Health Professions Education

Volume 7 | Issue 1 Article 3

2021

Impact of Intra-Lecture Physical Exercise on the Learning Outcomes of Medical Students

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Cover Page Footnote

This study was approved from the IRB at College of Medicine, King Saud bin Abdulaziz University for Health Sciences.

FEATURED ARTICLE

Impact of Intra-Lecture Physical Exercise on the Learning Outcomes of Medical Students

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Abstract

Purpose: **Literature suggests that physical exercise can improve learning. To evaluate the impact of physical exercise during lectures on the learning outcomes of 1st-year male students at the College of Medicine, King Saud Bin Abdulaziz University, Riyadh, Saudi Arabia.**

Method: **60 students from the College of Medicine, King Saud Bin Abdulaziz University, Riyadh, Saudi Arabia, were included in this study. These students were divided into two groups: A control group (n = 30) and an intervention group (n = 30). The students first completed pretests before joining a lecture. Then, during the lecture, the intervention group was asked to perform physical exercises every 10 min, for a duration of 1 min, while the control group remained seated. A posttest was administered after the lecture. Using a significance level of 0.05, the paired-tests were used to compare the exam results of the participant groups between pre- and posttest scores. The study also compared the mean values of students' posttest scores for both groups.**

Results: **There were significant differences ($p < 0.05$) in the posttest scores between the intervention and control groups. The intervention group's posttest scores had a higher mean value compared to the control group's. This was observed despite the pretest scores showing no significant differences between the intervention control groups ($p > 0.05$). The results show that physical exercise during lectures can help to improve the learning outcomes of medical students.**

Conclusion: **It is beneficial to incorporate physical exercises whilst attending lectures since it helps improve learning outcomes of students.**

Keywords: Physical exercise, Medical students, Learning outcomes

1. Introduction

1.1. Background

Physical exercise confers various benefits to the body. Engaging in physical exercise, for instance, promotes the development of strong bones and muscles. In addition, it helps to improve a person's overall health, whether respiratory, cardiovascular, or even mental. This is because, through physical exercise, a person can reduce weight, and thus, reduce the chances of developing heart diseases, blood pressure issues and diabetes, amongst other issues [1]. However, despite the apparent advantages of physical exercise, schools still insist on students concentrating more on studies than physical activities during academic hours. In other words, students are condemned to a sedentary lifestyle for up to 8 h each day whilst attending school attendance.

It might be assumed that students have the time required to engage in physical exercise after school, but this assumption cannot be further from the truth. With the development of technology, there has been a trend towards activities that do not require significant physical exertion [2]. Advanced modernization and technology mean that humans are not required to walk long distances, often do not

Received 11 November 2021; revised 03 December 2021; accepted 05 December 2021.
Available online 1 December 2021.

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https://doi.org/10.55890/2452-3011.1008

lift anything heavy, and can perform most tasks whilst seated, including whilst engaging in entertainment such as watching television and playing computer games. To compound the issue, due to the tiredness and fatigue often experienced after attending classes all day, students are more likely to resort to options that do not require them to exercise when they go home, and thus, further exacerbate their sedentary lifestyle [3]. More specifically, medical students have been shown to participate in very little intensive physical exercise after studying, thus prompting the need for the inclusion of physical exercise as part of medical schools' extra-curricular activities [4].

An additional benefit of physical exercise, and one that seems to justify the suggestion that exercise form an element of a learner's study time, is that it improves cognitive abilities. When the body moves, the movements stimulate the brain, and thus, optimize the brain for the collection and storage of information [5,6]. This stimulation also helps to improve brain function, both short- and long-term, at that particular moment and in the long-term. This is supported by action-based learning theory, which states that the movement of the body is a trigger that helps the brain to collect and store more data. When someone moves, the movements increase their heart rate, which in turn, increases the amount of blood flowing to the body and brain. This increase in blood flow helps to transport nutrients and oxygen to the brain, thereby stimulating it [7]. Based on these discussions on the importance of physical activity in improving cognitive abilities, it can be assumed that physical exercise at school would have a positive impact on learning outcomes in the classroom.

Studies have been conducted to determine whether student engagement in physical activity influences their academic achievement and learning outcomes. Madigan (2004), for example, conducted a study to determine the importance of physical activities in improving the students' learning. The study found that there was a significant positive relationship between physical success and the academic achievement of students in elementary and secondary schools [8]. Kohl & Cook (2013), also conducted a study to determine the effects of physical activity and physical education on academic performance, and found that increasing physical activity had a positive impact on academic performance. To this end, teachers advised to encourage physical activity in their students [9].

Given the results of Kohl & Cook's and Madigan's studies, it seems that teachers should increase students' physical activity to improve their learning outcomes [8,9]. However, this might not be true for students in higher education. Students in elementary and secondary education may engage in physical activities, and can be incentivized to engage in them by their teachers in the form of rewards, but learning in higher education requires a completely different format. In higher education, the students move away from creative learning settings to that of lectures. However, this format of learning delivery usually occurs in 50–75 min chunks and comprises passive knowledge receipt by the learners. Such a format does not sufficiently provide students the opportunity to remain concentrated, recall information, or use related material. Indeed, the disadvantages of lecture-format learning include overloading the students with information, causing them to lose concentration and tire, and thus reducing their ability to absorb the material being taught in class [10]. This is further aggravated by the fact that the normal concentration span of a student, on average, is 20 min [11]. This calls for interceptive measures to ensure that the students are in a position to absorb and build knowledge during lectures of a shorter time frame [12,13].

The use of intermittent physical activities within lectures can be a measure to achieve this, by segmenting a lecture into shorter periods of time due to the break in the monotony of being seated. Physical activities, as already discussed, help to stimulate the brain, and thus, improve the ability to receive, process and absorb information [14-16]. However, there are limited studies in the case of medical students to support such an assertion, and therefore, no evidence on which to give such a recommendation. There are also limited studies available with regards to the impact of intra-class physical activities on the learning outcomes of medical students. It should also be noted that, despite the adoption of active learning methods, such as problem-based learning, team-based learning, and other modern teaching methods, traditional lectures constitute the major part of teaching strategies for pre-clinical phases of medical school [17]. This then reveals the need for a study to investigate the impact of physical exercise during a lecture on learning outcomes among medical students.

1.2. Study purpose

The primary purpose of this study was to evaluate the impact of physical exercise performed during a lecture on the learning outcomes of 1st-year male medical students at the College of Medicine, King Saud Bin Abdulaziz University, Riyadh, Saudi Arabia.

2. Methods

2.1. Overview

The study included a pretest and posttest, included a control group and can be defined as a quasi-experimental methodology. The study participants (medical students) were divided into two groups: the control group and the intervention group. Both groups were asked to do a pretest to record their intelligence before the experiment. The students were then asked to attend a lecture. The control group attended as normal, whereas the intervention group was asked to perform simple physical exercises every 10 min. After the lecture, both the groups underwent a posttest to ascertain the degree to which their learning outcomes were affected.

2.2. Participants

The study population consisted of 1st year male students at the College of Medicine for the academic year 2019–2020. This population comprised approximately 200 students at the time of data collection.

All 200 students available at the time of study were invited. Any student who did not accept the invitation or withdrew, who did not attend the lecture, did not take the pre-test or post-test, or who had a prominent or temporary physical disability that prevented him from performing the assigned physical exercises was excluded. The study was conducted at the College of Medicine, King Saud bin Abdulaziz University for the Health Sciences, Riyadh, Saudi Arabia.

Based on these inclusion and exclusion criteria, the final sample size of the study was 60 students. The students who were available during the data collection process and who agreed and consented to be part of the study were randomly included in this study till we reached the calculated number for this study in order to reduce instances of bias when selecting the study participants.

2.3. Materials

The participants in this study were divided into an intervention group (n = 30) and the control group (n = 30), and attended a 50-min lecture. Every 10 min, the intervention group were asked to perform simple physical exercises such as standing and sitting three times consecutively or stretching hands or legs for 1 min. The control group, on the other hand, remained seated in the front seats of the lecture hall so as not to be disturbed by the movements of the intervention group. Both groups completed a pretest and posttest, each comprising 15 MCQs, with only one correct answer for each. The results of the tests were used as the outcome variables.

2.4. Data collection

The data was collected using the pretest and the posttest procedures, and the tests were based on the topic of vitiligo, which was taught during the lecture. The tests were in the form of 15 MCQs, with only one correct answer for each. These questions were created by subject experts and reflected the student's level of education. The students were given the pretest 10 min before the lecture and the posttest 10 min after the lecture. To ensure the validity of the tests, the pre- and posttests contained different questions. The results of these were analyzed to identify any significant differences in the performance of the experimental group after the intervention compared with the control group. The two groups were considered to be independent variables while the students' pre-/posttest scores served as the dependent variables.

2.5. Procedure

The participants were randomly assigned to either of the groups (control group or intervention group). The pretest was administered to both groups at the beginning of the experiment and their scores recorded. During the lecture, the intervention group was asked to sit at the back of the room and perform light exercises every 10 min for duration of 1 min throughout the lecture. The control group, on the other hand, remained seated in the front seats for the entire lecture. Once the lecture was over, both groups completed a posttest and the scores recorded. These results were later analyzed using t-tests and descriptive statistics. Both groups attended the same lecture, in the same lecture hall, at the same time.

2.6. Analysis

The study used SPSS version 20 for data entry and data analysis. The analysis was conducted using descriptive statistics and t-tests. The descriptive

statistics were used for the numerical variables (students' exam scores) and were presented in the form of mean and standard deviation. The paired t-tests, on the other hand, were used to compare the exam results of participant groups' pretests and posttests. The study compared the mean values of the students' posttest scores for both groups using the independent samples' t-tests. The significance level used in the study was $p = 0.05$.

2.7. Ethical clearance

This study was approved by the IRB and maintained the confidentiality and anonymity of the students' scores. The data was reported anonymously by randomly assigning the students a number, which was used instead of their names to record and store the test scores. The students were also asked not to write their names on the test papers. In addition to this, each participant had the right to withdraw from the study at any time prior the completion and submission of the posttest. After this, it was not possible for the student to withdraw since the data had already been anonymized.

3. Results

3.1. Descriptive statistics

Table 1: provides an overview of the mean scores (standard deviations between brackets) of the pre- and posttest for the two groups.

The data shows that in both groups, the mean was higher in the posttests. For the control group, the posttest mean was 8.77 while the pretest mean value stood at 5.33. For the experimental group, on the other hand, the posttest mean was 11.67 whereas the pretest mean was 5.1.

A *t*-test was also conducted to determine whether there were any significant differences in the results of the pretests between the control and experimental groups. The results show that there was no significant difference between the two groups during the pretest (p-value = 0.5101). The comparison of the test results between the intervention and control groups shows that the experimental group scored a higher value (mean = 11.667) compared to the control group (mean = 8.767). An additional *t*-test was conducted to determine whether there were any significant differences in the posttest results between the control and experimental group. The results show that there was a significant difference between the two groups during the posttest, since the p-value was less than 0.05 (P (p-value = 0.0.000127).

In addition, a comparison of the pretest scores and the results of the posttest mean highlights an increase in the difference in performance between the two groups. However, the difference in performance was higher for the intervention group compared to the control group. For the experimental group, the difference between the mean scores in the two test scores was 11.667−5.1 whereas, for the control group, the difference between mean scores in the two tests was 8.767−5.333. This shows that performing physical exercises resulted in higher scores. A possible explanation for this is that physical exercises conferred cognitive benefits to the students in the intervention group.

4. Discussion

Most medical school lectures do not incorporate physical activity, as standard, in their curricula: the students remain seated for 50−75 min, listening to lectures. This has been found to induce boredom in the students, and thus, cause them to easily lose their concentration [18]. Sturt & Rutherford also established that the concentration of medical students peaked at between 10 and 15 min, and declined steadily with each additional minute [18]. The current study aimed to determine whether classroom-based physical exercise interventions improve students' learning outcomes due to previous studies suggesting that the incorporation of physical exercises during lectures may improve students' concentration spans, and at the same time, improve their cognitive abilities such as information absorption and memory retrieval (14, 15 & 16).

There are two main explanations for this phenomenon. One is that physical exercises help to alleviate boredom, allowing the students to concentrate for longer periods and absorb more information. Studies have shown that the average concentration rate of a student is about 20 min [11]. Breaking the lecture into smaller segments through periodic exercise thus helped to ensure that the concentration of the students was at the optimal level. Fenesi et al. is one study which supports this

Table 1. Mean scores (standard deviations between brackets) of the pre- and posttest for the two groups.

Test	Control group (n = 30)	Experimental group (n = 30)	p- value
Pretest	5.33 (2.73)	5.1 (2.73)	0.51
Posttest	8.77 (2.42)	11.67 (2.29)	>0.001

assertion. They conducted a study in order to determine how exercise breaks during lectures affected the learning process and found that it reduced boredom, increased attention/concentration, and in the process, improved the students' learning outcomes [19]. Another explanation for this phenomenon is that the neurophysiological and neurochemical changes that take place in the brain due to exercise help to improve brain function by, for example, stimulating the brain to store information and easily retrieve this information, as indicated by Chang and Etnier, who have shown that moderate to intense exercises help to improve the performance of the working memory and its cognitive flexibility [7].

The results of this study are similar to the results of other studies that have sought to determine the effect that physical activities have on the students' academic success. Examples of such studies include Erwin et al., Grissom, Howie & Pate, Coe et al., and Keeley & Fox [20-24]. Erwin et al. for example, conducted a study to determine the association between learning outcomes and classroom-based physical interventions [20]. The results of the study showed that there was a significant positive relationship between classroom-based physical exercise interventions and the learning outcomes of children. These studies were conducted in a different context though, and sought to determine the effect of physical activity on academic achievement across longer time-scales, such as over an entire school semester [20-24]. This current study, on the other hand, has sought to determine whether physical exercises during a lecture have any effect on the learning outcomes of students. That said, the conclusions of previous researchers are relevant to this present study: it is essential that schools and teachers incorporate physical activities into the learning process and school day if they were to improve students' learning outcomes.

5. Conclusion

In the existing traditional lecture format used in medical schools, incorporating intra-lecture physical exercises within lectures would be beneficial because it may help in improving students' learning outcomes by improving their attention during lectures, thereby improving their cognitive abilities.

Disclosure

This study was approved from the IRB at College of Medicine, King Saud bin Abdulaziz University for Health Sciences.

Funding

None.

Conflict of interest

All authors declare that they have no conflicts of interest.

Acknowledgments

We thank the students who agreed to be a part of this study. In addition, we thank the technical staff who assisted in conducting and completing this study.

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