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Influence of lifestyle on academic performance in basic cycle medical students

Influência do estilo de vida no desempenho acadêmico em estudantes de medicina do ciclo básico

Influencia del estilo de vida en el rendimiento académico de estudiantes de medicina del ciclo básico

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ABSTRACT

Objective: To investigate the influence of lifestyle on academic performance in basic cycle medical students. **Methods:** The study involved applying two instruments to 51 medical students to identify cognitive function and lifestyle habits, as well as the level of physical activity through an international questionnaire. **Results:** No direct correlations were found between cognitive function and physical activity. Significant correlations were identified between participants' age and average correct answers in the Dissertation Cognitive Assessment (DCA) (r=0.4, p=0.01), extracurricular study days and average correct answers in the DCA (r=0.4, p=0.006), out-of-class study hours and average correct answers in the DCA (r=0.4, p=0.006), and between hours of sleep and days of alcohol consumption in the month (r=-0.6, p=0.000). **Conclusion:** The findings suggest that older students and those who spend more time studying outside the classroom exhibit better academic performance. Furthermore, a lifestyle with higher frequency of alcohol consumption is associated with reduced hours of sleep. These elements are fundamental to understanding and improving learning strategies and well-being of medical students.
Keywords: Academic Performance, Lifestyle, Medical Students, Cognitive Function, Physical Activity.

RSUMO

Objetivo: Investigar a influência do estilo de vida no desempenho acadêmico de estudantes de medicina do ciclo básico. **Métodos:** O estudo envolveu a aplicação de dois instrumentos a 51 estudantes de medicina, visando identificar a função cognitiva e hábitos de vida, bem como o nível de atividade física por meio de um questionário internacional. **Resultados:** Não houve correlações diretas entre função cognitiva e atividade física. Identificou-se uma correlação significativa entre a idade dos participantes e a média de acertos na Avaliação Cognitiva Dissertativa (ACD) (r=0,4, p=0,01), dias de estudo extracurricular e média de acertos no ACD (r=0,4, p=0,006), horas de estudo extraclasse e média de acertos no ACD (r=0,4, p=0,006), e entre horas de sono e dias de consumo de álcool no mês (r=-0,6, p=0,000). **Conclusão:** Os achados sugerem que estudantes mais velhos e que dedicam mais tempo a estudos fora da sala de aula apresentam melhor desempenho acadêmico. Além disso, um estilo de vida com maior frequência de consumo de álcool está associado a uma redução nas horas de sono. Estes elementos são fundamentais para entender e melhorar as estratégias de aprendizado e bem-estar dos estudantes de medicina.

Palavras-chave: Desempenho Acadêmico, Estilo de Vida, Estudantes de Medicina, Função Cognitiva, Atividade Física.

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RESUMEN

Objetivo: Investigar la influencia del estilo de vida en el rendimiento académico de estudiantes de medicina del ciclo básico. **Métodos:** El estudio involucró la aplicación de dos instrumentos a 51 estudiantes de medicina para identificar la función cognitiva y los hábitos de vida, así como el nivel de actividad física a través de un cuestionario internacional. **Resultados:** No se encontraron correlaciones directas entre la función cognitiva y la actividad física. Se identificaron correlaciones significativas entre la edad de los participantes y el promedio de respuestas correctas en la Evaluación Cognitiva Disertativa (ECD) (r=0.4, p=0.01), días de estudio extracurricular y promedio de respuestas correctas en la ECD (r=0.4, p=0.006), horas de estudio fuera de clase y promedio de respuestas correctas en la ECD (r=0.4, p=0.006), y entre horas de sueño y días de consumo de alcohol en el mes (r=-0.6, p=0.000). **Conclusión:** Los hallazgos sugieren que los estudiantes de mayor edad y aquellos que dedican más tiempo a estudiar fuera del aula muestran un mejor rendimiento académico. Además, un estilo de vida con una frecuencia más alta de consumo de alcohol está asociado con una reducción en las horas de sueño. Estos elementos son fundamentales para comprender y mejorar las estrategias de aprendizaje y bienestar de los estudiantes de medicina.

Palabras clave: Rendimiento Académico, Estilo de Vida, Estudiantes de Medicina, Función Cognitiva.

INTRODUCTION

In Brazil, the educational biomedical model can be considered predominant in the medical education of the 20th century (BESTETTI RB, et al., 2014). The National Curriculum Guidelines (DCN) for medicine graduation promoted a movement that induced changes towards the expansion of the biomedical approach, aiming the inclusion of subjective and social dimensions for a better understanding of the health-disease process and the illnesses from people and populations (CONSELHO NACIONAL DE EDUCAÇÃO, 2001; CONSELHO NACIONAL DE EDUCAÇÃO, 2014).

With the change in the demographic profile and the predominance of lifestyle-related diseases, the inclusion of subjective and social dimensions has become a critical factor for patient adherence to ongoing treatments that require changes in lifestyle habits (CONSELHO NACIONAL DE EDUCAÇÃO, 2014). In the face of these new challenges, the creation of an expanded medical training model was necessary.

It is worth noting that in the expanded model of medical training, in addition to the integration of biological, psychological and social dimensions, the organization of educational activities must focus on a collaborative construction in the health field, requiring new skills from professionals in order to act in multidisciplinary teams in a way that promotes the integrality of patient health care (LIMA VV, et al., 2018; RAMOS M, et al., 2019).

To this end, active learning methodologies such as problem-based learning (PBL) have been prioritized by several medical education institutions, along with basic-clinical articulation and the use of augmented reality, team-based learning (TBL), simulations of clinical skills in realistic contexts and the insertion of students in real practice scenarios, all this being done from the beginning of the course (DRING JC, et al., 2019; SERVANT-MIKLOS VFC, et al., 2019).

The use and diversification of active learning methodologies can be considered a global trend, associated with an appreciation of competency-oriented curricula and an assessment that articulates different skills for professional certification. The awakening of critical thinking, and the contextualization and singularization in the construction of solutions are results of this teaching model, allowing a reflexive action and the production of best practices, not only from an expanded interpretation of problems, but also from a perception committed to the improvement of people's health (XU W, et al., 2021).

Courses based on active methodologies demand more engagement time from students, since they are protagonists in their learning process, and must dedicate more time to searches, as demonstrated by Wiznia D, et al. (2012) where 22% of the students declare to spent “more” or “much more” time in their on study. Regardless of the model being predominantly traditional or expanded/integrated, the demands for studies outside the schedule of mandatory medical course activities can be considered a constant in the medical student’s academic life (WUNSCH K, et al., 2021).

The need to master a wide range of contents and to obtain positive results in performance evaluations can result in both physical and emotional overload for students, particularly for medical students. According to Wunsch K, et al. (2021), there is an increase in the number health problems, in both biological and psychological spheres, among higher education students. These problems are often due to poor sleep quality, high levels of stress and academic demands, which leads to cognitive impairment and a decline in academic performance (ACP).

Linked to these problems, attention is drawn to the challenge of a sedentary lifestyle, a growing trend in the population and university students in particular (ALSUBAIE SF, et al., 2020). Also, according to Alsubaie SF, et al. (2020), several studies report that the lack of physical activity (PA) is associated with a decline in cognitive activity and quality of life (QoL).

Few studies have correlated the effects of PA on the ACP of medical students. Several authors, such as Miranda IMM, et al. (2020), De Brujin, et al. (2020) and Wunsch K, et al. (2021) observed a positive association between the practice of PA and the physical and psychological domains, also generating relevant impacts on the students' QoL and ACP. According to these studies, students who practice PA tend to have better academic performance, as evidenced by higher grades and scores on cognitive tests (HARVESON AT, et al., 2019).

Considering this information, the PA level for students can be understood as an aspect of public health to be analyzed, as well as an element of care for managers of educational programs (KAYANI S, et al., 2018). For Wunsch K, et al. (2021), this association needs to be addressed more specifically in university populations, since there is a lack of data on higher education students.

To better understand the potential relationship between ACP, PA and life style variables, this study proposes to investigate undergraduate medical students and correlate different variables with ACP.

METHODS

This is a cross-sectional study, developed in a university center in the countryside of Sao Paulo state, Brazil, in 2021. The study used two different questionnaires that were applied to the students by the researchers, during free time between educational activities, not causing academic harm to the volunteers.

Before answering the questions, they received guidance on the questions presented, not having a stipulated time for the end and all the doubts presented were resolved.

At the end, they were asked to review the questionnaires so that there was no absence or inadequate annotation, thus reducing the number of sample loss.

Study Design

For data collection, two instruments were used, the first aimed at identifying and providing information regarding the characteristics of students and the assessment of the cognitive domain. The second, the International Physical Activity Questionnaire (IPAQ), to assess PA practice.

To analyze the results of the cognitive evaluation of the performance of the fourth period students, the number of correct answers in institutional tests, informed by the research subjects themselves, was used. The cognitive tests used as a reference for the analysis of ACP are dissertations and assess the content taught in the semester, integrating basic and clinical subjects.

The Dissertation Cognitive Assessment (DCA) of the medical course in question is a summative assessment instrument for student progression, which is based on 20 questions that aim to verify the individual capacity of students to identify problems and search for solutions based on the best scientific evidence.

For each problem-situation, the student must obtain a “satisfactory” concept, characterizing that he/she has met the required criteria for the answers.

Study Participants

The experimental population consisted of 51 students (34 women and 17 men) who met the inclusion criteria: being regularly enrolled in the fourth period (Second year) of medical school and being over 18 years of age. The choice of this group was due to the lower percentage of changes in the collective of students since the beginning of medical course.

In addition to this characteristic, the fourth period concludes the first educational cycle that comprises the first two years of the course and, in this situation, there is a greater chance of students adapting to active methodologies.

Ethical Considerations

The project was approved by local research ethics committee (Research Ethics Committee - Centro Infantil Boldrini), under the number 4,987,384 e CAAE 51165821.1.0000.5376. The research subjects were informed about the reason for the investigation and the confidentiality of the data. Once they agreed to the terms, the participants signed an informed consent term.

Instruments

I) Identification form and information relating to the student

A form was prepared for data collection according to an identification coded with letters and numbers, aiming at the anonymity of students (supplementary material). The following were collected: sex; age; height (in meters); weight (kilograms); occupation; profession; time of schooling in years from elementary school; number of days a week for extracurricular studies; average number of hours per day for extracurricular studies; average number of hours of sleep per day; ACP (number of correct answers in DCA); life habits: smoking, use of alcoholic beverages, illicit drug use; presence of morbidities.

II) International physical activity questionnaire (IPAQ)

Validated instrument used to quantify PA based on metabolic equivalents, calculating based on duration and weekly frequency, estimating the caloric load spent by that individual in their daily practices, following the criteria established by the IPAQ (SALAS-GOMEZ D, et al., 2020; ALSUBAIE SF, et al., 2020).

PA levels were evaluated, and the hours performed and the frequency of walking, moderate and vigorous activities during the week were considered. Questionnaire values are expressed in minutes for total practice or days of practice (BARBIERI JF, et al., 2018).

Statical Analysis

To identify the normality of the data, the Shapiro-Wilk test was used, which shows whether the data have a normal distribution. Thus, with parametric data, the statistical analysis of the work was performed using Pearson's correlation coefficient.

The Statistica 6.0 program was used for the analyses, with p value < 0.05 being considered significant, classifying in weak Pearson correlation when equal to 0.3 to 0.5 (positive or negative), moderate from 0.5 to 0.7 (positive or negative), strong from 0.7 to 0.9 (positive or negative) and very strong for values greater than 0.9.

RESULTS

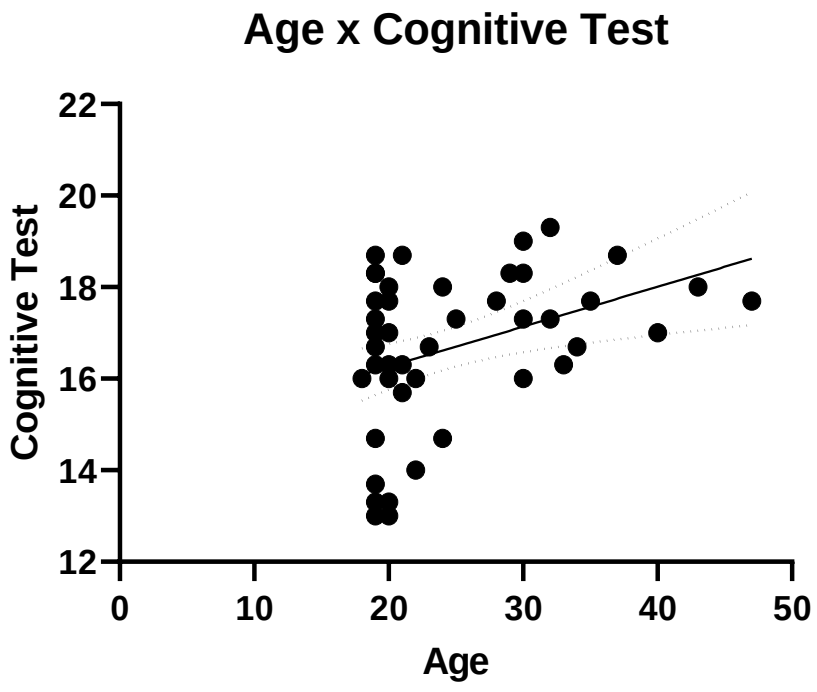
A stratified analysis comparing men and women (34 women, 17 men) did not identify significant differences for the level of ACP and PA between genders (except minutes of vigorous activity - men 64.5 ± 49.47 min; women 23.4 ± 49.47 min, 33.67 min, p=0.01). Thus, data from women and men were analyzed together, which generated a final sample number of 51 participants. The demographic and anthropometric data that characterize the subjects of the sample can be seen in **Table 1**, which presents the quantitative variables analyzed based on the Student Identification and Information Form and IPAQ.

Table 1 - Demographic and anthropometric variables.	n=51
Height (meters)	1,8 ± 0,0
Weight (kg)	79,4 ± 10,4
BMI (kg/m²)	25 ± 4
Age	24,1 ± 7,2
Schooling time from Elementary School (years)	15,4 ± 6,1
How many times a week do you carry out extracurricular studies? (days)	4,1 ± 1,6
How many hours, on average, do you carry out extracurricular studies per day?	3,7 ± 2,2
How many hours do you sleep on average per day?	6,6 ± 1,2
DCA performance (number of correct answers)	16,2 ± 1,5
How many days a month do you drink alcohol?	8 ± 5,5
How many days a week do you do light physical activity?	3,9 ± 2,4
Minutes of light physical activity	70,3 ± 88,5
Days of moderate physical activity	2,9 ± 2,2
Minutes of moderate physical activity	65,6 ± 46,5
Days of vigorous physical activity	1,8 ± 1,5
Minutes of vigorous physical activity	64,5 ± 49,5
Time sitting during one day of the week (minutes)	610,6 ± 221,4
Sitting time during a weekday signal (minutes)	589,4 ± 244,6

Source: Oliveira MCB, et al., 2024.

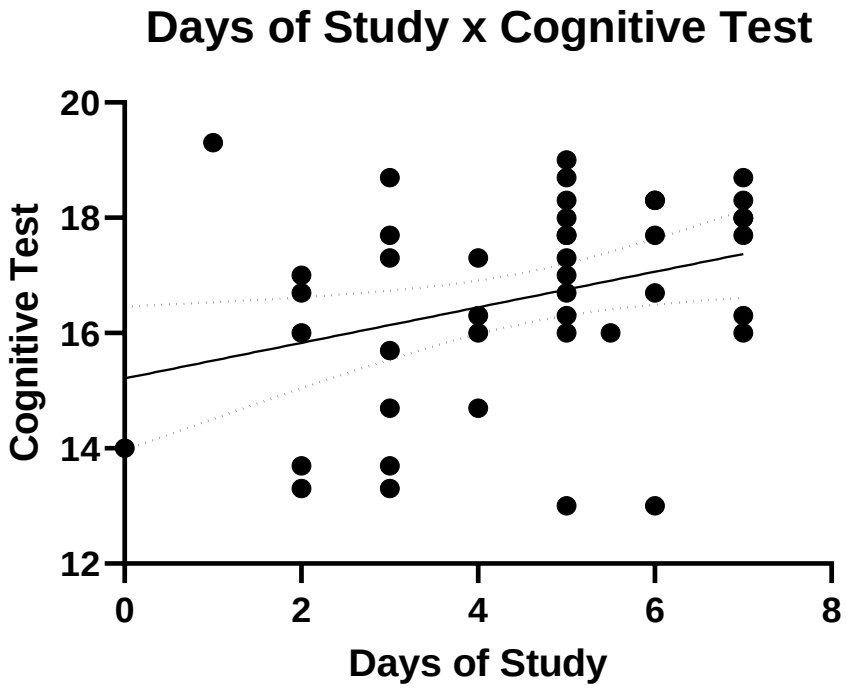
Pearson's correlation identified a significant correlation for the following variables: Participants' age x mean DCA correct answers (r=0.4, p=0.01), extra-class study days (times a week) x mean DCA correct answers (r=0.4, p=0.006), hours of extra-class study x average of correct answers in the DCA (r=0.4, p=0.006), hours of sleep x days of alcohol consumption in the month (r=-0.6, p=0.00). However, no significant correlation was obtained between ACP and PA. Correlations can be seen in **Figures 1-4**.

Figure 1 - Age x Cognitive Test, a significant correlation was identified for the following variables: Participants' age x average of correct answers in the DCA (r=0.4, p=0.01).



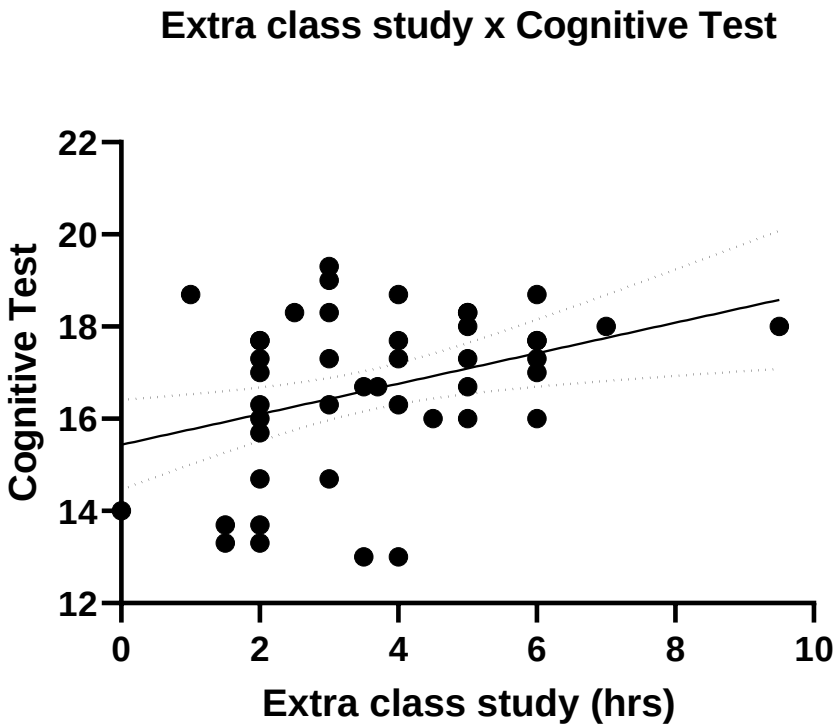
Source: Oliveira MCB, et al., 2024.

Figure 2 - Extra-class study days x Cognitive Test, a significant correlation was identified for the following variables: days of extracurricular study (times a week) x average of correct answers in the DCA (r =0.4, p=0.006).



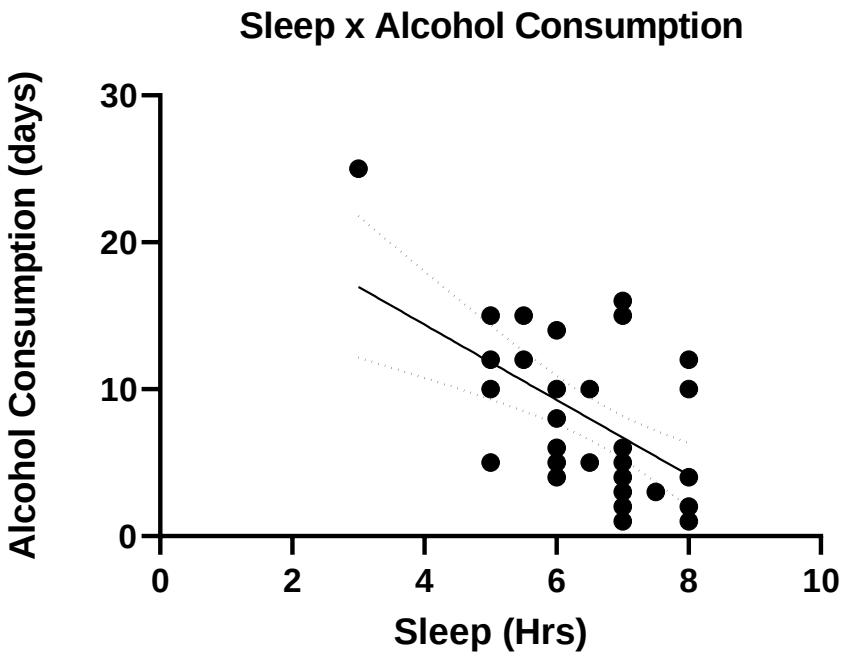
Source: Oliveira MCB, et al., 2024.

Figure 3 - Extra-class study hours x Cognitive Test, a significant correlation was identified for the following variables: hours of extra-class study x average of correct answers in the DCA (r=0.4, p=0.006).



Source: Oliveira MCB, et al., 2024.

Figure 4 - Hours of Sleep x Monthly Alcohol Consumption, a significant correlation was identified for the following variables: hours of sleep x days of alcohol consumption in the month (r=-0, 6, p=0.00).



Significant and positive correlations were also found for: Age x Minutes of light activity per week (r=0.3, p=0.04), and Age x Days of vigorous PA practice (r=0.3, p=0 .04).

Source: Oliveira MCB, et al., 2024.

DISCUSSION

The purpose of the present study was to analyze the relationship between the cognitive function of medical students and the practice of physical activities. The results of the questionnaires show that the level of PA did not present a direct correlation with the ACP, which is in line with some studies presented reporting uncertainty about these variables (YOUNG J, et al., 2015).

Given these data inconsistencies, we know the importance of new studies to the assessment of larger populations and with tools that directly assess the level of physical activity of the participants. The other results obtained, in particular, bring different knowledge, such as the non-correlation between PCA and gender distinction, and the convergence between participants' age, days and hours of extracurricular studies with the correct answers in the DCA, demonstrating the positive relation between student extracurricular attitude and better ACP, in addition to fewer hours of sleep leading to more days of alcohol consumption in the month.

The comparison between men and women showed no significant difference in ACP, this result being corroborated by the study carried out by Upadhayay N and Guragain S (2014), in which the cognitive profiles of both men and women were compatible. Based on the results obtained, a direct influence was observed between students' age and ACP. This result is supported by the study carried out by Yew EHJ, et al. (2011), which shows that the amount of prior knowledge influences ACP. Therefore, older students tend to do better in DCA. Particularly in the case of DCA, which requires interpretation, analysis, and application of knowledge, the greater the ability to interconnect knowledge, the better the chances of achieving positive results in this type of cognitive assessment.

The effects of PA on brain health and on the improvement of cognitive function have received special attention from researchers, mainly due to its potential association with an active lifestyle, with a decrease in the risk of dementia, and cognitive improvement at advanced ages (SALAS-GOMEZ D, et al., 2020). This may be a factor why older students had a positive correlation with minutes of light PA and days of vigorous PA in

the present study. According to Brown BM, et al. (2017), vigorous exercise compared to light and moderate exercise results in greater benefits, even in young adults.

Kovacevic A, et al. (2019) showed that high-intensity FA delays the loss of brain volume, mainly in regions involved in memory and improving signal transduction in white matter, also obtaining a linearity between the intensity of FA and positive neuroplasticity. Thus, vigorous FA proves to be more efficient, since it is associated with better results even with less time investment. This type of activity, when performed at least three times a week, induces cognitive benefits, generating greater adherence by students, especially those who have little time to practice PA.

Considering the days and hours of extracurricular study and the number of correct answers in the DCA, the correlation was positive. In this sense, the association of better cognitive results with extracurricular studies points to the importance of student engagement and effort to understand a particular subject or problem (ROTGANS JI and SCHMIDT HG, 2011).

According to Alves MVC and Bueno OFA (2017), memory consolidation is based on the stability of information, built over time. However, the registration of information, generated by neural processes after the initial contact, strengthens the fixation of the learned content, meaning that successive approximations are needed in relation to the objects of study to build information stability in semantic networks. This phenomenon is also confirmed by the Decay Theory, according to which information is gradually lost over time through synaptic pruning, if not reviewed or stimulated (ALVES MVC and BUENO OFA, 2017). Kim H (2017) and Fox O, et al. (2017) suggest that repetition can assist in the retrieval of both voluntary and involuntary information and, therefore, the sequence of this movement generates the consolidation of procedural memory.

Regarding the data obtained in this investigation, a factor that must be analyzed as an intervening variable is related to the teaching model used by the course in question. The use of active methodologies, in particular those that require students to study and guarantee time to search for information, may have influenced the number of hours found for extracurricular studies. In this sense, Yew EHJ, et al. (2011) state that the use of self-regulated learning positively influences ACP, so the individual self-directed learning phase is the most important for students' learning, as it is guide, monitor and take responsibility for their own learning. Thus, the more time dedicated to individual study, the greater the probability of a better ACP. Regarding life habits, epidemiological studies indicate that higher education students do not get enough sleep, one of the alleged factors being the demand for study. Therefore, managing academic and social demands is essential in students' lifes, contributing to regular sleep schedules, in addition to maintaining social interaction (PATRICK ME, et al., 2018).

However, sleep is often impaired not only by studying, but also by the consumption of alcoholic beverages. The results of the present study indicate that the hours of sleep showed a moderate negative correlation with the frequency of monthly alcohol consumption. According to Patrick ME, et al. (2018), alcohol increases cortical arousal and wakefulness, contributing to a decrease in sleep quality. Studies such as those carried out by Chakravorty S, et al. (2016) and Van Reen E, et al. (2016) presented evidence similar to that obtained by Patrick, (2018), showing that alcohol alters sleep architecture, promoting sedative and stimulant effects. Exposure leads to reduced sleep and rapid eye movement (REM) latency, as well as increased latency to REM and increased slow-wave sleep during the first half of the night.

Therefore, in the second half of the night, the decrease in REM sleep continues, with an increase in wakefulness, that is, a decrease in slow-wave sleep, generating a decrease in sleep time and an increase in awakening time. Chakravorty S, et al. (2016) report that even with an undetectable level of alcohol on the breath, after early night consumption, sleep is seen as shallow by high-frequency electroencephalogram, which shows increased arousal during sleep.

According to Patrick ME, et al. (2018), alcohol use is often combined with energy drinks, potentiating the negative consequences of alcohol in relation to sleep, which was also evidenced in other studies (VAN REEN E, et al., 2016). As with the data obtained in this investigation, the lower quantity and quality of sleep is associated with higher consumption of alcoholic beverages by students.

CONCLUSION

This study revealed that older students, who have a lifestyle incorporating mild to high intensity PA, exhibit better ACP compared to younger counterparts, highlighting the importance of addressing these aspects among students, particularly those in healthcare, who understand the biological mechanisms involved. Additionally, it was found that students dedicating more time to out-of-class studies also showed improved ACP, emphasizing the significance of self-directed learning and the need for time management for extracurricular studies. Although PA did not show a direct correlation with the ACP of the students studied, its various benefits are recognized and should be encouraged. Lastly, alcohol consumption was found to negatively impact students' sleep hours, with known biological, subjective, and social repercussions. Therefore, we suggest the inclusion of problem-based learning in classrooms that explore this issue, promoting a deeper understanding of the phenomenon and supporting decision-making to avoid compromising the training and health of medical students.

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REFERENCES

1. ALSUBAIE SF, et al. The Physical Activity Type Most Related to Cognitive Function and Quality of Life. Biomed Res Int., 2020.
2. ALVES MVC and BUENO OFA. Retroactive interference: Forgetting as an interruption of memory consolidation. Temas em Psicol., 2017; 25(3): 1055–67.
3. BARBIERI JF, et al. Influência do nível de atividade física sobre o desempenho cognitivo no teste de Stroop. ConScientiae Saúde, 2018; 17(3): 308–14.
4. BESTETTI RB, et al. Contextual considerations in implementing problem-based learning approaches in a Brazilian medical curriculum: The UNAERP experience. Med Educ Online, 2014; 19(1).
5. BROWN BM, et al. Study protocol of the Intense Physical Activity and Cognition study: The effect of high-intensity exercise training on cognitive function in older adults. Alzheimer's Dement Transl Res Clin Interv., 2017; 3(4): 562–70.
6. CONSELHO NACIONAL DE EDUCAÇÃO. Diretriz Nacionais da Educação - Medicina. 2001;38. Available from: http://portal.mec.gov.br/cne/arquivos/pdf/CES04.pdf.
7. CONSELHO NACIONAL DE EDUCAÇÃO. Diretriz Nacional da Educação. 2014; Available from: https://normativasconselhos.mec.gov.br/normativa/pdf/CNE_rces00706.pdf.
8. CHAKRAVORTY S, et al. Alcohol Dependence and its Relationship with Insomnia and Other Sleep Disorders, 2016; 40(11): 2271–82.
9. DE BRUIJN AGM, et al. Effects of aerobic and cognitively-engaging physical activity on academic skills: A cluster randomized controlled trial. J Sports Sci., 2020; 38(15): 1806–17.
10. DRING JC. Problem-Based Learning – Experiencing and understanding the prominence during Medical School: Perspective. Ann Med Surg., 2019; 47(September): 27–8.
11. FOX O, et al. Motor memory consolidation processes in young female adults with ADHD may be less susceptible to interference. Neurosci Lett., 2017; 637: 91–5.
12. HARVESON AT, et al. Acute exercise and academic achievement in middle school students. Int J Environ Res Public Health, 2019; 16(19): 1–7.
13. KAYANI S, et al. Physical activity and academic performance: The mediating effect of self-esteem and depression. Sustain, 2018; 10(10): 1–17.
14. KOVACEVIC A, et al. 1 Running head: Exericse intensity and cognition in aging: The effects of aerobic exercise intensity on memory in older adults Ana Kovacevic. Appl Physiol., Nutr. Metab., 2019; 1–38.
15. KIM H. Brain regions that show repetition suppression and enhancement: A meta-analysis of 137 neuroimaging experiments. Hum Brain Mapp., 2017; 38(4): 1894–913.

16. LIMA VV, et al. Challenges in the education of health professionals: An interdisciplinary and interprofessional approach. Interface Commun Heal Educ., 2018; 22(c): 1549–62.
17. LIM ST, et al. Physical activity amount and cognitive impairment in Korean elderly population. Brain Sci., 2020; 10(11): 1–9.
18. MIRANDA IMM, et. Quality of Life and Graduation in Medicine. Rev Bras Educ Med., 2020; 44(3).
19. PATRICK ME, et al. Energy Drinks and Binge Drinking Predict College Students' Sleep Quantity, Quality, and Tiredness. Behav Sleep Med., 2018; 16(1): 92–105.
20. RAMOS M, et al. Os Diversos Aspectos Da Integralidade Em Saúde the Different Aspects of Health Integrality. Rev Med Família e Saúde Ment., 2019; 1: 1.
21. ROTGANS JI and SCHMIDT HG. Cognitive engagement in the problem-based learning classroom. Adv Heal Sci Educ. 2011;16(4):465–79.
22. SALAS-GOMEZ D, et al. Physical Activity Is Associated With Better Executive Function in University Students. Front Hum Neurosci., 2020; 14(February): 1–8.
23. SERVANT-MIKLOS VFC. Fifty Years on: A Retrospective on the World's First Problem-based Learning Programme at McMaster University Medical School. Heal Prof Educ., 2019; 5(1): 3–12.
24. UPADHAYAY N and GURAGIN S. Comparison of cognitive functions between male and female medical students: A pilot study. J Clin Diagnostic Res., 2014; 8(6): 10–3.
25. VAN REEN E, et al. Current alcohol use is associated with sleep patterns in first-year college students. Sleep, 2016; 39(6): 1321–6.
26. WIZNIA D, et al. PBL 2.0: Enhancing problem-based learning through increased student participation. Med Educ Online, 2012; 17(1): 1–5.
27. WUNSCH K, et al. The tridirectional relationship among physical activity, stress, and academic performance in university students: A systematic review and meta-analysis. Int J Environ Res Public Health, 2021; 18(2): 1–18.
28. XU W, et al. The effectiveness of the problem-based learning in medical cell biology education: A systematic meta-analysis. Med., 2021; 100(39): E27402.
29. YOUNG J, et al. without known cognitive impairment (Review). Cochrane Database Syst Rev., 2015; (4): Art. No.: CD005381.
30. YEW EHJ, et al. Is learning in problem-based learning cumulative? Adv Heal Sci Educ., 2011; 16(4): 449–64.