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# Effectiveness of morning exercise routines on attention span in classrooms

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## Abstract

*The beneficial effects of morning exercise routines on children's attention spans in the classroom are the focus of an increasing number of research. The reason for this is because educators and health professionals are always searching for more comprehensive approaches to improve the academic performance and overall health of pupils. This study investigates the possible behavioural and cognitive benefits of including structured morning physical activity sessions into the daily school calendar. The sessions are scheduled to take place throughout the school day. According to study, engaging in moderate to intense physical activity prior to engaging in academic education is beneficial to the executive processes of the brain, which include attention, memory, and concentration. Exercising first thing in the morning provides a number of advantages, including improved blood circulation, less stress, and elevated levels of neurotransmitters that are known to improve mood, such as dopamine and serotonin. These benefits all contribute to improved cognitive processing and mental alertness in the classroom. Observational data, teacher ratings, and standardised attention span measures were used in this research to determine that students who participate in short, regular morning exercise routines outperform their counterparts who engage in sedentary activities in terms of concentration, decreased impulsivity, and engagement with learning tasks. Students often report feeling more emotionally prepared to meet academic challenges, as well as experiencing a rise in their level of energy. The findings lend support to the notion that providing children with the opportunity to engage in physical activity as part of their morning school routine is an excellent method to enhance their ability to concentrate and to make the learning environment more enjoyable.*

***Keywords:*** *Morning exercise, attention span, classroom behavior, physical activity, cognitive function.*

## 1. Introduction

In today's educational system, the intricate connection that exists between a person's physical health and their cerebral acuity is becoming more obvious. In reaction to the increasing prevalence of mental illness, addiction to screen time, and sedentary lifestyles, schools are coming under increasing amounts of pressure to bring about the implementation of more comprehensive policies that support the emotional and physical health of students. Morning exercise routines that are included into the school schedule are one example of a possible intervention that may be used. It has been shown via research that engaging in even brief bouts of physical activity first thing in the morning has a beneficial impact on the functioning of the brain, mood, as well as the capacity to focus and learn as well. It has been shown via study on the brain that physical activity enhances executive skills such as attention, memory, and self-regulation. As a consequence of this, an increasing number of educators are considering morning exercises as a straightforward method to improve the conduct and performance of their students in the classroom.

It is a direct correlation between the attention span of students and their capacity to concentrate, integrate, and recall the information that they acquire in the classroom; thus, attention span is an essential component in academic accomplishment. There are a lot of children that struggle to concentrate for extended periods of time, particularly in the mornings when school hours are just getting started. In situations when variables such as a lack of sleep, stress, and inactivity hamper cognitive function, it may be difficult for students to maintain their interest in the subject matter. As a result of its ability to stimulate cerebral blood flow, produce neurotransmitters that enhance mood, and reduce feelings of lethargy and restlessness, exercising first thing in the morning may be a healthy and effective strategy to tackle this aspect of the problem. Additionally, getting up and exercising first thing in the morning helps to establish an atmosphere that is favorable to learning by raising motivation and lowering disruptive behaviour.

In order to include morning exercise into the routine activities that take place at school, it is not necessary to devote a significant amount of time or effort to the development of intricate systems. It is possible that even short intervals of cardiovascular exercise, yoga, stretching, or guided movement might have a substantial influence on a child's ability to concentrate and their readiness to learn. In schools that have used these tactics, there is a tendency for students to enhance their ability to concentrate, their morale in the classroom, and their connections with their classmates. In the post-pandemic period, when young people are facing greater mental and physical issues, morning exercise is a realistic and economical alternative to enhance learning circumstances. This is especially true in the context of the younger generation. The goal of this study is to explore whether or if and how the attention spans of students are changed by their morning exercise routines. Additionally, the study aims to bring attention to the potential that this practice may lead to a student population that is healthier, more focused, and more successful academically.

## 2. Objective

1. To Regular morning exercise practices may improve kids' attention span and concentrate in class.
2. To evaluate students' behavioural and cognitive changes after starting the school day with physical exercise.

## Methods

In all, there were 39 first-year college students from Taiwan who voluntarily engaged in the study. There were 15 females, and their mean age was 20.79 years, with a standard deviation of 1.03. The individuals were allowed to live freely in an environment that was observed by wrist-worn trackers for a period of one hundred and ten days, beginning on March 10, 2016, and ending on June 23, 2016. During this time, they documented their daily activities. By establishing a connection with a computer or mobile phone using Bluetooth 4.0, the trackers were able to synchronise with the cloud. They used this method to collect the data. The Java programming language and an application programming interface (API) were used in the development of our assessment tool. Data on the daily activities of each participant was automatically obtained from the cloud and stored in an Impala data system after the retrieval process. In order to examine the participants' memory and attention capacities, we conducted SST and TMT twice for each subject; these test batteries were delivered a total of fourteen times throughout the course of the study. The test results were separated into two groups: those with normal to high values (above the 25th percentile) and those with low values (below the 25th percentile). Institutional Review Board (IRB) approval for this research was obtained under the number TH-IRB-0015-0016, which was issued.

For the purpose of this study, a wrist-worn tracker manufactured by Fitbit Inc. and referred to as a Fitbit Charge HRTM instrument was used. In the course of a day, this wearable device keeps track of a number of physiological and behavioural variables, such as the user's heart rate, the number of calories burned, the number of steps taken, the distance travelled, the number of floors climbed, the amount of activity, and the quality of sleep. It does this by reflecting Pure Pulse LED lights onto your skin, which can detect when your capillaries expand in response to changes in blood volume. This allows it to monitor your heart rate. According to the physical activity level (PAL), the following levels of activities were assessed as being of varying degrees of difficulty: There are four distinct degrees of physical activity levels, which are as follows: sedentary (with a PAL of 1.0 to 1.4), light (with a PAL of 1.4 to 1.6), fair (with a PAL of 1.6 to 1.9), and high (with a PAL of 1.9 to 2.5). Both low- and high-intensity exercises were included in the definition of moderate-to-vigorous physical activity, sometimes known as MVPA. The number of calories that are expended when the body is at rest is referred to as the basal metabolic rate. This rate is calculated in order to maintain a steady level of heart rate, respiratory rate, and brain activity. In the daily physical data that was collected, the individuals' gender, age, height, and weight were all altered according to the changes that occurred. Because of this, we did not proceed with the process of making individual changes to the data that was collected for this study.

In order to measure the participants' capacity for concentration, the TMT, which is a neuropsychological evaluation instrument that is frequently utilised, was used. This instrument may be used to test executive functions such as speed of processing, mental flexibility, visual search, and scanning. These are all examples of executive functions being measured. Because of their capacity for random transformation of positional repeatability measurement, their simplicity of use, and their accuracy, computers and tablets are excellent for the usage of TMTs. To further facilitate the collection of data in a dependable and expedient manner, a Java-based automated TMT version was built specifically for this study (Figure 1).

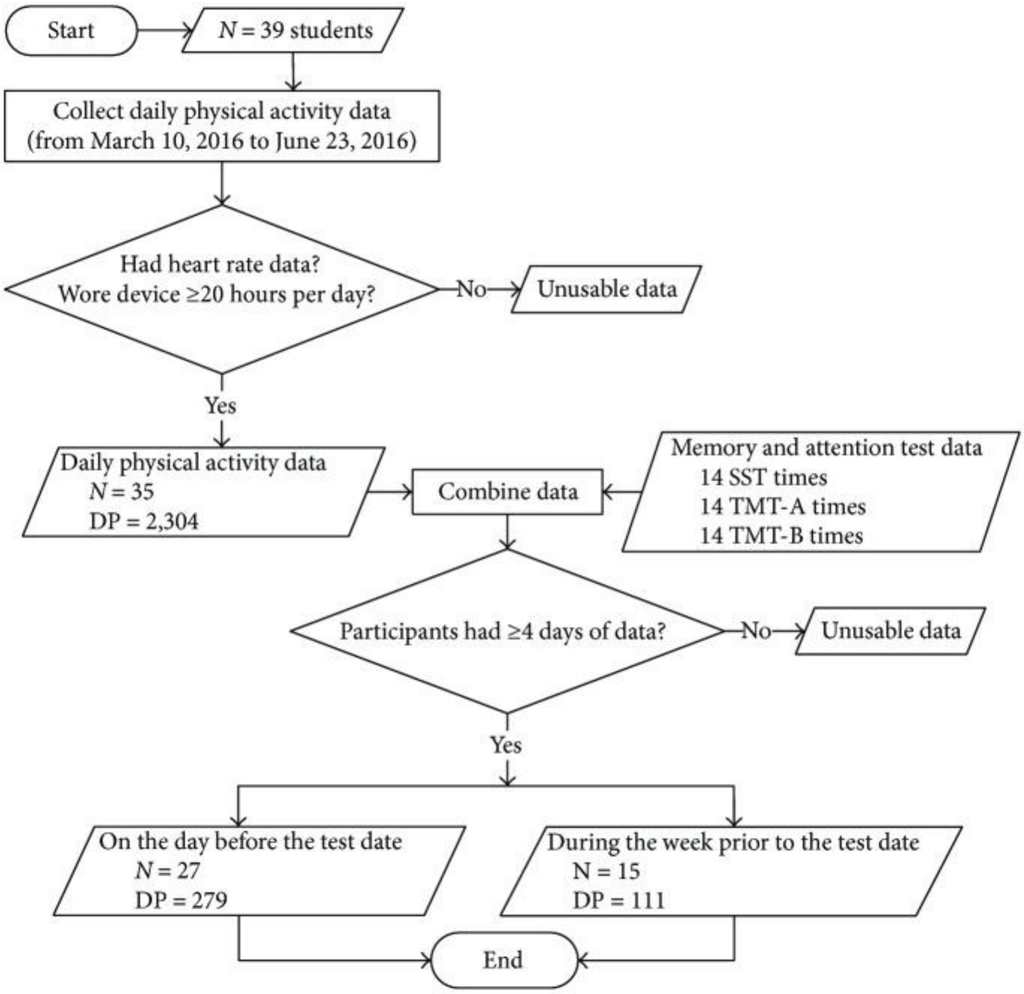


**Figure 1. See example flowchart. Day participant; spatial span test; trail creation test.**

The TMT is divided into two distinct portions. In TMT-A, players are required to click in a certain sequence in order to connect 25 consecutive numbers ranging from 1 to 25, which are shown on the interface in a random order starting from 1 and ending with 25. One of the tasks that users are required to do in TMT-B is to click on a sequence of links that are randomly put on the interface. These connections connect 13 numerals and 12 letters (A, B,..., L)—for instance, 1, A, 2, B, 3, and C. It was recorded as the result that the total amount of time it took to complete the exam was recorded; this amount of time on the attention test (TSAT) was a measure of attention capacity; hence, a lower score indicated a lower attention capacity.

The version of the SST that was developed and delivered by Cambridge Brain Sciences was an electronic implementation. The interface is composed of squares that light up and measure the amount of memory that is available. In the event that a player notices a square being illuminated, they are need to click on it in the exact same order. If the participants provide an incorrect response, the level that came before it is shown. In the event that the subject gives three incorrect replies in a row, the examination is terminated. It was established that the subject's memory capacity was assessed by the highest number of squares that they correctly answered.

According to the instructions provided by the manufacturer, the trackers used in the research were meant to be recharged every few days and removed when swimming or bathing. As a result, the raw data had to be filtered before data analysis could take place. For the purpose of analysing the heart rate data that was captured by the trackers at regular intervals of five seconds, the following filter criteria were utilised: The following steps were taken: (1) participants were excluded if data had not been captured for at least twenty hours each day; (2) data were excluded if simultaneous heart rate measurements were not available; (3) Daily activity records from the day before the test and data from the week previous were mixed with data from fourteen memory and attention tests; (4) individuals for whom fewer than four days of data were collected were eliminated from the research. Information collected the day before the test (N = 27; 279 DPs) and information collected the week before the test (N = 15; 125 DPs) were the two sets of data that were assessed in this examination. The scope of this study is limited to shorter physical activities that are associated with the capacity of college students to pay attention and recall information. We made an effort to determine which activity is most closely connected with attention and memory one day before to the examination. The day before the test, we had a look at the exercises that were provided. On the other hand, it is not impossible that people altered their routines the day before attending the examination. In order to circumvent this issue, we also investigated the level of activity that the participants had in the week preceding up to the examination.

## 3. Statistical Analysis

Using a combination of fourteen measurements from the memory and attention test that was administered once each week and data from the DPA that was administered the day before and the week before the test, the final findings were measured many times, with varied amounts of measurements for each participant. Therefore, the goal of this research was to use the PROC MIXED model, a method accessible in SAS 9.4, to examine the correlations between DPA and memory and attention capacities. This approach is the best course of action when working with incomplete data or measurements that have been made several times. Maximum likelihood (ML), which stands for maximum likelihood approach, was utilised in the mixed model with DDFM=KR and TYPE=UN representing a generic variance-covariance matrix. The 95% CIs were obtained using the bootstrap approach, and the correlation coefficient was estimated using the VCORR method that was used. Furthermore, in addition to the linear trend test, the program IBM SPSS Statistics Version 22 was used in this investigation for the purpose of analysing descriptive statistics, quartile data, and the data itself. Through the use of the receiver operating characteristic (ROC), the optimal calorie burns and VATD cutoffs were identified. This was accomplished by maximising the sensitivity-specificity difference.

## 4. Results And Discussion

There were 33 participants in our research at first, but six additional individuals joined over the course of the inquiry, and one member left the study. Upon completion of the data filtering process, a total of 2304 day-participants (DPs) were found. Of these, 35 participants (89.74%) wore a tracker for a period of twenty hours or more annually. All of the participants were given data over a period of at least four days, and the data consistently included fourteen attention and memory assessments the day before the test date. Out of the total of 27 participants (279 DPs), 16 of them were male, which accounts for 69.23% of the total. Every participant had data for at least four days, and the data from fourteen memory and attention tests that were given a week before the day of the test (for those who had seven days' worth of data) were combined with the data from daily activities. Fifteen people, ten of whom were male and accounted for 38.46 percent of the total number of DPs, were included in the study. The averages (standard deviations) of DPA, memory capacity, and attention capacity are shown in Table 1. These averages are displayed one day and one week prior to the day of the test, respectively.

**Table 1. Stats on DPA, memory, and attention.**

| Measure | Day Before (N = 27) <br>Mean (SD) | Week Before (N = 15) <br>Mean (SD) |
|---|---|---|
| Calories | 2,347.27 (490.97) | 16,435.97 (2,920.77) |
| Steps | 9,084.68 (3,467.87) | 63,828.14 (21,894.72) |
| Distance (km) | 6.36 (2.45) | 44.47 (15.54) |
| Floors | 21.74 (13.96) | 136.54 (68.24) |
| Elevation (miles) | 65.74 (42.52) | 412.97 (207.80) |
| Sedentary Time (min) | 795.42 (186.21) | 5,336.23 (759.71) |

| | | |
|---|---|---|
| LATD (min) | 168.80 (87.41) | 1,337.76 (411.19) |
| FATD (min) | 22.25 (20.05) | 176.52 (137.58) |
| VATD (min) | 24.08 (22.75) | 138.18 (109.42) |
| SST (score) | 7.04 (0.84) | 7.05 (0.83) |
| TMT-A (min) | 45.00 (10.58) | 43.18 (11.03) |
| TMT-B (min) | 56.59 (16.25) | 53.13 (16.55) |

The terms "day-participants," "fairly-active time duration," "very-active time duration," "spatial span test," and "trail-making test" are represented by the abbreviations "DPs," "LATD," "FATD," "VATD," and "SST," respectively.

There was a significant negative correlation between memory capacity and the number of calories burned on the day before the test and in the week before the test [r = -0.272 (95% CI: -0.342, -0.160), r = -0.364 (95% CI: -0.476, -0.179), respectively], according to the results of a study that employed multiple models. According to the analytical result, memory capacity and the VATD significantly decreased on the day before the test and in the week before [r = -0.176 (95% CI: -0.270, -0.079), r = -0.395 (95% CI: -0.524, -0.237), respectively]. Both the day before the exam and the week before the test demonstrated this. Refer to Table 2.

**Table 2.**

| **DPA Metric** | **Day Before SST** | **Mean TMT** | **Week Before SST** | **Mean TMT** |
|---|---|---|---|---|
| Calories | **−0.272** | **0.289** | **−0.364** | **0.268** |
| Steps | −0.025 | 0.059 | −0.041 | −0.050 |
| Distance | −0.031 | 0.037 | −0.098 | −0.096 |
| Floors | 0.005 | −0.051 | 0.111 | −0.115 |
| Elevation | 0.005 | −0.051 | 0.111 | −0.115 |
| Sedentary Duration | 0.046 | −0.044 | −0.071 | −0.098 |
| LATD | −0.077 | −0.077 | −0.152 | −0.190 |
| FATD | 0.062 | 0.059 | 0.092 | 0.012 |
| VATD | **−0.176** | **0.254** | **−0.395** | **0.241** |
| MVPA | −0.079 | 0.198 | −0.161 | 0.144 |

The 95% bootstrap confidence interval is what is meant by the term "95% CI." the "space span test" and the "trail making test" are both abbreviations. All of the components that make up the mean of total metabolic rate (TMR) are as follows: light-to-vigorous physical activity (MVPA), moderately active time duration (FATD), very active time duration (VATD), and light-to-moderately active time duration (LATD).

The results showed that in the two days before the test (r = 0.289, 95% CI: 0.207, 0.366) and the week before the test (r = 0.268, 95% CI: 0.095, 0.361), there was a positive correlation between the TSAT and caloric expenditure (i.e., a negative correlation between focus and caloric expenditure). In terms of focus, this was true. Both the day before the test and the week before it showed a favorable link between the TSAT and the VATD, according to the research. With correlation values of r = 0.254 and r = 0.241, respectively, and 95% CIs of 0.164, 0.351, and 0.091 and 0.405, respectively, this suggests that the VATD and attention ability were negatively correlated. However, there was a negative association with attention ability, with a correlation value of 0.198 (95% confidence interval: 0.090, 0.305) (Table 2). This was a positive correlation between the MVPA the day before the test and the TSAT, and a negative correlation with attention ability.

Based on the quantile analysis of physical activity the day before the exam, it was established that there is a linear connection between memory capacity, TSAT, calories burnt, and VATD (Figure 2). The significance level for the trend was found to be less than 0.05. In a similar manner, it was noted that there was a substantial linear connection between memory capacity, TSAT, calories burnt, and VATD in the week before to the test (p for trend was less than 0.05) (Figure 3).

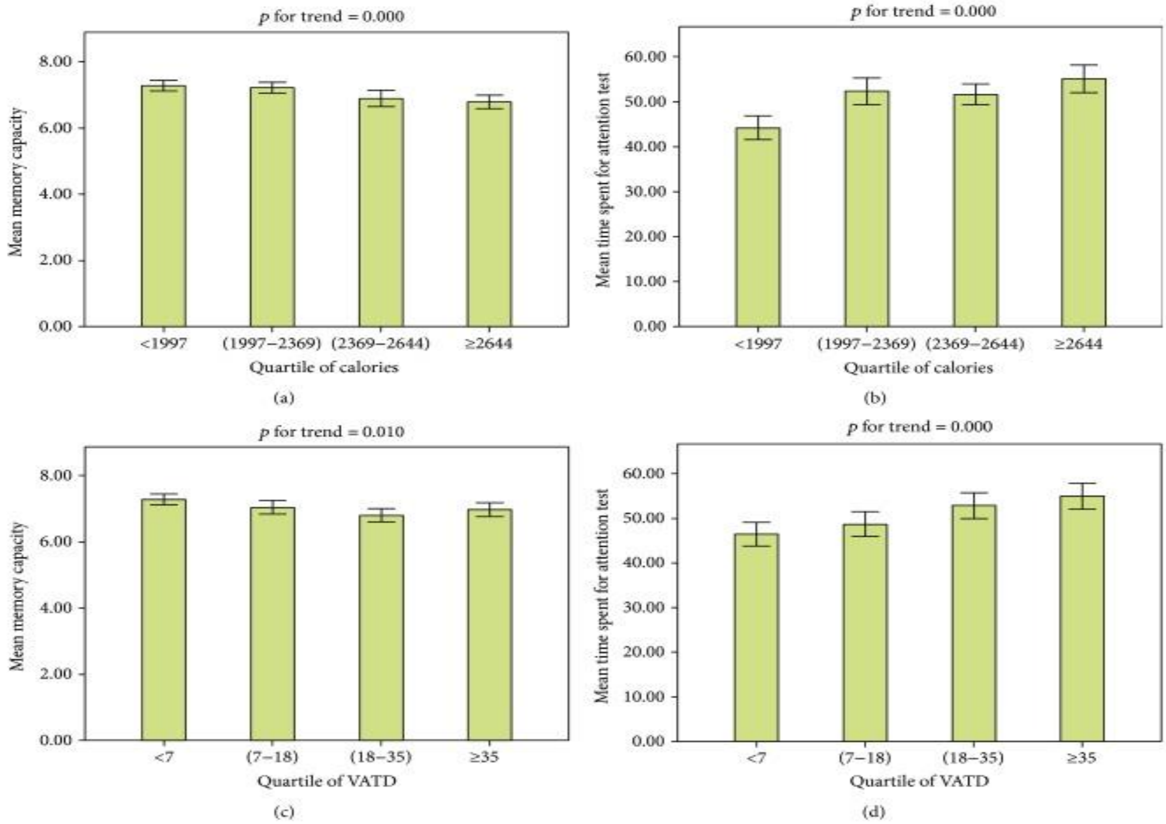


**Figure 2. Mean TSAT and memory capacity by quartile of calories and VATD the day before the test. Memory capacity, TSAT, VATD, and calories.**

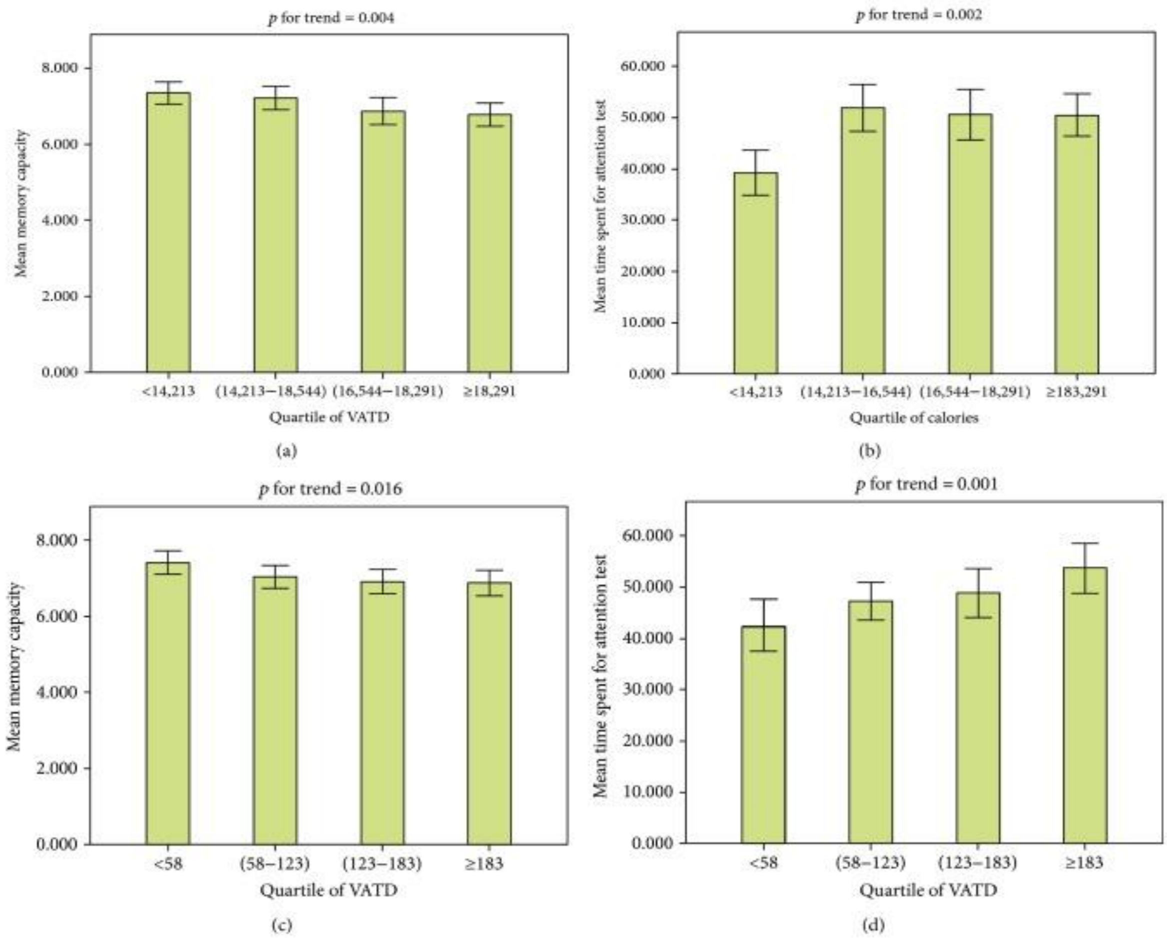


**Figure 3. Mean memory capacity and TSAT by quartile of calories and VATD week before test. Memory capacity, TSAT, VATD, and calories.**

Memory and attention are two areas that have been demonstrated to improve from regular moderate-to-vigorous physical activity (MVPA), according to research that was conducted in the past. An example of this would be the fact that a more sedentary lifestyle is substantially and consistently related with higher levels of academic success. Elementary school students are able to concentrate more effectively when they participate in physical activities throughout the school day. However, we discovered that there is a negative association between severe activity and the ability to remember things and pay attention to certain things.

Research by Galioto et al. included 122 participants in the Longitudinal Assessment of Bariatric Surgery-2 parent project. Self-reported aerobic physical activity was shown to have minor associations with reduced attention ability ($r = -0.21$, $p = 0.04$) and execution capacity ($r = -0.27$, $p < 0.01$), according to the study. Memory ability was shown to be negatively correlated with both self-reported and experimentally assessed weekly maximum voluntary physical activity minutes. $R = -0.20$, $p = 0.04$, and $r = -0.46$; $p = 0.02$ were the correlation coefficients, respectively. The results of our study also showed a negative correlation between memory capacity and the VATD the week before to the test and the VATD the day before. The following were the correlation coefficients: $r = -0.176$ (95% CI: -0.270, -0.079) and $r = -0.395$ (95% CI: -0.524, -0.237), respectively. Furthermore, there was a negative correlation with attention ability and a positive association with the TSAT for both the VATD given the week before and the VATD given the day before the test [$r = 0.241$ (95% CI: 0.091, 0.405), respectively] [$r = 0.254$ (95% CI: 0.164, 0.351).

Researchers in East Central Illinois, United States, conducted a study on 74 pupils at seven different schools between October 2013 and 2014. The students' mean age was 8.6 years, and their standard deviation was 0.58. They did not discover any significant connections between MVPA and inhibition, working memory, or academic achievement via their research. There were no significant connections found between MVPA and visual memory span or TMT in another study that was conducted in the Netherlands on a group of eighty children who were developing normally (44 of them were female and aged between eight and twelve years old). According to the findings of a study that was carried out by Nutrition in Adolescence in Europe between the years 2006 and 2007, it was discovered that the attention capacity test scores of adolescents were positively and significantly correlated with the amount of time they spent engaging in moderate physical activity, also known as MVPA, when they were free to move around as they pleased ($p < 0.05$). It is possible that the development of MVPA would be beneficial to attention capacity. Before monitoring the 273 people in terms of their daily activities in free-living situations using GT1M devices for seven days, eight hours per day, the d2 test of attention was used to examine the participants' capacity to pay attention until the monitoring continued. There was a wide variety of ages among the participants, from 12.5 to 17.5 years. In spite of this, our research looked at 39 students over the course of 106 days, with an average age of 20.79 years and a standard deviation of 1.03. 38.46% of these individuals were female. For the purpose of ensuring that the participants had data accessible for analysis for a minimum of twenty hours per day in free-living settings, we conducted a screening process. All of the subjects who were included in the final analysis had data from at least four days' worth of testing, which brought the total number of tests administered to the participants to fourteen. The duration of the VATD and the number of calories burnt were shown to have a significant and negative correlation with the memory and attention abilities of the students, as indicated by our survey results. We also agree that increasing the VATD of students might potentially make them sleepy, which would result in a decrease in their capacity to concentrate and recall information. As a result, it is possible to improve one's memory and attention skills by engaging in a moderate amount of daily activity or by engaging in light exercise.

According to the findings of Vanhelst, those who participated in MVPA for a duration of more than 58 minutes on a daily basis exhibited improved attention skills. In the immediate aftermath of a test, the attention capacity of the participants was adversely influenced if they burnt more than 2,283 calories and performed more than 20 minutes of VATD the day before the test, or if they burned 13,640 calories and did 76 minutes of VATD the week before the test. This information is shown in Table 3. The American Heart Association recommends that adults participate in intense physical exercise for a minimum of seventy-five minutes each week. This is the threshold that is considered to be significant for the development of VATD. One possible explanation for the observed association between decreased attention capacities in the short term after intense exercise is that fatigue had a part in the phenomenon. According to the findings of a study conducted by Davis and Bailey, continuous activity causes the release of ammonia into the bloodstream, which has the potential to alter the function of the central nervous system. As a result, it is evident that the central nervous system plays a role in the sensation of weariness that occurs after prolonged exercise. It is possible that subjects will be less awake and have less cognitive resources available to the person in question during the weariness phase, which would need more time for recuperation.

**Table 3. ROC physical activity cut-off points for excellent attention.**

| | On the day before the test | | | | | During the week before the test | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Unit/d | SE | SP | AUC | p value | Unit/d | SE | SP | AUC | p value |
| Calories burnt (calories) | 2283 | 0.649 | 0.676 | 0.698 | 0.000 | 13,640 | 0.917 | 0.593 | 0.794 | 0.000 |
| VATD (minutes) | 20 | 0.540 | 0.765 | 0.662 | 0.000 | 76 | 0.798 | 0.667 | 0.791 | 0.000 |

Unit/d: unit per day; SE: sensitivity; SP: specificity; AUC: area under the receiver operating characteristic curve.

Wearable trackers were used in this research in free-living conditions, which allowed for continuous data collection without disrupting the participants' normal routines. This was a significant advantage of the study. Personal characteristics and environmental factors, on the other hand, could have an impact on these figures. A good illustration of this would be the impact that demographic characteristics have on the quantity of physical activity. As a result of variances in habit and behaviour, the amount of personal physical activity achieved by each participant may be different from one another. It is likely that the participants' pre-test health, which may have included tiredness or sleeping, had an effect on their memory and attention capacities, neither of which we had evaluated. In addition, the participants were required to take off their wearable trackers before taking a shower or going swimming, and they were required to recharge them after a few days.

When compared to the baseline, when the participants were not wearing the devices, it is possible that the participants' conduct was accidentally altered while they were wearing the gadgets. There is a possibility that these factors will have an effect on the amount of physical exertion. Nevertheless, the findings of this study indicated that there is a potential use for wearable technology in the context of monitoring regular physical activity with the intention of enhancing memory and concentration.

## 5. Conclusion

The findings of this study underline the significance of providing students with regular morning exercise programs in order to improve their ability to concentrate and their behaviour when they are in the classroom. There is a correlation between the beginning of the school day with a structured physical activity and improvements in students' cognitive preparation, emotional stability, and active involvement in learning. Enhanced blood circulation, increased release of neurotransmitters such as dopamine and serotonin, and reduced stress and anxiety are the factors that contribute to a mind that is alert and focused, which is needed for good scholastic accomplishment. When youngsters walk about first thing in the morning, teachers have seen that there are more benefits than only an improvement in the children's ability to continue paying attention. Their students spend more time paying attention in class, are less likely to act rashly, and are usually better behaved overall. These advantages encourage variety and general growth, which is significant since they are not just beneficial to students who are interested in athletics or who have high levels of academic achievement. Through the implementation of morning exercise routines, it is possible to obtain improved concentration, classroom harmony, and overall student well-being with a little expenditure of both time and money. It is essential that educational institutions provide full support for the implementation of early physical activity into the school day. This is because educational institutions are always looking for innovative and practical approaches to enhance learning outcomes. This not only assists children in overcoming behavioural and cognitive challenges, but it also encourages them to engage in behaviours that are beneficial to their health, fitness, and mental resilience, which they may choose to follow for the rest of their life.

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