both physical activity participation and cognitive performance. Weight and height measurements were obtained using a digital scale (ASIMED® Type B, Class III) and a portable stadiometer (SECA® 214, SECA Ltd., Hamburg, Germany). All the measurements were conducted with participants wearing light clothing and no footwear.

2.3. Procedure

The data collection was conducted during the 2022/2023 academic year. The purpose and nature of the study were communicated both verbally and in writing to students, parents, and legal guardians. Authorization was obtained from the school administration, physical education teachers, and all the legal guardians of the study participants. To ensure anonymity and confidentiality, participants' names were coded. Each student completed a sociodemographic questionnaire, as well as surveys on school engagement and sedentary behavior. Approximately 30 min were allocated for completing these questionnaires. During this time, participants were called individually to have their weight and height measured. A trained researcher provided instructions and supervised the process, while two research assistants addressed any questions and managed potential disruptions (e.g., ensuring privacy during responses, minimizing external noise, troubleshooting electronic devices, or resolving internet connectivity issues).

This study was approved by the Bioethics Committee of the University of Jaén (Spain) under reference NOV.22/2.PRY. The study design adhered to current Spanish legal regulations governing clinical research in humans (Royal Decree 561/1993 on clinical trials), as well as the fundamental principles established in the Declaration of Helsinki (2013, Brazil).

2.4. Statistical Analysis

The comparison of continuous and categorical variables for all students, as well as between boys and girls, was conducted using Student's *t*-tests and χ^2 tests, respectively. Normality and homoscedasticity were verified using the Kolmogorov–Smirnov and Levene's tests. An analysis of covariance (ANCOVA) was performed to examine the potential differences in behavioral, emotional, and cognitive engagement between adolescents with low negative sedentary behavior ($\leq$3 h per day of recreational screen time) and low positive sedentary behavior ($\leq$1 h per day of homework with or without screens) and those with high negative sedentary behavior (>3 h of recreational screen time) and high positive sedentary behavior (>1 h per day of homework with or without screens) [9,13]. These cutoff points were based on research associating excessive sedentary time with lower academic performance, while the 1-h homework threshold aligns with the recommendations for improving academic achievement [8,9,14]. Each school engagement dimension was used as a dependent variable, while negative and positive sedentary behavior were included as fixed factors. To examine the risk of low school engagement based on scores from the School Engagement Measure (SEM), multiple binary logistic regression analyses were conducted. Negative sedentary behavior was categorized as low (0) and high (1), and positive sedentary behavior was categorized as low (1) and high (0), following the criteria of Brug et al. [9] and Jerrim et al. [13]. The different school engagement factors (behavioral, emotional, and cognitive) were classified as low engagement (1) and high engagement (0) using the median as a reference [36,37]. Age, BMI, and maternal education level were included as covariates in all the analyses. A confidence level of 95% ($p < 0.05$) was used for all the statistical tests. All the calculations were performed using the SPSS statistical software, version 25.0 for Windows (IBM Corp., Armonk, New York, NY, USA).

3. Results

3.1. Analysis of Covariance Between Negative Sedentary Behavior and Behavioral, Emotional, and Cognitive Engagement

The ANCOVA results highlighting the differences between low and high negative sedentary behavior in relation to behavioral, emotional, and cognitive engagement are shown in Figure 1. The findings revealed that adolescents with low negative sedentary behavior exhibited significantly higher cognitive engagement than those with high negative sedentary behavior (3.18 ± 0.76 vs. 2.87 ± 0.66 a.u.; $p = 0.009$). However, no significant differences were found between groups regarding behavioral engagement (4.26 ± 0.68 vs. 4.14 ± 0.67 a.u.; $p = 0.254$) or emotional engagement (3.67 ± 0.97 vs. 3.51 ± 0.90 a.u.; $p = 0.569$).

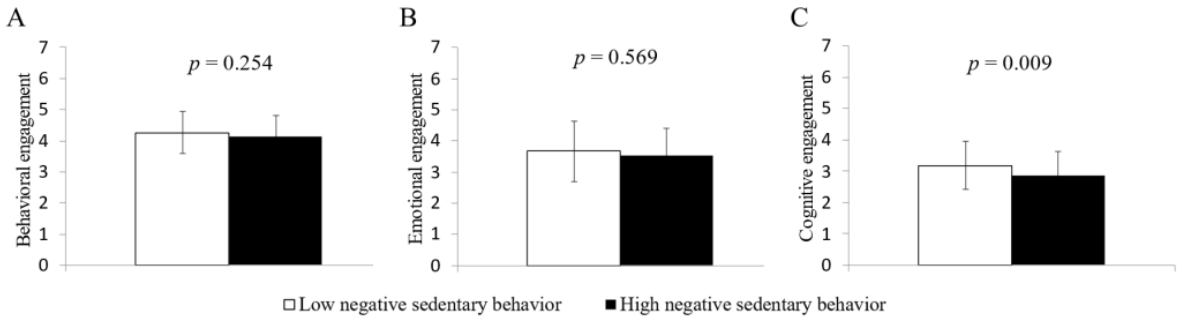

Figure 1. ANCOVA analysis comparing adolescents with low negative sedentary behavior (≤3 h of daily recreational screen time) vs. high negative sedentary behavior (>3 h of daily recreational screen time) in relation to (**A**) behavioral engagement, (**B**) emotional engagement, and (**C**) cognitive engagement.

3.2. Analysis of Covariance Between Positive Sedentary Behavior and Behavioral, Emotional, and Cognitive Engagement

The ANCOVA results highlighting the differences between low and high positive sedentary behavior in relation to behavioral, emotional, and cognitive engagement are shown in Figure 2. The findings revealed that adolescents with high positive sedentary behavior exhibited significantly higher behavioral engagement (4.28 ± 0.65 vs. 4.10 ± 0.66 a.u.; $p = 0.018$) and cognitive engagement (3.15 ± 0.74 vs. 2.89 ± 0.70 a.u.; $p = 0.008$) than those with low positive sedentary behavior. However, no significant differences were found between the groups in emotional engagement (3.68 ± 0.91 vs. 3.48 ± 0.98 a.u.; $p = 0.096$).

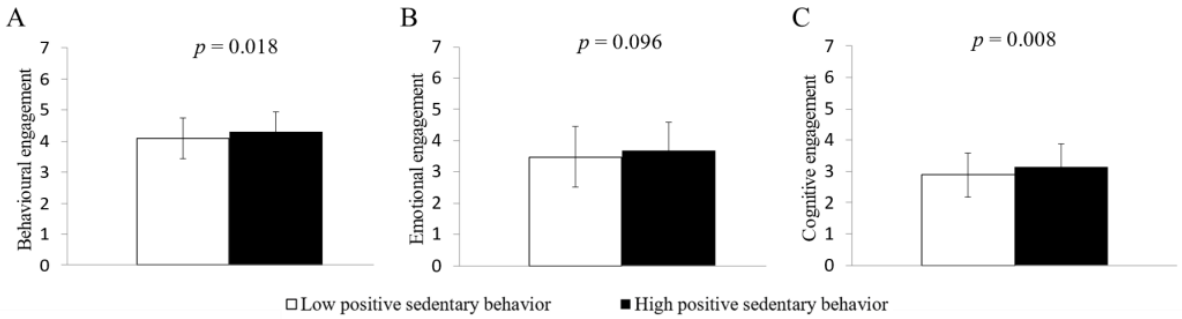

Figure 2. ANCOVA analysis comparing adolescents with low positive sedentary behavior (≤1 h of daily homework with or without screen use) vs. high positive sedentary behavior (>1 h of daily homework with or without screen use) in relation to (**A**) behavioral engagement, (**B**) emotional engagement, and (**C**) cognitive engagement.

3.3. Binary Logistic Regression Analysis Between Negative and Positive Sedentary Behavior and Behavioral, Emotional, and Cognitive Engagement

The data illustrating the risk of low school engagement associated with negative and positive sedentary behavior are presented in Table 2. Adolescents with high negative sedentary behavior were 2.37 times more likely to exhibit low cognitive engagement compared with their peers with low negative sedentary behavior (OR = 2.366; $p = 0.002$). No significant risks were found for behavioral or emotional engagement ($p > 0.05$). In contrast, adolescents with low positive sedentary behavior were 2.41 times more likely to have low behavioral engagement (OR = 2.409; $p = 0.007$) and 2.94 times more likely to have low cognitive engagement (OR = 2.986; $p < 0.001$) compared with those with high positive sedentary behavior. No significant risks were found for emotional engagement ($p > 0.05$).

Table 2. Binary logistic regression for negative and positive sedentary behavior (low vs. high) according to the categorized indicators (high vs. low) of behavioral, emotional, and cognitive engagement in adolescents.

		Behavioral Engagement				Emotional Engagement				Cognitive Engagement			
		n	***P***	**OR**	**95% CI**	***n***	***p***	**OR**	**95% CI**	***n***	***p***	**OR**	**95% CI**
Negative sedentary behavior	High engagement	228		1	Referent	154		1	Referent	84		1	Referent
	Low engagement	42	0.168	1.505	0.841–2.693	107	0.175	1.466	0.844–2.547	170	0.002	2.366	1.357–4.125
Positive sedentary behavior	High engagement	228		1	Referent	154		1	Referent	84		1	Referent
	Low engagement	42	0.007	2.409	1.268–4.576	107	0.679	1.129	0.636–2.006	170	<0.001	2.986	1.627–5.481

Notes. OR: odds ratio, CI: confidence interval. OR was adjusted for age, BMI (body mass index), maternal education, and weekly physical activity.

4. Discussion

This study aimed to analyze the association between negative and positive sedentary behavior and behavioral, emotional, and cognitive school engagement in adolescents. The main findings indicate that low negative sedentary behavior is associated with higher cognitive engagement, suggesting that reduced exposure to passive screen use and prolonged inactivity may benefit students' intellectual involvement in learning. Additionally, adolescents with high positive sedentary behavior exhibited significantly greater behavioral and cognitive engagement, reinforcing the idea that structured academic activities, such as reading and school assignments, contribute to student participation and deep learning. Conversely, low positive sedentary behavior was linked to a higher risk of low behavioral and cognitive engagement, while high negative sedentary behavior more than doubled the likelihood of experiencing low cognitive engagement.

These findings align with previous research indicating that educational technology use and structured study time enhance student engagement and academic performance [13,38]. However, excessive engagement in negative sedentary behavior, particularly recreational screen use, has been consistently linked to lower academic motivation, difficulties in concentration, and decreased school engagement [16,27,28]. Previous studies have shown that prolonged sedentary behavior, especially when it involves recreational screen time, not only diminishes academic engagement but also negatively affects executive functioning and students' self-regulation capacity [39,40]. Our results further support this association, as we found that high negative sedentary behavior is linked to lower cognitive engagement. Consistent with these findings, previous studies have shown that students who spend prolonged periods engaged in passive screen-based activities tend to exhibit weak time management skills and poor attention regulation, which may interfere with the develop-

ment of effective study habits [41]. Additionally, the overuse of recreational digital media can lead to cognitive overload and mental fatigue, further reducing students' ability to sustain effort in academically demanding tasks [42].

A possible explanation for these findings is the immediate gratification mechanisms associated with digital entertainment, which can undermine students' self-discipline and persistence in long-term academic activities [43]. Prior research has suggested that recreational screen exposure negatively impacts executive function and working memory, impairing students' ability to process and retain information effectively [44]. In line with this, research has indicated that increased sedentary time is associated with the reduced activation of neural networks involved in sustained attention and planning, which may help to explain the link between negative sedentary behavior and lower academic engagement [44,45]. Additionally, excessive negative sedentary behavior has been linked to increased procrastination tendencies and poorer time management, further weakening school engagement and academic performance [46]. Beyond cognitive effects, prolonged recreational screen use has been associated with a decline in the intrinsic motivation for learning, as the instant gratification of digital media can reduce students' willingness to engage in effortful academic tasks [47].

In contrast, positive sedentary behavior fosters structured study habits, promoting self-regulation and academic efficacy, which may counterbalance the detrimental effects of negative sedentary behavior [48]. Adolescents who engage in academic tasks with a structured approach tend to develop better self-discipline and perseverance, key factors for long-term academic success [49]. Thus, these findings underscore the importance of balancing screen time and structured learning activities to maximize cognitive engagement and academic performance. Our study shows that students who spend more time engaged in positive sedentary activities, such as reading and completing school assignments, exhibit higher levels of school engagement, particularly in the behavioral and cognitive dimensions [8,13]. This suggests that structured academic activities promote better time management, enhanced learning strategies, and increased motivation, all of which contribute to a higher degree of academic involvement [50]. These findings contrast with the effects of negative sedentary behavior, which has been linked to reduced motivation, lower interest, and decreased concentration in academic activities [51].

Our results align with the previous research by Arán-Filippetti et al. [52] and Sagredo [53], who found that students with better self-regulation in their study time exhibit greater engagement and academic performance. The association between positive sedentary behavior and academic success is largely explained by the development of cognitive skills, such as planning and organization, which are fundamental for school achievement [54]. Engaging in structured learning activities encourages greater perseverance, goal-setting, and academic discipline, fostering an environment where students are more likely to stay engaged and perform better in school [55,56]. Therefore, positive sedentary behavior can act as a protective factor for school engagement, helping students to develop effective study habits that enhance cognitive and behavioral engagement [57,58]. In contrast, negative sedentary behavior may serve as a disruptive element, impairing attention, self-regulation, and sustained academic effort [43].

While sedentary behavior increases with age, our findings highlight the need to regulate screen use among adolescents to enhance school engagement and academic performance [8,21]. Schools and families should promote structured academic activities while limiting excessive recreational screen time, integrating active learning strategies that foster student participation [59]. Additionally, raising awareness among parents and educators about effective study habits and responsible technology use could help students to develop better self-regulation skills. Future research should explore the long-term trends in

sedentary behavior and engagement to guide more effective interventions. Encouraging a balanced approach to sedentary time, prioritizing cognitive engagement over passive screen use, can foster better learning outcomes and overall well-being in adolescents.

Limitations and Strengths

This study presents certain methodological and procedural limitations that should be acknowledged. First, the cross-sectional nature of the design does not allow for causal relationships to be established, restricting the interpretation of the results to associations between variables. In addition, the quality of the data depends on the honesty with which the participants responded to the implemented measures, with the possibility that some provided answers aimed at projecting a favorable self-image. Another relevant limitation lies in the sample selection process, which was conducted based on convenience sampling, preventing the results from being generalized to the entire Spanish population. Nevertheless, this study also possesses significant methodological strengths. Among them, the differentiation between negative and positive sedentary behavior stands out as a novel contribution among studies of this nature. Additionally, the use of coding techniques ensured participant anonymity and confidentiality, promoting truthful responses. Moreover, highly reliable and internally valid measurement instruments were employed, reinforcing the robustness of the obtained data. Lastly, the inclusion of a broad set of covariates (such as age, body mass index, and maternal educational level) provides a novel approach and enriches the findings, offering unique insights in the field of education.

5. Conclusions

This study highlights the differential impact of sedentary behavior on school engagement among adolescents, emphasizing the importance of distinguishing between negative and positive sedentary activities. Our findings indicate that high negative sedentary behavior is associated with lower cognitive engagement, suggesting that excessive recreational screen time may interfere with students' ability to concentrate and process information effectively. Conversely, high positive sedentary behavior correlates with increased behavioral and cognitive engagement, reinforcing the role of structured academic activities in fostering self-regulated learning and motivation. Additionally, adolescents with high negative sedentary behavior were over twice as likely to exhibit low cognitive engagement, while those with low positive sedentary behavior had a significantly higher risk of low behavioral and cognitive engagement.

Given the rising prevalence of sedentary lifestyles among the youth, interventions should focus on reducing passive screen use while promoting structured academic activities. Schools can integrate active learning strategies and balanced technology use, while families play a crucial role in encouraging structured study habits and setting appropriate screen time limits. Future research should explore longitudinal trends and moderating factors to better understand the long-term effects of sedentary behavior on academic outcomes. Ultimately, fostering a balanced approach to sedentary time can enhance school engagement, academic performance, and overall cognitive development in adolescents.

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