

EÖTVÖS LORÁND UNIVERSITY
FACULTY OF EDUCATION AND PSYCHOLOGY

Doctoral (PhD) dissertation thesis

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The Role of Physical Activity in Body Composition, Academic Performance, and Sleep
Quality Among Hungarian University Students

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1. Introduction

With the continuous changes in our lifestyle, the number of people leading sedentary lifestyles is increasing significantly, which the World Health Organization (WHO) (World Health Organization, 2024) also draws attention to. Sedentary lifestyle has numerous physiological and health consequences (Boberska et al., 2018; Park et al., 2020; Pinto et al., 2023). Multiple studies worldwide have shown that one consequence of sedentary lifestyle is overweight and obesity among the adult population (Bullock et al., 2017; Silveira et al., 2022; Curran et al., 2023).

Physical activity has positive effects on these factors and brings numerous lifestyle benefits (Rippe & Hess, 1998; Lin, 2022; Silveira et al., 2022). This can even occur in young adulthood (Poobalan et al., 2012). During this period, guided activities (such as university or college physical education) can be of great importance (Cao & Luo, 2024; Huang et al., 2024).

In addition to the numerous positive effects on physical aspects, it can also affect mental abilities. For example, regular exercise alleviates symptoms of depression, anxiety, and stress while enhancing mood and emotional well-being, and can improve sleep quality, cognitive functions, memory (WHO, 2024), and even academic performance (James et al., 2023; Trott et al., 2024).

By reducing healthcare costs associated with non-communicable diseases, exercise can alleviate the economic burden on healthcare systems worldwide. Furthermore, regular exercise promotes the achievement of public health goals, thus contributing to reducing sedentary behavior, which promotes the development of healthier societies (World Health Organization, 2020).

However, modern lifestyle is characterized by increasingly less movement, and a significant portion of the population does not reach the recommended activity level. Research on physical activity helps identify barriers associated with the field and develop strategies that promote movement in daily life.

The benefits of physical activity have been a research area for years. Several recommendations aimed at this, including the effects of moderate and vigorous-intensity physical activity classified by the WHO, have become research areas for many (Chomistek et al., 2012; MacIntosh et al., 2021; Kettle et al., 2022).

The health benefits of physical activity also include areas that prevent the leading causes of death in Hungary, which is why they are particularly important in our country. For example, cardiovascular problems (Bassuk & Manson, 2003; Valenzuela et al., 2023; Kunutsor & Laukkanen, 2024), whose prevention should be started as early as possible (Daniels et al., 2011;

Chung et al., 2015; Genovesi et al., 2019). In domestic terms, the incidence rate of lung, colorectal, prostate, and breast cancer is also high. The rates of these diseases and deaths are above the EU average for both men and women (OECD & European Commission, 2025). At the same time, among those over 18 years of age, circulatory system diseases, diabetes, and respiratory diseases are the most common health problems currently affecting the Hungarian population. According to school health screening examinations, among the 8-18 age group, leading diseases include obesity and postural disorders (KSH, 2024).

Increasingly more research shows that among young adults, many diseases can be prevented with physical activity (Anderson & Durstine, 2019; Usmani et al., 2023; Fairag et al., 2024). However, it is also observable that physical activity decreases over time (Sallis, 2000; Dai et al., 2014).

Another important element of health preservation is sleep, which physical activity can also affect (Kredlow et al., 2015; Alnawwar et al., 2023). Sleep disorders are common among university students, accompanied by poor sleep quality, sleep problems, insomnia, or even nightmares (Gaultney, 2010; Alomri & Alghamdi, 2024; Nakie et al., 2024). These can have various underlying causes, such as study-related stress (Kim et al., 2022; Hu et al., 2024), lack of sleep routine (Minghelli, 2022), excessive use of electronic devices (Hysing et al., 2015), and mental health problems (Alghamdi & Alomri, 2025).

Several studies conducted among university students found that physical activity improved sleep quality (Li & Guo, 2023; Yin et al., 2025). Within these studies, many examined the effects of moderate and vigorous-intensity physical activity on sleep quality, finding positive correlations for both intensities (Memon et al., 2021; Huang et al., 2025).

Academic performance is an important factor in the university student age group, which, like sleep, is also affected by physical activity. Several studies have found that regular physical activity positively influences students' academic performance. Some studies conducted with university students concluded that students engaging in regular exercise were more likely to achieve higher academic averages than those who did not (Chung et al., 2018; Zhai et al., 2022; Bloom et al., 2024). Another study demonstrated stress reduction and improved recovery in addition to better academic performance due to physical activity (Teuber et al., 2024).

Sleep quality and university performance both affect various areas of life, including health. Both areas can be improved through physical activity at multiple ages, including young adults. In the latter age group, the above topics are considered under-researched areas.

2. Objectives, research questions

The aim of this research is to gain a comprehensive picture of the role of university students' physical activity, its effects, and relationships with various health and performance indicators. Through our investigations, we strive to explore how higher education physical education programs contribute to the development of students' physical condition, how activity level and intensity relate to academic performance, and what relationship can be demonstrated between physical activity and sleep quality.

Our specific objectives include understanding the extent to which regular, organized forms of movement can influence changes in students' body composition, muscle strength, and health indicators over one semester; furthermore, exploring how different physical activity patterns and sitting time affect academic performance. Additionally, our goal is to examine the relationship system between activity type and intensity and sleep quality, with particular attention to the role of lifestyle factors and sociodemographic background.

Our results may facilitate the development of higher education physical education programs, contribute to creating strategies aimed at increasing students' physical activity, and may provide a foundation for planning preventive and health promotion interventions.

Q1: Does university physical education result in changes in body composition, waist-to-hip ratio, and muscle strength?

Q2: Are there differences in the above regarding different forms of movement?

Q3: What characterizes the physical activity and studies of the examined age group?

Q4: Is there, and if so, what relationship exists between physical activity and studies?

Q5: What characterizes the physical activity and sleep habits of the examined age group?

Q6: Is there, and if so, what relationship exists between physical activity and sleep habits?

3. Materials and methods

3.1 Quantitative longitudinal research

- Our goal was to examine students' body composition at the beginning of the semester and 14 weeks later, at the end of the semester. The examinations took place under standard conditions, before physical education classes. Students were recruited online and voluntarily at the Budapest Business School.

- 339 people applied for the program. Applicants who participated in only one measurement (n=240) were excluded from the sample. (187 joined only at the beginning of the semester, and 53 joined only at the end of the semester.) The final sample size was 99 people.
- Body composition measurement with InBody 270 bioimpedance analyzer, which measured parameters including body fat, skeletal muscle, visceral fat, and body water mass.
- Anthropometric data collection by measuring waist and hip circumference with measuring tape at the narrowest and widest points, respectively, to estimate body fat distribution.
- Muscle strength measurement with digital hand dynamometer, two repetitions on both hands, recording the best result.
- The movement forms available within the physical education program were categorized into three main categories: (1) sports games (e.g., basketball, football, volleyball), (2) general conditioning activities (e.g., circuit training, functional training), and (3) running, swimming, and spinal gymnastics.

3.2 Cross-sectional qualitative questionnaire research

- Our goal was to examine students' physical activity and its relationship with academic performance and sleep quality. We conducted a questionnaire study with online and voluntarily participating students in the form of an anonymous online questionnaire.
- A total of 1340 people completed our questionnaire, of which 670 had previous semester university averages for academic performance research. For our sleep quality research, we were able to include data provided by all 1340 people.
- For measuring physical activity, we used the Hungarian version of the International Physical Activity Questionnaire Short Form (IPAQ-SF) (Craig et al., 2003; Lee et al., 2011; Ács et al., 2020). The study evaluates moderate and vigorous physical activity (MVPA), walking, and sitting behavior through recall.
- For examining sleep quality, we applied the Hungarian version of the Pittsburgh Sleep Quality Index (PSQI), which provides a global score between 0-21 by adding seven components. Sleep quality was categorized as: adequate, moderate, poor, and severe sleep disorder (Buysse et al., 1989; Takács et al., 2016).

- The questionnaire also contained sociodemographic and academic performance questions, which were important control variables for relationship exploration analyses.

Table 1 - Summary table of examined areas, research questions, and methods of the dissertation

(source: own compilation)

Examined areas	Research question	Materials and methods
Physical activity (physical education) - body composition	Q1: Does university physical education result in changes in body composition, waist-to-hip ratio, and muscle strength? Q2: Are there differences in the above regarding different forms of movement?	Quantitative, longitudinal, interventional InBody, hand grip strength, waist-to-hip ratio
Physical activity - academic performance	Q3: What characterizes the physical activity and studies of the examined age group? Q4: Is there, and if so, what relationship exists between physical activity and studies?	Quantitative, Cross-sectional Questionnaire
Physical activity - sleep quality	Q5: What characterizes the physical activity and sleep habits of the examined age group? Q6: Is there, and if so, what relationship exists between physical activity and sleep habits?	Quantitative, Cross-sectional Questionnaire

4. Data Analysis and data cleaning

- The raw data collected during the research, such as anthropometric results measured with the InBody 270 bioimpedance analyzer, digital hand dynamometer, and measuring tape, as well as data from online questionnaires (including IPAQ-SF and PSQI), were initially organized and cleaned in Microsoft Excel for further analysis.
- During data cleaning, we removed unreasonable or erroneous data, ensuring the reliability and consistency of the dataset.
- For physical activity questionnaire data, we applied validity criteria according to the IPAQ (Di Blasio et al., 2016) protocol, including limiting activity duration and total daily activity time, as well as excluding extreme or erroneous MET values.

- For sleep quality measurement with the PSQI questionnaire, we only used completely filled, logically consistent data, paying attention to the harmony between sleep time and time spent in bed, and filtering extraordinary or contradictory sleep patterns.
- The datasets were processed using Microsoft Excel, JASP, and IBM SPSS Statistics version 29, performing descriptive statistical analyses, paired sample t-tests (Student t-test), cross-tabulations, Chi-square tests, and linear regressions while maintaining a significance level of $p < 0.05$.
- The multi-step data processing and cleaning procedures ensured that information from different data sources and measurement methods was available in a reliable and consistent database suitable for analysis according to the research objectives.

5. Presentation of Results Based on the Research Questions

5.1 Physical activity (physical education) – body composition

Q1: Does university physical education result in changes in body composition, waist-to-hip ratio, and muscle strength?

Q2: Are there differences in the above regarding different forms of movement?

We sought answers to these questions through body composition, hand grip strength, and waist-to-hip measurements to determine whether changes occur in these areas as a result of the 14-week university physical education program in the examined sample.

During the study, we examined changes in body composition and fitness between the beginning and end of the semester among students performing different forms of movement. Based on the results, most examined variables – such as body fat percentage, visceral fat level, skeletal muscle mass, body water mass – showed statistically significant but typically small changes, except for right hand grip strength. Body mass index slightly increased in women and decreased in men, while changes in visceral fat mass and body fat ratio were not significant. Body water mass increased in both genders, somewhat more in men. Waist circumference decreased in both genders, while hip circumference increased in women and decreased in men. Left hand grip strength improved in women and deteriorated in men.

The majority of the examined sample experienced increased skeletal muscle mass and body water mass, while waist circumference decreased and hip circumference increased. Right hand grip strength varied, while left hand strength tended to decrease. The choice of different movement forms differed by gender: sports games were more chosen by men, conditioning

exercises more by women, while running and swimming occurred exclusively among women. The average height of men performing sports games was not more prominent than volleyball players, while among women, basketball players were the tallest. Regarding the effects of movement forms, those choosing sports games showed greater increases in skeletal muscle mass and body water mass, while data for those performing conditioning exercises tended to decrease.

5.2 Physical activity - academic performance

Q3: What characterizes the physical activity and studies of the examined age group?

Q4: Is there, and if so, what relationship exists between physical activity and academic performance?

We sought answers to these questions through questionnaires on academic performance and physical activity. We compared this with various sociodemographic factors and WHO moderate and vigorous-intensity physical activity guidelines.

The majority of questionnaire respondents were full-time students, most of whom are single or in relationships, and mainly live in the capital in their own property. A significant portion works alongside their studies and participates in state-funded education programs. The level of physical activity in most students falls short of the WHO-recommended amount of moderate-intensity movement, while the ratio is somewhat more favorable for vigorous-intensity activity, but many were still below the recommendation. Among women, moderate activity was more characteristic, while among men, vigorous-intensity movement was more typical, and marital status also influenced the amount of movement, as those in relationships and married proved to be more active. Residence, financing form, and work alongside studies showed no significant relationship with physical activity.

Regarding academic performance, based on the examined sample, women, those participating in state-funded education, and non-working students achieved better averages. No demonstrable relationship was found between time spent sitting and academic performance. A significant relationship was found between moderate-intensity physical activity and better academic performance: those who meet WHO recommendations are more likely to achieve outstanding academic averages. No such relationship was observed for vigorous-intensity physical activity. Overall, moderate movement is associated with more favorable academic results, while this relationship is not clear for vigorous-intensity activity.

5.3 Physical activity – sleep quality

Q5: What characterizes the physical activity and sleep habits of the examined age group?

Q6: Is there, and if so, what relationship exists between physical activity and sleep habits and sleep quality?

The study sample of approximately 1340 university students consisted of students averaging around 20 years old, mostly women, single or in relationships, and residents of the capital. The majority of participants were full-time, state-funded students, and more than half worked while studying.

Regarding physical activity, a significant portion of students engaged in daily multi-hour sitting activities. Moderate-intensity physical activity was very common among participants, yet most performed below WHO recommendations. Men were significantly more active in vigorous-intensity physical activity. According to IPAQ-SF classification among movement forms, most could be classified in the “low” category, which was more characteristic of women.

Regarding sleep quality, looking at PSQI Global scores, more than half of the participants fell into the “adequate sleep quality” category. Women reported worse sleep quality and more frequently used sleep aids. We found a significant relationship when comparing scores with time spent sitting. The relationship between physical activity and sleep is complex: there was no significant difference between IPAQ-SF and PSQI Global scores, but the frequency of sports participation played an important role in achieving positive sleep effects.

Overall, based on the examined sample, sleep quality is influenced by numerous factors, and although physical activity is important, it alone is not sufficient to ensure good sleep. However, structured sports activity may be key in alleviating negative effects. The research emphasizes the need for more systematic integration of movement forms and a multi-factor approach.

6. Conclusion

During the research, we gained valuable knowledge and experiences that can provide a useful starting point for preparing and conducting future studies exploring university students’ lifestyle and health.

Our results show that regular physical education induces significant changes in body composition, and that moderate-intensity physical activity is favorably related to better academic performance. Although sleep quality improvement is not directly linked to physical activity level alone, regular sports activity may be an important factor in achieving more

favorable lifestyle effects. As a lesson from all this, it should be emphasized that the role of physical activity is complex, and particular emphasis should be placed on promoting regular, moderate movement and its conscious integration into university students' daily lives.

7. Limitations

The main limitations of the research are that only BGE students participated, and most of them were full-time, undergraduate students, so the generalizability of the results is limited. The study focused only on physical activity and some lifestyle factors, not considering other health behavioral habits (such as nutrition, sleep, mental health), so precise assessment of the physical education program's effects is not possible.

Although body composition, hand grip strength, and waist-to-hip measurements were conducted under controlled conditions by professionals, the questionnaire method was based on self-reporting, which could result in biases.

In the first study, both the sample composition and the range of examined variables were narrow, so further research on larger and more diverse samples, involving other universities, would be needed. Additionally, it's important to emphasize that changes occurring by the end of the research period could have been influenced by physical activity performed outside physical education classes or physical education courses taken in the previous semester, which we did not specifically ask about or address. All this can form the basis for further research. The strength of the other two studies is that they worked with a large number of participants and examined physical activity from multiple perspectives, but based on the study results, further research is needed, especially about the possibilities of establishing and supporting an active lifestyle, and deeper exploration of the relationships between physical activity, sleep, and academic performance.

8. Novelty of the Study

In Hungary, this is the first longitudinal examination of the effects of a university physical education program on body composition, waist-to-hip ratio, and hand grip strength, which was rare in previous domestic research. The complex, multi-parameter analysis of body composition and tracking changes in hand grip strength are both novelties. The examination of different movement forms and gender-based breakdown is also novel, which demonstrated, for example, greater skeletal muscle mass increase in those choosing sports games.

The statistical relationship between physical activity and academic performance was rarely examined before. New results show that moderate-intensity activity is significantly related to

better academic performance, while high intensity shows no such relationship. The breakdown by WHO intensity and detailed examination of sociodemographic factors (e.g., marital status, work) are also novel among domestic research. The study is particularly new regarding the relationship between time spent sitting and academic performance.

This is the first large-sample domestic research examining university students' physical activity and sleep quality with IPAQ-SF and PSQI questionnaires in accordance with WHO recommendations. The detailed age breakdown and analysis of sociodemographic factors are novel. A significant discovery is the significant negative relationship between time spent sitting and sleep quality. The complex examination of relationships between exercise intensity, movement forms, gender, and sleep quality is also novel, as well as emphasizing regular, structured sports activity in sleep improvement. Women's worse sleep quality and greater use of sleep aids also emerged as novelties in domestic population studies.

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10. List of publications

10.1 Hungarian-language studies

1. Barka, N., Csonka L., Boros Sz. (2024) Az egyetemi testnevelés hatása a testösszetételre *Magyar Sporttudományi Szemle*, 109 (2024/3) pp. 44-52., 9 p.
2. Barka, N., Nagy V., Boros Sz. (2025) Egyetemi hallgatók fizikai aktivitása és annak tanulásra gyakorolt hatása – pedagógiai és tanárképzési implikációk *Pedagógusképzés*, 22 (3) pp. 66-97. [10.37205/TEL-hun.2024.3.04](https://doi.org/10.37205/TEL-hun.2024.3.04)

10.2 English-language studies

1. Barka, N., Wang, F., Jarai, R., Boros, Sz. (2025) Examining the relationship between physical activity and sleep among university students *Frontiers in Sports and Active Living Volume 7*, 1640770. 10.3389/fspor.2025.1640770

11.3. Conference papers published in abstract books

1. Barka, N., & Nagy V. (2023) The effect of university physical education classes on body composition *Book of Abstracts of the 28th Annual Congress of the European College of Sport Science European College of Sport Science* p. 600 978-3-9818414-6-6

11.4 Other publications

1. Edvy, L., Gyömörei, T., Barka N. (2021) Egyetemi hallgatók egészségtudatának fejlesztését befolyásoló aspirációk feltárása *Magyar Sporttudományi Szemle*, 94 pp. 3-9., 7 p.