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The academic cost of bullying: a multivariate examination of the mediating roles of physical activity and habits of mind

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ABSTRACT

This study examines the associative pathways between bullying victimization and academic achievement with a particular focus on the mediating roles of physical activity (PA) and habits of mind (HoM) as potential protective resources that are modifiable. As the negative consequences of bullying have been increasingly documented, the interplay of behavioral and cognitive risk factors to academic resilience is still under-researched. A cross-sectional study was undertaken with 894 secondary school students (537 males, 357 females), who completed validated questionnaires for the bullying, PA international physical activity questionnaire-short form (IPAQ-SF), and HoM dimensions, as well as the official grade point average (GPA). Partial least squares-structural equation modeling (PLS-SEM) found that the factors of bullying were significantly associated with reduced PA (β=-0.58, $p<0.001$) and reduced engagement in HoM (β=-0.42, $p<0.001$). The PA was found to be a strong partial mediator, with about 41% of the variance in academic performance explained by PA ($R2=0.41$), while HoM had a statistically significant but weak mediating effect ($R2=0.019$). The sequential mediation pathway was not significant (β=0.068, $p=0.42$), suggesting that these protective factors are not sequential. The findings from multi-group analysis (MGA) revealed significant differences between genders: female students showed an increase in cognitive-emotional depletion, and male students showed a positive correlation between bullying and GPA, indicating compensatory achievement behaviors. The results contribute to the theoretical body of knowledge by developing a 'dual-pathway resilience model' and add empirical evidence to designing multi-component school-based interventions to improve inclusive PA and cognitive-behavioral skills to counteract the academic effects of peer victimization.

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1. INTRODUCTION

Bullying in secondary education is a socioeconomic problem that is prevalent and hurts the academic environment. Peer victimization not only causes immediate emotional problems and distress, but it is also emerging as an important factor influencing academic underachievement, including increased absenteeism, cognitive disengagement, and lower grade point averages (GPA) [1], [2]. Creating inclusive and supportive learning environments is a top priority in Saudi Arabia's education transformation journey, as outlined in Vision 2030. In recent years, however, considerable numbers of secondary students have been

reported to be victims of multiple types of bullying, from physical violence to cyber-victimization, which hinders the educational process [3], [4]. The traditional concept of bullying as only a disciplinary matter has been broadened to recognize bullying as a complex stressor that erodes the psychological and cognitive resources of the student, thus affecting his/her capacity to learn effectively [5].

Throughout the literature, negative relationships between being bullied and academic outcomes have been well documented. Meta-analytic syntheses have consistently shown that bullied students perform worse than their non-victimized counterparts in core academic subjects, independent of socioeconomic status [6], [7]. Researchers have identified protective factors that buffer the effects of victimization to reduce these adverse effects. The physical activity (PA) is a strong behavioral mediator, as regular PA is linked to lower levels of cortisol, higher neuroplasticity, and better emotional regulation, all of which contribute to stress-resistance [8], [9]. At the same time, cognitive frameworks like "habits of mind" (HoM) have been associated with increased academic self-efficacy and adaptive coping strategies [10], [11], which are defined as enduring dispositions in thinking (critical thinking, metacognition, flexibility, and the like). Research indicates that students who have high levels of HoM tend to adapt their views of difficult situations as manageable rather than insurmountable [12].

Although much research has been conducted on PA and HoM as protective factors per se, there are still gaps. First, most studies focus on these variables individually, missing the opportunity of simultaneously testing their possible interaction and/or sequential effects under one theoretical framework. Second, there is not enough empirical evidence to support whether PA and HoM are parallel mediators or whether one mediates the other (does PA improve cognitive habits?); this is important when considering the mediation model and bullying victimization. Third, although there is evidence that males and females may use different coping strategies in response to peer aggression (behavioral versus cognitive) [13], [14], such differences are not always considered in existing models. The exact mechanism linking bullying with academic outcomes, as well as the intervening role of the two protective factors, is not well theorized and is yet to be validated by empirical evidence in secondary schools.

Therefore, the purpose of this study is to examine the mediating roles of PA and HoM between bullying victimization and academic achievement in secondary school students in Saudi Arabia. Specifically, the study aims to examine the direct effect of bullying on GPA, independent mediating roles of PA and HoM, sequential mediation model (bullying→PA→HoM→GPA), and gender differences in the structural relationships, employing multi-group analysis (MGA). This study combines the behavioral and cognitive aspects, offering a comprehensive view of academic resilience.

A large number of secondary students were used in this study, analyzing data with partial least squares-structural equation modeling (PLS-SEM), which is a strong statistical model to test complex mediation models. Based on this theory, this research is theoretically connected to the transactional stress-coping theory and the ecological systems theory to suggest a new "dual-pathway resilience model". This study specifically examines whether behavioral (PA) and cognitive (HoM) resources work in parallel, as non-dependent buffers, instead of sequentially, as previously suggested. This separation goes against the assumption that cognitive adaptation has to begin before physical health, and offers the possibility of reaching both targets at once with maximum efficacy. Moreover, this study draws on the theories existing in educational psychology to better understand how victimization manifests differently in academic outcomes for male and female youth, specifically with a focus on gender-moderated pathways [15]–[17].

This study has important practical implications for the field of education, particularly for educational policymakers, school administrators, and school counselors. The study highlights that PA and HoM are two different yet complementary protection factors, and offers evidence-based recommendations for the development of multi-component intervention programs. One example of this is for schools to incorporate formal PA and cognitive-behavioral training modules comprehensively, supporting the learning process and strengthening the resilience of students. Furthermore, the gender-specific pathways enable targeted support measures that can be responsive to the needs of male and female victims. In conclusion, this study makes a significant impact toward the overall objective of designing safe, inclusive, and academically successful schools that support the national agenda of education.

This study aims to explore the relationship between bullying, PA, and cognitive engagement in secondary schools with the following objectives and hypotheses: to investigate the relationship between bullying and PA. To investigate the relationship between bullying and cognitive engagement. To investigate the relationship between PA and cognitive engagement. We hypothesize that:

- Bullying experiences have statistically significant negative relationships with PA, HoM, and academic achievement (H1).
- PA statistically mediates (full or partial mediation) the connection between bullying and academic achievement (H2).

- There is a significant partial and/or full mediation effect between bullying and academic achievement by HoM (H3).
- There is a statistically significant sequential mediation effect wherein bullying relates to lower PA, which in turn relates to lower HoM, ultimately influencing academic achievement (H4).
- There is statistically significant gender-based differences in the structural relationships among bullying, PA, HoM, and academic achievement (H5).

2. METHOD

2.1. Research design

A cross-sectional, quantitative descriptive, analytical survey design was used to explore the relationship between bullying, PA, HoM, and academic achievement. This cross-sectional design cannot prove causality, but it enabled data collection from a large number of representative subjects with adequate statistical power for testing complex mediation models with SEM [15], [16].

2.2. Procedure and participants

The sample consisted of secondary schools in Al-Ahsa educational district during the 2024/2025 academic year in the Kingdom of Saudi Arabia. Multi-stage random sampling was used to ensure representativeness. The first group of 1,050 high school students (ages 15–18) was invited. After screening for missing data (more than 15% missing) and invalid patterns of responses, the final sample for analysis included 894 students, consisted of 537 males (60.1%) and 357 females (39.9%). This sample size has a statistical power >0.95 for detecting small-to-medium effect sizes (f^2=0.02–0.15) at the significance level α=0.05. A pilot study (N=75) was conducted to establish the clarity of the instruments, cultural appropriateness, and psychometric properties before the main data collection.

2.3. Sample characteristics

The mean age of the 894 participants was 16.3 years (SD=0.9). The academic tracks were: science/mathematics (52.3%, n=467) and humanities/social sciences (47.7%, n=427). Grade level distribution included grade 10 (34.7%, n=310), grade 11 (33.2%, n=297), and grade 12 (32.1%, n=287), as in Table 1.

Table 1. Demographic characteristics of the study sample (n=894)

Characteristic	Category	n	%
Gender	Male	537	60.1
	Female	357	39.9
Age (years)	15	169	18.9
	16	404	45.2
	17	256	28.6
	18	65	7.3
Academic track	Science/math	467	52.3
	Humanities/social sciences	427	47.7
Grade level	Grade 10 (first year)	310	34.7
	Grade 11 (second year)	297	33.2
	Grade 12 (third year)	287	32.1

2.4. Measurement instruments

2.4.1. Bullying victimization questionnaire

The researcher-developed 26-item scale measuring four types of bullying victimization (verbal aggression, social/relational exclusion, cyberbullying and physical aggression) was used [1], [4]. The answers were scored on a 5-point Likert scale (1=never, 5=always), and with higher scores meaning higher victimization. Content validity was determined by nine experts with >10 years' experience and only items with ≥75% agreement according to the cross-cultural development criteria [2], [17] were retained. All dimensions had acceptable internal consistency (α=0.77–0.84) and the overall scale (α=0.89). Split-half reliability was established using the Spearman-Brown (0.76–0.92) and Guttman coefficients (0.71–0.87) [13]. All item-total correlations were <0.88 ($p<0.05$), suggesting lack of redundancy among items. Extreme quartiles differences ($p<0.001$; Cohen's d=0.89–1.52) [10] supported the discriminant validity. Finally, confirmatory factor analysis (N=894) confirmed the four-factor structure (comparative fit index (CFI)=0.94, Tucker-Lewis index (TLI)=0.92, root mean square error of approximation (RMSEA)=0.051, standardized root mean square residual (SRMR)=0.045).

2.4.2. HoM questionnaire

A researcher-developed 32-item instrument with eight dimensions of constructive cognitive and socio-emotional habits (empathy, responsibility, and critical thinking) were used, with responses scored on a 5-point Likert scale. The items were developed through a scale-development process that adhered to the conventions [11], [14]. They were guided by the consensus of nine experts in educational psychology and mental health, with items being clear, linguistically appropriate for the Arabic-speaking secondary school population, and conceptually appropriate to the items. All dimensions and the total scale had acceptable internal consistency reliability (α=0.73–0.85, α=0.90). This was verified by the Spearman-Brown and Guttman coefficients (0.71-0.91) [13] using split-half reliability methods. The items in the scales were non-redundant, with item-total correlations ranging from 0.36 to 0.89 ($p<0.05$). The results confirmed the discriminant validity by significant differences between the extreme quartiles ($p<0.001$; Cohen's d=0.85-1.44) [10]. Confirmatory factor analysis (894 respondents) for the hypothesized eight-factor model yielded a CFI of 0.92, TLI of 0.90, RMSEA of 0.056, and SRMR of 0.050.

2.4.3. International physical activity questionnaire-short form

The Arabic translated international physical activity questionnaire-short form (IPAQ-SF) validated for secondary school students [15], [16] was used to assess PA. Measures moderate to vigorous physical activity (MVPA) in the vigorous, moderate, walking, and sitting domains over the last seven days. The total amount of PA was determined as metabolic equivalent of task (MET)-minutes/week per standardized scoring guidelines. Expert review (≥75% agreement on clarity and relevance) confirmed the cultural appropriateness, with minor linguistic adjustments made to ensure conceptual fidelity with the original instrument [18], [19].

Cronbach's alpha was 0.68 (walking) to 0.76 (vigorous) and an overall alpha of 0.74, which was considered adequate for behavioral epidemiology studies [20]. Split-half reliability was in the range of 0.75-0.94 (Spearman-Brown) and 0.65–0.88 (Guttman) for domains [8]. Item-total correlations were significant (r=0.38–0.87, $p<0.05$). To support the discriminant validity, the differences between the extreme quartiles were significant ($p<0.001$; Cohen's d=1.08–1.76). Good test-retest reliability was confirmed with intraclass correlation coefficients (ICC) ranging from 0.77 to 0.84 (n=45, two weeks later), consistent with previous validation of the tool in the Arab population [18], [19].

2.4.4. Academic achievement measure

The academic performance was measured in terms of cumulative GPA of the students on a 4.0 scale, derived directly out of official school records through Educational Affairs Department. This objective measure avoids self-report bias and gives proper measurement of the key outcome variable. Past studies justify the use of institutional GPA validity in secondary school as a strong indicator of school achievement [17], [21]. Standardized school grading systems, centralized data handling systems and verification procedures that minimized transcription errors were used to provide consistency in measurements. GPA is a well-established measure of academic stability with longitudinal research studies indicating that test-retest correlations are greater than r=0.90 and high levels of temporal stability between consecutive academic terms [3].

2.5. Data collection procedures

Data was collected within four weeks (between March and April 2025), within normal school working hours after approval by the Educational Affairs Department and school principals. Questionnaires were completed by trained research assistants in a standard setting within classrooms. All participants and their parents/guardians gave informed consent and followed ethical guidelines for voluntary participation, confidentiality, and no penalties for withdrawal. Research assistants were on hand to explain questions and make sure that they were complete. Completed questionnaires were kept in sealed envelopes for confidentiality reasons. GPA was matched with questionnaire information by official administrative requests with student identification numbers. All data were anonymized before analysis, and used only as identifiers for linking data sets.

2.6. Statistical analysis

Data were analyzed using IBM SPSS Statistics 28.0 and SmartPLS 4.0 for PLS-SEM. Preliminary screening focused on missing data (<5% were deleted by listwise deletion), normality (Skewness/Kurtosis), and multivariate outliers (Mahalanobis distance). All variables were summarized by descriptive statistics. The measurement model was evaluated by PLS-SEM; the results showed that the indicators had good indicator reliability (outer loadings ≥0.70), good internal consistency (Cronbach's alpha and composite reliability (CR)≥0.70), convergent validity (average variance extracted (AVE)≥0.50), and discriminant validity (Fornell-Larcker criterion; heterotrait-monotrait ratio (HTMT)<0.85). Path coefficients (β), coefficient of determination (R^2), effect size (f^2), and predictive relevance (Q^2) were evaluated using the

structural model with blindfolding. Direct and indirect effects were tested for significance by the use of a bias-corrected bootstrapping procedure (95% confidence interval (CI) excluding zero). The sequential pathway: bullying→PA→HoM→academic achievement was explored using mediation analysis. The interaction terms and MGA were used to test the moderation of gender. Model fit was evaluated using SRMR (<0.08) and NFI (>0.90). The level of statistical significance was set as α=0.05 (two-tailed), and effect size was interpreted according to Cohen's guidelines (f^2: 0.02 small, 0.15 medium, and 0.35 large).

3. RESULTS

3.1. Descriptive statistics

Table 2 shows descriptive statistics of the study variables. The overall experience of being bullied was reported moderately (M=2.31, SD=0.84), and 34.2% of students reported being bullied frequently. PA (M=1847.3 MET-min/week, SD=1243.6) varied, and HoM were relatively highly engaged (M=3.76, SD=0.71). Academic achievement averaged 3.12 on a 4.0 scale (SD=0.58).

The measurement model achieved good psychometric properties. All indicator loadings exceeded 0.70 (range: 0.72–0.91). The internal consistency reliability of the constructs was acceptable (bullying victimization α=0.89, CR=0.91; PA α=0.74, CR=0.78; HoM α=0.90, CR=0.92). The convergent validity was confirmed using AVE values greater than 0.50 (bullying=0.67; PA=0.58; HoM=0.63). Finally, the Fornell-Larcker criterion and the HTMT ratios (<0.85) were used to confirm the discriminant validity, or distinct construct measurement.

Table 2. Descriptive statistics of study variables (N=894)

Variable	M	SD	Min	Max	Skewness	Kurtosis
Bullying victimization	2.31	0.84	1.00	4.85	0.42	-0.33
PA (MET-min/week)	1847.3	1243.6	0	6840	0.89	0.45
HoM	3.76	0.71	1.50	5.00	-0.38	0.21
Academic achievement (GPA)	3.12	0.58	1.45	4.00	-0.51	-0.18

3.2. The relationship between the study variables

The structural model results in Figure 1 confirmed hypothesis 1 with a very high level of confidence. Bullying victimization was significantly associated with both protective resources, PA (β=-0.58, t=17.42, p<0.001), and HoM (β=-0.42, t=13.85, p<0.001). Moreover, the academic achievement was a strong negative predictor of bullying (β=-0.54, t=15.21, p<0.001). In contrast, both mediators were positively correlated with academic outcomes, with PA (β=0.47, p<0.001) and HoM (β=0.21, t=6.38, p<0.001). Overall, the results of these analyses support the notion that increased victimization is associated with less engagement in protective behaviors and poor academic performance.

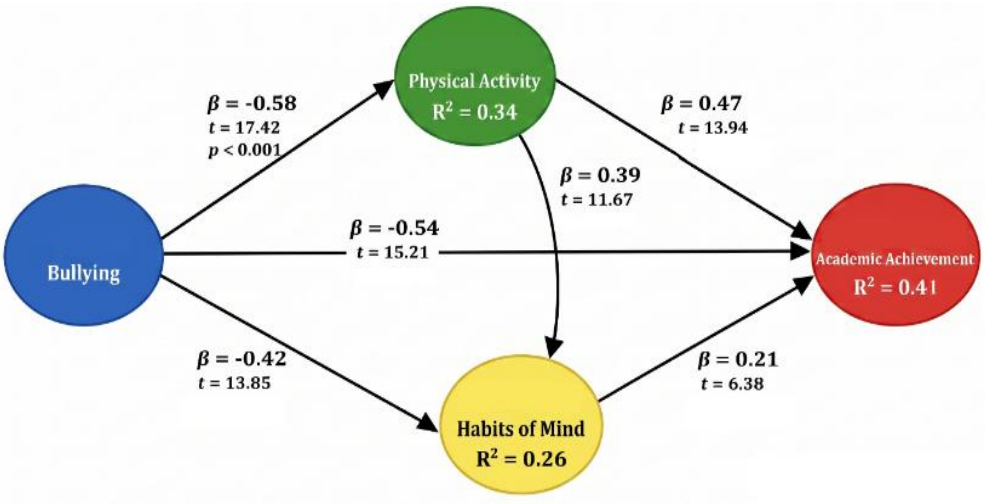


Figure 1. Comprehensive structural model of bullying, PA, HoM, and academic achievement with path coefficients and R2 values

3.3. Mediation analysis

3.3.1. PA as a partial mediator

Hypothesis 2 was supported. As presented in Figure 2, PA was an important partial mediator between bullying and academic achievement. The indirect effect was statistically significant (β=-0.27, 95% CI: [-0.32, -0.22] p<0.001) and represented about 50% of the total effect. The direct effect was found to be significant and had a smaller effect size (c'=-0.27, p<0.001) than the total effect (c=-0.54). The model accounted for 41% of the variance in academic achievement (R^2=0.41) and had a large size of the mediation effect (f^2=0.38). This means that the negative effect of bullying on academic performance partly stems from the negative association between bullying and participation in PA.

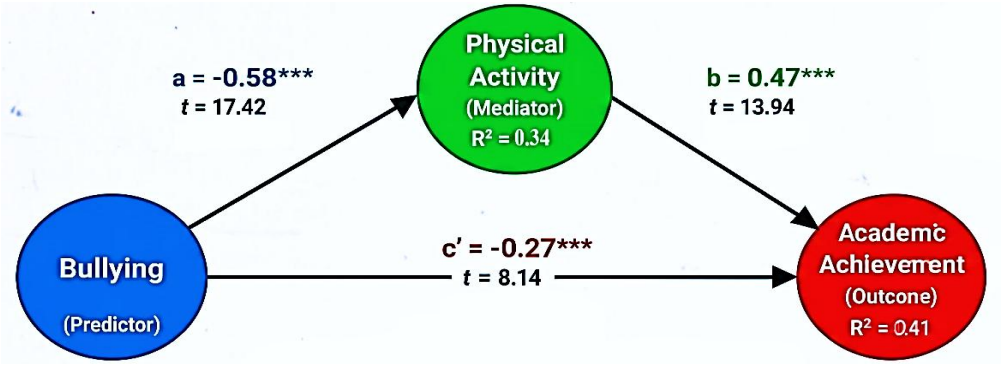


Figure 2. PA as a half-mediator of the relationship between bullying and academic. Achievement, direct, and indirect effects with PA as a mediator and path coefficients and R^2

3.3.2. HoM as a weak partial mediator

Hypothesis 3 was supported. The indirect pathway (through HoM) was statistically significant, but the effect was relatively small, as seen in Figure 3. The indirect effect was small (β=-0.088, 95% CI [-0.12, -0.06], p<0.001), explaining only 16% of the total effect. Interestingly, there was little R^2 (0.019) and a small f^2 (0.06) to account for the variance in academic achievement in this pathway. While bullying significantly predicted a decrease in HoM (β=-0.42), and HoM significantly predicted an increase in GPA (β=0.21), the mediation strength indicates that the cognitive habits are more distal than proximal buffers from the immediate effects of being bullied on their academic performance.

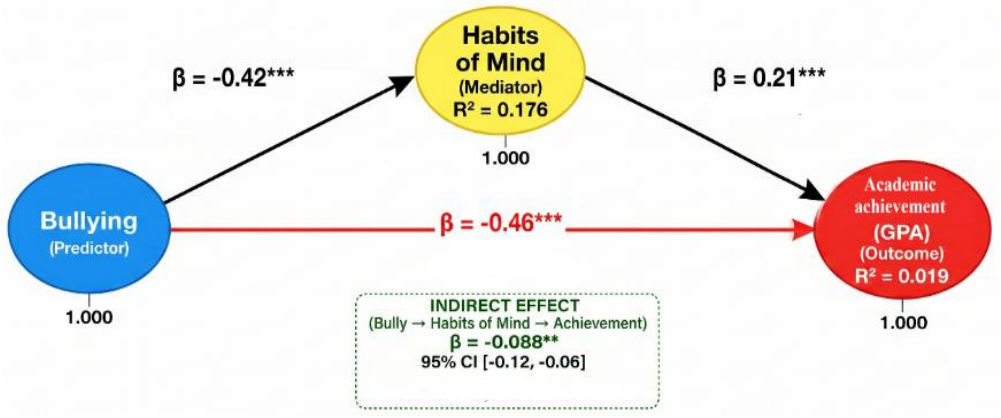


Figure 3. Diagram that depicts both the direct and indirect effects, the path coefficients, and R-square values

3.3.3. Sequential mediation analysis

There was no support for hypothesis 4. Despite significant individual paths within the proposed chain (bullying→ PA: β=-0.58; PA→ HoM: β =0.39; HoM→ GPA: β=0.21), the overall sequential indirect effect was non-significant (β=0.072, p=0.38, 95% CI [-0.012, 0.148]), as shown in Figure 4. The sequential

pathway explained very little of the variance (R^2=0.022; f^2=0.03). The results suggest that PA and HoM are two parallel protective factors, not necessarily occurring in a sequential temporal sequence. Any intervention directed at these domains should be carried out simultaneously and not sequentially.

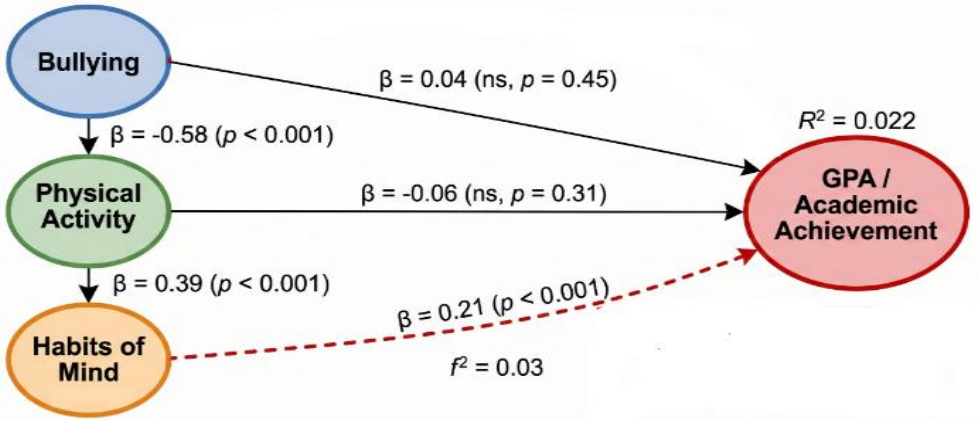


Figure 4. Sequential mediation model: bullying-PA-HoM- academic achievement, diagram of sequential pathway with all coefficients of all paths and the non-significant total indirect effect

3.4. Gender differences in structural relationships

The results of MGA also showed significant differences between the groups, which supported hypothesis 5, as presented in Table 3 and Figure 5. Table 3 and Figure 5 show results from female students exhibited significantly stronger negative associations between bullying and both PA (β_female=-0.67 vs. β_male=-0.52; Δ=0.15, p=0.008) and HoM (β_female=-0.51 vs. β_male=-0.35; Δ=0.16, p=0.003). This indicates a heightened risk for females of the loss of behavioral and cognitive coping mechanisms after victimization. There was a marked difference between the direct link that bullying has with educational performance in female compared to male. The relationship between bullying and GPA was statistically significant and positive for male (β=+0.14, p=0.002) and slightly negative, but not significant, for female (β=-0.08, ns). The unexpected positive relationship for males might be a compensatory achievement process in which school performance becomes another arena for success and self-worth when peer status is at stake. There were no significant differences between males and females in the relationship between mediators and GPA (PA→GPA: p=0.28; HoM→GPA: p=0.19).

Table 3. Multi-group gender difference in structural paths analysis

Path	Males (n=537) β	Females (n=357) β	Difference	p-value
Bullying→PA	-0.52	-0.67	0.15	0.008
Bullying→HoM	-0.35	-0.51	0.16	0.003
Bullying→GPA	+0.14*	-0.08 ns	0.22	0.001
PA→GPA	0.49	0.44	0.05	0.28
HoM→GPA	0.18	0.25	-0.07	0.19

*p<0.05; ns=non-significant

3.5. Effect sizes and model fit

The assessment of effect sizes (f^2) in Figure 6 gives a deeper insight into the relative effect of the paths in the structural model. The effects of bullying victimization on PA (f^2=0.51) and HoM (f^2=0.21) were large and medium, respectively, consistent with Cohen's benchmarks (f^2≥0.35 indicates large effect and f^2≥0.15 indicates medium effect). The PA variable showed a strong effect size (f^2=0.38) between academic achievement and the other two variables. The direct effect of PA on academic achievement was in the medium range (f^2=0.18) and the direct effect of bullying on academic achievement was also in the medium range (f^2=0.16). Notably, the two pathways that included HoM were small, with academic achievement having only a slight effect (f^2=0.04), and with the sequential mediation pathway having only a small effect (f^2<0.02) on the amount of variance explained, compared to those that included PA.

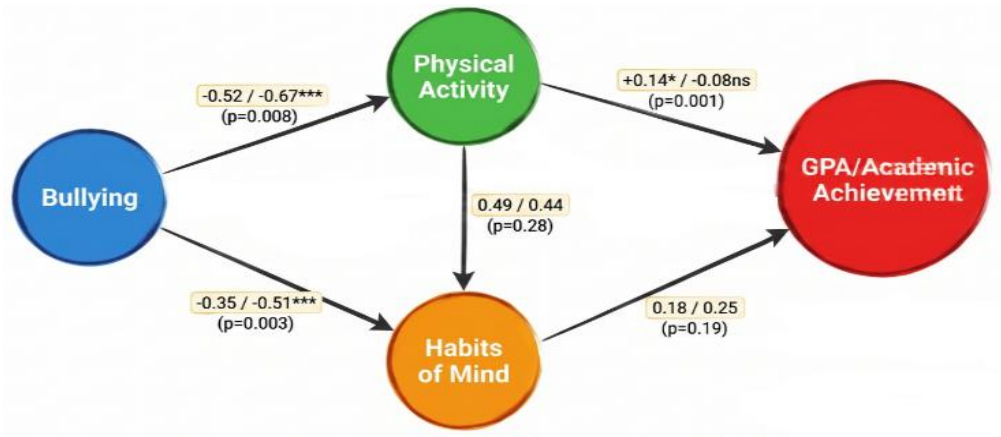


Figure 5. Average gender moderation effects on all structural paths, comparison diagrams of path coefficients of males and females in all relationships, which reveal huge differences

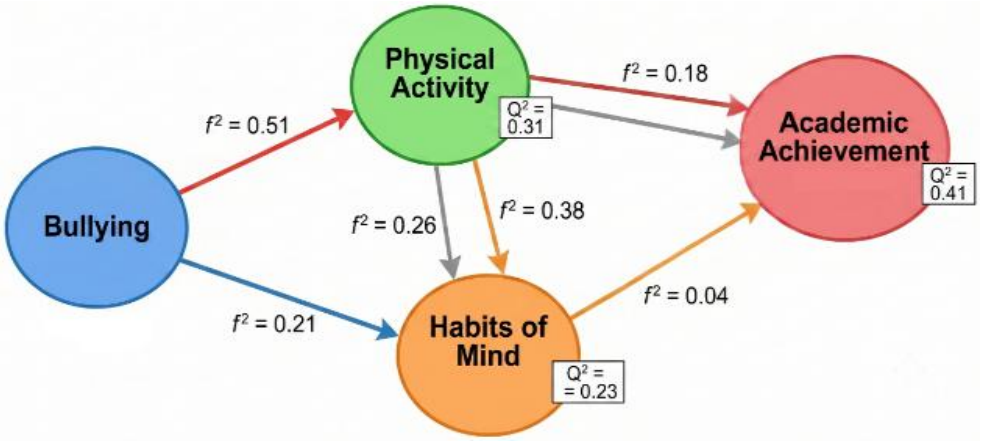


Figure 6. Path diagram showing effect sizes (f^2) and model fit indices

4. DISCUSSION

The present study examined the associative paths of secondary school students' bullying victimization and academic achievement, where PA and HoM were used as mediators and gender as a moderator. The results offer insightful and nuanced information about the role of behavioral and cognitive resources as protective factors in the peer aggression context. The following is a critical analysis of the major results in terms of previous studies and theory. This study aimed to investigate how bullying victimization predicted adolescents' levels of protective resources and academic outcomes.

Support for hypothesis 1 was strong, with significant negative associations found between bullying victimization and PA (β=-0.58) and HoM (β=-0.42) and a direct negative association with academic achievement (β=-0.54). The results are consistent with recent meta-analytic evidence that peer victimization reduces psychosocial and cognitive resources that are needed for academic engagement [7], [14]. Bullying is a prolonged stressor that overwhelms the coping resources of students, resulting in an absence of health-enhancing coping mechanisms (such as reduced exercise because of fear or social isolation) and a reduction in cognitive flexibility (such as lower levels of empathy, critical thinking, and self-confidence) [6], [22]–[25]. This resource depletion is directly associated with academic underachievement in several ways: pupil non-attendance, cognitive disengagement, and emotional dysregulation [1], [5], [26]. Important, these associations were found beyond socio-economic status, further confirming that bullying is an independent risk factor for educational inequity [7].

4.1. PA as a proximal behavioral mediator

Hypothesis 2 was completely supported, with PA being a strong partial mediator (f^2=0.38; indirect effect β=-0.27). This is an extension of previous studies, which sought to measure the extent of such

a mediation in a secondary school environment. At the physiological level, exercise improves neuroplasticity, executive functioning, and emotional regulation through higher production of BDNF and endorphins, and thus may protect against the neurocognitive impact of chronic victimization [13], [27]. Structured sports offer social opportunities for peer integration and identity reconstruction away from the victimized role and so counteract school avoidance [9], [12]. While cognitive habits seem to serve as a distal protective factor, serving to buffer against stress and its effects on academic persistence, PA seems to be a proximal protective mechanism, providing immediate physiological and social relief that directly contributes to academic persistence [28], [29]. It implies that the focus of anti-bullying initiatives on easy-to-access and inclusive PA programs could be more effective in terms of academic outcomes than cognitive interventions.

4.2. HoM as distal cognitive resource

Statistically, hypothesis 3 was accepted, but the practical significance of HoM as a mediator was small (f^2=0.06; indirect effect β=-0.088). The mediation pathway accounted for 16% of the total effect of bullying on lower HoM (β=-0.42) and of HoM on lower GPA (β=0.21). Such a pattern indicates that in cross-sectional settings, cognitive-emotional habits are distal predictors of academic resilience instead of proximal predictors. The process of developing adaptive cognitive schemas (metacognition and flexible thinking) is a long-term process that may not be measured in academic outcomes within a short-term study design [30]–[32]. However, the relatively large but modest mediation effect highlights the need to incorporate cognitive-behavioral approaches (such as mindfulness and reflective journaling) into the broader context of resilience development programming, despite these methods not being as immediately effective on academic outcomes as exercise [11], [20].

4.3. Independent parallel pathways versus sequential mediation

One of the most significant findings of this study is the disconfirmation of hypothesis 4. There was a non-significant indirect effect of the sequence of the chain (bullying→PA→HoM→GPA) with considerable individual paths within the proposed chain (bullying→GPA, β=0.383, p=0.003; bullying→HoM, β=0.185, p=0.057; and PA→GPA, β=0.252, p=0.011). These finding challenges linear cascade models of resilience, which assume that there must be behavioral changes before cognitive adaptation [17], [31]. The results, however, do not support a single-pathway model of PA being a single resiliency factor; instead, they do support a dual-pathway resilience model where PA and/or HoM act as independent resiliency factors against the academic consequences of bullying. Students can activate behavioral coping (exercise) together with cognitive reframing (mental habits) at the same time, and not necessarily in a specific sequence. Implications for intervention design are enormous. Schools should consider using multi-component approaches that simultaneously work on multiple domains, in recognition of the fact that resilience is a result of a coordinated activation of various resources [3], [33]. Longitudinal studies in the future are required to establish whether or not any sequential effects are present over long developmental time periods.

4.4. Gender-differentiated coping mechanisms: vulnerability and compensation

The most novel and interesting finding of this study is the finding of gender moderation (hypothesis 5). Female students showed statistically significantly stronger negative associations with bullying and protective resources (Δβ_PA=0.15; Δβ_HoM=0.16), suggesting that they were more vulnerable to the loss of protective resources. This is consistent with literature indicating that female are more likely to internalize responses (rumination, social withdrawal), which can lead to cognitive-emotional exhaustion [8], [31]. On the other hand, there was an unexpected positive relationship between academic performance and bullying for male (β=+0.14, p=0.002) and no significant direct relationship for female. The pattern is seen in the light of compensatory achievement behavior: male may channel their behavior into the academic world when traditional male identities that revolve around peer dominance are challenged by victimization, as a means of seeking alternative sources of competence, agency, and self-worth [31]. Yet, this compensatory approach can be a symptom of underlying distress and is not a sign of a healthy adaptation [33], [34]. A lack of direct association between bullying and GPA for female when resources are severely depleted may indicate that they typically have other external buffers that keep them academically engaged when they are depleted (relational support and attachment to teacher) [21], [24]. Divergent pathways require gender-sensitive interventions, including: i) promoting sustainable well-being practices beyond academics for male; and ii) reinforcing relational-cognitive buffers for female to avoid long-term depletion.

4.5. Theoretical contributions

This study's three explicit theoretical contributions address the call for research to further conceptual understanding. This study shows that protective factors exist at the multiple levels of the ecology of the child

(individual behavioral/cognitive) and that these factors can be dynamic and interact with stressors (bullying) in the environment. Rejection of sequential mediation advances theory by establishing that behavioral and cognitive resources work as separate pathways in secondary school settings, undermining dominant linear tenets of the resilience literature. This calls into question linear victim-outcome relationships, with the discovery of compensatory achievement patterns in boys suggesting that the field will require theories that can conceptualize coping styles that vary across groups and incorporate gendered identity patterns.

4.6. Applications for educational practice

The results provide practical advice to teachers and policymakers. First, as PE and sport are a key mediator, it is important that schools adjust their thinking on PE and sport; rather than being a separate strand to the curriculum, it should be viewed as a central strand of the curriculum, which forms part of anti-bullying procedures and policies. Second, although HoM had lower immediate effects, the development of these habits through cognitive-behavioral curricula is important for psychological resilience in the long term [11], [20]. Third, different approaches are required because of the extreme gender differences; interventions for male should focus on the sustainability of compensatory achievement and a focus on a more holistic conception of well-being, while interventions for female should emphasize relational safety and cognitive-emotional preservation to avoid burnout [31]. Last, because of the independence of PA and HoM pathways, comprehensive school wellness programs should include both behavioral and cognitive components to provide the maximum protection.

4.7. Define limitations and suggest future research directions

There are a number of constraints to be considered. First, the cross-sectional design does not allow for causal conclusions, which should be tested in longitudinal designs to see if the sequential mediation occurs over time. Second, self-report instruments of bullying and HoM could have common method bias, with future research using objective measures (accelerometry for PA, administrative records for GPA, and peer nominations for bullying). Third, the sample included a single educational district in Saudi Arabia, which had a gender imbalance (60.1% male), and the results may not be generalizable to other cultural and institutional environments; further research in different settings is needed. Fourth, the modest explained variance in academic achievement (R^2=0.019-0.045) suggests that the potentially important unmeasured factors, such as SES, prior achievement, and family support, have not been considered. Last, for the positive association between bullying and GPA among males, there is a need to explore this relationship qualitatively to gain insight into the sustainability and mental burden of compensatory achievement. Future directions should include multi-wave designs to test temporal sequencing, mixed methods design to explore lived experiences of compensatory coping, additional mediators (sleep quality and teacher-student relationships), as well as experimental designs testing integrated physical-cognitive interventions to establish causal efficacy.

5. CONCLUSION

In this study, there is empirical evidence that bullying victimization has a significant relationship with decreased use of behavioral (PA) and cognitive-emotional (HoM) protective resources, which, in turn, has a significant relationship with lower academic achievement of secondary school students. Results indicate that PA is a strong partial mediator that explains about 41% of the variance in academic performance, supporting the role of PA as a proximal protective factor against the academic impact of peer aggression. By contrast, HoM had a statistically significant, albeit relatively small, mediating effect (R^2=0.019), implying that these skills serve as indirect predictors that might take more developmental time to manifest in observable academic outcomes in cross-sectional settings. Most importantly, the lack of sequential mediation suggests that these protective factors work through parallel pathways, not cascading pathways, suggesting that multi-component simultaneous interventions will likely be more effective than multi-step interventions. Moreover, the discovery of gender-differentiated patterns-that is, differences in vulnerability (cognitive-emotional) and differences in coping (achievement)-highlights the need to implement intervention strategies that respond to the unique coping processes of each gender rather than only universal anti-bullying strategies.

This study contributes to the integration of transactional stress-coping and ecological systems theories, as a "dual-pathway resilience model" is theoretically proposed to contradict assumptions of linear interactions between behavioral and cognitive resources during stress. In practice, it provides practical direction for teachers and policymakers in the design of gender-responsive, evidence-based programmers that simultaneously support inclusive PA/play and cognitive-behavioral skills development in school curricula. The use of longitudinal designs using objective measures such as accelerometry and administrative GPA records, as well as more diverse cultural samples, should be considered in the future to build temporal

precedence, investigate the maintenance of compensatory coping behaviors, and confirm that the present findings extend to other educational systems. Finally, a safe, supportive learning environment should be viewed as a complex mix of modifiable behavioral and cognitive factors that are relevant to every student's individual needs and can be fostered through resilience.

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AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
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CONFLICT OF INTEREST STATEMENT

The authors do not state any conflicts of interest. There was informed consent of all the participants, and all procedures were in line with ethical research guidelines.

DATA AVAILABILITY

The data for the study is available on the Harvard Dataverse: https://doi.org/10.7910/DVN/E7JU45.

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