Analysis of academic performance from a binary logistic regression model

Análisis del rendimiento académico a partir de un modelo de regresión logística binaria

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RESUMEN

Introducción: la comprensión de los factores que inciden en el rendimiento académico de los estudiantes es crucial para la Universidad de Santander ya que le permite realizar ajustes y adaptaciones curriculares, cambios que son fundamentales para promover el desarrollo de competencias en los estudiantes, y de esta manera, contribuir al enriquecimiento de los procesos educativos y así cumplir con éxito la misión del sistema educativo. **Objetivo:** analizar los factores que afectan el rendimiento académico de los estudiantes de recién ingreso como oportunidades de mejora que respondan a las necesidades de los estudiantes. **Materiales y Métodos:** estudio exploratorio y transversal. La población fueron 1.161 estudiantes de recién ingreso. La variable respuesta fue el promedio académico logrado por el estudiante al finalizar el semestre académico. Los datos se obtuvieron de pruebas educativas nacionales y sistemas de información institucionales. Para los análisis estadísticos se utilizó la regresión logística binaria. Se utilizó el software estadístico SPSS versión 26. **Resultados y Discusión:** se realizó un ANOVA $F_{(2)} = 24.94$, $p<.001$, encontrándose diferencias significativas entre las medias del promedio en los tres campus. El análisis bivariado mediante la prueba de $X^2(2) = 26.72$, $p <.001$, indica que existe una asociación estadísticamente significativa entre el promedio académico y el campus al que pertenecen los estudiantes. Las competencias de la prueba Saber 11, especialmente el desempeño en niveles altos en Inglés y matemáticas son significativas para la estimación del

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modelo de rendimiento académico con regresión logística binaria. **Conclusiones:** estudiantes que ingresan a la universidad con una mayor consolidación en sus habilidades matemáticas, lectura crítica, competencias ciudadanas y de inglés logran una mayor consolidación en el proceso de enseñanza aprendizaje en la universidad.

Palabras clave: Sistema de alerta temprana**;** Competencia profesional; Rendimiento escolar bajo; Análisis de regresión; Mejoramiento de la Calidad.

ABSTRACT

Introduction: Comprehending the factors influencing students' academic performance holds significant importance for the Universidad de Santander. This understanding enables the university to implement curricular adjustments and adaptations, which play a fundamental role in fostering the development of student competencies. Consequently, these adjustments contribute to enriching educational processes, thereby aiding in the successful fulfillment of the educational system's mission. **Objective:** To examine the factors influencing the academic performance of incoming students as opportunities for improvement that address the students' needs. **Materials and Methods:** This study adopts an exploratory and cross-sectional design. Its comprised 1,161 new students. The response variable under consideration is the academic average attained by students at the conclusion of the academic semester. Data were sourced from national educational tests and institutional information systems. It was performed a statistical analysis using binary logistic regression, employing SPSS version 26 for the statistical software. **Results and Discussion:** An analysis of variance ANOVA $F_{(2)} = 24.94$, $p<.001$ was performed, finding significant differences between the means of the average in the three campuses. The bivariate analysis using the $X^2(2)$ test $= 26.72$, $p<.001$, indicates that there is a statistically significant association between the academic average and the campus to which the students belong. Furthermore, the competencies assessed by the Saber 11 test, particularly the performance levels achieved in English and mathematics, were identified as crucial factors for the estimation of the academic performance model through binary logistic regression. **Conclusions:** Students who enter college with a stronger foundation in mathematics, critical reading, citizenship, and English proficiency experience enhanced consolidation within the college teaching and learning environment.

Key words: Early warning systems; Professional competence; School underachievement; Regression analysis; Quality improvement.

INTRODUCTION

The academic performance of students encompasses the outcomes of their learning process, constituting a multifaceted and intricate concept. It is contingent upon a multitude of conditions capable of shaping students' knowledge acquisition, including family, social, and academic dimensions. In addition to these conditions, intrinsic factors wield considerable influence over academic performance, including prior competencies, cognitive aptitude, discipline, motivation, and diligence. Furthermore, a range of extrinsic factors tied to the educational institution and

socioeconomic milieu, peer-based learning, and parental educational backgrounds, among other facets, augment the aforementioned influences.

Comprehending the factors influencing students' academic performance holds significant importance not only for educational institutions but also for enabling them to implement curricular modifications and adaptations. These adjustments play a pivotal role in fostering the development of students' competencies, thereby enhancing the educational processes. In achieving this objective, the educational system effectively fulfills its mission.

Considering that competency development is a globally studied subject, the Organization for Economic Cooperation and Development (OECD) has been conducting analyses on students from various countries. These analyses serve as a foundation for shaping policy directives aimed at enhancing education systems, ultimately contributing to students' competency development (1).

As per the OECD (2021), the competencies strategy seeks to assist nations in enhancing several facets, including their responsiveness to educational requirements, the quality and efficiency of learning provisions, ensuring effective acquisition of relevant skills throughout one's working life, as well as their recognition and certification. Moreover, it aims to improve accessibility by reducing barriers within educational institutions, training centers, and companies, among other objectives.

The Program for International Student Assessment (PISA) was collaboratively established by member countries of the Organization for Economic Co-operation and Development (OECD) at the global level. PISA aims to assess the proficiency of 15-year-old students in reading, mathematics, and science within educational institutions. This assessment seeks to ascertain the extent of generic competencies in these subjects among students (2).

At the national level, Colombia assesses the competency levels of elementary, middle, and high school students in subjects including Mathematics, Critical Reading, Natural Sciences, Social Sciences, Citizen Sciences, and English. This evaluation is carried out by the Colombian Institute for the Evaluation of Education (ICFES) through the administration of standardized tests. Among these standardized assessments, Saber 11 stands out as a tool for gauging students' competency development as they reach the end of their eleventh-grade education. Saber 11 serves several crucial purposes, such as furnishing educational institutions with insights into the competencies of prospective students. This information aids in designing remedial programs and provides valuable self-assessment resources for both students and institutions. Additionally, it supplies data for monitoring educational quality, establishing value-added indicators, and facilitating inspection and surveillance efforts (3).

Academic improvement strategies: the Universidad de Santander case study.

In accordance with the guidelines set forth by the Ministerio de Educación Nacional (Colombia) in their 2015 publication on implementing a management model for student retention and graduation in Higher Education Institutions, it is imperative that each educational institution, as an integral component of their formative processes, actively develops and deploys their individual intervention strategies. These strategies should be rooted in the early warnings identified at various stages of student training and should encompass continuous monitoring,

spanning from admission to graduation. The overarching objective is to effectively curtail the prevalent levels of undergraduate attrition.

In line with a commitment to enhance the academic quality of its students, Universidad de Santander (UDES) has established the Academic Analytics Observatory to address the imperative need for a coordinating unit that effectively integrates and harmonizes academic diagnosis and evaluation processes. This observatory's design primarily revolves around three key pillars: diagnosis, intervention, and continuous improvement. In terms of the early warning system, it entails analyzing the results of the Saber 11 test administered to newly enrolled students, alongside other institutional data sources. Through this undertaking, the University compiles a comprehensive diagnosis encompassing students' entry conditions, socioeconomic characteristics, and their learning outcomes during the first academic semester, serving as a foundation for tailored learning approaches attuned to student needs. On the socioeconomic front, the University conducts a characterization survey of newly admitted students to collect information on various dimensions, including health, welfare, human development, sports, culture, environment, georeferenced place of origin data, and demographic and economic income details of students and their families. These findings serve as inputs for constructing institutional improvement plans rooted in the principle of equity and are pivotal in formulating welfare policies for diverse stakeholders.

To complement the information gleaned from Saber 11 and the characterization survey, the Directorate of Student Development administers two entrance evaluations. The first assessment gauges reading comprehension levels using the Progressive Linguistic Complexity (PLC) test, while the second evaluates written competency based on the parameters of the ICFES written communication test. These evaluations serve as diagnostics, enabling the design and implementation of targeted activities tailored to the specific needs of students and are conducted throughout the semester. Subsequently, students undergo an exit test before the conclusion of their first semester to gauge the progress made in reading comprehension and written communication skills following the intervention (unpublished data). This process verifies the impact of these activities on the adaptation and retention of first-time students within the institution.

Figure 1. Early warning system stages.
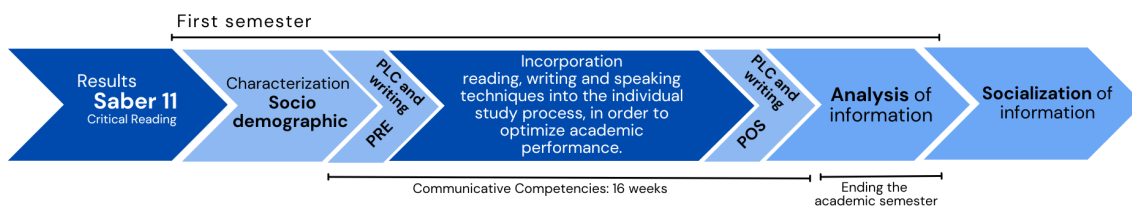
Source: Authors

Drawing upon the outcomes derived from the entrance diagnostics, namely Saber 11, the characterization survey, the Progressive Linguistic Complexity test, and the written communication test, Universidad de Santander (UDES) has, as part of its steadfast commitment to the academic excellence of its offerings, instituted an Early Warning (EW) system. This system now constitutes an integral facet of the continuous improvement processes. The established Early Warnings encompass the following categories: Alert 1, which centers on student

characterization and their initial conditions upon entering the University; Alert 2, which scrutinizes factors correlated with academic performance; Alert 3, dedicated to aspects related to student attrition; and Alert 4, which diligently monitors courses exhibiting high failure rates (4). Early Alert 5 pertains to the assessment of value added, serving as a metric to gauge students' academic progress in generic competencies relative to the Saber 11 and Saber Pro tests. These Early Warnings have been meticulously designed with the express purpose of diagnosing and providing individualized support to students, accounting for their unique circumstances, particularly concerning their retention in the institution, their impact on academic achievements, and the prevention of attrition.

Various statistical methodologies have been employed to study academic achievement, from descriptive and inferential (5) to multivariate techniques such as canonical discriminant analysis and logistic regression used by Gutiérrez-Monsalve (2021) to identify the association between pedagogical, institutional and sociodemographic variables with academic achievement (6). In the study by Bayona-Rodríguez (2021) multilevel logistic models were used in order to find school factors related to school success in vulnerable students based on information from the Program for International Student Assessment (PISA) 2018 (7). The K-means cluster test and stepwise regression analysis was implemented by (8) and was used to study the relationship between social origin and academic achievement in Mexican students. Considering the various methods used, this study applies binary logistic regression as a technique for data analysis. These analyses allow universities to have efficiency indicators that in turn show their academic work and thus provide accountability to the public and the state for their institutional work (9).

This endeavor exemplifies Universidad de Santander's unwavering dedication to elevating the academic excellence of its students. It goes beyond merely establishing an early warning system; it encompasses a comprehensive analysis of the factors influencing the academic performance of incoming students. This analytical approach identifies areas of improvement that are tailored to students' specific requirements. Consequently, it enables the institution to implement targeted, timely, pertinent, and efficacious follow-up and support strategies.

MATERIALS AND METHODS

This study adopts an exploratory and cross-sectional approach and was conducted in the initial academic semester of 2023. The study's population comprised 1,161 incoming students hailing from the university's three campuses situated in the cities of Bucaramanga, Cúcuta, and Valledupar in Colombia. Exclusion criteria encompassed students with incomplete records.

The data utilized in this study were sourced from the university's information systems. The response variable pertained to the academic performance of students at the conclusion of the semester, which was transformed into a dichotomous variable referred to as "average." This variable categorizes students into two groups: "lower or equal to 3.8" and "higher than 3.8," with consideration given to the University's grading system, where 5.0 represents the maximum achievable grade.

Regarding to the predictor variables, the study incorporated the performance levels on the High School State Examination, Saber 11, encompassing Critical Reading, Mathematics, Social and Citizenship, Natural Sciences, and English. These scores were procured from the Colombian Institute for the Evaluation of Education (ICFES) via the PRISMA System. The

performance levels on the first five tests were grouped into categories, namely (N1, N2) and (N3, N4), while for the English test, the categories (A-, A1, A2) and (B1, B+) were established.

As a complement to these findings, the results of the Survey of Characterization of Newly Entered Students in semester A-2023, applied by the institution, were considered, which consists of 106 questions that allow knowing socio-demographic, economic, cultural, and psychosocial aspects of the students that have allowed implementing follow-up and support strategies, which have been focused, timely, relevant and effective.

As a diagnostic and academic follow-up strategy, the University's Student Development division administered two tests. The first assessment focused on written communication, and its outcome was integrated into the model as a categorical variable. The second test centered on reading comprehension, and its results were incorporated as a continuous variable, derived from the difference between the test scores before and after the intervention (unpublished data).

In the data analysis phase, it was conducted a descriptive analysis. Continuous variables underwent an assessment of central tendency, complemented by histograms and normality tests (Kolmogórov-Smirnov test). Qualitative variables were analyzed through frequency tables. For bivariate analyses, we employed measures of association and conducted goodness-of-fit tests. Statistical significance was defined as $p < .05$.

Binary logistic regression was employed to evaluate the probability ($P(Y=1)$) of a student achieving a high GPA (greater than 3.8) based on the predictor variables (X_1, X_2, X_3... X_k). In this model, the coefficients for the predictor variables are denoted as β_1, β_2, β_3 ... β_k, with α representing the constant term. The binary logistic equation is formally presented as Equation 1:

$$P(Y = 1) = \frac{1}{1 + e^{(-\alpha - \beta_1 X_1 - \beta_2 X_2 - \beta_3 X_3 - ... - \beta_k X_k)}} \quad Equation\ 1$$

The logarithm of the likelihood was calculated to assess the model's data fit. The Hosmer-Lemeshow goodness-of-fit test was performed ($p > .05$), the Cox and Snell R-square, Nagelkerke R-square, classification tables were calculated, and 95% confidence intervals (95%CI) were estimated for the Odds Ratio (10). To execute the statistical model application process, we utilized SPSS version 26 statistical software.

RESULTS

The study encompassed 1.161 newly enrolled students in the first semester of 2023 across the institution's three campuses. Table 1 presents the descriptive analysis of the variable "average" by "campus". Regarding the variable "average" it was found that 66% of the students obtained an average "higher than 3.8" while 34% of the students presented an average "lower than or equal to 3.8". Within this group, 27% achieved an average between "≥ 3.2 to ≤ 3.8", 5% were on academic probation with average between "≥ 2.6 to <3.2", and 2% presented academic performance with average between "0.0 to < 2.6". Furthermore, an ANOVA F (2) = 24.94, p<.001 was performed, finding significant differences between the means of the average on the three campuses.

Table 1. Cumulative average descriptions by campus

Campus	n	Mean	Standard Error	IC 95%	Standard deviation	Coefficient of variation
Bucaramanga	534	3.79 [a]	0.03	[3.72, 3.86]	0.77	0.20
Cúcuta	277	4.11 [b]	0.02	[4.06, 4.16]	0.37	0.09
Valledupar	350	3.94 [c]	0.03	[3.88, 3.99]	0.48	0.12

Comment: a, b, c: different letters are statistically significant. 95% CI: 95% confidence interval.

In the bivariate analysis presented in Table 2, the relationship between GPA (classified as "High" and "Low") and the variable "campus" was evaluated. For this purpose, chi-square $X^2(2) = 26.72$, $p < .001$ was used. Which indicates that there is a statistically significant association between GPA and the campus to which the students belonged.

Table 2. Grade point average and campus

Campus	Average		Total n (%)
	High n (%)	Low n (%)	
Bucaramanga	322 (60.3)	212 (39.7)	534 (100)
Cúcuta	217 (78.3)	60 (21.7)	277 (100)
Valledupar	227 (64.9)	123 (35.1)	350 (100)
Total	766 (66.0)	395 (34.0)	1161 (100)

Binary logistic regression model

The estimation of a Binary Logistic Regression Model (BLRM) for each of the campuses is presented below.

Table 3 displays the BLRM results for newly enrolled students at the Bucaramanga Campus. The model reveals that students who attain performance levels N3 and N4 in the Critical Reading Test of the Saber 11° ICFES Exam are 1.9 times more likely to achieve a high average compared to students who scored at levels N1 and N2. Similarly, students who obtain performance levels N3 and N4 in the Mathematics Test of the Saber 11° ICFES Exam are 2.1 times more likely to attain a high average compared to those with levels N1 and N2. Additionally, students who demonstrate B1 and B+ performance levels in the English Test of the Saber 11° ICFES Exam are 2.0 times more likely to achieve a high average relative to students with A-, A1, or A2 performance levels. Furthermore, female students are 1.9 times more likely to attain a high average compared to male students.

For the Cúcuta campus, the analysis revealed that a first-semester student who enrolled in the Cúcuta campus of the UDES in the 2023-1 period (see Table 3) and achieved performance levels of B1 and B+ in the English Test of the Saber 11° ICFES Exam has a 2.5-fold higher likelihood of attaining a high average compared to a student who scored at an A-, A1, or A2 level of performance. Similarly, when a student achieves N3 and N4 performance levels in the

Mathematics Test of the Saber 11° ICFES Exam, their probability of having a high average increased by a factor of 3.1 relative to a student with N1 and N2 performance levels. Additionally, among this cohort, female students are 3.0 times more likely to achieve a high average in comparison to their male counterparts.

At the Valledupar campus (see Table 3), a student achieving N3 and N4 performance levels in mathematics tests of the Saber 11° ICFES exam has a 2.1-fold higher likelihood of attaining a high average compared to a student with N1 and N2 performance levels in English in the Saber 11 tests. Similarly, when a student obtains N3 and N4 performance levels in the social and citizenship tests of the Saber 11° ICFES exam, their probability of achieving high cumulative averages increases by a factor of 1.8 relative to those with N1 and N2 performance levels in Social and Citizenship competencies. Regarding attendance patterns, students who exclusively attend classes in the morning exhibit a 16.2-fold higher likelihood of achieving high averages compared to those who remain on campus throughout the day. Those who attend only in the afternoon are 3.8 times more likely to achieve higher performance, and students who solely attend classes are 3.1 times more likely to achieve higher performance than their peers who remain on campus all day. Additionally, students who do not participate in tutoring at the Faculty of Exact, Natural, and Agricultural Sciences are 2.1 times more likely to achieve higher yields compared to those who attend tutoring. This result aligns with the perspective that students attending tutoring are those in need of academic reinforcement and require academic support for their persistence.

Table 3. Estimation of the academic performance model with binary logistic regression.

Variables in Equation	B	Standard Error	Wald	df	p	Exp(B)	95% C.I. for EXP(B)	
							Inferior	Superior
Campus Bucaramanga								
Desempeño Lectura Crítica (N3 - N4)	0.66	0.26	6.29	1	.01	1.95	1.15	3.29
Desempeño Matemáticas (N3 - N4)	0.75	0.24	9.44	1	.00	2.12	1.31	3.43
Performance in English (B1 - B+)	0.70	0.28	6.26	1	.01	2.01	1.16	3.49
Gender (Female)	0.64	0.2	10.53	1	.00	1.91	1.29	2.83
Constant	-1.19	0.26	19.59	1	.00	0.30		
-2 log of plausibility 713.99 R2 de Nagelkerke 0.13 Sig. Hosmer-Lemeshow 0.09 % of well-classified cases 62.2								
Campus Cúcuta								
Performance in Mathematics (N3 - N4)	1.13	0.40	7.70	1	.00	3.10	1.39	6.92
Performance in English (B1 - B+)	0.94	0.37	6.39	1	.01	2.58	1.23	5.38
Gender (Female)	1.10	0.31	12.08	1	.00	3.00	1.61	5.59

Constant	-0.53	0.42	1.49	1	.22	0.59		
-2 log of plausibility 289.50 R2 de Nagelkerke 0.13 Sig. Hosmer-Lemeshow 0.70 % of well-classified cases 77.3								
Campus Valledupar								
Performance in Mathematics (N3 – N4)	0.74	0.26	7.80	1	.00	2.11	1.25	3.56
Performance in Social-Citizenship (N3 – N4)	0.60	0.29	4.27	1	.03	1.83	1.03	3.25
Tutorial (Does not attend)	0.77	0.26	8.87	1	.00	2.17	1.30	3.61
What is the length of stay at the university? (All day long) *			20.94	3	.00			
What is the length of stay at the university? (Only in the morning)	2.78	0.81	11.69	1	.00	16.24	3.28	80.28
What is the length of stay at the university? (Only in the afternoon)	1.35	0.35	14.77	1	.00	3.87	1.94	7.73
What is the length of stay at the university? (Only for the class)	1.13	0.33	11.58	1	.00	3.10	1.617	5.96
Constant	-1.74	0.35	23.52	1	.00	0.17		
-2 log of plausibility 467.67 R2 de Nagelkerke 0.20 Sig. Hosmer-Lemeshow 0.33 % well-classified cases 69.4 * Reference category								

Comment: B = beta, df= degrees of freedom. N3 = Level 3, N4 = Level 4. B1 = English Level B1. B+= English Level B+.

DISCUSSION

Research on school effectiveness serves as a strategic approach to enhance education overall and to bolster decision-making within educational institutions. The findings derived from studies on school effectiveness enable the exploration of actions aimed at institutional enhancement. Additionally, as highlighted by Blanco (2008), they furnish institutions with the means to identify the factors influencing school effectiveness and to ensure the equitable provision of educational services, tailoring them to individual needs (11). To gauge the quality of educational systems, evaluation systems have been established as tools for educational policy. These systems have served various purposes, including, as emphasized by Blanco (2008) in the specific context of Chile, monitoring the evolution of the school system's outcomes, guiding national educational policy decisions, offering guidance and feedback to educators and administrators, and fostering

the responsible commitment of schools, supporters, and parents. In Colombia, public universities employ a management indicators model based on evaluating causal relationships among inputs measured through a set of indicators. This approach facilitates enhanced efficiency within universities, thereby ensuring effective governance and administration (12).

Analyzing the factors affecting educational outcomes as a quality metric facilitates the identification of areas necessitating timely attention and the formulation of educational strategies tailored to the diverse student population. Research in education quality has spotlighted factors impacting school performance and student learning outcomes. The findings from this research, aligned with the specified methodology, align with the assertions of the World Bank (2009), which emphasizes that family background traits, notably parental income and education, alongside educational resources at home to a lesser extent, exhibit significant and positive correlations with academic achievement (13).

Evaluating the quality of educational systems through standardized tests like PISA provides researchers with a more comprehensive understanding of the factors influencing performance, as indicated by the institutions' conditions and test results (14). The incorporation of PISA into the analysis and comprehension of performance-related factors has played a pivotal role in shaping Colombia's standardized testing framework. This framework, according to OECD (2009), facilitates the alignment of policies that connect learning outcome data with student attributes, the identification of the impacts of educational institution and system characteristics on student performance, and the assessment of the development of generic competencies, among other aspects (15).

Analyzing student learning outcomes via standardized tests, such as the PISA tests, provides an opportunity to assess the quality of educational systems across different countries and to facilitate comparisons of the strategies they employ (García Villegas et al., 2013). However, this evaluation should be complemented by additional studies aimed at identifying factors that influence or sustain academic performance, contributing to a student's continuity within a program, institution, or the educational system as a whole (16).

The Universidad de Santander (UDES) early warning system facilitates the identification of factors impacting students' academic achievement, thereby guiding the implementation of strategies aimed at enhancing or sustaining academic performance and, consequently, ensuring their continuity within the educational system (16). In our analysis, it is discerned that entry competencies, as reflected in Saber 11 test results, play a pivotal role in influencing the attainment of a high academic average. Additionally, it is observed how students' socioeconomic conditions influence the dynamics of their learning (17–19).

Implementing learning assessment strategies in students represents a significant advancement in identifying factors influencing students' academic achievement. This is particularly crucial for comprehending the dynamics of learning in relation to students' socioeconomic conditions (Barrera, 2014). Analyzing the factors that impact academic achievement and, consequently, the attainment of student learning outcomes holds vital significance in fortifying the educational system.

The curriculum represents another factor closely linked to student academic performance. It delineates the educational trajectory for students and the development of future

professionals. Consequently, it becomes imperative to examine curriculum-related factors that contribute to enhancing academic value while identifying those that pose obstacles (20). Furthermore, it is essential to acknowledge the current generation of young individuals hailing from diverse socio-cultural backgrounds and originating from a variety of public and private institutions. These students exist within a spectrum, with some immersed in technology-rich environments and others navigating a globalized society amid economic challenges. In light of these considerations, institutions face the challenge of equipping students with the requisite tools and competencies. This preparation extends beyond ensuring good academic performance; it also encompasses enabling students to confront life's challenges and attain the goals outlined in their academic life plans.

Various studies elucidate that pre-college academic performance serves as a robust predictor of success in university studies. This performance is gauged by factors such as secondary education grades and state tests. Pre-university academic achievement stands out as one of the most potent predictors of university students' academic performance. Additionally, the educational quality of the institution attended by the student significantly influences this performance (21). Implementing academic improvement strategies, like tutoring, significantly enhances students' academic performance, particularly benefiting those with lower initial academic levels. (22).

Utilizing a binary logistic regression model for analyzing factors related to student learning aligns with Blanco et al.'s (2008) research, highlighting potential methodological and statistical errors induced by traditionally employed linear regression models. (11). The binary logistic regression model accommodates a hierarchical structure, facilitates aggregation levels, and yields more accurate estimations, enabling the assessment of the impact of various social, personal, and instructional factors on learning outcomes.

As a result of employing various research methods, it is essential to exercise caution when interpreting the data. It is imperative to recognize that the primary aim is to expand our understanding of the factors influencing school performance and, consequently, educational quality. Nonetheless, it is crucial to acknowledge that both academic performance and quality are multifaceted variables. The findings presented in this research align with observations made by the ICFES (2017), which emphasize several points: they do not establish a causal relationship between factors and performance, caution should be exercised in inferring the direction of the relationship between factors and performance (23), and the results should be construed as statistical relationships rather than deterministic ones (4).

CONCLUSIONS

In this context, students possessing enhanced proficiency in mathematics, critical reading, citizenship, and English skills upon entering the university experience a more substantial reinforcement in the teaching-learning process at the academic institution. Moreover, female students exhibit superior academic performance during their initial semester in comparison to their male counterparts. Notably, the timing of university attendance, whether limited to specific class time slots or encompassing an entire day, constitutes a significant determinant of student performance, yielding noticeable distinctions when compared to individuals who remain on campus throughout the entire day.

Future studies should take into consideration the recommendations made by Pattengale (24). Particular emphasis should be placed on addressing the unique challenges faced by first-generation students. This subgroup may encounter difficulties in adapting to the academic environment and could potentially have lower levels of academic preparedness compared to their peers with familial experience in higher education. To support first-generation college students effectively, it is beneficial to organize study groups or implement tutoring systems supervised by both fellow students and faculty members. These initiatives can ensure that students receive tailored assistance that aligns with their specific academic requirements. Further work may include the use of predictive analytics with machine learning techniques to optimize the correct classification rates of the cases evaluated.

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CONFLICT OF INTEREST

We, the authors, assert that within the scope of this study, there exists no conflict of interest.

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