

From Burnout to Balance: The Role of Peer-Assisted Learning in College Life

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Abstract

Background

Academic burnout (ABO) poses a significant threat to student well-being and performance, particularly among premedical undergraduates. While informal peer-assisted learning (IPAL) may mitigate this burden, limited research has explored this relationship in nonmedical student populations.

Methods

We conducted a cross-sectional survey of 245 undergraduate students at the University of Puerto Rico, Río Piedras Campus. ABO was measured using the nine-item School Burnout Inventory (SBI-9). IPAL engagement was assessed through a single-item measure. Internal consistency, item correlations, and confirmatory factor analysis (CFA) were performed to validate the SBI-9. ABO levels were analyzed by age, gender, academic year, study preference, and IPAL engagement.

Results

The SBI-9 demonstrated high internal consistency (Cronbach's $\alpha = 0.872$) and a validated three-factor structure. Overall, ABO levels increased slightly across academic years, with the highest scores observed in fifth-year students. Female students reported significantly higher ABO than males, particularly in the first two years. Globally, students who never engaged in IPAL reported significantly higher ABO scores (mean = 48.41%) compared to those with occasional or frequent IPAL engagement (mean = 42.48%, $p = 0.0384$). A similar trend was observed in students who preferred studying alone.

Conclusions

Informal peer-assisted learning may serve as a protective factor against academic burnout among undergraduate students. Gender differences and study habits further influence ABO vulnerability. Early peer-based interventions may promote academic resilience and psychological well-being in premedical populations.

Background

Academic burnout (ABO) is a growing concern in higher education, closely linked to poor academic performance, mental health deterioration, increased dropout rates, and even suicidal ideation [1,2]. Characterized by emotional exhaustion, depersonalization, and a diminished sense of accomplishment, ABO has been shown to negatively predict academic achievement, including performance on exams, course grades, and overall GPA [3,4]. Addressing ABO is therefore essential to safeguarding students' academic success and overall psychological well-being.

The nine-item School Burnout Inventory (SBI-9) is a widely used and validated instrument for assessing ABO, encompassing three core dimensions: exhaustion, cynicism, and inadequacy [5–8]. These dimensions are conceptually aligned with established models such as the Maslach Burnout Inventory [9]. They also reflect the World Health Organization's ICD-11 classification of burnout as an occupational phenomenon resulting from chronic, unmanaged workplace stress [10]. As such, the SBI-9 provides a robust framework for assessing burnout in educational settings.

As ABO gains increasing attention in higher education research, recent studies have reported a high prevalence among university students, driven by a combination of academic and psychosocial stressors [11], with lasting repercussions for students' educational and professional trajectories [12]. This burden is especially pronounced among students in health-related disciplines. In the United States, burnout among medical students increased by 6% between 2008 and 2014 [13], and globally, nearly half of all medical students experience ABO before entering residency training [14]. Similarly, at the Universidad Central del Caribe (UCC), local data reflect this global trend: burnout prevalence among first-year medical students rose from 10.91% in 2017 to 41.34% by 2022, with second-year students showing consistently elevated levels [7,8,15].

While these findings underscore the urgency of addressing burnout in medical education, emerging evidence suggests that the psychological toll of academic pressure may begin even earlier. Among premedical students, elevated levels of depressive symptoms and burnout have been linked to reduced interest in pursuing medical careers, particularly among women [16]. Furthermore, everyday

stressors in this population (such as academic procrastination and test anxiety) are associated with heightened suicidal ideation, especially when combined with perfectionism and limited psychological coping resources [17].

Despite these concerning trends, research on ABO in Puerto Rico has focused almost exclusively on medical students [7,8,15], leaving a gap in our understanding of ABO among university students preparing for medical careers. This is particularly concerning given the established link between burnout and unprofessional behaviors in students and future healthcare providers [18]. Collectively, these findings indicate that the burden of ABO can manifest well before entering medical school, underscoring the need for early identification and targeted support within premedical populations. Therefore, there is an urgent need to examine the onset of burnout earlier in the academic timeline and identify potential protective factors that may mitigate its impact during the premedical stage.

One such protective factor is the learning environment itself. Studies have shown that a poor educational environment is strongly associated with higher levels of burnout [1,2]. Within this context, Peer-Assisted Learning (PAL) has emerged as a promising approach to support academic success and student wellness [19–23]. Informal Peer-Assisted Learning (IPAL), in particular, refers to student-led, organically formed collaborative learning through peer interactions and study groups. While less structured than formal PAL programs, IPAL fosters knowledge exchange, social support, and the development of coping skills and self-efficacy, key contributors to academic engagement and psychological resilience. Among medical students, IPAL has been associated with reduced levels of ABO and improved academic confidence, comprehension, and problem-solving abilities [7,8,24].

While PAL's benefits in medical education are documented, little is known about its impact on burnout among general undergraduate populations, particularly premedical students. Understanding how IPAL engagement may influence ABO could inform the design of low-cost, peer-driven interventions aimed at reducing academic stress and promoting student success.

This study aims to address this gap by assessing ABO among undergraduate students and examining its relationship with IPAL engagement. Specifically, it investigates two primary research questions: (1) Is the SBI-9 a valid and reliable tool for measuring ABO in this population, and (2) Is there a significant correlation between ABO and IPAL engagement? We hypothesize that students who engage in IPAL will exhibit lower levels of ABO, proposing a null hypothesis of no significant correlation and an alternative hypothesis of a significant negative correlation. By identifying modifiable factors associated with ABO, this study seeks to inform early intervention strategies that promote academic balance and psychological well-being in university students.

Methods

Survey: Measurement Tools

We conducted a cross-sectional study in January 2024, targeting undergraduate students from the Faculty of Natural Sciences at the University of Puerto Rico, Río Piedras Campus (UPR-RP).

ABO was measured using the nine-item School Burnout Inventory (SBI-9), a validated instrument designed to measure three core dimensions of burnout: Exhaustion (EX), Cynicism (CY), and Inadequacy (IN) [5]. The SBI-9 was selected for its strong psychometric properties and comprehensive structure, which provide detailed insights into ABO while minimizing potential confounding factors. To ensure its applicability within this new undergraduate sample, the internal structure and reliability of the SBI-9 were subsequently evaluated through exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). In addition to assessing ABO, the survey included questions on IPAL participation to explore collaborative learning behaviors among the participants. [7,8].

The questionnaire was administered online, and participation was voluntary. Students provided demographic information, including gender, age group, and academic year. To accommodate the bilingual context of the UPR-RP campus, the SBI-9 was available in both its original English [5] form and a Spanish-adapted version [6], adhering to established guidelines for translating and adapting assessment tools [25].

All methods and protocols were approved by the Institutional Review Board (IRB) of UPR-RP (CIPSHI #2324-057), ensuring full compliance with ethical research standards.

Rating Scale

Participants rated each item on SBI-9 using a five-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree), providing a structured and consistent measure of burnout symptoms across the EX, CY, and IN subscales. This scale provided a structured

framework for assessing participants’ perceptions across the three dimensions of burnout while ensuring a concise yet detailed representation of their responses on the five-point scale.

Measurement of Informal Peer-Assisted Learning

IPAL engagement was measured through a single survey item that asked participants about the frequency with which they explained concepts to peers during informal study sessions. This approach is aimed at capturing informal collaborative learning behaviors among undergraduate students. The question, presented in Spanish [7], was phrased as follows: “Aunque estudie solo(a), generalmente explico los conceptos a mis compañeros.” Before administering the survey, the term “compañeros” was clarified to refer to classmates.

Responses were recorded on a three-point scale: ‘never’ (NE) = 0, ‘occasionally’ (O) = 3, and ‘frequently’ (F) = 5. For analytical purposes, responses were grouped into two categories: students who reported never engaging in IPAL (NE) and those who engaged occasionally or frequently (O/F). This grouping strategy was chosen to simplify analysis while capturing distinctions in students’ engagement levels.

Study Sample

In January 2024, 245 undergraduate students from the Faculty of Natural Sciences at the University of Puerto Rico, Río Piedras Campus, participated in the study. Eligibility criteria included enrolling as a full-time undergraduate student and providing informed consent.

Of the participants, 58% identified as feminine (n = 142), 30% as masculine (n = 73), and 12% (n = 30) selected “prefer not to answer” / other gender identities (Table 1). Regarding age distribution, 25% were between 16–19 years old (n = 61), 67% between 20–23 years (n = 163), and 9% were 24 years or older (n = 21).

Table 1
Demographics Characteristics of the sample

		N	Percentage
Gender	Female	142	58%
	Masculine	73	30%
	NM/Other	30	12%
Age range	16–19	61	25%
	20–23	163	67%
	24>	21	9%
Study year	First	14	6%
	Second	52	21%
	Third	74	30%
	Fourth	66	27%
	Fifth	37	15%
	NM	2	1%

Table 1. Demographic characteristics of the sample, N = 245, were sampled and distributed according to gender, age, and Study year.

Students from all academic years were represented: 6% were first-year students (n = 14), 21% second year (n = 52), 30% third year (n = 74), 27% fourth year (n = 66), and 15% fifth year (n = 37). Two students (1%) did not report on their academic year.

ABO Calculations

The overall ABO calculation was performed using the SBI-9, defining high ABO as an average exceeding 50%. For graphical representation, data from the entire sample population were aggregated. Likert scale scores from each participant were converted into percentages, which were subsequently averaged and analyzed statistically.

Statistical Analysis

Reliability and Validation of the SBI-9

The SBI-9's internal structure and reliability were evaluated before hypothesis testing. The scale demonstrated high internal consistency (Cronbach's $\alpha = 0.872$), with individual item-rest correlations ranging from 0.376 (EX3) to 0.757 (IN1) (Table 2).

Table 2
Reliability Analysis

Scale Reliability Statistics				
	Mean	SD	Cronbach's α	
Scale	2.78	0.853	0.87	
Item Reliability Statistics				
	Mean	SD	Item-rest correlation	Cronbach's α
EX1	3.09	1.27	0.647	0.855
CY1	2.73	1.07	0.677	0.853
IN1	3.03	1.20	0.757	0.845
EX2	2.88	1.16	0.516	0.866
CY2	2.57	1.13	0.677	0.853
CY3	2.68	1.24	0.593	0.860
EX3	2.96	1.22	0.376	0.879
IN2	2.72	1.37	0.685	0.851
EX4	2.36	1.22	0.582	0.861

Table 2. Items Correlation Matrix and Reliability Statistics. Data derived from Jamovi v2.3.21.0. Asterisks in the correlation matrix highlight statistically significant values as detailed in the table's footnote. The sub-parameters' item reliability is presented in Cronbach's α values only

Inter-item correlations were examined to assess construct validity. The correlation matrix (Table 3) revealed statistically significant positive correlations among most items, consistent with the proposed three-factor structure of the SBI-9. The strongest correlations were observed between IN1 and CY1 ($r = 0.635, p < 0.001$); IN1 and IN2 ($r = 0.63, p < 0.001$); and CY2 and CY1 ($r = 0.625, p < 0.001$). In contrast, EX3 exhibited the weakest correlations, particularly with CY1 ($r = 0.213, p < 0.001$) and EX1 ($r = 0.277, p < 0.001$), consistent with its lower item-rest correlation.

Table 3
Correlation Matrix of the SBI-9 and the overall Reliability per Item.

Correlation Matrix																	
	EX1		CY1		IN1		EX2		CY2		CY3		EX3		IN2	EX4	
EX1	—																
CY1	0.47	***	—														
IN1	0.62	***	0.64	***	—												
EX2	0.45	***	0.37	***	0.40	***	—										
CY2	0.41	***	0.63	***	0.60	***	0.43	***	—								
CY3	0.39	***	0.50	***	0.52	***	0.34	***	0.53	***	—						
EX3	0.28	***	0.21	***	0.33	***	0.32	***	0.28	***	0.26	***	—				
IN2	0.57	***	0.56	***	0.63	***	0.30	***	0.52	***	0.53	***	0.22	***	—		
EX4	0.45	***	0.44	***	0.46	***	0.37	***	0.43	***	0.32	***	0.33	***	0.51	***	—
Note. *** p < .001																	

Table 3. Items Correlation Matrix and Reliability Statistics. Data derived from Jamovi v2.3.21.0. Asterisks in the correlation matrix highlight statistically significant values as detailed in the table's footnote. The sub-parameters' item reliability is presented in Cronbach's α values only

Confirmatory Factor Analysis and Model Fit

To determine the best-fitting model of the SBI-9, we conducted a Confirmatory Factor Analysis (CFA) comparing four competing models with varying factor configurations. CFA was performed using AMOS Graphics 30 software for Windows. The procedure followed a 'model generation' logic [26], considering the results obtained interactively when analyzing their fit according to the recommendations of [27]: for chi-square (χ^2/df) ≤ 5 ; for the Tucker-Lewis Index (TLI) > 0.90 ; for the Goodness Fit Index (GFI) > 0.90 ; for the Comparative Fit Index (CFI) > 0.90 ; for the root mean square error of approximation (RMSEA) ≤ 0.08 [28]; for the root mean square residual (RMSR), a lower value corresponds to a better fit; and for the Parsimony GFI (PGFI) > 0.60 . With the data obtained from the CFA, construct reliability was calculated for each instrument's dimension, with a value greater than 0.70. The average extracted variance (AVE) was estimated to test convergent validity, which should be greater than 0.50 [29]. However, values above 0.40 can be accepted if the Cronbach's alpha value of the instrument is greater than 0.70 [30]. Finally, the discriminant validity of each factor of the instruments was also tested by comparing the square root of the AVE values with the correlation values between the factors. The square root of the AVE must be greater than the correlation value between the factors. The results are summarized in Table 4.

Table 4
Adjustment Indices Obtained in Confirmatory Factor Analyses

		RMSEA 90% CI									
MODEL	SBI-9	CFI	GFI	TLI	SRMR	RMSEA	Lower	Upper	PGFI	χ^2/df	p
M1	1F (CIYINEX)	0.94	0.94	0.92	0.070	0.088	0.066	0.111	0.56	2.90	< .001
M2	2F-a (CYIN-EX)	0.96	0.95	0.94	0.060	0.077	0.053	0.101	0.55	2.45	< .001
M3	2F-b (EXIN-CY)	0.96	0.95	0.94	0.065	0.078	0.054	0.102	0.55	2.49	< .001
M4	3F (CY-IN-EX)	0.97	0.96	0.95	0.056	0.069	0.043	0.095	0.65	2.16	< .001

Table 4. Statistical values for the Confirmatory Factor Analysis (CFA) and model fit are presented as follows. Model **M1** represents a single-factor (1F) model, where all subscales (CY, EX, and IN) are grouped into one factor. Models **M2**, **M3**, and **M4** represent two-factor (2F) models with different configurations of the subscales. In **M2** (2F-a), the CY and IN subscales are grouped into one factor, while EX remains a separate factor. In **M3** (2F-b), the EX and IN subscales form one factor, and CY remains the second factor. **Model**

M4 (3F) is a three-factor (3F) model in which CY, EX, and IN are represented as three distinct factors. A model in which CY, EX, and IN are factors. 1F represents a one-factor model, 2F represents a two-factor model, and 3F represents a three-factor model. 2F three different models (a, b, and c)

χ^2 = chi-square, *df* = Degrees of freedom, *CFI* = Comparative fit index, *GFI* = Goodness of fit index, *TLI* = Tucker–Lewis’s index, *RMSEA* = Root means square error of approximation, *PGFI* = Parsimony GFI, *p* = *p*-value

Model M1 represents a single-factor structure where all subscales (CY, EX, and IN) are grouped into one factor (CYINEX). Models M2 and M3 introduced two-factor configurations (CYIN–EX and EXIN–CY, respectively). Model M4 represents the original three-factor model (CY-IN-EX), maintaining separate factors for each subscale.

Among these, Model M4 demonstrated the best overall fit for the data. Fit indices were as follows: Comparative Fit Index (CFI) = 0.97, Goodness Fit Index (GFI) = 0.96, Tucker–Lewis Index (TLI) = 0.95, Root Mean Square Error of Approximation (RMSEA) = 0.069, 90% CI [0.043, 0.095], Standardized Root Mean Square Residual (SRMR) = 0.056, and Parsimony GFI (PGFI) = 0.65. The chi-square test (χ^2/df = 2.16, *p* < 0.001) supported the model’s adequacy. These results confirm the factorial validity of the SBI-9 in this undergraduate sample since all adjustment indices were found to be adequate only in the three-factor model [27]. After calculating composite reliability, values of 0.77 (EX), 0.78 (CY), and 0.77 (IN) were obtained, indicating that all factors have good composite reliability. For convergent validity, the AVE values obtained are 0.46 (EX), 0.74 (CY), and 0.64 (IN), indicating the existence of convergent validity in all factors [30]. Regarding discriminant validity, all AVE squared values are higher than the correlation between the respective factors (Table 5). These results indicate the existence of discriminant validity.

Table 5
Correlation between Factors and Discriminant Validity

	EX	CY	IN
EX	0.68		
CY	0.60***	0.86	
IN	0.65***	0.74***	0.80
Note. *** <i>p</i> < .001			

Table 5. Correlation between factors and discriminatory validity for exhaustion (EX), cynicism (CY), and inadequacy (IN). The square root values of the AVE are shown in bold.

Results

Academic Burnout in College Students

This analysis included 245 undergraduate students from the Faculty of Natural Sciences at the University of Puerto Rico, Río Piedras Campus. ABO levels by age group and gender are presented in Table 6.

Table 6
Academic Burnout in college students' demographics

Descriptives							
					95% Confidence Interval		
	Age	N	Mean		Lower	Upper	
ABO %	16–19	61	40.9		34.9	47.0	
	20–23	163	45.8		42.6	49.1	
	> 24	21	44.6		37.0	52.2	
Note. The CI of the mean assumes that sample means follow a t-distribution with N – 1 degrees of freedom							
					95% Confidence Interval		
	Age	Gender	N	ABO (%) Mean	Lower	Upper	
16–19		Female	26	54.3	****	44.1	64.4
		Male	25	27.7	****	21.2	34.1
		PNA	10	39.4		26.4	52.5
20–23		Female	108	46.8		42.6	51.1
		Male	40	44.5		38.7	50.3
		PNA	15	42.4		32.7	52.1
> 24		Female	9	44.4		30.4	58.5
		Male	7	50.0		34.7	65.3
		PNA	5	37.2		19.4	55.1
Note. The CI of the mean assumes that sample means follow a t-distribution with N – 1 degrees of freedom							

Table 6. The upper table presents the ABO percentages in college students categorized by age group and gender (upper part). For each group, the sample size (N), mean ABO percentage, and 95% confidence interval (lower and upper bounds) are provided. In the lower part, the age groups are divided into age ranges 16–19, 20–23, and over 24 years old, and by Gender categories include female, male, and prefer not to answer (PNA). Confidence intervals assume sample means follow a t-distribution with N – 1 degrees of freedom. Significant statistical difference ($p < 0.001$) is observed between males and females in the 16–19 years group.

When grouped by age, students aged 16–19 exhibited mean ABO score of 40.9% (95% CI [34.9%, 47.0%]); those aged 20–23 showed a mean ABO score of 45.8% (95% CI [42.6%, 49.1%]); and students over 24 years old had a mean ABO score of 44.6% (95% CI [37.0%, 52.2%]). Across all age groups, female students consistently exhibited higher ABO levels compared to their male peers. For example, females aged 16–19 had a mean ABO of 54.3% (95% CI [44.1, 64.4]) versus 27.7% (95% CI [21.2, 34.1]) for males. Students identifying as "prefer not to answer" (PNA) reported intermediate scores across age groups (range: 37.2–42.4%).

Academic Burnout by Years of Study

ABO levels were analyzed across undergraduate students from the 1st to the 5th year of study ($n = 243$). Figure 1 displays ABO levels across academic years. A trend of increasing ABO was observed from first- to fifth-year students, although differences were not statistically significant.

FIGURE 1 NEAR HERE

Figure 1. Academic burnout (ABO) levels among undergraduate university students across different years of study ($n = 243$). Mean ABO scores were as follows: 1st year – 40.28% (95% CI [24.55, 56.00], $n = 14$), 2nd year – 43.16% (95% CI [37.21, 49.12], $n = 52$), 3rd year – 43.51% (95% CI [38.99, 48.02], $n = 74$), 4th year – 42.72% (95% CI [37.30, 48.14], $n = 66$), and 5th year – 49.25% (95% CI [42.97,

55.53], $n = 37$). Due to the small number of respondents ($n = 2$), data from 6th-year students were excluded from the analysis. No statistically significant differences in ABO levels were observed across the different years of study. However, 5th-year students exhibited burnout levels comparable to those reported in medical students, suggesting a possible cumulative effect of academic stress over time. Error bars indicate 95% confidence intervals.

Mean ABO was 40.28% in 1st-year students (95% CI [24.55, 56.00], $n = 14$), 43.16% in 2nd-year (95% CI [37.21, 49.12], $n = 52$), 43.51% in 3rd-year (95% CI [38.99, 48.02], $n = 74$), 42.72% in 4th-year (95% CI [37.30, 48.14], $n = 66$), and 49.25% in 5th-year students (95% CI [42.97, 55.53], $n = 37$). Sixth-year data ($n = 2$) were excluded due to insufficient sample size. Notably, fifth-year students displayed ABO levels approaching those commonly observed among medical students.

Informal peer-assisted learning (IPAL) and academic burnout (ABO)

Figure 2A illustrates the cumulative probability distribution of ABO scores by IPAL engagement level. Students who never engaged in IPAL (NE, $n = 84$) reported significantly higher ABO scores (mean = 48.41%, 95% CI [43.10, 53.72]) compared to those who engaged occasionally or frequently (O/F, $n = 161$; mean = 42.48%, 95% CI [39.47, 45.49]). The difference (Fig. 2B) was statistically significant ($p = 0.0384$; unpaired two-tailed t-test). Error bars represent 95% confidence intervals. Total sample size: $n = 245$.

FIGURE 2A & 2B **NEAR HERE**

Figure 2. **Left** (figure A), the Cumulative Probability Distribution of academic burnout (ABO) scores among medical students, grouped by their engagement in informal peer-assisted learning (IPAL). Students who engaged occasionally or frequently in IPAL (O/F; white circles, $n = 161$) exhibited lower ABO scores (mean = 42.5%, 95% CI [39.5, 45.5]) compared to those who never participated (NE; gray circles, $n = 84$), whose ABO mean was 48.4% (95% CI [43.1, 53.7]). Each point represents an individual student's ABO score ($n = 245$). The distribution shows a rightward shift in burnout among students who did not engage in IPAL. **Right** (figure B), Academic burnout (ABO) levels by engagement in informal peer-assisted learning (IPAL). Students who never participated in IPAL (NE, $n = 84$) reported significantly higher ABO scores (mean = 48.41%, 95% CI [43.10, 53.72]) than those who engaged occasionally or frequently (O/F, $n = 161$; mean = 42.48%, 95% CI [39.47, 45.49]; $p = 0.0384$). Error bars represent 95% confidence intervals. Total sample size: $n = 245$.

Preferred study approach: alone or with peers

As shown in Fig. 3, students who preferred to study alone ($n = 145$) exhibited higher ABO levels (mean = 46.97%, 95% CI [43.28, 50.67]) than those who studied with peers ($n = 92$; mean = 41.49%, 95% CI [37.60, 45.37]). Although the difference approached statistical significance ($p = 0.0526$), it did not reach the conventional threshold ($p < 0.05$).

FIGURE 3 **NEAR HERE**

Figure 3. Academic burnout (ABO) levels among university students according to study preferences. Students who preferred to study alone reported higher levels of academic burnout (mean = 46.97%, 95% CI [43.28, 50.67], $n = 145$) compared to those who preferred studying with peers (mean = 41.49%, 95% CI [37.60, 45.37], $n = 92$). While this difference approached statistical significance ($p = 0.0526$), it did not reach the conventional threshold ($p < 0.05$). Error bars indicate 95% confidence intervals. Total $n = 237$; eight students did not report a study preference.

These results suggest a potential trend toward higher burnout among students who study alone. Error bars represent 95% confidence intervals. Data from eight participants who did not indicate a study preference were excluded from this analysis (final $n = 237$).

Gender differences in academic burnout

Female students reported significantly higher ABO than males (mean = 47.95%, 95% CI [44.18, 51.71] vs. 39.46%, 95% CI [35.01, 43.91]; $p = 0.0057$) (Fig. 4) -students who identified as other or preferred not to specify gender reported levels comparable to males.

FIGURE 4 **NEAR HERE**

Figure 4. Academic burnout (ABO) levels by gender among university students.

Mean ABO scores are presented for students identifying as male (M), female (F), and other/prefer not to mention (O/PNM). Female students reported significantly higher levels of academic burnout (mean = 47.95%, 95% CI [44.18, 51.71], $n = 142$) compared to male

students (mean = 39.46%, 95% CI [35.01, 43.91], $n = 73$; $p < 0.01$). Students in the O/PNM category (mean = 40.56%, 95% CI [34.25, 46.86], $n = 30$) showed burnout levels comparable to those of male students. Error bars indicate 95% confidence intervals. Total sample size: $n = 245$.

Gender, academic burnout, and year of study

Figure 5 disaggregates ABO levels by gender and academic year. The gender gap was most pronounced in the early years. Among first-year students, females exhibited significantly higher burnout (mean = 51.59%, 95% CI [27.00, 76.18]) compared to males (mean = 26.11%, 95% CI [- 1.11, 53.33]; $p = 0.0410$). A similar pattern was observed in the second year (females: 53.04%, 95% CI [41.59, 64.49]; males: 35.63%, 95% CI [28.47, 42.79]; $p = 0.0068$). From the third year onward, gender differences were no longer statistically significant, though females consistently reported higher ABO.

FIGURE 5 NEAR HERE

Figure 5. Academic burnout (ABO) levels among undergraduate students by gender and year of study. Female students ($F, n = 142$) reported significantly higher ABO levels (mean = 47.95%, 95% CI [44.18, 51.71]) than male students ($M, n = 73$; mean = 39.46%, 95% CI [35.01, 43.91]; $p = 0.0057$).

This gender disparity was most pronounced in first-year students, where females ($1/F, n = 7$) exhibited markedly higher ABO (mean = 51.59%, 95% CI [27.00, 76.18]) than their male counterparts ($1/M, n = 5$; mean = 26.11%, 95% CI [- 1.11, 53.33]; $p = 0.0410$).

A significant difference was also observed among second-year students, with females ($2/F, n = 21$) showing higher ABO (mean = 53.04%, 95% CI [41.59, 64.49]) than males ($2/M, n = 23$; mean = 35.63%, 95% CI [28.47, 42.79]; $p = 0.0068$).

No significant gender differences were detected in years 3 through 5; however, ABO levels consistently trended higher among females. Notably, the highest ABO mean was observed in 2nd-year ($2/F$) female students.

Error bars indicate 95% CI. Statistical significance was assessed using uncorrected Fisher's Least Significant Difference (LSD) test.

The highest average ABO values were recorded among second year ($2/F$) and fifth year ($5/F$) female students. Error bars in Fig. 5 represent 95% CI, and statistical comparisons were made using the uncorrected Fisher's Least Significant Difference (LSD) test.

Discussion

This study investigated ABO among undergraduate students in Puerto Rico and examined its relationship with IPAL. The findings provide new insights into the early emergence of burnout symptoms within the premedical population, an often-overlooked group in burnout research despite its high vulnerability to academic and psychological stress [16,17]. The SBI-9 demonstrated strong internal consistency and factorial validity, affirming its utility as a reliable instrument in this context [5,6].

Consistent with global trends, a substantial proportion of students reported moderate to high ABO levels, particularly among female students and fifth-year undergraduates [11,14]. Although ABO levels increased slightly with the academic year, the trend did not reach statistical significance (Fig. 1). This pattern may reflect the cumulative nature of academic stress and growing uncertainty about professional futures as students approach graduation [4,12]. Notably, the mean ABO score among fifth-year undergraduates closely mirrored those reported in Puerto Rican first-year medical students [7], suggesting that burnout may begin earlier than previously assumed and persist throughout the academic trajectory. This finding underscores the importance of monitoring student well-being throughout higher education, not just in high-stakes professional programs, particularly medical studies.

A key finding was the inverse relationship between IPAL engagement and ABO. Students who occasionally or frequently participated in IPAL reported significantly lower burnout levels than those who never engaged (Fig. 2B), with an observed difference of approximately six percentage points. Notably, even occasional participation appeared to be protective against burnout symptoms. This aligns with existing literature suggesting peer collaboration enhances academic self-efficacy and buffers psychological distress [19,21,23]. Further supporting this trend, the cumulative distribution curve for non-IPAL students (Fig. 2A) exhibited a rightward shift—indicating consistently higher ABO scores—echoing findings from studies on medical students [8,24]. Importantly, even after accounting for individual variability in scores, students engaged in IPAL displayed a more favorable burnout profile. These findings align with prior research emphasizing the protective role of peer interaction and academic collaboration in promoting emotional

resilience. The social and cognitive scaffolding provided through IPAL may contribute to a more supportive learning environment, reducing perceived academic pressure. While causality cannot be inferred from our cross-sectional design, the consistent trend supports further exploring peer-based interventions as low-cost strategies to promote student well-being.

A non-significant yet suggestive trend further supported the benefits of collaborative learning: students who preferred to study alone had higher ABO scores than those who preferred studying with peers (Fig. 3; $p = 0.0526$). This pattern is consistent with prior findings that social academic environments can foster belonging, shared problem-solving, and emotional resilience [2,22]. While this result should be interpreted cautiously, it underscores the potential value of peer-based academic interaction in alleviating stress and supporting well-being.

Gender differences in burnout were also notable. Female students reported significantly higher ABO than males (Fig. 4). This supports earlier findings that women often face heightened emotional demands, internalized performance expectations, and reduced access to coping resources in academic settings [1,2]. Students identifying as non-binary or opting not to disclose their gender reported burnout levels similar to male students, though the small sample size limits generalizability. Nonetheless, their inclusion highlights the need for gender-inclusive mental health research. Further studies with larger, more diverse samples are necessary to explore the unique stressors and protective factors relevant to non-binary or gender-nonconforming students. Figure 5 further contextualizes gender differences by year of study. Female students consistently exhibited higher ABO scores than their male counterparts, with statistically significant differences in the first and second years. This pattern suggests that early university experiences may be a particularly vulnerable period for female students. The elevated burnout among first-year females may stem from the emotional and academic demands of transitioning to university life, exacerbated by gender-specific expectations or coping styles. The persistence of this disparity into the second year suggests a cumulative effect of academic pressure. Although no statistically significant gender differences were observed from the third year onward, females continued to report numerically higher ABO levels across all remaining years. These trends are consistent with existing literature linking female gender to greater emotional exhaustion, even in the absence of overt academic underperformance.

These results highlight the urgent need for early, culturally sensitive wellness strategies targeting undergraduate populations, particularly premedical students. Premedical students—often navigate high academic demands, perfectionism, and limited institutional support—may benefit from structured and informal wellness programs incorporating peer-based models like IPAL. These interventions could foster academic engagement and emotional well-being before burnout escalates to the more severe levels commonly observed in professional training [15–17].

Finally, the similarity in ABO levels between late-stage undergraduates and early medical students raises critical questions about the origins of burnout: Does ABO begin in medical school, or does it emerge earlier and remain unaddressed? Our findings suggest the latter, underscoring the importance of preemptive measures that extend beyond professional programs.

Limitations

Several limitations should be acknowledged. The study used a cross-sectional design, precluding causal interpretations. IPAL was measured through a single self-report item, which, although pragmatically informative, may not capture the full complexity of peer-learning dynamics. Additionally, the study was limited to students in the natural sciences at a single institution, potentially affecting generalizability. Finally, while gender was disaggregated beyond the binary, small sample sizes limited robust statistical comparisons among non-binary or gender-diverse participants.

Conclusions

This study contributes to the growing body of literature on academic burnout by demonstrating that burnout symptoms are already prevalent among undergraduate students pursuing premedical tracks. The validated use of the SBI-9 in this population confirms its utility as a diagnostic tool for early detection of academic distress. Our findings suggest that IPAL may protect against burnout, offering promising, low-cost strategies to support student well-being. Furthermore, observed gender disparities and behavioral trends, such as a preference for studying alone, highlight the importance of tailoring academic wellness initiatives to student needs and lived experiences. Future research should explore longitudinal trajectories of burnout and evaluate the effectiveness of peer-based interventions across academic disciplines and institutional contexts.

Academic institutions should consider promoting informal peer-assisted learning opportunities into their educational support and wellness programs, particularly at the undergraduate and premedical levels. Fostering organic peer collaboration—such as peer study groups, tutoring circles, or mentorship networks—may help reduce burnout risk while strengthening academic engagement. Gender-sensitive approaches that address the unique stressors faced by female students and students from underrepresented gender identities are also warranted. By implementing early, peer-driven support systems, institutions can more effectively promote psychological resilience and academic success in future healthcare professionals.

Abbreviations

ABO: Academic Burnout

CFA: Confirmatory Factor Analysis

CY: Cynicism

EFA: Exploratory Factor Analysis

EX: Exhaustion

Fc1, Fc2 ... Factor 1, Factor 2 ...

IN: Inadequacy

IPAL: Informal Peer Assisted Learning

NE: Never

O/F: Occasionally / Frequently

PCA: Principal Component Analysis

SBI-9: School Burnout Inventory -9 items

Declarations

Ethics Approval and consent to participate

The research adhered to ethical guidelines, and all participants provided informed consent prior to taking part. This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. All methods and protocols were approved by the Institutional Review Board (IRB) of UPR-RP (CIPSHI #2324-057), ensuring full compliance with ethical research standards.

Consent for publication

Not applicable.

Availability of data materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing Interests

The authors declare no competing interests.

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Authors' Contributions

Project Conceptualization: NJ, LVR; Intervention Design: NJ, ICG, LVR. Supervision and Oversight: LVR; Data Curation: NJ, EJ, AM, LVR; Data Analysis: NJ, ICG, AM, EJ, LVR. Manuscript Drafting: ICG, AM, LVR. Writing the main manuscript text: ICG, AM, LVR. Preparation of Figures: NJ, EJ, ICG, LVR. Manuscript Revisions: ICG, NJ, AM, EJ, LVR. Final Approval for Submission: ICG, NJ, AM, EJ, & LVR. All authors agree to be accountable for all aspects of the work. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work. All authors approved the last version and agreed to be responsible for all aspects of the final product.

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Clinical Trials Number

Not applicable.

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Figures

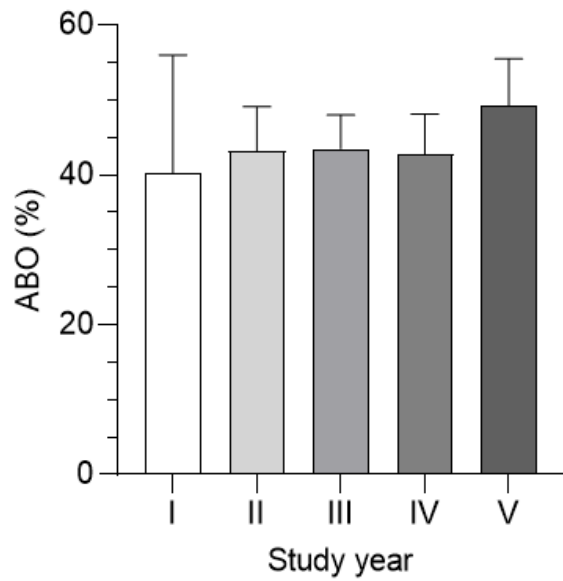


Figure 1

Academic Burnout Across University Years of Study.

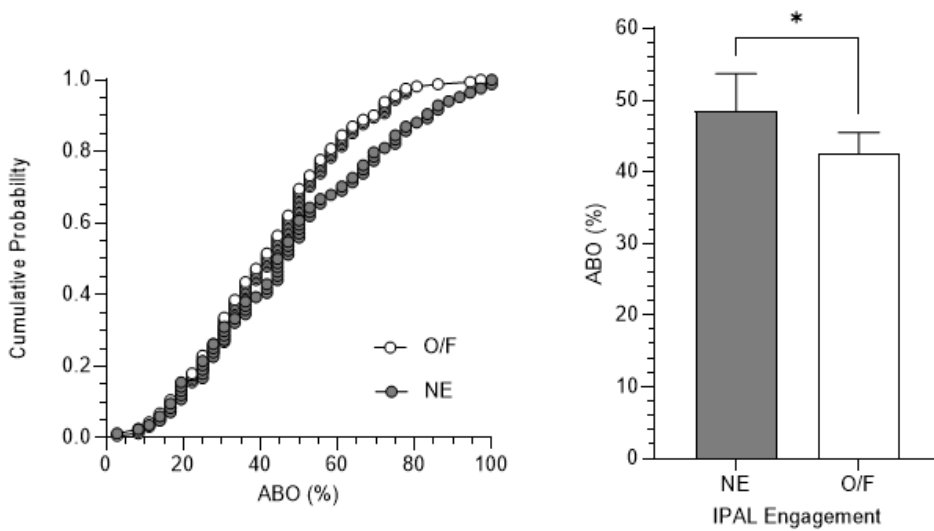


Figure 2

Cumulative probability distribution of academic burnout scores by informal peer-assisted learning engagement levels

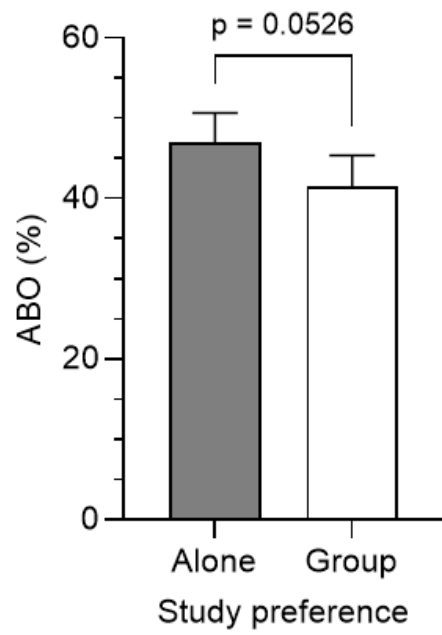


Figure 3

Academic burnout (ABO) levels among university students according to study preferences.

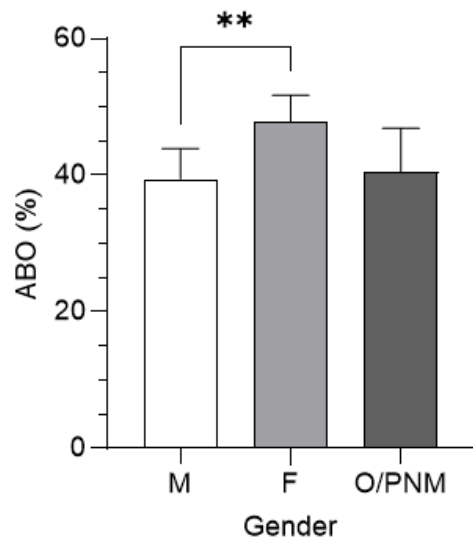


Figure 4

Gender Differences in Academic Burnout Among University Students

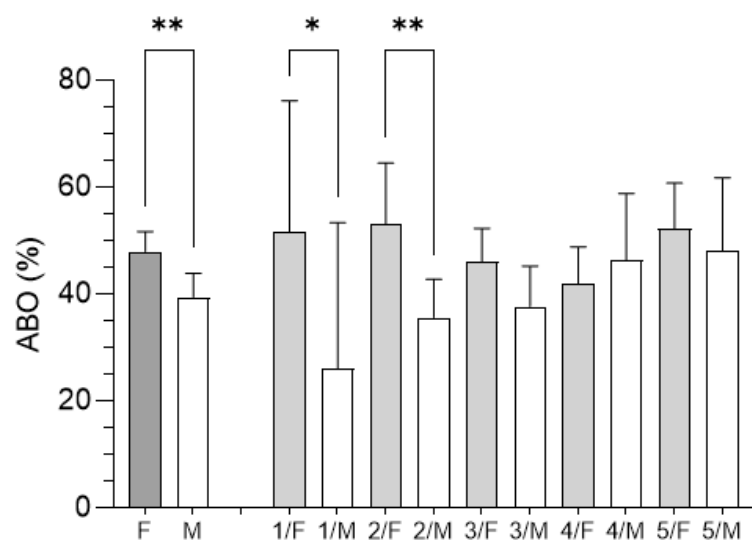


Figure 5

Academic Burnout by Gender and Year of Study in University Students.