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Exploring students' study time, sleep duration, and perceptions of course difficulty on final examination results: A cross-sectional study

Niu Zhang, MD, MS and Xiaohua He, MD, MS

ABSTRACT

Objective: To evaluate the possible association between student final exam scores and student-reported measures of study time, sleep duration, perception of course difficulty, and grade satisfaction.

Methods: A 4-item questionnaire was administered to 354 3rd-quarter students during finals week. Students were asked to report their study time, sleep duration the night prior to the exam, and perception of course difficulty as well as grade satisfaction using a 5-point Likert scale response prior to taking the exam. The relationship between exam scores from the immunology and endocrinology courses and those 4 items were analyzed.

Results: We found the grade satisfaction and total scores before the final exam and sleep duration had a positive relationship with final exam scores (immunology: $r = .29$, $r = .56$, and $r = .22$, $p < .01$; endocrinology: $r = .41$, $r = .42$, and $r = .26$, $p < .01$). In contrast, a negative relationship between the perceptions of course difficulty and the final exam score was found (immunology: $p < .01$, $r = -.15$; endocrinology: $p < .01$, $r = -.32$). Surprisingly, study time did have a significant correlation with final exam scores ($p > .05$).

Conclusion: Adequate sleep the night prior to an examination was positively associated with the exam scores. Study time for the final exam did not correlate with final exam scores. There may be a need for schools to consider the potential impact student sleep habits have on academic performance and to distribute this information to students.

Key Indexing Terms: Chiropractic; Education; Academic Achievement; Sleep

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INTRODUCTION

Almost all science coursework incorporates testing. Tests, exams, and quizzes are the most common summative assessment tools to measure whether students have achieved the learning objectives of a course. Several factors may influence student test performance. These include the number of hours studied,[1] careful textbook reading,[2] quality of lecture notes,[3] stressful life events,[4] and the duration of sleep the night or week before an examination or even during an entire term.[5] The potential consequences of tests also impact student learning. Students adapt to what and how they learn so as to meet the instructors' requirements as manifested on examinations, perhaps rather than understanding the material that is to be learned.[6,7] As instructors, we believe that learning is approached as a process leading to the production of knowledge, and assessment is a critical aspect of the teaching and learning process that aims at collecting, interpreting, and analyzing the students' performance. Learning is a complex process that involves multiple factors, including motivation, attention, memorization, and prior knowledge.[8]

A meta-analysis conducted by Crede and Kuncel[1] examined 88 studies that focused on the correlation between study time and academic performance. The analysis revealed a positive association between the 2 variables, indicating that students who devoted more hours to studying tended to perform better on tests. However, some researchers reported no significant effects of study time on students' grades in a class. Plant et al[9] posit that the amount of study done by college students is a poor predictor of academic performance. Stinebrickner and Stinebrickner[10–12] found it may be difficult to establish the relationship because many confounding factors, such as race, friends, roommates with video games, class attendance, and work, play a role in the relationship between studying and course grade. However, the strength of this relationship varied across different subjects and student populations.

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Table 1 - Final Exam Schedule Description

Test Group	Tests Taken on Day of Endocrinology Exam		Tests Taken on Day of Immunology Exam	
1. 3 classes ($n = 232$)				
T221 ($n = 64$)	Neuro of brain & brain stem	Endocrinology	Prof ethics & communication	Immunology
T222 ($n = 98$)	Neuro of brain & brain stem	Endocrinology	Prof ethics & communication	Immunology
T223 ($n = 70$)	Neuro of brain & brain stem	Endocrinology	Prof ethics & communication	Immunology
2. T224 ($n = 46$)		Endocrinology	Adv neuro	Immunology
3. T231 ($n = 76$)	Adv neuro	Endocrinology	Radiology	Immunology

T221 = winter 2022; T222 = spring 2022; T223 = summer 2022; T224 = fall 2022; T231 = winter 2023.

Other studies assessed the impact of sleep on academic performance. Yoo et al[13] demonstrated that a single night of shortened sleep duration resulted in decreased memory encoding, which led to less knowledge retention. A study by Zeek et al[14] conducted among student pharmacists showed that adequate sleep the night prior to an examination was positively associated with student course grades and semester grade point averages. Conversely, Okano et al did not find that sleep duration the night before an exam was associated with better test performance. Instead, they found that both longer sleep duration and better sleep quality over the full month before a midterm were more associated with better test performance.[5]

In consideration of these studies, we wanted to know the association between student final exam scores and student-reported measures of study time, sleep duration, perception of course difficulty, and grade satisfaction in chiropractic students. So we hypothesized that (1) increased perceived course difficulty would have a negative relationship with final exam scores, (2) satisfaction with grade prior to the final exam would correlate with both sleep and study time, and (3) both study time and sleep duration would positively correlate with the final exam scores.

METHODS

Student Participants

The academic year on our campus is organized into 4 terms: fall, winter, spring, and summer, according to a quarter system. Immunology and endocrinology are both 3rd-quarter courses, and only students who took both courses in the same semester were eligible to participate in this study. The 3rd-quarter students on our campus often have up to 8 exams during 4 days in a final-exam week. Five sessions of immunology and endocrinology courses were provided between January 2022 and March 2023 with the same instructor, who provided the same lecture structure and course materials.

A 4-item questionnaire was administered to 354 3rd-quarter students across the 5 consecutive classes during finals week. Students were asked to report (1) study time for these 2 courses and the other course, whose final exam was scheduled on the same day as either immunology or endocrinology for the final exams; (2) sleep duration the night prior to the exam; (3) perception of course difficulty; and (4) grade satisfaction prior to taking the final exam. Both course difficulty (from *easy* to *difficult*: 1–5) and grade satisfaction (from *highly dissatisfied* to *highly satisfied*: 1–5) were rated on a 5-point Likert response. The total scores prior to the final exam in each course were also collected. We asked 3 additional questions to identify the participants' age, sex, and ethnicity.

Among the 5 classes, students from 4 classes had 2 final exams in 1 day. The 5 classes in this study were divided into 3 testing groups according to the combinations of the final exams on same day of immunology or endocrinology with another course (Table 1). Prior to implementation, the study protocol was reviewed and approved by the Palmer College of Chiropractic institutional review board (#2022-002).

Test Performance Assessment

A total of 4–5 topic-specific quizzes, 1 midterm exam, and a cumulative final examination were administered for both endocrinology and immunology to each of the 5 classes. The exam questions were in the single-best-response, multiple-choice format. Exam questions were identical for all study classes.

Data Analysis

Because each participant studied both endocrinology and immunology, statistical comparisons were conducted within the students. We wanted to know if there was a difference in the sleep duration and the study time within the students between the endocrinology final exam and the immunology final exam. We used paired sample *t* tests to assess the difference in these 2 survey items between the 2 exams. We used the same statistical methods to assess for differences in midterm exam scores and final exam scores in endocrinology and immunology, respectively, and to compare endocrinology exam scores with immunology exam scores in midterm exam scores and final exam scores, respectively. Because the course difficulty score and satisfaction with grades before the final exam were not continuous data, we used the Wilcoxon signed-rank test for evaluating the difference in these 2 survey items between endocrinology and immunology.

The difference in study time between low levels ($<90\%$) and high levels ($\geq 90\%$) was examined via an independent *t* test.

We also wanted to know if there was a difference in 4 survey items across the testing groups. We used a 1-way analysis of variance (ANOVA) to assess the difference in study hours and sleep duration and the Gabriel test for *post hoc* procedures because our sample size was unequal between testing groups. A Kruskal-Wallis test was used to assess the difference in the

course difficulty score and grade satisfaction before the final exam.

The correlation between exam scores from the immunology and endocrinology courses and those 4 survey items was analyzed by Pearson's correlation test.

For all quantitative measures, effect sizes were estimated (Pearson's r for Pearson correlation, eta squared r for 1-way ANOVA, and Cohen's d for paired t test), and 95% confidence intervals (CIs) were reported. Statistical significance was evaluated at $p = .05$. Data were analyzed using SPSS version 22 (IBM Corp).

RESULTS

A total of 354 students were included in this study; 153 (43%) of them were women, and 201 (57%) were men. Across all 5 classes, the majority of pupils were white (64%) with 92% of them being under 30 years of age.

Comparison of the Survey Results Between Endocrinology and Immunology

To compare the sleep duration and the study time between endocrinology and immunology, a paired samples t test was performed, whereas the Wilcoxon signed-rank test was used to compare the course difficulty and the satisfaction of the grade prior to the final exam between those 2 courses. The findings demonstrated that students spent significantly less study time for endocrinology ($M = 5.56$, SD = 5.03) than for immunology ($M = 6.72$, SD = 5.67); 95% CI, −1.48 to −.85; $p < .01$; $r = .35$. Similarly, the sleep length the night before exams was significantly shorter for the endocrinology exam ($M = 6.59$, SD = 1.48) than those for the immunology exam ($M = 6.76$, SD = 1.33); 95% CI, −.31 to −.35; $p < .05$; $r = .13$. For levels of course difficulty, it was significantly lower for endocrinology (median = 3.00) than for immunology (median = 4.00), $z = -6.62$, $p < .001$, $r = -.25$. However, the satisfaction score of the grade prior to the final exam for endocrinology (median = 5.00) was significantly higher than that for immunology (median = 4.00), $z = -7.33$, $p < .001$, $r = -.27$. Furthermore, before the final exam, endocrinology's overall scores (percentage) were significantly higher than immunology's (endocrinology vs immunology: $M = 93.09$, SD = 4.72 vs $M = 85.16$, SD = 8.18; 95% CI, −8.62 to −.7.23; $p < .01$; $r = .76$).

Additionally, individual total scores prior to the final exam were categorized into low and high levels based on whether the total scores were less than 90% or equal (greater than 90%) to compare the effect of the total scores on the study time. An independent t test indicated that students in the high-level group spent significantly less time than those in the low-level group for immunology ($M = 5.17$, SD = 3.31; $M = 7.53$, SD = 6.42; $p < .01$; $r = .20$) but no statistically significant differences in study time for endocrinology ($p > .05$).

Correlation Between the Final Exam Scores and the Perceptions of Course Difficulty, the Sleep Duration, the Grade Satisfaction, and the Study Time

The results of the Pearson correlation analysis showed small-to-medium[15] positive correlations between final exam scores and both grade satisfaction and total scores prior to the final exam (immunology: $r = .29$ and $r = .56$, $p < .01$; endocrinology: $r = .41$ and $r = .42$, $p < .01$).

A small but statistically significant correlation between the final exam and sleep duration was observed in immunology ($r = .22$, $p < .01$) and endocrinology ($r = .26$, $p < .01$), respectively. On the other hand, perceptions of course difficulty and final exam score had a negative association (immunology: $r = -.15$ [small], $p < .01$; endocrinology: $r = -.32$ [medium], $p < .01$). The amount of time spent studying and the results of the final exam did not correlate ($p > .05$).

Table 2 - Means and Standard Deviations for Exam Scores

	Midterm Exam	Final Exam	
Course	Mean (SD)	Mean (SD)	*P* Value
Endocrinology	47.15 (2.69)	39.54 (7.08)	< .01
Immunology	40.09 (6.36)	43.26 (4.43)	< .01

Correlation Between the Satisfaction with Grade Prior to Final Exam and Both Sleep and Study Time

The grade satisfaction was small correlated with sleep time in both endocrinology ($r = .15$, $p < .01$) and immunology ($r = .18$, $p < .01$). Interestingly, the grade satisfaction and study time for immunology were small negatively correlated ($r = -.19$, $p = .001$).

Comparisons of Final Exam Scores and Midterm Exam Scores Between and Within Courses

Paired t tests showed that the endocrinology midterm exam mean score was significantly higher than that for immunology ($M = 47.15$, SD = 2.69; $M = 40.09$, SD = 6.36, $p < .01$, $r = .79$). By contrast, the mean endocrinology final exam score was significantly lower than that for immunology ($M = 39.54$, SD = 7.08; $M = 43.26$, SD = 4.43, $p < .01$, $r = .53$).

Furthermore, a paired t test demonstrated that the mean scores on the immunology final exam were substantially higher than those on the comparable midterm exams (midterm exam vs final exam: $M = 40.09$, SD = 6.36 vs $M = 43.26$, SD = 4.44; 95% CI, −3.73 to −.2.60; $p < .01$; $r = .50$). The endocrinology final exam mean score decreased by 15% from the midterm exam (midterm exam vs final exam: $M = 47.15$, SD = 2.69 vs $M = 39.54$, SD = 7.08; 95% CI, 6.98, 8.24; $p < .01$, $r = .78$). Table 2 presents more detail.

Influencing from Other Exam Scheduled at Same Day on Difficulty Level of Course Content, Study Time, and Sleep Duration of Endocrinology and Immunology Finals

To evaluate if there was a difference in the course difficulty score within each testing group, we used a Kruskal-Wallis test.

The results showed that there was a statistically significant difference in group 1 [$H(3) = 493.55$, $p = .00$] and group 3 [$H(3) = 29.08$, $p = .00$] between the 4 subjects that students took in 2 days. Mann-Whitney tests were used to follow up on this finding. In group 1, the course difficulty score for neuro of the brain and brain stem was significantly higher than those

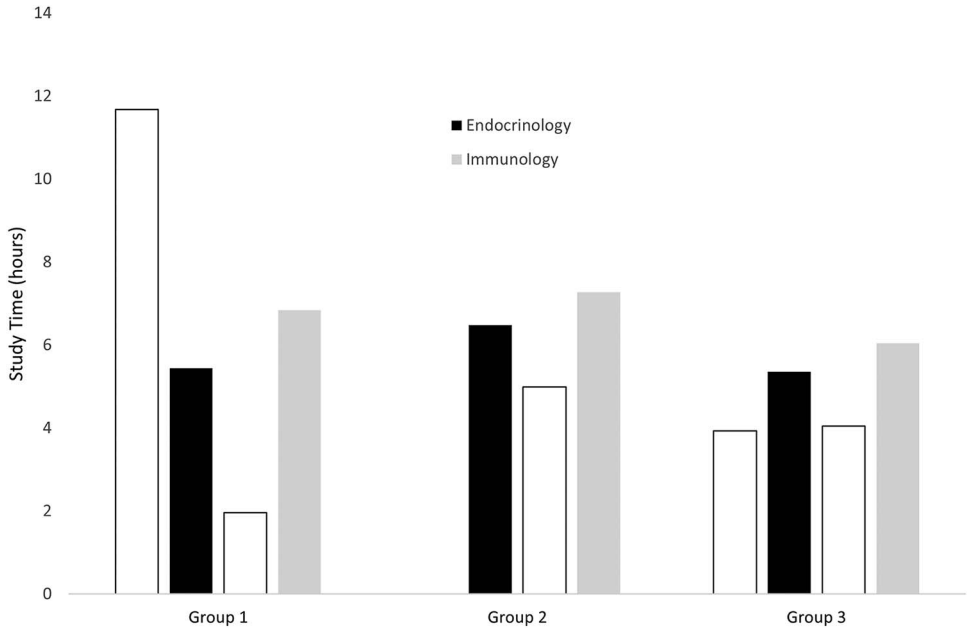

Figure 1 - Comparison of study time by testing group.

of endocrinology ($U = 12{,}370.50$, $r = -.49$), professional ethics and communication ($U = 1906.00$, $r = -.83$), and immunology ($U = 18{,}879.50$, $r = -.28$), whereas the score for professional ethics and communication was significantly lower than those of the other 3 subjects (neurology of the brain and brain stem: $U = 1906.00$, $r = -.83$; endocrinology: $U = 5356.00$, $r = -.72$; immunology: $U = 3159.00$, $r = -.79$). In group 3, the score for radiology was significantly lower than the scores for endocrinology ($U = 1616.00$, $r = -.04$) and immunology ($U = 1734.00$, $r = -.36$). The score for advanced neurology final exams (scheduled for the same day as endocrinology) was also significantly lower than the score for endocrinology ($U = 2219.00$, $r = -.21$). In group 2, there was no statistically significant difference in course difficulty scores between the 3 subjects [$H(2) = 2.55$, $p = .28$].

To assess the variations in the testing group's study time and sleep duration, a 1-way ANOVA was run. There was a statistically significant difference between 4 subjects in group 1 [$F_{(3,\ 924)} = 77.14$, $p = .00$, $r = .44$] and in group 3 [$F_{(3,\ 300)} = 7.45$, $p = .00$, $r = .26$]. The mean study time of neurology of brain and brain stem ($M = 11.68$, SD = 11.16) was the highest, and that of professional ethics and communication was the lowest ($M = 1.95$, SD = 1.55) among the 4 subjects in group 1. There was no statistically significant difference between 4 subjects in group 2 ($p = .07$) (Fig. 1).

There was a statistically significant difference in sleep duration for endocrinology between groups 1 and 3 ($M = 6.44$, SD = 1.57; $M = 6.94$, SD = 1.19, $p = .02$). There was not a statistically significant difference for immunology between the 3 groups ($p = .08$) (Fig. 2).

DISCUSSION

This study revealed 4 major findings. First, there was a negative correlation between final test scores and course difficulty level. Second, there was a positive correlation between final exam scores, grade satisfaction, and total scores before the exam. Third, the amount of sleep a student got the night before a test was positively correlated with the student's final marks. Fourth, remarkably, there was no relationship found between a student's final exam grade and the amount of time the student spent studying.

As we know, final exams are frequently used to assess students' knowledge and abilities as the culmination of their academic success. But being academically prepared is not the only way to perform at students' best on these important tests. Students' performance levels during these crucial examinations are shaped and influenced by a multitude of internal and external factors that interact. Numerous factors have been linked to students' success on final exams, according to some research reports. These variables span a wide range, including personal traits, study behaviors,[16] study time,[17] classroom settings,[18] and amount of sleep.[14]

Our findings demonstrated, as predicted, a favorable correlation between the final exam scores and the total scores obtained up until the final exam as well as grade satisfaction. This matches the findings of Wambuguh and Yonn-Brown, who similarly discovered a statistically significant positive correlation between quiz scores and final exam performance.[19] This implies that students are often happier with their grades when they receive higher marks. This relationship can be explained by their feelings of validation and success in their endeavors. When students do well, it frequently gives them confidence in their skills and validation that their efforts have paid off. Additionally, it raises the possibility that there is a positive association between grade satisfaction and final exam scores, suggesting that students who are confident in their performance may be more motivated and confident in their final exams, which could result in better results. Furthermore, additional factors, including study habits, test anxiety, and personal views about the final assessment's significance, might

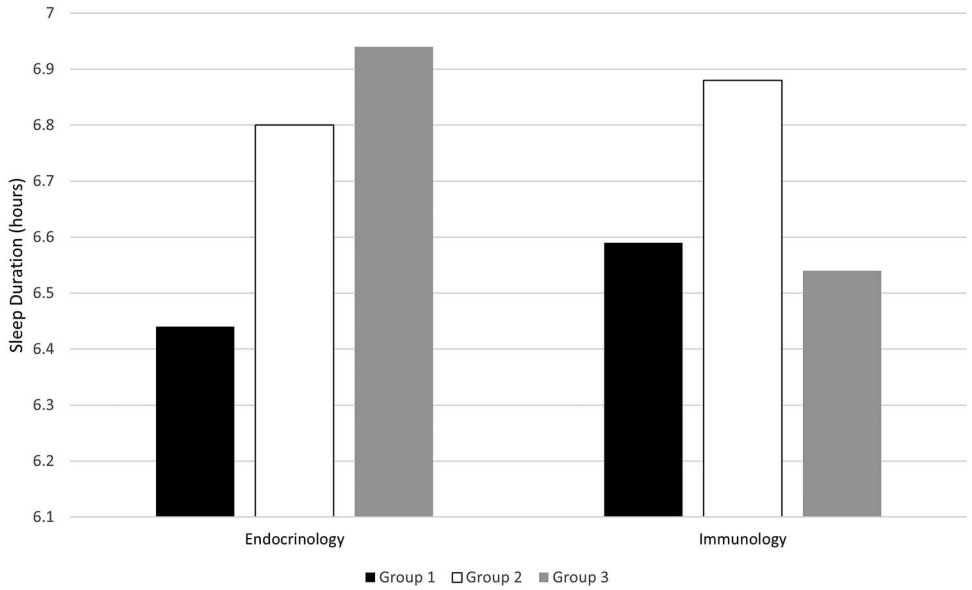

Figure 2 - Comparison of sleep duration between endocrinology and immunology by testing group.

also operate as mediators between grade satisfaction prior to the final exam and final marks.[20,21]

The results of the current study demonstrate the significance of getting enough sleep for academic achievement by showing a positive link between sleep duration and final exam scores. This results are in line with a study on medical students, which revealed that those who reported sleeping for longer periods of time performed better on tests.[22] Empirical evidence repeatedly demonstrates the beneficial effects of adequate sleep on cognitive capacities, including memory, attention, and problem-solving skills.[13,23] When students prioritize sleep and get the recommended amount, they are more likely to be mentally sharp and better equipped to absorb, retain, and recall information during exams. Consequently, this can lead to higher exam scores. Moreover, a well-rested mind is generally more resilient to stress, which is crucial during the exam period.[24] Students who maintain a healthy sleep schedule are often better equipped to manage the stress associated with exams, allowing them to perform to the best of their abilities.

The complex relationship between course difficulty and final exam scores has received much attention in educational studies. In the current study, we discovered an inverse relationship between the final test scores and the course difficulty level. The outcome concurs with a prior investigation conducted by England et al.[21] According to their study, there was a strong correlation between lower final course grades and an increase in students' perceptions of course difficulty from the start of the semester to the end. Furthermore, a variety of factors, including instructional strategies, student motivation, and individual learning preferences, can regulate the relationship between course difficulty and final test scores.

It's an interesting subject to research the relationship between study time for the final exam and exam results. Our findings showed that there was no relationship between study time and test results at the end. Our results concur with those of a few other studies. Okpala et al discovered that studying time had no discernible impact on academic performance.[25] Increased study effort boosts test scores although the study time effect was less pronounced than that shown by Stinebrickner and Stinebrickner,[26] according to Bonesrønning and Opstad,[27] who conducted another study on student test scores in macro concepts. According to Doumen et al, college students' course grades were impacted by their study time.[28] Similar findings have been observed for the positive association between study time and final test scores[29] and the positive correlation between study time and time spent in lecture halls and discussion.[30] Whereas test-taking preparation is well-recognized to have a significant impact on performance, there are a few other factors that may influence the degree of that impact. However, the quality of the study time is just as crucial as its quantity. Long stretches of time spent going through notes or textbooks won't guarantee success. The key to better results is to cultivate successful study habits, which involve utilizing a range of learning strategies, such as practicing problems or teaching concepts to others, actively interacting with the material, and adhering to a regular study plan—not cramming. In the current study, we only investigated the study time for the final exam, not the non-exam time. On the other hand, we also didn't study participants' study methods. Often, students seem to spend a lot of time studying without getting the good grades they desire. One reason may be the inefficiency of their study methods.

In our study, 2 exams were taken in a single day by students in 4 of the 5 classes. Two hundred thirty-two students (65% of the total) from testing group 1 had the endocrinology final exam and the neurology of brain final exam on the same day. The latter had the longest study period and the highest course difficulty score among students. On the same day, the same set of students took the least challenging exam out of all 4 courses (professional ethics and communication) with the immunology exam. According to the study's findings, students in the same testing group spent 6 times longer preparing

for the neurology of brain course than for the professional ethics and communication course despite the fact that the latter was 3 times easier. Students may have the tendency to devote more time to the subject that they believe to be more challenging. They might not devote enough attention to the other topic, which could result in inadequate preparation and poorer performance on the purportedly "easier" exam. Furthermore, the endocrinology students had a considerably shorter mean sleep duration the night before the exam than the immunology students, and the endocrinology students had a significantly higher total cumulative score prior to the final exam than the immunology students. Students may perform worse in endocrinology than in immunology as a result of these reasons.

Study Limitations

There are some limitations to this study. First, because it was a retrospective study, there was a disparity in sample sizes between 3 testing groups. An uneven sample size could have an impact on statistics. Second, there was the unequal distribution of examination frequency across the study groups. Group 2 underwent a single endocrinology final exam per day, whereas the other 2 groups were subjected to 2 exams on separate days. This discrepancy in examination schedules could introduce a confounding variable, potentially influencing the observed outcomes. Finally, this study focuses exclusively on collecting study time data during final exams without investigating study time during non-exam weeks. The omission of study time during periods without imminent exams may restrict the comprehensive understanding of participants' overall study habits and diligence. Students' study patterns during non-exam weeks may significantly contribute to their academic performance, and the absence of this data could result in an incomplete representation of the factors influencing exam scores.

CONCLUSION

First, our analysis revealed a significant positive correlation between final exam scores and both grade satisfaction and sleep duration. Students who reported higher satisfaction with their grades tended to achieve better exam scores. Additionally, those who obtained an adequate amount of sleep the night before the exam exhibited higher scores in courses. This underscores the importance of positive academic experiences and well-rested states in enhancing academic performance. Interestingly, we observed a negative relationship between final exam scores and the perception of course difficulty. This suggests that individual perceptions of course difficulty may influence academic outcomes, emphasizing the need for educators to address and support students in navigating challenging course content. Contrary to our expectations, study time for the final exam did not correlate with final exam scores. This unexpected result suggests that the mere quantity of study hours may not be the sole determinant of success. It raises questions about the quality and effectiveness of study strategies, which should be explored further in future research. In addition, students should have a regular study plan and avoid cramming.

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About the Authors

Niu Zhang (corresponding author) is a professor in the life sciences department at Palmer College of Chiropractic Florida (4777 City Center Parkway, Port Orange, FL 32129; niu.zhang@palmer.edu). Xiaohua He is a professor in the life sciences department at Palmer College of Chiropractic Florida (4777 City Center Parkway, Port Orange, FL 32129; shawn.he@palmer.edu).

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Author Contributions

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