REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

ATIVIDADE FÍSICA AUTORREFERIDA E INDICADORES DE CONTROLE INIBITÓRIO DERIVADOS DO STROOP EM ADOLESCENTES: ESTUDO TRANSVERSAL

SELF-REPORTED PHYSICAL ACTIVITY AND STROOP-DERIVED INHIBITORY CONTROL INDICATORS IN ADOLESCENTS: A CROSS-SECTIONAL STUDY

ACTIVIDAD FÍSICA AUTOINFORMADA E INDICADORES DE CONTROL INHIBITORIO DERIVADOS DEL STROOP EN ADOLESCENTES: ESTUDIO TRANSVERSAL

Kaio Fábio de Arruda Freitas
Bachelor of Physical Education, State University of Rio Grande do Norte, Brazil
freitas.kaio.br@gmail.com
Thalyta Shirley Queiroz
Bachelor of Physical Education, State University of Rio Grande do Norte, Brazil
thalytashirley@live.com
Lucas da Cunha Dantas
Master's student of Physical Education, State University of Londrina, Brazil
br.lucasdantas@gmail.com
Victor Gabriel Rozendo da Cunha
Bachelor of Physical Education, State University of Rio Grande do Norte, Brazil
victorgabs0022@gmail.com
Wallace Marrone Rocha dos Reis
Undergraduate student in Physical Education, State University of Rio Grande do Norte, Brazil
wallacereiisll@gmail.com
João Neiviton Fernandes Vasconcelos
Undergraduate student in Physical Education, State University of Rio Grande do Norte, Brazil
joaoneiviton23@gmail.com

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Victor Gabriel da Silva Martins

Undergraduate student in Physical Education, State University of Rio Grande do Norte, Brazil

victorgbiell@hotmail.com

Gleidson Mendes Rebouças

PhD in Neuroscience, Federal University of Rio Grande do Norte, Brazil

gleidsonreboucas@uern.br

Abstract

Background: Although physical activity has generally been associated with executive functioning during adolescence, evidence regarding its specific association with inhibitory control remains inconsistent. Differences in the specificity of physical activity and cognitive measures may partly explain these mixed findings. **Objective:** This study investigated the association between habitual physical activity and Stroop-derived inhibitory control indicators and examined whether a global self-reported physical activity index is sufficiently sensitive to explain individual variability in interference control during adolescence.
Methods: A cross-sectional study was conducted with 110 adolescents aged 14-17 years. Habitual physical activity was assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A), and inhibitory control was evaluated using a computerized Stroop Color-Word Interference Test. The primary outcome was absolute response-time interference using the Color Naming condition as the baseline. Relative response-time interference was treated as a secondary outcome, and inverse efficiency in the incongruent condition was treated as a complementary accuracy-adjusted outcome. Data were analyzed using descriptive statistics, exploratory sex-based comparisons, Pearson correlations, adjusted linear regression models, and sensitivity analyses. **Results:** The PAQ-A global score showed no evidence of statistically significant linear associations with absolute response-time interference ($r = 0.010$, $p = .914$), relative response-time interference ($r = -0.004$, $p = .964$), or inverse efficiency in the incongruent condition ($r = -0.067$, $p = .487$). This pattern remained consistent after adjustment for sex, age, weighted average screen time, sleep/fatigue indicators, and physical exercise outside school, as well as across sensitivity analyses. **Conclusions:** Self-reported habitual physical activity showed no evidence of a statistically detectable linear association with Stroop-based inhibitory control performance in this sample of adolescents. These findings suggest that global measures of habitual physical activity may have limited sensitivity for explaining individual differences in specific executive-function outcomes. Future studies should use longitudinal designs, objective physical activity measures, and multidimensional assessments of executive functioning.
Keywords: Neuropsychological tests; Exercise; Adolescent Health; Executive Function.

Resumen

Antecedentes: Aunque la actividad física es ampliamente reconocida como un factor potencialmente relacionado con el desarrollo cognitivo durante la adolescencia, la evidencia relativa a su asociación con el control inhibitorio continúa siendo heterogénea e inconsistente. Las divergencias observadas en la literatura podrían atribuirse, al menos en parte, a diferencias en la especificidad y sensibilidad de las medidas empleadas para evaluar tanto la actividad física como los procesos cognitivos. **Objetivo**: El presente estudio tuvo como propósito investigar la asociación entre la actividad física habitual y el control inhibitorio evaluado mediante indicadores derivados de la prueba de Stroop, así como examinar si un índice global de actividad física autoinformada posee suficiente sensibilidad para explicar la variabilidad individual en el control de la interferencia durante la adolescencia. **Métodos:** Se llevó a cabo un estudio transversal con 110 adolescentes de entre 14 y 17 años. La actividad física habitual fue evaluada mediante el Physical Activity Questionnaire for Adolescents (PAQ-A), mientras que el control inhibitorio se valoró mediante una versión

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

computarizada de la prueba Stroop Color–Word Interference. El desenlace primario fue la interferencia absoluta en el tiempo de respuesta utilizando la condición de denominación de colores como línea de base. La interferencia relativa en el tiempo de respuesta fue tratada como desenlace secundario, y la eficiencia inversa en la condición incongruente fue tratada como desenlace complementario ajustado por precisión. Los datos fueron analizados mediante estadística descriptiva, comparaciones exploratorias por sexo, correlaciones de Pearson, modelos lineales ajustados y análisis de sensibilidad. **Resultados:** La puntuación global del PAQ-A no proporcionó evidencia de asociaciones lineales estadísticamente significativas con la interferencia absoluta en el tiempo de respuesta (r = 0.010, p = .914), la interferencia relativa en el tiempo de respuesta (r = −0.004, p = .964) ni con la eficiencia inversa en la condición incongruente (r = −0.067, p = .487). Este patrón se mantuvo tras el ajuste por sexo, edad, tiempo promedio ponderado de pantalla, indicadores de sueño/fatiga y ejercicio físico fuera de la escuela, así como en los análisis de sensibilidad.
Conclusiones: La actividad física habitual autoinformada no proporcionó evidencia de una asociación lineal estadísticamente detectable con el desempeño en control inhibitorio evaluado mediante la prueba de Stroop en esta muestra de adolescentes. Estos hallazgos sugieren que las medidas globales de actividad física habitual podrían presentar una sensibilidad limitada para explicar diferencias individuales en resultados específicos de funcionamiento ejecutivo. Se recomienda que futuras investigaciones empleen diseños longitudinales, medidas objetivas de actividad física y evaluaciones multidimensionales de las funciones ejecutivas.
Palabras clave: pruebas neuropsicológicas; ejercicio físico; salud del adolescente; Función Ejecutiva.

Resumo
Introdução: Embora a atividade física seja amplamente reconhecida como um fator potencialmente favorável ao desenvolvimento das funções executivas durante a adolescência, as evidências relativas à sua associação com o controle inibitório permanecem inconclusivas e heterogêneas. Diferenças na especificidade das medidas empregadas para avaliar tanto a atividade física quanto os desfechos cognitivos podem contribuir para a inconsistência dos resultados observados na literatura. **Objetivo**: Investigar a associação entre a atividade física habitual e o controle inibitório avaliado por indicadores derivados do Teste de Stroop, bem como examinar se um índice global de atividade física autorrelatada apresenta sensibilidade suficiente para explicar a variabilidade individual no controle de interferência durante a adolescência. **Métodos**: Realizou-se um estudo transversal com 110 adolescentes de 14 a 17 anos. A atividade física habitual foi avaliada por meio do Physical Activity Questionnaire for Adolescents (PAQ-A), enquanto o controle inibitório foi mensurado por meio do teste computadorizado de Interferência Cor–Palavra de Stroop. O desfecho primário foi a interferência absoluta no tempo de resposta utilizando a condição de nomeação de cores como linha de base. A interferência relativa no tempo de resposta foi tratada como desfecho secundário, e a eficiência inversa na condição incongruente foi tratada como desfecho complementar ajustado pela acurácia. Os dados foram analisados por estatística descritiva, comparações exploratórias por sexo, correlações de Pearson, modelos lineares ajustados e análises de sensibilidade. **Resultados:** O escore global do PAQ-A não forneceu evidência de associações lineares estatisticamente significativas com a interferência absoluta no tempo de resposta (r = 0,010; p = 0,914), a interferência relativa no tempo de resposta (r = −0,004; p = 0,964) ou a eficiência inversa na condição incongruente (r = −0,067; p = 0,487). Esse padrão permaneceu após ajustes para sexo, idade, média ponderada de tempo de tela, indicadores de sono/fadiga e prática de exercício físico fora da escola, bem como nas análises de sensibilidade. **Conclusões:** A atividade física habitual autorrelatada não forneceu evidência de associação linear estatisticamente detectável com o desempenho em controle inibitório baseado no Teste de Stroop nesta amostra de adolescentes. Os achados sugerem que medidas globais de atividade física habitual podem apresentar sensibilidade limitada para explicar diferenças individuais em desfechos específicos das funções executivas. Estudos futuros devem privilegiar delineamentos longitudinais, medidas objetivas de atividade física e avaliações multidimensionais do funcionamento executivo.
Palavras-chave: Testes neuropsicológicos; Exercício físico; Saúde do adolescente; Função Executiva.

1. Introduction

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Adolescence is a period of intense biological, behavioral, and psychosocial change, marked by the progressive maturation of brain circuits that are critical for attention, self-regulation, and executive functions (TERVO-CLEMMENS *et al.*, 2023). These functions are essential for adaptive behavior, learning, and the maintenance of mental and physical health throughout adulthood (FERNANDES *et al.*, 2023). In this context, adolescence represents a critical window for the development of higher-order cognitive functions, particularly those associated with the prefrontal cortex, which supports planning, decision-making, and impulse control (PABLO-RÍOS *et al.*, 2024).

Among the instruments commonly used to assess inhibitory control, the Stroop Test is prominent because it is sensitive to attentional and executive processes, including the inhibition of cognitive interference and the suppression of irrelevant stimuli, while also reflecting processing speed, accuracy, and the ability to inhibit automatic responses (ICLOZAN; POP, 2024). Although the Stroop Test is widely used as a proxy for inhibitory control, increasing evidence indicates that Stroop performance reflects multiple overlapping cognitive processes, including processing speed, lexical access, selective attention, and response monitoring. Accordingly, associations between behavioral exposures and Stroop performance may depend strongly on how inhibitory control is operationalized (FORTE *et al.*, 2024; IDOWU; SZAMEITAT, 2023).

Habitual physical activity has been associated with better cognitive performance, and proposed mechanisms include cerebral perfusion, neuroplasticity, and neurochemical modulation, such as neurotransmitter release; these effects may be particularly relevant during adolescence, a critical period of brain maturation (FERNANDES *et al.*, 2023; SOUZA *et al.*, 2021; SUN *et al.*, 2022). Regular physical exercise has also been associated with better performance in higher-order cognitive domains, such as attentional control and cognitive flexibility, as reported in studies examining executive-function performance in adolescents (ALKHENAIZI *et al.*, 2025; PORFÍRIO *et al.*, 2025; FERNANDES JÚNIOR *et al.*, 2023).

However, a gap remains in the literature regarding the specificity of inhibitory-control assessment, as many studies address cognition globally and do not focus on the relationship between habitual physical activity and executive performance in adolescents (CABRAL *et al.*, 2021). This issue is compounded by the inconsistency of previous

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

findings, which may stem from differences in intervention designs, cognitive task demands, and measurement strategies (GONZÁLEZ-DEL-CASTILLO; BARBERO-ALCOCER, 2025). Most investigations do not thoroughly examine how different intensities and types of habitual physical activity are associated with inhibitory control in adolescents (SUN *et al.*, 2022). This lack of detail makes it difficult to identify which components are more consistently associated with cognitive performance and cognitive benefits in this population (KOJIĆ *et al.*, 2025; PÉREZ-ROMERO *et al.*, 2023).

Based on this rationale, the primary hypothesis of the present study was that higher self-reported physical activity levels, assessed using the PAQ-A global score, would be associated with lower Stroop interference, as indicated by lower absolute response-time interference, lower relative response-time interference, and lower inverse efficiency in the incongruent condition. The secondary hypothesis was that the PAQ-A global score would have limited explanatory capacity for specific Stroop-derived inhibitory-control outcomes, because a global self-reported score may not capture dimensions such as intensity, frequency, context, motor complexity, or cognitive demand. Therefore, the present study aimed to investigate the association between self-reported physical activity and Stroop-derived inhibitory-control indicators and to examine whether a global self-reported physical activity index is sufficiently sensitive to explain individual variability in interference control during adolescence.

2. Methods

2.1 Study design

A cross-sectional observational study was conducted with adolescents from a city in northeastern Brazil. Participant recruitment and data collection were conducted in 2025-2026, and all participants and their legal guardians provided informed consent before the initial assessments. This study was approved by a Research Ethics Committee under protocol CAAE: 84622124.1.0000.5294.

2.2 Participants

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

This cross-sectional observational study included 110 adolescents aged 14-17 years (56 boys and 54 girls), recruited from educational institutions in Mossoró, Rio Grande do Norte, Brazil, using a non-probability sampling approach. Sample size adequacy was assessed post hoc using G*Power software (version 3.1.9.7) (Verma; Verma, 2020) through a sensitivity analysis based on the primary association between the PAQ-A global score and Stroop Test-derived outcomes. For n = 110, α = 0.05, a two-tailed test, and 80% statistical power, the study had sufficient power to detect correlations of approximately r ≥ 0.26. For the adjusted linear models, considering one primary predictor tested, four total predictors, and the same α and power parameters, the analysis indicated a minimum detectable effect of $f^2 \approx 0.073$, equivalent to approximately 6.8% of additional explained variance. Therefore, the study was adequately powered to detect small-to-moderate associations but limited in its ability to detect very small effects, such as correlations between r = 0.10 and r = 0.20.

2.3 Measurements

After parents or legal guardians signed the informed consent form and adolescents signed the informed assent form, all participants completed the data collection procedures. Data collection took place in a reserved room within the school, without interference from other individuals. The researcher remained on site only to collect the questionnaires and respond to participant requests. Screen time and other socio-behavioral variables were obtained using an anamnesis-type questionnaire developed by the authors, consisting of open- and closed-ended questions.

Physical activity was assessed using the Physical Activity Questionnaire for Adolescents (PAQ-A), which measures physical activity performed during the previous seven days. Each item is scored on a scale from 1 (did not perform the activity) to 5 (performed the activity every day), and the responses are used to generate a global score. This global score ranges from 1 (very sedentary) to 5 (very active) (GUEDES; GUEDES, 2015).

Cognitive function was assessed using a computerized Stroop Color-Word Test.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Participants used a portable computer running TESTINPACS (Stroop Color-Word Interference Test) (CÓRDOVA *et al.*, 2008). Before the test began, the evaluator verified participants' familiarity with basic computer use, including keyboard and mouse handling, and asked about possible photosensitivity. If no condition that could prevent testing was reported, the evaluator proceeded with the assessment instructions.

The test involves two basic actions, Word Reading (WR) and Color Naming (CN), and is divided into three phases. In the first phase, participants respond according to the color of the rectangle displayed on the screen by selecting the word that names the rectangle color. In the second phase, the stimulus is a written color name, and the response options are color names displayed in white; participants must select the word corresponding to the written stimulus. In the third phase, the stimulus is a color name presented in an incongruent ink color, and the response options are color names displayed in white. In this phase, participants must select the response corresponding to the ink color of the stimulus while ignoring the word meaning. Performance is scored using response time and the number of correct and incorrect responses in each phase.

The primary outcome was absolute response-time interference using the Color Naming condition as the baseline. It was calculated as the mean response time for correct responses in the incongruent condition minus the mean response time for correct responses in the Color Naming condition. This outcome was selected as the primary endpoint because it directly represents, in milliseconds, the response-time cost imposed by the incongruent Stroop condition.

Relative response-time interference was treated as a secondary outcome because it expresses the same interference cost normalized by the Color Naming baseline. Inverse efficiency in the incongruent condition was treated as a complementary outcome because it combines response time and accuracy in a single accuracy-adjusted index. Alternative interference scores using the Word Reading condition and the average of the Color Naming and Word Reading conditions as baselines were examined only in sensitivity analyses.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

2.4 Derived Stroop indices

Stroop-derived indices were calculated from mean response time and the number of correct and incorrect responses in each task condition. The Color Naming condition was used as the primary baseline for the interference indices because the incongruent condition requires participants to identify the ink color while suppressing the automatic tendency to read the word. Thus, the primary absolute interference index was calculated as the mean response time for correct responses in the Color-Word incongruent condition minus the mean response time for correct responses in the Color Naming condition: absolute interference = response time incongruent - response time color naming. Relative interference was calculated as absolute interference divided by the mean response time in the Color Naming condition and multiplied by 100: relative interference = [(response time incongruent - response time color naming) / response time color naming] x 100. Correct-response interference was calculated as the number of correct responses in the Color Naming condition minus the number of correct responses in the incongruent condition: correct-response interference = correct color naming - correct incongruent. Error interference was calculated as the number of incorrect responses in the incongruent condition minus the number of incorrect responses in the Color Naming condition: error interference = errors incongruent - errors color naming. The inverse efficiency index in the incongruent condition was calculated by dividing the mean response time for correct responses in the incongruent condition by the proportion of correct responses in that condition: inverse efficiency = response time incongruent / (correct incongruent / total trials incongruent).

Higher values for response-time interference and inverse efficiency indicate worse performance, reflecting a greater interference cost or lower response efficiency. The primary Stroop-derived outcome was absolute response-time interference using the Color Naming baseline. Relative response-time interference was treated as a secondary outcome, and inverse efficiency in the incongruent condition was treated as an accuracy-adjusted complementary outcome. Alternative interference indices using the Word Reading condition and the average of the Color Naming and Word Reading conditions as baselines were examined in sensitivity analyses.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

2.5 Statistical analysis

The Shapiro-Wilk test was used to assess the distribution of continuous variables and guide the choice of statistical tests. Continuous variables were compared between groups using Student's t-test with Welch's correction for unequal variances. Categorical variables were compared using Fisher's exact test; the chi-square test of independence was used when assumptions were appropriate. Associations between continuous variables were examined using Pearson's correlation test. Analyses were performed in R (R Core Team, 2025), an open-source statistical computing environment, with support from the ggplot2 (WICKHAM, 2016) and gtsummary (SJOBERG *et al.*, 2021) packages. The significance level was set at $\alpha = 0.05$.

Because the PAQ-A global score may be too broad to capture specific dimensions of habitual physical activity, exploratory analyses were conducted using selected PAQ-A domains. The following domains were examined: leisure-time physical activity, higher physical exertion during Physical Education classes, active leisure/sports/physical exercise on weekends, weekly physical exertion intensity, and daily frequency of more intense physical activity. These domains were tested against the three main Stroop-derived outcomes: absolute response-time interference, relative response-time interference, and inverse efficiency in the incongruent condition. Because these analyses were secondary and exploratory, p-values were adjusted using the Benjamini-Hochberg false discovery rate procedure.

Sensitivity analyses were conducted to evaluate the robustness of the association between the PAQ-A global score and the Stroop-derived outcomes. First, Spearman correlations were performed as non-parametric alternatives to Pearson correlations. Second, alternative operationalizations of response-time interference were tested using the Word Reading condition and the average of the Color Naming and Word Reading conditions as alternative baselines. Third, PAQ-A x sex interaction terms were included in adjusted linear models to examine whether the association between self-reported physical activity and Stroop-derived outcomes differed between boys and girls. Fourth, influential observations were evaluated using Cook's distance in the fully adjusted models;

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

observations with Cook's distance greater than 4/n were considered potentially influential, and models were refitted after excluding these observations. Fifth, potential nonlinearity was examined by comparing adjusted linear models with models including a natural spline term for the PAQ-A global score with three degrees of freedom. Model comparison was performed using analysis of variance and Akaike's information criterion. The results of these sensitivity analyses are presented in Supplementary Table S1.

Sex-based comparisons were conducted for sample characterization and were treated as exploratory analyses rather than primary hypothesis tests. Continuous variables were compared between boys and girls using Welch's t-test, and categorical variables were compared using Fisher's exact test. Because multiple sex-based comparisons were performed across descriptive tables, the false discovery rate was controlled within each descriptive table using the Benjamini-Hochberg procedure. These analyses were interpreted as descriptive and secondary to the main association between the PAQ-A global score and Stroop-derived outcomes.

Covariate selection was based on theoretical plausibility and the potential relationship of each variable with both self-reported physical activity and Stroop-derived inhibitory-control outcomes. Multicollinearity among covariates was assessed using variance inflation factors. All VIF values were low, ranging from 1.09 to 1.47, indicating no evidence of excessive multicollinearity among the PAQ-A global score, sex, age, weighted average screen time, difficulty falling asleep, daytime sleepiness, and physical exercise outside school. For the adjusted models, only coefficients for the main exposure, the standardized PAQ-A global score, are reported in the main tables. Covariates were included for adjustment purposes.

Sex and age were included in the minimum adjusted model because they are demographic factors related to adolescent physical activity patterns and executive-function performance. Weighted average screen time was included because screen exposure may be associated with both lower physical activity engagement and cognitive performance. Sleep-related variables were also considered because sleep difficulties and daytime sleepiness may affect both physical activity participation and attention-dependent cognitive tasks. Therefore, difficulty falling asleep and daytime sleepiness were included in the behavioral model. Practice of physical exercise outside school was examined in the

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

expanded behavioral model because, although behaviorally relevant, it is closely related to the PAQ-A exposure itself and could represent partial adjustment for one component of the exposure.

3. Results

3.1 Sex-based sample characterization

Tables 1-4 present sex-based descriptive comparisons used to characterize the sample. These analyses were considered exploratory and are reported with false discovery rate-adjusted p-values.

Table 1 - Demographic Characteristics and Average Daily Screen Time (Weekdays and Weekends) in Adolescents, According to Sex.

Characteristics	Boys n = 56[1]	Girls n = 54[1]	Overall n = 110[1]	p-value[2]	q-value[3]
Age (Years)	15.55 (0.74)	15.65 (0.65)	15.60 (0.69)	.476	.476
Weighted average daily screen time (min/day)	510.64 (186.04)	557.72 (206.59)	533.75 (196.91)	.212	.386
Weekday screen time (min/day)	492.96 (214.40)	537.04 (219.71)	514.60 (217.15)	.290	.386
Weekend screen time (min/day)	554.82 (189.15)	609.44 (251.66)	581.64 (222.71)	.202	.386

Source: Authors' own elaboration based on research data. Note: [1]Mean (SD); [2]Welch Two Sample t-test; [3]Benjamini & Hochberg correction for multiple testing.

Boys and girls were similar in age and screen-time indicators. Some sex-related differences were observed in socio-behavioral variables and PAQ-A domains, particularly variables related to sleep/fatigue and physical activity participation. However, these comparisons were not part of the primary hypothesis and were used mainly to contextualize the sample and support the inclusion of sex as a covariate in adjusted models.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Table 2 - Association Between Sex and Socio-behavioral Variables Related to Sleep, Screen Use, and Physical Activity in Adolescents.

Sociobehavioral Variables		Boys n = 56	Girls n = 54	p-value[1]	q-value[2]
Do you share your bedroom with a family member?	No	34 (61%)	28 (52%)	.442	.575
	Yes	22 (39%)	26 (48%)		
Do you have a television in your bedroom?	No	31 (55%)	41 (76%)	**.028**	.073
	Yes	25 (45%)	13 (24%)		
Do you usually watch TV (in your bedroom or elsewhere) shortly before going to sleep?	No	24 (43%)	34 (63%)	**.038**	.083
	Yes	32 (57%)	20 (37%)		
Do you usually go to sleep before 11:00 PM?	No	34 (61%)	23 (43%)	.085	.159
	Yes	22 (39%)	31 (57%)		
Do you have difficulty falling asleep?	No	47 (84%)	31 (57%)	**.003**	**.040**
	Yes	9 (16%)	23 (43%)		
Do you take a long time to fall asleep even when lying down for that purpose?	No	39 (70%)	31 (57%)	.235	.339
	Yes	17 (30%)	23 (43%)		
Do you usually wake up during the night?	No	40 (71%)	32 (59%)	.230	.339
	Yes	16 (29%)	22 (41%)		
On a weekday (Monday to Friday), are you able to sleep more than 7 continuous hours?	No	21 (38%)	20 (37%)	1.000	>0.999
	Yes	35 (63%)	34 (63%)		
On weekends, are you able to sleep more than 7 continuous hours?	No	7 (13%)	6 (11%)	1.000	>0.999
	Yes	49 (88%)	48 (89%)		
Upon waking, do you feel unwilling to get out of bed?	No	25 (45%)	26 (48%)	.848	>0.999
	Yes	31 (55%)	28 (52%)		
Do you feel tired or sleepy during the day?	No	29 (52%)	15 (28%)	**.012**	.052
	Yes	27 (48%)	39 (72%)		
At school, do you attend practical Physical Education classes?	No	10 (18%)	22 (41%)	**.011**	.052
	Yes	46 (82%)	32 (59%)		
Do you do any physical exercise outside of school?	No	9 (16%)	20 (37%)	**.017**	.055
	Yes	47 (84%)	34 (63%)		

Source: Authors' own elaboration based on research data. Note: Data are presented as n (%); [1]p-values were obtained using Fisher's exact test. [2]Benjamini & Hochberg correction for multiple testing.

Table 3 - Differences in Physical Activity Domains Among Adolescents, According to Sex, as Assessed by the PAQ-A.

Domains	Boys n = 56	Girls n = 54	p-value[1]	q-value[2]
Leisure-time physical activity.	1.43 (0.32)	1.29 (0.25)	**.014**	.031
Higher physical exertion during Physical Education classes.	3.07 (1.06)	2.63 (0.96)	**.024**	.042
Active leisure/sports/physical exercise in the morning period.	2.32 (1.28)	1.69 (1.08)	**.006**	.025
Active leisure/sports/physical exercise in the afternoon period.	2.95 (1.35)	2.56 (1.37)	.135	.174
Active leisure/sports/physical exercise in the night period.	2.25 (1.19)	2.15 (1.17)	.653	.653
Active leisure/sports/physical exercise on weekends.	2.43 (1.11)	1.91 (0.92)	**.008**	.025

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Domains	Boys n = 56	Girls n = 54	p-value[1]	q-value[2]
Weekly physical exertion intensity.	2.68 (1.29)	2.56 (1.16)	.601	.653
Daily frequency of more intense physical activity.	2.56 (0.95)	2.19 (0.95)	**.042**	.063
Global Score.	2.46 (0.68)	2.12 (0.64)	**.008**	.025

Source: Authors' own elaboration based on research data. Note: Data are presented as Mean (SD); [1]p-values were obtained using Welch Two Sample t-test; [2]Benjamini & Hochberg correction for multiple testing.

Table 4 - Stroop Test–Derived Interference Indices According to Sex.

Derived Interference Indices	Boys n = 56	Girls n = 54	p-value[1]	q-value[2]
Absolute interference in response time (ms)	456.85 (374.47)	355.02 (351.36)	.144	.270
Relative interference in response time (%)	28.87 (21.96)	22.11 (21.67)	.107	.270
Interference in correct responses (absolute difference)	1.09 (2.34)	0.80 (1.38)	.424	.424
Interference in errors (absolute difference)	1.09 (2.34)	0.80 (1.38)	.424	.424
Inverse efficiency in the incongruent condition	241.52 (248.51)	193.60 (47.08)	.162	.270

Source: Authors' own elaboration based on research data. Note: Data are presented as Mean (SD); [1]p-values were obtained using Welch Two Sample t-test; [2]Benjamini & Hochberg correction for multiple testing.

3.2 PAQ-A associations

As shown in Table 5, the PAQ-A global score showed no statistically significant associations with the main Stroop-derived outcomes in bivariate analyses. This absence of a statistically detectable association was maintained in the raw and adjusted linear models shown in Table 6. Linear model assumptions were evaluated using graphical and analytical diagnostics. Linearity was examined by visual inspection of residuals versus fitted values and was further assessed in sensitivity analyses using natural spline models for the PAQ-A global score.

Table 5 - Bivariate Association Between the PAQ-A Global Score and the Main Stroop Test Outcomes in Adolescents (n = 110)

Exposure	Outcome	Coef. (r)	95% CI	p-value[1]	q-value[2]
Global Score	Absolute response-time interference	0.010	-0.177 to 0.197	.914	.964
	Relative response-time interference	-0.004	-0.191 to 0.183	.964	.964
	Inverse efficiency in the incongruent condition	-0.067	-0.251 to 0.122	.487	.964

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Source: Authors' own elaboration based on research data.

Homoscedasticity was examined by visual inspection of residual plots, and robust HC3 standard errors were used in the linear models to reduce sensitivity to heteroscedasticity. Influential observations were assessed using Cook's distance, with values greater than 4/n considered potentially influential. Models were refitted after excluding potentially influential observations to evaluate their impact on the estimates. Multicollinearity among covariates was assessed using variance inflation factors. These diagnostic and sensitivity procedures are summarized in the supplementary material.

Sensitivity analyses are presented in Supplementary Table S1. Spearman correlations were consistent with Pearson correlations, showing no statistically significant association between the PAQ-A global score and Stroop-derived outcomes. Models using alternative interference baselines produced estimates that did not materially change the interpretation of the main analysis. PAQ-A x sex interaction terms were not statistically significant, suggesting that the association between self-reported physical activity and Stroop-derived outcomes did not differ meaningfully between boys and girls. After excluding potentially influential observations based on Cook's distance, estimates for the main temporal interference outcomes remained stable. The inverse efficiency outcome showed greater sensitivity to influential observations and possible nonlinearity, supporting its interpretation as a complementary rather than primary outcome.

Because the PAQ-A global score may not capture specific dimensions of habitual physical activity, exploratory analyses were conducted between selected PAQ-A domains and the main Stroop-derived outcomes. These analyses were interpreted as secondary and were adjusted for multiple comparisons using the Benjamini-Hochberg false discovery rate procedure.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Table 6 - Association between the PAQ-A global score and Stroop-derived outcomes in raw and adjusted linear models. Minimum model = sex + age; behavioral model = sex + age + weighted average screen time + difficulty falling asleep + daytime sleepiness; expanded behavioral model = behavioral model + physical exercise outside school.

Outcome role	Outcome	Model	β	95% CI	p-value	q-value
Primary	Absolute response-time interference	Raw	3.79	−70.77 to 78.35	.920	.963
		Minimal: sex + age	−10.89	−90.38 to 68.61	.787	.787
		Behavioral: sex + age + screen time + sleep/fatigue	−7.16	−89.24 to 74.92	.863	.863
		Extended behavioral: + exercise outside school	7.59	−81.83 to 97.01	.867	.922
Secondary	Relative response-time interference	Raw	−0.10	−4.19 to 4.00	.963	.963
		Minimal: sex + age	−1.09	−5.50 to 3.33	.627	.787
		Behavioral: sex + age + screen time + sleep/fatigue	−0.76	−5.34 to 3.83	.744	.863
		Extended behavioral: + exercise outside school	0.25	−4.81 to 5.30	.922	.922
Complement.	Inverse efficiency in the incongruent condition	Raw	-145.62	-821.05 to 529.80	.670	.963
		Minimal: sex + age	-216.97	-1002.61 to 568.66	.585	.787
		Behavioral: sex + age + screen time + sleep/fatigue	-221.29	-1089.77 to 647.19	.614	.863
		Extended behavioral: + exercise outside school	-66.01	-787.93 to 655.90	.856	.922

Source: Authors' own elaboration based on research data. Note: β values refer to the association between the standardized PAQ-A Global Score and each Stroop-derived outcome in each model. Covariates were included for adjustment, but their coefficients are not shown. FDR-adjusted p-values were calculated using the Benjamini-Hochberg procedure.

In the exploratory analyses, none of the selected PAQ-A domains showed statistically significant associations with the main Stroop-derived outcomes after adjustment for multiple comparisons. This finding suggests that the absence of association observed for the PAQ-A global score was not substantially modified when specific self-reported physical activity domains were examined separately.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Table 7 - Exploratory associations between selected PAQ-A domains and Stroop-derived inhibitory control outcomes (n = 110).

PAQ-A (domains)	Outcome role	Stroop outcome	Coefficient (r)	95% CI	p-value	q-value
Leisure-time physical activity	Primary	Absolute RT interference	.117	-.072 to .298	.222	.577
	Secondary	Relative RT interference	.121	-.068 to .301	.208	.577
	Complementary	Inverse efficiency (incongruent)	-.051	-.236 to .138	.598	.730
Higher exertion in Physical Education	Primary	Absolute RT interference	.049	-.139 to .234	.608	.730
	Secondary	Relative RT interference	.004	-.183 to .191	.967	.967
	Complementary	Inverse efficiency (incongruent)	-.106	-.288 to .083	.269	.577
Weekend active leisure/sport	Primary	Absolute RT interference	.166	-.022 to .343	.083	.577
	Secondary	Relative RT interference	.133	-.056 to .312	.167	.577
	Complementary	Inverse efficiency (incongruent)	-.007	-.194 to .180	.940	.967
Weekly exertion intensity	Primary	Absolute RT interference	-.077	-.261 to .112	.424	.706
	Secondary	Relative RT interference	-.046	-.231 to .142	.633	.730
	Complementary	Inverse efficiency (incongruent)	-.067	-.251 to .121	.484	.726
Daily frequency of intense activity	Primary	Absolute RT interference	-.142	-.320 to .047	.140	.577
	Secondary	Relative RT interference	-.111	-.292 to .078	.248	.577
	Complementary	Inverse efficiency (incongruent)	-.094	-.277 to .095	.327	.613

4. Discussion

The main finding of this study was that habitual physical activity, measured using the PAQ-A global score, showed no evidence of a statistically detectable linear association with inhibitory-control performance assessed by the Stroop Test in adolescents. This pattern remained consistent in the bivariate analysis, in models adjusted for sex, age, screen time, sleep/fatigue indicators, and physical exercise outside school, and across sensitivity analyses. Taken together, these results suggest that, in this sample, higher self-reported levels of habitual physical activity were not clearly associated with better performance on the main indices of cognitive interference.

Although some exploratory sex-based differences were observed in socio-behavioral variables and PAQ-A domains, these differences did not translate into a significant association between self-reported physical activity and Stroop-derived inhibitory-control indicators. Moreover, adjusted models including sex as a covariate and sensitivity analyses testing PAQ-A x sex interactions did not materially change the interpretation of the main findings.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

Although the literature frequently reports favorable associations between physical activity and executive functions during adolescence, this association does not necessarily appear as a simple linear relationship between a global physical activity score and a specific marker of inhibitory control (AGUAYO *et al.*, 2022; SHI *et al.*, 2022). This distinction is important because the rationale of the present study is based on the existing gap regarding the specificity of measures used for both physical activity and executive function. In this sense, the present findings do not deny the relevance of physical activity for cognition but indicate that this relationship may depend on how both the exposure and the outcome are operationalized.

A plausible explanation is that the PAQ-A global score may be too broad to capture subtle differences in inhibitory control. By combining information from different physical activity contexts into a single score, the instrument is useful for characterizing overall habitual physical activity, but it may have limited sensitivity for identifying which dimensions of practice are more cognitively relevant. Adolescents with similar global scores may differ substantially in intensity, regularity, context, motor complexity, and cognitive demands of the activities performed. Thus, the aggregated score may not adequately discriminate the components of physical activity that are potentially more closely related to executive performance.

Another relevant aspect concerns the Stroop Test itself. Although it is widely used as a marker of inhibitory control, Stroop performance does not depend exclusively on cognitive inhibition. Processing speed, automatic reading, color naming, selective attention, and individual response strategies also influence performance. The manuscript acknowledges this limitation by emphasizing that the Stroop Test does not represent a pure measure of inhibition (PARRIS *et al.*, 2022; VIVIANI *et al.*, 2024). Thus, even if physical activity is related to cognitive performance, such effects may not clearly emerge in a single task, especially when the outcome is represented by interference-derived indices.

It should also be considered that the true association, if present, may be small and conditioned by multiple competing factors. During adolescence, executive performance is related to neurobiological maturation, sleep, screen use, school context, emotional state, physical fitness, body composition, and socio-environmental conditions (GUERRA *et al.*,

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

2021; LAUREYS *et al.*, 2021; TERVO-CLEMMENS *et al.*, 2023). In this context, habitual physical activity may represent only a limited portion of the variability observed in Stroop performance, especially when measured by self-report within a short recall window. This may help explain why a biologically plausible association is not always statistically detectable in cross-sectional studies using global behavioral measures.

The results also support the hypothesis that the link between physical activity and cognition may depend more on specific dimensions of practice than on overall self-reported volume. Indicators such as vigorous intensity, weekly frequency, structured sports participation, activities with higher coordinative demands, and cardiorespiratory fitness may be more sensitive markers of individual differences in inhibitory control. From this perspective, the lack of association observed here suggests not an absolute absence of a relationship, but a limitation in the sensitivity of an analytical model focused on the PAQ-A global score.

A key strength of the study was the consistency of the findings. The null pattern was maintained across Pearson correlations, Spearman correlations, adjusted models, and alternative operationalizations of interference cost, increasing confidence in the robustness of the main inference. In addition, no interaction with sex was observed, suggesting that, in this sample, the relationship between habitual physical activity and Stroop performance did not differ substantially between boys and girls. This aspect is particularly relevant because the descriptive analyses showed differences between sexes in some PAQ-A domains, but these group differences did not translate into an individual-level association between exposure and outcome.

By contrast, inverse efficiency in the incongruent condition required more cautious interpretation. In the sensitivity analyses, this outcome showed greater sensitivity to influential observations and signs of nonlinearity, unlike the main temporal indices, which were more stable. This suggests that inverse efficiency in the incongruent condition is more vulnerable to data distribution and should therefore be treated as a complementary outcome rather than a central focus of inference.

Several limitations should be acknowledged. First, the cross-sectional design does not allow temporal or causal inference; therefore, the findings should be interpreted as evidence regarding concurrent associations only. Second, habitual physical activity was

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

assessed by self-report over a short recall window, which may introduce recall bias and may not capture objective intensity, duration, energy expenditure, or cardiorespiratory fitness. Third, participants were recruited by non-probability sampling from educational institutions in a single Brazilian municipality, limiting generalizability beyond the studied sample. Fourth, pubertal maturation, socioeconomic status, parental education, and objective physical fitness were not assessed, although these factors may influence both physical activity opportunities and executive-function performance. Finally, the sensitivity analysis indicated that the study was better powered to detect small-to-moderate associations than very small effects, and the inverse efficiency outcome showed wider uncertainty and greater sensitivity to influential observations.

In summary, the findings indicate that, in this sample of adolescents, the PAQ-A global score showed no evidence of a statistically detectable linear association with Stroop-derived inhibitory-control outcomes. Rather than providing a definitive conclusion about the broader physical activity-cognition relationship, these results contribute to refining the debate by suggesting that future research should move beyond overly general exposure models and investigate more specific dimensions of physical activity, including intensity, cardiorespiratory fitness, coordinative demands, cognitive engagement during practice, and longitudinal regularity.

5. Conclusion

We conclude that habitual physical activity, as assessed by the PAQ-A global score, showed no evidence of a statistically detectable linear association with inhibitory-control performance measured by the Stroop Test, both in bivariate analyses and in adjusted models. This pattern remained stable across sensitivity analyses, reinforcing the robustness of the main finding, although very small effects cannot be ruled out given the study's sensitivity. These results suggest that the relationship between habitual physical activity and executive function during adolescence is more complex than a simple linear association between a self-reported global score and performance on a specific cognitive interference task. Therefore, future studies should use longitudinal designs, more specific measures of physical activity, objective indicators of physical fitness and activity intensity,

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

and more comprehensive cognitive assessments to clarify which dimensions of physical activity are most closely associated with executive functioning in this age group.

Generative AI statement

Generative artificial intelligence tools were used exclusively to support language translation and formatting according to journal requirements. These tools were not used for data analysis, generation of scientific results, interpretation of findings, or formulation of scientific conclusions. All scientific content, interpretation of results, final manuscript preparation, critical review, and intellectual responsibility remain entirely with the authors.

References

AGUAYO, B. B.; ROMÁN, P. Á. L.; SÁNCHEZ, J. S.; VALLEJO, A. P. Effect of physical activity and fitness on executive functions and academic performance in children of elementary school: a systematic review. Cultura, Ciencia y Deporte, v. 17, n. 51, 2022. DOI: https://doi.org/10.12800/ccd.v17i51.1699.

ALKHENAIZI, A. K.; SHAKEEB, F. N.; FREDERICKS, S.; GAYNOR, D. Physical activity levels, recreational screen time, sleep quality and mood among young adult healthcare students at an international university in Bahrain: a cross-sectional study. BMJ Open, v. 15, n. 5, e093655, 2025. DOI: https://doi.org/10.1136/bmjopen-2024-093655.

CABRAL, L. L. P. *et al.* Cardiorespiratory fitness and performance in multiple domains of executive functions in school-aged adolescents. Frontiers in Physiology, v. 12, 640765, 2021. DOI: https://doi.org/10.3389/fphys.2021.640765.

CÓRDOVA, C.; KARNIKOWSKI, M. G. O.; PANDOSSIO, J. E.; NÓBREGA, O. T. Caracterização de respostas comportamentais para o teste de Stroop computadorizado - Testinpacs. Neurociências, v. 4, n. 2, p. 75-79, 2008.

FERNANDES, V. R.; BECKER, D. R.; MCCLELLAND, M. M.; DESLANDES, A. C. Head-Toes-Knees-Shoulders task and EF in two samples of adolescents in Brazil and United States. Frontiers in Psychology, v. 14, 1149053, 2023. DOI: https://doi.org/10.3389/fpsyg.2023.1149053.

FERNANDES JÚNIOR, P. G.; NASCIMENTO, T. A.; SILVA, H. V. A.; COSTA, A. S. Efeito agudo da prática esportiva com engajamento cognitivo nas funções executivas em crianças. Revista Brasileira de Atividade Física & Saúde, v. 27, e0282, 2023. DOI: https://doi.org/10.12820/rbafs.27e0282.

FORTE, G.; TROISI, G.; FAVIERI, F.; CASAGRANDE, M. Inhibition changes across the lifespan: experimental evidence from the Stroop task. BMC Psychology, v. 12, n. 1, 2024. DOI: https://doi.org/10.1186/s40359-024-01844-0.

GONZÁLEZ-DEL-CASTILLO, J.; BARBERO-ALCOCER, I. Effects of school-based physical activity programs on executive function development in children: a systematic review. Frontiers in Psychology, v. 16, 1658101, 2025. DOI: https://doi.org/10.3389/fpsyg.2025.1658101.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

GUEDES, D. P.; GUEDES, J. E. R. P. Medida da atividade física em jovens brasileiros: reprodutibilidade e validade do PAQ-C e do PAQ-A. Revista Brasileira de Medicina do Esporte, v. 21, n. 6, p. 425-432, 2015. DOI: https://doi.org/10.1590/1517-869220152106147594.

GUERRA, A. *et al.* Developmental profile of executive functioning in school-age children from Northeast Brazil. Frontiers in Psychology, v. 11, 596075, 2021. DOI: https://doi.org/10.3389/fpsyg.2020.596075.

ICLOZAN, D.; POP, I. Executive functions in clinical and non-clinical populations: a comparative analysis. Studia Universitatis Babeș-Bolyai Psychologia-Paedagogia, v. 69, n. 1, p. 27-50, 2024. DOI: https://doi.org/10.24193/subbpsyped.2024.1.02.

IDOWU, M. I.; SZAMEITAT, A. J. Executive function abilities in cognitively healthy young and older adults: a cross-sectional study. Frontiers in Aging Neuroscience, v. 15, 976915, 2023. DOI: https://doi.org/10.3389/fnagi.2023.976915.

KOJIĆ, F. *et al.* Breaking barriers: challenging the notion of a strong link between physical fitness and executive functions in 10-year-olds. BMC Pediatrics, v. 25, n. 1, 469, 2025. DOI: https://doi.org/10.1186/s12887-025-05799-y.

LAUREYS, F. *et al.* The effects of age, biological maturation and sex on the development of executive functions in adolescents. Frontiers in Physiology, v. 12, 703312, 2021. DOI: https://doi.org/10.3389/fphys.2021.703312.

PABLO-RÍOS, M. V. *et al.* Dysexecutive symptomatology in everyday functioning and academic achievement in adolescents. Frontiers in Psychology, v. 15, 1323317, 2024. DOI: https://doi.org/10.3389/fpsyg.2024.1323317.

PARRIS, B. A.; HASSHIM, N.; WADSLEY, M.; AUGUSTINOVA, M.; FERRAND, L. The loci of Stroop effects: a critical review of methods and evidence for levels of processing contributing to color-word Stroop effects and the implications for the loci of attentional selection. Psychological Research, v. 86, n. 4, p. 1029-1053, 2022. DOI: https://doi.org/10.1007/s00426-021-01554-x.

PÉREZ-ROMERO, N. *et al.* Revisión sistemática sobre la incidencia de los programas de actividad física en la mejora cognitiva en la infancia y adolescencia. Apuntes de Psicología, v. 41, n. 1, p. 39-48, 2023. DOI: https://doi.org/10.55414/ap.v41i1.1526.

PORFÍRIO, G. B. *et al.* The impact of physical activity on cognitive, behavioral, and academic performance in children with ADHD: a systematic review. Dementia & Neuropsychologia, v. 20, e20250339, 2025. DOI: https://doi.org/10.1590/1980-5764-DN-2025-0339.

R CORE TEAM. R: a language and environment for statistical computing. Vienna: R Foundation for Statistical Computing, 2025. Disponível em: https://www.R-project.org/. Acesso em: 17 jun. 2026.

SHI, P.; TANG, Y.; ZHANG, Z.; FENG, X.; LI, C. Effect of physical exercise in real-world settings on executive function of typical children and adolescents: a systematic review. Brain Sciences, v. 12, n. 12, 1734, 2022. DOI: https://doi.org/10.3390/brainsci12121734.

SJOBERG, D. D. *et al.* Reproducible summary tables with the gtsummary package. The R Journal, v. 13, n. 1, p. 570-580, 2021. DOI: https://doi.org/10.32614/RJ-2021-053.

SOUZA, L. M. S. *et al.* Relação entre o nível de atividade física e atenção de alunos do ensino médio em uma escola pública do interior de Minas Gerais. Research, Society and Development, v. 10, n. 17, e247101724766, 2021. DOI: https://doi.org/10.33448/rsd-v10i17.24766.

REMUNOM
ISSN 2178-6925

Received: 13/05/2026 - **Accepted:** 22/06/2026
Vol: 13.13
DOI: 10.66104/mbdsg665
Pages: 1-22

SUN, F. *et al.* Physical activity and executive functions in adolescents: the mediating role of sleepiness. International Journal of Environmental Research and Public Health, v. 19, n. 19, 12972, 2022. DOI: https://doi.org/10.3390/ijerph191912972.

TERVO-CLEMMENS, B. *et al.* A canonical trajectory of executive function maturation from adolescence to adulthood. Nature Communications, v. 14, n. 1, 6922, 2023. DOI: https://doi.org/10.1038/s41467-023-42540-8.

VERMA, J. P.; VERMA, P. Use of G*Power software. In: VERMA, J. P.; VERMA, P. Determining sample size and power in research studies: a manual for researchers. Singapore: Springer, 2020. p. 55-60.

VIVIANI, G.; VISALLI, A.; MONTEFINESE, M.; VALLESI, A.; AMBROSINI, E. The Stroop legacy: a cautionary tale on methodological issues and a proposed spatial solution. Behavior Research Methods, v. 56, n. 5, p. 4758-4785, 2024. DOI: https://doi.org/10.3758/s13428-023-02215-0.

WICKHAM, H. ggplot2: elegant graphics for data analysis. 2. ed. Cham: Springer, 2016. DOI: https://doi.org/10.1007/978-3-319-24277-4.