International Journal of Health Literacy and Science 2 (2) (2024)
International Journal of Health Literacy and Science
https://ihelis.com

# Dissecting the Relationship Between Study Time, Gender, and Age: A Holistic Approach to Understanding Academic Performance in Contemporary Education

**Hendriani Selina[1]*, Tyas Anggraini[2], Rahel Amanda Konoralma[3], Andreas Wilson Setiawan[4], Rajwa Atsala Vindramekka[5], Hazel Arga Satya[6], Syifa Sofia Wibowo[7]**

[1]Pediatric Department, Universitas Dian Nuswantoro
[2]Molecular Biology Department, Universitas Dian Nuswantoro
[3,4]Public Health Department, Universitas Dian Nuswantoro
[5,6]Undergraduate Student of Medical Doctor Program, Universitas Dian Nuswantoro
[7]Faculty of Health Science, Universitas Dian Nuswantoro

## Article Info

*Article History*

Submitted: November 18, 2024

Revised: November 28, 2024

Accepted: November 30, 2024

*Keywords:*
*Study Time; Gender; Age; Academic Performance; Contemporary Education*

## Abstract

Academic performance is a complex and multifaceted outcome shaped by cognitive, behavioral, and biological factors influencing students' academic performance. This study aimed to investigate the relationships between the student's study time, gender, age, and academic performance in a sample of students. The study used correlation and comparative statistical methods to explore how these variables might influence student grades. The correlation between study time and grades was found to be weakly positive ($p = 0.037$, $R = 0.105$), indicating that while more study time is associated with slightly better grades, the strength of this relationship is modest. The comparative analysis between male and female students revealed a significant difference in average grades, with male students achieving higher grades ($p = 0.041$). The average grade for male students was 10.91, while female students averaged 9.97. Additionally, the correlation between age and academic performance was negative ($p = 0.001$, $R = -0.173$), suggesting that as students age, their academic performance tends to decline, albeit weakly. These findings underscore the complexity of factors influencing academic success, suggesting that study time, gender, and age play a role, but their impacts may vary in strength. The results highlight the need for further research to explore the cognitive, social, and biological factors that interact with these variables and contribute to students' academic performance. The modest correlations suggest that other variables, such as study strategies, motivation, and neurobiological factors, maybe more substantial in determining academic success.

Correspondence Address:
Pediatric Department, Universitas Dian Nuswantoro, Indonesia
E-mail: hendriani@dsn.dinus.ac.id

pISSN 2964-2035
eISSN 3025-9258

## Introduction

Academic performance is a complex and multifaceted outcome shaped by cognitive, behavioral, and biological factors influencing students' academic performance. Study time is often identified as one of the critical determinants of academic success, with numerous studies indicating that increased time dedicated to studying is positively correlated with improved knowledge retention, comprehension, and overall academic performance. (Liu, 2022). Research suggests that students who devote more time to their studies are better equipped to consolidate information, reinforce learning, and retain knowledge over the long term. In particular, longer study sessions allow for the repeated retrieval of learned material, facilitating deeper cognitive processing and reinforcing neural pathways associated with memory. (Roediger & Butler, 2011). This extended engagement with study materials contributes to better outcomes, as students can internalize information more thoroughly and make stronger connections between concepts. However, the relationship between study time and academic success is not uniform across all students. A range of individual differences, including gender and age, may significantly influence how effectively study time translates into academic achievement. (Amabile et al., 1994).

From a biological perspective, the impact of study time on academic performance is shaped by factors such as brain structure, hormonal profiles, and developmental stages. These biological variations influence cognitive processes like memory consolidation, learning ability, and neuroplasticity, affecting how individuals respond to study routines. The brain's ability to adapt and change in response to learning is critical to academic success, and this neuroplasticity is influenced by age and hormonal factors. (Kolb & Gibb, 2011). For instance, gender-based hormonal differences, particularly estrogen's role in memory enhancement and neuroplasticity may contribute to variations in study efficacy between male and female students. (Hara et al., 2015). Estrogen has been found to enhance synaptic plasticity, especially in areas of the brain involved in memory and learning, such as the hippocampus. As a result, female students may experience improved cognitive processing and memory retention during study sessions, making their study time more effective than their male counterparts in some contexts. Additionally, males tend to have higher testosterone levels associated with different cognitive patterns, potentially affecting how they engage with study materials and their academic performance. (Beauchet, 2006).

Age-related changes in brain development further complicate the study-time-performance relationship. As individuals age, their brains undergo significant structural and functional changes that influence learning and cognitive function. (Poldrack, 2000). These changes, particularly in regions related to executive function and learning, suggest that older students may process information more efficiently, which could lead to them requiring less study time to achieve similar academic outcomes as younger students. (Salthouse, 2012). Older students often have more advanced cognitive strategies and better-developed executive functioning skills, which enable them to organize information, manage their time, and solve problems more effectively. This might allow them to optimize their study time, using it more productively than younger students still developing these cognitive skills. As a result, while younger students may need to spend more time studying to achieve the same academic outcomes, older students may require less time due to their more refined cognitive abilities.

Understanding the complex relationships between study time, gender, and age provides valuable insights into how to optimize educational strategies tailored to individual student needs. Educators and researchers can use this knowledge to better design study interventions and provide personalized learning experiences considering these biological and cognitive factors. Such a comprehensive approach improves academic outcomes and helps create a more inclusive and effective educational environment. By recognizing the differences in how study time is utilized based on gender and age, creating more targeted and efficient teaching strategies that foster success for diverse students becomes possible. (Wiederholt et al., 1993).

## Methods

### *The Design of The Study and The Participants*

This cross-sectional study sampled secondary data from the UCI Machine Learning Repository. Participants were selected based on the availability of the duration of weekly study time, age, gender, and final grade.

### *The Collection of The Data*

This study utilized data gathered during the 2005-2006 school year from two public schools in the Alentejo region of Portugal. The data was collected through school reports and questionnaires containing 37 questions, completed in class by 788 students.

### *The Analysis of The Data*

The statistical analysis was conducted using the Statistical Package for the Social Sciences software on an observational, cross-sectional study to assess the correlation between the duration of weekly study time, age, gender, and final grade.

## Results

### *Correlation Between Study Time and Grade*

The correlation between study time and grade was assessed using the Spearman rank correlation test, which yielded a p-value of 0.037 and a correlation coefficient (R) of 0.105. The p-value indicates a statistically significant relationship between the time spent studying and students' grades, as it is below the conventional significance level of 0.05. However, the relatively small correlation coefficient suggests that while study time impacts grades, this relationship's strength is weak.

This finding supports the notion that more studying time can lead to better academic performance, but other factors may contribute more significantly to academic success. It is essential to recognize that this small correlation may be influenced by individual differences in study habits, study effectiveness, and the quality of the study sessions rather than simply the quantity of study time. Future studies could explore these additional variables, such as the focus and strategies employed during study sessions, which may provide a clearer picture of the relationship between the study's time and academic achievement. (Van Den Hurk et al., 1998).

### *Correlation Between Age and Grade*

The correlation between student age and grade was assessed using the Spearman rank correlation test, yielding a p-value of 0.001 and a correlation coefficient of -0.173. The negative correlation indicates that as student age increases, their grades tend to decrease, and this relationship is statistically significant given the p-value is well below the 0.05 threshold. The negative direction of this correlation suggests that older students, on average, maybe performing worse than younger students.

Several factors could explain this finding. Older students may face more external pressures, such as work or family responsibilities, which could reduce the time and energy available for academic tasks. (Zimmer-Gembeck et al., 2023). Additionally, the learning needs of older students might differ from those of younger students, potentially making it more challenging for them to keep up with academic demands. Another possibility is that older students may have developed less effective study habits or strategies over time, leading to lower academic performance. However, it is essential to note that the strength of the correlation is modest, and other factors, such as student motivation and cognitive development, may also play significant roles in explaining the observed relationship between age and academic performance. (Shi & Qu, 2022).

**Table 1. Relationship between Study Time and Age Towards Grade**

| Variables | Grade | |
|---|---|---|
| | R | p-value |
| Study Time | 0.105 | 0.037 |
| Age | -0.173 | 0.001 |

### *Gender Differences in Academic Performance*

The Mann-Whitney U test comparing male and female students' grades revealed a p-value of 0.041, indicating a significant difference in the statistical test between the two groups. Male students' average final test grade was 10.91, while female students had an average grade of 9.97. This suggests that male students, on average, performed slightly better than female students in terms of grades.

One possible explanation for this difference could be related to study habits, motivation, or the specific academic domains being assessed. Male students may have a different approach to studying those results in higher grades or be more likely to engage in subjects that align with their strengths (Saxena et al., 2024). Additionally, the study does not account for other variables, such as socioeconomic status, extracurricular involvement, or teaching methods, which could influence the academic outcomes of both

genders. Further research would be needed to explore the underlying causes of these gender-based differences and whether they persist across different assessments or educational settings.

## Discussions

Academic performance is influenced by various factors, including the amount of time students dedicate to studying and individual differences related to gender and age. Recent studies suggest that the relationship between study time and academic performance is complex, with additional factors such as cognitive development, brain structure, and neurobiological mechanisms playing a significant role. This literature review explores contemporary research on how study time, gender, and age affect academic success, focusing on the molecular and neurobiological perspectives.

### *The Impact of Study Time on Academic Performance*

Study time has long been considered a critical factor in academic success, with research consistently showing a positive correlation between the time of the study and their academic performance. A recent meta-analysis by Huang (2015) found that study time significantly predicts academic performance across various educational settings, with students who engage in longer study sessions often achieving better grades. (Nonis & Hudson, 2010). The neurobiological basis for this relationship can be traced to processes such as synaptic plasticity and neurogenesis, both of which are essential for learning and memory consolidation. For instance, studies by Abraham W. C. et al. (2019) emphasize that prolonged engagement in learning activities strengthens synaptic connections, particularly in the hippocampus, a brain region crucial for memory formation. (Abraham et al., 2019). Furthermore, research by Rodriguez et al. (2022) indicates that regular cognitive stimulation during study sessions enhances long-term potentiation (LTP), which is believed to underpin learning and memory. (Sánchez-Rodríguez et al., 2022).

However, the effectiveness of study time is not solely determined by its quantity. The quality of study sessions, including focus, cognitive load, and study strategies, also significantly impacts academic outcomes. Recent research by Stern et al. (2023) has highlighted that deep, focused study, as opposed to passive or distracted study, leads to more excellent retention and academic success. (Stern & Halamish, 2023)This suggests that while spending more time studying is beneficial, how that time is spent is equally vital in determining academic performance.

### *Gender Differences in Study Habits and Academic Performance*

Research on gender differences in academic performance has consistently shown that female students outperform male students, particularly in subjects requiring sustained attention and organization. McFarland et al. (2021) found that most female students spend more time on average studying, engage in more structured study habits, and perform better in academic assessments than male students. (Massachusetts. Executive Office of Education., 2019)The underlying neural mechanisms for these gender differences may be related to variations in the structure and function of the brain. For example, studies by Satterthwaite et al. (2017) reveal that females tend to have greater gray matter volume in areas such as the prefrontal cortex, which is involved in executive functions like making a plan, paying attention, and making decisions. (Gennatas et al., 2017). These structural differences may give females a cognitive advantage when managing and optimizing study time.

Hormonal influences also play a significant role in gender differences in academic performance. Estrogen, for example, has been shown to enhance cognitive functions such as learning, memory, and spatial awareness. (Hara et al., 2015). This may explain why female students are often more organized and focused in their study routines, leading to better academic outcomes. Male students, on the other hand, may excel in areas such as spatial reasoning and mathematics, possibly due to different neural organization in regions such as the parietal cortex. (Kaczkurkin et al., 2019). Despite spending less time studying, male students may still achieve high performance in specific academic domains due to these cognitive strengths.

### *Age and Academic Performance: Cognitive Development and Study Efficiency*

Age is another critical factor that influences how study time affects academic performance. Research has shown that older students, such as university undergraduates, typically perform better academically than younger students due to more developed cognitive abilities and refined study habits. A study by González et al. (2021) demonstrated that older students exhibit better time-management skills and are more likely to engage in effective study strategies, leading to more efficient use of study time. (García-González et al., 2022)As individuals age, cognitive functions related to memory and executive control improve, enhancing the ability to learn and retain information more efficiently.

At the molecular level, the maturation of the prefrontal cortex, which continues into the mid-20s, is crucial for the development of executive functions like planning, organization, and self-control. (Kaczkurkin

et al., 2019). This developmental trajectory explains why younger students, particularly adolescents, struggle with managing their study time effectively and may require more time to absorb academic material. Additionally, age-related changes in neuroplasticity and long-term potentiation contribute to the improved learning capacity observed in older students. Studies by Leung et al. (2015) suggest that older students benefit from enhanced neural plasticity, which allows for more efficient learning with less time spent studying. (Leung et al., 2015).

*The Interplay Between Study Time, Gender, and Age*

The relationship between study time and academic performance is not uniform across all students, as gender and age can influence how effectively study time contributes to academic success. A study by Liu (2022) found that the impact of study time on academic performance was more substantial for females and older students, suggesting that these groups benefit more from extended study sessions. (Liu, 2022). This aligns with research by Dodig et al. (2020), which indicates that both gender and age contribute to the cognitive efficiency with which study time is utilized. (Pavlinac Dodig et al., 2020). Additionally, motivational factors, which vary by age and gender, may mediate the effectiveness of study time. Older students, for example, may have more intrinsic motivation and better-developed strategies for managing their study time, leading to better outcomes despite potentially studying for shorter durations. (Jinmin & Qi, 2023).

The combination of cognitive, biological, and motivational factors highlights the complex interplay between study time, gender, and age in determining academic performance. By understanding these relationships, educators can better tailor study strategies and interventions to the specific needs of students based on their gender and age-related cognitive profiles.

## Conclusion

This study's findings suggest a statistically significant relationship between study time and academic performance. However, the weak correlation indicates that other factors likely contribute more significantly to academic success. Future research should explore these additional variables, such as the focus and strategies employed during study sessions, to understand better how study time impacts achievement. Furthermore, gender differences in academic performance revealed that male students, on average, scored slightly higher than female students, suggesting potential differences in study habits or academic strengths. However, the study does not account for other influencing factors, and further research is needed to explore the causes behind these gender-based differences. The correlation between age and grade demonstrated a statistically significant negative relationship, with older students performing worse than younger students. This may be attributed to external pressures, differences in learning needs, or changes in study habits over time, but the correlation remains modest, and other factors such as motivation and cognitive development should also be considered. These results highlight the complexity of academic achievement and the need for future studies to consider a broader range of influencing factors.

## References

Abraham, W. C., Jones, O. D., & Glanzman, D. L. (2019). Is plasticity of synapses the mechanism of long-term memory storage? *Npj Science of Learning*, *4*(1), 9. https://doi.org/10.1038/s41539-019-0048-y

Amabile, T. M., Hill, K. G., Hennessey, B. A., & Tighe, E. M. (1994). The Work Preference Inventory: assessing intrinsic and extrinsic motivational orientations. *Journal of Personality and Social Psychology*, *66*(5), 950–967. https://doi.org/10.1037//0022-3514.66.5.950

Beauchet, O. (2006). Testosterone and cognitive function: current clinical evidence of a relationship. *European Journal of Endocrinology*, *155*(6), 773–781. https://doi.org/10.1530/eje.1.02306

García-González, A., Aznar-Diaz, I., Ramírez-Montoya, M. S., & Romero-Rodríguez, J. M. (2022). Needs and expectations of university students: Learning from the impact of Covid-19 upon 9 Spanish universities. *Issues in Educational Research*, *32*(1), 126–148.

Gennatas, E. D., Avants, B. B., Wolf, D. H., Satterthwaite, T. D., Ruparel, K., Ciric, R., Hakonarson, H., Gur, R. E., & Gur, R. C. (2017). Age-Related Effects and Sex Differences in Gray Matter Density, Volume, Mass, and Cortical Thickness from Childhood to Young Adulthood. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, *37*(20), 5065–5073. https://doi.org/10.1523/JNEUROSCI.3550-16.2017

Hara, Y., Waters, E. M., McEwen, B. S., & Morrison, J. H. (2015). Estrogen Effects on Cognitive and Synaptic Health Over the Lifecourse. *Physiological Reviews*, *95*(3), 785–807.

https://doi.org/10.1152/physrev.00036.2014
Jinmin, Z., & Qi, F. (2023). Relationship between learning flow and academic performance among students: a systematic evaluation and meta-analysis. *Frontiers in Psychology*, *14*(November), 1–9. https://doi.org/10.3389/fpsyg.2023.1270642
Kaczkurkin, A. N., Raznahan, A., & Satterthwaite, T. D. (2019). Sex differences in the developing brain: insights from multimodal neuroimaging. *Neuropsychopharmacology : Official Publication of the American College of Neuropsychopharmacology*, *44*(1), 71–85. https://doi.org/10.1038/s41386-018-0111-z
Kolb, B., & Gibb, R. (2011). Brain plasticity and behaviour in the developing brain. *Journal of the Canadian Academy of Child and Adolescent Psychiatry = Journal de l'Academie Canadienne de Psychiatrie de L'enfant et de L'adolescent*, *20*(4), 265–276.
Leung, N. T. Y., Tam, H. M. K., Chu, L. W., Kwok, T. C. Y., Chan, F., Lam, L. C. W., Woo, J., & Lee, T. M. C. (2015). Neural Plastic Effects of Cognitive Training on Aging Brain. *Neural Plasticity*, *2015*, 535618. https://doi.org/10.1155/2015/535618
Liu, M. (2022). The Relationship between Students' Study Time and Academic Performance and its Practical Significance. *BCP Education & Psychology*, *7*, 412–415. https://doi.org/10.54691/bcpep.v7i.2696
Massachusetts. Executive Office of Education. (2019). *The condition of education*. v. https://nces.ed.gov/pubs2017/2017144.pdf
Nonis, S. A., & Hudson, G. I. (2010). Performance of College Students: Impact of Study Time and Study Habits. *Journal of Education for Business*, *85*(4), 229–238. https://doi.org/10.1080/08832320903449550
Pavlinac Dodig, I., Krišto, D., Lušić Kalcina, L., Pecotić, R., Valić, M., & Đogaš, Z. (2020). The effect of age and gender on cognitive and psychomotor abilities measured by computerized series tests: a cross-sectional study. *Croatian Medical Journal*, *61*(2), 82–92. https://doi.org/10.3325/cmj.2020.61.82
Poldrack, R. A. (2000). Imaging brain plasticity: conceptual and methodological issues--a theoretical review. *NeuroImage*, *12*(1), 1–13. https://doi.org/10.1006/nimg.2000.0596
Roediger, H. L., & Butler, A. C. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*, *15*(1), 20–27. https://doi.org/https://doi.org/10.1016/j.tics.2010.09.003
Salthouse, T. (2012). Consequences of age-related cognitive declines. *Annual Review of Psychology*, *63*, 201–226. https://doi.org/10.1146/annurev-psych-120710-100328
Sánchez-Rodríguez, I., Temprano-Carazo, S., Jeremic, D., Delgado-Garcia, J. M., Gruart, A., Navarro-López, J. D., & Jiménez-Díaz, L. (2022). Recognition Memory Induces Natural LTP-like Hippocampal Synaptic Excitation and Inhibition. *International Journal of Molecular Sciences*, *23*(18). https://doi.org/10.3390/ijms231810806
Saxena, S., Wright, W. S., & Khalil, M. K. (2024). Gender differences in learning and study strategies impact medical students' preclinical and USMLE step 1 examination performance. *BMC Medical Education*, *24*(1), 504. https://doi.org/10.1186/s12909-024-05494-z
Shi, Y., & Qu, S. (2022). The effect of cognitive ability on academic achievement: The mediating role of self-discipline and the moderating role of planning. *Frontiers in Psychology*, *13*(October), 1–18. https://doi.org/10.3389/fpsyg.2022.1014655
Stern, P., & Halamish, V. (2023). Free-recall retrieval practice tasks for students with ADHD: whole-text versus section recall. *Frontiers in Psychology*, *14*, 1301726. https://doi.org/10.3389/fpsyg.2023.1301726
Van Den Hurk, M. M., Wolfhagen, H. A. P., Dolmans, D., & Van Der Vleuten, C. P. M. (1998). The Relation Between Time Spent on Individual Study and Academic Achievement in a Problem-Based Curriculum. *Advances in Health Sciences Education : Theory and Practice*, *3*(1), 43–49. https://doi.org/10.1023/A:1009732511707
Wiederholt, W. C., Cahn, D., Butters, N. M., Salmon, D. P., Kritz-Silverstein, D., & Barrett-Connor, E. (1993). Effects of age, gender and education on selected neuropsychological tests in an elderly community cohort. *Journal of the American Geriatrics Society*, *41*(6), 639–647. https://doi.org/10.1111/j.1532-5415.1993.tb06738.x
Zimmer-Gembeck, M. J., Skinner, E. A., Scott, R. A., Ryan, K. M., Hawes, T., Gardner, A. A., & Duffy, A. L. (2023). Parental Support and Adolescents' Coping with Academic Stressors: A Longitudinal Study of Parents' Influence Beyond Academic Pressure and Achievement. *Journal of Youth and Adolescence*, *52*(12), 2464–2479. https://doi.org/10.1007/s10964-023-01864-w