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Regular Article

Academic performance of undergraduate health science students who participate in extracurricular academic activities: a cross-sectional study

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ABSTRACT

To investigate the association between participation in extracurricular academic activities and academic performance in biochemistry and human physiology in undergraduate health sciences students. A total of 214 university students (73.4 % women) from undergraduate health science courses participated in this study. Participants answered a questionnaire regarding biochemistry and human physiology. Participants were divided into two groups: those who participate in extracurricular academic activities (n = 124; 57.9 %) and those who do not (n = 90; 42.1 %). A Poisson regression model with a robust variance estimator was used to estimate the prevalence ratio (PR) and 95 % confidence interval (CI). In multivariate analysis, independently of gender and age, the group that did not participate in extracurricular academic activities had PR of 1.35 (95 % CI 1.12–1.63) for having worse academic performance. Our findings suggest an association between non-participation in extracurricular academic activities and lower academic performance in biochemistry and human physiology. Although a causal relationship cannot be established due to the study design, these results highlight the potential benefits of such activities and can inform institutional strategies to promote student engagement, potentially improving learning outcomes.

1. Introduction

The participation of undergraduate students in extension projects, study groups, academic monitoring, and scientific initiation can be defined as extracurricular academic activities (EAAs) (de Oliveira et al., 2015). The involvement of students in EAAs has been widely documented in the literature (Angeli et al., 2011; Aragão et al., 2013; Baker, 2008; Clark et al., 2015; Díaz-Iso et al., 2019; Griffiths et al., 2021; Hu & Wolniak, 2010; Huang & Chang, 2004; Hughes, 2011; King et al., 2020; de Oliveira et al., 2015; Oliveira et al., 2016; Peres et al., 2007; Steinmann et al., 2018; Stevenson & Clegg, 2011; Stuart et al., 2011; Tchibozo & Pasteur, 2007).

Oliveira et al. (2016) verified why undergraduate students take part in EAAs, the types of activities they choose, and how they evaluate this experience. The authors concluded that students identify the need to seek knowledge and opportunities to complement their educational backgrounds, and that they evaluate EAAs positively. In this context, Steinmann et al. (2018) showed that students evaluated EAAs as being key to developing their self-identity, social networks, and career prospects or pathways. The link between EAAs and academic success is often explained through constructs such as academic engagement and student integration theory (Tinto, 1993), which posit that involvement beyond

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classroom activities enhances commitment and performance.

Indeed, participation in EAAs allows students to deepen their knowledge of the content that they consider interesting, experience their future profession (real-world setting), familiarize themselves with new realities, deepen relationships to other colleagues and professors, and even generate motivation in their academic routine (De Oliveira et al., 2015). In this way, the student can develop the professional skills necessary to their professional practice (Seow & Pan, 2014), such as better interpersonal abilities, study skills, and altruistic values (Angeli et al., 2011).

Additionally, it has been shown that students who participate in EAAs have improved physical and psychological well-being, greater satisfaction with the course and institution, deeper knowledge of the structures and services that exist at the university (Baker, 2008), and present better cognitive and affective characteristics (Huang & Chang, 2004). Furthermore, for EAAs that provide financial resources through scholarships, these activities can act as a source of income to support the student during their academic formation (Peres et al., 2007).

Since participation in EAAs is optional (Bartkus et al., 2012), many students do not take part in these types of activities. This may be attributed to several factors, including unfavorable socioeconomic conditions, which implies the need to work outside the area of the course (Pereira & Schveitzer, 2020). Therefore, it is reasonable to assume that the benefits on performance when participating in extracurricular academic activities seems to be evident. However, while many studies show the general benefits of EAAs, there is a distinct lack of empirical evidence regarding their specific association with performance in foundational subjects like biochemistry and physiology among health science undergraduates. It is worth noting that a solid foundation in biochemistry and physiology is essential for the effective training of health professionals. Consequently, research exploring strategies to enhance knowledge in these core subjects is highly desirable.

To the best of our knowledge, no studies have associated academic performance in these specific subjects between students who participate in EAAs and those who do not. Therefore, the present study aims to investigate whether an association exists (without implying causation) between participation in EAAs and academic performance in biochemistry and human physiology in undergraduate health sciences students. We hypothesize that academic performance in biochemistry and human physiology is positively associated with participation in extracurricular academic activities (EAAs).

2. Methods

2.1. Study design and participants

This is a descriptive and cross-sectional study conducted with female and male students from undergraduate health science courses at the Federal University of Goiás, Brazil. Participants were invited through direct contact and were informed about the research objectives. Each participant signed an informed consent form before inclusion in the study. Thereafter, they answered a questionnaire on concepts of biochemistry and human physiology. All protocols were approved by the Federal University of Goiás Human Research Ethics Committee (Protocol no. 047/2011) and were in accordance with the ethical standards of Declaration of Helsinki.

A total of 280 students were invited to participate during classes and answered the questionnaire. A detailed flowchart of participant recruitment and eligibility, following STROBE guidelines, is presented in Fig. 1. The inclusion criteria were: being a student of a health science undergraduate course, aged ≥18 years old, and having studied biochemistry and human physiology, regardless of academic performance. At Federal University of Goiás, biochemistry and human physiology were offered from the third semester of the health science undergraduate course. Therefore, all students enrolled in this study were aware of the EAAs offered by the university. The exclusion criterion was answering the questionnaire incompletely. After applying the exclusion criteria, a final sample of 214 students were eligible for the study, of which 157 were women (73.4 %). The evaluated students were from the following bachelor's degree programs: 40 (18.7 %) were from physical education, 36 (16.8 %) from pharmacy, 35 (16.4 %) from nutrition, 32 (15.0 %) from biomedicine, 27 (12.6 %) from dentistry, 14 (6.5 %) from nursing, 11 (5.1 %) from biology, 10 (4.7 %) from medicine, and 9 (4.2 %) from physiotherapy. The participants' age was 21.2 [4.0] years (data expressed as median [interquartile range]).

2.2. Study procedures

Academic performance was assessed using a self-administered questionnaire with 15 objective questions (9 on biochemistry and 6 on human physiology). The questionnaire content covered: (i) biomolecules (5 questions); (ii) bioenergetics (4 questions); (iii) physiology of the endocrine system (3 questions); (iv) physiology of the digestive

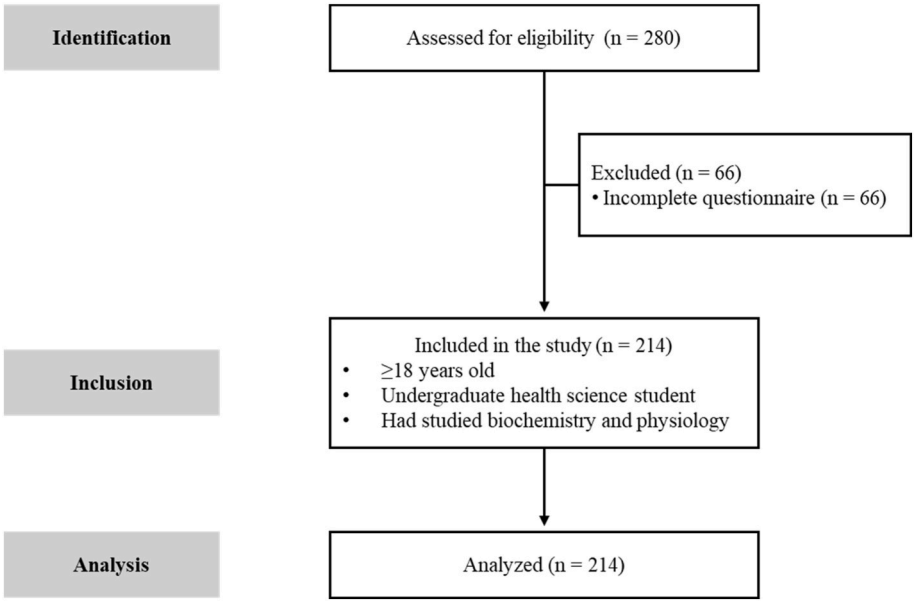

Fig. 1. Flow diagram of participant recruitment and inclusion in the study.

system (1 question); (v) physiology of the nervous system (1 question); and (vi) physiology of the urinary system (1 question). The questionnaire also included questions to investigate students' academic information, such as their participation in extracurricular academic activities, which was assessed using a binary response (Yes/No).

The questionnaire was developed by two professors (C.G.C. and C.A.B.L.) with over 10 years of experience teaching biochemistry and physiology. It was designed based on key curricular content to serve as a content-specific assessment tool. However, it was not subjected to formal validation procedures or statistical reliability analysis prior to application. To improve transparency, the full questionnaire has been provided as Supplementary Material 1.

The choice of biochemistry and human physiology as academic performance indicators was made because these are foundational courses across all health science programs, serving as a strong proxy for conceptual understanding early in a student's training. For the purpose of this study, the following were considered as extracurricular academic activities: participation in research projects, conferences, seminars, lectures, congresses, debates, other scientific, artistic, or cultural activities, teaching monitoring, and university extension program activities. Based on this information, the participants were divided into two groups: Extracurricular Academic Activities (EAA) and Did not do Extracurricular Academic Activities (DEA).

The scores from the questionnaire were classified based on a cutoff point of 6.0, which reflects the institutional minimum passing score at the university. This score was used as the criterion for a dichotomous outcome (approved/not approved). Institutional academic grades or grade point average (GPA) were not used as outcome measures due to the unavailability of official records. More importantly, as our sample includes students from various undergraduate programs (e.g., physical education, pharmacy, nutrition), using GPA would introduce significant bias due to the different curricula, grading systems, and course loads across these diverse programs. The use of grades from specific core subjects, such as biochemistry and physiology, allowed us to standardize the academic performance measure across all participants, ensuring a more valid comparison.

2.3. Statistical analysis

Analyses were performed using the IBM SPSS package (version 26.0, USA). For data normality, the Kolmogorov-Smirnov test was used. The description of the sample was based on the calculation of absolute and relative frequencies, median and interquartile range. Comparisons between groups were performed using the Mann–Whitney *U* test for age (*effect size r*) and Pearson's chi-square test for categorical variables (sex vs. approval and sex vs. participation in extracurricular academic activities), with Cramér's V reported as the measure of effect size. Effect sizes were interpreted according to Cohen's benchmarks: for r, 0.10 = small, 0.30 = medium, 0.50 = large; for Cramér's V (df = 1), 0.10 = small, 0.30 = medium, 0.50 = large. Additionally, we computed post hoc statistical power for the chi-square tests using a noncentral chi-square distribution ($\alpha = 0.05$). Power values are reported for the key comparisons.

The crude and multivariate analyses were used to estimate the prevalence ratios (PR) of academic performance using as reference category “approved”, according to extracurricular activities participation (Yes/No), gender and age. A Poisson regression was performed using generalized linear models, with a robust estimator. The confidence interval (CI) of 95 % was considered, and the significance level of 5 % was adopted. Additionally, a posteriori power analysis (GPower 3.1, Germany) was performed for the main comparison (EAA vs. non-EAA approval rates), indicating achieved power of 0.87.

3. Results

A total of 214 students were evaluated. Of these, 161 (75.2 %) were approved and 53 (24.8 %) were not approved on the questionnaire based on the cutoff point of 6.0. Regarding participation in EAAs, 90 students (42.1 %) were in the DEA group and 124 (57.9 %) were in the EAAs. There was no significant association between sex and academic performance, χ^2 (1, n = 214), p = 0.199, Cramér's V = 0.097 (small effect). In contrast, a significant association was observed between participation in EAAs and academic performance, χ^2 (1, n = 214), p = 0.002, Cramér's V = 0.225 small-to-medium effect. Regarding age, no significant differences were found between approved and not-approved groups (U = 3406, p = 0.155, r = 0.10, small effect). A posteriori power analysis (noncentral chi-square, $\alpha = 0.05$) for the association between extracurricular activities and approval was 0.87 (n = 214), indicating adequate power.

The approval rate was higher among students engaged in EAAs (64.0 %) compared with those engaged in directed study activities (DEA) (39.6 %). Table 1 summarizes the characteristics of the participants and the statistical comparisons between approved and not-approved students.

Table 2 presents the crude and multivariate analyses of prevalence ratios for the age, sex and academic activities in relation to academic performance. The results indicate that in multivariate analysis, independent of gender and age, the DEA group has a higher prevalence ratio in 1.35 (CI95 % 1.12–1.63) for having worse academic performance. In other words, participants from DEA group were 35 % more likely to have a worse academic performance.

4. Discussion

The aim of this study was to investigate the association between participation in EAAs and academic performance in biochemistry and human physiology among undergraduate health sciences students. The main findings were that students who did not participant in EAAs had a higher likelihood of exhibiting worse academic performance.

Student participation in EAAs and its effect on professional training has been evaluated by several studies (Angeli et al., 2011; Aragão et al., 2013; Baker, 2008; Clark et al., 2015; Díaz-Iso et al., 2019; Griffiths et al., 2021; Hu & Wolniak, 2010; Huang & Chang, 2004; Hughes, 2011; King et al., 2020; de Oliveira et al., 2015; Oliveira et al., 2016; Peres et al., 2007; Steinmann et al., 2018; Stevenson & Clegg, 2011; Stuart et al., 2011; Tchibozo & Pasteur, 2007). In general, these studies show that EAAs provide knowledge acquisition and new experiences that complement the basic curriculum. Our results align with this body of literature and further suggest that participation in EAAs may contribute to stronger conceptual retention in foundational coursework (biochemistry and human physiology). Rather than generalizing

Table 1
Characteristics of students according to academic performance, gender, and age.

Variables	Approved (n = 161)	Not approved (n = 53)	*p-value*	*Effect size*
Age (years)	21.18 (IIQ 2.12)	21.57 (IIQ 3.36)	0.141*	r = 0.10 (small)
Sex (*n* %)			0.199**	Cramér's V = 0.097 (small)
Female	120 (77.4)	36 (67.9)		
Male	35 (22.6)	17 (32.1)		
Academic activities (*n* %)			0.002**	Cramér's V = 0.225 (small-to-medium)
EAA	103 (64.00)	21 (39.60)		
DEA	58 (36.00)	32 (60.40)		

n: absolute frequency; %: relative frequency; IQR: interquartile range; EAA: extracurricular academic activities; DEA: did not engage in extracurricular academic activities. p-value * Mann–Whitney *U* test; ** Pearson's chi-square test. Effect sizes are reported as r for the Mann–Whitney *U* test and Cramér's V for chi-square tests.

Table 2
Poisson regression models for academic performance according to age, sex and academic activities.

Variables	Academic performance			
	Crude	*p*	Multivariate *	*p*
	PR (95 % CI)		PR (95 % CI)	
Age	0.96 (0.93–1.00)	0.093	0.96 (0.92–1.00)	0.080
Sex				
Female	1.16 (0.94–1.45)	0.159	1.06 (0.86–1.30)	0.566
Male	1		1	
Academic activities				
DEA	1.34 (1.11–1.62)	**0.002**	1.35 (1.12–1.63)	**0.002**
EAA	1		1	

PR: prevalence ratio; CI: confidence interval; *Wald test; EAA: the group of students who participated in extracurricular academic activities. DEA: the group of students who did not participate in any extracurricular academic activities.

broadly, our study narrows this focus by connecting participation in EAAs with specific academic outcomes in two core disciplines, offering a measurable and discipline-specific contribution to the field.

Previous studies have investigated strategies to improve undergraduate students' academic performance. Oliveira et al. (2015) reported students who participated in monitoring sessions in a human anatomy course performed better than those who did not. Similarly, Viana et al. (2019) demonstrated that a near-peer teaching program improved the final grades of students in a functional anatomy course. More recently, Pessoa et al. (2025) evaluated a near-peer teaching program in human anatomy with undergraduate physical education students and found that participants achieved final grades 14.5 % higher than non-participants, in addition to reporting favorable perceptions of the program and recommending its continuation. However, to our knowledge, no previous study has examined the association between participation in EAAs and academic performance in biochemistry and human physiology. Therefore, the present findings expand the current evidence base.

Studies that investigated participation in EAAs indicate that students who are engaged in these activities tend to value the search for knowledge (Peres et al., 2007; Thiry et al., 2011). This may be a possible explanation for the results found in the present study. Another possible explanation for the results found is that EAAs are supervised by one or more professors with an academic background and expertise on a given subject.

Hughes (2011) tested the implementation of a learning program 2–4 times weekly for 1-h sessions. During each session, the students answered questions related to course material about anatomy and physiology. The authors showed significant improvement in the final grades of those students who regularly participated in the program. In addition, students agreed that this type of activity helps them understand the content.

Furthermore, Hryciw et al. (2013) demonstrated that peer mentoring was perceived as beneficial by both mentors (students actively involved in teaching) and mentees (those with better academic performance). For mentor students, this activity provided tools and strategies for approaching their studies, to develop skills in teamwork, cooperation, and communication that may not be fostered in other components of their studies during classes. In this context, King et al. (2020) demonstrated that those students who participated in extracurricular activities at the university had a stronger sense of belonging to the university compared to those who did not participate; students who participated reported a weaker sense of belonging. In addition, it was found that participation in university groups tended to increase life satisfaction. Therefore, the benefits of undergraduate students' participation in EAAs are numerous. For example, Oliveira et al. (2016) reported that most students perceive direct links between extracurricular activities and their first job. In addition, those students who dedicate themselves to teaching and research as extracurricular academic activities also have superior academic achievements (Lumley et al., 2015). In addition, Cunha and Carrilho (2005) analyzed the dimensions of academic experiences related to academic performance; they found that involvement in EAAs provides an academic experience that is favorable to performance.

Lehmann (2012) showed that although students are interested in EAAs, they often cannot dedicate themselves to these activities due to the need to support themselves through paid employment. In this context, universities could create scholarship programs for student participation in extracurricular academic activity programs. Another aspect that can keep students away from EAAs is the difficulties related to time management (Peres et al., 2007). When viewed together, our results highlight the potential value of institutional policies and support structures aimed at encouraging student participation in EAAs during their undergraduate studies. Although our cross-sectional design does not allow for causal inference, these findings provide a valuable starting point for policy discussions focused on enhancing academic engagement and performance.

Brazilian public universities, including Federal University of Goiás, have established programs to foster student engagement in research initiation (Secretaria de Educação Superior; Silva Junior et al., 2014), monitoring (Viana et al., 2019; Pessoa et al., 2025), and extension and culture programs (Brasil, 2018) funded by the budget of the universities themselves, as well as the Ministry of Science, Technology, and Innovations and the Ministry of Education. A key incentive for participation is a financial grant, typically around BRL 400.00 (corresponding to US$85.00, according to the exchange rate on 04/06/2022, at the time of writing this study). However, a protracted national financial crisis, exacerbated by the COVID-19 pandemic, led to a decade-long freeze (2013–2023) on the value of these grants and a reduction in their availability. Compounding this issue, the primary national research funding agency, the National Council for Scientific and Technological Development (CNPq), saw the real value of its grants erode by approximately 60 % due to inflation during this period (SBPC, 2021). This concerning landscape of underfunding likely creates a significant barrier to student participation in EAAs. Although it is speculative, our findings, which show a clear association between non-participation and lower academic performance, suggest that this barrier could ultimately compromise the quality of student training. Consequently, future professionals may perform activities in the labor market with lower performance than expected. These results demonstrate the importance of implementing public policies to encourage and support undergraduate students to engage in EAAs.

A discussion of study limitations and strengths is important for a complete interpretation of the findings. First, the cross-sectional design limits causal inferences, as it does not allow the establishment of temporal precedence between participation in EAAs and academic performance. Second, we did not collect data on important potential confounders such as socioeconomic status (SES), part-time employment, and prior academic performance, all of which could influence both the likelihood of engaging in extracurricular activities and academic outcomes. The absence of these variables represents an important limitation of our study. Nevertheless, the potential impact of the lack of SES data may be partially mitigated. According to a national survey conducted by the National Association of Directors of Federal Institutions of Higher Education (ANDIFES, 2018), approximately 70 % of students in Brazilian federal public universities come from families with a per capita income of up to 1.5 minimum wages, and 65 % are from public high schools. This suggests that students in these institutions generally belong to a relatively similar socioeconomic stratum, which may have reduced, but not eliminated, the impact of SES heterogeneity in our sample. Future studies should include these factors in their design to provide a more comprehensive understanding of the relationship between extracurricular activities and academic performance. Third, the year of study was not assessed; although we controlled for age, it is reasonable to

assume that students in more advanced semesters might perform differently. Fourth, we did not use final course grades or GPA due to lack of access to official academic records; instead, we employed a content-specific instrument focused on conceptual understanding. Fifth, although the questionnaire was developed by experienced faculty, it was not formally validated using psychometric techniques such as test-retest or factor analysis, which may limit its generalizability and reproducibility. Sixth, the absence of a control group limits experimental inference; however, implementing a design that restricts participation in educational activities would be ethically questionable. Finally, no a priori power analysis was conducted, although we consider that the final sample of 214 participants provided sufficient power for the primary analysis. Future research should address these limitations by incorporating validated assessment tools, controlling for additional confounders, and adopting longitudinal or experimental designs.

Despite these limitations, this study provides several important strengths. These include a diverse sample drawn from multiple health science programs and a focus on assessing conceptual understanding in foundational subjects (biochemistry and physiology) rather than just final grades. Furthermore, the statistical analysis was robust; we employed Poisson regression with a robust variance estimator, which is a recommended method for analyzing cross-sectional data with binary outcomes and directly estimating prevalence ratios (PRs), providing a more intuitive interpretation of the effect measure compared to odds ratios from logistic regression. Finally, the use of a content-specific instrument developed by experienced faculty ensured that the assessment was directly aligned with the core learning objectives of the courses, enhancing its face and content validity despite the noted limitation.

5. Conclusion

We conclude that there is an observed association between non-participation in extracurricular academic activities (EAAs) and lower academic performance in biochemistry and physiology among undergraduate students. It is also possible that reverse causality plays a role, where students with lower academic performance may be less likely to engage in such activities. Longitudinal or interventional studies are needed to further investigate this complex relationship.

Therefore, it is important to emphasize that structured and high-quality EAAs in higher education can be an enriching path to academic formation. Our findings can serve as a valuable first step to inform institutional policies aimed at encouraging student participation in these activities, rather than as a definitive guide for public policy. We believe that increasing the budget allocated to promote these activities could contribute to greater student engagement, ultimately benefiting their academic and professional development.

CRediT authorship contribution statement

Mila Alves Matos Rodrigues: Conceptualization. **Rizia Rocha-Silva:** Conceptualization. **Vinnycius Nunes de Oliveira:** Conceptualization. **Marilia Santos Andrade:** Conceptualization. **Rodrigo Luiz Vancini:** Conceptualization. **Mário Hebling Campos:** Conceptualization. **Gustavo De Conti Teixeira Costa:** Conceptualization. **Beat Knechtle:** Writing – review & editing. **Cléver Gomes Cardoso:** Conceptualization. **Claudio Andre Barbosa de Lira:** Writing – review & editing, Supervision, Conceptualization.

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Ethics Statement

Each participant signed an informed consent form before inclusion in the study. All protocols were approved by the Federal University of Goiás Human Research Ethics Committee (Protocol no. 047/2011) and were in accordance with the Declaration of Helsinki's ethical standards.

Declaration of generative AI use

The authors declare that no generative AI tools were used in the writing or editing of this manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssaho.2026.102501.

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