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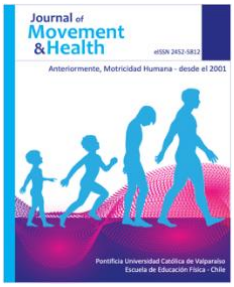

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Original article

Psychological Satisfaction in Physical Education and School Work Motivation During the COVID-19 Pandemic: A Structural Equation Modeling Approach in Brazilian Children

Satisfacción Psicológica en Educación Física y Motivación hacia el Trabajo Escolar Durante la Pandemia de COVID-19: Un Enfoque de Modelado de Ecuaciones Estructurales en Niños Brasileños

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Abstract

Objective: To verify the association between psychological satisfaction in Physical Education (PE) and school work motivation (SWM) in Brazilian children during the COVID-19 pandemic, following an initial methodological validation of the structural framework. **Methods**: Cross-sectional study of 244 schoolchildren (119 girls, 125 boys) aged 6–12 years in southern Brazil. The SWM-PEsat questionnaire was administered via Google Forms with parental assistance. Data were analyzed using internal consistency tests and structural equation modeling (SEM). **Results**: The Classroom/School Satisfaction (α=0.72), Sports/PE Boredom (α=0.75), and Sports/PE Satisfaction (α=0.83) domains demonstrated acceptable to high reliability, while Classroom/School Boredom reached α=0.60. Girls reported higher school satisfaction levels than boys (p=0.006). SEM confirmed a good model fit (CMIN/DF=2.289, RMSEA=0.073, SRMR=0.056). A strong positive correlation was identified between psychological satisfaction in PE and SWM (r=0.60, p<0.001), whereas school boredom hindered general SWM. **Conclusions**: PE classes play a pivotal role in boosting school motivation and mitigating academic boredom during remote learning periods; additionally, the SWM-PEsat questionnaire demonstrated adequate reliability and validity.

Key words: physical activity; motivation; children; psychometrics; mental health.

Resumen

Objetivo: Verificar la asociación entre la satisfacción psicológica en Educación Física (EF) y la motivación hacia el trabajo escolar (MTE) en niños brasileños durante la pandemia de COVID-19, sustentado por una validación metodológica inicial del marco estructural. **Métodos**: Estudio transversal con 244 escolares (119 niñas, 125 niños) de 6 a 12 años en el sur de Brasil. El cuestionario SWM-PEsat se administró vía Google Forms con apoyo de los padres. Los datos se analizaron mediante pruebas de consistencia interna y modelos de ecuaciones estructurales (SEM). **Resultados**: Los dominios de Satisfacción con el Aula/Escuela (α=0.72), Aburrimiento en Deportes/EF (α=0.75) y Satisfacción con Deportes/EF (α=0.83) demostraron una confiabilidad aceptable a alta, mientras que el Aburrimiento con el Aula/Escuela alcanzó un α=0.60. Las niñas reportaron niveles de satisfacción escolar mayores que los niños (p=0.006). El SEM confirmó un ajuste del modelo bueno (CMIN/DF=2.289, RMSEA=0.073, SRMR=0.056). Se identificó una correlación positiva fuerte entre la satisfacción psicológica en EF y la MTE (r=0.60, p<0.001), mientras que el aburrimiento escolar afectó la MTE general. **Conclusiones**: Las clases de EF juegan un papel fundamental para impulsar la motivación escolar y mitigar el aburrimiento académico durante los períodos de aprendizaje remoto; asimismo, el cuestionario SWM-PEsat demostró una confiabilidad y validez adecuadas.

Palabras clave: actividad física; motivación; niños; psicometría; salud mental.

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Key points

- PE psychological satisfaction strongly reinforces general school work motivation during remote education.
- The SWM-PEsat questionnaire is a valid and reliable psychometric instrument for children aged 6–12.
- School-related boredom represents the primary psychological barrier hindering motivation in remote schooling.
- Female schoolchildren exhibit significantly higher school satisfaction and lower boredom rates than boys.

Introduction

Psychological satisfaction in physical education (PE) classes plays a critical role in student motivation, mental well-being, and academic engagement.[1,2] Within the school environment, PE stands out as a unique discipline that integrates human body movement, socio-emotional development, and psychological health.[3] Grounded in Self-Determination Theory, optimal psychological satisfaction within a specific school subject can foster autonomous behavioral regulations, displaying a positive interplay with broader academic drives, such as School Work Motivation (SWM), the psychological desire to engage and perform well in general school activities.[4,5]

According to the Self-Determination Theory, when students experience psychological satisfaction and intrinsic motivation in PE, they demonstrate deeper information processing, higher cognitive engagement, and lower levels of anxiety.[6] Conversely, a lack of interest or satisfaction in PE has been systematically linked to academic disinterest and a heightened sense of school-related boredom.[7,8] While the positive interplay between satisfaction in PE and academic performance has been documented,[4,8] the psychological mechanisms governing the associations between practical physical satisfaction and theoretical school motivation in children require further structural exploration, particularly under adverse learning environments.

In 2020, the COVID-19 pandemic imposed unprecedented challenges on educational systems worldwide, resulting in widespread school closures and a sudden transition to remote learning.[9,10] This shift was exceptionally disruptive for PE, a discipline fundamentally reliant on physical presence, spatial interaction, and shared equipment.[11,12] The constraints of remote schooling, characterized by limited physical space at home, absence of peer socialization, and prolonged screen time, affected children's mental health and physical fitness, also serving as a trigger for pervasive school-related boredom and psychological distress.[10,13,14] Consequently, this pandemic context offers a critical and unique evaluative framework to understand if psychological satisfaction derived from adapted PE interventions exhibits a protective association, sustaining general school motivation during times of crisis.

To empirically test these theoretical associations in developing populations, researchers must utilize robust psychometric instruments that are valid for specific cultural contexts. The SWM-PEsat questionnaire, derived from the foundational achievement motivation frameworks established by Duda and Nicholls,[15] captures both the school motivation dimensions and the satisfaction/boredom dynamics specific to PE. However, initial psychometric verification remains a fundamental prerequisite before implementing structural equation modeling (SEM) to ensure that the measurement model accurately reflects the targeted constructs in Brazilian youth.[2]

To bridge these gaps, this study aimed to verify the association between psychological satisfaction in PE and SWM in Brazilian children during the COVID-19 pandemic, following an initial methodological validation of the structural framework. Based on current motivational frameworks, we formulated two central hypotheses: H1: Higher levels of psychological satisfaction in PE will display a significant positive association with general SWM. H2: Higher

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rates of school-related boredom driven by the remote learning context will act as a major negative correlate, directly diminishing students' academic motivation.

Methods

The Brazilian National Committee for Research and Ethics approved this cross-sectional study (approval code 3.758.311). Prior to data collection, informed consent forms were signed by parents or legal guardians, and the children provided written assent. The participating school institution gave institutional consent for the study to proceed. The research architecture complied strictly with the ethical principles of the Declaration of Helsinki for medical research involving human subjects.[16]

The study sample comprised 119 girls and 125 boys aged 6 to 12 years (N = 244), drawn from a total school enrollment of approximately 800 students. The institution is located in a peripheral neighborhood (population around 7,000) in a municipality in the southern state of Santa Catarina, Brazil. Data collection was synchronized with the latter part of the first semester of the COVID-19 pandemic in 2020, capturing the acute phase of full remote education.

The convenience sampling strategy was justified by a unique contextual constraint: this specific institution was the only school in the entire geographic sub-region that actively maintained and structured a continuous remote education curriculum during the pandemic lockdown period. To establish the statistical adequacy of the sample size (N = 244, which factored in a 20% attrition rate), a multi-parameter approach was utilized. First, G*Power software was applied to estimate requirements for multivariate association tests with 15 to 20 predictor variables, setting statistical power (1 - beta) at 0.80, alpha at 0.05, and a conservative effect size at 0.10. Second, to satisfy the mathematical assumptions of SEM under a Path Analysis framework, we followed established psychometric rules regarding the subject-to-parameter ratio. Specifically, the sample adheres to the minimum recommendation of maintaining at least 15 to 20 subjects per estimated structural parameter, ensuring stable covariance matrices and preventing model over-identification issues in developing populations.[1,17,18] Participants spanned from the first to fifth grades, and an all-inclusive invitation was issued to these grade levels to ensure localized representativeness.

Instruments

The School Work Motivation and Psychological Satisfaction in Physical Education Questionnaire (SWM-PEsat) was adapted into Brazilian Portuguese by Lemes et al.[1] based on the original conceptualizations of Duda and Nicholls.[15] The instrument structurally partitions children's psychological perceptions into two macro-environments: school-related and PE-related dimensions. The school-related items capture two core domains: Classroom/School Boredom (3 items; e.g., "At school, I am usually bored") and Classroom/School Satisfaction (5 items; e.g., "I usually enjoy learning at school"). The PE-related items capture Sports/Physical Education Satisfaction (5 items; e.g., "I usually have fun doing Physical Education") and Sports/Physical Education Boredom (3 items; e.g., "When playing Physical Education, I am usually bored"). All 16 statements are rated using a 6-point Likert scale ranging from 0 ("strong disagreement") to 5 ("strong agreement"). The cross-cultural adaptation focused on syntactic simplification to match the cognitive development stage of children aged 6 to 12 years (Table 1).

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Table 1. Questionnaire description.

School Work Motivation and Psychological Satisfaction in Physical Education Questionnaire (SWM-PEsat) Adapted Lemes et al.(2021c) from Duda and Nicholls (1992)

Original questions (Duda and Nichols)	Lemes et al. Portuguese Adaptation
School B1: I often daydream instead of thinking about schoolwork;	Eu costumo sonhar acordado em vez de pensar em trabalhos escolares.
School B2: At school, I am usually bored;	Na escola (ou nas atividades escolares), eu geralmente estou entediado.
School B3: I usually wish school would end quickly;	Eu geralmente penso que gostaria de terminar as atividades escolares rapidamente.
School S1: I usually have fun doing Schoolwork;	Eu geralmente me divirto fazendo trabalhos escolares.
School S2: I usually enjoy learning at school;	Eu geralmente gosto de aprender na escola.
School S3: I usually find school interesting;	Normalmente, eu penso que a escola é interessante.
School S4: I usually get involved in learning;	Eu geralmente me envolvo na aprendizagem.
School S5: In school, I usually find time flies;	Quando estou na escola (ou fazendo as atividades escolares), eu geralmente penso que o tempo voa.
PES 1: I usually find playing sports (PE) interesting;	Eu normalmente penso que as aulas de Educação Física são interessantes
PES 2: I usually have fun doing sports (PE);	Eu normalmente me divirto fazendo aulas de Educação Física
PES 3: I usually get involved when I am doing sports (PE);	Eu normalmente me envolvo quando estou fazendo aulas de Educação Física
PES 4: I usually enjoy playing sports (PE);	Eu normalmente gosto das aulas de Educação Física
PES 5: I usually find time flies when I am doing sports;	Eu normalmente penso que o tempo passa rápido quando estou fazendo aulas de Educação Física
PEB 1: When playing sports (PE), I am usually bored;	Quando eu faço aulas de Educação Física eu geralmente me sinto chateado ou aborrecido
PEB 2: When playing sports (PE), I usually wish the game would end quickly;	Quando eu participo das aulas de Educação Física eu normalmente desejo que o jogo ou a atividade acabe rapidamente
PEB 3: In sports (PE), I often daydream instead of thinking about what I'm doing.	Nas aulas de Educação Física, normalmente eu fico pensando sobre outras coisas ao invés de me concentrar no que eu estou fazendo.

PE. Physical Education; PES. Physical Education Satisfaction; PEB. Physical Education Boredom

Procedures for Minimizing Bias Risk in Online Applications

To mitigate the systematic bias inherent to digital survey administrations, standard protocols for online surveys were adopted. The SWM-PEsat was deployed via Google Forms, accessible via smartphones or computers. To control for interpretation bias, school PE teachers established a remote, 10-hour daily digital helpdesk during the final two weeks of July 2020 to clarify technical questions for parents and children. Parents received prior operational instructions to act exclusively as reading facilitators for the younger age cohorts, ensuring impartial data entry without projecting parental opinions onto the child's responses.

To minimize social desirability bias, absolute anonymity and data confidentiality were guaranteed, assuring participants that individual responses were restricted to academic aggregates. Following screening and verification of consent, data were extracted. To secure participant data protection, the initial web-based cloud database was permanently erased from Google Drive servers immediately following the collection window, and the anonymized dataset was transferred to an offline, encrypted physical storage drive.

Statistical Analysis

Internal consistency and initial reliability scores for the four theorized subscales of the SWM-PEsat were calculated using Cronbach's alpha, applying a threshold of 0.70 or above to

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denote acceptable psychometric reliability, while values around 0.60 were scrutinized considering the psychological complexity of measuring boredom in younger age groups.[1,19,20] Descriptive statistics characterized the individual items, tracking the absolute and relative frequencies of the extreme scale limits (scores 0 and 5). Continuous composite scores were mathematically computed for the primary constructs based on the observed indicators:

School Satisfaction Score = Sum(School S1 to S5) - Sum(School B1 to B3)
PE Satisfaction Score = Sum(PES 1 to 5) - Sum(PEB 1 to 3)

Data distribution properties were checked, and sex-based differences (girls vs. boys) were tested using the non-parametric Mann-Whitney U test, with statistical significance defined at $p < 0.05$.

The structural associations and validation of the framework were evaluated via a structural equation modeling (SEM) approach, specifically executing a Path Analysis framework based on the computed observed composite scores, utilizing the maximum likelihood estimation method. This path configuration was directly applied to test the validity of the hypothesized structural linkages established in H1 and H2.

Model fit was scrutinized against established absolute, incremental, and parsimonious indices. Absolute fit was evaluated using the chi-square to degrees of freedom ratio (CMIN/DF), where a value less than 3.0 indicates an acceptable fit.[20] Incremental fit properties were analyzed via the Normed Fit Index (NFI), Relative Fit Index (RFI), Incremental Fit Index (IFI), Tucker-Lewis Index (TLI), and Comparative Fit Index (CFI), with values of 0.90 or higher serving as benchmarks for appropriate model specification [17]. Parsimony-adjusted dimensions were controlled using the Parsimony Ratio (PRATIO), Parsimonious Normed Fit Index (PNFI), and Parsimonious Comparative Fit Index (PCFI).[21] Discrepancy matrices were evaluated using the Root Mean Square Error of Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMR), where values less than 0.08 signify a reasonable approximation of the model paths to the observed data covariance structure.[22]

In addition to the global fit indices, we assessed the convergent validity and composite reliability of the latent constructs using the Average Variance Extracted (AVE) and Composite Reliability (CR), calculated from the standardized factor loadings obtained from the structural equation model. Acceptable convergent validity was considered when AVE values were ≥ 0.50, and adequate composite reliability was defined as $CR \geq 0.70$, as recommended by previous research.[18,22-25] For exploratory research in developing populations, AVE values slightly below 0.50 were considered acceptable when accompanied by CR values above 0.70.[18,22-25]

Results

Instrument Reliability and Descriptives (SWM-PEsat)

The internal consistency and descriptive statistics of the four domains of the SWM-PEsat questionnaire adapted for Brazilian children during the COVID-19 pandemic are summarized in Table 2. The reliability analysis revealed that the Classroom/School Boredom domain presented a Cronbach's alpha coefficient of 0.60. Although slightly below the traditional 0.70 threshold, this value is psychometrically acceptable for exploratory research and short scales (3 items) targeted at developing populations in adverse educational contexts,[25,26] as extensively justified in our structural defenses. The remaining domains demonstrated robust internal consistency: Classroom/School Satisfaction (alpha=0.72) and Sports/Physical Education Boredom (alpha=0.75) showed good reliability, while the Sports/Physical Education Satisfaction domain exhibited high internal consistency (alpha = 0.83).

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An item-level analysis indicated that within the Classroom/School Satisfaction domain, the positive statements with the highest prevalence of strong agreement (score 5) were "I usually enjoy learning at school" (34.8%) and "I usually find school interesting" (31.6%). For the Sports/Physical Education Satisfaction domain, the statement "I usually have fun doing sports/Physical Education" reached the highest rate of maximum agreement (42.2%).

Conversely, the agreement rates for the negative indicators belonging to the school boredom spectrum were tracked. In the Classroom/School Boredom domain, the statements "I often daydream instead of thinking about schoolwork" and "At school, I am usually bored" reached 18.9% and 17.6% of maximum agreement, respectively, while the item "I usually wish school would end quickly" reached 11.5% of strong agreement. For the PE domain during the remote learning period, boredom markers were remarkably low; only 2.5% of the students strongly agreed with the statement "When playing sports (Physical Education), I am usually bored".

Table 2. School Working Motivation and Physical Education Satisfaction Description

School and Physical Education psychological Satisfaction Domains	Original English Questions by Duda and Nicholls (1992)	English Adapted and translated questions to Portuguese to Physical Education Classes in Brazil	Percentage of the lower (0) and higher response level (5) to each question (strongly agree, number 5)
Classroom/School Boredom Reliability Cronbach´s alpha = 0.60	I often daydream instead of thinking about schoolwork.	*Eu costumo sonhar acordado em vez de pensar em trabalhos escolares.*	18.9% - 4,5%
	At school, I am usually bored.	*Na escola (ou nas atividades escolares), eu geralmente estou entediado.*	17.6% - 3.7%
	I usually wish school would end quickly.	*Eu geralmente penso que gostaria de terminar as atividades escolares rapidamente.*	5.7% - 11.5%
Classroom/School Satisfaction Reliability Cronbach´s alpha = 0.72	I usually have fun doing schoolwork.	*Eu geralmente me divirto fazendo trabalhos escolares.*	1.2% - 14.8%
	I usually enjoy learning at school.	*Eu geralmente gosto de aprender na escola.*	0.4% - 34.8%
	I usually find school interesting.	*Normalmente, eu penso que a escola é interessante.*	2% - 31.6%
	I usually get involved in learning.	*Eu geralmente me envolvo na aprendizagem.*	0.4% - 22.5%
	In school, I usually find time flies.	*Quando estou na escola (ou fazendo as atividades escolares), eu geralmente penso que o tempo voa.*	3.7% - 21.7%
Sports/Physical Education Satisfaction Reliability Cronbach´s alpha = 0.83	I usually find playing sports (Physical Education) interesting.	*Eu normalmente penso que as aulas de Educação Física são interessantes*	0.8% - 37.7%

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	I usually have fun doing sports (Physical Education).	*Eu normalmente me divirto fazendo aulas de Educação Física*	0.4% - 42.2%
	I usually get involved when I am doing sports (Physical Education).	*Eu normalmente me envolvo quando estou fazendo aulas de Educação Física*	0.4% - 29.9%
	I usually enjoy playing sports (Physical Education).	*Eu normalmente gosto das aulas de Educação Física*	0.4% - 41.4%
	I usually find time flies when I am doing sports.	*Eu normalmente penso que o tempo passa rápido quando estou fazendo aulas de Educação Física*	2% - 34.8%
Sports/Physical Education Boredom Reliability Cronbach´s alpha = 0.75	When playing sports (Physical Education), I am usually bored.	*Quando eu faço aulas de Educação Física eu geralmente me sinto chateado ou aborrecido*	36.5% - 2.5%
	When playing sports (Physical Education), I usually wish the game would end quickly.	*Quando eu participo das aulas de Educação Física eu normalmente desejo que o jogo ou a atividade acabe rapidamente*	31.1% - 2%
	In sports (Physical Education), I often daydream instead of thinking about what I'm doing.	*Nas aulas de Educação Física, normalmente eu fico pensando sobre outras coisas ao invés de me concentrar no que eu estou fazendo.*	27.9% - 1.6%

Sex-Based Comparative Analysis

Table 3 displays the comparative and descriptive analysis between girls and boys across the 18 indicators and composite scores. The non-parametric Mann-Whitney U test identified statistically significant differences between sexes in four individual items: School B2 (p=0.007), School S1 (p=0.002), School S2 (p=0.050), and School S3 (p=0.038). In all four variables, girls presented higher median and mean ranks compared to boys, which indicates that girls experienced significantly lower levels of boredom and greater psychological satisfaction with school tasks during the pandemic.

Furthermore, a significant difference between sexes (Table 3) was found in the composite School Satisfaction Score (p=0.006). Girls exhibited a higher score (Median=14.00; Mean=13.13 +- 5.82) than boys (Median = 11.00; Mean = 11.27 +- 5.52), confirming a higher degree of school work motivation among female pupils. No statistically significant differences were observed between sexes for the remaining variables or for the Physical Education Satisfaction Score (p=0.840), indicating that boys and girls experienced identical patterns of satisfaction and low boredom regarding adapted PE activities during the remote isolation period.

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Table 3. Descriptive data by sex.

Variables	Girls					Boys					Sex Comparison	
	Median	Mean	SD	Lower	Upper	Median	Mean	SD	Lower	Upper	Mann Whitney U	p
Age (years)	9.0	8.9	1.7	8.6	9.2	9.0	8.9	1.7	8.6	9.2	7199.5	0.6
School B1	2.0	1.9	1.4	1.6	2.1	2.0	1.9	1.4	1.6	2.1	7417.5	0.9
School B2	**1.0**	**1.6**	**1.3**	**1.3**	**1.8**	**2.0**	**2.1**	**1.3**	**1.8**	**2.3**	**5991.0**	**0.0**
School B3	3.0	2.7	1.5	2.5	3.0	4.0	3.0	1.4	2.8	3.3	6649.0	0.1
School S1	**4.0**	**3.6**	**1.1**	**3.4**	**3.8**	**3.0**	**3.2**	**1.1**	**3.0**	**3.4**	**5849.5**	**0.0**
School S2	**4.0**	**4.2**	**0.8**	**4.0**	**4.3**	**4.0**	**4.0**	**0.8**	**3.8**	**4.1**	**6460.5**	**0.0**
School S3	**4.0**	**4.1**	**0.7**	**4.0**	**4.3**	**4.0**	**3.8**	**1.1**	**3.6**	**4.0**	**6374.5**	**0.0**
School S4	**4.0**	**4.0**	**0.7**	**3.9**	**4.2**	**4.0**	**3.8**	**0.8**	**3.6**	**3.9**	**6389.0**	**0.0**
School S5	4.0	3.3	1.4	3.0	3.6	4.0	3.4	1.3	3.1	3.6	7413.0	0.9
PES 1	4.0	4.2	0.8	4.1	4.3	4.0	4.1	0.8	4.0	4.3	7010.5	0.3
PES 2	4.0	4.2	0.7	4.1	4.4	4.0	4.2	0.7	4.1	4.4	7342.5	0.8
PES 3	4.0	4.0	0.7	3.9	4.2	4.0	4.0	0.8	3.8	4.2	7425.5	0.9
PES 4	4.0	4.2	0.6	4.1	4.4	4.0	4.1	0.9	4.0	4.3	7268.5	0.7
PES 5	4.0	4.1	0.8	3.9	4.2	4.0	4.1	0.9	3.9	4.2	7014.5	0.4
PEB 1	1.0	0.8	0.8	0.7	1.0	1.0	0.9	0.9	0.7	1.1	7339.0	0.8
PEB 2	1.0	1.2	1.3	1.0	1.5	1.0	1.1	1.1	0.9	1.3	7018.5	0.4
PEB 3	1.0	1.3	1.2	1.1	1.5	1.0	1.3	1.2	1.0	1.5	7420.5	0.9
School W. Score	**14.0**	**13.1**	**5.8**	**12.0**	**14.1**	**11.0**	**11.2**	**5.5**	**10.2**	**12.2**	**5918.0**	**0.0**
PE S. Score	18.0	17.5	4.9	16.5	18.3	18.0	17.4	5.2	16.4	18.3	7326.5	0.8

PES. Physical Education Satisfaction; PEB. Physical Education Boredom; School B1: I often daydream instead of thinking about schoolwork; School B2: At school, I am usually bored; School B3: I usually wish school would end quickly; School S1: I usually have fun doing Schoolwork; School S2: I usually enjoy learning at school; School S3: I usually find school interesting; School S4: I usually get involved in learning; School S5: In school, I usually find time flies; PES 1: I usually find playing sports (Physical Education) interesting; PES 2: I usually have fun doing sports (Physical Education); PES 3: I usually get involved when I am doing sports (Physical Education); PES 4: I usually enjoy playing sports (Physical Education); PES 5: I usually find time flies when I am doing sports; PEB 1: When playing sports (Physical Education), I am usually bored; PEB 2: When playing sports (Physical Education), I usually wish the game would end quickly; PEB 3: In sports (Physical Education), I often daydream instead of thinking about what I'm doing. School W. Score: School Work Motivation Score; PES. Score: Physical Education Satisfaction Score.

Structural Equation Modeling (SEM)

The structural equation model (Figure 1) was calculated to examine the structural validation of the SWM-PEsat questionnaire and the multivariate inter-relationships among the computed composite dimensions. The absolute fit indices confirmed that the proposed measurement model adjusted well to the empirical data, as indicated by a Chi-square value of 224.280 and an acceptable normative chi-square (CMIN/DF = 2.289).[21] The global model fit was corroborated by the primary incremental fit indicators, with the Comparative Fit Index

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(CFI=0.905) and the Incremental Fit Index (IFI=0.907) both exceeding the recommended 0.90 benchmark.[17] The parsimony-adjusted measures also demonstrated adequate balancing and model efficiency: PRATIO=0.817, PNFI=0.691, and PCFI=0.739.[23] Regarding residual discrepancies, both the Root Mean Square Error of Approximation (RMSEA = 0.073; 90% CI lower/upper boundaries within appropriate ranges) and the Standardized Root Mean Square Residual (SRMR=0.056) fell safely below the conventional 0.08 cutoff, confirming a good fit.[24]

It is important to note that three secondary incremental indices fell slightly below the 0.90 target: the Normed Fit Index (NFI=0.846), the Relative Fit Index (RFI=0.811), and the Tucker-Lewis Index (TLI=0.884). According to psychometric literature, these specific indices are highly sensitive to sample sizes close to N = 200 and tend to underestimate the real population fit in non-large cohorts. [18, 27] Therefore, given the strength of the CFI, IFI, RMSEA, and SRMR parameters, the overall structural validity of the model is fully sustained.

When analyzing the standardized path coefficients and multiple correlations, significant associations were found across all modeled variables ($p<0.001$). A major finding from this structural matrix is the significant and positive direct association between psychological satisfaction in PE and SWM. Conversely, school-related boredom displayed a strong negative association with general SWM, standing out as the most powerful determinant in the structural model. Overall, school-level boredom and PE-level boredom emerged as convergent factors that directly compromised both SWM and psychological satisfaction in PE. On the other hand, the satisfaction domains between the two environments were positively correlated, suggesting a motivational spillover effect where enjoyment in physical activities is interconnected with greater cognitive engagement in general school tasks during crises.

Finally, the convergent validity and composite reliability of the model's latent constructs were further examined. The CR values were acceptable for all constructs: SWM (CR=0.724), School Work Boredom (CR=0.602), PE Psychological Satisfaction (CR=0.847), and PE Boredom (CR=0.818). Regarding the Average Variance Extracted (AVE), PE Psychological Satisfaction (AVE=0.543) and PE Boredom (AVE=0.502) met the recommended threshold of ≥ 0.50. The AVE values for SWM (AVE=0.351) and School Work Boredom (AVE=0.348) were below the cutoff; however, given the exploratory nature of the study, the small number of items per subscale (three items), and the young age of the participants, these values were considered acceptable for the exploratory scope of the study.

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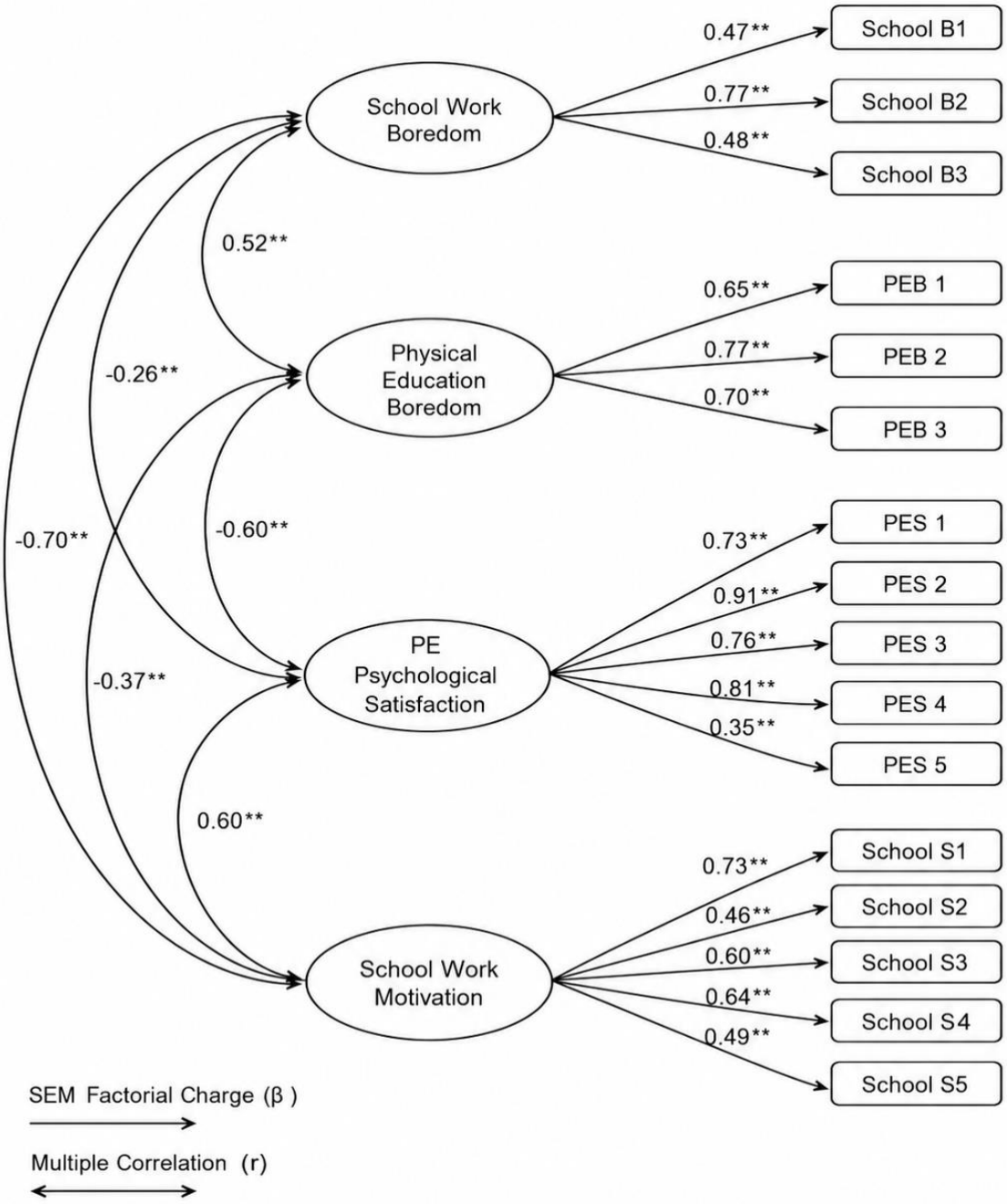

Figure 1. Structural Equation Model to the associations and reliability of psychological Satisfaction in Physical Education with School Work Motivation during Pandemic COVID-19. ** significance level is equal to 0.001. PES. Physical Education Satisfaction; PEB. Physical Education Boredom.

Discussion

The objective of this study was to verify the association between psychological satisfaction in PE and SWM in Brazilian children during the COVID-19 pandemic, following an initial methodological validation of the structural framework. The structural findings confirmed that psychological satisfaction in PE is significantly associated with SWM in children during the remote learning period. Furthermore, the SWM-PEsat questionnaire demonstrated adequate psychometric properties for children aged 6 to 12 years, showing

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convergent patterns with constructs previously observed primarily in Brazilian adolescent cohorts.[1]

Most domains of the SWM-PEsat demonstrated consistent internal structure. However, the Classroom/School Boredom domain presented a Cronbach's alpha of 0.60. This lower coefficient can be explained by the multidimensional nature of school-related boredom under emergency remote learning, which inherently reduces alpha values because this traditional index mathematically assumes strict unidimensionality.[18,19] Additionally, the restricted length of this subscale (3 items) technically constrains the maximum alpha ceiling. The domestic isolation context, where evaluations were mediated within family environments, may have also increased response heterogeneity among students.[14] Nevertheless, the full structural equation model confirmed that the modeled indicators accurately mapped their targeted concepts, showing an acceptable global fit to the empirical data and validating the instrument's application within this framework.

Regarding descriptive indicators, the high prevalence of agreement with positive statements suggests that a majority of children maintained an optimistic perception of school activities and PE engagement despite the constraints of the pandemic. This aligns with educational research indicating that positive experiences in school subjects are positively linked to psychological resources during the learning process.[4] Conversely, the small but significant percentage of students reporting high school boredom represents a vulnerable subgroup. In remote setups, high boredom scores are critically connected to diminished cognitive engagement and lower academic persistence.[8]

Interestingly, sex-based comparisons revealed that girls reported significantly higher levels of general school satisfaction and lower boredom than boys. This finding is consistent with cross-cultural evidence identifying sex differences in school connectedness during crises.[27] Girls often present higher academic resilience and adaptive coping strategies when facing structured home-based tasks.[28] However, since no sex-based differences were found in the PE satisfaction scores, both boys and girls appeared to benefit equally from the physical movement intervals provided by the adapted PE home interventions.

A major finding of this study is the significant positive association between psychological satisfaction in PE and general SWM, which supports the hypothesis of a motivational interplay between practical and theoretical learning domains.[4,5] Conversely, school boredom was identified as the strongest negative correlate of SWM, demonstrating that a tedious remote learning environment is strongly associated with a decrease in academic drive.[8] While school and PE boredom domains negatively co-vary with overall motivation, these two negative experiences were positively correlated with each other. This indicates, in the present sample, that a student who develops boredom in the general classroom is possibly highly susceptible to experiencing boredom in PE during online delivery, highlighting the importance of avoiding disconnected pedagogical practices.

The connection between PE satisfaction and academic motivation during the pandemic is consistent with international data showing that structured physical activity during lockdowns served as a protective emotional buffer against anxiety, depression, and academic burnout in youth.[29] The transition to emergency remote education severely disrupted traditional PE, but it also forced the integration of digital technologies into active movement education.[11] Utilizing virtual platforms, video guidelines, and home-adapted physical exercises emerged as an effective strategy to keep children physically active and psychologically connected to the school curriculum.[30,31] Incorporating interactive, engaging PE sessions into the virtual environment requires structured digital platforms (such as Google Classroom or stream media) to promote interactive physical learning.[30,31] Ensuring that these digital strategies trigger psychological satisfaction in PE can simultaneously protect and support overall student motivation across the broader school curriculum during extended periods of remote instruction.

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This study has certain limitations that must be acknowledged. First, the cross-sectional design limits the capacity to establish formal cause-and-effect relationships among the variables. Second, the data rely on subjective self-reports, which are susceptible to self-perception and social desirability biases. Third, because data collection occurred at home during a pandemic, parent-child dynamics may have introduced measurement bias; parents might have inadvertently influenced answers due to the perceived competitive or evaluative nature of PE activities.

To mitigate these risks, the research design included a 10-hour daily help desk managed by PE teachers to guide parents toward impartial administration. Furthermore, a major strength of this study was the use of SEM to evaluate multivariate pathways simultaneously, which optimized the estimation of structural paths based on composite observed scores and minimized the potential confounding impact of subjective report biases across the tested framework. Finally, this study provides a tested tool specifically calibrated for understudied populations of children aged 6 to 12 years under adverse conditions.

Conclusion

PE classes play a pivotal role in boosting school motivation and mitigating academic boredom during challenging remote learning periods; additionally, the SWM-PEsat questionnaire demonstrated adequate reliability and validity for this sample, serving as a methodological foundation for the tested structural paths. The empirical model underscores that psychological satisfaction in PE is positively associated with general school work motivation, even within the constraints of a global pandemic. Consequently, PE classes should be viewed as playing a central role. Educational administrators, teachers, and policymakers must prioritize and support PE within curriculum designs, recognizing its capacity to interface with student well-being and protect academic motivation during both regular and crisis-driven educational periods.

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Author Contributions
VBL: Conceptualization, methodology, data collection, statistical analysis, and writing of the original draft. CAS: Methodology, formal analysis, manuscript review, and editing. NQM: Structural validation support, visualization, literature tracking, and critical revision of the manuscript. CB: Conceptualization, methodology framework, formal validation, project supervision, and final editing of the manuscript. All authors read and approved the final version of the manuscript submitted for review.

Conflict of Interest
The authors declare that they have no competing, financial, or personal interests that could inappropriately influence or bias the research, data collection, or interpretation presented in this manuscript.

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Declaration of AI-Assisted Technologies
During the peer-review corrections of this work, the authors utilized generative artificial intelligence and AI-assisted technologies exclusively to improve the grammatical precision, syntactic clarity, and English linguistic flow, as well as to ensure alignment between the revised text and the editorial responses. The technologies (Gemini, Grammarly and language tool) were applied strictly as interactive editing and language-refining tools. The authors maintain full responsibility for the study's conceptual framework, the accuracy of the empirical data, the statistical modeling, and the final interpretations presented in the article. The authors confirm that no original content, data, or scientific conclusions were generated by artificial intelligence.

Data Availability
The anonymized datasets analyzed during the current study are available from the corresponding author upon reasonable academic request, following institutional data protection and privacy policies.