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# Sleep quality as a mediating role in general health and academic performance in the context of sustainable education

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## Abstract

One of the most important factors influencing a student's life is their academic performance as it contributes to their success. It is also known that poor sleep quality can consequently cause students to obtain poor academic grades. There are many different studies that assess the relationship between general health and educational performance. However, this study emphasizes the mediation effect of sleep quality on the relationship between general health and academic performance which was not common in other studies conducted. The ICPSR's National Longitudinal Study of Adolescents dataset was specifically DS 8 (home data) and DS 16(education data) which were merged and cleaned using SPSS. Pearson's correlation and mediation analysis are performed to test the relationship between sleep quality, general health and academic performance using SPSS Macro Process 4.0. The results of this study revealed that mental health was negatively correlated with academic performance. Physical health was also found to have a positive relationship with academic performance. The results of the mediation analysis showed that sleep was not a mediating factor in the relationship between academic performance and physical or mental health. This study plays an important role in providing a better understanding of the mediating role of sleep and also the direct and indirect effects of general health on academic performance. The insights provided can be useful to improve the educational achievements of students by ensuring that their general health is well-maintained and contribute to educational data analytics and education quality.

**Keywords:** Academic performance, Daytime sleepiness, Education quality, General health, Mental health, Physical health, Sleep quality.

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## 1. Introduction

Academic performance is crucial for students as it drives them towards achieving their goals and achieving success [1]. Quality of life could be a crucial aspect that determines the success of students because it can affect students' lives in many ways. The duration of their sleep which has been related to academic achievement is a significant factor in determining their quality of life. Furthermore, overall health and well-being also play an important role in their academic progress as unhealthy habits of students can cause physical health problems such as hyperglycemia, hypertension and adiposity. In addition to physical health, mental health problems such as mental anguish, excessive nervousness and intense pressure can also decrease academic performance. Studies reveal that mental health issues have a direct impact on a person's physical health by leading to symptoms such as headaches, nausea, dizziness, fever etc. According to one study, female students experienced higher levels of anxiety than their male counterparts. The study also revealed that mental health problems reduced their focus and caused them to perform poorly in their studies [2]. A study also found that physical activity intensity can improve the immune system reducing the likelihood of illness among college students and having a positive effect on academic performance [3]. Furthermore, sleep is a vital component of human health and is recognised as one of the primary markers of health and academic achievement because of its many advantages in enhancing brain function and the performance of the body. Although there has been considerable research on the association between sleep, overall health and educational achievement, it is still mandatory to understand the intermediate influence of sleep quality on this relationship. The relationship between sleep quality, overall health and educational achievement has the possibility of being reciprocal in nature with each element capable of influencing the other [4]. Additionally, the specific mechanisms through which sleep quality may affect the relationship between overall health and educational performance remain unclear. Therefore, this study aims to provide important information on the mechanisms through which sleep affects these outcomes by investigating the relationship between general health and academic performance and using sleep as a mediator in this relationship. The main research questions for this study are the following: What is the *relationship* between physical health, mental health and academic performance? Does daytime sleepiness mediate the *relationship?* The results of this study may have some crucial outcomes for teachers, parents and researchers in developing interventions intended to improve the health and educational achievement of students.

### *1.1. Problem Statements*

The problem addressed in this study is the discrepancy between the recommended and actual duration of sleep for university students. Inadequate sleep affects students' academic abilities because sleep is critical for memory consolidation and cognitive functions [5-10]. Therefore, poor sleep quality and lack of sleep will have adverse effects on academic performance such as poor grades and a lack of academic motivation [5, 7, 11-13]. Therefore, adolescents should get 8 to 10 hours of sleep per day and young adults aged 18 to 26 should get 7 to 9 hours of sleep per day to maintain health and benefit from the positive effects of sleep such as better memory and learning ability [10]. However, according to a weekly report from the CDC, 73% of US high school students are sleep deprived, with 44% of them getting no more than 6 hours of sleep [14] highlighting the problem that the majority of students are sleep deprived which ultimately affects their academic performance. Additionally, numerous studies show that psychological health problems particularly depression and social anxiety are prevalent among college students [5-8, 11] and that mental health has an impact on sleep quality, duration and regularity [15] because of the continual strain of the academic workload, peer pressure, a lack of free time and parental expectations that their children perform well in school [16, 17]. Furthermore, one study found that stress and sleep have a bidirectional relationship in which they influence each other [18]. According to a statistic from an association in America that focusses on both anxiety and depression, 80% of US students feel stressed while some of them are frequently stressed throughout their lifetime with 34% suffering from depression [19]. Meanwhile, 54.4% of adults reported stress and excessive nervousness as factor in their sleep problems [20]. Therefore, students with mental health conditions are affected by sleep problems such as daytime sleepiness, night-time awakenings and difficulty falling asleep [21, 22]. These mental health problems affect students' ability to sleep well which is a grave problem for the general health of U.S. students and whether they get enough quality sleep daily to regenerate their health. Lastly, the physical, mental and psychological elements of an individual are related to their quality of life [23]. However, poor habits and ways of life can lead to serious issues for an individual but not limited to obesity, diabetes, hypertension, anxiety and depression [24]. Chronic diseases would negatively impact the school performance of students. According to a study by the American College Health Association in 2022, 35% of students were diagnosed with anxiety in their college years while 27% were affected by depression [25]. Furthermore, 23% of those who experienced depression said that depression had an adverse impact on their academic performance [25]. Students who experienced mental health issues have been found to have declining grade point average results and many of them dropped out of school [26]. A sense of failure and low self-esteem may emerge from receiving low scores since depressed individuals typically have negative attitudes about the world, themselves and the future [27]. Additionally, students with low self-esteem would be reluctant to take on difficult assignments and homework which would eventually have an impact on their academic achievement [27]. Therefore, more research on the effects of psychological health and unhealthy lifestyles on school performance are required to increase student awareness of this issue.

## 2. Literature Review

Students' academic performance is clearly expressed as an indicator of their success in the classroom and in the future since education can provide them with knowledge that will improve their understanding of life [1]. However, there are many factors that can affect academic performance and among them are proper sleep management and overall health. A

study revealed that around half of international university students only get six hours of sleep a day [14]. In addition, another study found that 50% of general students worldwide suffer from sleep problems while 62% of university students have poor sleep quality [14]. Furthermore, according to data from the American College Health Association (ACHA) for 2022, 77% of approximately 55,000 college students experience mental health issues [25]. These statistics show that students may face sleep and health problems that affect their academic performance. Many studies have examined how sleep affects students' academic performance, but few have examined the impact of health issues including stress, worry and depression. However, the mechanisms through which sleep quality impacts academic performance and general health are not yet fully understood. More research is required to explore the function of sleep quality as a mediator between general health outcomes and academic progress outcomes.

### *2.1. General Health and Academic Performance*

Physical health is a major part of a student's quality of life and could greatly impact their academic performance. Many students focus primarily on their school lessons and educational achievements and only a minority of students take the time to involve themselves in physical activities to maintain general health [23]. A study states that students are also forced into schools that require them to sit in one place for long hours where they are sedentary 70% of the time [28]. In addition, school management also increases the time students spend in school learning because they want to meet academic standards [29]. Students are more likely to have health problems including obesity, diabetes, and cardiovascular disease since many of them lead sedentary lifestyles and poor diets [23, 30]. Studies show that children who participate in physically demanding activities like sports for roughly five hours a week do better in subjects like science, maths and English [3]. Furthermore, their educational achievement was higher compared to those students who participated in physical activities for just 2 hours a week [3]. A study conducted among students showed that the relationship between general health and health-related quality of life showed that students who had a poor general health condition were also affected by depression which consequently contributed to their poor academic performance at school as they faced a difficult time learning and understanding lessons [23]. Another study that collected data from 4936 students from 40 different public schools indicated that physical activity and academic performance were not moderated by gender, race, ethnicity, the environment of physical activity or other school factors [29].

In the category of physical health, diabetes mellitus is also a factor that impacts students' academic performance. Type 1 diabetes mellitus is the most common type of endocrine imbalance problem that affects young people [31]. The academic performance of the students would be affected due to the immediate and lasting effects of the condition and the difficulty in maintaining their glucose levels at optimal levels on a daily basis. A study states that poor control of the glycemic level can cause hypoglycemia and keto-acidic effects that can affect student memory, attention, intelligence and motor skills consequently impacts their academic performance [31-33]. The study also concluded that poor academic grades of the students were significantly related to poor control of diabetes along with the longer period of the disease [32]. Students also tend to lose their concentration on their studies because they have a restricted time allocation for physical activities and study hours [34]. Furthermore, monitoring blood glucose levels, focusing on dietary intake and taking medications are among the reasons that can distract students from their education [34]. Furthermore, facing lots of difficulties with diabetes would take a toll on student mental health and their mental ability to focus on class [34].

In addition to physical health, aspects of psychological health issues such as depressive disorders, anxiety disorders, and intense pressure can also lead to unsatisfactory academic progress in students. Mental health refers to an individual's stability in emotional, social and psychological elements. College students who are unable to manage their stress levels adequately may miss class, do poorly on tests and in many cases, drop out [26]. Students who have stable mental health have an increase in self-efficacy which means they are more confident in themselves. This also increases their educational achievement [26]. Anxiety and depression are two major factors that can negatively influence a student's academic progress. Possible consequences of these two are behavioural problems, illegal substance use, increased body weight, poor social interactions etc. [2]. Depression can cause students to experience unstable mood changes, a lack of cognitive skills and energy deprivation. Additionally, anxiety and sadness impede students' capacity to comprehend courses and do proficiently on tests by adversely affecting their memory and focus [35]. Anxiety-related symptoms in students include overthinking, putting off tasks, being afraid of things, etc. which hinder their academic performance. According to the Norwegian SHoT study, students who experienced mental health problems were twice as likely to perform poorly academically as their classmates who did not have such problems [35]. In addition, another study conducted among Canadian students revealed that mental health issues, psychological health and depression were related to poor academic grades [36]. However, the study stated that apart from other mental health problems, only anxiety had the opposite result in which students who had higher anxiety levels scored higher grades in language-related subjects [36]. A different study found that inadequate sleep quality could lead to anxiety, depression and stress which negatively impact academic performance. However, students with good-quality sleep tend to perform better academically [23].

### *2.2. General Health and Sleep*

The relationship between sleep quality and overall health has been extensively investigated. According to some studies, individuals with poor mental health have a much higher chance of developing sleep disorders that can affect the quality of their sleep [15, 22, 37]. A study involving 7630 students from various universities was conducted to inspect the association between mental health and sleep disorders by analyzing the collected data. The result of the study revealed that different mental health issues affect specific aspects of sleep where anxiety symptoms lead to increased sleep disturbances and greater use of sleeping pills. On the other hand, depression symptoms led to more severe consequences from daytime

impairment. ADHD-related symptoms were associated with a reduction in sleep quality and an increase in the frequency of sleep disturbances but there was a difference in the frequency of daytime dysfunction [15]. This study is consistent with previous research suggesting that children with various psychological problems experience distinct sleep problems [22]. However, most studies focus on psychological health disorders especially mood disorders and use the PSQI scale to assess sleep quality [15, 22, 37, 38]. These psychological disorders are more prevalent and thoroughly researched. Individuals who do not have these disorders may still experience poor mental states such as feelings of helplessness, self-doubt and worthlessness which may affect their sleep quality [39]. Therefore, more in-depth research is needed to examine the relationship between less common psychological health disorders and sleep quality.

Consequently, there is also a relationship between physiological health and sleep quality. Some studies have shown that the relationship between the two is bidirectional which is in line with a study showing the mutual influence of physical health and sleep in adolescents [40]. When adolescents engage in more moderate to vigorous physical activity (MVPA) than their typical level, they tend to fall asleep earlier, sleep longer and experience better sleep quality. On the other hand, when they engage in more sedentary activities than their usual routine, they experience delayed sleep onset and offset, shorter sleep duration but better sleep quality. A group of 67 female students participated in an eight-week study wherein they were split into two groups: the experimental group which did three hours of aerobic activity each week and the control group. The findings of the study indicate that the experimental group achieves better sleep quality measured by PSQI than the control group. In this study, the significant effect of aerobic exercise is only recorded after 4 weeks of intervention and it states that the intensity of the exercise should be moderate rather than mild to increase its positive significance for sleep quality [41]. According to research, moderate exercise is more effective than vigorous exercise in improving sleep quality across a range of age groups [42]. However, two other studies find that there is only a slight positive relationship between intense physical exercise and sleep among university students and healthy children, respectively [43, 44]. These studies suggest that it is important to examine the impact of exercise intensity on the relationship between health and sleep quality, however, physical activity and exercise are positively correlated with sleep quality.

*2.3. Sleep and Academic Performance*

Numerous studies have shown a significant relationship between sleep and academic achievement making it a crucial aspect. Previous research has established that sleep is a key determinant of academic performance because it affects the consolidation of memory and cognitive functions including human attention and memory which are both crucial for effective learning [5-8, 45]. Sleep quality is frequently used as a predictor of academic performance using the Pittsburgh Sleep Quality Index (PSQI) to provide statistics on sleep quality. Several studies have shown that the predominant issue among students especially health students is inadequate sleep which results in lower academic performance but some studies have contradictory results. For example, a study revealed that poor sleep quality leads to an adverse effect on the educational achievement of medical students [46] while other studies conducted a cross-sectional study to conclude that low-quality sleep and daytime impairment are common occurrences among students who study medicine and are associated with poor academic outcomes [45, 47]. However, the reason for the conflicting results is that multiple studies have found no significant relationship between the quality of sleep and academic achievement in healthcare students [6, 48, 49]. These studies suggest that future research should consider measures to investigate the effect of sleep quality on educational achievement as it may not be the only determining factor.

In addition, students often struggle to get high-quality sleep due to sudden changes in their lifestyle and development after enrolling in new schools. These events affect their quality and duration. Several studies support the idea that sufficient sleep is also important to ensure that students are alert and motivated the next day as a lack of sleep will cause poor attention, fatigue and daytime sleepiness leading to worse academic performance [5, 10, 13]. For example, a study uses the effect of chronic sleep deficits on the average grade point average (GPA) and the graduation rate to show the relationship between sleep deficits and educational achievement in college students [13]. The study concludes that inadequate rest shows significance with a lower GPA and a lower chance of graduation for students drawing attention to the impact of sleep deprivation on college students during their final year as opposed to their first year is more significant in terms of their chances of graduating from college. Furthermore, another study shows healthy children around 10 years of age who receive 39 minutes less sleep seven days in a row face a challenge in doing well in school and lower well-being [50]. On the other hand, a study reveals that among medical students, sleep quality and daytime dysfunctionality have a significant association with academic performance but there is no such relationship with sleep duration [51] while another study shows that sleep duration only affects the mental health of pharmaceutical students and not their academic performance [49]. According to this issue, the majority of research supports the starting time of classes in schools which can increase the sleep duration of students and reduce excessive daytime fatigue among students thus promoting educational achievement and highlighting the significance of increasing sleeping hours to perform better academically [52-55]. However, some studies show that there is no relationship between classes timing and academic performance [56, 57]. These studies show that sleep duration has less significance for academic performance especially among medical students due to the inconsistency of the results which suggests further research on this topic [5, 58, 59]. Several studies have been conducted and their results show that sleep regularity and academic performance correlate positively [5, 58-60]. For example, a study shows that students with a consistent sleep schedule have a greater chance of getting higher marks in their examinations which improves the positive correlation between sleep consistency and educational performance [61]. According to another study, a systematic review of 72 observational studies has been conducted and shows a significant connection between sleep consistency and educational achievement among students [58]. This study states that students who delay sleep during the weekends have lower academic performance than those who delay sleep during the weekdays

and the timing of sleep is highly correlated with lower academic performance [58]. Furthermore, a study linked sleep quality, duration and consistency together and concluded that the relationship of all three sleep elements with academic performance is significant [5]. The study shows that both sleep quality ($r = 0.38$, $p < 0.00005$) and duration ($r = 0.44$, $p < 0.0005$) have a positive relationship with academic performance while sleep consistency ($r = -0.36$, $p < 0.001$) correlates negatively correlated with academic performance using Pearson's product correlation. The study also used wearable activity trackers that collect objective data on the sleep measures of 100 college students including their current academic performance and demographic information (age and sex) which are analysed using statistical methods. In general, the data show that females performed better than males in academic performance. However, when controlling for sleep quality, there was no significant difference between the sexes. Furthermore, the study found that sleep inconsistency is negatively associated with academic performance in men but not in females indicating that males should avoid irregular sleep schedules to excel in academics.

*2.4. General Health, Sleep and Academic Performance*

There is little research on sleep's mediation on general health and academic performance. For example, a study in Saudi Arabia analysed data collected from questionnaires made by 206 students using statistical methods to investigate the influence of poor sleep quality on mental health and academic performance among medical students. The results show that poor sleep habits increase the risk of mental health problems among students [62]. The results of this study agree with other studies [6, 48, 49] but focus mainly on the effects of sleep among medical students. Another study also shows that there is a relationship between the difference in sleep from weekdays to weekends and obesity as well as depression and academic performance [58]. This study includes bedtime, wake-up time, the midpoint of sleep and sleep duration to investigate this relationship and highlights that Asian children are more prone to being overweight due to sleep differences between weekdays. In addition, another type of study linked general health, sleep and academic performance by using the efficiency of sleep and the duration of sleep as the mediator in the relationship between physical activity and cognitive abilities. The study includes mediation analyses to test the indirect effect of physical activity on cognitive abilities while taking into account age, sex and education and concludes that sleep efficiency played a role in mediating this non-significant relationship [63]. Other similar studies investigate the relationship between physical activity and ADHD symptoms and cognitive-related task performance in children with ADHD and show partial mediation of sleep latency between physical activity and two of the aspects of executive function (working memory and cognitive function) [64]. This suggests that there are various ways to look at the relationship between general health, sleep and educational achievement but the majority of studies focus on the influence of sleep on mental health and educational achievement. Therefore, it is a necessity to explore how sleep mediates the relationship between general health and educational achievement among students (see Figure 1).

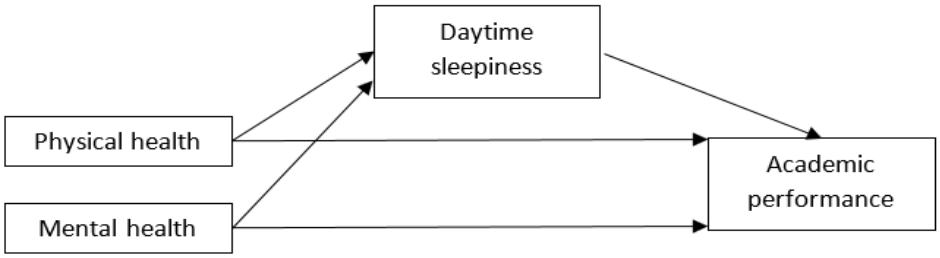


**Figure 1.**
Conceptual framework for the relationship between physical health, mental health, daytime sleepiness and academic performance

Hypotheses are developed based on the conceptual framework in Figure 1 and are shown as follows:
*$H_1$: Physical health correlates significantly with academic performance.*
*$H_2$: Daytime sleepiness mediates the relationship between physical health and academic performance.*
*$H_3$: Mental health is significantly negatively related to academic performance.*
*$H_4$: Daytime sleepiness mediates the relationship between mental health and academic performance.*

## 3. Research Methodology

The Inter-University Consortium for Political and Social Research (ISPSR) is a consortium consisting of 750 academic institutions and research centres where social science researchers are trained in data access, curation and analytical methods. ICPSR manages over 250,000 research data files related to the social and behavioural sciences. This study uses a data set from ICPSR 21600, the National Longitudinal Study of Adolescent to Adult Health (1994 - 2018). Wave I (1994-1995) collected data from more than 90,000 students through questionnaires and interviews. Data was collected on various topics such as social and demographic aspects, the level of education and occupation, health status etc. Wave II data collection was from April to August 1996 when it was collected from 15,000 participants from the previous wave I. The questions were more related to nutrition and sun exposure. Wave III data were gathered from August 2001 to April 2002. Information was collected from 15,170 participants in wave I through in-home interviews. Wave III questions were details about their family, relationships, history of education, civic engagement, religious and spiritual beliefs, etc. Next, we have wave IV from 2008 and 2009 which gathered information through in-home interviews with wave I respondents. The survey

questions included social, economic and health aspects, financial status, diet habits, medical complications etc. Lastly, wave V was conducted in 2016 and 2018 where the data was related to the social, environmental, economic and health situations of the respondents [54].

This study used a single dataset from the senior participants specifically DS 8 demographic data and DS 16 education data which were merged and cleaned using SPSS. The data set consisted of 200 variables and 3000 cases with 32 variables confirmed and a total of 3517 cases. Among these variables, 24 belonged to the health category and the remaining 8 belonged to the education category. The merged data set was cleaned using the process described in Figure 2 adapting the methodology of Ting, et al. [65] which involved removing any missing data in cases with more than 10 variables and removing the variable with over 30% missing data. The handling of missing data varied across variables is adapting from Ting, et al.'s [65] process such as substituting the missing values of the GPA variable with the mean value or replacing missing values with "0" if the variable indicated non-adoption [65].

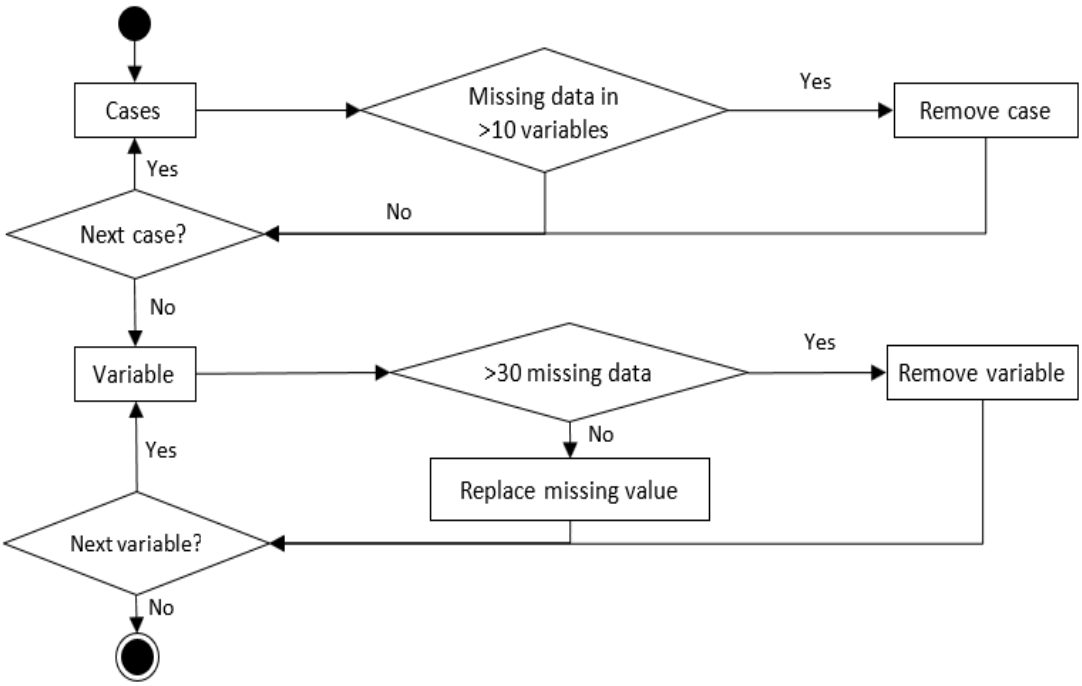


**Figure 2.**
The transformation process flow.

Twenty-seven study-related variables are chosen, combined and divided into four primary variables based on the cleaned dataset. Variables are labelled as physical health, mental health, daytime sleepiness and academic performance (see Table 1).

**Table 1.**
Variables selected for this study.

| Category | Variable ID | Questionnaire question or item |
|---|---|---|
| Physical health | H3GH1 | In general, how is your health? |
| | H3GH20 | In the last month, have you taken any vitamins or minerals? |
| | H3HS6 | Has there been a time in the past 12 months when you thought you should get medical attention but did not? |
| | H3ID7 | Does your health limit you in any of these activities? If so, are you limited a little or a lot? |
| | H3ID10 | Does your health limit you in any of these activities? If so, are you limited a little or a lot? |
| | H3ID22 | Have you ever been diagnosed with high blood pressure or hypertension? |
| | H3ID27 | In the past five years, how many times have you been seen in an emergency room or emergency department? |
| | H3ID29 | In the last five years, how many times have you been admitted to the hospital for at least a one-night stay? |
| | H3ID40 | Do you have a problem with stuttering or stammering? |
| Mental health | H3SP5 | You were bothered by things that usually don't bother you during the past seven days? |
| | H3SP6 | In the last seven days, despite the support of your friends and family, you were unable to overcome your sadness. |

| Category | Variable ID | Questionnaire question or item |
|---|---|---|
| | H3SP7 | You felt as good as other people during the last seven days. |
| | H3SP8 | You had trouble keeping your mind on what you were doing during the past seven days. |
| | H3SP9 | You have been depressed for the past seven days. |
| | H3SP10 | You were too tired to do things during the last seven days. |
| | H3SP13 | You felt that people disliked you during the past seven days. |
| | H3SP15 | Do you agree or disagree that you have often said something bad about a friend behind his or her back? |
| | H3SP17 | Do you agree or disagree that you go out of your way to avoid having to deal with problems in your life? |
| | H3SP18 | Do you agree or disagree that when making a decision, you go with your "gut feeling" and don't think much about the consequences of each alternative? |
| | H3SP24 | Do you agree or disagree that you live your life without much thought of the future? |
| Daytime sleepiness | H3GH1 | In the past seven days, how often did you fall asleep when you should have been awake (for example, during class or at work)? |
| Academic performance | EAMGPAC | GPA of maths courses taken each year (EAMGPA1-6) and cumulatively (EAMGPAC). |
| | EASGPAC | GPA of science courses taken in each year (EASGPA1-6) and cumulatively (EASGPAC). |
| | EAOFIXC | Proportion of all courses that students failed in each year (EAOFIX1-6) and cumulatively (EAOFIXC). |
| | EAMFIXC | Proportion of maths courses that students failed in each year (EAMFIX1-6) and cumulatively (EAMFIXC). |
| | EASFIXC | Proportion of science courses that students failed in each year (EASFIX1-6) and cumulatively (EASFIXC). |
| | EAOFIXC | Proportion of all courses that students failed in each year (EAOFIX1-6) and cumulatively (EAOFIXC). |

IBM SPSS 24.0 is used in the preliminary analysis of Pearson correlation followed by Macro Process 4.0 in the mediation analysis. The setting of the mediation analysis is 5000 bootstraps for indirect effects. Non-zero confidence intervals indicate a significant indirect effect. Various mediation models including: 1. Full mediation (when there are significant direct and indirect effects between independent and dependent variables). 2. Partial mediation (significant indirect effect between independent and dependent variables). Furthermore, descriptive statistics between measures are calculated while SPSS bivariate analysis (Pearson correlation) was used to investigate the relationship between the variables.

## 4. Results

### *4.1. Preliminary Analysis*

Descriptive statistics and correlations between measures are reported in Table 2. The results show that only mental health is significantly negatively correlated with academic performance ($r = -0.152$, $p < 0.001$) while physical health ($r = 0.225$, $p < 0.001$) significantly positively correlated with academic performance. Therefore, the results of this study support hypotheses H1 and H3.

**Table 2.**
Scale means, standard deviations and correlations (N = 3517).

| Variables | M | SD | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|---|
| AP | 2.38 | 0.77 | - | | | | |
| DS | 0.21 | 0.48 | -0.054*** | - | | | |
| PH | 4.28 | 0.47 | 0.225*** | -0.139*** | - | | |
| MH | 0.46 | 0.42 | -0.152*** | 0.237*** | -0.317*** | - | |

**Note:** AP = Academic performance; DS = Daytime sleepiness; PH = Physical health; MH = Mental health. *** $p < 0.001$.

### *4.2. Mediation Analyses*

The results show that daytime sleepiness did not mediate the relationship between physical health and academic performance (indirect effect = 0.0055, 95% CI = [-0.0014, 0.0132]) or the relationship between mental health and academic performance (indirect effect = 0.0004, 95% CI = [-0.0165, 0.0169]). Therefore, these results did not support hypotheses H2 and H4.

**Table 3**.
Unstandardized direct and indirect effects with a bootstrap 95% confidence interval for mediation analyses.

| Predictor | Mediator | Dependent variable | Direct effect | Indirect effect (95% CI) |
|---|---|---|---|---|
| PH | DS | AP | 0.3575*** | 0.0055 (-0.0014, 0.0132) |
| MH | DS | AP | -0.5186*** | 0.0004 (-0.0165, 0.0169) |

**Note:** PH = Physical health; MH = Mental health; DS = Daytime sleepiness; AP = Academic performance. Results based on 5000 bootstrap samples; CI: Bias-corrected 95% confidence interval for indirect effects. *** $p < 0.001$.

## 5. Discussion

The significance level of physical health is shown to be significant and therefore hypothesis H1 is accepted based on Table 2 because physical health is found to affect the academic performance of students. Physical health in this context refers to physical activities, health issues and the intake of medications that can greatly affect the quality of life which subsequently causes their grades to drop. The result of this study is different from a study that indicates that there is no significant relationship between moderate to vigorous physical activity (MVPA) and educational achievement regardless of gender, ethnicity, physical activity environment and socioeconomic status [29]. The difference in the result could be due to the study only focusing on the physical activity and not taking into account their physical activities. However, other studies that specifically focused on the relationship between type 1 diabetes and academic performance show that the academic performance of students was significantly affected by the disease [32-34]. The results of this study imply that schools and parents should take proactive steps to encourage students to participate in physical activities frequently without affecting their academics. This could prevent students from being physically ill, reduce their stress levels and improve their academic performance significantly.

Based on Table 3, the significance level for the mediating effect of daytime sleepiness on physical health and academic performance is not significant and therefore H2 is rejected. This could be due to inconsistencies in the measurements of the variables of physical health and sleep. The result is different from previous studies both showing the mediation effect of sleep in the relationship between physical activity and cognitive functions [63, 64]. According to one study, the mediation effects of various sleep effects on physical activity and each cognitive domain differ. Only sleep efficiency, not sleep time is a significant mediator between physical activity and the majority of cognitive domains [63]. However, there are many aspects of sleep and inconsistency in measuring and difficulty in determining each sleep aspect leads to inconsistent results in different studies. In addition, physical activity or exercise is more commonly used to study its association with sleep and academic performance than other physical health indicators such as diabetes, high blood pressure, diet and supplement intake. This suggests studying the impact of physical health aspects on sleep and academic performance.

The significance level for mental health is proven to be significant and therefore H3 is accepted based on Table 2 because the mental health of students can impact their educational achievements. Students with mental health problems such as depression, anxiety, stress may not to feel as motivated to complete their homework and attend classes which contribute to their poor academic grades. The finding of this study was consistent with that of a study among adolescents, 13-19 years old that showed that anxiety and depression affected educational achievement [2]. Similarly, studies conducted in Pakistan, the UAE and Norway showed the same results as those of this study showing that an increase in mental health issues decreases the academic performance of students [26, 27], [35]. Although the studies agree with the results of this study, most of the studies collected data on math grades and other language grades only unlike this study which focuses on math, science, the CGPA overall failure index, etc. More studies should be conducted to assess the relationship between mental health and various aspects of academic performance as mentioned above. School management can take preventative measures by organizing mental health campaigns and encouraging students to consult with their school counsellors to discuss the mental issues they are facing and find a potential solution.

Since the significance level for the mediating effect of daytime sleepiness on mental health and academic performance is not significant as shown in Table 3 therefore, H4 is rejected. This might be due to inconsistencies in the measurements of mental health and sleep variables. However, there are few studies showing the mediation effect of mental health problems in the relationship between sleep and academic performance as most of the studies focus on the relationship of sleep with mental health conditions and academic performance. However, it is important to note that most existing studies have focused on examining the direct relationship between sleep, mental health and academic performance [15, 60]. In addition, the aspects of mental health used in studies do not include unfamiliar psychological problems such as pessimism, autism and anorexia. Each study usually focuses on a single aspect of mental health such as anxiety, depression or life satisfaction [66] and may not capture the full range of mental health problems that could affect academic performance. This suggests further research on the indirect effect of a wider range of mental health conditions on academic performance and by doing so, a more comprehensive understanding of the complex relationship between sleep, mental health and academic performance could be gained leading to the development of more targeted interventions to improve academic outcomes.

## 6. Conclusion

The study focused on the relationship of general health, physical health and mental health with academic performance in students and how sleep mediates this relationship. The study results suggest that general health is a mandatory indicator in determining the outcome of academic performance as it impacts sleep quality which in turn affects the outcomes of educational progress. It is clear that maintaining good health particularly in terms of physical condition and mental well-being is essential to achieve academic achievement. However, unhealthy habits related to diet, sleep and electronic usage can cause minor health issues that accumulate over time leading to more severe conditions that can directly negatively

impact academic performance. Therefore, universities are suggested to provide external resources and support to help students develop positive study habits and mindsets that prioritize their health and well-being. Students can enhance their academic performance and achieve their full potential.

The main contribution of this study is to provide insight to policymakers, teachers and researchers regarding the theory of academic performance covariates. The covariates are further analysed in terms of mediation effects. Mediation analysis is important for answering more meaningful and nuanced questions that extend beyond the simple Pearson correlation. Some variables may not be directly related to an outcome. However, mediation analysis might include these variables as predictors.

The study has limitations as it relied only on one aspect of sleep which is daytime sleepiness, to assess the influence of the mediator, sleep on the relationship between general health and academic performance. This could restrict the applicability of the study findings as the influence of sleep on educational achievement may be more intricate and diverse than what can be measured by this single aspect. Therefore, future research could benefit from employing a more comprehensive evaluation of sleep considering various aspects of sleep quality and quantity to gain a better insight into its role in academic performance. Furthermore, the study did not consider other variables that could affect educational achievements such as socioeconomic status, previous academic achievements or participation in extracurricular activities. Therefore, it is challenging to establish the level to which general health and sleep impact academic performance as opposed to other unmeasured factors.

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